RESEARCH REPORT

1. Name: Mohamed AbuAli （ID No.: SP08001）

2. Current affiliation: University of Cincinnati, OH

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: OMRON Keihanna Innovation Center

5. Host researcher: Dr. Hiroshi Nakajima

6. Description of your current research

Increasing energy costs, significant compliance and regulatory pressures, and the need to effectively correlate maintenance activities with energy consumption; are three major needs for Omron facilities today. An effective Precision Energy Management System (PEMS) can adopt advanced technologies to remedy such issues and fulfill the goal of enhancing energy performance for Omron's products, processes, and plants. Over the long-term, such a system is expected be an integral part of energy and maintenance cost reduction, increased product and process quality, and an enhanced market share adoption for the Omron Corporation.

The vision for this project is related to three major players (3 Ps):

- PRODUCT: the PEMS must be able to define, measure, analyze, and predict energy consumption per product manufactured, in such a way that each product process line can have an "Energy Label" that resembles the amount of energy consumed in manufacturing this product.
- PROCESS: the PEMS must be able to use the developed energy metrics and parameters for detailed operational analytics. In other words, the PEMS will assess both equipment level and process-level degradation and integrity. Such a correlation between maintenance activities on the shop floor and energy consumed through the machines and processes is an essential part of the PEMS initiative and is a large gap in today's industry

operations.

- PLANT: the PEMS will enable a strategic IT-centric evolution for Omron by considering energy framework for effective KAIZEN development and implementation.

7. Research implementation and results under the program

Title of your research plan:

Application of Prognostic Algorithms in Energy Management Systems

Description of the research activities:

Energy Management Systems (EMS) are systems used by operators in industry to monitor, evaluate, and control the performance of different energy-consuming elements such as motors, pumps, compressors, and HVAC. The relationship between maintenance and energy management cannot be overlooked and thus maintenance is an integral part of an energy management program in all facilities.

The goal of this project is to research the applicability of prognostic (predictive) tools and algorithms in the field of energy management in order to formulate technical strategies for energy savings and conservation. To fulfill this goal, the following objectives will be met within an allotted time frame:

- Defining an industrial energy system, its key components, and capabilities.
- Collecting representative data for energy-related variables within the energy system using appropriate sensing hardware and software tools.
- Analyzing energy data using prognostic (predictive) algorithms to investigate energy efficiency and performance levels of the energy management system (EMS), as well as correlate energy performance to machine health and behavior.
- Researching and proposing an effective monitoring and analysis methodology for improved energy efficiency and reduced energy use within the energy management system.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Jenica M. Allen
（ID No.: SP08002 ）

2. Current affiliation: University of Connecticut (Storrs, CT, USA)

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Forestry and Forest Products Research Institute (Formal), Utsunomiya University

5. Host researcher: Dr. Nobuyuki Tanaka (FFPRI), Dr. Takayoshi Nishio (Utsunomiya University), Dr. Tatsuhiro Ohkubo (Utsunomiya University)

6. Description of your current research

Biological invasions have become increasingly common over the last century and pose a serious threat to the biodiversity and functioning of native ecosystems. Since many species invasions are the direct result of human movement around the globe, it is imperitive that we determine how to best predict the spatial distribution of newly introduced, potentially invasive species and identify mechanisms that allow for introduced species to become problematic. My research focuses on understanding the drivers of invasive plant distrubutions, building predictive statistical models of potentially invasvie species, and identifying mechanisms that allow introduced plants to become problematic in their new range.

My current project is a multi-scale deterministic and mechanistic study of invasive plant distributions and herbivory in their native and invasive ranges. A common problem in predicting potential distributions of newly introduced species is the lack of species distribution data in the new region. In this case, we must rely on the ecological data from the native range to predict distributions in the new range, but there are potential shifts in the ecological requirements of each species due to the many filters a new, potentially invasive species must endure (e.g., transport, abiotic conditions in the recipient area, and limitations in genetic diversity). The magnitude and prevalence of such ecological niche shifts has not been well quantified in the literature and my study attempts to assess these shifts for a suite of invasive species for which distributional and ecological data are available in both ranges. Based on the findngs of this study, the predictive power and appropriateness of current modeling techniques for newly indroduced species can be assessed.

The second component of my study is assessing the impact of herbivory on invasive plant success at multiple spatial scales. In the literature, lower herbivore loads have been documented on invasive plant species in their invasive range as compared to the native range. However, when comparisons are made within the invasive range between invasive plants and plant species native to that region, no clear reductions in herbivore

load on the invasive relative to the native plants are observed. To date, studies on the same plant species comparing herbivore loads at both scales (across ranges and within the invasive range) are quite rare, but are important for resolving apparent spatial contradiction in herbivory. My study is designed to compare herbivore loads at both the biogeographic and community scales for a suite of invasive plant species, thereby contributing to our mechanistic understanding of invasive plant success.

Such synthetic approaches require study of abiotic and biotic interactions at the local, community, and regional scales in both ranges in order to accurately identify invasion drivers. For example, processes that appear important at the community scale, such as competition, may not be as important at the regional level and beyond and biogeographic patterns, such as reduced herbivore loads in the invasive range, may not scale-down to community level changes in plant abundances. Trans-continental comparisons are also vital because it is not clear that the relative influence of different biotic interactions (e.g., competition, herbivory) and abiotic conditions will be similar in the native and invasive range at the same spatial scale. My research addresses all of these components to provide holistic knowledge that can be used for both preventing future and managing current plant invasions.

7. Research implementation and results under the program

Title of your research plan: New England Invasive Plant Species in Their Native Range: Distributions and Natural Enemies

Description of the research activities:

The goal of my research during the JSPS Summer Fellowship Program was two-fold. First, I wanted to assess, in wild plant populations, the prevalence of insect herbivory and herbivore functional groups on a suite of plants invasive in the northeast United States and native in Japan. Second, I planned to develop native range statistical species distribution models for the same suite of species using a vegetation database covering all of Japan administered by the Forestry and Forest Products Research Institute (FFPRI). I spent approximately one month working on each respective aspect of my project, with field work based out of the Weed Science Center and the Department of Forest Science at Utsunomiya University and modeling work based at the FFPRI in Tsukuba.

The first aspect of my project required insect and leaf collections from wild plant populations and required close collaboration with my host researchers, Dr. Takayoshi Nishio and Dr. Tatsuhiro Ohkubo, and their lab members to locate populations of my target plant species: *Berberis thunbergii* (Japanese barberry), *Celastrus orbiculatus* (Oriental bittersweet), *and Euonymus alatus* (burning bush). At each sampling site, I conducted exhaustive insect collections on up to 10 individuals of each target plant species and collected a minimum of 10 randomly sampled leaves per target plant. Complete branches were collected and stored individually in the lab in an attempt to rear larvae of insects that reside inside the leaves, such as leaf miners, and any caterpillars found. Since the habitat for each target plant species is different, sampling was often conducted in different areas for each target species, though effort was made to locate sampling locales with multiple suitable habitats within minimal distance. Ultimatly, the sample size for each site was dictated by the number of

available individuals of the target plant species and ranged between 1 and 10 per site. A minimum of three sites per species were sampled, with final sample sizes of 31, 27, and 21 individuals from 6, 4, and 3 sites for *B. thunbergii*, *C. orbiculatus*, and *E. alatus*, respectively. All sampled individuals are geographically referenced for mapping purposes.

Leaves were mounted on standard backgrounds and digitally scanned upon return to the laborotory for subsequent image analysis of herbivore damage and insects were stored for later identification. Leaf miner rearing was successful in most cases and specimens were collected and stored daily as adults emerged. The field sampling and specimen processing portion of the project consumed all of the time allocated to my stay in Utsunomiya, so insect identifications and leaf image analysis will be conducted in the coming months, in addition to equivalent insect and leaf collections in the northeast United States for comparison.

The second aspect of the project, species distribution modeling at the FFPRI using their Phytosociological Relevé Database (PRDB) database, required comprehensive discussions about database development, the details of the data compiled in the database, and important limitations to the modeling approach based on available data for the native and invasive regions of the focal species. I had completed some work on the modeling protocols and data preparation prior to arriving in Japan based on my communication with my host, Dr. Noboyuki Tanaka. However, a large amount of the data preparation, utilizing R and ArcMap software, had to be completed once I was provided with the georefferenced PRDB data due to the importance of spatial association in species distribution modeling. The modeling aproach used was a hierarchical Bayesian model that incorporated a normal conditional autoregressive (CAR) model to quantify spatial random effects. Sixteen fixed factor covariates at three spatial scales were selected among nearly 50 available covariates for analysis. Models were implemented using OpenBUGS 3.0.3 software. Due to the computational complexity of such models, model runs extended over 2-3 days allowing good, but slow-paced progress. One complete run for each of four focal species (*B. thunbergii, C. orbiculatus, E. alatus*, and *Rosa multiflora*) has been completed and model revisions based on the analysis of the preliminary results are underway. Additional model runs and any subsequent revisions will be conducted during the fall semester. Dr. Tanaka and I have agreed on a work plan and necessary steps in continued model assessment and development so that we can more easily contunue our collaboration on this project after my departure.

In sum, both aspects of my research program are ongoing, but my time in Japan was essential for the project to occur. I have developed strong working relationships at two different research institutions and have plans to continue collaboration with my hosts to complete both research objectives. In addition, I have identified several additional collaborative projects with each lab that may be pursued upon completion of this research.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Kyle Anderson （ID No.: SP08003 ）

2. Current affiliation: Stanford University

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Earthquake Research Institute, University of Tokyo

5. Host researcher: Prof. Minoru Takeo

6. Description of your current research

My research focuses on the geophysics of effusive (non-explosive) silicic volcanism – in particular, the ground deformation associated with the ascent of magma to the surface during volcanic eruptions. The fact that magmatic processes can deform the surface of the ground has been well demonstrated, but the exact nature by which this occurs is poorly understood. Indeed, while some eruptions may occur with a baffling near-total lack of ground deformation (Mount St. Helens, 2004), other eruptions may generate huge deformations on the order of many meters, visibly displacing roads and houses (Mount Usu, 2000). Obtaining a better understanding of these processes is of vital importance so that volcanologists may better understand and predict volcanic eruptions and protect human life and property.

The goal of my research is to better understand the link between magmatic processes and ground deformation, and to use real-world deformation data to better understand specific volcanic eruptions. To date, my research has followed two tracks: 1) numerical modeling of an evolving effusive eruption involving the ascent of magma from a deflating magma chamber through a conduit to the surface, and the resulting ground deformation, and 2) processing and modeling ground tilt data from the 2004-2008 eruption of Mount St. Helens, Washington, USA. My work in Japan during the summer of 2008 extends my research to the eruption of Mount Usu, Japan, in 2000.

7. Research implementation and results under the program

Title of your research plan: Remarkable Ground Deformation Associated with Magma Emplacement at Usu Volcano, Japan

Description of the research activities:

Usu Volcano is one of the most active and well-monitored volcanoes in Japan, and the 2000 eruption was captured with a variety of instruments and techniques including GPS, leveling, EDM (electronic distance measurement), synthetic aperture radar, photogrammetry, airborne laser altimetry, and theodolite. This data is not maintained in a single, publicly-accessible database, but is rather distributed across various research institutes, universities, and government agencies in Japan. Prof. Yosuke Aoki at ERI spent considerable time and effort during my visit tracking down data and obtaining permissions for its use. He was able to obtain EDM, theodolite, photogrammetry, and some GPS data.

Over the course of the summer, I examined this data and spent time learning GPS processing techniques and processing GPS data using the GIPSY software package. GIPSY is very powerful but far from user-friendly, and many features are poorly documented. Additionally, different techniques are required for processing single-channel vs. dual-channel data, and for processing high-rate data (I worked mostly on data with a 30-second sampling interval). Therefore while it took only a few days to obtain a rudimentary understanding of the code and to begin to process GPS data (in a simple way), a much greater amount of time was required to become more proficient with the software and to process data in a more sophisticated manner. Indeed, analysis of the best ways to process GPS data is an active research field, with considerable effort being put into understanding and removing such noise effects as multipath and atmospheric distortion. I was fortunate that Dr. Hiroshi Munekane of Japan's Geographical Survey Institute was kind enough to visit ERI to assist me with these sorts of issues, and to share some of his recent work.

I also spent time this summer examining other types of deformation data at Usu (EDM, etc.), and preparing a digital-elevation model for use in later finite-element modeling. I was also fortunate to be able to visit Asama volcano and the Asama Volcano Observatory with Profs. Takeo and Aoki for a short period of fieldwork. This was a great chance for me to learn more about current research at the volcano

and see how one of Japan's volcano observatories operates.

Of course the summer research experience ended far too early, as it probably does for most participants. My research goals proved too ambitious for a single summer, and it proved impossible to learn the necessary data processing techniques, process the data, and develop models all in a single summer. My work was slowed by the time required to obtain access to the necessary data from a variety of sources all over Japan (indeed, the arrival of some important GPS data is still pending). However, the summer was a success as I made a good start on the project and learned a great deal. I certainly plan to continue this work after my return to the United States, in collaboration with my new colleagues at ERI.

8. Please add your comments (if any):

Working at ERI for the summer was a great experience, both intellectually and culturally. I hope to have the opportunity to work in Japan again in the future.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: CHRISTOPHER ARIYARATANA （ID No.: SP08004）

2. Current affiliation: UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: TOKYO INSTITUTE OF TECHNOLOGY

5. Host researcher: DR. AKIRA WADA

6. Description of your current research

My current research activities are focused on computational studies of BRBFs that are part of a dual structural system. In short, buckling-restrained braces (BRB) are steel braces encased in concrete such that buckling under axial compression is prevented. As a result, BRBs exhibit excellent cyclic response and develop significant energy dissipation under seismic loading. Open System for Earthquake Engineering Simulation (OpenSEES) is used as the software framework for my current research. OpenSEES is the simulation component of the NSF-funded George E. Brown Jr. Network for Earthquake Engineering Simulation (NEES) that focuses on the response of structural systems subjected to seismic loading. Using the models that I develop, my nonlinear dynamic analyses will focus on the investigation of a typical BRBF-MRF dual system and its ability to control excessive story drift, residual story drift, and large floor accelerations, all of which are considered shortcomings of the singular BRBF system. A comprehensive comparison will be made to the singular BRBF system using a probabilistic framework that quantifies a frame's ability to withstand collapse under different earthquake intensities. Although the conclusions formulated will provide closure through the development of guidelines for the practical implementation of methods to improve BRBF system performance, this research will also act as a precursor to an innovative topic in earthquake engineering that I intend to investigate next: rocking structural systems. In doing so, I will use the knowledge and skills gained researching BRBFs, energy dissipation, and structural response reduction.

7. Research implementation and results under the program

Title of your research plan:

Computational Analysis of a Wood Rocking Frame Under Seismic Loading

Description of the research activities:

Under the guidance of Dr. Wada and Dr. Kishiki, Wada Laboratory conducted several experimental tests of a wooden rocking frame. The specimens were not connected to their respective foundations, thus, uplift occurred under high lateral loads. The frame is also used in conjunction with post-tensioned steel. Viscous dampers are also under consideration. The combination of such mechanisms is intended to mitigate the damage that would be sustained to a typical wood frame house due to earthquakes.

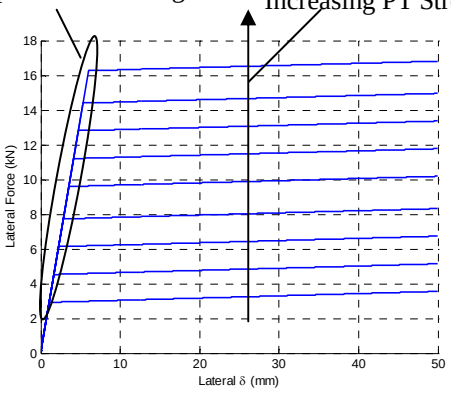
Four specimens were tested at Wada Laboratory. All specimens were 3m x 1m in dimension; however, each frame had its own distinct structural configuration to provide varying lateral stiffness. The first frame used standard wooden X-cross bracing, the second used wooden X-bracing reinforced with steel plates, the third used just a wooden panel, and the final specimen used wood X-bracing with the wooden panel. Cyclic loads and static pushover analyses were performed on each one to test their respective lateral capacity and failure modes. It was found that their ultimate load capacity increased as the rigidity of the frame increased. Various failure modes were also observed under extreme drifts and they include brace buckling and excessive deformation at the connections.

Part of my responsibilities at the Tokyo Institute of Technology included the computational modeling of one of the wood rocking frame specimens. OpenSEES was used to model the frame. It is a dynamic analysis software package developed at UC Berkeley and is the official computational tool of the Network for Earthquake Engineering Simulation (NEES) in the US. For adequate use of the model, it was first required to confirm that OpenSEES was able to simulate uplift at the base of the frame. It was expected that OpenSEES would encounter various numerical instabilities while modeling a frame that lacked a stable connection to its own foundation. Thus, various modeling assumptions were made and calibration techniques had to be performed. For example, semi-rigid connections between the beam and columns were modeled as fully pinned in OpenSEES while the bracing was also made fully pinned. The actual uplift of the frame from its support

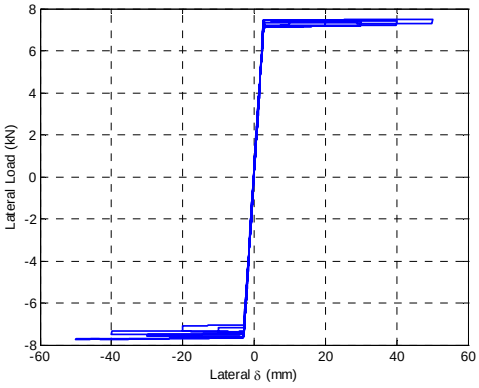
condition caused many numerical convergence issues with OpenSEES. To model this, elements with special material properties were used. Under tensile stress, the element was designed to be nearly infinitely flexible thus allowing uplift of the frame with no resistance. Under compressive stress, the material would be very stiff thus simulating the rigid foundation of the structure. The post-tensioning steel was modeled as a very flexible material with an initial load to simulate its initial post-tensioning stress. After the completion of the model, a series of parametric studies and load configurations were performed on the model to form a comprehensive view of the frame's behavior.

Uplift behavior begins

Increasing PT Stress



Cyclic tests reveal that the frame can remain relatively damage free



The use of OpenSEES in conjunction with Wada Laboratory's extensive experimental testing can help conclusively assert the effectiveness of structural rocking as a seismic hazard mitigation tool.

8. Please add your comments (if any):

In addition to the static analysis at the Tokyo Institute of Technology, Tokyu Corporation provided the use of their shake table for real time dynamic testing of the wood rocking frames. They will be subjected to a sine wave function of varying frequency. Testing will take place on August 27, 2008 and continue until September. I will be able to join the first test.

Finally, I would like to thank Dr. Wada, Dr. Kishiki, Ms. Onoguchi, and Wada Laboratory for inviting me to join their work and for all of their hospitality during my stay in Japan.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Justin Atchison （ID No.: SP08005 ）

2. Current affiliation: Cornell University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry **X** Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Japanese Aerospace eXploration Agency

5. Host researcher: Dr. Junichiro Kawaguchi

6. Description of your current research

I'm studying fuel-free propulsion opportunities for spacecraft. Specifically, I'm interested in exploring how solar pressure and electrostatic propulsion scale with the size of a spacecraft. My results suggest that there is a unique opportunity for in-space propellantless propulsion at extremely small scales. If the traditional components of a spacecraft are integrated and fabricated onto a single silicon wafer, we may be able to produce an inexpensive swarm of sensing spacecraft capable of traversing the solar system with very large lifetimes.

7. Research implementation and results under the program

Title of your research plan:

Trajectory Design of the Post-Hinode Solar Observation Mission

Description of the research activities:

This summer, through the JSPS and NSF fellowship, I studied orbital maneuvers for a potential solar observation mission under Dr. Kawaguchi of the Japanese Aerospace eXploration Agency. My goal was to find a low fuel trajectory which would place a spacecraft into a near-circular orbit which would pass over the sun's poles. I evaluated the use of gravity assists at both Jupiter and Earth in order to both tilt the orbit and reduce its energy. Using the proposed launch date of 2015 to 2020, I produced a large set of solutions which enable a mission designer to quickly evaluate potential final orbits. The problem was computationally challenging, requiring extensive use of orbit propagators, solvers for Lambert's problem, and analysis of the 3D gravity assist geometry. In particular, analysis of the multiple gravity assist trajectories required use of a nonlinear least-squares optimization routine to find solutions which united each boundary condition. Within the valid solution set, I found that a Jupiter gravity assist followed by a powered (Δv = -3 km/s) Earth gravity assist can produce a near-circular (eccentricity of 0.35) polar orbit (inclination of 88^o) with a period of only two years. This orbit seems to best support the science payload by offering frequent pole-passage, synchronicity with Earth's orbit, and a relatively constant thermal environment.

8. Please add your comments (if any):

I sincerely thank both JSPS and NSF for this incredible opportunity. Over the past eight weeks, I have grown a great deal both professionally and personally. I greatly appreciate the generosity of these organizations and the hard work of so many people required to produce this phenomenal experience.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Robert Charles Augustine （ID No.: SP08006）

2. Current affiliation: University of Massachusetts at Amherst

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Basic Biology

5. Host researcher: Dr. Mitsuyasu Hasebe

6. Description of your current research

The moss *Physcomitrella patens* is emerging as an excellent model plant system due to a unique array of intrinsic molecular genetic and cell biological tools. To gain widespread use among researchers, it will be important to address fundamental cellular questions. In particular, the spatiotemporal distribution of calcium and protons in moss cells has not been studied. Regulation of ion levels is important in nearly all aspects of biology from the biochemical control of individual proteins to the modulation of signal transduction pathways.

At the National Institute for Basic Biology, I utilized green fluorescent protein derivatives to image the spatiotemporal distribution of both calcium and protons during polarized cell growth and transdifferentiation, a process in which one cell type differentiates into another. This information is important to test existing models and develop new hypotheses about plant growth and differentiation. In particular, this work will impact my graduate research, which has focused on understanding the significance of regulatory mechanisms that control actin depolymerizing factor - an essential moss protein regulated directly by protons and indirectly by calcium.

7. Research implementation and results under the program

Title of your research plan:

Subcellular Localization of Calcium and Protons in Tip-Growing and Transdifferentiating Cells of the Moss *Physcomitrella patens*

Description of the research activities:

My research activities have focused primarily on the imaging of protons in the filamentous, apical cells of the moss *Physcomitrella patens*. The goal of this research is to determine whether pH-gradients are present in growing moss cells. I used a confocal microscope system to image stable, transgenic moss lines expressing a green fluorescent protein (GFP) derivative that is useful for determining intracellular proton concentrations. Collection of the emitted light intensity after excitation at a pH-dependent wavelength (488 nm) and a pH-independent wavelength (440 nm) of light is necessary to perform the analysis. In the absence of a 440 nm laser, I performed these experiments with a 405 nm wavelength, which is useful for acquiring qualitative data. The preliminary results from this experiment suggest that pH-gradients are present in moss. Most strinklingly, the nuclear region has a higher pH compared with the rest of the cell. I also performed timelapse imaging to test if there are temporal component to the pH-gradients, however I did not observe any obvious patterns.

More recently, I discovered that the National Institute for Basic Biology has a microscopy facility equipped with a 440 nm wavelength laser which is useful for acquiring both qualitative and quantitative measurements of pH gradients. However, preliminary analysis using data collected with the 440 nm wavelength laser does not suggest the existence of a higher pH in the nuclear region. Therefore, further analyses and experimentation will be necessary to determine whether pH-gradients are present in moss.

In another set of experiments, I investigated the spatiotemporal distribution of calcium gradients by imaging moss lines stably expressing Aequorin-GFP. This fusion protein emits light in the presence of calcium and a cofactor called coelenterazine. The imaging requires extremely sensitive cameras and no signal was detectable in initial experiments. Subsequently, I tested a variety of conditions and determined that incubation times of at least 4 hours in coelenterazine are required to obtain a signal. I am now poised to begin collecting data for this experiment when I return to my laboratory in the United States.

8. Please add your comments (if any):

I am very fortunate that my stay in Japan coincided with a week long workshop conducted by my host laboratory. The workshop was designed to teach cellular and molecular biological techniques using the moss *Physcomitrella patens*. Many of the techniques that I learned will be fundamental for my graduate research as well as the overall success of my research advisor in the United States. Of particular importance was learning how to stimulate sexual reproduction, which will be critical for crossing transgenic lines. Furthermore, the workshop gave me the opportunity to meet many friendly and knowledgeable researchers from Japan and throughout the world.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Amanda V. Bakian （ID No.: SP08007 ）

2. Current affiliation: Ecology Center and Department of Biology, Utah State University, Logan, Utah, USA 84103

3. Research fields and specialties: (Statistical Ecology)

Humanities Social Sciences **X**Mathematical and Physical Sciences
Chemistry Engineering Sciences **X**Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Center for Ecology Research, Kyoto University

5. Host researcher: Dr. Takayuki Ohgushi

6. Description of your current research:

My current research spans multiple areas as a result of my graduate research assistantship with Utah State University's ADVANCE grant and my concurrent work on two graduate degrees: a Masters in Statistics and a Doctorate in Ecology. My MS thesis research involves developing matrix population models to predict the future demographic gender composition of Utah State University's Science and Engineering faculty based on demographic parameters including new hire rates, promotion rates, and attrition rates. Through ADVANCE, a National Science Foundation initiative focused on the promotion and retainment of women scientists, I am conducting research investigating whether the under-representation of professional women scientists can be partially attributed to differences in the graduate school and post-doctoral experiences of men and women. For my doctoral dissertation research, I am interested in understanding how individual birds respond to a heterogeneous landscape through their selection of food and breeding resources. More specifically, I have collected radio telemetry data in a population of Willow Flycatchers, *Empidonax traillii* adastus, to examine differences in diet and foraging strategies between male and female flycatchers. Diet analysis also involves quantifying the use of terrestrial and aquatic insects by Willow flycatchers during the breeding season in order to obtain a sense of the influence of landscape and ecosystem level processes on individual and population level dynamics. Finally, through the development of a new statistical approach to analyzing animal space use and resource

selection, I hope to further develop my ecometric skills.

7. Research implementation and results under the program

Title of your research plan:

Structural network properties of plant-mediated indirect interaction webs

Description of the research activities:

Plant mediated indirect (herbivore-induced changes in plant traits impacting herbivore population and community dynamics) and direct effects influence both plant-herbivore and higher trophic level communities through bottom-up cascades. Network analyses have recently identified structural properties common among different types of networks including ecological communities. The identification of universal network architecture among ecological communities suggests the existence of shared ecological and evolutionary processes responsible for producing common patterns. Food webs depicting direct predator/prey relationships are the typical approach to investigating ecological communities. The structural analysis, however, of ecological community webs lacking indirect interactions such as food webs, is shortsighted due to the incompleteness inherent in their web structure. My EAPSI research marks the first effort to statistically analyze the network structure of an ecological community web inclusive of both direct and indirect interactions.

Dr. Ohgushi and some of his laboratory members at the Center for Ecological Research at Kyoto University investigate the influence of plant-mediated indirect effects on plant/herbivore community structure and function. They have been generous in providing me data with which to conduct this analysis. Specifically, I have examined the statistical network properties of a goldenrod/herbivore community at various temporal stages. The first step in the analysis was to convert an indirect interaction web into a two dimensional graph in which species are treated as nodes and interactions (both direct and indirect) are considered the links between nodes (see figure 1). Next, network metrics including connectance (the proportion of possible links between species that are realized), average degree (average number of interactions/species), average path length (average number of links connecting two species), and clustering coefficient (the average fraction of pairs of species one link away from a species that are also linked to each other) were quantified. The final step in the analysis involved fitting the cumulative distribution of nodal degrees (degree distribution: the probability of observing *k* interactions/species) to various statistical

distributions including the power-law, truncated power-law, exponential and log-normal distributions (figure 2). Preliminary results from this analysis indicate that multiple statistical distributions including the power-law and exponential distributions fit the goldenrod/herbivore degree distributions. Data collection for constructing indirect interaction webs is logistically challenging, and hence the indirect interaction webs developed thus far are small; the good fit of multiple statistical distributions to the degree distribution is a relic of scant sample sizes.

Following the initial analysis of real webs (e.g. goldenrod/herbivore webs), an attempt to understand the mechanistic processes responsible for ecological community structure was made through a computer simulation exercise in which numerous community webs were constructed using different basic rule sets. The resulting webs were analyzed for their topological structure following the procedures outlined above.

It is clear that investigating the network topology of indirect interaction webs is important for understanding ecological community structure and function. This area of essential research is presently in its infancy stages but has great potential in uncovering mechanisms responsible for shaping ecological communities.

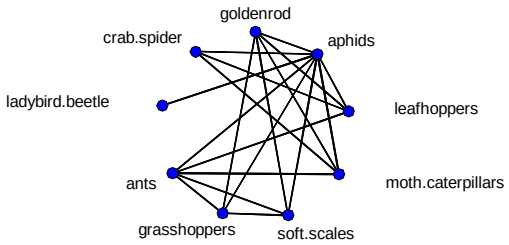


Figure 1. Goldenrod/herbivore indirect interaction web.

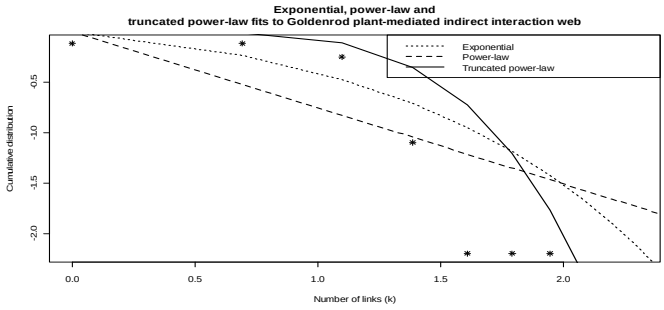


Figure 2. Fit of goldenrod/herbivore indirect interaction web to three statistical distributions: exponential, power-law and truncated power-law.

RESEARCH REPORT

1. Name: Peter Barry (ID No.: SP08008)

2. Current affiliation: Scripps Institution of Oceanography

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: The University of Tokyo – Ocean Research Institute

5. Host researcher: Dr. Yuji Sano

6. Description of your current research

Ocean basalts afford a unique means to tackle large-scale geological problems associated with the geochemical history of the Earth. They enable us to geochemically access the mantle and through chemical and isotopic analyses have provided fundamental constraints on the properties of, and interactions between, the mantle-crust-atmosphere system. For example, problems associated with the mantle's chemical and isotopic heterogeneity, the long-term isolation of different mantle reservoirs, and the degree and means of interaction between these reservoirs have been tackled through geochemical studies of ocean basalts [Craig and Lupton, (1976); Hauri et al. (1994)].

My studies on ocean basalts have focused on their volatile characteristics (CO_2, nitrogen and noble gases) which when sampled by ocean basalts have yielded insights into the formation of the Earth's early atmosphere, the subsequent degassing history of the solid Earth and the extraction and formation of continental crust [Fanale (1971); Staudacher and Allegre (1982); O'Nions and Oxburgh (1988)]. However, relatively little is known about the mantle characteristics of the most abundant volatile in the Earth's atmosphere – nitrogen. My studies this summer focused on measuring nitrogen isotopes and abundances of basaltic glasses to better understand nitrogen characteristics in the mantle.

Nitrogen is the most abundant volatile in the Earth's atmosphere. Identifying its origin and evolution is intimately tied to understanding: (a) the volatile composition of the silicate Earth at the time of accretion, (b) the subsequent degassing history of the mantle, and (c) the nature of recycling between the atmosphere, sediments and the mantle [Allegre et al. (1986/87); Exley et al. (1986/87); Fischer et al. (2002); Sano et al. (1998)]. Each of these topics necessitates information on the isotopic characteristics of nitrogen in the present-day mantle. Constraining the N-isotope systematics of the mantle contributes to a number of related themes of broad geochemical interest, such as the nature and scale of mantle reservoirs, their degree of interaction and their intrinsic heterogeneities. Nitrogen isotopes offer an opportunity to test, from a geochemical and volatiles perspective, the scale of mantle convection and the extent of recycling of surface material into the mantle.

The utility of nitrogen is based on its distinct isotopic composition in various terrestrial reservoirs. The nitrogen isotopic composition of the upper mantle, as sampled at mid-ocean ridges, is estimated to be ~ -4 to -5‰ [Javoy et al. (1986); Marty and Zimmerman (1999)] (Air is the standard and 0.0‰), although this range could extend to values as low as –12‰ [Mohapatra and Murty (2004)]. In contrast, the deep mantle, as sampled in the Kola magmatic province, Iceland, Loihi Seamount, Hawaii and the Society Islands is enriched in $\delta^{15}N$ by up to +8‰ [Marty and Dauphas (2003)]. Organic sediments on the ocean floor are enriched in $\delta^{15}N$ with $\delta^{15}N$ values from +5 to +7 ‰ [Peters et al. (1978); Kienast (2000)]. Therefore, the large contrast in isotopic composition between the upper (depleted), deep (plume) mantle and the surface reservoir gives nitrogen great potential as a tracer of volatile recycling between the Earth's exterior and internal reservoirs.

Given the isotopic contrasts in terrestrial nitrogen, a number of studies have exploited nitrogen as a tracer for surficial recycling into the mantle [Zimmer et al. (2004); Sano et al. (1998); Sano et al. (2001)]. This is not only important for understanding volatile systematics at subduction zones but is also relevant to 'deep recycling' and the origin of mantle plumes [Hilton et al. (2002)]. Surprisingly, however, there are still relatively few N-abundance or isotopic composition data of ocean basalts which have been influenced by hotspot activity.

7. Research implementation and results under the program

This summer I investigated the nitrogen systematics of basaltic glasses collected along the Central Indian Ridge (CIR) – a region with helium isotope ratios ranging from typical mid ocean ridge basalt (MORB) values of ~8 R_A to hotspot values ~11 R_A. A total of 21 samples from the CIR were analyzed for nitrogen isotopes and abundances showing an overall negative correlation with helium isotopes. This negative correlation suggests that the source of the helium-3 enrichment may be depleted in $\delta^{15}N$ and runs counter to conventional models linking helium and nitrogen isotope systematics. The glasses analyzed varied between 2 ‰ and -6 ‰ with respect to $\delta^{15}N$. The implications of the study will not be fully realized until nitrogen data are combined with a complete noble gas (He-Ne-Ar) and volatile (CO_2) data set for the CIR sample suite. This study has greatly expanded the N-isotope database for the CIR and shed new light on the link between plume related volcanism and volatile heterogeneities while providing new and useful insight into mantle mixing processes.

In addition to the CIR samples, 15 basaltic glass samples from Iceland and the Reykjanes Ridge were analyzed. The combined study of Iceland, a hotspot region marked by very high helium isotope rations (~ 17 R_A) and the adjacent Reykjanes Ridge, a submarine mid ocean ridge extending to the south-west of Iceland, provide a similar means to study the interaction between MORB-type and plume-type (hotspot) magmatism. Unlike the samples from the CIR these samples show a distinct positive correlation between $\delta^{15}N$ and helium isotopes suggesting a much different mantle evolution and distinctly different source of plume type magma. The samples measured ranged from 6 ‰ and -7 ‰ with respect to $\delta^{15}N$. Both data sets are of great geochemical interest and potentially publishable.

Title of your research plan:

Nitrogen isotope study of Central Indian Ridge ocean basalts.

Description of the research activities:

My research this summer was heavily laboratory oriented. The purpose of my visit was to use the Micromass 3600 mass spectrometer to make precise nitrogen isotopic measurements on basaltic glasses. Samples were collected prior to my visit and brought to the University of Tokyo's Ocean Research Institute (ORI) for the analysis. After familiarizing myself with the equipment and undergoing an intensive training period I was successfully able to measure 36 samples during the course of the summer.

8. Please add your comments (if any):

I am extremely grateful for the privilege to participate in such a wonderful program. The experience of working in a foreign laboratory and the unique opportunity to collaborate with some of the leading scientists in the field of geochemistry has been a real honor for me. I hope that the relationships established through my EAPSI experience will have a fruitful future.

9. Advisor's remarks (if any):

Mr. Peter Barry has visited our laboratory for 8 weeks during the summer in 2008 and performed nitrogen isotopic determinations of volatiles extracted from basalt glass samples in the Indian Ocean. He has worked hard and observed data that are very important in the field of isotope geochemistry. So we are very happy and appreciate your program.
Best, Yuji

RESEARCH REPORT

1. Name: Michael J. Bendewald (ID No.: SP08009)

2. Current affiliation: University of Colorado at Boulder, USA

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of the Ryukyus

5. Host researcher: Dr. Jun-ichiro Tsutsumi

6. Description of your current research

Since the first green building rating system was introduced in 1990 in the United Kingdom, more than twenty methods of assessment have emerged around the world. First introduced in 1997, the United States rating system known as LEED (Leadership in Energy and Environmental Design) has become a prominent international tool for building designers, owners, and other project stakeholders. In 2002, the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was set forth as the Japanese green building rating system. While similar to LEED in many respects, preliminary research has revealed CASBEE may significantly differ regarding ongoing assessment. LEED-certified buildings require a one-time building commissioning, or the assessment of environmental management systems within a building, just a year after construction. The CASBEE manual, on the other hand, suggests that ongoing assessment is required. Since the functionality of buildings can degrade significantly after a year—at the cost of occupant comfort as well as the ecosystem—it is more appropriate for building sustainability assessments to include ongoing assessment. At the University of the Ryukyus, I plan to work closely with my host researcher to interview building designers and operators of CASBEE-certified buildings. Using this information I hope to understand how ongoing assessment functions in the context of Japan, and how this type of assessment could exist in LEED in the context of the United States.

7. Research implementation and results under the program

Title of your research plan:
Investigation of Ongoing Assessment of Building Sustainability in Japan

Description of the research activities:

Prof. Tsutsumi connected me to numerous professionals in the field of building administration and assessment. I was able to make case studies of three separate government buildings in Okinawa. (I have the opportunity for a case study of a non-governmental building in Japan after the end of the Summer Program.) Throughout the program my experiences were enriched by members of Prof. Tsutsumi's international lab group hailing from Ethiopia, Russia, China, and of course Japan. Different members of this group would accompany Prof. and I on the case studies. Prof. Tsutsumi would translate during the tours.

The first case study was of Itoman City Hall, a CASBEE-certified building. We watched an informative video (English subtitles) on the building concept, including the role it plays in the mitigation of global warming and its integration of traditional Okinawan and modern design. This was followed by a tour of the building that highlighted the major sustainable design strategies, including a public display of building energy use and greenhouse gas emissions.

The following case study was of a prefectural administration building in Naha. This building was recently the subject of an energy-efficiency project being implemented by the national government, known as ESCO (Energy Service Company). We heard a presentation by government employees on the project and asked questions. The project is of a type that originated in the US that involves a technical design firm, the building owner, and a funding third party (in this case, the government). We accessed both the roof and basement to see the new, more energy-efficient aspects of the air conditioning system.

The final case study was made of unique administrative buildings in the new city center (*shintoshin*) of Naha. This branch of the government includes the

environmental assessment of buildings in Okinawa. Like the Itoman City Hall, traditional Okinawa building design is employed. Inside the building is a public space where a touch screen informs users of any and all sustainable design strategies used in the building. In addition to a tour, we had a conversation with government employees who were implementing the environmental assessment of government buildings. We discussed the methods they use, including a brief overview of the use history.

The objective of my research was to better understand the role of CASBEE in Japan and, a more focused inquiry, to understand how CASBEE encourages building commissioning. Ideally, a framework in CASBEE would be revealed for application to LEED in the US. Unfortunately my case studies in Okinawa were not sufficient to answer my focused question; however, I expect to know more the day after the program ends when I meet with a CASBEE professional in Tokyo. I came away from my case studies with two major conclusions:

1) CASBEE is required for all government buildings but there is an apparent lack of public outreach (e.g., no plaques on the entrances of buildings).
2) Ongoing assessment of buildings is promoted by the government via the ESCO project (a profit driven-mechanism toward greater equipment efficiency), not as a way to a higher score in CASBEE (a value-driven mechanism toward a more comprehensive maintenance/upgrade of building systems).

In addition to the above research I presented my work to Prof. Tsutsumi's lab group and accompanied the group on a major experiment. I also gave a modified presentation to high school students at Okinawa Shogaku Junior and Senior High School in Naha.

8. Please add your comments (if any):

I've really enjoyed spending time with fellow researchers from around the world. Through the Summer Program I was able to make meaningful professional contacts in Japan and Ethiopia.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Broox G.V. Boze （ID No.: SP08010）

2. Current affiliation: Colorado State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University Primate Research Institute

5. Host researcher: Dr. Michael A. Huffman and Dr. Alex D. Hernandez

6. Description of your current research:

Examples of parasite-induced behavioral changes in intermediate hosts range across most major host taxa. However, parasite transmission patterns and behavioral modification are often overlooked in foraging studies. Altered behavior of prey by parasites is an extremely important factor in transmission because it can affect the abundance and encounter rate between predator and prey. This study evaluates the physical and behavioral differences in infected and uninfected beetles by looking at environmental preference for shelter, substrate color, and rate of dung processing.

My work focuses on behavioral modification of a coprophagous beetle by a nematode parasite. The parasite transmission cycle of focus involves a nematode worm (*Streptopharagus pigmentatus*), intermediate host coprophagous beetles (*Onthophagus lenzii* and *Geotrupes laevistriatus*) and primary primate host (*Macaca fuscata yakui*). Adult *S. pigmentatus* inhabit the host intestine and depend on coprophagous beetles such as *O. lenzii, O. atripennis, O. ater, and Aphodius mizo* to complete their life cycle (Gotoh, 2000). While *Macaca fuscata* are host to a variety of nematode parasites, *S. pigmentatus* is the most common. *Streptopharagus pigmentatus* eggs shed with primate feces and are consumed by the arthropod where nematode larva encyst in the beetle hemoceol and are transmitted to the primate when consumed.

Dung beetles are the intermediate host for many parasites and serve specific environmental functions, without which ecosystems are threatened. They enrich soil and help plants regenerate through fecal movement (Stockstad, 2004). Most coprophagous beetles eat specific or limited feces types so diversity of beetle species and an understanding of their ecology and life history is important to ecosystem health.

7. Research implementation and results under the program

Title of your research plan:

Behavioral Responses of a Coprophagous Beetle to a Nematode Parasite

Description of the research activities:

During my stay Japan and collaboration with Dr. Michael Huffman, I have used the majority of my time to collect and experiment with two wild beetle species populations on the island of Yakushima in Southern Japan. I tested individual beetles for behavioral preference of shelter versus no shelter and black versus white substrate. In addition, I measured size and the amount of dung that was processed by beetles in a forty-eight hour period. After experiments were run beetles were preserved and later dissected to determine the presence and intensity of infection by the nematode parasite *S. pigmentatus*.

It was previously thought that these beetles were a nocturnal species. However, after several weeks of observation it became obvious that some individuals are active during the daylight hours and others are active at night. My data show that individuals active during day light hours are much smaller (between 2-4 mm in length) than those active at night (between 7-9 mm in length). In addition, we found that both the intensity and abundance of infection were greater in beetles active during the day. The reasons for increased intensity and abundance of worms in currently unknown. However, it may be possible that beetles active during the day encounter primate feces sooner than those active at night and that the eggs of *Streptopharagus pigmentatus* are more viable immediately after excretion. Alternatively it could be that the presence of the parasite is causing a shift in the beetles circadian rhythm which would increase the encounter rate between predator and prey and aid in the completion of the worms lifecycle. At this time these explanations are speculative and more work needs to be done in this area.

Parasites can modify the behavior of their host in many ways. This study looked at only three of the many behaviors that are likely to change with parasite presence. The most striking finding from this study was that *Onthophagus* beetles infected with *Streptopharagus* larvae consume significantly less feces (0.01926 $\pm$ 0.00144 grams versus 0.02469 $\pm$ 0.00131 grams) in a forty-eight hour period than their

non-infected counter parts. Dung beetles play an important part in the forest ecosystem by processing feces of larger animals and it is clear that the infected beetles are less efficient at completing this task. Once again, the reasons and ramifications of this behavioral change are not yet understood. Infection did not affect the beetle's preference for black versus white substrate, nor did it affect their shelter seeking behavior.

The results of this small field project indicate that behavioral modification does take place in this system. Modification of host behavior by parasites can occur in a multitude of ways and out study has revealed many more questions that need to be answered about how these changes in behavior affect the health of their beetle intermediate host, their final hosts, and the Yakushima ecosystem in which they all live.

8. Please add your comments (if any):

This program has really helped opened my eyes to the international scientific community. In addition to learning a lot about the beetle ecosystem on Yakushima Island I had the wonderful opportunity to explore Japanese culture through interaction with other students and visits to various shrines and temples throughout the country. Thank you NSF and JSPS for a wonderful experience.

9. Advisor's remarks (if any):

This is my first time to host a JSPS Summer Program junior researcher and have found it a very rewarding experience. Ms. Boze was a very energetic, highly motivated individual. She conducted herself with the utmost courtesy and respect here in Japan and I think has been able to contribute greatly to our on-going project on Yakushima with her study design integrating well into the overall focus of our research. I am sure that her experience will be beneficial for her career development and enforce Japan – US scientific exchange and interactions as a member of the next generation of international science professionals.

RESEARCH REPORT

1. Name：MICHAEL BRADY （ID No.: SP08011 ）

2. Current affiliation: INDIANA UNIVERSITY

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
X Interdisciplinary and Frontier Sciences

4. Host institution: ATR

5. Host researcher: PROFESSOR NICK CAMPBELL

6. Description of your current research

Articulatory speech synthesis and artificial speech recognition. I use a mechanical vocal tract in conjunction with an artificial neural network to address speech as a problem of robotic motor planning and control. The robot learns by listening to itself babble and then by listening to and working to reproduce simplistic speech-like patterns. The major innovation I pursue in terms of the network is the inclusion of a spectral timing model. The model helps to encode timing relationships in speech patterns. Transforming timing information into spatial activations is needed for both speech perception and production because speech sounds must relate to each other in working memory where sequential structure is abstracted. Japanese is a strategic language to work with in investigating speech timing because Japanese exhibits phonological distinctions based on segmental durations.

7. Research implementation and results under the program

Title of your research plan:

Research relating to robotic speech synthesis for Japanese

Description of the research activities:

Research was divided between two related areas (1) collecting and analyzing Japanese speech timing data, and (2) investigating non-verbal speech cues - specifically laughter and affect in vocal quality. Evaluating how and why laughter may be incorporated into a robotic speech model became of particular interest.

For speech timing and analysis, a large corpus of Japanese speech samples collected and annotated by the Campbell lab provided a very powerful resource. The corpus was used to evaluate the predictive power of the spectral model. Results may have strong implications for the speech processing community and we have already accepted an invitation to present our findings at a prestigious workshop in Tokyo in September. Additionally, I ran a similarity rating experiment with native Japanese speakers using a battery of non-linguistic rhythmic vowel patterns to explore potential cross-linguistic timing perception. Preliminary results indicate that Japanese speakers hear similarity relationships between the test patterns in much the same way that native American English speakers do. This combined with other work may allow for the assumption that certain timing parameters of the model need not be language-specific and can be hard-coded.

Relevant and compelling non-verbal speech research mostly related to laughter analysis. I ran a study to investigate the perceptual influence of the gasp for air during laughter. Listeners were asked to rate the similarity of pairs of laughs recorded from a talker. Recordings systematically either included or did not include laughter gasps. Initial results indicate that the laughter gasp - even when artificially generated - correlates with higher levels of perceived social engagement. Results from this study will be presented at a workshop in Berlin next spring.

RESEARCH REPORT

1. Name: Brandon R. Briggs （ID No.: SP08012）

2. Current affiliation:

Oregon State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: JAMSTEC-Kochi

5. Host researcher: Dr. Fumio Inagaki

6. Description of your current research

Gas hydrates are a crystalline mineral composed of gas (mainly methane) surrounded by water. Hydrates form in cold, high-pressure sediments in arctic regions under permafrost, and on continental margins. An estimate of 500-2500 gigatons (GT) of methane carbon in hydrates has spurred several areas of research related to these geological features.

First, methane is known to be a potent greenhouse gas and accordingly, a release of methane from hydrates may play a role in global climate change. Second, with the depletion of traditional fossil fuels alternative or “non-conventional” fuels such as hydrates may be sought to address our energy needs. Some estimates suggest that there may be more than twice the energy present in methane hydrate than present in all other fossil fuels combined. Finally, seafloor stability may also be an issue with these formations. Gas hydrates are present in large masses on continental slopes. They are also easily affected by temperature perturbations. If a large amount was to dissociate the sediment could collapse, causing an underwater slide or slump. There is evidence of very large slides in locations rich in gas hydrates, however it is uncertain if the gas hydrate actually created the slide.

Methane produced by microorganisms is a significant fraction of the methane that occurs in marine sediments where hydrates are present and diverse communities populate these

formations. Recently, Inagaki et al. determined that a distinctive microbial community occurs in sediments that have methane hydrates. However, the factors that control the distribution of the microbial communities that influence the presence of methane in these sediments are not well understood. Our objective is to determine the quantity, diversity, and distribution of microbial communities in gas-rich marine sediments. Understanding the fine-scale distribution and factors that control the presence of sediment communities will provide better parameters for computational models that describe carbon cycling in these systems.

7. Research implementation and results under the program

Title of your research plan: Distribution of the Dominant Microbial Communities in Marine Sediments Containing High Concentrations of Methane Hydrate

Description of the research activities:

Deep sediment cores were collected as a part of the National Gas Hydrates Program (NGHP). Cores were collected from the Bay of Bengal off the coast of the Andaman Islands. This site is a convergent margin that contains gas hydrates in coarse-grained tephra layers, and is the deepest (~600 meters below seafloor (mbsf)) hydrate found thus far. Thirteen samples were collected for microbiological analysis, 8 of which contain hydrate.

Molecular analysis, cell counts, and cultivation techniques were used to characterize the microbial communities. Molecular analysis consisted of direct DNA extraction from sediment and subsequent quantitative polymerase chain reaction (qPCR), and clone libraries of bacterial and archaeal 16s rDNA and functional genes (accC, pmoA, cbbL, oorA, mxaF, and porA).

DNA extraction was performed using three different protocols. It was found that using the Mobio PowerMax Soil Kit produced the highest quantity of DNA. Subsequent analysis using qPCR on bacterial 16s rDNA showed that the extracted DNA was amplifiable. In addition, the comparison of bacterial and archaeal 16s

copy numbers indicated that this methane hydrate environment is dominated by bacteria.

Terminal Restriction length polymorphism (t-RFLP) was also performed on bacterial 16s rDNA. Many samples presented with the same electropherogram profile with 4-5 peaks. A clone library was created from 4 samples that differed in there t-RFLP profile. About 100 DNA sequences were obtained from each sample. Blasting the sequence against the NCBI database showed that a Bacillus species was dominant. In addition to sequencing 16s rDNA, functional genes were also sequenced. Only two samples contained amplifiable cbbL (RubisCo protein used in the Calvin-Benson cycle), while most samples contained oorA (oxoglutarate oxidoreductase enzyme used in reductive TCA cycle). This indicates that the dominant microbes are chemolithotrophs and not heterotrophs.

Bacillus species are capable of forming spores that are heat tolerant. Cultivation studies are being performed to determine if the Bacillus is present in the sample as a spore.

8. Please add your comments (if any):

Cultivation of microbes will be an ongoing experiment due to slow growth. I am looking forward to continuing this collaboration and others in the future.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Scott Broderick （ID No.: SP08013 ）

2. Current affiliation: Iowa State University

3. Research fields and specialties:

Humanities Social Sciences **X** Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Prof. Shuichi Iwata

6. Description of your current research

The computational branch of materials science has become increasingly important with the improved power of computers, making the calculations of complex quantum properties possible. The current research combines two important areas within computational materials science: first principles calculations and materials informatics. Materials informatics is a new and emerging field analogous to bio-informatics and drug discovery, addressing issues in data driven discovery in materials science. This work uses materials informatics to analyze the density of states (DOS) to extract the structural dependence and materials properties from the quantum structure. The objective of my work is to classify materials based solely on the DOS. In addition to containing materials properties the DOS also contains structural information. Therefore, the entire DOS curve provides an input for a data mining analysis that contains all properties and parameters at the electronic and atomic level. We use statistical learning techniques to augment more classical approaches to computational based design of materials by extracting the principal contributions which define the density of states. This work seeks to describe the relationship between crystal and electronic structure based on a quantitative interpretation of the density of states, while considering how capturing the principal contributions suggests future work in modeling the density of states using less computationally expensive data mining techniques

7. Research implementation and results under the program

Title of your research plan:

Structure Classification and Crystal Design Rules through Data Mining the Density of States

Description of the research activities:

The proposed goals of the research performed in Japan were to identify the ideal data to analyze with the developed methodology, calculate and collect the necessary data, identify which information should be extracted from the DOS, and to better understand the implications of the research from a condensed matter physics perspective. All of these goals have been adequately accomplished. The most critical result was the identification of how to use the developed methodology, which is based on data mining principles, as a design tool. This identification required numerous discussions with condensed matter physics experts.

An excellent candidate class of materials to apply the analysis to was determined to be oxides, such as ZrO_2, HfO_2, and others. This work can then be used to assess the electronic similarity between oxides to better analyze the electronic structure, and assess the impact due to changes in chemistry, structure, introduction of defects, or other such changes. Discussion with experts led to identification of how to appropriately perform the analysis and organize the data, and the developed approach can now become integrated with their existing research. Therefore, through the time in Japan, all of my objectives were met and my future research now has a clearer purpose and this time will greatly benefit me as I move forward in my research.

Additionally, time was spent visiting other laboratories and facilities throughout Japan. During each visit, discussions were carried out on the differences of research approaches between American and Japanese laboratories, as well as how the culture and background of each geographical area impacts the respective research process. Discussions and exchange of ideas has the potential to lead to numerous future collaborations, and many new ideas for future research directions have been created. This trip has proved fruitful not just based on meeting stated research objectives, but also in better understanding the research culture in Japan.

RESEARCH REPORT

1. Name: Bryan Brown （ID No.: SP08014）

2. Current affiliation: McGowan Institute for Regenerative Medicine – University of Pittsburgh

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Women's Medical University

5. Host researcher: Professor Masayuki Yamato

6. Description of your current research

The current research sought to utilize the cell sheet techniques developed by Professors Yamato and Okano of Tokyo Women's Hospital to create a three-layer sheet of airway chondrocytes, which would then be seeded onto an extracellular matrix (ECM) scaffold derived from either the urinary bladder or the trachea. The cell sheet/ECM scaffold composite construct was then evaluated to determine the attachment of the cell sheets to the ECM material and the feasibility of using cell sheet engineering to promote the formation of cartilaginous tissue in an ECM scaffold. In the future, this combined scaffold/cell sheet approach may provide an effective method by which to promote cartilaginous tissue formation in a tissue engineered graft to be used in long segment tracheal repair.

The hypothesis of the work was as follows: A three-layer airway chondrocyte cell sheet seeded onto an ECM scaffold derived from either the urinary bladder or the trachea will be capable of fully attaching to the scaffold, maintaining chondrocyte phenotype, and promoting the formation of cartilaginous tissue within the scaffold.

The goals of the research are three fold:

1. Learn the cell sheet technology including preparation of the thermoresponsive polymer, coating of the culture surface, and cell sheet culture techniques
2. Create three-layer chondrocyte cell sheet and characterize the maintenance of chondrocyte phenotype and the production of cartilage ECM constituents

3. Seed the chondrocyte sheet onto ECM scaffolds and characterize cell attachment, maintenance of chondrocyte phenotype and formation of cartilaginous tissue within the scaffold.

7. Research implementation and results under the program

Title of your research plan:
Development of Chondrocyte Cell Sheet Seeded ECM Scaffolds for Use in Tracheal Tissue Engineering

Description of the research activities:

The first two to three weeks of the research activities were spent working towards research goal #1. During this time the cell sheet technique was learned and cell culture techniques specific for rabbit tracheal chondrocytes were developed and optimized. This work was essential for the success of the following work and will be useful for continuing research upon return to Pittsburgh.

The following weeks activities were focused on achieving research goal #2. One and three layer sheets of rabbit tracheal chondrocytes were created using the techniques developed in the previous weeks and were subsequently evaluated with respect to the phenotype of the cells in the sheets and their production of cartilaginous ECM proteins. The results of this work indicate that the cells did appear to maintain a chondrocyte like phenotype during culture and were producing cartilaginous ECM molecules. This finding is important to the success of the research goal #3 and shows the efficacy of the technique for the culture of chondrocytes.

The remaining period of the research focused on research goal #3. A process for the seeding of the cell sheets onto the ECM scaffolds was developed and optimized. The results showed, interestingly, that the sheets did not appear to adhere or grow as well on the tracheal ECM as they did on the urinary bladder ECM. Therefore, the majority of the time was spent investigating the growth of one and three layer sheets on the urinary bladder ECM scaffolds. The results of the culture

on the urinary bladder scaffold showed good integration of both one and three layer sheets into the scaffold as well as continued maintenance of chondrocyte phenotype. With time the seeded cells also appeared to be depositing cartilaginous neo-matrix. It was found that the phenotype and growth characteristics of the cells grown in three layers were improved when compared with those grown in monolayer.

Overall, the results suggest that the techniques developed during the course of this work are effective in promoting the growth of cartilaginous tissue in an ECM scaffold and hold promise for future use in the development of a tissue engineered graft for long segment tracheal repair.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Jessica M. Budke （ID No.: SP08015）

2. Current affiliation: University of Connecticut, Department of Ecology and Evolutionary Biology, 75 N. Eagleville Rd. U-3043, Storrs, CT 06269-3043 USA

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Basic Biology, 38 Nishigounaka, Myo-daiji-cho, Okazaki 444-8585, Japan

5. Host researcher: Dr. Mitsuyasu Hasebe

6. Description of your current research

Mosses have a unique interaction between their sporophyte (2N=diploid) and gametophyte (1N=haploid) phases. During early stages of development, a sheath of gametophytic tissue, the calyptra, surrounds the unbranched sporophyte. Premature removal of the calyptra, has been shown to interfere with sporophyte development. Critical transitions in the dividing cells of sporophyte meristematic regions appear to be affected. This research will examine the calyptra-sporophyte interaction in relation to sporophyte meristems on a genetic level. Class 1 KNOX genes are involved in meristem maintenance in all major lineages of land plants. Using mutant lines of the moss Physcomitrella patens, the pattern of KNOX gene expression in the sporophytes will be compared between controls and manipulated samples that have had their calyptra removed. It is hypothesized that 1) KNOX gene expression will change, both in terms of location and intensity and 2) these effects will diminish as the sporophyte ages. This study represents a novel combination of manipulation experimentation and a gene expression study to explore the calyptra-sporophyte interaction in mosses. Results of this study will increase our knowledge of this unique developmental interaction and will contribute to a broader understanding of the calyptra's evolutionary influence on taxonomically important moss sporophyte features.

7. Research implementation and results under the program

Title of your research plan:

The gametophyte-sporophyte interaction in the moss *Physcomitrella patens*: effect of calyptra removal on KNOX gene expression in the sporophyte.

Description of the research activities:

During the second week at my host institution, I attended the 3rd International Practical Laboratory Course and Workshop on *Physcomitrella patens* held at the National Institute for Basic Biology (NIBB). During this workshop, I learned many critical molecular techniques that are used in Dr. Hasebe's laboratory. This included techniques for making moss mutants, staining for gene expression patterns, and stimulating sporophyte production. This workshop taught me techniques that I used during my summer research.

I carried out calyptra removal experiments on *Physcomitrella patens.* From these removals it was determined that the anchoring of the moss sporophyte foot into the gametophyte tissue occurs at the same time as the dehiscence of the calyptra. This presented a challenge to performing the calyptra removal experiments. When calyptrae were removed the sporophytes did not remain attached to the apex of the leafy gametophyte as anticipated. At this young stage of sporophyte development, the calyptrae appears to be critical for maintaining the connection between the gametophyte and sporophtye of *Physcomitrella patens*. I may explore this developmental timing of the foot anchoring and the calyptrae dehiscing in comparison with other moss species upon my return to the USA.

In addition to the KNOX mutants, I also experimented with another mutant (GH3:GUS) that enables staining and observation of the plant hormone auxin in the moss tissues. The sporophyte and calyptra were separated and stained independently to compare the patterns of hormone concentration between the two organs. A preliminary observation indicates, that the two organs have different auxin patterns. Thus they may be producing auxin independently. Additional examinations of auxin distributions may help to determine whether the developmental interaction between

the calyptrae and sporophyte has a hormonal component.

While in Japan my hosts and I corresponded with researchers at another institute to acquire a Japanese population of *Funaria hygrometrica* to use in my dissertation research. Additionally a variety of the new skills and techniques that I have learned in Japan will be applicable to the experiments and research that I am carrying out in my dissertation. Specifically I am planning to create GUS expression mutants of the moss *Funaria hygrometrica.* This species is in the same moss family as *Physcomitrella patens* but has a very different of sporophyte and calyptrae. Thus it is an ideal candidate for comparative studies. By using these techniques on a non-model organism moss we can gain a broader evolutionary perspective on the discoveries that have been made in *Physcomitrella patens.*

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: CharlesDavid Cash （ID No.: SP08016）

2. Current affiliation: Georgia Institute of Technology

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Ibaraki University

5. Host researcher: Prof. Kaoru KUROSAWA

6. Description of your current research

This project addresses fundamental questions related to the design of protocols for secure communication. This project follows the established paradigm of *provably secure cryptography*, that is, we use rigorous mathematical reasoning as a tool to design protocols that should resist any attack. This work is motivated by the need for increased theoretical understanding of security in general, and by the current state of protocol design, where we are forced to choose between high efficiency or high security. Protocols designed according to the provable security paradigm include all of the most common mechanisms for security on the Internet, and form the basis on which all sensitive data is exchanged online.

We investigate constructions of efficient and provably secure public-key encryption. Public-key encryption, perhaps the most widely used type of cryptography on the Internet, is an application which allows two users to communicate secretly in the presence of eavesdroppers, even when they have not met beforehand. Given the widespread use of public-key encryption on the Internet for applications like electronic banking, it is of great importance to develop a detailed theoretical understanding of its construction. This understanding is necessary to guide future constructions to be as efficient as possible without sacrificing security, as casual optimizations of encryption algorithms without a careful review can lead to subtle attacks. We measure the efficiency of a public-key encryption scheme in terms of how much time and memory are needed to encrypt and decrypt messages and also in how much bandwidth the encryption scheme consumes. It is a basic result that encryption will always introduce some communication overhead, but it is possible to minimize this cost, as the commonly deployed schemes attempt to do.

7. Research implementation and results under the program

Title of your research plan:

Secure and Efficient Public-Key Encryption

Description of the research activities:

We investigated two directions in the development of secure and efficient public-key encryption. First, we showed that if certain mathematical objects called *multilinear forms* exist, then a variety of encryption applications can be constructed with optimal communication overhead without resorting to heuristic arguments for security. Current constructions of public-key encryption with optimal communication overhead must argue their security based on heuristic assumptions, which leads to some doubt about their security. Unfortunately, our results are contingent on the construction of multilinear forms, which are not currently known to exist; however, the mathematical techniques we introduce may be useful in other areas of cryptography, even without multilinear forms.

A second direction involved a study of the security of encryption *under key dependent messages*. This type of security is important when a user encrypts information that depends on their secret key, such as a hard drive backup. While security under key dependent messages is crucially important in practice, it has only recently been studied from a theoretical viewpoint. Our results show that practitioners must be careful when deploying encryption products, because basic security does not imply this stronger type of security. We were able to prove more detailed relationships between security notions for key dependent messages, some of where explicitly posed as open problems in recent literature.

In addition to carrying out mathematical research on these topics at Ibaraki University, I also visited AIST and the NTT Research and Development Musashino office, each for one week, where I gave a total of 7 hours of lectures on this and prior research. My visits lead to some collaboration on the described research, and both visits were very productive.

RESEARCH REPORT

1. Name: Darcie Debevec （ID No.: SP08 018 ）

2. Current affiliation:

Case Western Reserve University

3. Research fields and specialties:

Humanities XSocial Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:

Waseda University

5. Host researcher:

Dr. Glenda Roberts

6. Description of your current research

My research seeks to explore Japan's gradual opening to the global market of migrant health workers made possible by Economic Partnership Agreements signed between Japan and, most notably, Indonesia and the Philippines. Nurses and caregivers from Indonesia arrived to Japan on August 7th, 2008. Migrant health workers are needed to compensate for an expanding Japanese elderly population, diminishing labor force, and existing national nursing and caregiver demands. The specific case of migrant care workers is set apart from other contexts of migration within Japan in that it touches intimately upon important fundamental social and cultural notions surrounding gender, intergenerational relationships, and the actual, and expected, provision of medical care. These ideologies are interpreted and reinterpreted as they meet with the globalization of health workers.

Health worker migration is a major global health issue. Acute health worker shortages and the unequal distribution of health workers are felt worldwide. This is a complex issue in which receiving and sending countries experience both benefits and losses from the transnational movement of health workers. To respond to this issue, research-based policies and actions are needed to address the dynamics of the health labor market, the production of the health workforce, and to improve the distribution and practice of health workers.

My research interests are positioned at the point at which health worker migration to Japan intersects with global health worker shortages and imbalances, thereby speaking to global processes and to the anthropology of Japan. I am particularly interested in the process of caregiver and nurse migration to Japan. What are the specific steps that Japan, Indonesia, and nurses and caregivers alike undertake in order to make migrant caregivers to Japan a possibility? These steps are influenced by important social and cultural dimensions, as well as by globalization.

7. Research implementation and results under the program

Title of your research plan:

Caring for Japan: An Anthropological Investigation into the Global Market of Healthcare Workers

Description of the research activities:

Health worker migration to Japan is a multi-factorial process. My research centered on the following:

1) I conducted a further review of policies related to Japan's Economic Partnership Agreements with Indonesia and the Philippines, especially as concerns the Movement of Natural Persons provisions. Policies concerning the Movement of Natural Persons provisions of the Economic Partnership Agreements made with the Philippines are made available through the websites of the Ministry of Foreign Affairs (MOFA), Ministry of Health, Labour and Welfare, Japanese Ministry of Trade and Industry (METI), and the Japan International Corporation of Welfare Services (JICWS). In my review of these documents, I was most interested in the way in which the global labor market of healthcare is written into the specific context of Japanese policies and Economic Partnership Agreements concerning health workers. In doing so, I investigated the term of residency nurses and caregivers will be provided, their training and national licensure requirements, and expected compensation and professional roles.

2) I met with several employees and managers of language and cultural training centers, with representatives of the Japanese Nursing Association, and with academic researchers interested in the issue of health worker migration to Japan. I

also interviewed several Japanese health providers, including caregivers, nurses, and physicians, and spoke with many people outside of the health field to ascertain a better understanding of public perception of the issue. In addition, I visited a large Tokyo-based hospital to observe the daily functioning of hospital practices in Japan. As a result, I was able to determine the locations of institutions where health workers will be placed, and the gender and total number of nurses and caregivers who have already arrived in Japan.

My research activities contributed to my ongoing planning and preparation of my dissertation research project. With the information obtained, I was able to determine the future sites of my fieldwork, my research sample size, and to clarify my research objectives. I also used my time to study the Japanese language. This is important in that much of my ethnographic research will be conducted in Japanese.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Douglas M. Detert （ID No.: SP08019）

2. Current affiliation: University of California, Berkeley

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Keio University

5. Host researcher: Dr. Kohei Itoh

6. Description of your current research

The objective of this project is to develop a versatile fabrication route for nanostructures from metal-patterned silicon-on-insulator (SOI). Such a processing route takes unique advantage of the oxidation that occurs in the vicinity of metal features patterned onto Si surfaces. In recent experiments, we have used Au-patterned Si substrates in two ways: as templates for the lateral organization of epitaxially grown Ge quantum dots [1] and as templates for “chemical nanomachining,” the sculpting of Si nanostructures from SOI by subtractive wet etching techniques [2]. This latter process gives rise to wire, ring, and pillar structures with readily definable aspect ratios, lateral organization, and cross-section geometry, and is the focus of our current study.

The long-term goals of our project are to more thoroughly investigate how metal-mediated oxide patterning can be implemented in nanoscale processing, and to explore its suitability for photonic crystal, nanopore, and other applications. By exploring the versatility of this processing technique, we can also gain a better understanding of how it might be used in conjunction with other fabrication techniques such as metal-assisted nanowire growth.

[1] J.T. Robinson et al., "Sculpting semiconductor heteroepitaxial islands: from dots to rods," Physical Review Letters 98, 106102 (2007).
[2] J.T. Robinson et al., "Chemical Nanomachining of Si by Au-catalyzed oxidation," Nano Letters 7, 2009-20013 (2007).

7. Research implementation and results under the program

Title of your research plan:

Sculpting silicon with metal-mediated oxide patterns

Description of the research activities:

Under this program, I planned to explore the effects of nanostructure geometry on the optical properties of these Si nanostructure arrays. In order to carry out this project, I would create substrates with “chemically nanomachined” features and then probe their optical properties using Raman and UV-vis spectroscopies.

This processing route takes unique advantage of the two types of surface oxidation that occur when Au is deposited onto Si: the anodization of Si around the perimeter of Au features, and the oxidation of Si that diffuses to the surface through the patterned Au shapes. The oxidized region masks the Si during subsequent wet etching with KOH. If the sample is treated with HF before KOH, the oxide within the area of the patterned Au feature is removed and does not re-form, while the ring of oxide surrounding the feature regenerates. The anisotropy of the KOH etch selectively favors the formation of (111)-oriented sidewalls on the resultant nanostructures. As such, (100) substrates should give rise to structures with angled sidewalls, while (110) substrates should yield those with vertical walls.

Over the course of this program, several challenges have hindered progress in both the processing and spectroscopic analysis portions of this work. While the chemical nanomachining process has in the past yielded consistent results using one particular set of processing tools, during the program it has been necessary to perform a new set of calibration experiments to determine deposition and etch rates. The optical analysis portion of this project, which would have probed the optical response of these arrays using spectroscopic techniques, was impeded by an untimely detector failure.

Because of these setbacks, the focus of this project was altered midway through the program to a new goal: to explore the lower size limit of the underlying chemical nanomachining technique, pushing it below the previously obtained sizes of 150 nm. Silicon nitride masks with 50 nm square features were used to pattern Au on Si (110), which were then rinsed with HF and etched with KOH. The resultant structures were detectable using Scanning Electron Microscopy (SEM), but the array showed significant variation in nanostructure size.

The size scale of these patterned Si features is set by the geometries defined on the evaporation mask used for Au deposition, but is also dependent on the etching parameters and the characteristic length scales involved in the underlying surface oxidation processes. Future study of the fundamental size limits of this process will require us to fabricate masks with hole sizes smaller than 50 nm.

8. Please add your comments (if any): I would like to thank the Itoh group for all of their assistance during this program.

RESEARCH REPORT

1. Name: Robert Dietz （ID No.: SP08020）

2. Current affiliation: University of Minnesota

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Research Center for Coastal Lagoon Environments, Shimane University

5. Host researcher: Dr. Kengo Kurata

6. Description of your current research

The aim of my research is to determine whether bivalve mollusks serve as accurate bio-recorders of nitrogen pollution in Lake Shinji, Shimane Prefecture, Japan. Lake Shinji is located near the Sea of Japan in the San-in district of southwestern Honshu. It supports a dense population of *Corbicula japonica*, a brackish-water clam native to the region, and an active shellfishery. The Hii River and several small streams supply freshwater to the western end of Lake Shinji and are affected by agricultural drainage. Urban runoff and wastewater are more pronounced at the east end of the lake, which is near the downtown area of Matsue City, and further downstream. The Ohashi River connects Lake Shinji to Lake Nakaumi, which exchanges water with the Sea of Japan through the Sakai Channel.

Studies conducted in other aquatic environments have shown that the nitrogen stable isotopic composition ($\delta^{15}N$) of bivalve soft tissues reflects inputs of anthropogenic nutrients found in wastewater and runoff. Elevated $\delta^{15}N$ values tend to be associated with animal wastes and organic fertilizers while lower values are often associated with inorganic fertilizers. Bivalves would be ideal for monitoring spatial variation in nitrogen pollution because they are sedentary and easy to collect. They also integrate pollutants over a long period of time and may preserve a multiyear record of environmental conditions in the accretionary growth of shell material. Little research has addressed the potential use of shell material for reconstructing historical nitrogen conditions, however. Measurement of $\delta^{15}N$ in old shells may be particularly useful in aquatic systems where natural (pre-disturbance) ecological baseline conditions are unknown. Comparing the

modern nutrient status of a lake to a historic baseline could reveal the extent to which the system has been impacted by human activity.

Live *C. japonica* were collected at multiple locations within Lake Shinji and the Ohashi River using grab samplers dropped from the side of a research vessel. On-foot collection of clams near shore and in source streams was also conducted. All live-collected clams were stored in a freezer prior to dissection to prevent tissue degradation. Adductor muscle and foot material were then separated from the main tissue mass, rinsed in deionized water, and freeze dried. Subsequently, they were soaked in a 2:1 methanol-chloroform mix to remove lipids, and freeze dried again. Completed samples were shipped to the Environmental Isotope Laboratory (EIL) at the University of Arizona for nitrogen isotope measurements. Preliminary results reveal that $\delta^{15}N$ values are highest in clams collected at the eastern – and more urbanized – side of the lake and in the Ohashi River ($\delta^{15}N$ = 12.3‰ and 11.7‰ for adductor muscle and foot tissue, respectively). $\delta^{15}N$ values are lowest in clams collected at the far western edge of the lake, which is more affected by agricultural runoff ($\delta^{15}N$ = 10.4‰ and 10.2‰ for adductor muscle and foot tissue, respectively).

The shells of live-collected clams were also prepared for $\delta^{15}N$ measurements at the EIL. They were first cleaned with a stiff brush and rinsed in deionized water. The outer organic coating (periostracum) and hinge material were then removed by abrasion with a small dentral drill. This ensures that $\delta^{15}N$ measurements represent only the organic matrix of the shell. Finally, each shell was ground into a powder using a mortar and pestle.

Sediment cores were obtained at two locations, one at the far eastern end of Lake Shinji and one at the far western end. After physical characterization, the cores were sliced at 2-cm intervals and sieved for mollusk shells and plant fragments. The shells of dead clams found at multiple depths in the cores will be used to investigate whether temporal shifts in nitrogen isotopic signals have occurred. Core chronologies will be constructed from ^{210}Pb dates and from ^{14}C dates on terrestrial plant material. Furthermore, grain size, elemental composition (C, N, S), and stable isotope signatures ($\delta^{15}N$, $\delta^{13}C$) will be analyzed and used to cross-correlate the sediment cores. Prior work on Lake Shinji sediments has shown that the highest $\delta^{15}N$ values in lake sediment occur near the largest urban area on the lake. Jomon-period (~6000 ka BP) shells, obtained from museum collections, will add another temporal dimension to the data set.

Detailed analysis of results is not possible until additional data becomes available. Isotopic measurements of soft tissue and shell material are in progress, as are the construction of core chronologies and determination of clam growth rates.

7. Research implementation and results under the program

Title of your research plan:

Evaluating the efficacy of the brackish bivalve *Corbicula japonica* as a biomonitor of nitrogen pollution in a Japanese coastal lake.

Description of the research activities:

Please see above.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Paul Alexander Dow （ID No.: SP08021 ）

2. Current affiliation: University of California, Los Angeles

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry x Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Institute of Technology

5. Host researcher: Dr. Osamu Watanabe, Dr. Alex Fukunaga

6. Description of your current research

The world is filled with difficult computational problems that need to be solved, many of which can be classified as "combinatorial". These problems are typically distinguished by discrete components and an astronomically large number of possible solutions. Some examples are routing calls in a cell phone network, packing shipping containers, and scheduling Japan's intricate Shinkansen network. Finding the best way to handle any of these problems is theoretically hard, though that does not diminish our need for solutions. My research involves an approach to solving such difficult problems called heuristic search algorithms.

One aspect of hard combinatorial problems (known as NP-hard problems) is the conjecture that, in the long run, there is no better way to solve them than to just iterate through all possible solutions. Unfortunately, the number of solutions is so big, that just trying every possibility is only feasible for the smallest of problem instances. The goal for heuristic search is to develop tools that allow us to ignore the vast majority of those possible solutions and focus our efforts on a small set of the most promising solutions. Some of these tools determine the order in which the space is searched, when the search can halt, where symmetries exist in the solution space, and how large portions of that space can be disregarded.

While there is a limitless supply of hard combinatorial problems that heuristic search techniques can be applied to, my research focuses on the computation of a set of graph

theoretical parameters known as "width parameters". The most famous width parameter is the so-called treewidth of a graph. Given a graph (a collection of vertices and edges between vertices), we can informally understand its treewidth as a measure of how close that graph is to being a tree, i.e., an undirected graph with no cycles. Treewidth has applications to a large number of problems in discrete mathematics, artificial intelligence, operations research, bioinformatics, and various engineering disciplines. These applications are related to the fact that a graph is a simple model than can represent very complicated relationships. To find the treewidth of a graph is a hard combinatorial problem, but, when it is found, a large number of other problems related to the graph suddenly become much easier to solve.

A primary goal of my research is to develop new techniques for finding the treewidth and other width parameters for general graphs, and thereby enable faster and more complex computations in various disciplines. Furthermore, my research includes other combinatorial problems related to optimization and constraint satisfaction.

7. Research implementation and results under the program

Title of your research plan:

Heuristic Search Applied to Treewidth

Description of the research activities:

My research as a part of the summer program has been a combination of looking for problem-specific insights, the development of algorithms based on those insights, and, finally, implementation and empirical evaluation. The primary problem to which my research has been directed is finding exact treewidth of general graphs. The heuristic search algorithms that I have applied to this problem in previous research suffered from various drawbacks and bottlenecks. The research I have conducted this summer at the Tokyo Institute of Technology has attempted to address these issues.

A recently published result exposes a significant bottleneck in the state-of-the-art algorithm for finding exact treewidth. While that publication attempts to address this bottleneck, its proposed solution has significant drawbacks. One activity of my Summer Program research has been to address this same bottleneck with new and more scalable methods. I have fully developed and implemented these methods, and preliminary testing shows that they address the issues of earlier approaches.

A key component of heuristic search algorithms is a fast method of generating good lower bounds for partially solved problem instances. Since a problem like treewidth

is inherently difficult the size of the problem space is extremely large. A good lower bound will allow a search algorithm to disregard the vast majority of that space. To this end, my research this summer has included an investigation of a new lower bound for treewidth, as well as new ways of utilizing existing lower bounds.

Much of the research I have conducted this summer has focused on specific problems. Nevertheless, some of the new ideas and insights I have developed can be applied to a more general class of problems. One particular insight regards a general, state-of-the-art heuristic search algorithm, known as breadth-first heuristic search. As a part of my summer research, I have identified a significant limitation inherent in this algorithm. Furthermore I have developed several possible ways of addressing and correcting for this limitation. This research is still in the development phase, though some implementation and empirical evaluation has been conducted.

A significant aspect of my summer research experience has been interaction and exchange with other researchers, in particular computer science theorists and discrete mathematicians. My research is focused on finding practical methods of solving useful combinatorial problems. In order to make significant progress on hard problems a substantial amount of theoretical results is typically necessary. Both at the Tokyo Institute of Technology and other universities I visited, I met researches working on a wide variety of problems. They were willing to educate me on relevant problems of which I was not previously aware. Additionally, I shared with them information on the techniques that I employ as well as relevant application areas. These discussions heightened my awareness of the problems I am currently working on, as well as introduced me to new avenues of future research.

8. Please add your comments (if any):

This is a truly unique program that allowed me to gain insights and perspectives I would have been unlikely to experience at my home university. In the short term, I intend to continue pursuing several of the results achieved this summer. The product of this will be joint publications with Japanese researchers. Additionally, these results will play a significant role in my doctoral dissertation. In the long term, I believe that I have forged relationships this summer that will turn into lasting collaborations. While I certainly look forward to returning to Japan, I also anticipate some day in the future when I can host Japanese researchers back in the United States.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Michael Dziomba
（ID No.: SP08022）

2. Current affiliation: University of Washington

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo – Institute for Cosmic Ray Research

5. Host researcher: Dr. Masato Shiozawa

6. Description of your current research

This summer the Super-Kamiokande experiment is performing tests in preparation for an upgrade during this coming autumn. Super-Kamiokande, or Super-K, detects neutrinos by means of Cerenkov radiation (a form of light) generated following their interactions in a large volume of water. In order to guarantee the stability of the detector for the coming years, the data acquisition system is being upgraded.

As part of the upgrade, my research work is to develop two new simulation systems and test them in the detector. The first of the simulation systems uses a pulsed laser-diode light source and a high-frequency signal generator to make an artificial high-rate supernova signal. This high-frequency signal is meant to imitate the short burst of neutrino interactions following a supernova. After testing the system in the detector, my research has focused on analyzing the data to examine the capability of Super-K to record high-rate data and look for possible dead-time periods.

The second simulation system uses two LEDs flashed in short succession to simulate muon decay, a two-particle event. A muon stopping in the Super-K detector can decay into an electron, and light from both of these particles can be detected. My research work has been to take data with the system and to evaluate the efficiency of detecting both particles as a function of the separation time between the flashes.

Both of these systems were connected to optical fibers which led into the tank. At the end of the optical fiber, in the middle of the tank, a diffuser ball is used to spread the light sources out uniformly.

7. Research implementation and results under the program

Title of your research plan: Super-Kamiokande Electronics Upgrade

Description of the research activities:

The research activities for this work varied greatly in content. I worked with Super-Kamiokande electronics equipment, soldering a small circuit together and using NIM modules to create a logic circuit. I set the systems up inside the detector and collected data during the testing period

After data collection, my activities focused on analysis of the data. I modified computer code in Fortran and used graphical analysis programs to examine the quality of the data. From the data analysis, we determined that the detector is capable of collecting high-rate supernova simulation data with high efficiency and minimal dead-time. We are also in the process of determining the detection efficiency for the muon decay simulation system.

I also attended the local group meetings and presented updates of my research throughout the summer to my fellow Japanese collaborators.

8. Please add your comments (if any):

This was a very successful and productive summer. I became familiar with the experiment, and was very pleased with the progress I made on my research. My host researcher was extremely helpful and instructive to me. I will gladly continue to work on the same systems from back home, helping out with future data analysis.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Matthew V. Fagerburg （ID No.: SP08023 ）

2. Current affiliation: University of Pittsburgh

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Dr. Kunio Takeyasu

6. Description of your current research

My work in the Sanford Leuba laboratory has focused on single-molecule fluorescence studies of proteins that are involved in the maintenance and processing of DNA structures. Recently we have begun a project that aims to create a robust, single-molecule fluorescent biosensor for the study of nuclear hormone receptors (NHRs) and their interaction with nucleosomes. NHRs form a large and important class of transcription factors, and modulation of their normal activity can lead to disease-states. Several recent publications suggest that estrogen receptor-alpha (ERalpha, a prototypical NHR) can bind to its DNA target sequence (estrogen response element, or ERE) even when this DNA is wrapped around a histone-protein core, forming a nucleosome. We seek to understand this interaction more completely, and hopefully exploit it to engineer a platform for high-throughput studies of NHR ligands. Our work so far has entailed preparing suitable fluorescent DNA templates that contain both a high-efficiency nucleosome positioning sequence as well as an estrogen response element, and reconstituting mononucleosomes using these constructs. In addition, preliminary ERalpha binding studies have been performed.

7. Research implementation and results under the program

Title of your research plan:

AFM Studies of Estrogen Receptor Binding to Nucleosomal DNA

Description of the research activities:

I have spent most of my time in the Takeyasu laboratory making reconstituted nucleosome preparations and probing them with Atomic Force Microscopy (AFM). Using DNA constructs and protein samples that I had prepared in Pittsburgh, I used the improved techniques of the Takeyasu lab to make both mononucleosome preparations as well as arrays of nucleosomes on pre-engineered plasmids. These samples were subsequently imaged using a Digital Instruments Nanoscope AFM. Once I was comfortable with the basic operations of the microscope, I began binding studies using my nucleosome preparations and recombinant estrogen receptor (ERalpha). The results of these binding reactions were likewise imaged with the AFM, and features in the images from the two sets of experiments (both with and without ERalpha) were compared in an effort to identify the effect that ERalpha has on nucleosome structure.

Unfortunately, the mononucleosome system proved to be a poor choice for AFM analysis. The short oligos I had designed complicated the image analysis because they did not result in measurable DNA ‘tails’ projecting from the reconstituted nucleosomes. Individual nucleosomes thus had to be identified on the basis of their size alone, which was problematic, as the unbound ERalpha turned out to be of similar dimensions (rendering population statistics impossible to determine with any confidence). I did not observe any larger features suggesting that ERalpha bound stably to mononucleosomes under my reaction conditions.

Images of my nucleosomal-array plasmid show regularly-spaced nucleosomes (of exceptionally regular spatial periodicity) on discrete regions of the plasmid. This suggests that the positioning sequences used in our nucleosome reconstitutions are specific, and robust. These results also suggest that further AFM studies using nucleosomal arrays may be easier to interpret than studies with mononucleosomes.

8. Please add your comments (if any):

Although my experiments failed to answer the question I set out from, my summer research experience was very fruitful. One of my main goals I had in coming to the Takeyasu laboratory was to learn how to use the AFM to study nucleoprotein complexes. At the end of two months, I am now proficient in using the microscope, and analyzing images collected with it. I also have a much clearer idea as to what the technology's capabilities and limitations are.

9. Advisor's remarks (if any):

We have been very pleased to have Matt in our laboratory. He is very bright and helpful in many ways in our laboratory activities.

One of the excellent outcomes from this program is that a new collaboration has been established. The experiments planned were highly challenging, but we have obtained the highly exciting initial results, which can be continued in the collaboration between Dr. Luba's and my laboratories.

Everyone in our laboratory highly appreciate this NSF-JSPS summer student program.

RESEARCH REPORT

1. Name: Sarah Felix （ID No.: SP08025 ）

2. Current affiliation: University of California, Berkeley

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tohoku University

5. Host researcher: Dr. Masayoshi Esashi

6. Description of your current research

My research involves vibration control of small structures using integrated piezoelectric sensors and actuators. The specific application that we are investigating at UC Berkeley is vibration suppression in hard disk drive suspension structures. This project addresses three common problems that arise in such micro-scale motion control systems: fabrication, signal extraction, and control design.

As for fabrication, material selection and process development are common challenges for micro-scale systems. The application to disk drive suspensions is particularly difficult because functional piezoelectric films must be deposited directly onto steel, as opposed to commonly used semiconductor materials such as silicon. Differences in thermal expansion between the steel and the piezoelectric film cause adhesion and cracking problems. As such, we have been fabricating sensors from ZnO, which can be deposited at a relatively low temperature, but which has attained mediocre material properties. Also, in our system, the actuator is a bulk PZT material (rather than a thin film) bonded to the structure. While this configuration is more robust, it complicates assembly, and the larger actuator can adversely alter the dynamics of the suspension.

The second issue is signal extraction. Micro-scale devices tend to generate very small electrical signals that can be overwhelmed by noise. Further, in motion control systems, driving signals sent to nearby actuator elements can corrupt the sensing signal due to

capacitive coupling. Thus filtering and sensing circuitry must be carefully designed.

Finally, a controller must be designed to best exploit the vibration signal from the sensors. We are developing adaptive filter-based controllers which use the vibration signal to estimate disturbances. With this estimate, vibration disturbances, particularly in the problematic high frequency range, can be canceled to improve tracking performance in the disk drive.

7. Research implementation and results under the program

Title of your research plan: Self-sensing for microscale motion control using PZT films on steel substrates.

Description of the research activities:

My research conducted at Tohoku University extends two aspects of my current research: 1) using a single element for actuation and sensing, called “self-sensing,” in the mircoscale regime, and 2) depositing PZT film on steel instead of ZnO. These issues are relevant to the research conducted in my lab because they begin to investigate the possibility of motion control of disk drive suspensions using a single PZT element for sensing and actuation. The first issue was of mutual interest to my host researchers because they have developed a cantilever device for atomic force microscopy (AFM) which has an integrated thin-film PZT sensor and actuator for a precise resonator function. They were previously unable to implement the resonator using only the onboard sensor and actuator because of electrical coupling between the two.

I hoped to work with this AFM device to investigate self-sensing. However, during my stay, there were no operational prototypes of this device. Thus I worked with a larger mock-up cantilever consisting of bulk PZT bonded to steel. This mock up also has closely-located actuator and sensor elements. With the help of my host researchers, who have extensive experience in instrumentation circuitry, I designed and built a circuit to be able to actuate and sense with the same element. I ran several tests to demonstrate the benefits of self-sensing. In the first test, a driving signal was sent to the actuator and a displacement signal was obtained using a laser Doppler velocimeter (LDV). This test characterized the resonant modes of the structure. In the second test, a driving signal was sent to the actuating element and a sensor signal was extracted from a separate, nearby element. The

sensor was able to detect the resonant modes, but the frequency response was distorted in the higher frequency range, probably due to electrical coupling. Finally, the self-sensing circuitry was implemented to drive and sense with the same element. When properly tuned, this configuration performed very well, detecting the same resonant modes observed in the LDV response. Future work will involve implementing such a self-sensing scheme on the actual AFM resonator.

The second aspect of my research at Tohoku University involved sputtering PZT on steel substrates. A standard process was used to sequentially deposit a Pt/Ti electrode followed by a PZT film. The deposition temperature was 350^{o} C and a mix of argon and oxygen were used. Film thicknesses of 250 nm and 500 nm were deposited. Following the sputtering was a rapid thermal annealing (RTA) step at 680^{o} C for 10 minutes. A wet etch was used to form test patterns in the PZT film. One set of samples was etched before RTA to see if thermal stress problems would be relieved. As expected, all samples had various problems with cracking and film adhesion. However, the 250 nm film that was etched before RTA was the most successful. With some futher process development, it is possible that PZT could be successfully deposited on steel.

8. Please add your comments (if any):

Additional educational and professional accomplishments include: 1) giving a seminar talk at Tohoku University, 2) meeting Mayor of Sendai regarding collaboration with UC Berkeley, 3) visiting Fujita lab at University of Tokyo IIS, 4) networking with visiting professor from City College of New York and being invited to give a talk there, 5) gaining understanding of the research environment in a Japanese lab, 6) gaining valuable insight about being a foreign student which I will pay forward by assisting foreign students in my home lab at Berkeley.

9. Advisor comments (if any):

RESEARCH REPORT

1. Name: Thomas F. Flood （ID No.: SP08026）

2. Current affiliation: University of Massachusetts Medical School

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Kei Ito Ph.D.

6. Description of your current research

Organisms within the kingdom Animalia have the ability to maneuver their bodies in various ways to survive and reproduce. An animal's movement is realized through the contraction of muscle cells throughout the animal's body. This movement is coordinated by the nervous system, which regulates a specific pattern of muscle contractions that culminate in the expression of unique behavior. Increasing the understanding of how an animal's nervous system is constructed and shaped to regulate complex behavior is the general goal of the current research proposal. Specifically, *Drosophila melanogaster* and the powerful genetic tools available with it will be utilized to test the hypothesis that activation of unique subsets of neurons mediate the full expression of various aspects of the fruit fly's behavioral repertoire. The current research will utilize the GAL/UAS system present in *Drosophila* to express an ion channel that can be artificially activated in specific subsets of neurons. GAL4 is a yeast transcription factor that binds to a sequence called the upstream activation sequence (UAS), causing the expression of downstream elements. When it was originally developed, the genetic sequence for GAL4 was coupled to a weak promoter and placed within a P element, a transposon present in the fruit fly. When P elements interact with the enzyme transposase, they begin to randomly jump around the fly genome. Crossing GAL4 flies with flies expressing transposase induces the excision and random insertion of the P element. This results in novel strains of flies, each with a different P element insertion site. Since the sequence for GAL4 is fused to the sequence of a weak promoter, adequate expression of GAL4 can only exist if the P element carrying GAL4 inserts in a location that places it under the control of transcriptional regulatory elements such as enhancers. Because transcriptional regulation of genes is cell specific, a GAL4 sequence inserting at a specific location can be uniquely expressed in a certain subset of cells. Further, any gene placed downstream of a UAS can be expressed in the same pattern. Therefore, if the genetic sequence for a protein, such as an artificially activated ion channel, is placed after the UAS it is possible to restrict the expression of that channel to specific subsets of neurons and thus artificially activate specific subsets of neurons. The current research will mate fruit flies carrying an ion channel that can be artificially activated with a large collection of fruit flies strains that each express GAL4 in a unique pattern. The progeny of these mating will express the ion channel in unique

patterns. Next, the ion channel will be artificially activated and the progeny will be observed to determine if a behavior has been induced. All flies displaying an artificially activated behavior will be analyzed according to their GAL4 expression pattern to identify the relevant neurons for specific behaviors.

7. Research implementation and results under the program

Title of your research plan:

Unraveling the Neuronal Mechanisms of Complex Motor Output in Drosophila

Description of the research activities:

During the 2008 Summer program approximately 1000 GAL4 expressing fruit flies were mated with fruit flies carrying an ion channel that can be artificially activated. The progeny, which express the ion channel in 1000 unique patterns, were observed for the expression of a behavioral phenotype during the time that the ion channel was artificially activated. Testing of each of the 1000 strains of fruit flies during behavioral screen resulted in the isolation of various behavioral phenotypes in approximately 20% of the flies tested. After isolating the various flies demonstrating an artificially induced behavioral phenotype it is necessary to determine their GAL4 expression pattern to identify the neurons responsible for the various behaviors. This can be accomplished by mating the isolated GAL4 strains with fruit flies expressing a fluorescent protein. This will result in progeny that express the fluorescent protein in the same neuronal pattern as the ion channel. Neurons expressing a fluorescent protein can be visualized and identified under a microscope. In this way, the neurons that were artificially activated to produce a behavior can be identified. I am currently being trained in the techniques of fruit fly nervous system dissection, staining and microscopic imaging. Once trained I will be able to visualize the fruit fly nervous system and begin to identify the neurons responsible for the induction of specific behaviors. I hope to acquire imaging results before my departure from Japan.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Jamie Gilmore （ID No.: SP08027）

2. Current affiliation: University of Nebraska Medical Center

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Dr. Kunio Takeyasu

6. Description of your current research

My current research focuses on the use of atomic force microscopy (AFM) to understand the dynamics of biological molecules. In particular, I'm looking at protein-DNA interactions. I have worked with three site-specific DNA cleavage proteins so far which catalyze cleavage by forming a synaptic complex between two or more sites: two type II restrictions enzymes: EcoRII and SfiI, which cleave DNA at specific base-pair sequences, as well as the RAG1/RAG2 proteins which perform the initial DNA cleavage event of V(D)J recombination. The RAG proteins bind to certain DNA sequences which flank antibody coding regions in the DNA. These regions are later spliced together to form the variable regions of antibody genes. This process is essential for the development of a specific immune system, and a severe combined immunodeficiency (SCID) phenotype results if they are not able to perform this process. I use AFM imaging techniques to look at single molecule protein-DNA interactions to observe the structures of the complexes formed, and to try to develop models of how protein performs it functions of binding, cleaving, and dissociating from the DNA to better understand the mechanisms by which these processes occur.

7. Research implementation and results under the program

Title of your research plan:

Fast AFM imaging of synaptic protein-DNA complexes

Description of the research activities:

This summer, I came to Dr. Takeyasu's lab to perform fast AFM imaging on proteins previously studied with conventional AFM. Fast AFM is made possible by a small cantilever design which results in typical scan speeds of 2-3 frames per second, compared to the 1-3 minutes needed to capture an image with conventional AFM. With AFM, we can image in aqueous conditions to acquire time lapse images of consecutive events of the molecular interactions. The increased time resolution allows us to see events which happen on much smaller timescales, providing the possibility to see details of the interactions that were previously missed.

All of the imaging was done with the help of Yu-ki Suzuki, a graduate student in Dr. Takeyasu's lab. All of the proteins I use in my experiments require Mg^{2+} ions as cofactors for cleavage to occur, however, with Ca^{2+} cofactors, they can still bind DNA, but do not cleave it. For all experiments, the complexes were preformed in a tube, and then deposited on mica for imaging.

EcoRII in noncleavage conditions : The first experiments we did were in noncleaving conditions with the EcoRII protein to observe the protein interactions without cleavage. EcoRII is a dimeric protein which has recently been shown to require three recognition sites in order to cleave one site. The complexes are formed with a fragment containing three recognition sites. The fragment has previously been shown to form two loop complexes, as well as one loop complexes bound to two sites, as well as one site complexes. In the fast AFM movies, we observed two loop complexes dissociating to one loop complexes, as well as dissociation of one loop complexes dissociating to one site complexes by two different mechanisms – either dissociating to a dimer bound to one site or splitting into two monomers each bound to a site, showing the intermediate steps of the protein dissociation from the DNA.

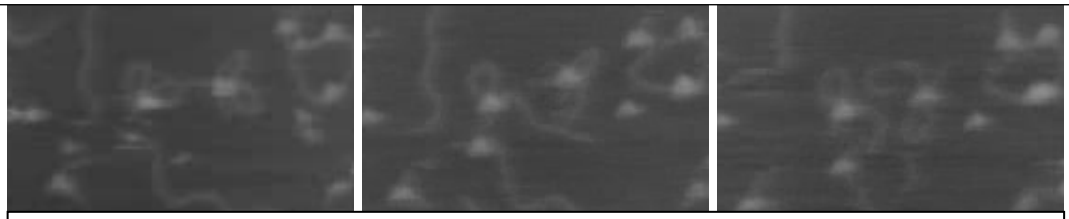


Fig1: Selected frames of the EcoRII two loop complex dissociating to a single loop complex

SfiI in noncleavage conditions: The next set of experiments involved a different type II restriction enzyme, SfiI. SfiI is a tetrameric protein which interacts with two sites to concertedly cleave both of the sites. These experiments were done with a DNA fragment containing two recognition sites. The two site complex appeared to be very stable in this case. However, once the complex dissociated, one-site binding could be detected only very transiently, for only a matter of seconds before it completely dissociated away from the DNA, suggesting that the protein interaction with only one DNA site is very unstable. Once the protein dissociated away from the DNA, it could be seen dissociating into subunits.

SfiI in cleavage conditions: Past experiments to see DNA cleavage with the fast AFM have yielded little success. However, we attempted to image in cleavage buffer (with Mg^{2+} ions) to see if it would be possible with these particular proteins. To our surprise, we were able to obtain clear images of the looped complex with the SfiI protein being concertedly cleaved at both restriction sites on the DNA fragment.

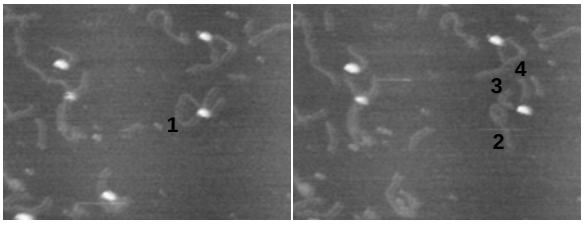


Fig2: Selected frames of the SfiI protein concertedly cleaving two sites on the DNA strand.

Overall, these results show that the two type II restriction enzymes have different mechanisms by which they carry out their functions. The structural and mechanistic information gathered about these proteins can lead to a greater understanding of how similar processes occur in biological systems.

In my original proposal, I wanted to image three systems: EcoRII, SfiI, and RAG1/2, however, with the time restraints, I wasn't able to do experiments with the RAG proteins. In addition, we attempted to get cleavage with the EcoRII protein, but were unsuccessful, possibly because the geometry of the molecules on the mica surface was unfavorable for cleavage. However, with future collaborations with Dr. Takeyasu's laboratory, we hope to eventually achieve these goals as well.

RESEARCH REPORT

1. Name: Erica Gjersing （ID No.: SP08028 ）

2. Current affiliation: University of California, Davis

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tohoku University

5. Host researcher: Dr. Hideki Maekawa

6. Description of your current research

Chalcogenide glasses composed Ge, As, or P and one of the chalcogen elements (S, Se, and Te) are the subject of recent interest due to their applications in infrared optics, non-volatile memory, and non-linear optics. For these glass systems there is a wealth of information available about the short-range order but very little is known about the relationship between their structure and transport properties such as diffusion and viscous flow. An understanding of these underlying atomic-scale mechanisms of transport is vital to the compositional engineering of these glasses for technological applications. This knowledge is especially important around the glass transition region where the supercooled liquid “freezes” into the solid glass, which can range from 100-600C in the GeAsP(S,Se,Te) glasses. Nuclear Magnetic Resonance (NMR) spectroscopy provides detailed information on the structure of materials and can also track changes in the structure due to atomic rearrangements at various temperatures. The focus of my research connects the NMR processes of molecular reorientation and chemical exchange of atomic species with macroscopic transport properties such as viscosity in technologically promising GeAsP(S,Se,Te) glasses.

7. Research implementation and results under the program

Title of your research plan: High Temperature NMR Spectroscopy of Chalcogenide Glasses

Description of the research activities:

Two main experiments were conducted under the JSPS summer program:
1) Natural abundance ^{33}S NMR was attempted on the 930MHz solid-state spectrometer at the National Institute for Materials Science. These experiments were very exploratory in nature since 33S has extremely low natural abundance (<1%) and spectra of 2-coordinated Sulfur, as would be present in these glass systems, has never been observed.
2) Static ^{31}P High Temperature NMR experiments on a 90%As_2S_3 10%P_2S_5 glass were run from 25°C up to 600°C. The glass transition temperature of this glass is 195°C so that spectra were easily acquired around the glass transition as well as into the liquid state for this glass composition. In addition to collecting the NMR spectra, the host laboratory was perfectly equipped for handling the sample preparation of this glass for high temperature experiments which requires that the sample be vacuum sealed to remove any oxygen. These experiments worked exceptionally well and publication quality data was obtained.

8. Please add your comments (if any):

I am extremely satisfied with the work that was accomplished during my two month stay at my host laboratory. It was extremely interesting to learn about the other types of research going on in the laboratory and how NMR is used for these different studies. In addition to the research, everyone in the lab was very helpful and I enjoyed spending time with all of them.

9. Advisor's remarks (if any):

今回のサマープログラムによって、Erica Gjersing さんを本研究室に迎え、2 ヶ月の短期間に当初予定していた以上の NMR 実験結果が得られたことに驚いている。彼女自身も日本の生活を充分楽しんだものと思う。また、研究室のメンバーにも有意義であった。サポートした B4 学生の英語能力向上に非常に役立ったと考えている。

RESEARCH REPORT

1. Name: Christopher Goranson （ID No.: SP08029 ）

2. Current affiliation: New York City Department of Health and Mental Hygiene; The Pennsylvania State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

X Interdisciplinary and Frontier Sciences

4. Host institution: Department of Technology Assessment and Biostatistics, National Institute of Public Health

5. Host researcher: Dr. Toshiro Tango

6. Description of your current research

The success of a prospective surveillance system hinges on its ability to successfully predict and detect a spatial or temporal signal of an event. In New York City (NYC), syndromic surveillance is an attempt to detect disease outbreaks early by identification of statistically significant spatial signals. Key syndromes (otherwise known as the "chief complaints") are analyzed from daily Emergency Department data (Heffernan, 2004). The information collected includes the date and time of visit, age, sex, home ZIP Code area and the chief complaint information of each patient.

SaTScan is a program often employed to detect signals by identifying spatial clustering occurring in either time, space, or both time and space. One known limitation to SaTScan because it employs a circular spatial scan statistic is that clusters that are not circular in nature may be more difficult to detect. FleXScan is one approach to trying to better identify non-circular clusters by employing a flexible spatial scan statistic (Tango, 2005).

Using sample signal data this analysis will look at the same spatial and temporal signal data to try and determine how and when FleXScan may be incorporated into existing syndromic surveillance methodologies to provide alternative ways to improve analysis during future signal detection events. A second objective is to improve cluster detection in by improving geographic characteristics of the input files.

7. Research implementation and results under the program

Title of your research plan: Cluster Detection Comparison in Syndromic Surveillance

Description of the research activities:

Counts of syndrome visits were aggregated at the zip code level for 2005. FleXScan's flexible scan and SaTScan's circular scan were analyzed by comparing the most likely cluster (primary cluster) identified; the secondary clusters identified; location and area of identified cluster; p-value and relative risk. Both projected and unprojected coordinate systems were used to identify sensitivity in clusters to changes in measurement and coordinate systems. Improving the FleXScan matrix file provided a method for capturing area connectivity where bridges, tunnels, or subway lines existed between them. This was not possible to do in SaTScan. ZIP code area centroids were weighted to reflect the underlying population distribution of the areas.

Both FleXScan and SaTScan were run again using the reweighted centroids. FleXScan and SaTScan both detected similar, overlapping areas in three of the time periods investigated during 2005. Non-circular clusters with a high relative risk were detected by FleXScan's flexible scan, and known clusters were detected at a significant p-value ($p=0.002$) by SaTScan. Weighting ZIP code centroids based on population and improving the connectivity matrix changed results; over a one week period p-values increased 50% of the time, decreased 36% of the time, and stayed the same 14% of the time when weighted centroids were employed. The differences were most prominent where unweighted centroids had not been representative of underlying population distributions in the areas.

Flexible and circular scans are complementary tools that each have their strengths and should be used together. SaTScan provides a useful method for detecting clusters more circular in nature; FleXScan is one approach to better identify non-circular clusters by employing a flexible spatial scan statistic. Used together they may provide the best alternative to characterizing an outbreak.

Updating and improving the quality of area centroid files through population weighting, and the creation of accurate matrix files may improve the accuracy of syndromic surveillance. Additional analyses should be conducted to provide a statistical basis to comparisons between the methods. A second comparison between other confirmed outbreaks will attempt to identify the sensitivity and specificity of each under different circumstances.

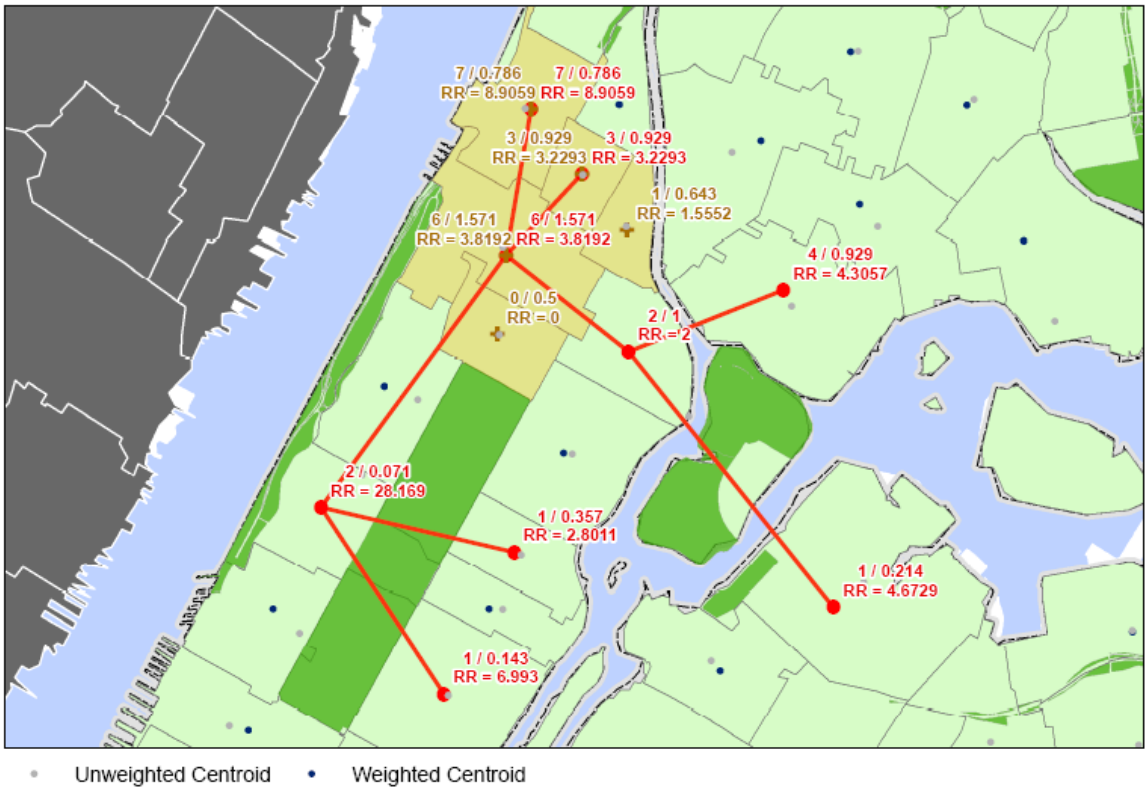


Figure 1 – Circular scan significant cluster (orange) and flexible scan significant cluster (red). Relative risk is also shown.

8. Please add your comments (if any):

The NSF EAPSI program has provided an invaluable opportunity to pursue challenging research leaders in biostatistics and developers of cluster detection tools and techniques. I owe a debt of gratitude to my host researcher, Dr. Tango, and his team at the Department of Technology Assessment and Biostatistics for their support and assistance during the project. I would also like to thank the syndromic surveillance team at the New York City Department of Health and Mental Hygiene, and colleagues at Penn State University.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Michael Goren （ID No.: SP08030 ）

2. Current affiliation: University of Wisconsin-Madison

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Ehime University

5. Host researcher: Yaeta Endo

6. Description of your current research

My thesis work is focused on studying the function of human stearoyl-CoA desaturase (SCD), the terminal protein of a three-component membrane-protein complex. The complex catalyzes a critical step in *de novo* lipid biosynthesis and has been implicated in a wide range of metabolic disorders, including diabetes, heart disease and obesity. Despite this importance, studies of the protein have been performed mainly *in vivo*, as over expression of the protein in traditional

In order to facilitate continued studies *in vitro* studies of the protein complex, I have been investigating the utility of cell-free expression systems to produce correctly folded and catalytically active protein. The system used in my work is derived from wheat-germ and was developed at Ehime University in Matsuyama, Japan. Recently, I have reported *in vitro* reconstitution of the active SCD complex by cell-free production of the peripheral membrane protein Cytochrome b5 and the integral membrane protein human SCD isoform 1 in the presence of preformed synthetic liposomes.

Efforts are underway to understand the mechanism and extent of protein incorporation into liposomes during cell-free translation. In addition, I am interested in using the aforementioned methodology to probe structure and substrate specificities of the multiple human and mouse SCD isoforms.

7. Research implementation and results under the program

Title of your research plan:

Analysis of Synthetic Membrane Compositions on Orientation and Function of Cell-Free Produced Membrane Proteins and Complexes.

Description of the research activities:

Initially, my work during the JSPS summer research program was to examine how different synthetic liposome constructs effect the structure and function of a panel of cell-free synthesized peripheral and integral membrane proteins. The initial data I gathered suggested that while the addition of exogenous liposome appeared to stimulate membrane protein incorporation, incorporation was also observed in the absence of exogenous liposomes. In light of this data, the scope of my work shifted to understanding what role exogenous liposomes have on membrane protein incorporation.

To study this, I analyzed floatation and protease protection of C14-leucine labeled SCD1 translated in the absence and presence of exogenous liposome. With protease protection assays, we can determine how much of the expressed protein is protected by the non-permeable liposome. These studies demonstrated that in the absence of exogenous liposome, roughly 40-50% of the protein is incorporated. Addition of liposome, even as little as 4 ug, resulted in an upper limit of ~80% protection. This increase in protection was not observed when liposomes were added after translation. It is unclear if protection is a function of exogenous or endogenous liposomes.

In a modification of the protease protection assay, detergent was added in order to solubilize the liposome and remove any protection provided. This can differentiate between protease resistant peptide and protected peptide. Using SCD1, and a panel of membrane proteins including human SCD5, and Bacteriorhodopsin, I observed 50-80% more proteolysis, and reduced band sizes as determined b Tris-Tricine SDS-PAGE, in the presence of 0.5% w/v SDS. This suggests that most of the protein is protected.

Floatation of proteoliposomes takes advantage of the less dense liposome interior floating through a density gradient, usually prepared with sucrose. In the presence of exogenous liposome, >90% of the expressed protein was found with floated liposomes, as expected. It was also possible to pre-treat proteoliposomes with protease and recover floated, protected protein. In the absence of exogenous liposomes, expressed protein was found equally distributed throughout the density gradient.

RESEARCH REPORT

1. Name: Richard N Hanna （ID No.: SP08031）

2. Current affiliation: East Carolina University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Ehime University

5. Host researcher: Dr. Takeshi Miura

6. Description of your current research

Progestins are essential factors for the initiation of meiosis in spermatogenic cells, regulation of early stages of oogenesis and initiation of final oocyte maturation in fish. However, the exact receptors mediating these meiotic events have not been definitively identified and are a matter of recent debate. As a PhD student at East Carolina University, my research is focused on identifying unique membrane and nuclear progestin receptors in zebrafish, and has begun characterization of their functions. The progestin receptors in zebrafish show definite progestin mediated activation of reproductive signaling, reproductive tissue specific localization and involvement in oocyte maturation. My collaborator, Takeshi Miura at Ehime University, has done extensive work on progestin control of meiosis in spermatogenic cells and early stage oocytes, and has developed a number of unique techniques for meiotic study. This study combines our knowledge of progestin receptors with the expertise of Dr. Miura in fish meiotic cycle control to identify the specific progestin receptors mediating meiotic control. Specialized methods used by Dr. Miura including germ cell isolation, culture, and BrdU detection of meiosis, combined with immunohistochemistry using specific progestin receptor antibodies, were used to identify unique progestin receptors involved in the control of meiotic processes.

7. Research implementation and results under the program

Title of your research plan:

Involvement of Progestin Receptors in Zebrafish Meiosis

Description of the research activities:

During the summer research period, the culture of zebrafish testis and ovary was successful using Dr. Miura's culture method. Testis and ovarian structure was maintained and responded to steroidal treatment in cultures up to 4 week. BrdU was successfully incorporated into proliferating gonad tissue and immunhistochemically stained as a measure of mitotic and meiotic cell proliferation. Changes in BrdU incorporation were then used as a measure of steroidal activity on cell proliferation in gonad cultures treated with various steroids. Preliminary results seem to indicate that, similar to Dr. Miura's previous studies in the Japanese eel, 17α,20β-dihydroxy-4-pregnen-3-one (the active reproductive progestin in fish) increases zebrafish meiotic cell proliferation, while the fish androgen 11-ketotestosterone increases both general mitotic and meiotic cell proliferation. However, further experimentation including co-stain with a meiotic specific marker are needed to validate these results and will be conducted upon return to the visiting researcher's institute. Over 300 gonad culture samples were collected and prepared during the summer period, which will be used for further examination

Interestingly, preliminary staining with the full length nuclear progestin receptor antibody did not appear to co-localize with proliferating meiotic cells. However, other progestin receptor antibodies did not react as expected possibly due to degradation of antibodies during shipping or differences in staining methods. Therefore, the remaining samples will be stained with multiple progestin receptor antibodies and follow-up experiments will be conducted upon return to the visiting researcher's institute.

8. Please add your comments (if any):

During the summer program I learned many new research techniques such as gonad organ culture, BrdU staining and agarose embedding of tissue fragments, which will be applied to my future research projects. I plan on continuing gonad organ culture experiments when I return to my lab to further identify progestin receptor mediated signaling pathways involved in meiosis, with the possibility of applying the culture method to studying the process of oocyte maturation. Dr. Miura and members of his lab were very friendly, knowledgeable, helpful and willing to assist me in my research project. I also learned many important lessons on overcoming communication difficulties and how to conduct research in a foreign environment. In addition, I was exposed to many unique cultural aspects and the great beauty of Southern Japan. I look forward to future collaborations with Dr. Miura and other researchers in Japan.

9. Advisor's remarks (if any):

Mr. Richard Hanna stayed for 2 months in our laboratory and he mainly tried to a construct new testicular organ culture system using zebrafish according to our fish testicular culture system (Miura et al. PNAS 1991). His experiment were well done and succeeded to construct the culture system in this short period. Furthermore, his preliminary results were much greater than estimated. I consider that he will get more excellent results by his future research collaborations with us. He could also communicate well with the members of our lab and local community, and he contributed to the local social contribution of the University.

RESEARCH REPORT

1. Name: Michael Raymond Hill （ID No.: SP08033）

2. Current affiliation: University of Pittsburgh

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tohoku University

5. Host researcher: Akira Takahashi, MD, PhD

6. Description of your current research

The current research is aimed at elucidating the mechanisms underlying early development stages of cerebral saccular aneurysms. The mechanical factors influencing the initiation of brain aneurysms are still the subject of scrutiny. Degradation of elastin has been hypothesized to play a major role in the formation of aneurysms, as well as the inelastic mechanical changes observed in cerebral vascular wall tissue under large deformations. Previously, a multi-mechanism constitutive model for the formation of aneurysms was developed to incorporate this loss of elastin (Wulandana & Robertson, *Biomech Model Mechanobiol*, 2005). The material constants arising in this model have been determined for data provided in the only known published study on the inelastic behavior of cerebral arteries (Scott et al., *Can J Physiol Pharmocol*, 1972). However, there were limitations to this experimental study: the vessel was subjected to uniaxial deformation, the elastin content and degradation were not analyzed, and the stress-free configuration was not taken as the reference configuration. These limitations warrant further investigation into the mechanical and structural properties of cerebral arterial wall tissue. Therefore, a biaxial testing device was developed to analyze the mechanical properties of cerebral arteries, for loading beyond the hypothetical rupture strength of elastin, and the internal elastic lamina (IEL) analyzed under confocal microscopy for structural defects by exploiting the autofluorescent properties of elastin.

7. Research implementation and results under the program

Title of your research plan: A model system for cerebral aneurysm initiation

Description of the research activities:

Factors hypothesized to be responsible for cerebral aneurysm initiation have been analyzed by using vascular corrosion casting (VCC) of experimental aneurysms induced in a rat model. However, to the author's knowledge, no studies have been performed to couple VCC with computational fluid dynamics analysis (CFD). Also, casting has been performed in conjunction with histological analysis of the vascular wall on separate rats (Jamous et al., *J Neurosurg*, 2007), but simultaneous casting, CFD analysis, and histological analysis on the same vessels has not been reported. Therefore, the goal of this project was to perform VCC, to perform spatial histological analysis of cellular markers, and to perform CFD analysis on 3D reconstructions of micro-computed tomography (μCT) scans of casts, all in the same vessels taken from rats following aneurysm induction surgery.

Introduction: VCC techniques, in which lumen imprints can be visualized under scanning electron microscopy, have been compared to images of 2D histological sections of arterial bifurcations to study the changes of the endothelium in response to artificially-induced aneurysms in rats (Jamous et al., *J Neurosurg*, 2007). From analysis of the anterior cerebral artery-olfactory artery (ACA-OlfA) bifurcation, the authors conjectured that hemodynamic changes lead to injury of endothelial cells at the apical intimal pad (location at the bifurcation of the artery), and then to local inflammation characterized by macrophage infiltration and smooth muscle cell (SMC) migration, which leads to destruction of vessel wall components. The main limitation of their study was that VCC and pathological sections for histological analysis could not be prepared on the same animal. Furthermore, CFD analysis was not performed on the casts. Therefore, the major goal of this project was to address these limitations

Methods: Twenty Sprague-Dawley (SD) and 10 Dahl Salt-Sensitive (DSS) rats were subjected to aneurysm induction surgery. In SD rats, the right common carotid artery was ligated and cut, oopherectomy was performed, and the posterior renal arteries and inferior anterior arteries were ligated on both kidneys. DSS rats underwent similar procedure but with no renal artery ligation. A high salt diet was given to all rats one week following surgery. For VCC, the Circle of Willis (arteries supplying blood to the brain) was perfused with heparinized saline via a pump, the wall was fixed with paraformaldehyde, and then casting was performed with either Batson's No. 17 or PU4ii. Batson's No. 17 Plastic Replica and Corrosion Kit (Polysciences) has been used previously with success, though a new casting material, PU4ii, has been used in cerebral arteries with simultaneous histological analysis and subsequent μCT of the casts (Ulmann-Schuler, *Proc Adv Vasc Cast*, 2007), but not

with CFD. The whole Circles were then placed in primary antibodies (anti-αSMA or anti-eNOS + anti-laminin), followed by secondary antibodies, and then mounted on a slide for analysis under confocal microscopy. After confocal analysis, the vascular wall was removed and the cast analyzed with microCT. The microCT scans were converted to appropriate format and analyzed with CFD.

Preliminary Results and Discussion: A total of 16 Sprague-Dawley (SD) and 8 Dahl Salt-Sensitive rats successfully underwent aneurysm induction surgery. However, the duration for aneurysm formation exceeded the time allotment for this program. Five SD rats that had undergone surgery, without high salt diet, 6 months prior were sacrificed and analyzed by methods given above, using PU4ii (Group A), and two SD rats that had undergone surgery with high salt diet 6 months prior were sacrificed and analyzed using Batson's No. 17 (Group B). The PU4ii seemed to perfuse the Circle better than Batson's No. 17, though there were some apparent air bubbles. Four Circles from Group A were dissected, but time constraints did not allow the investigator to complete the analysis. The brains from the two rats of Group B were removed and tissue dissolved in KOH; the Circles were mounted for μCT and stacks of images were taken, along with 10 casts prepared by a previous researcher. No aneurysms were observed in the scans. The images were prepared for CFD as stated above, but time constraints prevented detailed confocal and CFD analysis. However, the investigator will continue to perform CFD remotely.

8. Please add your comments (if any): There was no time to fully complete the study, although the techniques acquired by the primary investigator (PI) would allow him to return to continue this project. Additionally, the PI may continue to work on this project remotely, as he was granted remote access to the CFD software on the supercomputer at the Institute for Fluid Sciences (IFS) of Tohoku University. The host researcher, Dr. Akira Takahashi, and Dr. Makoto Ohta, an Assistant Professor in the IFS, encouraged the PI to continue this joint collaboration.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Matthew T Hunley （ID No.: SP08034）

2. Current affiliation: Virginia Tech

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Waseda University

5. Host researcher: Prof. Hiroyuki Nishide

6. Description of your current research

My current research at Virginia Tech focuses on harnessing intermolecular interactions to develop functional scaffolds and devices. Specifically, we are interested in the electrospinning process to form nonwoven fibrous scaffolds composed of nanometer-diameter polymer fibers. Due to their high porosity and surface areas, such scaffolds show tremendous promise as active membranes for filtration, electromechanical actuation, heterogeneous catalysis, and cell-growth (tissue-growth).

We are currently synthesizing macromolecules and surfactants with tailored structure and charge, based on the imidazolium cation. Through systematic changes in surfactant and macromolecule chemical structure, we can tune the intermolecular associations and self-assembly behavior. We have found that small changes, such as the location of charge within the surfactant or the length of a surfactant hydrocarbon tail, significantly affect the self-assembly of our surfactants as well as their ability to undergo electro-spinning. Our goal is an understanding of the structure-property relationship between surfactant chemical structure, self-assembled structure, and electrospinning behavior.

Similarly, we are also investigating the effect of charge on the electrospinning behavior of antimicrobial polymers, in particular poly(2-N,N-dimethylaminoethyl methacrylate). Through changes in the strength of the ionic charge on the pendant nitrogen, the antimicrobial activity can be tuned. We are systematically investigating the effect that these changes in ionic charge strength have on the solution properties and processing characteristics (through electrospinning) of this polymer.

7. Research implementation and results under the program

Title of your research plan:

Tailored Charged Macromolecules and Surfactants Containing Imidazolium Cations for Emerging Electronic and Energy Applications

Description of the research activities:

During the short research stay at Waseda University, we prepared and initially characterized membranes composed of poly(styrene sulfonate) (PSS) with 1-methyl-3-hexadecyl imidazolium surfactants as the counteranion. This surfactant (in the bromide salt form) is crystalline at room temperature, but exhibits liquid crystalline behavior at elevated temperatures (above 50 °C). The temperature for the liquid crystalline transition can be tuned through changes in the molecular structure. The prepared membranes exhibited similar thermal transitions, corresponding to the liquid crystalline transition of the surfactant counterion within the PSS matrix. At low temperatures, ionic conductivity of the membrane was significantly lower than that of PSS sodium salt (at 30 °C, conductivities are $4 \cdot 10^{-6}$ S/cm for PSS-sodium salt, and $4 \cdot 10^{-8}$ S/cm for PSS-imidazolium salt). The activation energy for ion conductivity was also found to be very high (65 kJ/mol, compared to 27 kJ/mol for the PSS-sodium salt), indicating that the incorporation of the surfactant counterions provides a barrier to ion transport. At temperatures above the thermal transition of the surfactant, however, ionic conductivity increased significantly (up to $1 \cdot 10^{-6}$ S/cm), with much less of a barrier to ion transport. By tuning the structure of the surfactant and the thermal properties, we hope to develop a series of membranes with tunable thermal and electrical properties. Similarly, we expect the gas barrier properties of these membranes to show similar thermal properties. Attempts to measure gas permeability of the membranes are currently underway.

Additionally, we developed a synthetic strategy for polymerizable imidazolium-based surfactants. In a three step synthesis, we prepared a double-chain surfactant with a terminal polymerizable acrylate group. The incorporation of polymerizable group allows the self-assembled structure of the surfactant to be “locked-in,” creating a more robust and durable functional scaffold. Ongoing experiments expand this synthetic route to surfactants of different structure, including single-chain surfactants and gemini surfactants (surfactants possessing two separate charges). Additionally, we are currently investigating the thermal properties of these monomers and their corresponding polymers.

8. Please add your comments (if any):

The JSPS/NSF Summer Program catalyzed a fruitful and well-matched collaboration at Waseda University in Tokyo. Not only could we exchange ideas and techniques on a scientific level, but my hosts at Waseda were also ambitious in introducing me to the Japanese culture and traditions. Already, we are planning to continue the scientific collaboration into a longer-term project. The Summer Program set the stage for a memorable, once-in-a- lifetime scientific and cultural exchange.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Aaron Kaplan （ID No.: SP08035）

2. Current affiliation: University of Rochester

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Professor Nakano Yoshiaki

6. Description of your current research

My M.S. research thesis is the investigation of all-optical switching and logic circuits. Currently my research is focused on achieving an all-optical flip-flop within a vertical cavity semiconductor optical amplifier (VCSOA) based solely on dispersive bistability.

All-optical signal processing devices are expected to play an essential roll in future all-optical data networks. Optical cavities that contain a nonlinear medium within often exhibit bistable behavior, for a given set of static conditions two output powers are possible. Semiconductor optical amplifiers are a focal point of current research into bistable devices due to the high nonlinearity of semiconductor active regions as index of refraction is highly dependent on carrier density populations within such devices. VCSOAs are advantageous over similar transverse amplifiers due to their compact, symmetrical, surface emitting design. The all-optical flip-flop is a two state switch whose output power dependent on the previous input signal thus retaining one bit of memory and allowing for sequential processing. Previously a polarization-dependent all-optical flip-flop using two coupled VCSOAs was demonstrated using 1s set and reset signals operating at 850nm. Currently being researched is an all-optical flip-flop based solely on the dispersive bistability of a single 1550nm VCSOA. Setting of the flip-flop is achieved by control of the hysteresis through cross-phase modulation. Reset operation is achieved by a reduction in holding beam power via cross-gain modulation in an external SOA. Flip-flop operation is achieved using control, holding beam, set and reset signals all sub-milliwat in power and insensitive to polarization.

7. Research implementation and results under the program

Title of your research plan: Over-ride behavior of MMI all-optical flip-flops and applications to format-conversion

Description of the research activities:

My proposed research plan revolved around investigating the multi-mode interference all-optical flip-flop which was concieved, fabricated and tested at the laboratories of Professor Yoshiaki Nakano at the University of Tokyo. Upon arrival at the University of Tokyo, however, the MMI-BLD was not a current area of investigation. Due to the life cycle of designing, fabricating and testing devices I was presented with an alternative project to study a more recent device, the Mach-Zender-interferometer semiconductor optical amplifier (MZI-SOA), a project I was eager to take on. The MZI-SOA is an all-optical switch, which works by cross-phase modulation within a nonlinear medium. My project was to investigate the dynamic response of the MZI-SOA to determine operational limits of switching speed and on-off contrast. During experiments a 1550nm 1Gb/s reference frequency signal is modulated onto a 1546nm continuous wave signal (Fig. 1). During experiments the static state of applied currents set the device for minimum transmission. An 'on' pulse in the RF signal experiences gain within the active region of the SOA creating an XPM-induced π-phase shift, switching the MZI into an on-state. With one-to-one bit conversion it was discovered the greatest operational speed greater than 1Gb/s as the device is limited by the carrier recovery time. A maximum rise-time of 234ps and fall-time of 474ps is achieved with an extinction ration of 11dB. Several unique results were noted during experiments that will require further investigation. One is the rise- and fall-time dependence on whether the CW and RF signals were injected from the same or opposite directions within the device, one possible cause the non-uniform distribution of current across the active regions. Another is was the response time dependence to the applied current. Expected were faster response times when higher currents were applied to the arm undergoing nonlinear actions, however, little or no improvement was noted in these cases.

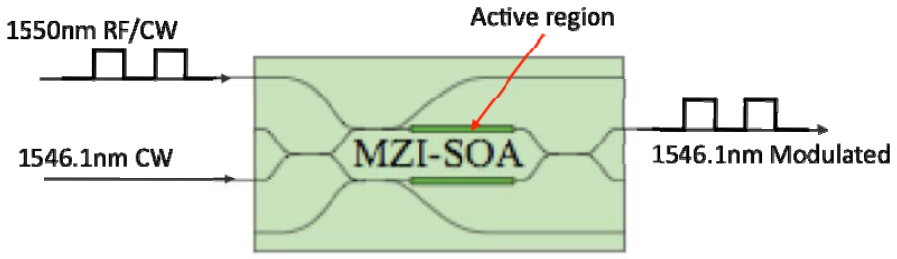


Figure 1. The MZI-SOA experimental operation.

8. Please add your comments (if any):

My experience in Japan was one of the most rewarding of my life. The research project went exceedingly well. Even with a change in focus in my research plan I was still able to contribute to the ambitions of my Master's thesis in all-optical logic and switching while keeping interests in line with the research of members of the Nakano Laboratory. Studying in Japan was a unique and exciting experience. I learned as much inside the laboratory as I did outside learning about Japanese culture and language. I look forward to further collaborations with my Japanese colleagues and hopefully a return trip to Japan in the near future.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Maria Kharitonova （ID No.: SP08036 ）

2. Current affiliation: University of Colorado at Boulder

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences **X** Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: RIKEN Brain Science Insitute

5. Host researcher: Dr. Yoko Yamaguchi

6. Description of your current research

How does the brain orchestrate the multitude of signals across distinct regions to produce complex, intelligent behaviors and thoughts? Recent electrophysiological evidence in both animals and humans points to the critical role of oscillatory dynamics in achieving this level of orchestration. Dynamic synchronization of multiple frequency bands has been proposed as a possible mechanism for large-scale integration needed for complex cognitions to emerge. The specific frequency bands implicated in cognitive task performance are slow oscillations at the theta frequency (3-10 Hz) and fast oscillations at the gamma frequency (26-60 Hz). Furthermore, recent proposals suggest that the cross-frequency coupling of gamma and theta rhythms supports higher-level functions, such as working memory. The specific prediction postulated on the basis of theoretical models (but not yet empirically tested) suggests that for each individual person, the number of gamma oscillations nested within a theta cycle corresponds to that individual's working memory capacity on a given working memory task. The goal of my study in Japan was to investigate the presence of both gamma and theta oscillations during the maintenance period of the working memory task in healthy human participants, and to begin examining the role of theta-gamma coupling in individual differences in working memory capacity.

The data that were analyzed in Japan were collected at the University of Colorado at Boulder. To collect these data, I adopted a working memory paradigm developed by Vogel & Machizawa (2004) and Vogel, McCollough & Machizawa (2005). In this paradigm, EEG activity is recorded as participants first view one visual array of several rectangles flash very quickly on the screen (100 ms) and after a retention interval of 900 ms are asked to make same/different judgments about a similar array that is presented on the screen again. One can examine EEG activity during the 900-ms retention interval to investigate brain activity while information is being actively maintained in memory.

One way to analyze EEG activity is through event-related potentials (ERPs). Event-related potentials (ERPs) are computed by averaging segments of the EEG that were time-locked to the stimulus presentation, thus isolating defections in the EEG that were due to processing the specific event. In this visual working memory task, the activity during the retention interval that is contralateral to stimulus presentation (contralateral delay activity, or CDA) can be used to index active maintenance of these items in visual working memory. More specifically, the extent to which the amplitude of the CDA component increases for trials with many items to remember (e.g. 4) relative to trials with few items to remember (e.g. 2) can reliably predict that individual's visual working

memory capacity, and can thus be used as a reliable neurophysiological index of actively maintained visual representations (Vogel & Machizawa, 2004).

One can also analyze EEG activity in terms of synchronous activity across different frequencies. My goal for the summer was to reanalyze the raw EEG data during the retention interval of this working memory task in terms of oscillations of theta (3-10 Hz) and gamma (26-60 Hz) frequency bands, in order to test whether successful working memory emerges with synchronization of these oscillations.

7. Research implementation and results under the program

Title of your research plan:

The role of EEG-recorded theta and gamma oscillations in visual working memory

Description of the research activities:

This summer was spent learning how to analyze EEG data in terms of synchronous activity across various channels and frequencies. In the process, I also learned to use and to program in several software packages used for computational analyses, such as MATLAB and Mathematica.

The first few weeks were spent putting the data in a proper format for subsequent analyses (pre-processing). The first step of pre-processing involves taking raw EEG data and breaking into segments, around the time of the event of interest (in my case, around the time of the onset of the first visual array, in order to examine what happens during the retention interval. After the data were “epoched” in this way, relevant channels needed to be selected. I recorded EEG data from 128-channels, but the scripts for analyses that were available at RIKEN were made for 62 channels; hence, only the relevant channels needed to be selected. Finally, the data needed to be re-referenced to the average of the 2 mastoid channels (located behind the ears). Pre-processing the data took a few weeks, since all the scripts needed to be modified to fit the format of the data that I had brought with me from the University of Colorado.

After the pre-processing steps were completed, I was ready to start analyzing the data. I wanted to explore whether there exists synchronous activity across different electrode pairs at the theta (3-10 Hz) and gamma (26-60 Hz) frequencies, as was reported in previous studies. Furthermore, I wanted to investigate whether such synchronous activity was modulated by individual differences in working memory capacity. (I have data from 30 individuals, along with estimates of each individual’s working memory capacity). Finally, I wanted to explore whether there was significant cross-frequency coupling between gamma and theta oscillations; specifically, whether the amplitude of fast gamma oscillations was modulated by the phase of the slow theta oscillations, as was reported in several studies.

My results demonstrated that during the retention interval of this working memory task, there is significant theta (3-10 Hz) activity. Moreover, the extent of this synchrony is related to working memory capacity in several interesting ways. Specifically, there is a positive correlation between synchrony at the theta range (both long-range and local) and working memory capacity. There is also a positive correlation between working memory capacity and duration of synchrony, and a negative correlation with the duration of de-synchrony. Finally, I found a positive correlation between working memory capacity and the contrast between synchrony and de-synchrony; i.e. larger working memory capacity is related to a larger difference between the amount of synchrony and the amount of desynchrony.

While encouraging, these results are still preliminary, and additional analyses need to be done to draw conclusions about the relationship between working memory capacity and the extent to which different brain regions synchronize their activity during the retention interval of the working memory task. Additional, more analyses need to be conducted to investigate whether there is significant cross-frequency coupling between theta and gamma rhythms, as was predicted. So far, data from only one participant was analyzed in terms of the cross-frequency coupling patterns, and no significant coupling was found. However, data from more participants need to be analyzed before final conclusions can be drawn.

Overall, the results of my summer project are encouraging, and I plan to continue working on this study upon my return to the University of Colorado.

8. Please add your comments (if any):

The program was fantastic and I am grateful for the opportunity to conduct research at the DEI Laboratory in RIKEN, Japan this summer. The results of my research are preliminary but promising, and I plan to continue working with the DEI Laboratory upon my return to the University of Colorado to bring this project to fruition. Thanks for such an amazing learning experience!

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Sasha Kimel （ID No.: SP08037 ）

2. Current affiliation: University of Michigan, Ann Arbor

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Yukiko Uchida

6. Description of your current research

The purpose of the present work was to provide the first empirical evidence for the prediction that individuals with an interdependent view of the self would feel more distressed in response to social exclusion. In the present study we examined the neuroendocrine response to social exclusion and inclusion in both a Japanese and European-American cultural context by using salivary cortisol as a measure of emotional stress.

7. Research implementation and results under the program

Title of your research plan:

Cultural differences in the neuroendocrine response to social exclusion

Description of the research activities:

In the present study we used a well-established social exclusion task (i.e. the Cyberball game) to manipulated social exclusion and inclusion. In this game, participants are told that they will play a ball tossing game with two alleged students over the internet for approximately three minutes. In the inclusion condition, all players receive the ball an equal amount of times. However, in the exclusion condition, the participant only receives the ball from the other players two times at the beginning of the game.

Participants' physiological response to social exclusion was examined by collecting salivary cortisol at four timepoints in the study. In addition, we examined participants' psychological response to exclusion by measuring the emotions they experienced during the game.

At present we have set up the Japanese site for data collection and have successfully collected half of the data required for our Japanese sample. We will resume data collection in Japan at the start of the next school year. In addition, upon returning the US, I plan to begin collecting our European-American sample. Furthermore, I will begin analyzing saliva samples for cortisol.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Ashley E. King （ID No.: SP08038 ）

2. Current affiliation: University of Montana, Missoula, MT

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Dr. Akira Mori

6. Description of your current research

Fitness is measured by an individual's contribution of genes to the next generation. Despite the fact that Darwin is remembered by the popular catchphrase "survival of the fittest," it really is reproduction of the "fittest" that is of final importance. First, an individual (typically a male) must gain access to one or more mates. However, he will only achieve fitness if he fertilizes eggs. The ornaments and weapons of sexual selection facilitate the first step, and the traits of sperm competition assist the second. *But what is the relationship between the traits of sexual selection and sperm competition?* I am using populations of a horned beetle already known to differ in relative horn size to examine *the relationship between weapons, testes, and reproductive success*. Three possible relationships exist between horns and testes: 1) horns and testes may trade-off due to resource allocation, 2) males in good condition may be able to invest fully in both weapons and testes, or 3) weapons and testes may develop independently of each other. My approach combines both field measures of sexual selection and sperm competition with quantitative genetics studies of correlations among these traits.

My initial fieldwork (NSF EAPSI 2006 Taiwan) revealed that populations differ in their relative allocation to at least one trait (horns), raising the possibility that geographic variation in selection may favor divergent solutions to the same tradeoff. Sap sites are a more limiting resource in Japan than in Taiwan (there are fewer sap sites but more males in Japan), and I showed that male beetles from Japan have larger horns than

Taiwanese males of the same body size (King and Hongo, in prep). Additionally, we found that male dimorphism was more pronounced in Japan. I will be testing whether this difference is environmental or genetic, but either way, these findings suggest that sexual selection and mating systems differ significantly between locations. I also was able to measure both Taiwanese and Japanese male specimens from almost 40 years ago, I able to measure both Taiwanese and Japanese male specimens from almost 40 years ago, and horn lengths were not different at that time. Thus my collaborative international study of these beetles captures a recent, rapid change in at least one major morphological character (horns). I have shown that populations differ in horn allometry, but *what about testes allometry? Does this also differ?*

7. Research implementation and results under the program

Title of your research plan: Sexual selection and sperm competition in the horned beetle, *Trypoxylus dichotomus*

Description of the research activities: I spent one or two nights every week in the field collecting beetles for dissection. Prothorax width, horn length, and weight were measured for each beetle. Back at the lab, each beetle was placed in a jar with wire mesh separating it from paper soaked in ethyl acetate. The beetles were placed in these jars approximately one hour before they were dissected in order to kill them. It was important to dissect the beetles immediately after being killed because the testes begin degrading upon death. Testes were weighed immediately after removal. Additionally, they were weighed every minute for up to 15 minutes in order to determine the average weight at which the testes degrade. This allows me to control for differences in dissection and handling time. Genitalia were saved for shipment to my lab in the US for future studies of size and shape. Wings also were saved in case they are used for a side project on the effect of horns on flight and tradeoffs between horns and wings.

So far, 78 beetles have been collected and dissected, but more will be dissected before leaving Japan. The same methods will be repeated in Taiwan in order to make population comparisons and see whether horn/testes allometries differ between populations.

RESEARCH REPORT

1. Name: Karah E. Knope （ID No.: SP08039 ）

2. Current affiliation: The George Washington University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

X Chemistry Engineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University, Institute for Chemical Research

5. Host researcher: Dr. Masaru Nakahara

6. Description of your current research

Inorganic/organic coordination polymers are hybrid materials that consist of metal centers connected through organic linker molecules to form extended networks. Traditionally, these materials have been prepared through the direct coordination of either presynthesized or commercially available ligands to metal ions. Alternatively, and more recently, in-situ ligand synthesis has become an effective approach to crystal engineering. Typically the in-situ formation of organic linkers relies on the rearrangement or cleavage of organic compounds, a process that is often metal mediated. The rearranged organic species are then observed in the crystalline reaction products. This route offers many advantages over traditional syntheses including simplified synthesis, slow ligand formation to promote single crystal growth, and environmental friendliness. Additionally, this approach to materials synthesis has been shown in some cases to provide a pathway to materials unobtainable from the direct reaction of the metal ion with the linker molecule found in the structure. Whereas the frequency of in-situ ligand syntheses reported has increased, mechanisms remain poorly understood and occurrences are largely unexpected. Researchers most often rely on ex-situ diffraction techniques to characterize reaction products and as a consequence mechanisms are typically inferred retrospectively at best. The objective of my research is to hydrothermally synthesize novel f-element containing hybrid materials through the coordination of metal centers to organic ligands generated in-situ. More specifically, I am interested in (1) elucidating and rationalizing mechanistic information leading to the formation of otherwise inaccessible f-block containing materials and (2) exploiting these reactions and directing an otherwise serendipitous result towards a desired structure type.

7. Research implementation and results under the program

Title of your research plan: In-situ investigation of hydrothermal metal-organic reactions via Nuclear Magnetic Resonance Spectroscopy

Description of the research activities:

To capitalize on the notion of generating ligands in-situ, it is necessary to understand the chemical evolution of organic species in water under non-ambient conditions. The goal of this work was to monitor high temperature organic transformations, in hot water, using Nuclear Magnetic Resonance (NMR) Spectroscopy both in the presence and absence of metal ions. F-metal/organic oxidation/degradation hydrothermal systems known to generate oxalate ($C_2O_4^{2-}$) ligands in-situ including (1) the oxidation of the 1,4-diazabicyclo[2.2.2]octane (DABCO) and (2) the decarboxylation of 2,3-pyrazinedicarboxylic acid (H_2pzdc) were explored.

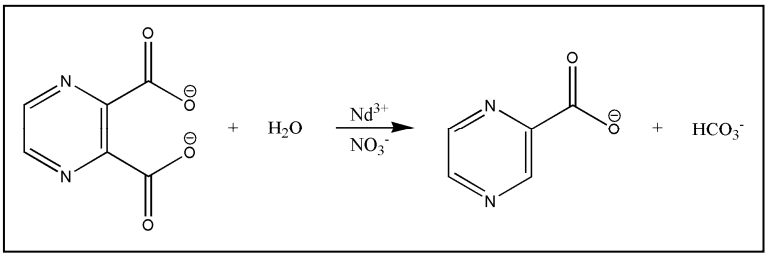
(1) Oxalate formation via oxidation of DABCO

We recently reported the in-situ formation of a Uranium(VI) coordination polymer containing oxalate ($C_2O_4^{2-}$) and glycolate ($H_2C_2O_3^{2-}$) linkages generated from the metal mediated oxidation of DABCO. A mechanism for the oxalate and glycolate anion formation was proposed based on the crystallographic data obtained from solid-state reaction products. Due to the difficulty of obtaining crystalline products however, portions of the mechanism were largely speculative and no direct observation of reaction intermediates existing in the aqueous phase were made. As such, to further elucidate the reaction pathway, the work carried out this summer focused on identifying solution phase organic species using Nuclear Magnetic Resonance Spectroscopy. As a consequence of the precautions necessary for handling U(VI) containing materials, hydrothermal reactions of Nd^{3+}, Mo^{6+} and DABCO (also known to yield oxalate anions) were investigated. Solutions of $Nd(NO_3)_3$•$6H_2O$, MoO_3, and DABCO in D_2O were prepared in the molar ratio of 1.5:0.5:3.0 respectively. Approximately 2.5mL of the solution was transferred to a quartz tube, purged with Argon(g)/O_2(g) and then flame sealed. The reactions were subsequently heated in a furnace at a desired temperature, quenched at 30 minute time intervals (out to 6 hours), and both 1H- and 13C-NMR spectra were collected. Reaction variables including metal:ligand ratio, oxygen enriched atmosphere, and temperature were explored. From these studies the disappearance (oxidation) of DABCO and the evolution of organic species in the aqueous phase as a function of time were observed. It was found that the oxidation of the organic reactant was accelerated by both the presence of MoO_3 and O_2(g). Moreover, peaks attributed to oxalate precursors such as glycolic acid and glyoxylic acid were observed. Despite our success in observing these reaction intermediates, however, the complexity of the spectra made it difficult to further assign any additional peaks. That said, we decided to focus our efforts on a seemingly less complex system also known to generate $C_2O_4^{2-}$.

(2) Oxalate formation via 2,3-pyrazinedicarboxylic acid

Reactions of 80mM Nd(NO3)•6H2O and 80mM 2,3-pyrazinedicarboxylic acid (H2pzdc) were prepared as described above. 1H- and 13C-NMR spectra of the initial solution (time 0) were collected and the peaks resulting from the H2pzdc were assigned. Trivalent lanthanide ions are paramagnetic and known to cause a lanthanide induced chemical shift. Therefore, solutions of various metal:ligand concentrations were prepared and the chemical shift of the reactant as a function of concentration was established. Reference spectra for proposed intermediates were also collected. Reactions were then heated at 120 ºC and quenched at 30 minute time points. 1H- and 13C-NMR spectra were collected on both the solution and the gas were collected. Peaks attributed to the formation of 2-pyrazinecarboxylic acid were observed in both the 1H and 13C-NMR spectra. Consistent with the decarboxylation of H2pzdc, 13C-NMR spectra of the solution and gas phase showed the appearance

of a peak at ~125ppm that can be assigned to CO_2(g), likely formed from carbonic acid. Scheme 1 depicts these results.



Scheme 1. Decarboxylation of 2,3-pyrazinedicarboxylic acid to yield 2-pyrazinecarboxylic acid and carbonic acid.

Furthermore, peaks that can be assigned to glyoxylic acid and glycolic acid were likewise observed. Upon successful identification of the solution phase species, we followed the reaction system in-situ at 120 ºC and species evolution as a function of time was established. The reaction solution was prepared in D_2O, transferred to a pyrex tube and then flame sealed. Using a high temperature probe, 1H-NMR spectra were collected at 10 minute intervals. Though not presented here, these results will allow us to establish a rate law for the transformation of H_2pzdc to 2-pzca at 120 ºC. Finally, reactions were prepared in H2O so that we could comment more conclusively on the state of the 2-pyrazinecarboxylic acid. Previously, it had been proposed that subsequent hydrolysis/oxidation of 2-pzca was likely to occur and yield 2,3-pyrazinediol. 13C- and DEPT spectra show, however, that 2-pyrazinecarboxylic acid remains in the solution phase in the acid form. In summary, from the work performed this summer, we are able to comment/speculate on the formation of oxalate anions from H2pzdc as follows; (1) Whereas decarboxylation (-CO2) of H2pzdc and the subsequent reductive coupling of CO_2 has been commonly propsed to yield oxalate ligands in-situ, our results suggest that the functionality of the ligand (namely the presence of the carboxylate moieties) is relevant to the solubility of the organic and the chelation of the organic to the metal ion. That said, though the formation of CO_2(g) is observed, it does not appear to be relevant to in-situ ligand formation. Admittedly more studies are necessary to say this conclusively. (2) Prior to precipitation, the presence of metal cations and nitrogen-lone pair/, -CO_2 chelation accelerate in-situ ligand formation and control end product formation prior to precipitation.

8. Please add your comments (if any):

These studies are the product of many people's efforts. First and foremost, I would like to thank Dr. Masaru Nakahara not only for his direction and many thoughtful discussions but also for his patience over the past two months. While working at Kyoto University I also had the opportunity to work with many of the graduate students. Specifically I would like to thank Mr. Hiroshi Kimura for all of his time and efforts devoted to this project. Similarly, I would also like to thank Mr. Yoshiro Yasaka for his help and the other members of the Nakahara research group for welcoming me into the laboratory.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Eric R. Larson （ID No.: SP08040）

2. Current affiliation: University of Washington

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Environmental Studies

5. Host researcher: Dr. NISIKAWA Usio

6. Description of your current research

Advancing our understanding of the ecological impacts of invasive species is needed in freshwater ecosystems which have witnessed the widespread invasion of non-indigenous species, while concurrently experiencing high rates of extinction. Crayfish are among the most harmful aquatic invaders because they interact with all levels of aquatic food webs as omnivorous consumers of animal matter, plant matter, and detritus, and serve as ecosystem engineers by modifying physical habitat through their foraging and burrowing behavior. Little is known about many major invasive crayfish from their native habitats, even though this information may be useful in understanding how they will affect aquatic communities and ecosystems in their invaded ranges. My research addresses this knowledge gap by comparing the food web effects of the invasive signal crayfish *Pacifastacus leniusculus* between its native range in the Pacific Northwest of the United States and its invaded range in Hokkaido, Japan. I use carbon and nitrogen stable isotopes to assess resource use and trophic position of crayfish and other aquatic invertebrates and fish. I predict that invasive crayfish will have stronger food web effects in their invaded than native range due to ecological release from coevolved predators and parasites, as well as a lack of evolutionary history with the crayfish among invaded range prey and competitors. This study will be the first to explicitly test hypotheses related to the food web effects of an invasive crayfish between its native and invaded ranges, and will add to the small but important literature on comparative home-and-away studies of invasive species. Results of this study may be useful in anticipating impacts of *P. leniusculus* and other invasive crayfish in newly invaded habitats and will contribute to an understanding of the role of these species' in their native ranges.

7. Research implementation and results under the program

Title of your research plan:

A Home-and-Away Comparison of the Effects of an Invasive Crayfish on Aquatic Food Webs

Description of the research activities:

While in Japan, I visited Hokkaido from 30 June to 2 August to sample a series of lakes with and without introduced populations of *P. leniusculus*. I was able to collect samples for stable isotope analysis from four lakes with *P. leniusculus* (Kussyaro, Mashu, Oketo, and Shikaribetsu), four lakes without *P. leniusculus* (Chimikeppu, Kanayama, Nukabira, and Taisetsu), and one lake with separate areas where *P. leniusculus* has and has not established populations (Shikotsu). I also visited the Hokkaido University museum and fish collection, where I was able to collect tissue samples for stable isotope analysis from historic specimens for lakes Shikaribetsu and Shikotsu. These samples will allow the reconstruction of lake food webs prior to *P. leniusculus* introduction. Upon returning to Washington in late August 2008, I will immediately sample native range lakes paired to match those sampled in Hokkaido using the same field techniques. I will then process stable isotope samples and analyze results during autumn and winter 2008.

8. Please add your comments (if any):

Due to the nature of my field research, I was fortunate to travel extensively in Hokkaido, experience Japanese culture while staying at inns in rural areas, and become familiar with new species and ecosystems. Work with my field assistants, graduate students at Hokkaido University, and researchers at NIES produced friendships and research collaborations I hope to sustain in the future. Finally, I hope to have a long and productive collaboration with my host researcher, and we are already assisting each other with studies related to distribution modeling of invasive crayfish as well as a genetics studying involving *P. leniusculus* in both its native and invaded ranges.

9. Advisor’s remarks (if any):

Overall, Eric Larson did a fine job in conducting his summer research in such a short period. The summer exchange program has given us an opportunity to further collaborate on an invasive species project. I look forward to working with Eric Larson and his supervisor Julian Olden in the near future again.

Nisikawa Usio, Research Scientist, National Institute for Environmental Studies

RESEARCH REPORT

1. Name: Nicole M. Lashbrook (ID No.: SP08041)

2. Current affiliation: Stony Brook University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Genetics

5. Host researcher: Dr. Takashi Gojobori

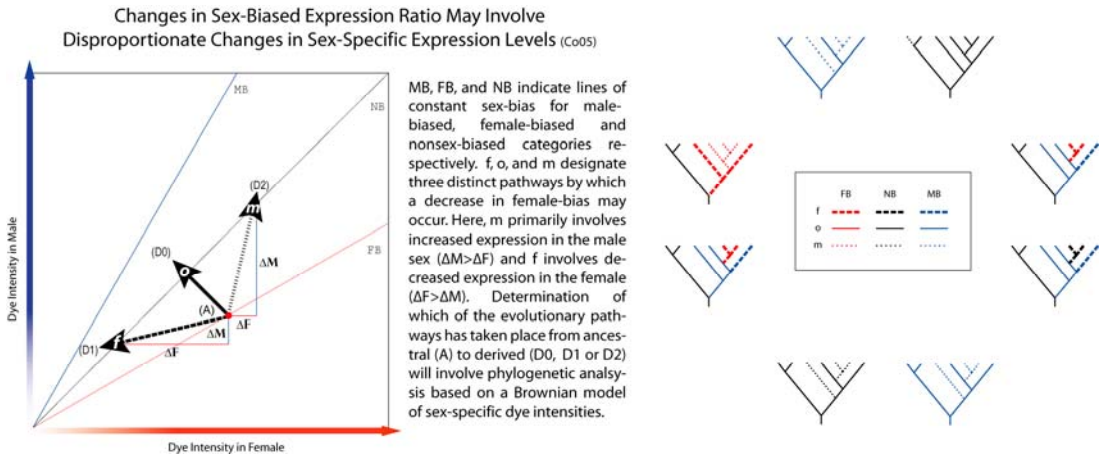
6. Description of your current research

Understanding the causes of sexual dimorphism has been of central interest to evolutionary biologists ever since Charles Darwin elaborated his theory of sexual selection in *The Descent of Man, and Selection in Relation to Sex*, published in 1871. Microarray studies of sex-biased gene expression in the genus Drosophila have generated a tremendous amount of data that can be used to assess sexual dimorphism at the molecular level and investigate the relative importance, in terms of genome evolution, of different models of evolution in relation to sex. Studies comparing genes based on classification of bias have provided evidence for the existence of genome-wide sex differences for a number of evolutionary parameters[1]. Observed differences in the strength and prevalence of positive selection between males and females have led some to propose that *intrasexual* competition is the primary causal factor underlying molecular patterns of sex difference[1]. Standard genomic measures, however, do not adequately discriminate among alternative forms of sexual selection, nor properly delineate the role of constraint. Further clarification of the role of coevolution in shaping patterns of molecular dimorphism is also relevant to understanding observed taxonomic variation in the distribution of male-biased genes with respect to the X-chromosome. Because the fixation rate of alleles with sexually antagonistic fitness effects is expected to differ as a function of dominance on the X chromosome as compared to the autosomes[2], antagonistic coevolution may play a role in determining the distribution of sex-biased genes throughout the genome[3].

Theoretical considerations suggest that sex-biased expression is especially likely to evolve when expression is advantageous in one sex and neutral or costly in the other[4], thus it has been suggested that the evolution of sex-biased expression will often involve decreased expression in the unbiased sex[5]. However, as evolutionary opportunity permits, a tug-of-war may ensue over optimal expression as mean population fitness is maximized alternatively at the expense of one sex or the other[6]. Some of the most basic questions regarding sex-biased expression evolution are still outstanding:

- Does divergence within category of sex-bias evolve primarily through regulatory change in the sex of bias? Is this dependent on the direction of sex-bias change (an increase or decrease)?
- Are transitional changes in category of bias more likely to involve regulatory change in one sex over the other? Is this dependent on the state of ancestral sex-bias?

Phylogenetic analysis of sex-biased expression is an as yet underutilized approach for extracting biological information from microarray datasets. The recent publication of a seven species genome-wide microarray analysis of sex-bias in Drosophila[7] permits the use of phylogenetic methods on a genome-wide scale. In particular, inference about ancestral expression and the relative level of expression change that has occurred between each sex along each branch may provide important information for resolving the genomic effects of different models of evolution in relation to sex.



7. Research implementation and results under the program

Title of your research plan:

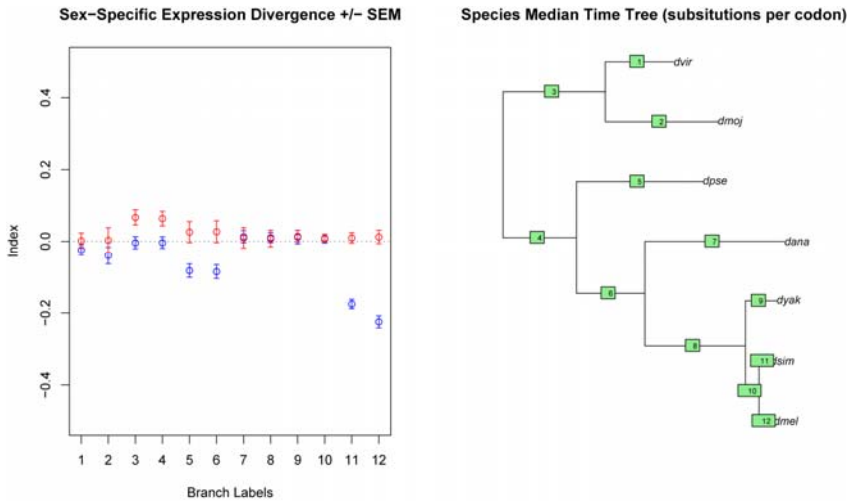
Phylogenetic Analysis of Sex-Biased Expression in the Genus Drosophila to Investigate Models of Evolution in Relation to Sex

Description of the research activities:

Given the short duration of the summer program, my primary objective has been to obtain a working dataset and to develop some flexible code to serve as a scaffold for future analyses. To this end, I made use of pre-existing analyses as much as possible. My working dataset consisted of orthologous groups of genes for which the constituent genes are all classified as sex-biased by Zhang *et al.* In all, there are 314 such groups, 51 of which include at least one transition (note that these are direct transitions between male and female bias); the rest are consistently either male or female biased. With this dataset, I focused on the following question: *Does divergence within category of sex-bias evolve primarily through regulatory change in the sex of bias?*

Using sex-specific expression data for each of the 314 sets of orthologous groups of genes, I estimated *ancestral dye intensities* using sex-specific expression data for each species according to the assumption that the opportunity time for expression divergence is determined by the branch lengths given by the seven *species tree*. Specifically, I used the "ape" package in R implemented by Bioconductor which estimates ancestral nodes for any continuous character according to a Brownian model of evolution. For each set of orthologous genes, I conducted this analysis separately for both male- and female-specific dye intensity readings. I based my analysis on the *species tree* derived from sequence data simply to meet my objective of obtaining preliminary results. At a later, stage this analysis will be conducted using the sequence data derived *gene tree* for each orthologous gene set. Alternative models of expression evolution will also be considered.

Using inferred ancestral expression estimates for each node, I calculated sex-specific divergence (ΔF and ΔM) for each branch, and obtained an "index" (defined, for the time being, as the difference between the absolute values of sex-specific divergence, abs(ΔF)-abs(ΔM)).



Red data points indicate the average "index" for female-biased genes; blue represents the same for male-biased genes. At this preliminary stage, it appears that when there are sex differences in the measured index, this may be primarily due to an increased number of male-biased genes with reduced expression along those branches (given comparisons of the distribution of *ΔM* and *ΔF)*. Divergence of genes classified as female-biased may not primarily involve expression change in females while, among male-biased genes, there may be a better case for the notion that changes in bias between species primarily involves expression changes affecting males. My next step will be to look at index as a function of the magnitude of sex-specific expression and magnitude of sex-bias to see if these factors predict the differences between male- and female-biased genes. Also, I will explore the factors that may cause expression change including changes in body or tissue size between species.

Finally, I looked at whether gene groups containing at least one transition across the tree are more likely to be associated with the X chromosome (in any species) and found an insignificant trend (chi-squared). Of wide interest is an explanation for the under-representation of male-biased genes that is seen on the X chromosome for all seven species of Drosophila. More work will be done to assess the dynamics of these trends in a phylogenetic context and assess the role of expression divergence. Due to the temporary exclusion of genes that are non-biased in any one of the seven species, this preliminary dataset only gives a hint of genome-wide patterns. Nonetheless the methodology that has been developed can be easily modified for inclusion of this set of genes upon further analysis.

[1] Vicoso, Beatriz and Charlesworth, Brian, Evolution on the X chromosome: unusual patterns and processes. *Nat Rev Genet* **7** (8), 645 (2006).

[2] Charlesworth, B., Coyne, J. A., and Barton, N. H., The relative rates of evolution of sex chromosomes and autosomes. *Am. Nat.* **130**, 113 (1987).

[3] Connallon, T. and Knowles, L. L., Intergenomic conflict revealed by patterns of sex-biased gene expression. *Trends Genet.* **21**, 495 (2005).

[4] Rhen, Turk, SEX-LIMITED MUTATIONS AND THE EVOLUTION OF SEXUAL DIMORPHISM. *Evolution* **54** (1), 37 (2000).

[5] Rice, W. R., Sex chromosomes and the evolution of sexual dimorphism. *Evolution* **38**, 735 (1984).

[6] Rice, W. R. and Chippindale, A. K., Intersexual ontogenetic conflict. *Journal of Evolutionary Biology* **14** (5), 685 (2001).

[7] Zhang, Yu et al., Constraint and turnover in sex-biased gene expression in the genus Drosophila. *Nature* **450** (7167), 233 (2007).

8. Please add your comments (if any): I am sorry that this is too long.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Jina Lee （ID No.: SP08042 ）

2. Current affiliation:

University of Southern California

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Informatics

5. Host researcher: Professor Helmut Prendinger

6. Description of your current research

My current research is focused on generating nonverbal behaviors for virtual humans. Nonverbal behaviors indicate various *wordless* behaviors including head movements, facial expressions, hand gestures, gaze, etc. They serve to repeat, contradict, substitute, complement, accent, or regulate spoken communication. Virtual Humans with appropriate nonverbal behaviors can support interaction with users that ideally mirrors face-to-face human interaction. Nonverbal behaviors can also help create a stronger relationship between virtual humans and users as well as allow applications to have richer, more expressive characters. Overall, appropriate nonverbal behaviors should provide users with a more immersive experience while interacting with virtual humans, whether they are characters in video games, intelligent tutoring systems, or customer service applications.

In my previous work, I developed a top-down rule-based Nonverbal Behavior Generator (NVBG) [1] for virtual human systems. The NVBG analyzes the syntactic and semantic structure of the surface text (i.e. virtual human's dialog) as well as the emotional state of the virtual human and annotates the surface text with appropriate nonverbal behaviors. Some of the advantages top-down approach are that it does not require much data to construct the rules and the rules can be fine-tuned for specific cases. However, the limitations include sparse coverage of a wide range of phenomena and manual construction of the rules. To overcome these limitations, I have worked on a bottom-up approach for learning gesture

models from a large gesture corpus. More specifically, I focused on predicting nod movements using machine learning techniques.

During the JSPS internship, I investigated whether including the emotional state of the speaker would help predicting the head movements occurring with speech.

7. Research implementation and results under the program

Title of your research plan:

Predicting Head Movements with Multimodal Gesture Corpus

Description of the research activities:

The data I used for my previous work is from the AMI Meeting Corpus [2], which includes the transcript, annotation of dialog acts, head movements, hand movements, etc. I used 10,000 sentences from the corpus and annotated each word with various features (e.g. part of speech, boundary of sentence, boundary of noun/verb phrases). At National Institute for Informatics, I also obtained the predicted emotional state of the speaker for each sentence as well as for each word using the Affect Analysis Model [3]. After obtaining the emotional data, I aligned it with my previous data and trained the head gesture models (hidden Markov models) with different conditions to compare the performances of each model. One experiment used the overall emotional state over the whole sentence (i.e. each word in the same sentence gets the same emotion label). This improved the accuracy of predicting head nods than having no emotional data. Another experiment used the emotional data of each word (i.e. each word has its own emotion tag). However, this worsened the prediction of head nods compared to having no emotional data or having the emotion data over the whole sentence. The actual measurements are summarized below.

	Accuracy	Precision	Recall	F1
No emotion Data	.8528	.8957	.8257	.8588
Emotion over sentence	.8957	.9018	.8909	.8963
Emotion of each word	.8589	.7791	.9270	.8467

Reference

[1] Lee, J., Marsella, S.: Nonverbal Behavior Generator for Embodied Conversational Agents. In: Proceedings of the 6th International Conference on Intelligent Virtual Agents, Marina del Rey, CA, 2006. pp. 243-255.

[2] Carletta, J. (2006) Announcing the AMI Meeting Corpus. The ELRA Newsletter 11(1), January-March, p. 3-5.

[3] Neviarouskaya, A., Prendinger, H., Ishizuka, M.: Textual Affect Sensing for Sociable and Expressive Online Communication. In: Proceedings of the 2nd International Conference on Affective Computing and Intelligent Interaction, Springer, Heidelberg (2007)

8. Please add your comments (if any):

I very much enjoyed my internship at NII. Professor Prendinger did everything he could to help me perform the research at NII. I would also like to thank Ms Alena Neviarouskaya for letting me use her system and helping me with the technical details as well as other colleagues at the Prendinger Lab. I am very satisfied that I was able to combine my work and Professor Prendinger's research to produce useful results.

9. Advisor's remarks (if any):

Ms Jina Lee performed her internship to my full satisfaction. By integrating her own research and a component developed in my laboratory, Ms Lee obtained excellent results. Hence, her internship at NII can be seen a great success, and also an entry point for further collaboration between NII and Ms Lee's institute at the University of Southern California.

RESEARCH REPORT

1. Name: Anthony R Marino （ID No.: SP0843）

2. Current affiliation: Department of Chemistry, University of Chicago

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Shizuoka University, Shizuoka

5. Host researcher: Prof. Yasuhiro Kobori

6. Description of your current research

Melanin in cells absorbs light and quickly converts it into heat, a property essential to prevent photoreactions with oxygen that can lead to oxidative stress. One process by which this occurs is through interconversion between the first excited singlet state and the ground state. It is believed that intersystem crossing to excited triplet states does not occur. Triplet states are longer-lived and prone to create the types of harmful side-reactions which melanin presumably exists to prevent.

Another process by which melanin dissipates light energy is to create radical pairs. Time-resolved electron paramagnetic resonance (TREPR) can be used to study radicals on a sub-microsecond time scale. The polarization of radical pairs contains information about the electronic states from which they were born. Extracting this information, however, can be a challenge, as the TREPR spectra are often complex. Data I've taken in Chicago has suggested that some radical pairs in melanin need to have come from an excited triplet state, but the work is incomplete without a mechanism to explain exactly how.

7. Research implementation and results under the program

Title of your research plan:

Spin Chemistry of Photoexcited Melanin

Description of the research activities:

Previous to my time in Shizuoka I had taken time-resolved electron paramagnetic resonance (TREPR) spectra, but their interpretation had been problematic.

Three possible interpretations were explored. The first was a radical-triplet polarization mechanism. This is where the polarization of electronically excited molecules can be transferred to pre-existing radical electrons. This possibility was quickly dismissed upon analysis of data from collected in Chicago. The second interpretation, that the orientation of the radical species could be determined by changing the angle made by the laser polarization and the magnetic field, was abandoned after the experiment produced no result. In the third interpretation, relaxation of the excited triplet molecule modulates the polarization ceded to the resulting radical pair. Experiments conducted this summer support this interpretation.

Relaxation in excited triplet states depends on temperature, and variable-temperature experiments found evidence for this relaxation. The spectra, however, remain sufficiently complicated to require numerical simulations, the coding of which is nearly complete. Simulations in support of this interpretation would demonstrate mechanistic evidence for the existence of excited triplet states in melanin and suggest a pathway for the photoprotective conversion of light energy into heat.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Timothy John Maxwell （ID No.: SP08044）

2. Current affiliation: Northern Illinois University

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Uesaka Laboratory, Nuclear Professional School, University of Tokyo

5. Host researcher: Dr. Mitsuru Uesaka

6. Description of your current research:Charged particle accelerators continue to develop in favor of custom applications, shorter pulses, and higher energies. For such advances to succeed, better knowledge of the behavior of the constituent bunches of the beam is required for beam monitoring, control, and analysis of beam dynamics. The focus of my present research is on novel charged particle beam diagnostic systems. These include single-shot (one bunch), non-destructive (minimal beam interference) and sub-picosecond time resolution measurements. The best diagnostic candidates for such demands are based on the direct optical analysis of some form of radiation emitted from the beam. One current project focuses on the detailed computer modeling of instruments used to analyze the coherent radiation emitted by a bunch colliding as it crosses a change in medium (coherent transition radiation). This sub-millimeter radiation may be diffracted as it travels through an instrument, distorting the measured spectrum. Software for analyzing the problem has been developed, and comparison to experimental data is now underway, as with our current 2008 summer experiment with the Uesaka Laboratory at the University of Tokyo Nuclear Professional School. More current and continuing research is also being pursued in techniques based on non-linear optics. This technique, referred to as electro-optic sampling, uses crystals whose optical properties in response to radiation such as that found in the vicinity of an electron beam. As diagnostic methods based on this can be implemented primarily using laser light as a probe, it also holds great promise for ultra-fast, non-interfering diagnostic applications.

7. Research implementation and results under the program

Title of your research plan:

Coherent Transition Radiation Based Electron Beam Diagnostics

Description of the research activities: Experiments to determine the bunch length of picosecond and sub-picosecond electron bunches on a high-energy electron beam were carried out. Emphasis was placed on analysis of a novel diagnostic instrument: the polychromator. This device allows the bunch length measurement of a single bunch of electrons by directly analyzing its associated radiation over ten fixed wavelength bands. Training on the ultra-low temperature cooling system for the device and testing of a new data acquisition system were carried out. The instrument was then used to measure electron bunches produced from an electron linear accelerator. Measurements were taken using a different device (streak camera) for comparison. An experiment to measure a known radiation source was also designed and performed to provide calibration data for the polychromator. Information necessary for a new, detailed simulation of the device's performance was taken and the first set of calculations agree well with design. All necessary data for analysis of the beam, polychromator and new simulation software have been collected.

8. Comments: This being my first international research experience, I was truly overwhelmed by the friendship, professionalism and quality of research shared with me. My time here helped me grow in every positive way. I look forward to future work with Dr. Mitsuru Uesaka's group, and any other chance I may have to work or travel in Japan.

9. Advisor's remarks: I have had him for about two months at Tokai and Tokyo campuses of the University of Tokyo. He's been working for the single-shot measurement of femto- through picosecond electron beams from an electron linear accelerator. He studied in detail and used the far-infrared polychromator which was also upgraded from picosecond beam to femtosecond. He first got the signals of the picosecond beam from the linear accelerator, analyzed them, and is also performing a numerical simulation of the device, which we had not yet done. Those achievements are important for not only him, but us also. Furthermore, he studied a lot of Japanese language and culture so that he really fit in at our laboratory. He joined several friendship parties at our lab and school. We learned a lot from each side. Therefore, his program was extremely successful. Thank you very much for such a nice occasion promoted by JSPS. We look forward to having another chance in the near future.

RESEARCH REPORT

1. Name: Toby Mitchell （ID No.: SP08045 ）

2. Current affiliation: University of Illinois at Urbana-Champaign

3. Research fields and specialties: Engineering Sciences

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Dr. Kenji Oguni

6. Description of your current research

My research at the University of Illinois concerns the simulation of structures subjected to combined thermal, mechanical, and acoustical loading. Examples of such structures are hypersonic aircraft and spacecraft, for which heat, stress and vibration due to atmospheric friction can lead to catastrophic structural failure. This work models the nonlinear dynamical interactions arising under these load conditions with the goal of developing physically accurate and robust simulation algorithms. Such simulations should lead to prediction and avoidance of thermally and acoustically induced buckling of structural components under extreme load conditions.

Research at the University of Tokyo concerns the nonlinear dynamics of fracture in brittle materials. An efficient method for the simulation of dynamic crack propagation developed by Drs. Muneo Hori and Kenji Oguni is being implemented and tested using the ADVENTURE_Impact finite element analysis code. In this method, imperfections in the material are represented by the finite element mesh itself. Monte Carlo simulation can then be used to predict the most statistically likely crack patterns given a particular geometry and set of loading conditions. The resulting simulation tools may allow engineers to predict crack paths in structures subjected to earthquakes, blasts, or other sudden and severe loading events and use such information to improve structural performance and reliability.

7. Research implementation and results under the program

Title of your research plan:

Particle Discretization of the Finite Element Method (FEM-Beta) for Dynamic Fracture Modeling

Description of the research activities:

A particle discretization of the finite element method (referred to as PDS-FEM) was implemented in the explicit dynamics parallel processing finite element code ADVENTURE_Impact. The resulting analysis tool was applied to a simple test problem and the speed of crack propagation in the simulation was compared to analytical and experimental results. Several different spatial and temporal discretizations were tested, including a mesh of over one million elements.

Although the specific geometry of the fracture surface varied with the different discretizations used, the crack speed was found to be remarkably constant for all parameters tested, indicating the robustness of the PDS-FEM method. Qualitative results compared well with experiment, and research is in progress to determine the quantitative accuracy of results. Overall the results were very encouraging, as the method reproduced many of the expected results while avoiding the complexity and computational cost of other simulation algorithms used in this field.

8. Please add your comments (if any):

On a personal note, the experience of studying in Japan under the EAPSI program was extremely rewarding. Both my supervising professors and the other students in my lab were very helpful, and their assistance made it possible to achieve significant results in the limited time available. Other research projects I encountered in Japan were very impressive, and the life in Japan was a constantly interesting and eye-opening cultural experience. In every respect, the experience surpassed my expectations.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Jared W. Nelson
（ID No.: SP08046）

2. Current affiliation: Montana State University (MSU), Bozeman, MT, USA

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: NIED Snow and Ice Research Institute (SIRC), Nagaoka, Japan

5. Host researcher: Dr. Isao Kamiisi and Dr. Satoru Yamaguchi

6. Description of your current research

Avalanches are a significant economic and safety concern in the western United States as well as other mountainous snowy regions throughout the world. Tens of millions of dollars are spent annually by highway departments, railroads and ski areas to mitigate snow avalanches. The goal of this research is to gain a more comprehensive understanding of surface hoar which is a major contributor to increased avalanche danger. Surface hoar is a crystalline growth that occurs during clear, humid and relatively calm conditions. It is believed that these crystals tend to have little adhesion to other crystals or the surrounding layers. Thus, if surface hoar is subsequently buried by snow, it poses a significant avalanche potential as there is little bonding between the layers above and below this weak layer. This research has three components to ensure the analytical and laboratory advances are consistent with field observations. The analytic component focuses on determining physical properties of surface hoar and how this type of growth contributes to avalanche as a potential road hazard. Laboratory research is being performed to better understand the morphology of the microstructure resulting from surface hoar growth using a CT scanner. Exact temperature and humidity are also measured at the snow surface to better understand how these parameters affect growth. In addition, mechanical strength variations over time are measured using a snow micro-penetrometer and shear tests. The field component is performed with the help of snow professionals that are in the field daily. This component allow correlation between what is observed in the laboratory with natural occurrences. In short, this research is not only to better understand the properties of surface hoar, but to also predict when it will form and how various conditions will influence the strength resulting in better avalanche formation.

7. Research implementation and results under the program

Title of your research plan:

Metamorphosis of Depth Hoar in an Isothermal Snowpack

Description of the research activities:

Depth hoar is a faceted grain structure that is commonly the result of a temperature gradient larger than 10 ºC m-1 at the interface between the ground and the snowpack. While significant research has been performed to understand the growth of depth hoar under temperature gradient conditions, little research has been performed to understand the metamorphosis of depth hoar under isothermal conditions. Thus, depth hoar was grown and then subject to isothermal conditions while observing the changes in grain structure. The duration of this program was not long enough to process and analyze all of this data and will continue after the program officially ends. This analysis will be used to establish relationships between depth hoar stage, temperature, time and grain size which will be used to improve the existing modeling software package, SNOWPACK.

This research was performed in the cold laboratory to induce large temperature gradient snow metamorphism. A specific apparatus was used to precisely control the temperature gradient throughout the snowpack. For each experiment, depth hoar was grown at specific temperature gradient for 5-7 days. Initial crystal size was also varied. Upon completion of the growth phase, images were taken using both a hand lens and a photomicrograph for determining the depth hoar stage. Next, the snowpack was placed in an isothermal environment and images were recorded daily for one week and every second day for another week. Over the period of this research, more than 7500 images of the snowpack were gathered. To analyze the changes, each of these images must be processed to gain measurements of the shadows of each crystal. Measurements include for area, perimeter, major and minor axis length, circumference, circularity and various ratios of these parameters. Processing this many images is a lengthy operation which will continue after the program concludes. These parameters will continue to be compared to existing known stages of depth hoar to determine metamorphism type of the crystals in isothermal conditions. Preliminary visual results suggest that the depth hoar stage and crystal size decrease with time in isothermal conditions. Changes appear to be more dramatic with increased initial grain size and at an isothermal condition closer to the freezing point of water. A more comprehensive model will be realized upon completion and analysis of the images gather during this study.

8. Please add your comments (if any):

This project is very interesting and I am extremely grateful to have worked at this institute with these scientists. While this topic was not directly applicable to my PhD research, this opportunity allowed me to work with some of the most renowned snow and ice scientists in the world. Working with them allows me to approach my research differently and more effectively.

While the project was not able to be completed within the timeframe of the EAPSI program, it will continue as a joint effort further fostering a working relationship between MSU and the SIRC.

9. Advisor's remarks (if any):

Even though the cold room experiments in summer are very demanding, Jared carried out them as hard as he could. Thanks to his patient work, a large quantity of data has been collected. We are sure that this work will contribute to the advance the understanding of metamorphism of depth hoar under an isothermal condition. Unfortunately, the period of this program was too short to complete analysis of all data. We look forward to continue working with him after his return home.

RESEARCH REPORT

1. Name: Jeffrey L. Nolte （ID No.: SP08047 ）

2. Current affiliation:

University of Georgia

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: International Christian University

5. Host researcher: Dr. Lukas Pichl

6. Description of your current research

My current research is in computational atomic and molecular collisions. In particular, I am focusing on collisions between highly - charged solar wind ions and neutrals from the inter stellar medium. It is thought that these ion - atom collisions within our solar system are in large par t responsible for the diffuse soft x - ray background which has been revealed through all – sky surveys. The mechanism by which these collisions contribute to the soft x -ray background is through charge transfer, wherein an electron is captured into an excited state from the neutral atom by the incident ion and subsequently decays, emit ting a photon. Models of this heliospheric x – ray emission thus require detailed knowledge of state - selective charge transfer cross sections for the colliding particles. Cross sections are essentially a measure of the probability of capture to a particular state.

The particular collision system which I have studied over the course of the summer is that of O^{7+} , a dominant solar wind ion, and H. Calculations are performed over a wide range of energies, from 0.01 - 50 keV/u. Two methods of calculation are used: for the lower energy range, fully – quantum methods are used, while the semiclassical approximation is used for 1 – 50 keV/u. The reason for implementing this approximation is that, for higher energies, the number of partial waves that must be included in the expansion of the wave function becomes very large and the required computational time increases dramatically.

7. Research implementation and results under the program

Title of your research plan:

Nonequilibrium Effects in Highly -Charged Ion Collisions with Atoms:
Applications to X-ray Emission in the Solar System

Description of the research activities:

Calculations were performed using both a fully - quantal code prepared by Dr. Stancil's group at UGA which utilizes the molecular – orbital close - coupling (MOCC) method, and a semiclassical code prepared by Dr. Pichl. Adiabatic potentials and coupling element s, a vital ingredient in charge transfer calculations, were provided by Dr. Watanabe of Ochanomizu University.

The MOCC calculations utilized a 14 - state basis set. The states selected included all singlet sigma and pi states belonging to the O^{6+} n =5 manifold, to which it was predicted electron capture would primarily occur, as well as two states each for n =6 and n =4. The inclusion of so many states also meant even more computational time required for convergence, but preliminary results have been obtained. These suggest a greater contribution from the n =6 states than was expected, with both n =6 states dominant at energies below 1000 eV/ u, while, as expected, capture to pi states—which are weakly coupled to the entrance sigma channel—is generally seen to be not as significant as capture to sigma states. Further calculations should therefore include more n =6 channels, while saving computational time by removing channels which are seen to be less significant.

Work was also carried out using the semiclassical code written by Dr. Pichl. Numerical methods for the solution of the appropriate first - order differential equations with respect to time and the formalism of the semiclassical formulation were studied. Changes were made to the code in order to read the potential and coupling data and to accommodate the large number of basis states. A short program was also writ ten to integrate the output probabilities over the impact parameter in order to obtain the desired cross sections. Calculations using the same basis set as above show the sigma states corresponding to the O^{6+} 5g and 5d states to be clearly dominant at higher energies.

Curiously however, all pi states give virtually no contribution at all, in contradiction to the MOCC results. Further work must be done to elucidate this discrepancy. Nevertheless, the results so far obtained provide a firm basis for future research.

Finally, contacts and friendships were made with professors and student s of Tokyo Metropolitan University and student s of Kyushu University. In their visits to ICU, we exchanged talks regarding our respective research interests. Preparing a talk on the formalism of the molecular - orbital close - coupling enabled me to consolidate and refine my knowledge of quantum scattering calculations.

8. Please add your comments (if any):

Special thanks is due to the JSPS, NSF, Dr. Lukas Pichl and the administrations of International Christian University and Hitotsubashi for allowing me the privilege to live and work in Japan this summer.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Jeremy C. Palmer （ID No.: SP08048 ）

2. Current affiliation: North Carolina State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Professor Minoru Miyahara

6. Description of your current research

Disordered nanoporous carbons (DNCs) are amorphous materials with heterogeneous microstructures. Due to their high specific surface areas (upwards of 2500 m^2/g), excellent surface activities, and tunable pore-sizes, these materials have found widespread use in many industrial applications such as gas and liquid purification, gas storage systems, and commercial desiccants. Their disordered natures, however, make them very difficult to characterize using conventional experimental techniques such as small-angle x-ray or neutron scattering. As a result, little is known about the detailed microstructures of DNCs and how their disordered natures affects the nanoscale phenomena (e.g. adsorption, diffusion, and chemical reactions) that take place within these materials. This limited understanding poses a significant barrier to synthesizing new DNCs with structural properties that are optimized for specific industrial applications.

My work focuses on using theoretical approaches to develop realistic models for DNCs. We have developed a molecular simulation technique, known as Hybrid Reverse Monte Carlo (HRMC), that generates structural models of DNCs from physical principles and measured structural characteristics. Using this method, we have generated models for five DNCs to date. The overall structural features of these models are in excellent agreement with those obtained from experimental measurements. I use additional simulation techniques such as molecular dynamics (MD) and Monte Carlo (MC) to investigate impact of the heterogeneous nature of these carbons on a wide variety of phenomena relevant to industrial applications such as adsorption, diffusion, and chemical reactions. Using these simulation methods, we are often able to study these phenomena in a level of detail that is far beyond the current capabilities of experimental methods.

7. Research implementation and results under the program

Title of your research plan:
Molecular Simulation of Diffusion in Disordered and Ordered Nanoporous Carbons

Description of the research activities:

The aim of the initial research proposal was to study the impact of the heterogeneous nature of DNCs on the diffusion of simple fluids such as argon, nitrogen, and hydrogen. Using a model for a DNC, known as titanium carbide derived carbon (TiCDC@800C), which was developed using the HRMC method, we used MD simulations to study the diffusive behavior of argon confined within the carbon.

In our initial model, the carbon structure is assumed to be fixed rigid while the motion of the argon molecules in is obtained by integrating Newton's equations of motion. From these simulations, the diffusion coefficient and other quantities of interested were calculated for argon under a variety of experimentally relevant state conditions. Our preliminary results demonstrate that the diffusive behavior of argon confined with in the heterogeneous geometry of TiCDC@800C is qualitatively different from that observed in highly ordered carbon structures and bulk argon. For highly ordered carbons, it has been observed that at a fixed temperature, the diffusivity monotonically decreases as the pressure in the system increases. However, for our disordered model we observed non-monotonic behavior. The diffusivity of argon goes through a maximum at an intermediate pressure and decreases dramatically at lower and higher pressures. This non-monotonic behavior may adversely affect the use of disordered for the hydrogen and methane storage in applications that require materials with a high power density. For instance, this behavior implies that the optimal state conditions for storing a fluid a disordered material are not necessarily the optimal state conditions for removing the fluid from the material. We have also observed that the confining geometry of the carbon structure also alters the physical mode of diffusion for argon, indicating that diffusion in these materials does not strictly obey phenomenological laws such as Fick's equation.

As a result of our preliminary findings, we are in the process of running larger simulations for longer time durations to obtain a higher degree of statistical accuracy in our calculations. We have expanded upon our initial research proposal to include studying of diffusion of argon in carbon structures which are flexible. It is expected that the flexibility of the carbons will have an impact of the diffusivity of argon, especially at low pressure. We have already begun to perform simulations with flexible carbon structures. However, due to the computational expense of these simulations, the duration of this portion of the collaboration will be extended beyond the initial proposed timeline. Finally, we have also extended our investigation to include the study of adsorption and diffusion of hydrogen in disordered porous carbons. Experimental measurements have shown that TiCDC@800C is a promising candidate for storing energy dense fluids such as hydrogen. However, simulation of hydrogen under the experimentally relevant state conditions is a very challenging task due to the fact that quantum corrections to classical Newtonian dynamics must be made to ensure the accuracy of the model. To this aim, we have also developed software during the research duration period to perform the calculations necessary to simulate hydrogen in disordered carbons. We plan to continue our collaboration and use this software to study the diffusive behavior of hydrogen in rigid and flexible DNC structures.

RESEARCH REPORT

1. Name: Portia R Peters （ID No.: SP08049）

2. Current affiliation: University of Southern California

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Japan Aerospace Exploration Agency/Institute of Space and Astronautical Science

5. Host researcher: Dr. Kenji Minesugi

6. Description of your current research

There is a severe vibration environment in the powered flight phase of a launcher. This is a significant design factor for the satellite as well as the electrical components on board. By relaxing the vibration environment there will be an improvement of reliability in addition to a reduction in development costs. With the energy-recycling semi-active method the vibration energy from a structure is extracted and reused for vibration suppression rather than simply being dissipated. By using piezoelectric materials, the strain energy can be converted into electrical energy for vibration suppression.

In my summer project, I applied the energy-recycling semi-active method to a honeycomb sandwich panel in order to reduce the acoustic transmission through the material. The panel consisted of glass fiber facesheets and a Nomex honeycomb core. Piezoelectric actuators were applied and then connected to a circuit that activated the energy-recycling method. Experimental tests were conducted to obtain quantitative data to determine the relationship between vibration suppression and acoustic damping. Several circuit configurations were tested to determine the optimal control setting for maximum acoustic damping. The goal is to relax the acoustic environment in the nose fairing of a rocket launcher by applying this method. The results from this experiment will be used as a basis for performing the experiment on the actual rocket cylinder.

7. Research implementation and results under the program

Title of your research plan:

Application of Energy-Recycling Semi-Active Vibration Suppression Method for Acoustic Damping

Description of the research activities:

1. Identified the elastic modes of the panel by modal test and analysis
2. Determined the optimal positions for the transducers on the panel to get the most effective suppression of vibration that is excited by the acoustic pressure
3. Performed the vibration suppression test and measured the acoustic reduction through the panel both with and without control

Future activities to follow up this research include numerical simulation as well as investigating the logic for acoustic reduction based on the results of the vibration suppression experiments. Preliminary results show there is a direct relationship between the amount of vibration suppression and the amount of acoustic damping.

8. Please add your comments (if any):

I really enjoyed this summer program and I learned a lot by working with Dr. Minesugi and his graduate students. I perform acoustic research on honeycomb sandwich panels at my home institution and my research at JAXA expanded my knowledge base of materials, structural analysis, and vibration control. It was the perfect complement to my current research base.

9. Advisor’s remarks (if any):

Ms. Portia has eagerly studied the research subject and obtained significant results. Her work is greatly helpful and important for our project. Moreover, her single-minded devotion to the study has impressed the graduate students in our laboratory. I greatly appreciate her work. I believe this summer program is fruitful for her and us.

RESEARCH REPORT

1. Name: Heather May Pressler （ID No.: SP08050 ）

2. Current affiliation: Graduate Partnerships Program National Cancer Institute and Johns Hopkins University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry XEngineering Sciences XBiological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Professor Kazunori Kataoka

6. Description of your current research

Currently I am investigating biological molecules as possible drug discovery and therapeutic targets as well as diagnostic tools for prostate cancer at the National Cancer Institute in NIH. In collaboration with the Kataoka Lab I hope to also develop targeted delivery methods for siRNA.

7. Research implementation and results under the program

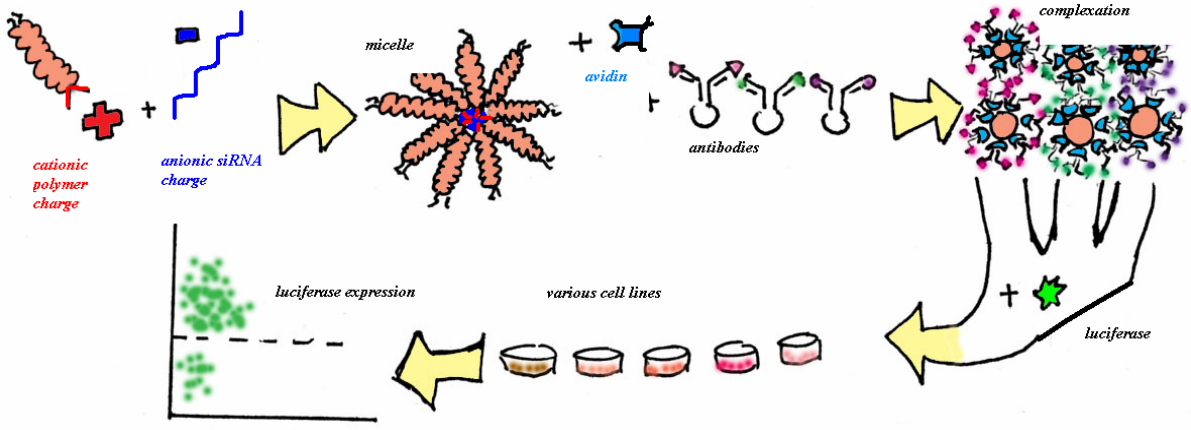
Title of your research plan: **Immune System Targeted Polyplex Micelles**

Description of the research activities:

Project Overview

Specific delivery of siRNA or DNA to immune cells has great potential for treating immune related disorders. Our goal was to develop siRNA encapsulating-polyplex micelles conjugated with an antibody to increase the delivery of siRNA to immune cells. Over the course of the project we were able to synthesize, characterize, and conduct preliminary *in vitro* testing of cell-targeted polyplex micelles for the delivery of siRNA. See Figure 1.

Figure 1: Illustration of Project Outline



Synthesis of Biotin-PEG-b-PLL

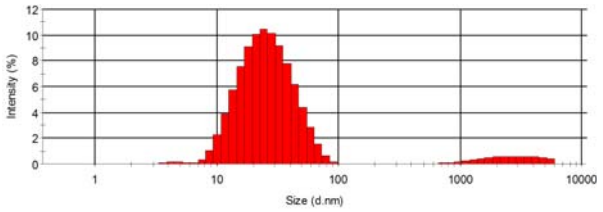
Several synthesis conditions of biotin-PEG-*b*-PLL(IM) were tested. First, activation of the polymer for addition of biotin after deprotection of acetal-PEG-b-PLL was optimized with respect to pH and temperature. A pH of 3.0 and temperature of 37oC for 48 hours resulted in 90% deprotection as observed by 1H NMR spectroscopy. Second, a reaction of biotin hydrazide with deprotected acetal-PEG-*b*-PLL was optimized. This synthetic strategy was chosen because the resulting hydrazone bond formed between hydrazide and aldehyde groups has been shown to be stable at neutral pH. The reaction conditions resulted in approximately 0.73 biotin per PEG as confirmed by 1H NMR. Finally, the biotin-PEG-*b*-PLL was modified to include iminothiolane groups for crosslinking in the micelle core through disulfide bond formation.

Micelle Formation

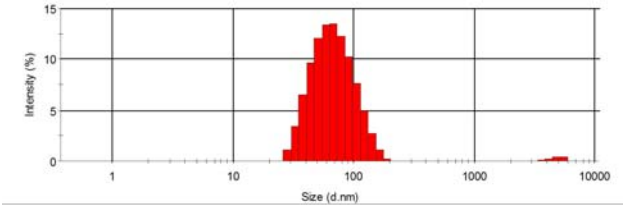
Micelles were formed by mixing the biotin-PEG-*b*-PLL(IM) polymer with predetermined ratios of siRNA followed by dialysis for several days. Once formed, micelles were incubated with avidin labeled antibody (anti-CD44) to attach antibodies to the micelle exterior. Dynamic light scattering was used to determine the size and dispersity of the antibody-micelle conjugates. Before attachment, micelles were approximately 72 nm and avidin-antibody 10nm. After complexation the average diameter increased to 90 nm approximately the same as the average avidin-antibody size See illustration below.

Figure 2: Dynamic light scattering results

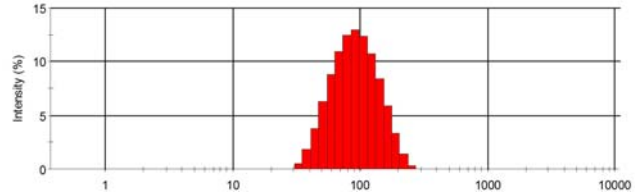
Avidin-antibody



Micelle alone



Micelle and antibody



Caption: Before attachment micelles were approximately 72 nM in diameter, which increased to 90 nM after antibody coupling. Disappearance of the antibody/avidin peak at approximately 23 nM and the increase in micelle size by about 20nM confirms formation of the desired conjugate.

In vitro Testing

Micelles complexed with avidin and antibody we added them to HepG2 (CD44+), HeLa (CD44+), and HEK 293T (CD44-). The gene silencing efficacy of micelles was determined using the dual luciferase assay. Micelles with and without antibody as well as naked siRNA was added to the cells in predetermined, equal molar amounts. The results show excellent gene silencing ability of siRNA encapsulating micelles, however the effect of antibody attachment is unclear and more results are forth coming.

8. Please add your comments (if any):

The synthesis was more complicated and took longer than expected. Due to the time constraints we were unable to conduct *in vivo* research with the targeted particles. I will return to NIH and do more in vitro assays, but may need to return to Japan if in vivo assays are to be completed. I look forward to collaborating with the Kataoka Lab in the future.

RESEARCH REPORT

1. Name: Abigail J. Reft （ID No.: SP08051）

2. Current affiliation: The Ohio State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Seto Marine Biological Laboratory, Field Science Education and Research Center, Kyoto University

5. Host researcher: Dr. Shin Kubota

6. Description of your current research

My research aims to understand the morphology of nematocysts, the defining feature of the animal phylum Cnidaria. All cnidarians produce nematocysts, intracellular capsules with attached tubules. The tubules are packaged inside the capsule, but with an appropriate stimulus, discharge to reveal spines and release toxins. Nematocysts are used in a diversity of ways by the animals, including prey capture, defense against predators, larval attachment, and intracnidarian aggression.

Although all nematocysts share a basic capsule and tubule construction, they vary considerably in the morphology of the tubule and spines. This morphological diversity could reflect the way in which a nematocyst is used by the animal or evolutionary history, i.e. cnidarians may share similar nematocysts due to convergence on similar morphologies or common ancestry of the organisms. My research helps to resolve these questions by fully documenting the morphological variation found across the phylum and then utilizing that variation in phylogenetic analysis. Before coding this variation, the morphology of the nematocyst structures needs to be carefully documented across the phylum.
Therefore, I am collecting cnidarians and characterizing the morphological variation with different types of microscopes. Primarily, I use Scanning and Transmission Electron Microscopy (SEM and TEM), as well as light microscopy and atomic force microscopy to

visualize the morphology of nematocysts. By analyzing the nematocyst characters I discover with other morphologic and genetic characters, I can determine how much concordance or disagreement there is between the diversity of nematocysts and the evolutionary history of the animals that bear them.

The phylum Cnidaria consists of two lineages: Anthozoa and Medusozoa. The laboratory at my home institution focuses on Anthozoa, therefore my sampling of nematocyst diversity was more complete for that lineage than for Medusoza. My primary goal in Japan was to collect several species from as many of the four classes of Medusozoa as possible, and also to collect a few anthozoan species that I cannot readily get in the US. I also analyzed some of the samples using the SEM while in Japan.

7. Research implementation and results under the program

Title of your research plan:

Microscopic diversity of nematocysts of Cnidaria

Description of the research activities: I focused most of my time in Japan collecting cnidarians to sample for nematocysts, preparing some of these samples, and observing them with the Scanning Electron Microscope. With the help of Dr. Kubota, I collected medusae (i.e. jellyfish) with a plankton net during the day and at night with the use of an aquatic light. I collected polyps off a floating dock, and from both the Kyoto University Aquarium and Kushimoto Aquarium. Once collected, the samples had to be sorted and identified; Dr. Kubota and his lab members helped me to do this. Some samples were fixed and prepared for SEM with a freeze drier, whereas most samples where sent to the US (with appropriate permits and permission) for later study. I collected a total of thirty species of cnidarians: ten anthozoans and twenty medusozoans. I have collected representatives of three of the four medusozoan classes (Hydrozoa, Scyphozoa, and Cubozoa), and while established a collaboration with Dr. Yayoi Hirano (Kominato Marine Laboratory) to study the fourth class (Staurozoa).

I have been able to analyze seven species with the SEM while at Seto. My study of hydrozoan species *Turritopsis* sp. and *Eutima japonica* nematocysts reveals that one of the nematocysts types common to both species is morphologically identical to the same type in anthozoans, possibly indicating a nematocyst morphology that is conserved across the phylum. Furthermore, my study of three scleractinian species

(i.e. corals) reveals that their holotrichous isorhizas (a particular nematocyst type) strongly resemble those of corallimorpharians. Studies of DNA sequences and of polyp morphology have strongly supported a close relationship between these two anthozoan orders, therefore, the similarities in holotrichous nematocysts is presumed to be the result of shared ancestry.

The hydrozoan polyp *Halecium* sp. appears to have nematocysts entirely unlike those of other hydrozoans or even medusozoans. Further study is necessary to understand the morphology these odd nematocysts. Therefore, I am also returning to the US with samples of this species to study these nematocysts prepared for SEM by critical point drying, which will ensure that I am not just documenting an artifact of the fixation procedure.

Study of the more than 50 remaining samples representing more than 20 species will proceed at my host institution in the US.

8. Please add your comments (if any):

I accomplished my primary goal of collecting medusozoans for SEM study. Additionally, I learned a new technique for preparing samples for SEM (freeze drying). I also gained experience in collecting and identifying medusozoans, the cnidarian group for which I previously had little experience. I established collaborative relationships with three Japanese researchers, Drs. Kubota and Fukami (an expert on corals) at Seto, Dr. Uchida of Sabiura Marine Park Research Station, and Dr. Hirano of Konimato Marine Laboratory.

9. Advisor's remarks (if any): Lots of needed materials could be collected by field works near the laboratory. All these materials could be prepared for the detailed study of nematocysts of diverse cnidarian groups from Shirahama, Wakayama Prefecture, Japan with good results of SEM observations. Corroborated papers will be expected to publish in a suitable academic journals in the near future. Moreover, a familiar relationship is established with many staffs and graduate students of the Seto Marine Biological Laboratory, Kyoto University as well as other expert Japanese researchers.

RESEARCH REPORT

1. Name: Lee Ellen Rodak (ID No.: SP08053)

2. Current affiliation: West Virginia University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Chubu University

5. Host researcher: Dr. Mikio Kasahara

6. Description of your current research

Extensive research efforts are focusing on the development of Solid State Lighting (SSL) primary due to the potential energy savings it presents over current technologies. For example, incandescent lighting used in most homes only converts approximately 5-10% of the energy consumed to visible white light[1]. In order to produce white light, SSL techniques mix several different colors such that they appear 'white' to the human eye. The two basic approaches include color mixing and color conversion phosphors. In color mixing techniques, the emission from Light Emitting Diodes (LEDs) of different colors are optically mixed in order to create 'white light.' Typically this involves mixing light from red, green, and blue LEDs. Color conversion phosphors are another technique in which a phosphor film absorbs photons of a particular wavelength and then emits photons of a longer wavelength. For example, yellow phosphors or a mix of red and green phosphors are combined with emission from a blue emitter in order to produce white light. The efficiency of the phosphor is heavily dependent on the uniformity, thickness, and packing density of the film.

This work targeted the deposition and characterization of Sinloihi Electroluminescent and cerium doped yttrium aluminum garnet (YAG:Ce) phosphors deposited via silk screening. Silk screening is a traditional deposition technique and was used in this work as it allows a quick means of depositing of thin films. Different weight concentrations were investigated in order to determine the ideal concentrations and color rendering properties. Human eyes are detect light from approximately 400 to 700 nm, and are most sensitive to 550 nm. In order to render colors well, light must be broad and extend over these wavelengths, but not beyond exceed the maximum luminous efficacy of the eye[1].

7. Research implementation and results under the program

Title of your research plan:

Phosphor Development for Solid State Lighting Applications

Description of the research activities:

This work investigated the emission properties of the FA-00X (X=number according to color) series of Sinloihi color conversion pigments and YAG:Ce phosphors. The phosphor powders were mixed with JuJo Polyethylene Terephthalate (PET) #9100 ink in different weight concentrations as listed in Table 1. The weight concentration is defined as $\frac{Phosphor\_Weight}{Phosphor\_Weigth + Ink\_Weight} \times 100$. The films were then deposited on 125 μm thick polyester sheets by conventional silk screening techniques using a 180 mesh screen. As seen in Table 1, Arton from JSR Corporation were also investigated. Arton films have excellent heat resistivity and would be potentially less affected by the heat dissipated by the LED. Table 1 also lists the peak wavelengths of the phosphors. Sinloihi FA-006 was prepared in greater concentrations as the 580 nm peak was anticipated to lead to good color rendering when mixed with the 469 nm blue light from the LED. After printing, all films were cured under Ultra Violet (UV) light for approximately two minutes. The phosphor was then combined with a blue led and the luminescence was measured using a CCD detector. The phosphor film was located approximately 90 mm from the spectrometer and the phosphor was placed flush with the blue LED as it proved to yield highest phosphor emission.

Figure 1 shows the spectrum for FA-006 phosphor. The luminescence from the blue LED and phosphor are shown by the 469 nm and 565 nm peak, respectively. As the weight concentration is increased, the intensity of the phosphor emission is also increased. In order to investigate the effect of thickness, multiple sample sheets were

Table 1 – Phosphors and weight percentages investigated

		Weight Percent				
Phosphor	**Wavelength (nm)**	**5**	**6.3**	**9.5**	**13.3**	**20**
FA-001	590	PET				
FA-005	525	PET				
FA-006	580		PET, Arton	PET	PET	PET
FA-007	600	PET				
YAG:Ce	540		PET	PET	PET	PET

PET = Deposition on polyester sheet
Arton = Deposition on Arton Sheet

mounted together in parallel to maintain the same weight percentage, but increase the total thickness. One, two, and three sheets were measured and are also shown in Figure 1. As the phosphor thickness is increased, the peak emission is also increased indicating that the color rendering can be adjusted by altering the thickness. Also observable is the decrease in the intensity of the blue light as the phosphor concentration is increased, due to the absorption by the phosphor. Figure 2 shows the spectra of FA-001, 005, and 007 when three sample sheets were mounted together. The 5% weight concentration did not yield significant phosphor emission and therefore only the results obtained when three sample sheets are mounted together are shown in Figure 2. Of the samples prepared in a 5% concentration, FA-005 demonstrated the largest peak which we are attributing to variation in the silk screening method that led to a thicker film. Figure 3 shows the spectra from the YAG:Ce phosphor films. The phosphor emission peak was very weak and therefore up to six sample sheets were mounted together in parallel. The peak is considerably broader than the FA-00X peaks, but has a weaker intensity. The YAG phosphor particles are approximately twice the size of the Sinloihi phosphor particles and therefore future work includes determining the density and making a comparison based on volume percent instead of weight.

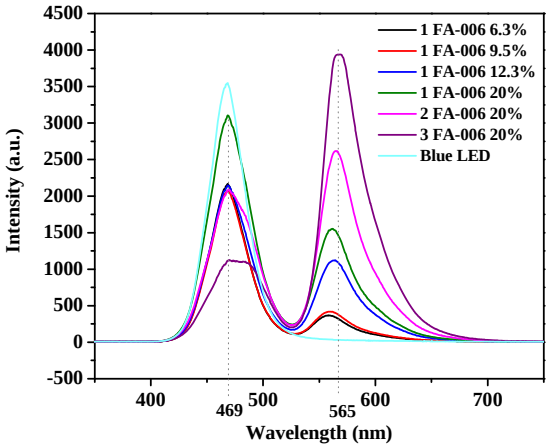


Figure 1 - Spectra of different weight concentrations of FA-006. Spetra when multiple sample sheets of the 20% concentration are mounted in parallel. (In the legend label "x FA-006 y%," x is the number of sheets and y is the weight percent.

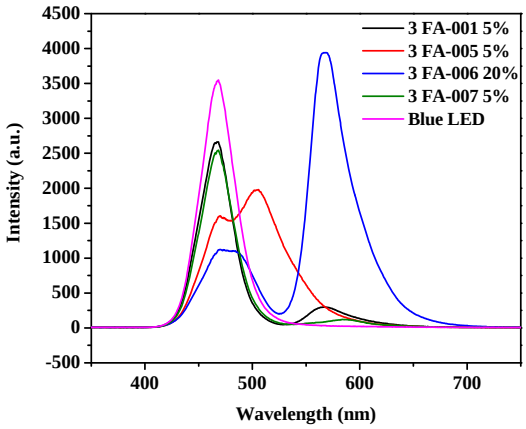


Figure 2 – Spectra of FA-00X series phosphors. Three sample sheets were mounted in parallel. FA-001, 005, and 007 in 5% concentrations while FA-006 in

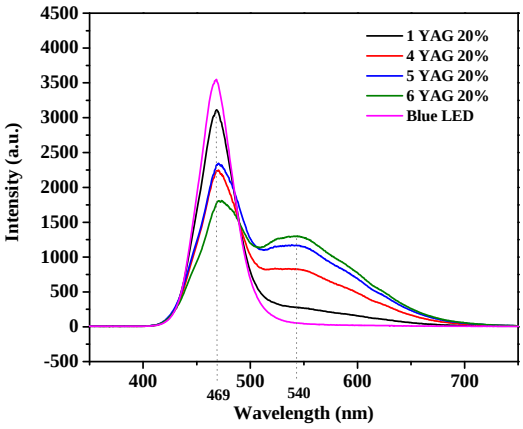


Figure 3 – Spectra of YAG:Ce phosphor and blue LED. Figure illustrates emission when multiple sample sheets are mounted in parallel.

1. "Basic Research Needs for Solid State Lighting." Report of the Basic Energy Sciences Workshop on Solid State Lighting. May 2006.

RESEARCH REPORT

1. Name: John Sarik （ID No.: SP08054 ）

2. Current affiliation: Columbia University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: IBM Tokyo Research Laboratory

5. Host researcher: Yoichi Taira

6. Description of your current research

My group's research focuses on thin film devices and systems, specifically optoelectronic and sensing devices based on organic and amorphous metal oxide thin film materials. Traditional, silicon-based devices are not suited to create systems that must be large, flexible, non-planar, or grown directly on materials which cannot tolerate high processing temperatures. Our group addresses these needs by using low temperature fabricated thin film devices. The ultimate goal of our group is to create a collection of devices, such as organic field effect transistors (OFETs), organic light emitting diodes (OLEDs), and organic photodetectors (OPDs), which can be easily integrated into complex systems on a variety of substrates. These devices will allow novel, low-cost applications which would not possible with traditional electronics.

My current focus is developing imaging systems based on the organic photoconductor titanyl phthalocyanine (TiOPc). In the first stage of the project, single element photodetectors with different device geometries were fabricated and characterized. Two possible geometries for the single element photodetectors, a vertical geometry with stacked electrodes and a lateral geometry with interdigitated electrodes, were explored. The next stage of the project involves designing a fabrication process to create large arrays of devices. Different methods for depositing the TiOPc (spin-coating, inkjetting, and micro-dot dispensing) and different methods for addressing the devices are being explored. In addition, a model for the devices is being developed. Important properties of the devices, such as turn-on voltage, on/off ratio, and signal to noise ratio, will be modeled as function of the device geometry. This will enable the quick and easy design of application-specific photodetectors.

7. Research implementation and results under the program

Title of your research plan:

Design and Characterization of Optical Interconnect Systems

Description of the research activities:

Because of time constraints, the focus of my research this summer was shifted. The goal of my project was to design the transmitter for a high-speed, low power optical interconnect system. This project provided me with experience in modeling optoelectronic devices which will be applied to my current research at Columbia. An optical interconnect system consists of the optical components, which send and receive optical signals, and the optical control circuitry, which convert between electrical and optical signals. In the transmitter, there is an optical source, typically a semiconductor laser, and a laser driver (LDD). In the receiver there is an optical receiver, typically a silicon photodetector, and a transimpedance amplifier (TIA). For this project, the optical source is a 990nm InGaAs vertical-cavity surface-emitting laser (VCSEL) and laser driver is a CMOS IC provided by IPtronics. To optimize the overall performance of the transmitter, the different components were characterized under different operating conditions. Two measurements of transmitter performance are signal quality and power consumption. An eye diagram provides a visual representation of the signal quality. Important information about the signal, such as amplitude, rise and fall times, and jitter, can be read from the eye diagram. Power consumption is typically reported using the power per data rate ratio, measured in milliwatts per Gigabits per second (mW/Gbps).

The first stage of the project considered the operation of the laser driver. The characterization of the laser driver was performing using the IPtronics IPBVD12G011 – Quad VCSEL driver board evaluation kit. A 250 mV peak-to-peak 10 Gbps differential input signal was applied to the laser driver and the output signal was connected to an oscilloscope to analyze the signal quality. The output signal is composed of a constant bias current and an oscillating modulation current. The power consumption and signal quality were measured under a variety of bias and modulation currents. A pre-emphasis current can be added to the signal to correct distortions in the transmission. By selecting an appropriate value for the pre-emphasis current, rise and fall times can be decreased by up to 33% while only increasing power consumption by 15%. The power per data ratio typically ranged from 4.0 - 6.0 mW/Gbps. The laser driver drew a significant fixed power under all

operating conditions, and therefore this particular laser driver may need to be redesigned for use in future systems.

The second stage of project considered the effect of the VCSEL design on transmitter performance. For applications in optical interconnect systems, the VCSEL must have a large modulation bandwidth. This can be achieved by designing a device with low threshold current, small optical mode volume, high internal efficiency, and a large differential gain. To minimize power consumption, the bias current necessary to achieve the desired modulation bandwidth and differential efficiency should be minimized. A model was developed to study the effect of device composition and geometry on these quantities. The model includes corrections for temperature effects, and the results of the model showed good agreement with measurements of fabricated devices. Using the model it is possible to investigate the tradeoffs between performance (high modulation bandwidth, high differential efficiency) and power consumption (low bias and modulation current). The model predicted a number of design changes that could improve VCSEL performance. However, using the current laser driver, the reductions in the necessary bias and modulation currents do result in significant decrease in power consumption.

In the final stage of the project, new VCSELs will be fabricated and characterized. The results of these characterizations will be used to improve the model's predictions. In addition, the techniques developed during the first two stages of the project can be applied to the components in the receiver. This will provide a more complete framework for designing a complete optical interconnect system.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Ryan Seebruck （ID No.: SP08055）

2. Current affiliation: University of Arizona

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Shizuoka University

5. Host researcher: Dr. Tatsushi Ogino

6. Description of your current research

Jinji idou is an annual practice employed by Japanese organizations in which employees are transferred to other positions within the same organization as a way to broaden their employees' experience levels. In Japan's education system this means that teachers, administrators, and even office workers are transferred to other schools within the prefecture every five to seven years. My research looks at how the careers of educators in Japan are managed by examining the formal and informal organizational structure of the jinji idou system found in Japanese public schools in Shizuoka prefecture.

My proposal is predicated on four claims supported by extant literature. First, Japan's education system is more effective than the U.S. system. This claim is supported by federally-published results on international tests and statistics that show Japanese students outperforming their U.S. counterparts. Second, teacher quality is the predominant causal variable affecting student performance. This claim is supported by dozens of studies asserting that the effect of teacher quality on student achievement outweighs other variables. Third, there is an unequal distribution of quality teachers throughout the U.S that produces disparities in educational opportunities. Fourth, this unequal distribution is caused by policies that encourage quality teachers to gravitate to affluent schools while less qualified teachers remain at poor schools.

Following that, my general research question asks, *how does the organizational structure of an education system affect educational egalitarianism*?

7. Research implementation and results under the program

Title of your research plan:

Organizational Structure and Educational Egalitarianism:
Japan's Teacher Transfer System

Description of the research activities:

I conducted over thirty interviews with teachers and administrators at the elementary, junior high school, and high school education levels throughout Shizuoka to better understand how the *jinji idou* system functions. From these interviews I learned the system's cultural and historical significance, the official reasoning behind the system's implementation, the systematic differences at each level of education, the role of the teachers' union in the transfer process, the official structural design of the system, the informal structure that has developed that affects the organizational processes of the system, and the effects of this system on the distribution of teachers. Such an examination will demonstrate how the organizational structure of educational labor markets influences the lives and careers of its educators, and with that, its students.

Furthermore, I also conducted a small survey on teacher's attitudes toward the *jinji idou* system as well as individual career paths that will allow me to map out the careers of each educator.

8. Please add your comments (if any): Originally I had hoped to obtain quantitative data on teacher quality. Such data would have allowed me to test my hypothesis that the centrally-controlled educational labor market of Japan is more egalitarian than the locally-controlled market of the U.S. because it prevents the clustering of quality teachers at certain schools. *Teacher quality* would have been measured by certification status, subject area, and experience level, which would have been used to calculate an index that measures the percentage of under-qualified teachers at each school while adjusting for the percentage of inexperienced teachers. I would have then used this index to calculate a *distribution spread* (based on standard deviation) in order to determine how equitably schools are staffed. These data are considered off limits for fear of privacy violations; however, I urge Japan to make these data available in anonymous form because access to these data could provide other countries with statistical evidence on how to best structure an education system to maximize egalitarianism.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Denton Shanks （ID No.: SP08056 ）

2. Current affiliation: Drexel University School of Public Health

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Nagasaki University School of Medicine, Department of Neuro Anatomy and Biology

5. Host researcher: Nozomu Mori

6. Description of your current research

My previous basic science biochemistry research at Kansas State University was related to the enzyme protein kinase C gamma (PKCγ) whose mutants cause spinocerebellar ataxia type 14 (SCA-14) in human families. My current research at Drexel University School of Public Health is related to global health, preventive medicine, and environmental health. I am also a research assistant at the Drexel Autism Center, where we conduct clinical medication trials and provide diagnosis and ongoing treatment for children with autism. My summer research at the Nagasaki University School of Medicine, Department of Neuro Anatomy and Biology enabled me to combine my previous biochemistry research and interests in neurodegenerative diseases and ageing, with my future as a medical school student and physician scientist.

7. Research implementation and results under the program

Title of your research plan:

Tubulin acetylation and deacetylation in aging and neurodegenerative disorders

Description of the research activities:

My research consisted of growing HeLa and neuronal mouse cell cultures, treating them with genes and drugs, and measuring the results. I completed western blot experiments and immunochemistry assays. The specific gene I worked with is the Huntingtin gene. The neurodegenerative disorder called Huntington's disease is caused by a genetic mutation in the Huntingtin gene, where CAG nucleotide expanded repeats more than 35 times and is thus unstable. A defect in microtubule-based transport plays a major role in the neuron cell toxicity that is observed in Huntington's disease. Histone deacetylase inhibitors, which also deacetylate the residue lysine 40 of α-tubulin of microtubules, provide neuroprotective effects against these problems. I tested the drugs NCT-10b and NCH51, two novel histone deacetylase inhibitors, in their ability to cause deacetylation in Hela and neuronal mouse cells and ability to increase the number of inclusion bodies per area of cells. With further investigations into the specific mechanism of these drugs, as well as other Histone deacetylase inhibitors, novel therapeutic pathways may be discovered to correct problems that lead to Huntington's disease and other polyglutamine repeat diseases.

8. Please add your comments (if any):

From the interaction among my highly intelligent and kind lab-mates and research professor, to the mountain hiking and swimming in the ocean, to the research I accomplished and the scientific and cultural knowledge I gained, every aspect of my JSPS Summer Fellowship experience was excellent. I ate delicious Japanese food, completed exciting experiments, traveled to hot springs and small rural islands, met numerous Japanese and international researchers and doctors, relaxed in numerous spas (onsens), and edited and co-authored scientific research articles. The people were extremely polite and accommodating, the environment was clean, the food was healthy (yet, I ate a ton), the public transportation was efficient, and my research was successful. I think I had a pretty good time ;-).

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Guneeta Singh-Bhalla （ID No.: SP08057）

2. Current affiliation: University of Florida

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Harold Y. Hwang

6. Description of your current research:

My current research at the University of Florida entails trying to understand the unusual electronic properties of manganese oxide (manganite) thin films. Even in single crystal form, the manganite $(La_{0.5}Pr_{0.5})_{0.7}Ca_{0.3}MnO_3$ (or LPCMO), exhibits coexisting islands of metallic and insulating regions within a certain temperature range. In other words, though the crystal lattice is uniform 'physically', electronically it is inhomogeneous. To better understand the nature of the micrometer scale inhomogeneity (or phase separation), we have fabricated thin wires with sub-micrometer widths such that upon lowering the temperature, alternating insulating and metallic regions naturally form along the length of the wire. Such nanometer wide structures have allowed us to gain insights and discover new phenomenon that is strictly size dependent (ie. the constrained dimensions of the nanowires). For example, at low temperatures, when LPCMO becomes a fully ferromagnetic metal with conventional Bloch and Neel domain walls, our measurements suggest that a new type of *insulating* domain wall (IDW) can form in the confined structures. Because of the insulating nature of this domain wall which separates adjacent ferromagnetic metallic domains, we observe signatures of spin dependent electron tunneling across the IDWs. Other observations include unusual current-voltage characteristics which qualitatively resemble the well known coulomb blockade effect and a magnetic anisotropy in the signature colossal magnetoresistance of the nanowire which is not observed in bulk or thin films.

In addition to probing LPCMO on the nanoscale by the fabrication of narrow wires as described above, we have additionally fabricated tri-layer capacitor structures where the manganite forms one of the electrodes rather than the dielectric. Though unusual, this configuration has allowed us to probe the anisotropic conduction in LPCMO thin films

which results from substrate induced strain.

This summer, we have utilized the capacitance techniques previously employed for the LPCMO system for further trying to understand the unusual properties of the two dimensional electron gas that forms at the interface between the two insulators, $LaAlO_3$ and $SrTiO_3$ as discovered by Dr. Harold Y. Hwang, my host researcher at the University of Tokyo.

7. Research implementation and results under the program

Title of your research plan:

Two Dimensional Electron Gas at the Interface Between Insulating Oxides: A Capacitance Probe.

Description of the research activities:

This summer in Japan, I have been working with Dr. Harold Y. Hwang who pioneered work on the electronic rather than ionic reconstruction of interfaces in complex oxides. Specifically, he and his collaborators found that because of the charge distribution across the planes of certain complex oxide insulators, a carefully constructed interface between two such insulators, $LaAlO_3$ (or LAO) and $SrTiO_3$ (or STO) actually becomes highly conducting forming a two dimensional electron gas (2DEG). Since engineering such highly conducting interfaces between perovskite insulators is a fairly new field, there is still much to be learned and understood about the nature of the electronic states that form. For instance, it was found that *gating* the electron gas by applying a large bias voltage across the STO can act as a switch, either depleting the 2DEG or reinstating it by changing the bias polarity. In other words, there is a change in the density of the electrons in the 2DEG upon applying a bias voltage. One way to probe the charge density at the interface of a material is to perform capacitance measurements. A capacitor, which is generally a tri-layer metal-insulator-metal sandwich, can give several insights about the system. For instance, one can learn more about the electronic properties of the interface between the layers and additionally, learn more about the dielectric.

To better understand the charge distribution of the interfacial 2DEG in our system we have fabricated somewhat unconventional capacitor structures. Here, instead of a conventional metal, the electron gas forms one of the electrodes. In addition to using insulating STO substrates, as a control we have also used Nb doped (0.01%) STO substrates, which are conducting and act more like a conventional capacitor electrode. In the latter case, we hope to distinguish the 2DEG from the remaining substrate (since both are conducting) by applying a voltage and depleting a portion of the interface. In fact, in this manner, we can measure the change in the charge density at the interface upon application of a bias voltage across the capacitor, i.e.

map out the depletion spectroscopy.

Thus far, our results indicate an unusual diode-like behavior across the LAO dielectric when a bias voltage is applied across the LAO. In other words, for one voltage polarity, the LAO suddenly begins to conduct while it remains insulating for the opposite case. When a positive voltage is applied to the top electrode, we expect an accumulation of the negatively charged electrons at the LAO/STO interface, and similarly a depletion of the electron gas would occur when a negative voltage is applied to the top electrode. It is for the accumulation case described above that we observe conduction across the LAO. It is a reversible process implying that we have not damaged the LAO film via a dielectric breakdown, which would result in permanent conduction paths. We are currently trying to understand this peculiar result. Though gate voltages have been applied to the 2DEG in previous experiments, they were only applied across the STO substrate, and such diode like behavior has not yet been reported in the literature.

There are several other aspects of this experiment that are currently work in progress and will be continued upon my return to the US. For instance, we are currently in the process of measuring the change in charge density with respect to the applied voltage for the measurements performed on the Nb doped STO substrates, as mentioned earlier. In addition, we would like to compare the *dynamic* transport properties (since capacitance is performed with AC voltages which are time dependent, or dynamic) with the steady state or DC voltages. In this way we hope to decipher the properties of the bulk material from that of the interface. I have prolonged my stay in Japan and also plan to take samples with me to the US, thus continuing the project and the collaborative effort.

8. Please add your comments (if any): I am very happy with my decision to apply for the NSF/JSPS summer fellowship program. This has been an invaluable experience for me both scientifically and culturally. I have enjoyed not only learning new techniques and working on a topic that I find interesting, but have tremendously enjoyed interacting with other Japanese graduate students and having this opportunity to experience an academic environment that in some ways is quite different from that in the US. Thank you to NSF and JSPS for organizing this program and giving us all this opportunity.

9. Advisor's remarks (if any): I have been very pleased with the work of Ms. Guneeta Singh-Bhalla. She has rapidly adapted to a new environment and new field, and she has already found rather interesting new experimental results, which she will continue to pursue. This fellowship has allowed us to start a collaboration which will continue after her return to Florida, and has been a valuable opportunity for us both.

RESEARCH REPORT

1. Name: Stacey D. Standridge （ID No.: SP08058 ）

2. Current affiliation: Northwestern University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo

5. Host researcher: Prof. Tetsu Tatsuma

6. Description of your current research

When silver nanoparticles are irradiated, a collective oscillation of the conduction band electrons arises that is known as a plasmon. The unique properties of plasmons have been implemented in a variety of applications ranging from enhanced fluorescence to sensing. In addition, previous research in the Tatsuma lab has found that when silver nanoparticles on a single-crystalline TiO_2 substrate are irradiated with monochromatic visible light, the samples change color. After irradiation, the color of the samples matches the color of the incident radiation, regardless of wavelength. Furthermore, AFM images of the samples before and after irradiation indicate that spectral changes in the samples are due to morphological changes of the silver nanoparticles. This led the Tatsuma group to hypothesize that upon irradiation, electrons from the excited plasmon are injected into the TiO_2, where they travel until they recombine with silver ions at the TiO_2 surface, either forming new particles or increasing the size of existing particles.

The goal of my research this summer was to further investigate this phenomenon on nanoparticulate TiO_2 substrates. Preliminary experiments in the Tatsuma lab indicated that silver nanoparticles deposited on nanoparticulate substrates are more anisotropic than silver nanoparticles deposited on single-crystalline substrates, leading to the question of how anisotropic particles change morphologically and spectrally when irradiated with light. Thus, my research objectives were twofold: to determine how to deposit anisotropic silver nanoparticles, and to elucidate the effect of irradiation of anisotropic particles. The ultimate ambition of this project is to control the anisotropy of a silver nanoparticles by

varying the post-deposition illumination conditions.

7. Research implementation and results under the program

Title of your research plan:

Investigation of Morphological Changes in Anisotropic Silver Nanoparticles on Nanoparticulate TiO_2 Films

Description of the research activities:

Silver nanoparticles were deposited onto nanoparticulate TiO_2 substrates by drop-casting a $AgNO_3$ solution on the substrate and illuminating with UV light. The spectral properties of the sample were measured using UV-Vis spectroscopy, and the morphological properties of the sample were recorded using AFM. It was determined that a relatively concentrated $AgNO_3$ solution (5 mM) and a moderately long exposure time to UV light (10 min) produced the highest ratio of anisotropic particles. Under these deposition conditions, the anisotropic particles consisted mainly of nanoplates standing with their long axis perpendicular to the substrate.

Upon illumination with blue light (460 nm), which happened to spectrally overlap with the plasmon absorption, a drastic decrease in particle size and particle number was observed. In fact, the morphological changes observed occurred much more quickly and much more efficiently than the changes observed in analogous experiments on single-crystalline TiO_2 substrates. Furthermore, after irradiation, the samples exhibited a deep blue color. Upon irradiation with red light (640 nm), the morphological changes of the samples were much more subtle but still existent. After irradiation, the particles sizes were generally smaller and the sample was a faint red color. My results this summer, particular the drastic changes in morphology with blue light illumination, will provide the basis of future research to be conducted in the Tatsuma Lab.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

Ms. Standridge obtained very interesting results in such a short period. She found that multicolor photochromism of silver nanoparticles on a TiO_2 particulate film involves significant photoinduced changes in the shape of the nanoparticles. This is an important finding in elucidating the mechanisms of the photochromism.

RESEARCH REPORT

1. Name: Laurence Tai （ID No.: SP08059）

2. Current affiliation: Kennedy School of Government, Harvard University

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Research Institute of Economy, Trade and Industry (RIETI)

5. Host researcher: Mitsuhide Hoshino, Director of Research

6. Description of your current research

My current research considers the influence of institutional design on innovation in policy outcomes, with a particular focus on role of the civil services in the US and Japan in environmental policy. My focus is on the policymaking process, with the goal of ascertaining how different policies can result from changes in organizational structure and rules. The salience for research on this topic derives from the growing challenges posed by global climate change and other forms of environmental degradation. Studying the US and Japan allows for richer comparison of different organizational forms than is possible within either country. Analyzing administrative agencies within each country is appropriate because they have been the loci of expertise in various issue areas.

The main empirical analysis for this summer is the impact of civil servant turnover and leadership tenure on innovation in environmental policymaking in Japan's government. The turnover rate is the percent of employees that join or leave a ministry each year. Some turnover is thought to be beneficial to introduce new ideas into an organization. The Japanese "political staff" consists almost solely of Diet members appointed to lead a ministry. Thus, the minister's term length can be used as a proxy for leadership tenure, which is thought to provide stability. Two kinds of innovation are to be analyzed as dependent variables. First, in particular environmental areas, technical innovation is to be measured in terms of standards or targets that are established and achieved, such as air pollution emission standards or recycling rates for various substances. Second, policy innovation is to be measured in terms of laws and regulations passed or revised. The ministries to be studied are the Ministry of Environment (MOE), which makes most policy in environment, and the Ministry of Economy, Trade and Industry (METI), which also contributes.

Complementing this empirical analysis is formal mathematical modeling of the policymaking process. To do this, it is first necessary to acquire an understanding of the details of environmental policymaking beyond what is available in books. After finding these details, formal modeling serves two purposes. First, it serves to provide a mechanism for explaining the relationship between the independent and dependent variables described above. Second, it may suggest additional causes for innovation.

7. Research implementation and results under the program

Title of your research plan:

The Impacts of Civil Servant Turnover and Leadership Term Length on Innovation in Environmental Policy

Description of the research activities:

Thanks to the assistance of staff and fellows at RIETI, I have been able to collect data on the key independent and independent variables. On the independent variable side, I have found a time-series data set indicating the number of people employed in each Japanese government agency, the number of people who entered, and the number of people who exited. This dataset dates back to 1969. In addition to aggregate numbers, breakdowns are also available by age categories. Since Japanese civil servants traditionally start working after college graduation and continue until retirement, this age data allows for more nuanced analysis of the extent to which this pattern has changed in recent years and for closer identification of which workers are leaving. As for leadership tenure, it was relatively easy to find the lengths of tenures for various ministers of MOE and METI.

On the dependent variable side, I have been able to find data on targets for air pollution and recycling, as well as air pollutant concentrations and recycling rates, for measuring technical innovation. For policy innovation, I have been able to find a list of regulations passed by MOE. Since each regulation lists the dates of revision, I now have a measure of regulatory activity. In addition, I have obtained a list of proposed legislation by METI and MOE (and their predecessor organizations)* from 1995 to 2008. Comparing this list to the list of legislation currently in force makes it possible to calculate how often ministries have succeeded in initiating large-scale policy.

Since this research is in political science, I have opted to wait until returning to the US to analyze this data, since data analysis requires only statistical software. Instead, I have focused my research visit to learning things that can only be discovered by going to Japan. In addition to much of the Japanese data mentioned above, these things include the context in which this country's ministries formulate policy. Thus, the second component of my research activities was to interview experts on Japanese bureaucracy and environmental policy. I was able to conduct fifteen interviews, including nine with experts outside of RIETI. RIETI staff and researchers were quite helpful in securing many of these interviews. These interviews were designed to explore the possible mechanisms relating turnover and tenure to innovation, and also to discover potential alternative avenues for bureaucratic innovation.

Lessons from these interviews include the following: First, lawmaking in Japan more heavily involves the civil service than is evident from the nation's constitution, showing how, in practice, informal rules complement formal rules. Second, mentioned in the previous section, is that, unlike their American counterparts, political appointees to lead ministries have almost no staff of their choosing to assist them. Third, bureaucracies promote and rotate their staff among different divisions very regularly, but MOE, a small ministry, has been significantly more flexible in its personnel policy than other ministries, which have more staff and more divisions.

Fourth, unlike in the US, environmental policymaking in Japan by both MOE and METI seems to involve little economic analysis of benefits and costs, with the exception of climate change policy. Detailed versions of these stylized facts provide a rich basis for comparison between US and Japanese environmental policy via formal

modeling. This last lesson required the originally planned definition of innovation, the use of economic instruments in regulation, to be amended to the definitions provided in the research description.

* Until 2001, MOE and METI were respectively the Environment Agency and the Ministry of International Trade and Industry.

8. Please add your comments (if any):

I am very grateful to JSPS and to NSF for offering me this opportunity to gain more knowledge about environmental policy in Japan. This summer has allowed me to establish a significant number of contacts with scholars and civil servants, whose willingness to spend time in interviews I very much appreciate. I also appreciate the help of RIETI staff and fellows in helping me navigate Japanese documents, a necessity given my limited skills in the language. This was my first research visit in Japan, and my research experiences while staying at RIETI have encouraged me to learn more Japanese and more about this country's policymaking.

9. Advisor's remarks (if any):

As a replacement of Mr Nakanishi, I have been an advisor of Mr Tai since the 28th of July, 2008. To the best of my knowledge, he has been very active in (1) gathering and understanding data and information including Japanese documents, (2) discussing the data and information with me, and (3) participating in discussions with METI officers. I hope that his experience in this summer can contribute to his academic and professional success in the future.

RESEARCH REPORT

1. Name: Jonathan Trump （ID No.: SP08060）

2. Current affiliation: University of Arizona, Steward Observatory

3. Research fields and specialties: Astronomy

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Ehime University, Research Center for Space and Cosmic Evolution

5. Host researcher: Prof. Yoshiaki Taniguchi

6. Description of your current research

I study supermassive black holes (SMBHs) in the distant universe. SMBHs were first observed only 50 years ago and were initially thought to be rare and exotic objects. In the last decade, however, astronomers have realized that SMBHs are ubiquitous, present in the centers of all known galaxies. SMBHs seem to oscillate between an “active” accreting phase, in which they are so bright that they can outshine their host galaxy, and a “passive” quiescent phase, in which they are nearly invisible. The physical nature of the “on/off switch” between active and passive phases remains unknown. The properties of SMBHs are observed to tightly correlate to the properties of their host galaxy, suggesting that the evolution of galaxy and SMBH are tightly linked. This co-evolution is almost certainly driven by the active phase, where the SMBH grows through accretion and has an energy output (both in luminosity and dusty winds emitted from its violent accretion disk) sufficient to regulate its host galaxy’s properties. For example, a SMBH may provide “feedback” on its host galaxy, both initiating and halting star formation with its tremendous flux of light and matter. And active SMBH winds have been invoked in several theories and indirect observations in order to provide enrichment and distribution of heavy elements in the host galaxy, such as carbon, nitrogen, oxygen, and the other elements of life. This immediately suggests that the SMBH in our own Milky Way galaxy may have been crucial for the establishment of life as we know it, at least during its past active phases. Yet our SMBH is passive and invisible, effectively hiding all of its past secrets. Instead I use SMBHs and their host galaxies in the distant past as proxies for the history of the Milky Way and our own SMBH. In this way I seek to understand

one piece of life's origin in our galaxy.

This work is only possible because I work as part of the Cosmic Evolution Survey (COSMOS), a collaboration of 200+ astronomers from around the world (including my advisor in Japan, Prof. Yoshiaki Taniguchi). The international nature of COSMOS allows for tremendous time allocations on telescopes operated by many nations and institutions: resulting in the deepest survey of its size to date. COSMOS includes observations from radio to X-rays over 2 square degrees of sky, allowing for the first ever study of a large ensemble of AGN over their entire multiwavelength emission spectrum. My advisor Chris Impey and I have led the spectroscopic follow-up of active SMBHs in COSMOS, while my Japanese advisor Yoshiaki Taniguchi has led an extremely ambitious 21-band optical photometry campaign with Japan & Hawaii's Subaru Telescope. Collaborating between the two data sets allows for the first large sample of active SMBHs with masses comparable to our galaxy's SMBH at only one-quarter to half the age of the universe: the epoch which corresponds to the peak of cosmic star formation and the birth of our sun. This means we can directly observe proxies for our own galaxy's SMBH when it was likely to be most important in influencing the formation of stars like our sun, as well as the enrichment of the elements of life. I intend to use the multiwavelength properties of these active SMBHs to understand the interplay of galaxy and SMBH: through observations I want to learn the physical nature of how a galaxy drives its SMBH to an active phase, as well as how an active SMBH influences its host galaxy.

7. Research implementation and results under the program

Title of your research plan:

The Co-evolution of Galaxies and Supermassive Black Holes: Understanding the Formation of Galaxies like the Milky Way

Description of the research activities:

In combining my host's deep photometry with my spectroscopy, I stumbled upon what seems to be the first observational evidence of an exotic accretion state for SMBHs with masses comparable to our galaxy's own. This result centers on a peculiar class of active SMBHs called X-ray bright, optically normal galaxies: XBONGs for short. Their strangeness is that while their X-ray luminosity indicates an active AGN, their optical emission shows no sign of accretion. The first XBONG was discovered ten years ago, and only about a dozen have been studied in subsequent works. Our COSMOS sample reveals 44—roughly four times the

number of all previously studied XBONGs combined. While these targets were identified using the spectroscopy, the most intriguing result came only from also studying the 21 bands of photometry. my collaborators and I noticed variability in the different years of observations. This finding immediately rules out previous suggestions that the optical dimness of XBONGs is caused by obscuration, since the required size of material that obscures optical light but not X-rays is far too large to be variable on year-long timescales. (The obscuration of only optical light would require material distributed thousands of light-years from the black hole, and variability in only a year would then require changes in this material occurring thousands of times faster than the speed of light). The most feasible remaining explanation for these XBONGs is that they are a special kind of radiatively inefficient accretor, with a truncated accretion disk emitting only at high energies (X-rays). This kind of active SMBH was theoretically suggested many years ago, and was especially suggested as potentially important in lower-mass SMBHs like the one in our galaxy. But my collaborators and I have found completely new observational evidence for the existence of these objects. We're so impressed with the finding that we're currently rushing to put it into publication and I can confidently say that my JSPS/NSF fellowship has directly resulted in a significant new result to be submitted to the Astrophysical Journal this September/October.

8. Please add your comments (if any):

In addition to the most important result described above, my summer research opportunity was extremely important in forging new collaborations with fellow astronomers in Japan. We're already planning at least one telescope proposal to be submitted this fall, and we have many other ideas for tackling the edges of understanding of SMBHs. So stay tuned: it's very likely that several other important results are yet to come.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Frank Tulenko （ID No.: SP08061 ）

2. Current affiliation: Wesleyan University Department of Biology

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: RIKEN Center for Developmental Biology, Kobe Institute

5. Host researcher: Dr. Shigeru Kuratani

6. Description of your current research

My current research focuses on understanding evolutionary changes in mesodermal patterning of the musculoskeletal system in vertebrates. Lamprey diverged from other vertebrates prior to the radiation of gnathostomes (jawed vertebrates), and lack jaws and paired fins. Because of their phylogenetically basal position, the developmental morphologies of lamprey are a proxy for those of ancestral gnathostomes. I am interested in studying the dynamics of the interface between somitic and lateral plate mesoderm during body wall formation in lamprey, and using these data to gain insight into evolutionary changes that have occurred in other vertebrate lineages. During the EAPSI program, I have performed cell fate mapping experiments to determine the role of presumptive lateral plate mesoderm during myotome formation in the Japanese River Lamprey, *Lethenteron japonicum*.

7. Research implementation and results under the program

Title of your research plan: Body Wall Formation in the Japanese River Lamprey, *Lethenteron japonicum.*

Results: Histological analyses demonstrate the presence of a cell population lateral to the somites shortly after gastrulation and somitogenesis. When these presumptive lateral plate cells are labeled with the vital dye DiI, they contribute to structures including the lining of the body coelom and pronephros in older embryos and ammocoete larvae. In several embryos DiI labeled cells invest the lateral margins of the somites, but do not surround individual muscle cells within the myotome. These preliminary data suggest that somitic cells do not delaminate and mix with lateral plate cells during myotome expansion and formation of the body wall. In amniotes, somitic migratory cells leave the somite and enter the lateral plate to give rise to the muscles of the limb, abdominal body wall and diaphragm. The cell fate mapping experiments described herein suggest that the evolutionary innovation of

migratory somitic cells occurred in the context of a primitive system in which somitic cells differentiated within a somitic environment.

Description of the research activities:

Eggs of the Japanese River Lamprey (*Lethenteron japonicum*) were artificially fertilized and maintained in 10% Steinberg's solution at 16^{O}C. Embryos at select developmental stages were embedded with glycol methacrylate and sectioned at 2–4μm using a Leica Ultramicrotome to determine the location of the presumptive lateral plate mesoderm. Fine glass micropipettes were used to inject DiI into either somitic mesoderm or mesoderm lateral to the somites in live embryos at developmental stages 22 through 24. Embryos were maintained in laboratory incubators and fixed with 4% paraformaldehyde at various developmental stages, including free-living, premetamorphic ammocoete larvae. Fixed embryos were washed with PBS, cryostat sectioned, and immunohistochemically labeled with MF20 to identify skeletal muscle. Hoechst was used as a general nuclear marker. The location of DiI label was evaluated with fluorescence microscopy.

8. Please add your comments (if any):

The JSPS EAPSI program was one of the most meaningful experiences of my academic career, and exposed me to a non-western perspective on science. The training I received at the RIKEN Center for Developmental Biology has been tremendous. Additionally, the networks I have formed during my time in Dr. Kuratani's laboratory for Evolutionary Morphology have opened the door for exciting future collaborations. I am deeply grateful for the opportunity and privilege to study in Japan and look forward to future visits.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Jann Vendetti （ID No.: SP08062）

2. Current affiliation: Integrative Biology Dept & Museum of Paleontology, UC Berkeley, Berkeley California 94720-4780

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Nagoya University

5. Host researcher: Dr. Seiji Hayashi

6. Description of your current research

Marine whelks (snails in the family Buccinidae) are one of the most diverse families of marine snails. The western Pacific buccinid fauna of Japan alone includes 344 species within ten subfamilies. My goal in studying these animals is to reconstruct their family tree (or phylogeny) and assess their early developmental modes. In addition, I am interested in the evolution of their early development, which can be investigated using fossil whelk shells. To do this I characterize the size and shape of the very top of the shell, called the protoconch. This method has been used by paleontologists since the 1970s to generally infer the developmental mode of all marine snails, but has never been applied and tested specifically within the buccinid whelks. These snails have two kinds of developmental “options” in the early stage of their life. Such modes of development are consistent within species, but vary across species. Shelled whelk larvae hatch into either a planktonic free-swimming forms called veligers or as non-planktonic crawling juveniles. Their larval shell/protoconch remains at the shell apex into adulthood, which can then be used to infer whether it was a swimming or crawling developer. My goal in Japan was to gather a large amount of data on buccinid gastropod development and within-family relationships, then carry out specific analyses back to UC Berkeley.

7. Research implementation and results under the program

Title of your research plan: Developmental evolution in marine whelks (Gastropoda: Buccinidae): an analysis of ontogeny and phylogeny

Description of the research activities:

The particularly diverse buccinid fauna of Japan presented a singular opportunity to collect whelk protoconch data and through DNA sampling, improve the resolution of their family tree. The goals of this proposed research project were to (1) collect data for evaluating the shell apex/developmental mode of as many fossil and extant buccinids of Japan as possible, and (2) take tissue samples from 25-35 species of whelk for molecular analysis and phylogeny construction back at my home institution, UC Berkeley. To succeed in these objectives required fieldwork, specimen preparation, and extensive museum work- which involved locating, identifying, sampling, and photographing whelk specimens.

For goal (1) my sampling technique was to make molds of the protoconchs of buccinid whelks. To assess the size and shape of protoconchs requires their analysis and measurement under the high power of an electron microscope. This would have been prohibitively time-consuming and too expensive to undertake in seven weeks. So, prior to arriving in Japan, I developed and tested an efficient and non-destructive way to mold the tops of whelk shells (and therefore mold the protoconch). This procedure involves extruding a quick setting silicone-based impression material, used commonly by dentists, onto the apex of shells. In only three minutes, this compound dries into small, easily portable, light-weight, and dimensionally stable molds. Casts from these molds will be made at UC Berkeley and analyzed as described above with electron microscopy.

While in Japan, I made molds of more than 150 extant and fossil whelk specimens and photographed approximately 250 individual shells, though I am still counting, so this is probably an underestimate. All data were gathered from the following ten museums or collections (listed in the order that I visited them); The Museum of Sea and Shells in Rikuzen-Takata, the Tohoku Museum of National History in Sendai, the private collection of Mr. Higuchi in Sendai, the K. Amano collection at the Joetsu University of Education in Joetsu, the Nishinomiya Shell Museum in Nishinomiya, The Paleontological collection of the National Science Museum in Tokyo, the Tokyo University extant gastropod collection, the National Science Museum in Tokyo Kawamura Collection, the Mizunami Museum of Natural History in Mizunami, and the Nagoya University paleontological museum collection.

For goal (2) I collected 27 whelk foot tissue samples, identified them to species, removed the animal remains from their shells, stored the sampled tissue in 95% ETOH, and cleaned and retained the empty shell. Because whelks are eaten by the Japanese and sold at fish markets, much of my fieldwork was searching fish markets for whelk specimens. I visited fish markets in Nagoya, Sendai, Joetsu, Osaka, Tokyo, and Kyoto. I was also given frozen, fresh, or prepared whelk samples by three Japanese whelk collectors. The following list details the whelk tissue samples that I collected;
(1) Babylonia japonica, Nagoya Fish Market, (2) Beringion polynematicus, Hokkaido fisherman, (3) Buccinum bayani= Buccinum aniwanum, Tsukiji Fish Market, Tokyo, (4) Buccinum leucostoma, Gift of U.Tokyo graduate student, L. Haga, (5) Buccinum

middendorffi, Nagoya Fish Market, (6) Buccinum senshumarue, Joetsu Fish Market, (7) Buccinum tenuissimum, Joetsu Fish Market, (8) Buccinum tsubai, Joetsu Fish Market, (9) Buccinum verkruzeni, Hokkaido fisherman, (10) Clinopegma unicum, Gift of: Seiji Hayashi, (11) Colus (Aulacofusus) hiranoi, Gift of U.Tokyo graduate student, L. Haga, (12) Colus (Aulacofusus) sp., Gift of U.Tokyo graduate student, L. Haga, (13) Golikovia ennae Gift of U.Tokyo graduate student, L. Haga, (14) Japelion pericochlion, Given by Mr. Higuchi in Sendai, (15) Lirabuccinum fuscolabiatum Given by shell museum curator, (16) Mohnia multicostata, Gift of U.Tokyo graduate student, L. Haga, (17) Nassaria/Microfusus magnifica, Gift of U.Tokyo graduate student, L. Haga, (18) Neptunea arthritica Nagoya Fish Market, (19) Neptunea arthritica cumingii, Sendai Fish Market, (20) Neptunea constricta, Joetsu Fish Market, (21) Neptunea eulimata, Nagoya Fish Market, (22) Neptunea intersculpta, Nagoya Fish Market, (23) Neptunea (intersculpta) frater, (24) Neptunea polycostata, Sendai Fish Market, (25) Neptunea sp., Gift of U.Tokyo graduate student, L. Haga, (26) Neptunea Kuroshio, Gift of U.Tokyo graduate student, L. Haga, (27) Volutharpa ampullacea perryi, Given by Mr. Higuchi in Sendai.

8. Please add your comments (if any):

I am pleased with the success of my project as well as the amount of culture that I could experience in Japan.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Anh Vu （ID No.: SP08063）

2. Current affiliation: University of California, Riverside

3. Research fields and specialties: Intelligent Systems

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University

5. Host researcher: Hiroshi Ishiguro

6. Description of your current research

Over the course of the years, there have been a lot of works in the robotics community focusing on robots as a single agent trying to carry out tasks on their own. As more and more researchers have learned, some of the tasks are better carried out as a distributed multi-agent as opposed to a single agent. For applications such as surveillance and autonomous personal mobility, multi-agent robots might benefit from having redundant units and the ability to communicate amongst themselves, as well as sharing of knowledge within the swarm of robots. While there have been a number of efforts to study systems in the wild such as those in plants, insects, and the animal kingdom exhibiting the traits of a multi-agent system, a lot of these studies have not been successfully adapted to the field of robotics. In this research, we want to come up with a mobile multi-agent system, where the agents work and communicate to one another so that they are more efficient in applications involving a cluttered and dynamical environment. The applications in which we are considering are: general surveillance of an area, autonomous personal mobility vehicle, and personal robot helper in a highly cluttered area (shopping mall, train station, airport). Each of the agents rely on acatadioptric Omni-Directional Vision Sensor (ODVS) for sensing which give them a full 360˚ view around the robot agent, the information extracted from the ODVS will also be shared with other agents over a wireless network, allowing the robots to build a probabilistic map identifying occluding objects to make better judgments, and help them perform long term planning.

7. Research implementation and results under the program

Title of your research plan: Multi-agent Sensing and Navigation in a Crowded Environment

Description of the research activities:

A large amount of time has been spent on identifying applications that would benefit from a multi-agent framework, proposing robot and sensor architecture for these applications, and simulating these robots in a crowded area filled with pedestrians. More specifically, we are aiming at applications where a swarm of mobile robots work and interact in a dynamical environment where there is a lot of human movement. Each of the robots has to carry out a number of different tasks depending on the environment and how human interact with each of the robots. Such a system of robots can be implemented at a train station, or an airport to carry out tasks such as help answering frequently asked questions, directing and facilitating traffic by taking pedestrians to their destinations, as well as performing security surveillance to identify suspicious items and activities. Another unique application could be an autonomous personal mobility platform, capable of navigating through traffic on arterial roads to minimize traffic congestion.

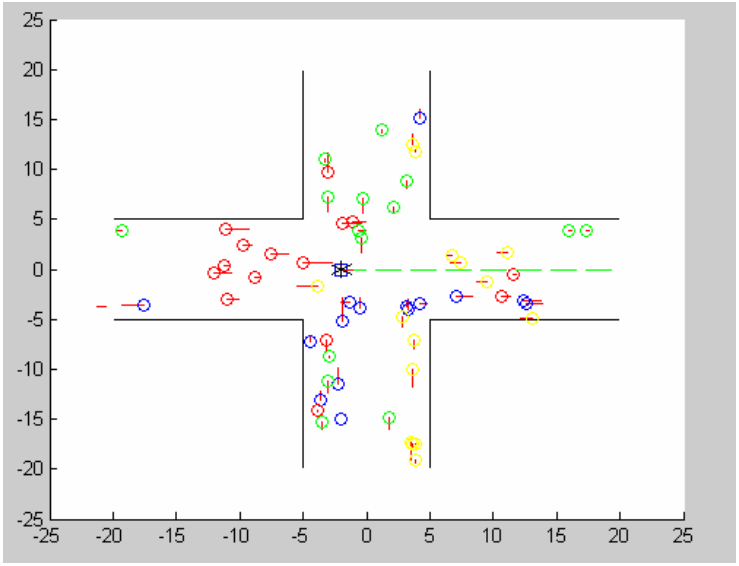


Figure 1: Simulation of a single robot agent moving through a crowded intersection

The framework we are proposing in which each of the agents would follow to work together and navigate toward their destinations more quickly and efficiently make use of a catadioptric omni-directional vision sensor (ODVS). The images from the ODVS are preprocessed to extract edge and optical flow information. Afterward, we extract only a single circular line from the ODVS image with their correspondence edge and optical flow information to use in an online incremental learning algorithm that will predict the velocity and direction, in which the robot is

capable of moving into. Using the predicted velocity that the robot is capable of moving in the surrounding, the robot performs a cost analysis to determine the heading and velocity that is going to give it the most reward while optimizing parameters such as power usage and the time it takes for the robot to move from the starting point to the destination. Also, by using the predicted velocity, the robots will be able to share information with one another to build a probability map of occluding objects in the surrounding. The probability map can be used to help the robots make better decision by narrowing down the action choices, while eliminating the ones that it is sure will be bad actions to take.

Figure 2: A mobile robot (left) was used to gather ODVS image (right)

Using a small mobile robot equipped with an ODVS, we gathered a lot of experimental data on the Osaka University campus, busy shopping malls around train stations, where we are analyzing the data to see if there is a trend, or pattern in a crowded environment and how the environment affects the sensor, as well as our processing framework.

8. Please add your comments (if any): This summer program has provided me with a unique opportunity to interact and have discussions with some of the leading scientists in the fields of robotics, where we have identified some challenging problems to cooperate in research. I also made a lot of friends in the lab, and we had a lot of fun discussing concepts, ideas, and they helped me out a lot with things I am unfamiliar with in Japan. The home stay with a Japanese family was also a very unique and fun experience.

9. Advisor's remarks (if any): While the summer program is short, Anh has been working diligently and making a lot of progress in his research. Anh will continue with his current research when he goes back to the U.S. and we will continue to keep in touch to make sure that there is steady progress toward the goal of the research. We also had a lot of discussions and identified challenging research topics in which we can continue to cooperate in the future.

RESEARCH REPORT

1. Name: Jared Wayne Westbrook （ID No.: SP08064 ）

2. Current affiliation: University of Florida Department of Botany

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
X Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Okayama University Institute for Bioresources

5. Host researcher: Dr. Jian Feng Ma

6. Description of your current research

7. Research implementation and results under the program

Title of your research plan:

Does Si ameliorate Al-toxicity and reduce the Al-tolerance response of buckwheat, an aluminum accumulating crop plant?

Description of the research activities:

Background: Aluminum toxicity is a major limitation to agricultural productivity in acidic soils worldwide. At pH >5, Al^{3+}, the phytotoxic ionic species, becomes soluble and binds to negatively charged sites on plants roots disrupting metabolism and restricting root growth. As an Al-tolerance strategy, many plant species exude organic anions (e.g. oxalate) from roots that chelate aluminum alleviating aluminum-induced root growth inhibition. Some plant species that are well adapted to acidic soils may also take up aluminum into cells, detoxify it internally in roots, leaves, stems with organic anions, and sequester aluminum away from sensitive cellular sites in vacuoles or in chelated form in cell walls.

Silicon, also a naturally abundant element in soils has been demonstrated to alleviate aluminum stress, partially restoring root growth. There has been some debate in the literature as to whether the primary reason for silicon's ameliorative effect is because it reduces Al^{3+} activity by forming Al-Si complexes in the soil solution or *in planta*. Researchers have demonstrated that the formation of insoluble Al-Si complexes in solution is pH dependent occurring most prevalently at pH 5.5. At lower pH, it seems that Si has lower affinity for Al, perhaps forming soluble complexes, but the toxicity of these complexes to plants is still poorly understood. Supporting *in planta*

amelioration of Al by Si, researchers have observed that Al is co-localized with Si in cells walls of leaves and roots of some species, but it is not clear whether these plants are coincidentally storing these elements in cell walls or whether this co-localization is part of an aluminum tolerance strategy.

In an attempt to resolve this debate, I have chosen to perform physiological experiments in hydroponic media with buckwheat (*Fagopyrum esculentum*), an aluminum accumulating crop plant. The aluminum tolerance strategy of this species has already been well characterized, but its response to Si is unknown.

Experiment 1: Al-Si interactions in solution

If Al-Si interactions are minimal at pH < 4.5 as some researchers claim, yet Si-induced amelioration of Al-toxicity is observed, then ameliorative effect of Si occurs in planta. I prepared simple solutions with constant 50 uM [$AlCl_3$] + 500uM [$CaCl_2$], but varied [$Si(OH)_4$] (0, 500, 1000, and 1500 uM) and pH (4.0, 4.4, 4.75). I measured monomeric Al concentration (Al^{3+} + $Al(OH)^{2+}$ + $Al(OH)_2^{+}$) colorimetrically with pyrocatechol violet.

Experiment 2: Si effect on Al-induced root elongation inhibition

This experiment is fundamentally important in determining if Si ameliorates aluminum root growth inhibition in buckwheat. I pre-cultured buckwheat seeds in 500uM $CaCl_2$ at pH 5 for 72 hours in the dark. After, I exposed the seedlings to 50 uM $AlCl_3$ at pH 4, 4.4, and 4.75 with varying concentrations of Si (0, 500, 1000, 1500) for 24 hours with 10 replicates per treatment. I measured root length with a ruler before and after treatment to determine elongation. Results are presented at relative root elongation which is treatment average root elongation divided by Al/Si free control at a given pH.

Experiment 3: Si effect on Al-induced oxalate exudation from roots

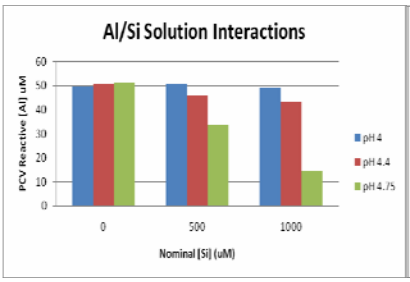
Buckwheat exudes oxalate ($C_2O_4^{2-}$) from root tips to chelate aluminum and reduce its toxicity to roots. If Si reduces Al activity in the solution or within the cell walls of plant root cells, then oxalate exudation rates should decrease in the presence of Si because exudation rate is proportional to Al-activity near root cell plasma membranes. I measured oxalate exudation into the hydroponic growth media with HPLC. The treatment lasted 6 hours at pH 4.4 and 50 uM nominal $AlCl_3$ + 500 uM $CaCl_2$ concentration. I varied $Si(OH)_4$ (0, 500, 1000 uM). I normalized exudation rate by dry mass of roots with three replicates per treatment.

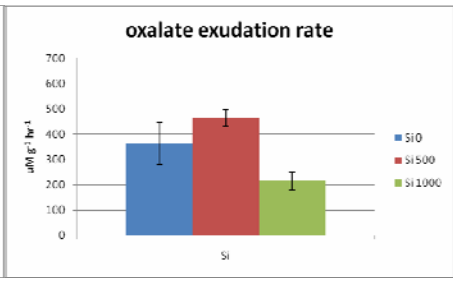
Experiment 4: Si effect on aluminum accumulation in roots, stems, and leaves

If Si uptake is indeed an aluminum tolerance strategy of buckwheat than I would expect to see increased capacity of the plant to take up Al in the presence of Si and the co-localization of these two elements perhaps in the cell wall or vacuoles of leaf and root cells. Previously, my host researcher demonstrated that buckwheat stores aluminum in vacuoles. I treated two week old plants for 10 days alternating treatment solutions and 1/5 Hoagland nutrient solution every day. The treatment solutions had the same composition as the root exudation experiments. I measured Al concentration in tissues with AAS after digestion in concentrated HNO_3.

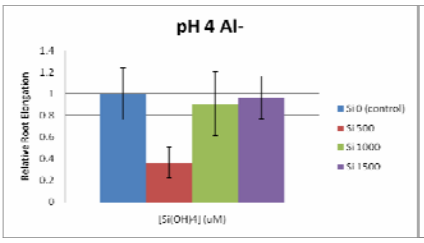
Results:

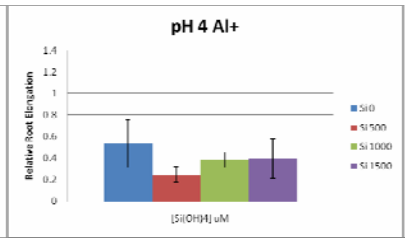
Experiments 1&3 Al/Si solution interactions and oxalate exudation rates (+/- 1 SE):

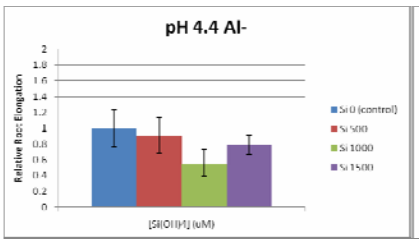


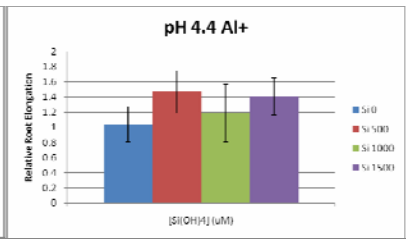


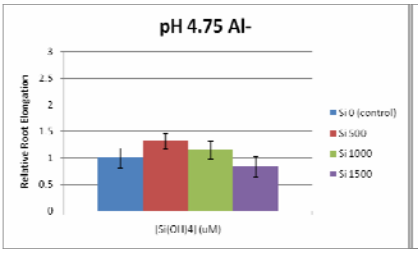
Experiment 2: Root elongation (+/- 1 SE):

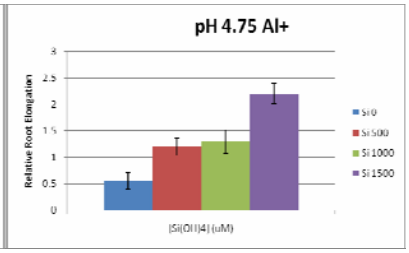




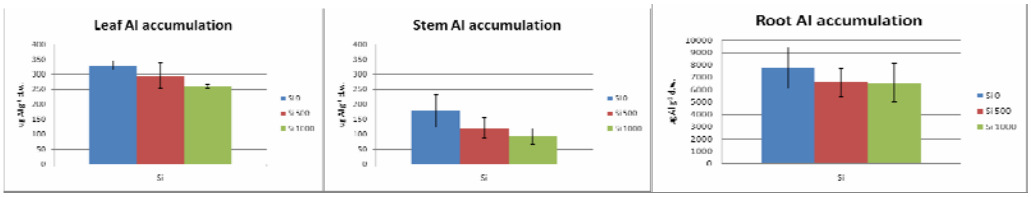








Experiment 4: Aluminum accumulation (+/- 1 SD)



Conclusions: Al activity in solution is reduced by increasing concentrations of Si with the effect more prevalent with increasing pH. With the exception of pH 4.75 where Al-Si interactions in solution are the greatest, it appears that Si does not significantly ameliorate Al-induced root growth inhibition, nor does it affect oxalate exudation Al-tolerance response of this species, although the presence of Si reduces Al accumulation. These results suggest Si-amelioration of Al-toxicity in buckwheat is due to a reduction of Al activity in solution.

RESEARCH REPORT

1. Name: Erin Whorton （ID No.: SP08065 ）

2. Current affiliation: University of Washington

3. Research fields and specialties: Earth and Space Sciences (Glaciology)

Humanities Social Sciences （X） Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Hokkaido University- Institute for Low Temperature Science

5. Host researcher: Dr. Takayuki Shiraiwa

6. Description of your current research

The region of ice at the sole of a glacier is called basal ice. Many polar glaciers have a prominent debris-rich basal ice layer, which may deform more easily than the overlying ice. Echelmeyer and Zhongxiang (1987) observed that flow mechanisms in the debris-rich basal layers of Urumqi Glacier No. 1 in China accounted for 60-80% of the overall glacier motion, even though the layers were only 1-2% of the effective glacier thickness. We present results from a study exploring the importance of these debris-rich basal ice layers to the flow dynamics in the terminus region of Taylor Glacier, a cold-based outlet glacier of the East Antarctic Ice Sheet. Observed surface velocities are 20 times greater than that predicted by laminar flow for clean, homogenous, isotropic ice at the field site. We hypothesize that a soft basal-ice layer near the bed is accommodating the large strain rates.

A two-layer two-dimensional flowband model is used to study the relative contributions from the debris-rich basal ice and the overlying clean ice to the deformation rates. The model unknowns are the softness parameters for the clean and debris-rich ice, and the thickness of the basal layer along the flowband. We constrain the model inputs and outputs using 2 years of field observations, including ground penetrating radar, ablation, ice temperature, basal ice thickness, and surface velocity measurements. Results show that the basal ice contributes 63-76% to the total flow rates in the terminus region. This weak layer, therefore, significantly affects the glacier dynamics and suggests that it would be worthwhile to incorporate rheologically distinct layers in models of polar glacier dynamics.

Basal ice studies are essential in glaciology since the basal zone directly reflects the interactions between a glacier and the substrate beneath it (e.g. Lawson, 1979; Souchez and Lorrain,1991). Sediment is transported to the cliff margin in these debris-rich basal layers, and may provide the main source of debris for moraine formation, which are a useful indicator of past glacial positions. Glaciers significantly alter the morphology of landscapes through erosion at the bed and margins. The erosion and debris entrainment rate is directly proportional to the basal sliding speed. Until recent observations of sliding in glaciers previously thought to be frozen to their bed (Echelmeyer and Zhongxiang, 1987; Cuffey and others 1999), current erosion models assumed bed deformation and basal sliding did not occur beneath cold-based glaciers. The sliding observations at Urumqi Glacier No. 1, China and Meserve Glacier, Antarctica revised the belief that cold-based glaciers are incapable of eroding the bed material, entraining sediments and contributing to landscape evolution (Sugden and John, 1976; Kleman, 1994; Paterson, 1994).

7. Research implementation and results under the program

The glacier flowband model used in this study utilizes an informal inverse approach to determine the rheology of the overlying clean ice and debris-rich basal ice, and basal ice thickness at Taylor Glacier. We constrain possible model solutions using several criteria: basal ice thickness observations in marginal tunnels (Samyn and others, 2005), observed and extrapolated surface velocity data, a smoothness factor to describe the model basal ice thickness and surface velocity profiles, and the overlying clean ice fabric data. Essentially, the model tries to match the steady-state velocity and geometry profile at Taylor using many ice rheologies. We use the constraints to limit the possible ice softness parameter choices.

Glacier ice flow is generally analyzed using a Glen's law (Glen, 1958), which is an empirically derived function defining the strain-rate as a nonlinear function of stress and temperature. A softness parameter, *E*, is introduced as a multiplier of the stress term and is used to explain significant strain-rate variations that cannot be described by Glen's law alone. Several ice properties that affect strain rate in addition to temperature including, chemical and solid impurities, water content, crystal size and orientation, have been identified (Budd and Jacka, 1989). During the JSPS 2008 summer program, we utilized two experimental data sets (Miyamoto, 1999; masters thesis, 1997) collected at the Institute for Low Temperature Science at Hokkaido University, to constrain the ice rheology inputs into the flowband model. Each of these studies investigated the direct effect a specific ice property has on ice deformation rates. We employ these data and the measured ice properties of the Taylor Glacier clean and debris-rich basal ice to assign

specific softness parameter values to each ice property. The prescribed softness parameters are used in the model to determine the effects this ice rheology combination has on the flow dynamics of Taylor. The work done this summer is significant for two main reasons, (1) I incorporated previously unutilized ice property data from Taylor (2) the primary model input, the two ice rheology values, were determined from my host institutions experimental data sets.

Miyamoto preformed uniaxial compression ice deformation studies on ice core samples collected in Greenland. In these experiments, he explored the links between crystal orientation and strain-rate. Softness parameter values of 6 and 2 are attributed to the crystal orientation of the overlying, clean and debris-rich basal ice of Taylor respectively. A master's student preformed constant stress and strain-rate experiments on isotropic ice with variable debris concentration to explore the effects debris content has on strain-rate. Surprisingly, he concluded that debris concentrations higher than ~20% had a very small effect on increasing the ice strain-rate. The basal ice debris concentration at Taylor is ~30% by volume. We infer that the softness parameter for the debris effect at Taylor is negligible compared to the crystal orientation effect. The total bulk glacier viscosity utilizing the two experimental data sets is much smaller than found in the previous model runs (~15% smaller). The higher ice viscosity results in a 20% average thickening of the basal ice layer beneath Taylor Glacier, and only ~42% of the total glacier velocity can be attributed to deformation in the debris-rich basal ice. The softness parameter for the overlying clean ice found in the model runs and using the ice deformation experiments agrees very well. These experiments indicate that the basal ice viscosity is higher than the clean ice, which directly contrasts our previous conclusions. However, this method to determine the average softness parameter for the basal ice zone is probably too simple to incorporate the multiple effects from the widely varying ice properties within the basal ice. Samyn and others (2005) have postulated that discreet shear zones accommodate the bulk of the deformation within the basal ice. The basal zone structure influence was not included in the ice softness parameter estimates, and may be the primary source of discrepancy between the previous model investigations and this summer's research.

Title of your research plan:

Debris-rich basal ice layer effects on polar glacier dynamics

Description of the research activities:

8. Please add your comments (if any):

9. Advisor's remarks (if any)

RESEARCH REPORT

1. Name: Elizabeth Savory
（ID No.: SP08066）

2. Current affiliation: Department of Plant Pathology, Michigan State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Nara Institute of Science and Technology
8916-5 Takayama, Ikoma, NARA 630-0192 JAPAN

5. Host researcher: Noriko Inada

6. Description of your current research

Downy mildew is an important disease of cucurbits (e.g., cucumbers, melons, etc.), caused by the obligate pathogen *Pseudoperonospora cubensis*. Historically, cucumber (*Cucumis sativus*) in the United States has been resistant to downy mildew, but introduction of a potential new pathotype of *P. cubensis* has been causing devastating losses in recent years. Understanding the molecular genetic interactions between host and pathogen during the infection process will enable us to elucidate the mechanisms behind infection and disease progression and allow us to identify potential strategies for breeding downy mildew resistant cultivars.

Laser microdissection (LCM) couples a microscope with a focused laser beam for isolation of specific cells or microscopic regions of interest which then provide cell-or region-specific DNA, RNA, protein or metabolites for subsequent analysis. This technique is particularly useful in studying gene expression during the initial stages of pathogen infection, especially in plant cells due to their highly regular tissue organization and stable cell walls. I propose to utilize this technique to characterize the interaction between cucumber and *P. cubensis* at the cellular level. Through the use of LCM, we will be able to isolate single host cells at various stages of pathogen infection, which then will be used to profile gene expression during pathogen invasion. These analyses will in turn provide information about pathogen recognition pathways, potential defense signals, and communication between host and pathogen. This study would not only be important to my future research into the gene expression of *C. sativus* during compatible interactions with *P. cubensis* but will also be a starting point for identification of potential disease resistance genes, pathogenesis proteins or other compounds that could be utilized in a breeding program for downy mildew resistant lines.

7. Research implementation and results under the program

Title of your research plan:

The use of laser microdissection to facilitate gene expression profiling of the *Cucumis sativus- Pseudoperonospora cubensis* compatible interaction.

Description of the research activities:

While at NAIST, I was able to accomplish several important steps necessary to use LCM for gene expression analysis in the cucumber-*Ps. cubensis* system. I have optimized section preparation steps and have successfully extracted cucumber DNA as well as RNA from sections. In addition, I have identified infected cells in cucumber sections to be specifically isolated by LCM.

Fixation Methods

First, I compared paraffin preparation methods in terms of morphological preservation of cucumber leaves. Conventional paraffin preparation for plant tissue takes more than 5 days, while microwave fixation of samples facilitates cell permeation by the fixatives, reducing preparation time to 5 hours. This short preparation time maintains morphology, as well as limits degradation of nucleic acids and proteins. Both conventional and microwave paraffin fixation methods. For the conventional method, only Farmer's fixative was used. For the microwave method two additional fixatives, methacarn and Sorensen's buffer were also tried. Samples prepared by conventional fixation using Farmer's fixative maintained their structure best compared with the microwave paraffin samples (Figure 2). These tissues have round, intact epidermal cells and distinct phloem cells, two signs of proper structure preservation.

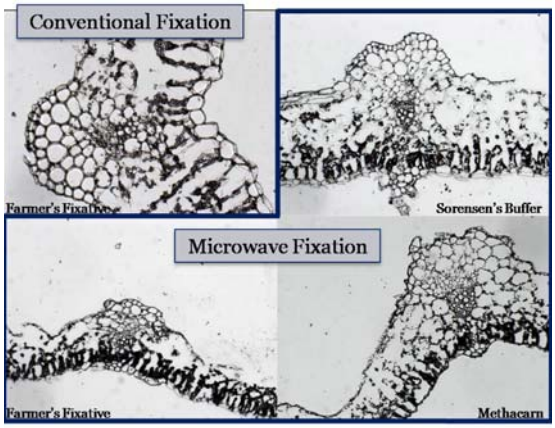


Figure 2. Conventional and microwave paraffin fixed cucumber samples

DNA & RNA Quality of Samples

The differently prepared samples were analyzed for both DNA and RNA quality. Paraffin sections (10 µm in thickness) prepared on microscope slides were deparaffinized in xylene, and then collected by scraping with a razor blade. DNA and RNA were extracted using their respective PicoPure Extraction kits (Arcturus, Mountain View, CA). A nested primer set specific to cucumber Heat Shock Protein 70 was used to assess both DNA and RNA quality. Bands were successfully amplified from samples using all fixation types, except for the methacarn fixation treatments (Figure 3). PCR results showed that Sorensen/microwave treatment samples likely maintained most intact DNA and RNA.

Laser Capture Microdissection

Cucumber leaf tissue was collected from plants two weeks after inoculation with *Ps. cubensis* and prepared for LCM using the conventional paraffin fixation method. Round-shaped *Ps. cubensis* haustoria were clearly identified in abaxial epidermis cells, which are otherwise empty (Figure 4). Using the Arcturus Veritas Microdissection System, individual cells containing *Ps. cubensis* haustoria were successfully isolated cells (Figure 4A-D).

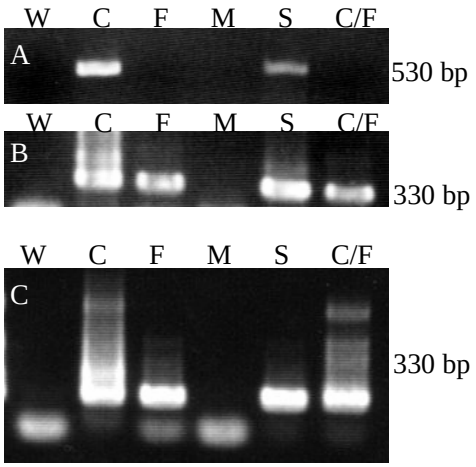


Figure 3. PCR (A,B) and RT-PCR (C) to assess DNA and RNA quality. W, water; C, cucumber; F, Farmer's fixative; M, methacam; S, Sorensen's buffer; C/F conventional/ Farmer's fixative; F, M, and S were fixed using the microwave method.

Conclusions

The work accomplished at NAIST will provide the foundation for additional work in understanding the *Ps. cubensis* –cucumber pathosystem. Future work will include optimization of RNA extraction and RT-PCR protocols for gene expression analysis as well as using LCM as a tool for constructing a gene expression map of *Ps. cubensis* infection of cucumber.

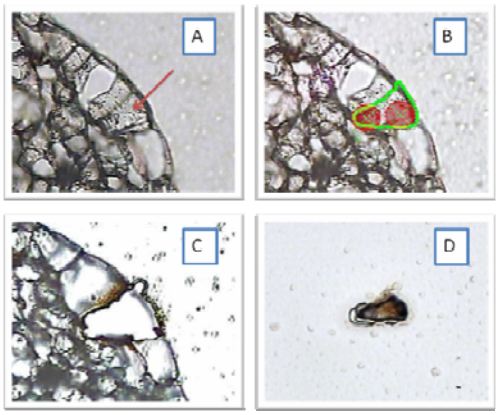


Figure 4. Laser capture microdissection of cucumber cell containing *Ps. cubensis* haustoria. A. Haustoria containing cell. B. Targeted for capture. C. After capture. D. captured cell.

8. Please add your comments (if any)

9. Advisor's remarks (if any)

RESEARCH REPORT

1. Name: Zachery Oestreicher （ID No.: SP08067 ）

2. Current affiliation: Ohio State University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kanazawa University

5. Host researcher: Dr. Yoshihiro Fukumori

6. Description of your current research

My current research is studying proteins involved with the synthesis of magnetosomes of the magnetotactic bacterium *Magnetospirillum magnetotacticum*. Magnetotactic bacteria were first discovered over thirty years ago. These microbes are capable of biomineralizing tiny crystals of magnetite (Fe_3O_4) inside of lipid vesicles within the cells; these vesicles are called magnetosomes. The magnetosomes are arranged in a linear manner inside the cells. The organisms presumably use the magnetosomes to align themselves with the earth's geomagnetic field, like a biocompass, which allows them to actively navigate to suitable environments of low oxygen.

Exactly how the organisms synthesize the magnetite crystals is not completely understood. In order to investigate the biomineralization of magnetite and synthesis of magnetosomes, the proteins implicated with the magnetosome are currently being studied It is important to study the spatial location of the proteins involved with the magnetosomes because it will reveal insights into the function of the different proteins. More studies need to be done to determine the full range of proteins involved in this process. For example, as a result of examining the proteins of the magnetosomes with the electron microscope, the locations of different proteins can be identified.

7. Research implementation and results under the program

Title of your research plan:

Transmission Electron Microscopy immunogold staining of proteins associated with magnetosome formation in *Magnetospirillum magnetotacticum*

Description of the research activities:

The overall objective of my EAPSI project was to use the transmission electron microscope (TEM) to analyze the localization of proteins involved in the biomineralization of magnetite in *Magnetospirillum magnetotacticum* MS-1 bacteria (Figure 1A). My research focused on two different proteins, Mam12 and Mam22, associated with the magnetosomes. These proteins have been putatively identified as being essential for the formation of Fe_3O_4 nanoparticles. My research at Kanazawa University was a three-step process. First I cultured 20 liters of *M. magnetotacticum* MS-1 cells. Next, I removed the magnetosomes from the cells and purified the magnetosomes. Then I labeled the cells with a primary antibody for either the Mam12 or Mam22 protein, followed by attaching a secondary antibody with a gold particle to the primary antibody. Finally, I examined the gold labeled proteins with the TEM. The gold particle was used because it is visible in the TEM as a small opaque sphere and it reveals the location of the protein.

The results (shown below) reveal the locations of the proteins within the magnetosome chain. Figure 1B demonstrates that Mam12 proteins are more closely associated with magnetosomes. Whereas the Mam22 proteins are not only associated with the magnetosomes, but also with the area surrounding the magnetosomes (matrix).

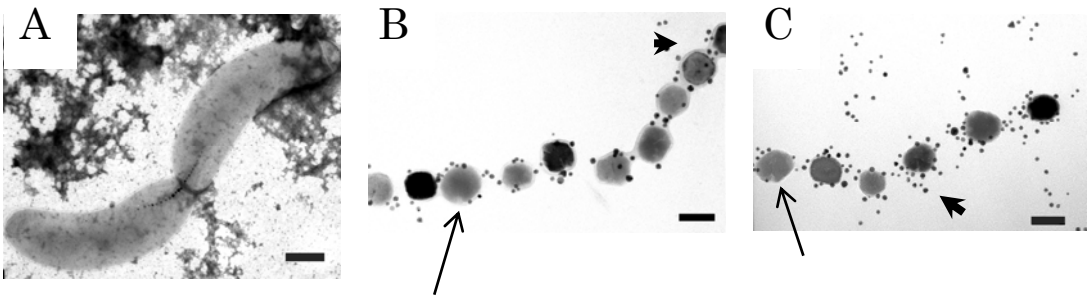


Figure 1 Transmission electron micrographs of *Magnetospirillum magnetotacticum* MS-1 bacteria (A) and gold labeled proteins Mam12 and Mam22 in magnetosomes (B and C respectively). In images B and C the arrow shows the magnetite crystal, the arrowhead shows the 5 nm gold particle. Scale bars: (A) 500 nm, (B) and (C) 50 nm.

8. Please add your comments (if any):

Working in the lab or Dr. Fukumori was a wonderful experience both academically and culturally. I learned many new techniques to analyze magnetosomes, which I will continue to use on my graduate research when I return to Ohio State. It was great to work with the students in the lab because they were extremely helpful and friendly. They always made me feel welcome from the moment I stepped into the lab. I enjoyed every minute I spent in Kanazawa and I want to thank the NSF and the JSPS for giving me the chance to come to Japan.

The lab group of Dr. Fukumori and myself at a restaurant on my first evening at Kanazawa University.

9. Advisor's remarks (if any):

Zach has been working as an EAPSI Young Foreign Researcher in my laboratory for 2 months. He has completed the experimental plan proposed during the time and gained competence in a range of basic immunogold staining techniques. He will make a productive contribution to the research field that he will be working in the future. Zach was the first native English speaker for the lab members. All members enjoyed the close interactions. In his proposal, he stated "I think this will enrich my educational experience and will also teach me to successfully communicate with scientists across language and cultural boundaries." I hope he will bring this plan to a successful issue and work with us again some time in the future. Finally, I think that the program provided significant benefits to Zach and us.

RESEARCH REPORT

1. Name: Lindsay Egan （ID No.: SP08101）

2. Current affiliation: School of Chemistry, University of Edinburgh, Scotland, UK

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Graduate School of Science, University of Tokyo,

5. Host researcher: Professor Shin-ichi Ohkoshi

6. Description of your current research

Magnetic materials underpin many of the modern technologies which are now integral to life in the 21st century. Advances in technology demand increasingly sophisticated magnetic materials and over the past two decades scientists have looked towards molecule-based materials to meet these demands. The electronic and magnetic properties of molecule-based materials can be tailored to meet specific requirements by introducing subtle changes in molecular precursor composition or connectivity, thus giving them an advantage over classical magnets such as metals and metal oxides.

The Prussian blue analogues (PBAs), with general formula $A_xM^{II}[M'^{III}(CN)_6]\cdot nH_2O$ (where A= alkali metal cation and M, M'= transition metal ions), are prototypical molecule-based magnets exhibiting a plethora of unusual electronic and magnetic behaviours. The availability of degenerate or quasi-degenerate electronic states in PBAs facilitates the fine tuning of their magnetic properties upon application of external stimuli. Latterly the miniaturization of technological devices and the need for high-density data storage has driven PBA research towards the nanoregime. The magnetic properties of these nanostructures are quite distinct from those of their bulk counterparts due to the increased surface to volume ratio. Prior to the exploitation of PBAs in technological applications it is imperative that the molecular interactions responsible for their exotic behaviour, and subsequently the size dependency of such behaviour, are understood. My research focuses on the use of X-ray light and hydrostatic pressure to induce switching between the ground, and otherwise inaccessible, excited states in both bulk and nanoscale PBAs.

7. Research implementation and results under the program

Title of your research plan:

Nanostructured Multifunctional Molecular Magnetic Materials

Description of the research activities:

Collaborative research undertaken at the University of Tokyo has focused on the preparation of nanoscopic systems based upon PBA compounds which, in their bulk form, exhibit altered magnetic properties when externally perturbed by photoirradiation or changes in temperature. Poly(vinylpyrrolidone) (PVP) has been introduced as a confining nanoreactor medium into the synthesis of several such compounds which have been extensively studied within the Ohkoshi research group. The objective of this work is to establish the optimal size and shape for observation of these phenomena.

The bulk forms of the PBAs $CsFe[Cr(CN)_6]$ and $RbMn[Fe(CN)_6]$ exhibit magnetic thermal hysteresis, an attribute which is desirable in technological applications such as memory devices. The hysteresis of $CsFe[Cr(CN)_6]$ is a consequence of spin-crossover while that of $RbMn[Fe(CN)_6]$ is due to a thermally induced electron transfer. Transmission electron microscopy (TEM) images of PVP protected $CsFe[Cr(CN)_6]$ ([PVP]:[Fe^{2+}] = 100) reveal well-dispersed spherical nanoparticles with an average diameter of 30 nm. Infra-red (IR) spectroscopy indicates that the CN stretching frequency of this material is analogous to that of the unprotected compound while X-ray powder diffraction (XRPD) reveals that it - like the bulk – adopts a face centred cubic structure. The broad diffraction peaks of the PVP protected $CsFe[Cr(CN)_6]$ compound corroborate the results of TEM, since peak width is inversely proportional to particle size. The magnetic ordering temperature of this material is somewhat higher than that of bulk $CsFe[Cr(CN)_6]$, suggesting that the ratio of metal ions is not 1:1:1 as expected. A deviation from this ideal stoichiometry could also explain why no magnetic thermal hystereis loop is observed, however this may also be a consequence of reduced particle size. Elemental analysis will now be performed to establish the stoichiometry of this material and hence determine the source of these observations.

Initial efforts to fabricate PVP protected $RbMn[Fe(CN)_6]$ nanoparticles consistently produced materials comprising both the high temperature (HT), Mn^{II}-CN-Fe^{III}, and low temperature phases (LT), Mn^{III}-CN-Fe^{II}, suggesting that the

presence of PVP promotes internal electron transfer. A systematic study of reaction conditions revealed that fraction of the low temperature phase grows with increasing reaction time and polymer concentration, thus providing support for this hypothesis. These findings will subsequently be used in efforts to prepare single-phase PVP-protected $RbMn[Fe(CN)_6]$ particles with reduced dimensionality.

The bulk form of the octacyanometalate $Co^{II}_3[W^V(CN)_8]_2(pyrimidine)_4 \cdot 6H_2O$ exhibits a thermally induced charge transfer with a thermal hystersis loop and a photoreversible magnetic effect, both of which are desirable for technological applications. However, observation of these phenomena has proven to be strongly dependent on the dimensions of the crystal structure which in turn are intimately linked to particle size and morphology. We aimed to tune the particle size, and subsequently also the magnetic behaviour, of $Co^{II}_3[W^V(CN)_8]_2(pyrimidine)_4 \cdot 6H_2O$ by means of PVP protected synthesis.

The IR spectra and XRPD patterns of polymer protected $Co^{II}_3[W^V(CN)_8]_2(pyrimidine)_4 \cdot 6H_2O$ are similar to those of the unprotected compound, although the diffraction peaks of the latter are much broader thus indicating a reduction in particle size. Magnetization measurements of the compound prepared with $[PVP]/[Co^{2+}]$ ratio of 10 reveal a surprisingly large thermal hystersis loop of 120 K, one of the largest ever reported for an octacyanometalate. Further characterization by TEM and ICP-MS is necessary to establish whether this phenomenon is a consequence of reduced dimensionality or altered stoichiometry. We also plan to measure the magnetic and IR spectroscopy measurements of this material under photoirradiation to determine whether a photoreversible magnetic effect exists.

8. Please add your comments (if any):

I would like to express my sincere gratitude to Prof. Ohkoshi for hosting me and also to all members of his group for their kindness and support. My time in the Ohkoshi lab has given me a unique opportunity to further my research and collaborate with world-leaders in the field of molecule-based magnetism. It has been a fantastic experience, both scientifically and culturally, and I hope it is the beginning of a long and fruitful collaborative relationship.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Philip J. Kitson （ID No.: SP08102）

2. Current affiliation: University of Glasgow

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
XChemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

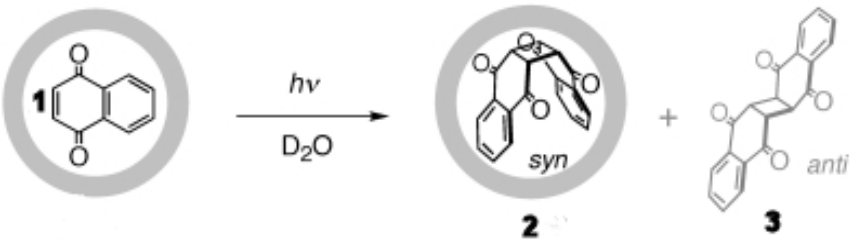
4. Host institution: University of Tokyo

5. Host researcher: Professor Makoto Fujita

6. Description of your current research

Selective encapsulation of molecules in nanometer scale cage compounds has been shown to dramatically increase the effective concentration of the substrates for certain reactions, as well as promoting a strict arrangement of the reactants in relation to each other which can combine to promote the acceleration of a particular reaction as well as inferring remarkable regioselectivity on the reaction being studied. Such is the case of the [2+2] photodimerisation of 1,4-naphthoquinone (**1**), which has been observed to proceed extremely rapidly and selectively for the *syn*-dimerised product (**2**) when the reactants are encapsulated in the M_6L_4 Pd bowl structure of the Fujita group (Fig. 1).[1] So far the reaction has been observed to proceed stoichiometrically and the dimerised product forms an inclusion complex with the Pd bowl structure. The product can then be easily extracted with an organic solvent leading to formation of the *syn* product in >98% yield.

As it had been observed in other such cases of encapsulation promoted reactions that it is possible for the cage structure to act as an effective catalyst for a given reaction, it was decided to investigate this reaction for the possibility that the Pd bowl could act as a catalyst for the dimerisation of 1,4 naphthoquinone.



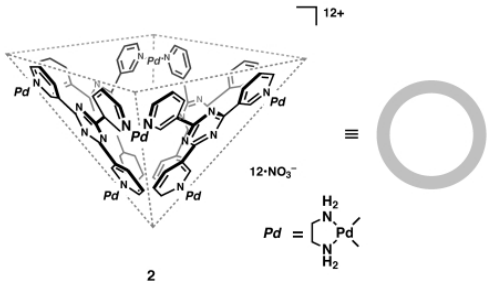


Figure 1. Photodimerisation reaction of 1,4-naphtoquinone (top) promoted by encapsulation in a bowl shaped supramolecular cage (Pd bowl, bottom)

7. Research implementation and results under the program

Title of your research plan: Catalysis of the photodimerisation of 1,4-naphthoquinone.

Investigation of the effect of Pd bowl concentration on the dimerisation reaction in aqueous conditions, in the presence of excess starting material showed that the reaction was not catalytic under these conditions. It was hoped that biphasic conditions would allow the removal of the product molecule from the inclusion complex resulting from the dimerisation reaction and therefore allow the encapsulation of more starting matrial and the catalytic dimerisation reaction to proceed. However, a variety of organic solvents used in the reaction conditions yielded at best stoichiometric results, but in many cases the organic solvent, being present in greater quantities than the starting material, replaced the starting material in the bowl complex and underwent side reactions of their own, yielding a complex mixture of reaction products which it proved extremely difficult to separate and characterize.

It is known that the product inclusion complex formed involves a significant distortion of the ideal geometry of the Pd bowl complex forming a kinetically stable complex the structure of which is known from X-ray crystallography. It was hoped that by heating the reaction during irradiation, the product complex would be given sufficient kinetic energy to dissociate, thus allowing the completion of the catalytic cycle. Using the Pd bowl this process appeared to produce a higher proportion of *syn*-dimer (Fig. 2.), however heating to 80-100°C lead to a significant amount of degradation of the bowl complex itself, leading to contamination of the product with ligand from the bowl complex. Also observed were significant impurities in the product, and it is yet to be determined if these arise from contamination or decomposition of the starting material under reaction conditions. Subsequent experiments have suggested that using a lower reaction temperature could reduce the Pd bowl decomposition, while retaining the catalytic nature of the reaction.

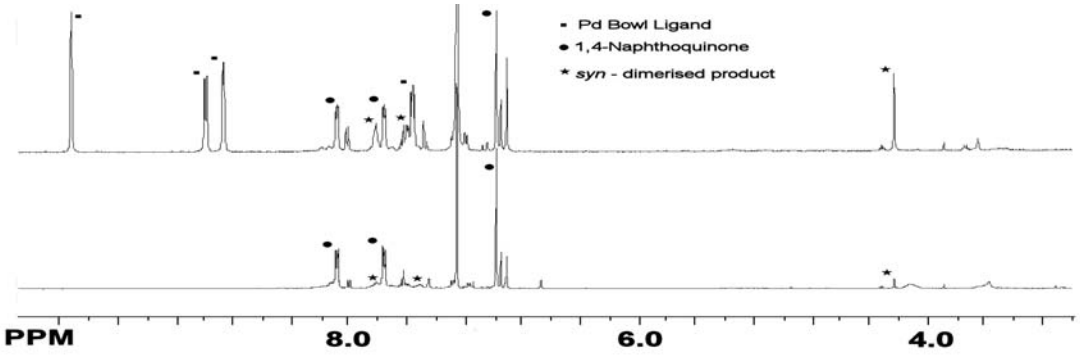


Figure 2. Photodimerisation reaction in the presence of Pd bowl carried out at 80-100°C (above) compared with control experiment in the absence of Pd Bowl (below).

References:

1. Yoshizawa, M. Takeyama, Y. Kusukawa, T. Fujita, M. *Angew. Chem. Int. Ed.* **2002,** 41(8), 1347.

Description of the research activities:

Photodimerisation reactions were carried out using a 400W high-pressure mercury lamp for 4h at room temperature or 80-100°C. Various reaction conditions were investigated including biphasic solvent systems using a variety of organic solvents.

8. Please add your comments (if any):

I would like to thank Professor Makoto Fujita, Professor Lee Cronin Dr. Murase and Keichi Sato, for enabling me to work in such a friendly atmosphere with such an exciting project to work on.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Dr Petko Kusev （ID No.: SP08103）

2. Current affiliation: City University London

3. Research fields and specialties:

Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo and Tokyo Institute of Technology

5. Host researcher: Professor Kazuo Shigemasu and Professor Kimihiko Yamagishi

6. Description of your current research

My research is concerned with cognitive psychology, judgment and decision-making, memory, categorization and identification of perceptual information. Our research indicates a failure of the descriptive invariance axiom of expected utility theory (economics). For risky prospects with moderate and high probabilities overweighting of probability is observed - a finding not anticipated by normative (economics) and descriptive (psychology) theories. The results highlight a need for theories which differentiate between decisions about monetary gambles and other types of decision-making under risk and uncertainty.

For judgments, the experiments show that judged frequencies of sequentially encountered stimuli are affected by certain properties of the sequence configuration. We find (a) a first-run effect whereby people overestimate the frequency of a given category when that category is the first repeated category to occur in the sequence and (b) a dissociation between judgments and recall; respondents may judge one event more likely than the other and yet recall more instances of the latter. Judged frequency of categories of items is influenced by the first run - which may reflect the operation of a judgment heuristic.

7. Research implementation and results under the program

Title of your research plan:

Memory-Biased Preferences with Judgments and Decision Prospects

Description of the research activities:

AIMS AND OBJECTIVES:

The overall aim of the research was to develop further the theoretical model of accessibility of events in memory (Kusev et al., 2008) for judgments and decision prospects. Two objectives for the research were pursued in this project:

(1) Contribution to the psychology of risky decision-making, judgments and memory:

We tested the generality of existing psychological theories of memory, judgments and decision making, in particular, the extent to which these theories can predict people's preferences. We found further evidence that high-accessible features in memory (e.g. samples of risk, frequencies of events) influence judgments and decisions, whereas features of low accessibility (e.g. abstract gambles and inaccessible real-world events) in memory are largely ignored.

(2) Research collaboration:

The research has been conducted in collaboration with Professor Kazuo Shigemasu (expertise in psychology, Bayesian statistics and modeling of process of human decision making) and Professor Kimihiko Yamagishi (expertise in cognitive psychology, judgment and decision-making). Professor Kazuo Shigemassu will visit our research lab in London later this year to discuss future research of mutual Interest. During my stay in Tokyo, I have been invited to give three talks and had the opportunity to establish a collaboration with Professor Takemura Kazuhisa - Waseda University Tokyo (Director of Centre for Decision Research, Psychology Department) and Professor Noboru Hidano - Tokyo Institute of Technology (Economics Department). These international collaborations will allow further testing and modeling the generality of main theoretical concepts in memory, judgment and decision-making by using a combination of empirical methods including online experiments, laboratory and field studies.

RESULTS:

The leading normative (von Neumann & Morgenstern, 1947) and descriptive psychological theories (e.g., Birnbaum, 2008; Brandstätter et al., 2006; Tversky & Kahneman, 1992; Tversky & Koehler, 1994) of judgment and decision-making share a common representational assumption: people's preferences and decisions under risk and uncertainty are task-independent. In four computer-based experiments (overall 80 participants from University of Tokyo, Tokyo Institute of Technology and Tama University) we investigate the validity of this assumption by studying the factors that affect people's reactions to presented judgments and decision-making prospects. Across the experiments participants were asked to consider a presented scenario and choose one of two options (probabilistic or certain) in the abstract gamble or precautionary domains (Experiments 1, 2 and 3), and to recall/not recall

events and make choices between options, and then also to make judgments of these options (Experiment 4). Relevant to our concerns here, we suggest that the accessibility of information in memory influences decisions (a) to chose or reject certain options - with high or low accessible features (b) to select or not select a particular precaution and (c) to predict uncertain events (e.g. baseball matches). We hypothesize that, similar to our previous findings, decisions with accessible features in memory differ from monetary gambles because the former cue accessible features in memory while the latter do not. In four experiments we studied the extent to which theories of judgment, decision-making and memory can predict people's preferences. Applying Prospect Theory and Support Theory to these data we find that (a) the weighting function required to model decisions with 'high-accessible' features in memory exhibits different properties to those required to model choices between monetary gambles and (b) the accessibility of events in memory affects choices between options, influencing participants' decisions, but not their judgments of these options. Instances of some risks are encountered in everyday life disproportionately frequently and the probability associated with highly accessible events in memory tends to be exaggerated. This result confirmed the failure of the descriptive invariance axiom of Expected Utility Theory (Kusev et al., 2008).

DISSEMINATION OF THE RESULTS:

Research findings will be disseminated to the academic community - through conferences (2 papers have been accepted for oral presentation at the annual meetings - The Psychonomic Society and Society for Judgment and Decision Making, Chicago 2008), workshops and academic papers. We aim to reach the widest possible audience; two papers in two journals are anticipated.

8. Please add your comments (if any):

I am extremely grateful to Professor Takuya Ohmori and the researchers from University of Tokyo and Tokyo Institute of Technology for their invaluable help and hospitality. I am also incredibly grateful to the JSPS for the opportunity to conduct my research in Japan.

9. Advisor’s remarks (if any): Dr. Kusev has spent very productive two months at the University of Tokyo and Tokyo Institute of Technology. He has been hard-working and had intensive discussions with the staff and graduate students. He is writing up a paper based on several experiments he has conducted. He gave a talk at the International Seminar on Experiments and Surveys in Economics. He also made a key-note speech at the third Seminar of Integration of Cognition, Behavior and Measurement, which attracted young researchers. I am glad we have established a plan for future collaborations.

RESEARCH REPORT

1. Name: Djordje Mitrovic （ID No.: SP08104 ）

2. Current affiliation: : Institute for Perception, Action and Behaviour, School of Informatics, University Of Edinburgh

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: ATR Computational Neuroscience Labs, Kyoto

5. Host researcher: Dr. Rieko Osu

6. Description of your current research

My work focuses on the investigation of Optimal Feedback Control (OFC) in arm reaching movements for redundant, highly nonlinear systems. In recent years OFC has become a promising motion generation strategy for biological movement systems. I am focusing on iterative methods such as the *iterative Linear Quadratic Gaussian (iLQG)* algorithm, which allows to find an optimal control law for nonlinear systems with nonquadratic costs. I have extended iLQG by using a learned system dynamics to account for uncertainties in the plant dynamics. This algorithm is called *iLQG with Learned Dynamics (iLQG-LD)*. This algorithm not only allows to model nonlinear system within OFC without having an explicit analytical system dynamics model, but also is able to realise data driven adaptation towards external perturbations. The observed adaptation process in iLQG-LD has striking resemblance to human adaptation patterns.

7. Research implementation and results under the program

Title of your research plan:

Optimal feedback control with learned system dynamics from surface EMG.

Description of the research activities:

My research during this program aimed to create a human arm model, which is based on data (arm positions and electromyography data) recorded from human subjects. This nonparametric model then should be used in our novel iLQG-LD framework to compare the biological plausibility of OFC for nonlinear systems. The research I carried out can be divided in 4 main steps:

1) Experimental Setup: First I set up the experimental apparatus for collecting data from human subjects. I acquired the required hardware knowledge for collecting position data with the OPTOTRAK system, which realizes motion tracking with infrared markers. I setup an air-sled system (similar to a hovercraft) which allows me to make planar human arm motion without any surface friction. Finally, I learned about surface EMG data collection and processing of the 6 major arm muscles during planar motion.

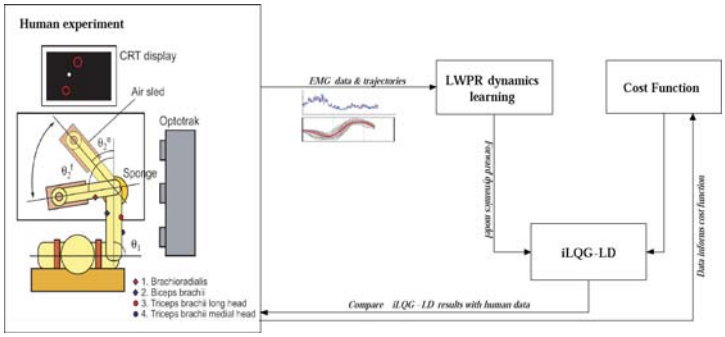


Figure 1: Experimental Setup for learning the dynamics of the human arm. The subject makes reaching movements. The collected data is used to learn the forward dynamics function with the LWPR learning algorithm. The acquired forward dynamics model is used to produce results with iLQG-LD. The trajectories and muscle signals can be compared to the recorded human motion patterns.

2) Data Collection and Data processing: After having collected data in a wide operating area (30cm by 30cm) from several subjects, appropriate filtering methods were required in order to facilitate a successful learning. Then main issues here are to detect and filter the variability of EMG data within subjects over time and due to fatigue.

3) Learning the dynamics: In a next step I used *Locally Weighted Projection Regression (LWPR)* to learn the forward dynamics mapping from position data and EMG data collected. As expected the dynamics showed to be highly non-linear.

4) Comparing iLQG-LD results with human motion: In a next step I generated reaching movements using iLQG-LD with the learned human arm dynamics. The plots in Figure 2 show that we get very similar end-effector trajectories and velocity profiles. We conclude that iLQG-LD can be used to reproduce human motion in the kinematics domain. However the muscle space needs to be investigated further in future work, since the control signals do not match the human results accurately.

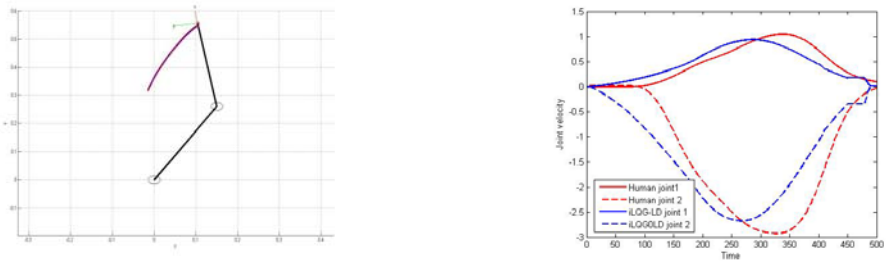


Figure 2: Comparison of human data (blue) with iLQG-LD data (red). Left: end-effector trajectory; Right: Joint velocity profiles.

Conclusion: Learning human arm dynamics from surface EMG can be described as a rather involved task. This is mainly due to the high levels of noise and variability in the EMG data, but also due to the large non-linearity and hysteresis effects that occur with the delay of EMG activity and actual contraction of the muscles. Another difficulty is the large space that has to be covered during learning (10 dimensional input space in our case). To cover the whole space with training data, we would require a more extensive data collection approach for trials of multiple hours to days. For the future I am planning to extend my analyses on different cost function parameters and how they relate to the human motion.

8. Please add your comments (if any):

It was a great pleasure and big fun to work this summer at ATR in this outstanding research environment. Even though 2 months are a very short time, I was able to conduct my research successfully and efficiently with the great support of the people here. I made many interesting contacts with great researchers in my field and we exchanged interests in many interesting discussions. The JSPS summer program was a fantastic experience I am very grateful for and which I will never forget!

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Dr Risha M. Patel （ID No.: SP08105）

2. Current affiliation: University of Bristol, School of Biological Sciences, Bristol, UK

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto Prefectural University, School of Agriculture

5. Host researcher: Professor Yasuyuki Kubo

6. Description of your current research

The initial aim of this study was to use *Agrobacterium*-mediated transformation technologies in a number of fungal organisms in order to apply them to a less optimized system, *Botrytis cinerea*. This fungus is capable of infecting over 200 plant species worldwide, including ornamentals, vegetables and fruits, destroying approximately 20% of infected harvests worldwide (Genoscope, France). Upon observing such procedures, we decided to expand the scope of research accomplished during the JSPS summer program. Specifically, the aims of the project was to also clone a number of mycovirus open reading frames (ORFs) so that their function could be investigated in *B. cinerea*.

Mycoviruses are viruses that infect fungi. A number of mycoviruses have been found effective in reducing fungal pathogenicity. This process, however, has been understudied. As a result, we aim to clone each ORF from *Botrytis Virus X* (BVX). Each ORF can then be transformed into *B. cinerea* to test for gene function. Long term aims include the cloning of BVX so that its function can be assessed in *B. cinerea*. The overall aims of this project are to 1) decipher viral gene function in the fungus and 2) discover the true effects of BVX *in vivo*. During the JSPS summer program, the primary aim is to clone each ORF so that they can be transformed into the fungus upon my arrival into the UK.

7. Research implementation and results under the program

Title of your research plan:

The cloning of Botrytis Virus X ORFs for gene characterization into viral function.

Description of the research activities:

This project aims to investigate mycovirus activity and its effects in B. cinerea to better understand fungal-virus interactions at a molecular level. This study concentrated its investigations on the characterization of Botrytis virus X (BVX). BVX contains a single stranded RNA genome with five potential ORFs (Howitt et al., 2006). ORF1 encodes a replicase with 73% identity to the RdRP region of the garlic virus A (GarV-A), while ORF3 shares high homology with the plant potex-like coat proteins. The function of the remaining ORFs is unknown but may play a significant role in virus replication or transmission. In order to amplify each open reading from (ORF) from BVX, a number of primers were designed. These primers are able to amplify each gene due to sequence identity. The primers were used to obtain the following fragments: ORF1, ORF2, ORF3, ORF4, ORF5 and a miscellaneous region (Figure 1). Fragments obtained were identified by size as well as by sequence analysis. Each fragment was then ligated into a vector, which can be easily manipulated for future analyses. The vectors have been purified and sent back to the UK for further analysis.

Secondary experimentation included the assembly of BVX. In order to do so, a second set of primers were designed. In order to amplify the entire virus, four partial viral fragment (PVFs) were generated before coming to Japan. These PVFs span the entire region of BVX. The primers that were designed allowed for overlapping sequences to be added to each PVF. These overlaps are necessary when using overlap-extension PCR (OE-PCR) technologies to make larger gene fragments. As a result, the construction of BVX was attempted. Due to the complexities of OE-PCR, only two of the four PVFs were combined. The combination of the two fragments, however, is a large step forward to the completion of BVX. As a result, the combined PVF has been cloned into a versatile vector. After purification, the vector was sent back to the UK for further analysis.

Since this research involves preliminary experimentation, it will be extremely

beneficial to experiments carried out in the UK. Each ORF will be used to better understand gene silencing mechanisms in vivo. Current research focuses upon the applications of gene silencing as well as uncovering gene silencing pathways. This research plan, however, proposes to study the interactions between a host species and a virus. Therefore, the transformation of each ORF into B. cinerea will allow for a greater understand of 1) protein function (encoded by the ORF) and 2) interactions between fungal and viral proteins. The completion of BVX will also prove important in uncovering viral function in the fungus.

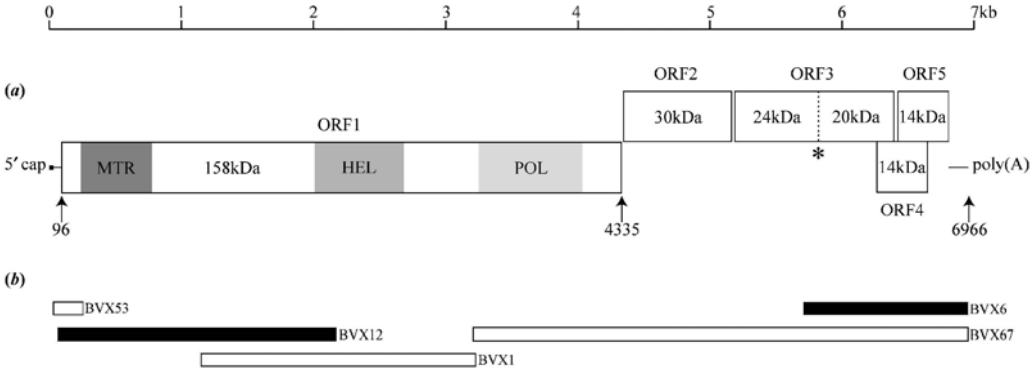


Figure 1: Schematic representation of the genome organization of (A) BVX and (B) map of overlapping cDNA clones. Positions of ORFs (boxed) and relative positions of the conserved domains are indicated with shaded boxes: MTR, methyltransferase; HEL, helicase; POL, RdRP; SGP, subgenomic promoter. The position of the putative initiation codon for coat protein (CP) synthesis is indicated with an asterisk.

Howitt, R. L. J., Beever, R. E., Pearson, M. N., and Forster, R. L. S. 2006. Genome characterization of a flexuous rod-shaped mycovirus, *Botrytis* virus X, reveals high amino acid identity to genes from plant 'potex-like' viruses. Arch Virol 151:563-579.

8. Please add your comments (if any):

RESEARCH REPORT

1. Name: Magdalena E. Powell （ID No.: SP08106）

2. Current affiliation: University of Bath

3. Research fields and specialties:

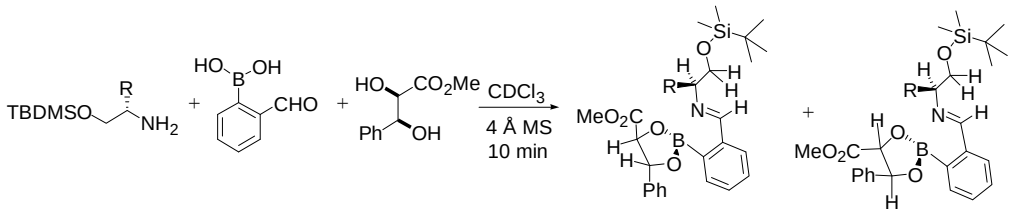
Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: The University of Kitakyushu

5. Host researcher: Prof. Kazuo Sakurai

6. Description of your current research

Currently, investigations are taking place into devising a practically simple chiral derivatisation protocol for determining the enantiopurity of *O*-silyl-protected-amino alcohols by ^{1}H NMR spectroscopic analysis. This protocol involves their treatment with a boronic acid and an enantiopure diol to afford a mix of imino-boronate esters whose diastereoisomeric ratio is an accurate reflection of the enantiopurity of the parent amino alcohol.



7. Research implementation and results under the program

Title of your research plan:

The synthesis of a novel carbohydrate lipid for pDNA transfection.

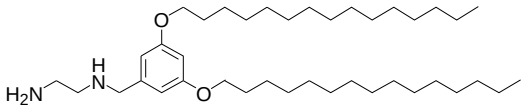
Description of the research activities:

Organic synthesis of target lipids including Silica Gel Chromatography

Structural determination using ^{1}H NMR Spectroscopic Analysis

Design of synthesis towards target carbohydrate lipid.

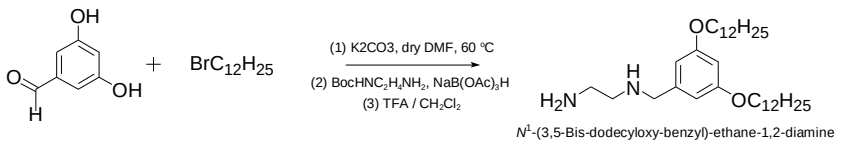
Previous collaborations between the Sakurai and James/Bull groups have resulted in the successful synthesis of a novel cationic lipid bearing a di-amino headgroup. This has found its application as a novel transfection reagent as it is combined with plasmid DNA (pDNA) to form a lipoplex.



N^{1}-(3,5-Bis-pentadecyloxy-benzyl)-ethane-1,2-diamine

A lipoplex is an ionic complex, formed from the complexation of cationic surfactants (or lipids) with pDNA. Ionic intermolecular binding between the positively charged surfactant and negatively charged substituents on the pDNA strand is known to assist in the transfection (the introduction of DNA into eukaryotic cells such as animal cells) of bound pDNA. Indeed, since bacteria such as e-coli contain pDNA, almost 20% of current clinical trials of gene therapy involve transfection of such lipoplex macromolecules. In lipoplex formulations, the ratio of cation to anion is carefully tuned so that the resultant lipoplex is positively charged overall; this aids transfection of pDNA.

Engbert *et al*. has recently reported the synthesis of a sugar-based cationic gemini surfactant that undergoes a pH-induced structural transition and interpreted excellent transfection based on this transition. Consequently, our aim was to synthesise a novel lipid incorporating our diamino headgroup as well as incorporating a carbohydrate chain that could greatly enhance the transfection ability. Firstly, a series of di-amine lipids, with differing lengths of hydrophobic tails were successfully synthesised.

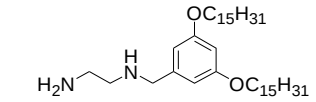


N^{1}-(3,5-Bis-dodecyloxy-benzyl)-ethane-1,2-diamine

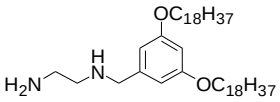
Synthesis of *N*^{1}-(3,5-Bis-dodecyloxy-benzyl)-ethane-1,2-diamine

Alkylation followed by reductive amination and facile cleavage of the Boc group

using TFA methodology afforded three di-amine lipids in good yield.



N^1-(3,5-Bis-pentadecyloxy-benzyl)-ethane-1,2-diamine



N^1-(3,5-Bis-octadecyloxy-benzyl)-ethane-1,2-diamine

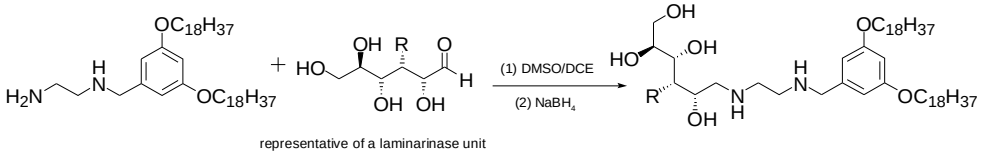
Two other diamine lipids were successfully synthesised.

Having successfully synthesised the starting diamino lipids, we proceeded to attempt to incorporate the carbohydrate moiety into the structure.

We selected laminarin, a polysaccharide chain of approximately 26 glucose base units connected through β(1→3)-linkages for our synthesis as we would expect this structure to afford excellent pDNA transfection. Our strategy was to use reductive amination methodology, similar to that employed in the synthesis of the diamino lipids above.

However, despite trying a range of methodologies, all standard techniques failed to show any product formation due to the insolubility of either the starting hydrophobic lipids or the highly hydrophilic carbohydrate chain.

We then proceeded to consider a novel mixed-solvent system which would be able to dissolve both reactants. We found that a 1:1 mixed system of DMSO:dichloroethane successfully solubilised all starting materials, so we then proceeded to use this for our reductive amination reactions.



representative of a laminarinase unit

Further analysis is currently being undertaken to assess the successfulness of this mixed solvent system technique. We expect that we will eventually be able to use such a system for the synthesis of our target carbohydrate lipids.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Benjamin Stevens （ID No.: SP08107）

2. Current affiliation: Dept. of Electronic and Electrical Engineering, University of Sheffield, UK

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: TARA, University of Tsukuba

5. Host researcher: Dr Nobuhiko Ozaki

6. Description of your current research

I am currently interested in semiconductor light emitting devices based on quantum dots (QD) for application in medical imaging and data transmission applications. For data transmission applications I have optimized device geometries in order to enable high speed modulation of the device, as well as providing advantages such as easy fibre coupling and single lateral mode operation. I am also investigating novel modulation methods for QD lasers.

Optical coherence tomography (OCT) is a medical imaging technique that requires infra-red light sources with a reasonable power but very broad bandwidth or the ability to sweep the wavelength of light rapidly and predictably.

In order to obtain very broad bandwith light I am investigating superluminescent diodes (SLD), which are optical cavities with low reflectance mirrors on either end. This inhibits lasing giving amplified spontaneous emission. Current methods of achieving broad emission are to chirp the QD layers (differing amounts of Indium, differing position in quantum well) and to utilise multi-section SLD devices in which several sections can be driven with differing drive currents to obtain optimum emission spectrum.

The swept laser source (SLS) that I developed has been the subject of a patent application and provides a monolithically integrated, compact and cheap SLS. The SLS relies on the naturally broad emission from QDs and upon an additional, current induced, cavity loss. Such a device offers several advantages over electro mechanical alternatives such as cost, size, linearity and speed, but the sweep range must be increased first if it is to become useful for OCT.

7. Research implementation and results under the program

Title of your research plan:

Selective area growth of two colour quantum dots for ultra broadband superluminescent diodes for application in optical coherence tomography.

Description of the research activities:

Molecular beam epitaxy (MBE) is an ultra high vacuum technique to grow semiconductor crystals, in this case GaAs/AlGaAs. A wafer is held on a rotating platen which can be heated. Elements to be grown are held in Knudsen effusion cells facing the wafer. When heated and the individual cell shutters opened the elements effuse across the vacuum and are able to form new growth on the crystal. The stochiometry of the grown material may be varied by varying the effusion cell temperatures (and hence beam flux).

The quantum dots (QDs) here are grown via the self assembled Stranski-Krastanov transition in which one material with a greater lattice constant grown on another undergoes a transition from smooth growth to 3 dimensional island growth – the InAs QDs of interest here. The QDs provide 3 dimensional confinement of the carriers which leads to favourable light emitting chararcteristics.

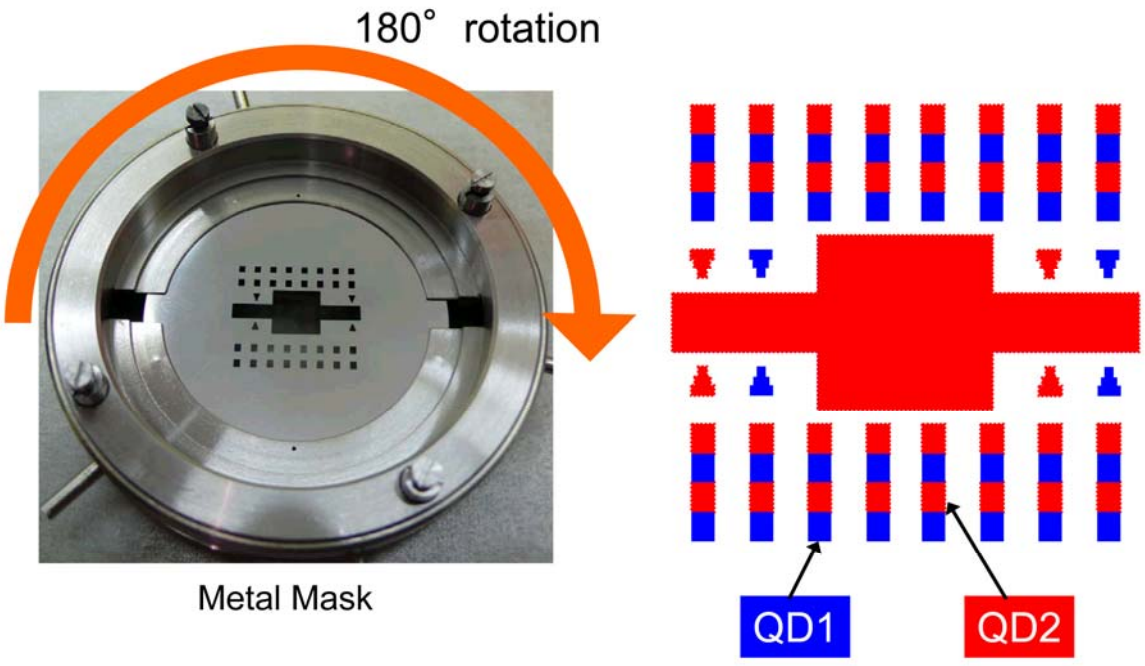
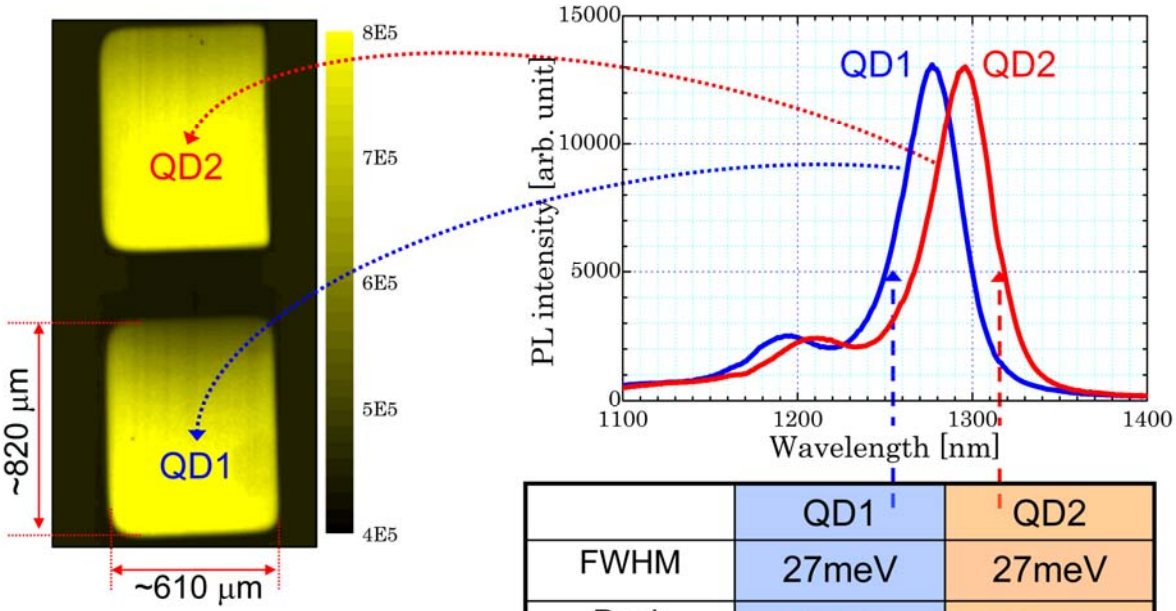


Photo of the metal mask, with rotational symmetry, such that removing the mask, rotating 180° and reapplying results in the pattern on the right with two regions of different colour emission. The large section in the middle is to enable RHEED observation.

During the period of the summer program the selective area growth (SAG) of QDs has been

optimised. SAG is achieved using a metal mask, held an precise distance from the substrate that can be removed under ultra high vacuum. The growth conditions of the QDs has been optimised to achieve high special uniformity, measured via spatially resolved photoluminescence measurements and observing surface topologies using atomic force microscopy.



	QD1	QD2
FWHM	27meV	27meV
Peak wavelength	1277nm	1296nm

Spatially resolved PL measurements showing two distinct regions of differing wavelength emission.

8. Please add your comments (if any):

I'd like to take this opportunity to thank JSPS for enabling this research through the JSPS Summer program.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Benjamin Steventon （ID No.: SP08108 ）

2. Current affiliation: University College London

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Hyogo

5. Host researcher: Takehiro Kusakabe

6. Description of your current research

My research interest is in the early development of neural plate border in vertebrate embryos. The neural plate gives rise to the central nervous system, whereas the neural plate border gives rise to both the neural crest and sensory placodes. Together these two neural plate border cell populations result in the production of many vertebrate specific structures, an observation that led to the proposal of the 'New Head Hypothesis' by Northcutt and Gans (1983). These novel features arose together with a switch been passive to active forms of predation.

Induction is a process by which an inducing tissue releases a signal that results in a change in the direction of differentiation of the responding tissue. My PhD research has focused on timing of action of signaling molecules that act to induce the neural crest in its specific location along the lateral neural plate border. My postdoctoral work shall begin upon my return to London at Kings College London in Andrea Streit's lab and will focus on the induction and specification of the pre-placodal territory surrounding the anterior neural plate border. In the interim, I have been here in Japan working with Ascidian embryos, a non-vertebrate chordate whose embryonic development has and will continue to yield much information regarding the appearance of vertebrates.

7. Research implementation and results under the program

Title of your research plan:

A Comparison of the Mechanisms of Induction between Vertebrates and the Urochordate *Ciona intestinalis*

Description of the research activities:

Ascidians belong to the subphylum Urochordata, which together with Cephalochordates and Vertebrates compose the phylum Chordata. The free-swimming larvae of this species has many similar properties to vertebrates however is lacking in many of the specific sensory structures that arise from the vertebrate placodes. Hence, if homologues to the vertebrate placodes could be found in these larvae, a comparative understanding of their development would illuminate the evolutionary-developmental mechanisms by which vertebrates evolved.

Such homologues have been suggested. These are the primordial for the atrial and siphon primordial, which have been shown to express specific genes that are also expressed in the vertebrate placodes (for a review see Mazet and Shimeld 2005). I wanted to learn more about the mechanisms by which these structures are induced and to ask whether similar mechanisms operate as in vertebrates.

The signals known to induce the placodes in vertebrates include FGF and BMP activation, together with an inhibition of Wnt signalling (see Streit 2007). I made use to specific chemical inhibitors to the FGF and BMP pathways as well as an activator of the Wnt pathway in ascidian embryos to ask whether there are similar requirements for the induction of the atrial and oral siphon primordial. And indeed there was, I noticed a specific loss of early gene expression in both the oral and atrial primordial at early and late stages in the absence of FGF signalling. In addition, a specific loss of gene expression in the early oral siphon primordial when either BMP signalling is inhibited or Wnt signalling is activated.

This data strengthens the hypothesised homology between the siphon primordial in ascidians and the vertebrate placodes as well as proving an initial insight into the early development of these structures. I will continue to discuss with my host researcher as he works to expand this project and I learn more about placodal development in the

embryos of frogs and chick. In the long term I aim to return to Japan and ascidian research to continue this comparative analysis.

Mazet, F., Shimeld M., (2005). Molecular evidence from ascidians for the evolutionary origin of vertebrate cranial sensory placodes. Journal of Experimental Zoology Part B: Molecular and Developmental Evolution 304B, 340-346.

Northcutt, G., Gans, C. (1983). Neural Crest and the origin of Vertebrates: A New Head. Science 220, 268.

Streit, A. (2007). The preplacodal region: an ectodermal domain with multipotential progenitors that contribute to sense organs and cranial sensory ganglia. Internationl Journal of Developmental Biology 51, 447-61.

8. Please add your comments (if any):

This has been a highly rewarding research experience, both in terms of directing my future research and establishing an important collaboration to achieve the aims of it. I thank the JSPS , SOKENDAI, the British Council and members of my host laboratory.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Tristan Leigh Temple （ID No.: SP08109）

2. Current affiliation:

University of Southampton, UK.

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:

Institute of Advanced Industrial Science and Technology, Tsukuba

5. Host researcher:

Professor M. Kondo

6. Description of your current research

My research involves investigating the methods by which metal nanoparticles can improve the efficiency of silicon solar cells, and then optimizing the design of such structures.

Metal nanoparticles exhibit an extremely strong interaction with ultra-violet (UV), visible and near-infrared (NIR) light. This interaction is manifest as intense absorption and/or scattering of incident light. By modifying the size, shape and composition of particles it is possible to tune their response such that a strong interaction can be achieved across the entire solar spectrum. To date my research has focused on the simulation, fabrication and characterization of optimized particle ensembles for solar cell applications.

7. Research implementation and results under the program

Title of your research plan:

Using silver nanoparticles to reduce reflection and improve light-trapping in amorphous silicon solar cells

Description of the research activities:

The aim of my project at AIST was to investigate the effect of coating amorphous silicon (thin-film) silicon solar cells with various types of metal nanoparticle, with the aim of reducing reflection and improving light-trapping within the cells.

The first phase of the project was to establish a nanoparticle fabrication method at AIST. Metal film islanding was chosen as it was the simplest method to set up with the given facilities. In this method an extremely thin layer of metal is evaporated onto the substrate, and then annealing (heating) separates the continuous or semi-continuous film into islands, i.e. nanoparticles. In previous work I have developed metal island films with strong optical scattering in the wavelength range where amorphous silicon is weakly absorbing. However, this process required annealing temperatures of up to 500oC, which would damage amorphous silicon. During my project I found that islands could be fully formed at a lower annealing temperature.by greatly reducing the film deposition speed. Optical measurements confirmed that isolated particles had been formed, and the relationship between deposition parameters and the optical response was also studied.

The second phase of the project was to fabricate amorphous silicon solar cells. 32 substrates were prepared, each with 9 1 cm2 solar cells, giving a total of 304 cells. This large number of devices was required in order to fully investigate various parameters, and to account for variations in efficiency between cells. Both textured and untextured substrates were used in order to investigate light-trapping. Additionally, the thickness of the semi-transparent top-contact was varied in order to investigate anti-reflective properties and substrate-particle coupling effects.

Half of the cells on each substrate were coated with nanoparticles, and the remaining uncoated devices were used as references. Four different metal film thicknesses were

investigated, with the aim of investigating the effect of particle size and surface coverage. The annealing temperature and time were 200oC and 2hr respectively. The optical and electrical properties of each device were measured.

Larger size nanoparticles were found to strongly increase photocurrent in the infrared region of the spectrum, due to a corresponding reduction in reflection (Fig. 1). However, this improvement was countered by a strong reduction in photocurrent across the visible and UV region of the spectrum. It is thought that intra-particle absorption is responsible for the reduction in efficiency, while scattering is responsible for the increase in efficiency. It is hoped that by using even larger particles that the absorption can be minimized. However, this is not possible using metal island films due to temperature restrictions, and so an alternative nanoparticle fabrication method must be employed. It is hoped that this will be the subject of future work.

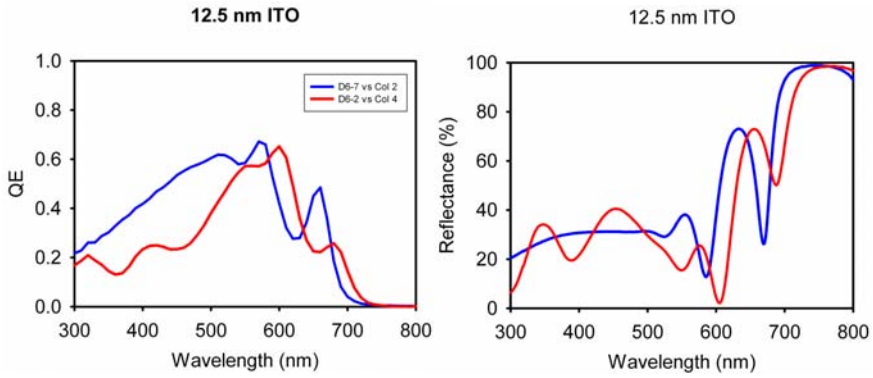


Figure 1: Comparison of uncoated [blue] and coated [red] solar cells. (Left) Spectral response; (right) reflectance.

8. Please add your comments (if any):

I have thoroughly enjoyed my time at AIST. Prof. Kondo and his team made me feel extremely welcome and were very helpful throughout the project. Overall it has been a very interesting and useful experience, and I look forward to visiting Japan again!

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Ming Wang （ID No.: SP08110 ）

2. Current affiliation:

Imperial College London

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:

National Cancer Centre, Tokyo, Japan.

5. Host researcher:

Dr Takahiro Ochiya

6. Description of your current research

We are developing lipid-based nanoparticles for the targeted delivery of nucleic acids to cancer cells. Using a novel peptide ligand, U11, already shown to have affinity against the metastatic cancer-related receptor, urokinase plasminogen activator receptor (uPAR), we are distinguishing properties that constitute a successful gene delivery agent. We find that for optimized targeting effect, the nature of the nanoparticle platform on which the ligands are presented is as important as the organization of the surface ligands themselves.

Firstly, a DNA nanoparticle system was used to show the uPAR-targeting effect of U11-deocrated nanoparticles. Methods of nanoparticle characterization included, photon correlation spectroscopy, zetapotentials, *in vitro* reporter gene assays and circular dichorism for studying the secondary structure of the surface peptide ligands. On translation of our optimized nanoparticles for siRNA delivery, we used an *in vivo* bone-metastatic model (PC3M-luc into knee cartilage of mice) to determine their delivery efficiency to metastatic tumours.

In midst of developing a U11 targeted-nanoparticle, we recognized the importance of small size, low charge and PEG lipid concentration within the nanoparticle platform on maximizing targeting effect. Important also was to extend the peptide from the nanoparticle surface, onto the distal end of PEG lipids, to prevent peptide aggregation. Hence, a final optimized U11-targeted system gave a 30-fold increase in luciferase transfection in uPAR-expressing cell lines compared to non-targeted controls. As for siRNA-delivery, the non-targeted nanoparticle (carrying anti-luciferase siRNA, i.v.) was shown to knock down 75% of luciferase expression in PC3M-luc tumours. Following such promising results, we continue by performing similar *in vivo* experiments to

investigate improved delivery to metastatic tumours by targeted siRNA-nanoparticles.

7. Research implementation and results under the program

Title of your research plan:

The Targeted Delivery of RNAi to Metastatic Cancer Cells *In Vivo.*

Description of the research activities:

RNAi, or interference RNA, is a type of nucleic acid with great potential as a cancer therapy. Unlike traditional gene therapy methods of delivering DNA constructs that code for the expression of anti-tumour proteins, the delivery of RNAi to cancer cells allows the downregulation of mRNA sequences plus their corresponding proteins that are associated with cancer induction and progression. The successful delivery of RNAi to cancer cells can be shown by the downregulation of the proteins for which the targeted mRNA corresponds to.

One fast but reliable method of proving the delivery of such RNAi is by analyzing the decrease in luciferase content in cancer cells post-administration of anti-luciferase siRNA (short interference RNA). Luciferase, exogenous to mammals, is a protein that produces bioluminescence on reaction with the substrate, luciferin. The bioluminescence produced by the luciferase protein can be quantified by the imaging system, IVIS (in vivo imaging system).

The specific delivery of cancer-related therapeutic genes is important for efficient cancer therapy. Firstly not only to reduce side effects on the healthy tissue surrounding malignant tumours, but also to increase the uptake of these therapeutics genes by cancer cells. Our optimized nanoparticle delivery system is designed to have surface ligands that can carry the RNAi-containing nanoparticle to cancer-specific sites. The surface ligands we use is called ‘U11’, a peptide sequence with high affinity to the urokinase plasminogen activator receptor (uPAR), which is over-expressed on a number of highly metastatic cells. It is this affinity that directs the site-selective delivery and uptake of such nanoparticles by cancer cells.

Firstly we characterized the expression level of the receptor of interest, uPAR, in a variety of cell lines, by real-time PCR. It was found that MDA-MB231-luc, a highly metastatic breast cancer cell line had over 30-fold higher expressional levels of uPAR than 143B-luc, an oesteosarcoma derived cell line. Both of the cell lines mentioned have stably-expressing luciferase, which means a successful delivery of

anti-luciferase siRNA would result in the downregulation of the luciferase protein. To show the targeting ability of the uPAR-targeted nanoparticle, an *in vivo* experiment was planned to inoculate subcutaneously uPAR-high and uPAR-low cell lines MDA-MB231-luc and 143B-luc.

6 days post-inoculation of MDA-MB231 and 143B tumours, mice were treated by injection through the tail-vein with a dose of 50mg/kg anti-luciferase siRNA encapsulated in uPAR-targeted and non-targeted nanoparticles. 3 days after injection, it was observed by IVIS that the MDA-MB231 tumours (highly over-expressing uPAR) treated with uPAR-targeted nanoparticles showed an average of 87% decrease in luciferase expression. All other control groups, non-targeted nanoparticles, and nanoparticles containing non-specific siRNA did not show a reduction in luciferase expression in the MDA-MB231 tumours. This is a clear indication of the ability of the targeted-nanoparticles to increase uptake efficiency in cancer cells. To further demonstrate the specificity of the uPAR-targeted nanoparticles for the uPAR receptor, 143B tumours (low uPAR expression) did not show decrease in luciferase expression after treatment with targeted or non-targeted nanoparticles.

Results from our studies firstly demonstrate the targeting efficiency of the U11 ligand, and also highlights the importance of the inclusion of such targeting ligands for increased delivery efficacy and uptake of nanoparticles. Further experiments would include the use of a therapeutic siRNA, which if successful would induce tumour suppression and/or reduce tumour size. Biodistribution experiments using radiolabelled siRNA can also allow us to determine the accumulation of encapsulated siRNA in all organs post-injection.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Conrad Vink （ID No.: SP08111 ）

2. Current affiliation: Centre for Immunodeficiency, University College London

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Division of Gene Therapy, Osaka University

5. Host researcher: Professor Yasufumi Kaneda

6. Description of your current research

The Centre for Immunodeficiency at University College London is currently engaged in clinical trials using gene therapy to treat inherited immune system disorders in children. At present we use retroviral vectors to express a functional copy of the mutated gene in bone marrow stem cells, and these are transplanted into affected patients. However, problems have arisen in five patients treated in this way, namely leukemia-like cell expansions caused by interference between the integrated retrovirus and proto-oncogenes in the transplanted cells. At present we are testing alternative ways to transduce bone marrow stem cells such as vectors based on different viruses or using alternative integration systems to reduce the risk of insertion near a proto-oncogene. My particular research is to use the Sleeping Beauty integrating element to stably correct target cells as this has been shown to integrate into genes less often than standard retroviral vectors. We have shown that it is possible to substitute the integration step of the virus using Sleeping Beauty and are currently collecting integration sites to understand the pattern of integration.

7. Research implementation and results under the program

Title of your research plan:

Gene delivery to bone marrow stem cells using Haemagglutinating Virus of Japan Envelope Vector

Description of the research activities:

Our goal was to test the ability of the HVJ-E vector to transduce primitive stem cells from bone marrow in order to ascertain its potential as a gene therapy vector for diseases arising in this cell type. The experimental system was to isolate the cells from murine whole bone marrow by magnetic cell sorting and then to transduce the cells with HVJ-E carrying a gene for the enhanced green fluorescent protein eGFP. In the first part of the project, we optimized the system for isolating these cells using the Kaneda lab MACS setup and were able to purify lineage negative cells to over 90% purity. In parallel, we made and tested HVJ-E envelope expressing eGFP on HeLa cells and were able to achieve gene expression in 40% of these cells under optimized conditions. Finally, we tested the vector on the stem cell population. Gene expression was not detected despite repeated attempts to improve the transduction conditions with protamine sulphate and centrifugation. However, the Kaneda lab has an interest in using this cell type for transplant experiments to treat skin conditions, so the successful isolation system is useful in itself. In addition, we intend to continue our experiments to discover conditions under which HVJ-E can infect this cell type.

8. Please add your comments (if any):

Two months is a very short time in research, but it is a perfect amount of time to try out a new idea or a theory in a new environment with different expertise and an alternative viewpoint. We intend to pursue this research in the future and also pursue a side project with bone marrow stem cell treatment for skin disorders.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Marc Bompart （ID No.: SP08203）

2. Current affiliation: Université Technologique de Compiègne

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
XChemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Institute for Chemical Research, Kyoto University (Uji Campus)

5. Host researcher: Pr. Yoshinubu Tsujii

6. Description of your current research

The project of my thesis is to develop detection systems for chemicals in the form of microchips, based on molecularly imprinted polymers for recognition, and metal nanocomposites for signal amplification and optical readout.

Parallel detection of molecular species in very small amounts of fluid is one of the main motivations behind micro and nanosystems. Molecularly imprinted polymers (MIPs) are tailor-made synthetic receptors, they are extremely versatile materials in this context, as they allow for the recognition and detection of many chemical and biological species with a single technology. We design and fabricate systems equipped with nanodots or multifunctional nanobeads of MIPs containing gold nanoparticles, or MIPs coupled to surface-bound metallic nanostructures. This allows for their individual addressing and for the parallel optical detection of different molecules by UV-Vis spectroscopy, surface-enhanced Raman scattering (SERS), or localised SPR. The radical reduction of the size of the functionalized MIPs allows a strong relative increase in the number of detection sites. Specially designed nanostructures will also have the advantage of allowing the use of antenna effects and near field optical enhancements. Chemical species will thus be detectable and identifiable without labels at low concentrations. The composite MIP particles are synthesised using, among other techniques, controlled/living radical polymerisation.

7. Research implementation and results under the program

Title of your research plan:

Synthesis of Molecularly Imprinted Polymer by Control and Living Radical Polymerization.

Description of the research activities:

Despite efforts to optimize the selection of functional monomers and improvements in the physical form and morphology of MIPs, binding of the target is often associated with a relatively low affinity, broad site heterogeneity and slow kinetics. Furthermore traditional free radical polymerization processes are difficult to control with regard to chain propagation and termination. By gaining better control over the polymerization reaction therefore, it is expected that improved molecular recognition with MIPs can be achieved. The problematic chain termination encountered in traditional addition polymerization can be minimized when using living radical initiators, resulting in a more constant rate for polymer chain growth, and a narrow molecular weight distribution for linear (non cross-linked) polymers.[1] The present work was aimed at studying Reversible Chain Transfer Catalyzed Polymerization (RTCPs)[2] for the preparation of molecularly imprinted polymers.

1. *S. Boonpangrak et al. / Biosensors and Bioelectronics 22 (2006) 349–354*
2. *A. Goto et al. / J. AM. CHEM. SOC. 2007, 129, 13347-13354*

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: COLMARS Julien （ID No.: SP08204 ）

2. Current affiliation: Laboratoire de mécanique et Génie Civil, Montpellier. France.

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: (1)Lab. of Active Bio-based Materials // Research Institute for Sustainable Humanosphere // Kyoto University / Uji // JAPAN(3) Laboratory of (2)Biomaterials Design // Division of Forest and Biomaterials Science // Graduate School of Agriculture // Kyoto University // JAPAN

5. Host researcher: (1)Hiroyuki YANO, (2) Takato NAKANO

6. Description of your current research

At the LMGC in Montpellier, I'm investigating the mechanical behavior of panel paintings, which are paintings (mainly from the 15th or 16th century) painted on a wooden support.

The variations of humidity, together with time, lead to important deformations on wood panels, and sometimes damages logically occur on painting.

The mechanical behavior of ancient wood is still unknown from the specialist of this material.

7. Research implementation and results under the program

Title of your research plan:

Analysis of heat treatment effects on poplar wood creep behavior.

Description of the research activities:

In the last decades, many Japanese scientists have tried to use heat treatment as an accelerated way to get ageing of wood. Some of them show evidences of good results for dimensional stability (heat treated wood, as old wood, absorb less water than new wood), and underlines also differences on the mechanical point of view (ancient wood shows increasing elastic modulo with an increase of time, whereas heat treatment reduces it).

For a better understanding of ancient wood, be it in Japanese temples or in panel paintings, we should learn more about long term behavior of heat treated wood.

To that purpose, different heat treatments have been carried out during the program, after different duration of heat treatment.

At the end of the summer program, conclusions have been established yet, because results will need further discussion. Nevertheless, the creep results already show significant differences between heat treated samples and non treated samples.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: DARIBO ISMAEL （ID No.: SP08205 ）

2. Current affiliation: Telecom ParisTech, Paris, France

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: KEIO University, Tokyo, Japan

5. Host researcher: Prof. Hideo Saito

6. Description of your current research

Three-dimensional television (3DTV), as the next revolution in visual technology, promises to bring to the customers a new generation of services. Enjoy three-dimensional entertainments; navigate freely around a sportive show, to name but a few of the new promising 3DTV applications. Another target fields can be expected, like Digital Cinema, IMAX theaters, medicine, dentistry, air-traffic control, military technologies, computer games, and more. In the meantime, the development of digital TV and autostereoscopic displays allow to easily introduce 3D in broadcast applications like television. The creation and the transmission of autostereoscopic content have to be thought with the new broadcast constraints, and especially with two of them: the adaptivity with respect to the different receiver capabilities and the backward compatibility allowing to extract the 2D information for existing 2D displays.

Among the various studies, recent researches give much attention to 3DTV, more specifically to depth image-based rendering (DIBR) approaches. Indeed, DIBR technique has been recognized as a promising tool which can synthesize some new ”virtual” views of the scene from the so-called video-plus-depth data representation, instead of using the former 3DTV proposals, such as 3D models or stereoscopic images. The video-plus-depth data representation uses a regular color video enriched with the depth map providing the Z-distance for each pixel. This format is currently standardized by the MPEG (Motion Pictures Experts Group) within the MPEG-C part 3 framework of the compression of the per-pixel depth information within a conventional MPEG-2 transport stream.

Classically the correlation between the texture motion vectors and the depth sequence motion vectors is not exploited in the coding process. One of the aims of my past

researches was to reduce the amount of information for describing the motion of the texture video and the depth map sequences by sharing one common motion vector field. Intuitively, the texture video and the depth map sequences have common characteristics, since they describe the same scene with the same point of view. For that reason, in both domains (color-surface structure and distance information) boundaries coincide and the direction of motion is the same. My approach exploits the physical relation between the motion in both videos, the texture and depth map videos.

Furthermore, considering a fixed global bit-rate we proposed a new distribution of the available bandwidth by establish an objective ratio between the number of bits of the texture and depth map. We optimize the bandwidth repartition between the texture and the depth map data.

Once the 3D data have been encoded and transmitted over the TV broadcast, some "virtual" sequences are generated from the transmitted video at the TV set-top boxes for the 3DTV purposes. However, due to the 3D rendering, some areas that were occluded in the transmitted sequence become visible in some "virtual" sequences. To deal with this problem we propose a new filtering technique for DIBR allowing to reduce or completely remove the holes without degrading the entire depth map. The proposed filter account the distance to object boundaries. The advantage is not to introduce distortion in the depth map when it's not necessary. Experiment results have illustrated the high efficiency of the proposed method.

7. Research implementation and results under the program

Title of your research plan:

Interview prediction among views within a uncalibrated cameras framework

Description of the research activities:

After the High-Definition, the next revolution for the video communications is the 3D perception. Three-dimensional television (3DTV) is one of the promising next-generation multimedia appliances which exploits this visual sense and provides viewers with more realistic and immersive impression. In recent years, considerable research projects have been conducted on 3DTV. This is in this context that my present research takes place.

The near-future new TV display will bring to the consumers a new kind of services and application. One of them is the free viewpoint. By capturing a scene with multiple cameras, it's possible to create a 3D visual effect that simulates the free navigation in the scene from different angles. An example is the famous effect in the movie "Matrix" or the "Eye Vision" system used for the American Super Bowl. Due to the multiple streams captured by each camera, this kind of system consumes a lot

of quantity of data. Thus, this amount of data needs to be encoded for storage or transmission purposes. My present work consists in propose an efficient coding scheme satisfying the reduction of the data under the constraint of an optimum 3D perception quality.

Sharp, Sony and Sanyo, three Japanese companies, have formed, in March 2003, the 3D Consortium in order to help the development of 3D technologies. Japan seems to be again among the first country in the world to put 3DTV in the market, and to develop the 3DTV applications like Free Viewpoint as discussed above.

The proposed research conducted in Japan consists in extend my past video-plus-depth work to the case of using uncalibrated multiple cameras. From now, I exploit the temporal redundancies in a video and its associated depth map in uncalibrated camera framework and the inter-view correlation between the different videos. In order to achieve this goal, multiple video cameras are used to simultaneously acquire the scene from different viewpoints. The captured data is referred to as multiview video which is composed of a regular texture video and an associated depth map sequence which provides per-pixel the distance between an object in the scene and the camera. The research fits into utilizing the interview similarity among views within a uncalibrated cameras framework, and thus reduces the interview spatial redundancy.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Benoit Eble （ID No.: SP08206 ）

2. Current affiliation: Paris Institute of Nanosciences

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University

5. Host researcher: Professor T. Itoh

6. Description of your current research

Optical Orientation in InAs/GaAs quantum dots

Fine understanding of mechanisms which drive the physics of electron spin confined in a quantum dot (QD) is a prerequisite to use this degree of freedom (spin) in quantum information processing. For III-V semiconductor, optical measurement based on optical Valance/conduction bands transition is a powerful tool to investigate in the spin relaxation process.

I demonstrate that individual confined spin carrier (electron or hole) can be very easily initialized under circular-polarized light excitation with a high level of fidelity. This definitely underlines that spin relaxation dynamics, in QDs, is extremely slow, compared to spin relaxation dynamics in quantum wells and bulk material, because of the full quantification of electronic state which suppresses classical spin relaxation mechanisms.

My study reveals the important role of two spin-dependant interactions which must be cancelled or screened to succeed in polarizing spin carriers with a very high level of fidelity: the first interaction takes its roots from Coulomb interaction in low-symmetry QD. It’s called electron/hole Anisotropic Exchange Interaction (A.E.I) and is the source of a very fast relaxation of photo-created exciton angular momentum in the picoseconds timescale. Coupling the QD state to electron reservoir by a gate bias, allows quenching of the A.E.I when the QD is charged with one resident electron or hole. In this regime, we are looking at the photo-luminescence of excitonic complexes called trion (X+ or X-) which are formed by singlet spin states of electron (for X-) or hole (for X+).

The second perturbation is related to the host material of the QD and is hyperfine interaction (H.I) between electron and nuclear spins. By mean of time-resolved photo-luminescence performed on QDs ensemble and magneto-optics measurement on single QD, we show that on the one hand H.I with randomly oriented nuclear spins is the source of a efficient electron spin dephasing, and on the other hand , optically-oriented electron spin is able to build-up via H.I, a macroscopic nuclear spin polarization (Overhauser effect). Most of the protocols proposed for initializing the quantum state of a single electron spin in III-V semiconductors-based QDs should be reconsidered by taking into account this strong coupling with the system of nuclear spins.

7. Research implementation and results under the program

Title of your research plan:

Ultrafast pump-probe spectroscopy of high dense magnetic polaron in CdMnTe

Description of the research activities:

Semimagnetic semiconductor, also referred to diluted magnetic semiconductor is a semiconducting alloy whose cation is partially substituted by the magnetic ions. The sp-d exchange interaction between itinerant electrons and the 3d5 electron localized on the magnetic atom yields peculiar proprieties. If we form electronic excitation through light pumping, the electron and hole of exciton align the spins of magnetic ions within their wavefunction through the sp-d exchange interaction. This ferromagnetic domain is called exciton magnetic polaron.

Dr. KATAYAMA has studied a heavy doped Manganese ions (Mn2+) bulk sample of CdMnTe. The spatial fluctuation of Mn concentration allows the formation of quantum pocket in which strong and quasi-resonant optical pumping can address a high density coupled exciton/Mn spin state called dense magnetic exciton polaron.

By mean of photoluminescence (PL), under strong optical pumping, a new PL line appears and is red-shifted in respect of the exciton PL energy because of huge energy stabilization by overcoming the electron/hole pairs scattering through sp-d exchange interaction.

My participation to this subject was to perform with Dr. KATAYAMA and his student, the first two colors-pump-probe experiments, measuring the time-resolved Faraday rotation with a picosecond time resolution, in order to study the spin dynamics of the dense magnetic exciton polaron. While the pump energy is set into

quasi-resonance with the dense magnetic polaron energy, the probe energy is set into the transparency region of the sample, in such way that probe photons are not absorbed. This two-color experiment performs a non-demolition quantum measurement.

Unfortunately, the data are very complicated to understand, because of non-linearities coming from the huge light excitation power.

This study remains under investigation in the Japanese group.

8. Please add your comments (if any): During my stay in Osaka University, I improved my experimental skills and have access to experimental equipment not available in Paris University such as optical parametric amplifier and two-color pump-probe measurement. I had also the opportunity to give seminar in order to present my experimental results about spin physics in InAs/GaAs quantum dots.

Professor Itoh who is internationally recognized as a leader in non-linear optics in semiconductor, proposed me to attend EXCON 2008 conference, which took place in Kyoto University. Then I have also the opportunity to present my study during the poster session. Moreover, Professor Itoh proposed me to visit Kobe University which has developed many experiments to study Terahertz physics.

Moreover, increased participation in both faculty and graduate student exchanges should result from this JSPS visitation program.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Nicolas Foin （ID No.: SP08207 ）

2. Current affiliation: Imperial College London , Department of Bioengineering

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Tokyo
Department of Biomedical Engineering
Graduate School of Medicine

5. Host researcher: Prof. Joji Ando

6. Description of your current research

Atherosclerosis is the arterial disease underlying heart attacks and strokes which are the leading cause of death in the western countries. It has been recognized that the patterns of blood flow in arteries influence the development of diseases. Low and disturbed flow enhances the initiation and progression of the disease whereas high laminar flow has a protective effect.

Endothelial cells, the cells covering the inner wall of arteries, can sense the mechanical force exerted by the flowing blood and consequently alter their gene expression. This has been shown to be critical in the development of cardiovascular diseases.

Blood flow also induced some transport of molecules from and to the endothelial cell surface. It was suggested that this could be another mechanism through which endothelial cells sense and respond to flow. It is however a major challenge to identify the exact contribution of these two mechanisms on the biology response as they tend to co-localize in-vivo.

With the aim to identify a possible transport effect in the activation pathway of pro-inflammatory genes, we exposed endothelial cells cultivated in-vitro to controlled levels of shear forces and mass transport and we performed serial measurements of a protein of interest expression to capture temporal and spatial changes. The optimal conditions were determined by extensive flow and mass transport simulations.

7. Research implementation and results under the program

Title of your research plan:

Shear and mass transport effects on endothelial cell biology

Description of the research activities:

Learn different cell culture lab techniques

Presentation of my research results to the group.

In vitro flow experiment on cells and protein expression measurement.

Learn specific techniques of interest (Calcium and Nitric oxide probes/ Isolation of cells/ transfection) and try on flow experiments.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Grandsire Anne-Flore （ID No.: SP08208）

2. Current affiliation: CNRS (Centre Nation al de la Recherche Scientifique)

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Institute for Chemical Research (Uji Campus), Kyoto University

5. Host researcher: Professor Yuichi Shimakawa

6. Description of your current research

The first part of my research activities was dedicated to the synthesis of hybrid organic-inorganic materials made from silylated compounds, derived from polyethylene glycols. Three precursor organic compounds were synthesized. Each of them shows a possible dimerization by hydrogen bounding. The hydrogen bounding strength is different in the three cases. First, I synthesized some nanostructured materials functionalized by polyoxoethylene and I studied the effect of alkalin complexation by these materials. These materials did not show a lamellar structure with or without presence of alkalin salt during the synthesis. I also used these precursors for synthesize some mesoporous materials. The 2D hexagonal structure appears only for one of the silylated precursor, which has the strongest hydrogen bounding.

The second part of my research activities concerns the studies of the properties of a lamellar hybrid material, functionalized by a carboxylic acid function. The insertion of cobalt nanoparticles is stabilized by this function in this material which is the aim of my 3rd theses year.

7. Research implementation and results under the program

Title of your research plan:

" Preparation of new magnetic compounds by using high pressure and high temperature synthesis routes "

Description of the research activities:

The aim of my project in the Prof. Shimakawa's Laboratory was to learn a new experimental technique for synthesis of transition metal oxides under high pressure and high temperature conditions. I tried to synthesize new two materials under high pressure and high temperature conditions with this technique during the JSPS summer program. This project gave me a good opportunity to learn the new synthesis technique.

The project concerned the synthesis of two new rare earth containing perovskites such as $Tb_{2/3}Cu_3B_4O_{12}$ with B = Sn or Ge under high-temperature and high-pressure conditions. A related interesting oxide $CaCu_3B_4O_{12}$[1] with B = Sn or Ge has been synthesized by a high-temperature and high-pressure condition at 6GPa and 1000C for 30 minutes. In $CaCu_3B_4O_{12}$ with nonmagnetic ions at the B-site, the special alignment of the CuO planes gives rise to a delicate balance between ferromagnetic direct exchange and antiferromagnetic superexchange interactions. As a result, either ferromagnetic or antiferromagnetic properties can appear within the same structure framework. The change in magnetic behaviors by introducing magnetic ions at the Ca site should be interesting.

The first target material of my project was $Tb_{2/3}Cu_3Sn_4O_{12}$. Stoichiometric mixture of the appropriate starting materials was pressed into pellets and calcined at 1000C for 12H in air. It was reground, packed into a platinum capsules and then pressed under 8GPa at 1300C and 1500C for 30 min. I also directly pressed the mixture of the starting materials in platinum capsules under 8GPa at 1300C for 30 min. The obtained each grey powder sample was studied by X-ray diffraction, but the data didn't show any diffraction peaks from $Tb_{2/3}Cu_3Sn_4O_{12}$ phase.

The second target material, $Tb_{2/3}Cu_3Ge_4O_{12}$, was tried to synthesize. Stoichiometric mixture of CuO, GeO_2 and Tb_4O_7 was packed into a platinum capsule and then pressed under 8GPa at 1300C. The X-ray diffraction data showed diffraction peaks of $Tb_{2/3}Cu_3Ge_4O_{12}$ phase but it contained some GeO_2. In order to decrease the amount of GeO_2, I tried synthesis with different conditions. Finally, I found that other starting materials and decreased synthesis temperature gave a good result. The amount of GeO_2 in the final product was less than in the previous sample. Although a pure single phase was not obtained yet, I made some magnetic measurements on this sample and it showed a ferromagnetic transition at 11K under an external magnetic field of 100 Oe.

[1] H.Shiraki, T. Saito, T. Yamada, M. Tsujimoto, M. Azuma, H. Kurata, S. Isoda, M. Takano, and Y. Shimakawa, *Physical Review B,* **2007**, 76, 140403

8. Please add your comments (if any):

I had a wonderful time in the lab. All members were really nice and helpful. All in all, it has been a great scientific as well as personal experience. JSPS summer program was arranged very well to make my Japanese life really simple and gave a great introduction to Japanese culture. In a personal point of view, my stay in Japan was a very exciting and interesting experience. I have also had some opportunities of visiting some very interesting and cultural places.
I can only recommend people to try ! My many thanks to my host researcher and my supervisor (Y. Shimakawa and T.Saito in Kyoto University) and to the JSPS.

9. Advisor's remarks (if any):

I found Ms. Anne-Flore to be a talented young scientist. She quickly mastered the concepts of high-pressure synthesis and succeeded in preparing a new important material. She had a good relation with people in the laboratory, and she really enjoyed her stay in Japan. It is virtually certain that this summer program was a really good experience for her. (Prof. Y. Shimakawa, ICR, Kyoto University)

RESEARCH REPORT

1. Name: Pierrick NUN （ID No.: SP08209 ）

2. Current affiliation: Institute of Biomolecules Max Mousseron

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

X Chemistry Engineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Graduate School of Engineering, Kyoto University

5. Host researcher: Pr. Michinori Suginome

6. Description of your current research

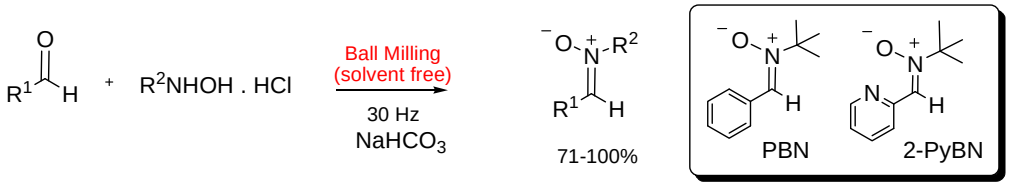
I am working on the development of solvent-free method to synthesize organic molecules. Organic solvents are often volatile, toxic, expensive and obtained from petroleum. It is important to find new synthetic pathways with less or without solvents. Some alternatives are already described and promising: use of water, ionic liquids or supercritical CO_2. But the best alternative to solvents is their absence.

For that I am mainly using two apparatus: a ball-mill and a microwaves oven.

Microwaves allow to conduct reactions at high temperatures and if the reaction mixture is homogeneous enough, it is possible to make some reactions using solid reactants without solvents to dissolve them. Some examples are already described but the main part use a liquid reactant in a large excess, and this reactant will act as solvent. I am working on organometallic reactions as the Suzuki reaction using microwaves activation to obtain compounds without any purification.

The most promising apparatus for solvent-free reactions is the ball-mill. Reactants are put into a jar with balls (jar and ball are in stainless steel), the jar is closed and the ball-mill induce a violent vibration (30Hz). In the jar, reactants are submitted to shocks between wall and balls. They are ground very closely and the reaction will occur. At the end of the reaction, the jar is open and product is obtained without use of solvent. This system already showed its applicability to various syntheses as aldol reaction, condensations, Wittig reaction… I demonstrated that it can be used for the synthesis of nitrones, starting from an aldehyde and a hydroxylamine. At the end of the reaction, the nitrone is isolated after just a filtrations on cotton to remove salts. Comparing to existing methods, it reduces considerably the use of solvents, no purification needed and the reaction time is shorter. I also showed the efficiency of ball-milling in the synthesis of hydrazones.

Synthesis of nitrones using ball-mill:



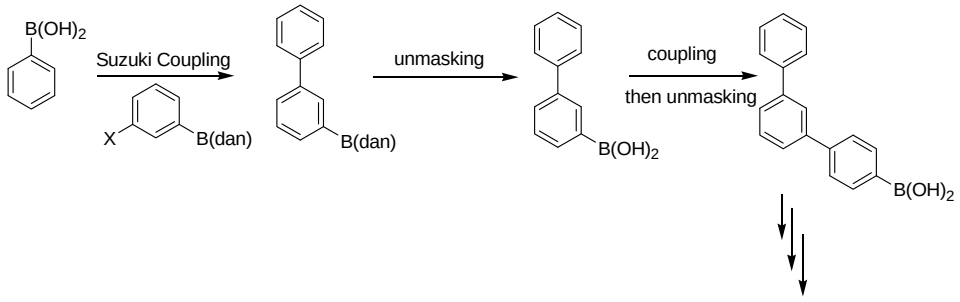
7. Research implementation and results under the program

Title of your research plan:

The Boron-Masking Strategy: application to the synthesis of oligothiophene-pyridine derivatives

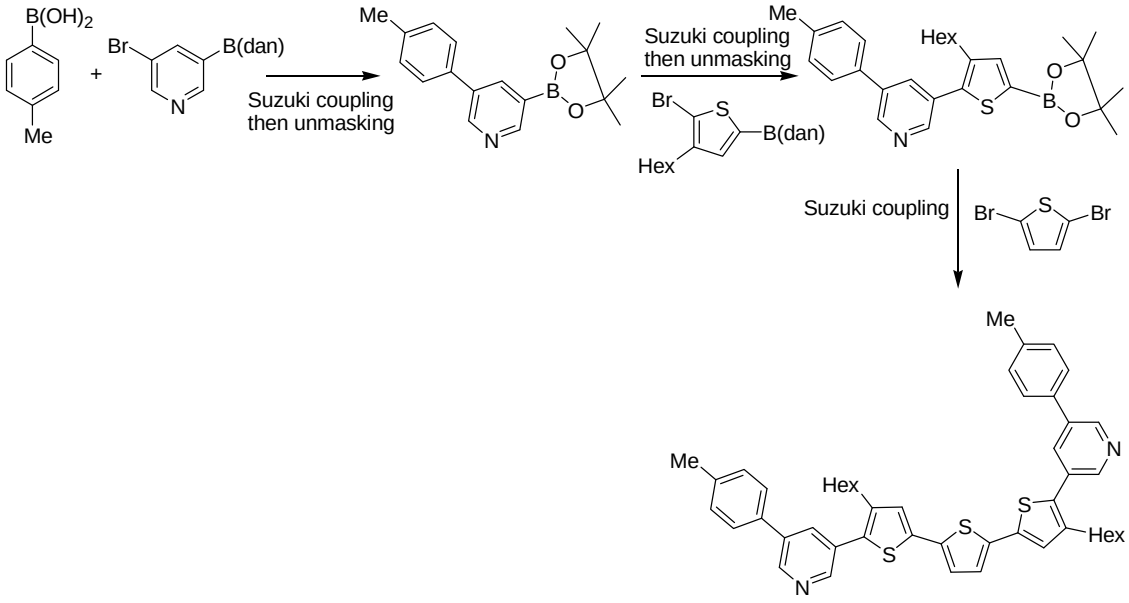
Description of the research activities:

The boron-masking strategy was developed in the Suginome's laboratory, featuring masking the boronyl group by the 1,8-diaminonaphtalene to block its reactivity. The diaminonaphtalene group is removed after coupling reaction in acidic conditions. This stategy showed its applicability in the synthesis of oligoarenes:



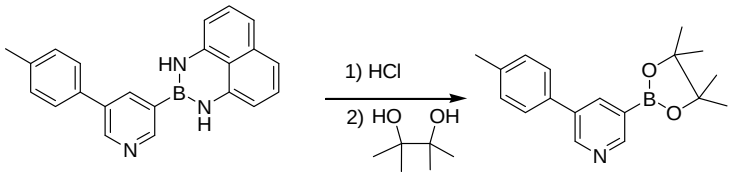
My work during this program was to use this strategy for the synthesis of oligothiophene-pyridine derivatives. These compounds are known to have great optical and electronical properties.

I describe here briefly the synthesis made at the laboratory. Other pyridine derivatives were prepared but I have no enough time to obtain the final compound.



The main difficulties of this work were caused by the pyridine ring. During the unmasking reaction, protonation of the nitrogen occurs and I had to develop a new method to obtain the boronic ester instead of the boronic acid as described with

benzene rings.



The boronic ester can then be engaged in the Suzuki-Miyaura coupling as shown in the scheme above.

This compound will be tested for its potential electronical properties.

8. Please add your comments (if any):

It was a great experience to work in the Pr. Suginome's laboratory. I learned a lot of things and new working methods. Everybody was very nice with me in the lab, always available to give me some help or advices. I advise every student to come in this laboratory for the summer program.

I want to thank Pr. Suginome for hosting me and for his kindness and his availability.

9. Advisor's remarks (if any):

Dr. Nun quickly get acclimatized to our laboratory and made great contribution to our research project. During his short stay with this summer program, he prepared some new coupling modules and succeeded in iterative coupling of these modules for the synthesis of his target molecule. The molecule shows interesting light emitting properties, which will be the interesting research subject in our laboratory. In addition to his scientific contributions, Dr. Nun brought to our laboratory an international atmosphere, which lets the students conduct weekly literature seminars in English. I hope we will have another summer program student in the near future. I also hope that the experience here contributes to the success of Dr. Nun in his Ph.D. work and in his future carrier.

RESEARCH REPORT

1. Name: Volland Sabrina （ID No.: SP08210）

2. Current affiliation: PhD student in Chemistry and Physico-Chemistry of Materials at Chemistry Institute Charles Gerhardt, University of Montpellier II, FRANCE

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:

Graduate School of Materials Science, Nara Institute of Science and Technology, NAIST

5. Host researcher: Pr. Tsuyoshi Kawai

6. Description of your current research: ***Encapsulation of complexes (catalytic, luminescent,…) in "ionogels".***

Ionogels are ionic liquids immobilized in porous network. These new kind of materials were created in my laboratory in 2005.[1] There particularity is that ionic liquid could be confined in a solid matrix but keeping a lot of ionic liquid properties as liquid conductivity.[2.3.4]On these bases, a lot of application can be developed in various domains.

I have encapsulated palladium complexes in order to use this advanced material in the case of the Heck reaction. By this way, we could avoid any step of purification, any problem due to the cost and the viscosity of ionic liquid. This material could combine heterogeneous and homogenous catalytic advantages.During collaborations with other labs, we also encapsulate other kind of complex as luminescent complexes with europium.[5]

Professor Tsuyoshi Kawai's lab has synthetized some luminescent compounds that could be incorporated in my ionogels.[6,7] This work could lead to a new advanced material and this collaboration offer the possibility to study properties of this material

1. Chem. Commun., 2005, 1082–1084,

2. Chemistry of Materials **2006,** 18, (17), 3931-3936,

3. Physical Chemistry Chemical Physics **2007,** 9, (40), 5419-5422.

4. Progress in Solid State Chemistry **2006,** 33, (2-4), 217-222..

5. *Chem. Mater.* **2006,** 18, 5711-5715.

6. Jpn. J. Appl. Phys., Vol. 47, No. 2 (2008)

7. Org. Lett., Vol. 9, No. 21, 2007 Vol. 9, No. 21 4195-4198

7. Research implementation and results under the program

Title of your research plan:

Study of fluorescent molecules quenching and Encapsulation of luminescent complexes in "ionogels".

Description of the research activities:

A novel arylene ethynylene molecule has been synthesized by Kawai's team.[2] This molecule is more stable in a coplanar form than in a twisted form as in the cases of typical arylene ethynylene molecules. When the cationic charge was introduced into the ð-conjugated system, the perpendicularly twisted form became more stable than the coplanar state. The conformational change was controlled by introduction and removal of cationic charge

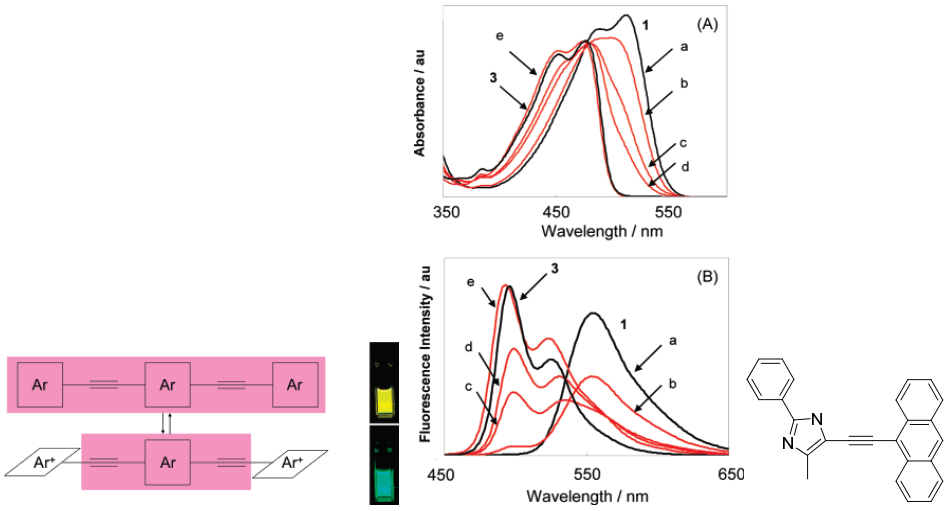


Figure 1: Compound 1

Different molecules were tested as quencher for the compound 1in ionic liquid.[8] The first one, tetracyanobenzene, is not revealed as a good quencher. The second one, dichlorodicyanobenzene has an influence on the spatial structure of the compound as the molecule previously studied by Kawai's team.

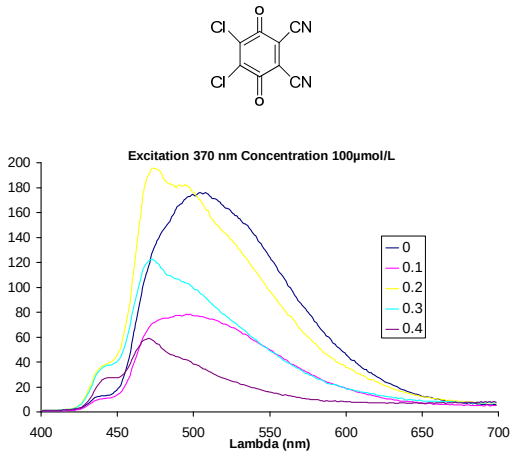
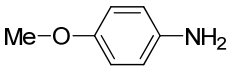


Figure 2: Fluorescence spectrum of Compound 1 in BmiTFSI with addition of dichlorodicyanoquinone

The anisidine is revealed as a good quencher for the compound 1



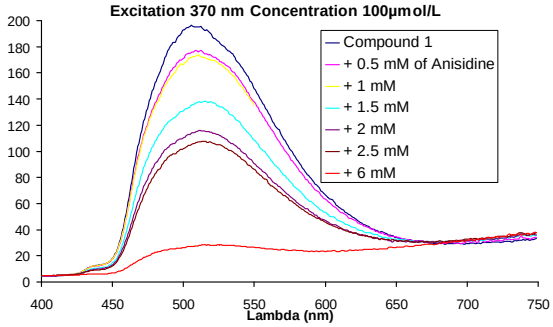
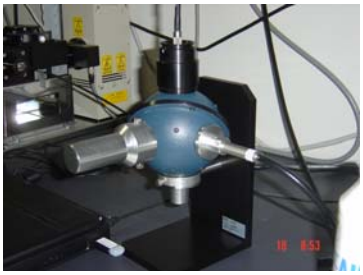


Figure 3: Fluorescence spectrum of Compound 1 in BmiTFSI with addition of anisidine

The compound 1 was inserted in ionogel (synthesized in France) and fluorescence on the solid gel was measured.



Inside the ionogel, compound 1 have changed from coplanar form to twisted form without any addition of another molecule. It maybe due to the walls nature or the confinement effect. For the moment changing of walls nature does not avoid this.

8. J. Phys. Chem. B **2007,** *111*, 5023-5029,

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Dr. Carmen Bachmann （ID No.: SP08301 ）

2. Current affiliation: University of Augsburg

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences X Business Sciences

4. Host institution: National Graduate Institute for Policy Studies (GRIPS)

5. Host researcher: Prof. Dr. Takashi Fukushima

6. Description of your current research

The current research deals with the problem that the tax aspects of decisions to invest abroad are generally calculated merely on the basis of the income tax burden and do not include the inheritance tax burden. Even though disregarding inheritance tax issues is perfectly fine in respect of publicly traded corporations, with regard to closely held companies （”Small and medium sized enterprises" - "SMEs") the close ties between the owner's business spheres and their private spheres – hence, their inheritance tax burden – have to be considered.

Whereas earlier studies examined income and inheritance tax planning seperately, the current research integrates both types of taxes into a single model. The subject of examination described in a first article, which is based on a theoretical model, is a German limited liability company (GmbH), which performs activities abroad via a foreign corporation. The examination demonstrates that taking income and inheritance tax simultaneously into consideration – in contrast to a model based exclusively on income tax – during a thirty year testing period an indirect participation in the foreign corporation via a domestic limited liability company might become more beneficial from a tax perspective compared to a direct participation by a domestic entrepreneur. While taxes on income apply on an ongoing basis and, hence, on the current income, the subject of inheritance taxes are the assets themselves. Therefore the respective return on an

investment determines the amount to which an inheritance tax advantage might compensate or outweigh disadvantages with regard to the income tax burden.

7. Research implementation and results under the program

Title of your research plan:

” Impact of the Japanese inheritance tax burden on the investments of foreign SMEs”

Description of the research activities:

Having determined the general influence of the inheritance tax burden, the prospective research was intended to examine the concrete impact of the Japanese inheritance tax burden on investments to foreign SME in Japan.

Enterprises engaged in economic activities in Japan are subject to (corporate) income taxation in Japan with the profits generated by these economic activities. Furthermore in the case of succession the foreign owner of the business respectively his or her beneficiaries can be subject to inheritance taxation in Japan with the assets attributable to Japan. Due to the fact that the Japanese tax system has comparably high inheritance tax rates, it seemed to be quite likely that the general influence of inheritance taxation described above might be even more significant with regard to an investment in Japan. Even though Japanese inheritance taxation offers potential deductions, which may reduce the effective tax rate, not all deductions are also applicable to non-residents. Additionally the effective inheritance tax rate may rise in value in dependence of the inheritance tax law in the residence country of the owner of the business. Due to the fact that domestic tax exemptions and reductions are basically limited to mere domestic situations and that double tax treaties in general do not include inheritance taxes, the tax burden in the case of a succession can be significant.

During the research stay at the National Graduate Institute for Policy Studies, we first worked out the location factors for SMEs in Japan. The investment decisions of SMEs mainly depend on the so called "soft location factors". Compared to other Asian countries, Japan provides many such factors: e.g., is a minor rate of losses of bad debts, the political situation is solid, the stability of law is existent, and there is a comprehensive support by the state for foreign investors. All these local factors make the investment in Japan interesting for the SMEs in particular.

Hence, this is main reason for examining the impact of the tax burden (especially the inheritance tax burden), given that the tax burden can negate all these advantages.

The further goals for the research stay were the work out the legal foundations for this project. It is impossible to read and understand a Japanese tax code without knowing the language (a simple translation, apart from the fact that it is usually not up to date, is not enough to understand the fiscal situation in Japan). Hence, it was very helpful to discuss the Japanese tax law with competent Japanese professors. The Japanese company law is quite similar to the German company law. Hence, the German SMEs will find a legal environment in which they feel familiar. Regarding the Japanese tax law: Overall, the main difference between the tax law in the European countries and Japan is that in Japan, the European law does not have to be taken into consideration. For instance, the Japanese thin-capitalization-rule in the corporate tax law is quite similar to the thin-capitalization rule in Germany before January 2004. But Germany's thin-capitalization has since had a ruling of the European Court of Justice in 2002 (Lankhorst-Hohorst-Decision), and changed very often in order to fulfill the input of the European Court of Justice. So on the one hand, a European investor has, compared to an investigation in other European Countries, no protection by the European Law, but on the other hand he or she will find a stability of law. And, of course, if an investor wants to go to Asia, he or she will miss this European law in every Asian country.

This legal background provides the basis for further studies: Now the general impact of the Japanese inheritance tax on the tax planning of foreign investors can be analyzed and identified. Based on that the break-even point between income and inheritance tax will be assessed, *i.e.*, to what extent or in which situations a reduction in the inheritance tax burden exceeds an income tax advantage. Due to the fact that in extraordinary business situations (*i.e.*, financing decisions, decisions about the legal structure of a venture or the owners' stake in the venture) the relation of the inheritance to the income tax burden depends especially on the asset-to-profit-ratio, the critical rate of return will be determined for different scenarios.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Anita Büttner （ID No.: SP08302）

2. Current affiliation: Faculty of Organic Chemistry, Leipzig University, Germany

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Laboratory of Freshwater Fish Stocks,
Bioscience and Biotechnology Center, Nagoya University

5. Host researcher: Prof. Y. Wakamatsu

6. Description of your current research

The plant alkaloid cyclopamine was discovered around 1950 to be responsible for severe malformations in offspring of sheep fed with a diet that included *V. californicum*. The teratogenic phenotype is characterised by formation of one fusion eye (cyclopia) caused by the failure of the embryo's forebrain to form a bilateral cerebral hemisphere (holoprosencephaly). The molecular target of cyclopamine is a member of the sonic hedgehog (Shh) signaling pathway, which plays an important role in the development of the brain, the formation of limbs and dorsoventral patterning in vertebrates. Some cancers are caused by the dysfunction of proteins involved in this pathway. Interestingly, it was discovered that cyclopamine was able to cure a certain type of medulloblastome cancer in mice.

In my PhD work I use a luminescence reporter gene assay to identify potent Shh-pathway modulators as possible tumor therapeutics. Based on the results of a chemical library screening with SANT-2 derivatives we were able to specify molecular residues necessary for Shh interaction. The Japanese medaka fish (*Oryzias latipes*) also shows the characteristic cyclopia phenotype by cyclopamine treatment. Thus, these phenotypic effects will be analysed in medaka embryos in order to compare different potential Shh-modulating compounds and to identify potential side-effects.

7. Research implementation and results under the program

Title of your research plan:

Characterisation of the phenotypic effects in medaka strains and mutants exposed to sonic Hedgehog signaling pathway modulators

Description of the research activities:

The aim of the research at Nagoya University was the characterization of the effect of Cyclopamine and other Shh-interferring compounds on the development of the teleost fish medaka. I was able to make use of the excellent medaka strain collection in the laboratory, learn new technics and document my results with high quality microscopy. The dose dependent phenotypic effect of Cyclopamine was shown in experiments before. Beside this, I came to further conclusions, for example that the embryos cannot hatch anymore (because of the missing expression of hatching enzyme) or that there might be a very small time window for Cyclopamie to work during the development of the embryos. First medaka exposures indicate that the late blastula and early gastrula stages are important for Cyclopamine activity in medaka. Furthermore, I learned more details about medaka embryo developmental biology. It is supposed that the Shh protein is present at left/right axis formation in Kupffer's vesicle in medaka. To investigate whether there could be a liquid flow of Shh and presented Shh receptors I did some in situ hybridization experiments using appropriate markers for early development stages. Comparison of control hybridization and Cyclopamine treated embryos gave interesting results, so the experiments will be repeated at later time and used for continuative researches.

In previous experiments during my PhD work, a small library of Shh pathway inhibitors (SANT-2 derivatives) was synthesized, whose activity was proven by using a cell based assay. However, these compounds were not able to induce the cyclopia phenotype in medaka after exposure. First I repeated these findings, while additionally I was able to take more detailed pictures. Second I tried injection, based on the idea that the missing effect could be due to the inability of these compounds to cross the embryo's chorion. But neither injection over the cells, into the yolk nor direct injection into the cells could induce cyclopia. This might indicate the possibility to use SANT-2 as anticancer drug without inducing teratogenic effects.

Exposure and injection of Shh pathway activators (SAG derivatives) into normal and eye mutated medaka gave no further results, because the origin of the eye mutation and the target of SAG action are totally different. Beyond it, the toxic concentration seems to be in low micro molar range, concerning the high death rate.

Beside all these experiments, I learned a lot about the medaka itself, its treatment and taking care. Under the special guidance I was able breed different medaka strains in a short time from fertilized eggs to grown up fishes.

8. Please add your comments (if any):

This JSPS Summer Program not only gave me the change to have a look at scientific work in Japan, but also showed me the possibility of doing my Postdoc there. I deeply want to thank Prof. Wakamatsu and her group. I learned a lot and won new ideas for my research in a great working atmosphere. The friendly welcome and the kind help, as well as the enjoyable conversations and activities made these two month a pleasure and unforgettable.

9. Advisor’s remarks (if any):

Ms. Anita Büttner studied hard and obtained some new and interesting results with medaka during her stay in our laboratory. She learned many things about not only medaka but also Japan and its culture. Her experiences during her stay will bear a lot of fruits in future.

RESEARCH REPORT

1. Name: Nicole Einsporn （ID No.: SP08303 ）

2. Current affiliation: European University Viadrina

3. Research fields and specialties: Law

4. Host institution: Ohara Institute for Social Research, Hosei University, Tokyo

5. Host researcher: Prof. SUZUKI Akira

6. Description of your current research

Endeavoring the relations between labour market, social structure and their influence on law and the forms of punishment. In Japan I compared specific changes in japanese economical history with changes in criminal law.

A. Economical background and labour policy

During the centuries there were many crisis in labour market originated by general economic regression. In times of prosperity there are less restrictions in criminal law and a different practice of legislation than in times of crisis.

Economic, political, and ideological factors such as the value of labour, the systemic needs of capitalism, and the ideology of judges and their communities have changed through the centuries as well as during the last decades.

During the Edo period (江戸時代) several changes in labour market took place, which I documented in my main research paper.

Beginning in the 1920ies japanese labour unions tried to build a more concrete system of security by implementing the seniority system in labour structure. After WWII regression there arroused a big crisis in manpower followed by shuntō (春闘), the spring wage offensive, which is a unique japanese phenomenon. Boosted by the militancy of the workers who brought the cities of Japan to a halt every spring, it was key to boosting the comparatively low wages of the 1940s and to improving conditions and other benefits. The rengo (連合), the Japanese Trade Union Confederation, customarily set a specific target, "base-up", for the annual wage increases to aid the collective bargaining.

During the oil crisis Japan contintued its not-discharge politics which could be an assertion for the rare changes in criminal law during this time compared to similar developments in other countries. A connatural development can be seen during in the 1990ies crisis.

Labour market performance in Japan has improved in the meantime. In 2007, the employment-to-population ratio was about 70%, substantially higher than the OECD average of 66% . Likewise, the unemployment rate is among the lowest unemployment in the OECD. In 2006, the unemployment rate was around 4% --down from 5 ½ % in 2002-- compared to an OECD average of 6% and an EU15 average of 7 ½ %.

B. Punitive tendencies

Besides corporal and capital punishment, including seppuku(切腹) sentence for samurai (お 侍) which were common during the Edo Jidai, an interesting development can be seen for crimes requiring moderate punishment. Convicts could be sent to work at labour camps such as the one on Ishikawa-jima in in Edo Bay. More serious acts could result in being sent to work in the gold mine on Sado jima (island of Sado). In 1590, Hideyoshi had banned "unfree labor" or slavery, but forms of contract and indentured labour persisted alongside the period penal codes' forced labor. For example, the Edo period penal laws prescribed "non-free labor" for the immediate family of executed criminals in Article 17 of the *Gotōke reijō* (Tokugawa House Laws), but the practice never became common. The 1711 *Gotōke reijō* was compiled from over 600 statutes promulgated between 1597 and 1696. A penalty that targeted mainly merchants was kesshō (血書), the confiscation of a business.

The Keihō (刑法) , the Criminal Code of Japan was passed in 1907 as Law No. 45. It is one of the Six Codes that form the foundation of Japanese Law.

During the last decades fine became more important in Japan as well as in the West.

However, it´s rare in the west that firms that fall foul of regulators can be fined, though they can then launch legal appeals that last for years. Forcing a company to shutter its operations for a while is a popular form of punishment in Japan. In recent months it has been imposed upon several food companies and financial-services firms, among others.

Financial penalties are considered ineffective, since companies can simply pay a fine and then pass the cost on to their customers in the form of higher prices, with little impact on corporate behaviour. Lengthy legal fights are expensive.

But in countries with Confucian traditions, such as Japan, Korea, Taiwan, China, Mongolia and Indonesia, the freedom of action of a person or company stems not from a fundamental right, but is based upon the “grant of a benefit” from the state.

In sum, the evidence shows that Japan still has a low crime rate, and an especially low rate for violent crime. However, the Japanese public has low confidence in its safety, a high level of fear of crime, and a very punitive attitude toward offenders. The high level of media focus on rising recorded crime and a campaign for victims’ rights have contributed to this rise in public punitiveness. New legislation has not only imposed more severe punishment on offenders, but also widened the criminal justice net. A greater proportion of people who used to be diverted from the formal criminal justice process, are now included in the formal process, and a greater proportion of offenders who used to be tried in summary courts and sentenced to fines, are now dealt with by formal trial and sentenced to prison. Criminal justice agencies, especially the police and the public prosecutor’s office have gradually lost their discretion in using informal procedures due to the demands from victims. Western scholars have generally focused on the role of apology and forgiveness in everyday life and in criminal justice in Japan. However, the questions posed above beg further research into whether Japan has started to resemble other developed countries in moving towards popular punitivism, or whether, at least to some extent, the Japanese public were always more punitive than they were perceived to be.

In 1990 the police identified over 2.2 million Penal Code violations. Two types of violations—larceny (65.1 percent of total violations) and negligent homicide or injury as a result of accidents (26.2 percent)—accounted for over 90 percent of criminal offenses in Japan. In 1989 Japan experienced 1.3 robberies per 100,000 population, compared with 48.6 for West Germany, 65.8 for Great Britain, and 233.0 for the United States; and it

experienced 1.1 murder per 100,000 population, compared with 3.9 for West Germany, 1.03 for England and Wales, and 8.7 for the United States that same year. Japanese authorities also solve a high percentage of robbery cases (75.9 percent, compared with 43.8 percent for West Germany, 26.5 percent for Britain, and 26.0 percent for the United States) and homicide cases (95.9 percent, compared with 94.4 percent for Germany, 78.0 percent for Britain, and 68.3 percent for the United States). This is connected to the fact that prosecutions are less likely to be successfully challenged compared to the above mentioned countries, a fact that has caused human rights concerns and has led to a change in the law which will take effect in 2009.

7. Research implementation and results under the program

Title of your research plan:

Labour market, social structure and their influence on punishment

Description of the research activities:

Mainly comparing japanese statistics and discussing the political issues with my advisor, further institute members and researchers not only on the field of law, but also economics, history, politics and social sciences

RESEARCH REPORT

1. Name: Ulrike Endesfelder （ID No.: SP08304）

2. Current affiliation: University of Bonn

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Waseda University, Tokyo

5. Host researcher: Prof. Kazuhiko Kinosita Jr.

6. Description of your current research

My research is based in the field of applied physics. For my recent diploma thesis at the research center caesar in cooperation with the University of Bonn the focus has lain on medical sciences. My research group conducts holography for ultrafast three-dimensional facial imaging medical diagnosis, ablation of human body tissue with laser pulses for medical treatment and trace gas analysis of human breath by cavity-ringdown spectroscopy for medical diagnosis.
I was involved on developing an online feedback system for tissue differentiation during tissue ablation with short-pulsed CO_2 lasers. For differentiation the analysis of the acoustic and optical signal generated by the ablation process was used, since different composition of tissue yields different ablation processes. Here the signals itselves, their frequencies and for the optical signal also the spectroscopic data was used and the results compared.
For my current PhD research I have stayed in the field of applied physics but shifted the focus on biological physics. I just started my research in studying cellular signalling pathways.

7. Research implementation and results under the program

Title of your research plan: Single Molecule Physiology

Description of the research activities:

Activities of living organisms like extracting energy from nutrients, the movement of the body or signal detection such as light or smell are performed by molecular machines. These molecular machines are tiny, of the order of 10 nm or only tens of atoms wide and in the majority of cases made of proteins.
Studying the behavior of these individual molecules is crucial for finding the mechanisms of the machines, because these machines operate stochastically and thus cannot be synchronized with each other in the rigorous sense.
"Single-molecule physiology" done by optical microscopy enables us to image in real time, and also to manipulate, single machines at work.

Important systems that are explored in my host research group are F1-ATPase, a rotary molecular motor, myosin V, a linear molecular motor, and enzymes working along DNA.

My time in the lab was devided into two parts. In the first month I studied the methods and techniques of single molecule physiology for the main molecules used in the lab: F1-ATPase, myosin V and isotopomerase.

In the second month I focussed on myosin V. By preparing samples with fixed myosin V on a glass plate it is possible to let fluorescentic actin filaments slide on it. Holding one of the ends of the actin filaments tight, the filaments will start bending. Therefore a system to explore the sliding force is gained.

For myosin II it is reported that this force has a right-handed torque component, letting the actin filament rotate. For myosin V there are experiments oberserving moving myosin V on a fixed actin filament where the myosin rotates along.

By analyzing the data set observed with the system described above, one can enhance the previous results. This will be the next step to be done.

8. Please add your comments (if any):

First of all I would like to thank JSPS for giving me the opportunity to participate in this outstanding program. I have benefited greatly from my stay at my host laboratory.
I would like to thank my host Prof. K. Kinosita Jr. for all the arrangements, advice and opportunities he gave me.
Futhermore I would like to thank the whole lab group, introducing me to all the lab equipment and helping me with all the problems I had like e.g. japanese control menus.
Beside the scientific part of my stay I had an incredible and unforgettable cultural experience while participating in this program. I would like to highlight and thank my host family Sunahara for all their efforts introducing me to the japanese way of life.

RESEARCH REPORT

1. Name: Andreas G. Gierlich （ID No.: SP08305）

2. Current affiliation: Institute of Solid State Research, Research Center Jülich, Germany

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Graduate School of Advanced Integration Science, Chiba University

5. Host researcher: Prof. PhD. Ferdi Aryasetiawan

6. Description of your current research

The electronic structure of solids is subject to most intensive investigation in both experimental and theoretical solid state physics, since many properties of a certain material such as conductivity, magnetic behavior or its crystal structure are directly related to the distribution of the electrons inside the solid. The electronic many-body Schroedinger equation is the fundamental equation in the theoretical analysis of the electronic structure, since its exact solution completely characterizes the physics of the electrons in a certain material. Due to the immense computational effort involved in the solution of the Schroedinger equation it can however not be solved exactly for systems containing more than a couple of electrons. For the study of real materials containing millions of electrons one has to find approximate solutions to make calculations feasible.

In my past and present work in Germany I am conducting first principle calculations to study various aspects of the electronic structure of magnetic metals. Calculations from first principle aim at directly solving the many-electron Schroedinger equation in an approximate manner as opposed to the study of models derived from the Schroedinger equation. During the past 40 years the density functional theory (DFT) [1] within the most commonly applied local-density approximation (LDA) has become the standard technique for first principle calculations. However, LDA-DFT calculations show systematic deviations from experiments like the underestimation of band gaps in semi conductors and too large band widths in simple metals. Diagrammatic many-body perturbation theory can be used to systematically improve the LDA-DFT description by taking into account physical processes which are either described insufficiently or not contained at all in the LDA-DFT picture. Along this line the *GW* approximation [2] used in the group of Ferdi

Aryasetiawan has evolved as the state-of-the-art scheme for the analysis of the electronic structure of semi conductors.

In my past work I have deployed yet another technique from many-body perturbation theory, the FLEX method [3], which is especially suited to study the optical spectra of magnetic *3d* metals such as iron, cobalt or nickel. In my current work I am using various schemes based on many-body perturbation theory as well as the time-dependent extension of DFT to study magnetic excitations, the so-called spinwaves, in metallic systems.

[1] P. Hohenberg und W. Kohn, Phys. Rev. 136, B864 (1964); W. Kohn und L.J. Sham, Phys. Rev. 140, A1133 (1965)

[2] L. Hedin, Phys. Rev. 139, A796 (1965)

[3] N.E. Bickers and D.J. Scalapino, Ann. Phys. 193, 206 (1989)

7. Research implementation and results under the program

Title of your research plan:

Comparison between an Exact Downfolding Method and the Hubbard Model [1)]

[1)] *Title and content of the research conducted in the group of Ferdi Aryasetiawan deviate from the original proposal handed in to JSPS for the application to the summer program. Please see further notes in 8.*

Description of the research activities:

Despite the rapid progress of computer performance first principle calculations of the electronic structure of realistic materials are still limited to comparably small systems. Furthermore, today's standard approaches LDA-DFT and the *GW* approximation are not sufficient to describe the problem of strong electron correlation occurring in some classes of materials of growing importance. Since the electronic correlations originate from the confinement of the electrons to small regions inside the solid such materials have mostly been studied by introducing models, which describe only these regions of the solid explicitly whereas the surrounding parts are taken into account only implicitly by introducing respective model parameters. An example, which revealed a lot of physical insight into the correlation problem, is the Hubbard model, where the Coulomb interaction between the electrons in the small, localized region is treated as an adjustable parameter *U* chosen in such a way, that the static screening of the charges in the surrounding area is taken into account. However, the presence of an adjustable parameter *U* limits the predictive power of the model. Moreover, the Hubbard model is not strictly derived from the many-electron Schroedinger equation but was only intuitively postulated.

Recently Ferdi Aryasetiawan proposed a Green function-based method denoted downfolding. Since it is derived directly from the many-electron Schroedinger

equation, it allows calculating the exact electronic structure of a distinct region in a solid by properly incorporating all interactions between this region and the surrounding area. Consequently the full dynamics of the screening of the charges in the surrounding area is included naturally in this new approach as opposed to only including the static screening as is the case in the Hubbard model. Furthermore, by direct comparison with the exact expressions obtained from the downfolding method it was demonstrated, that some terms describing the interaction of the surrounding area with the region localized in space are entirely missing in the Hubbard model.

The purpose of this research project is to analyze the differences between the exact downfolding method and the Hubbard model by studying the electronic structure of an artificial four-level system. This simple system allows for an exact solution of the many-electron Schroedinger equation. The downfolding method and the Hubbard model can than be applied to characterize the electronic structure of a subset of the four levels thus mimicking a smaller region where correlations are stronger. Comparisons between the results from the different methods will provide a first quantitative estimate of the error caused by the absence of the terms in the Hubbard model. Furthermore, it allows the study of the influence of the dynamic vs. the static screening. The following steps are taken:

1) Derivation of mathematical expressions describing the four-level system.
2) Writing a computer code to:
   a. exactly solve the four-level system and,
   b. apply the exact downfolding method to a subset of the four levels.
3) From the results of step 2a) the statically screened Coulomb interaction for the subset of levels can be calculated and the electronic structure of can be determined using the respective Hubbard model.
4) Comparison of the results from part 2) and 3).

During my two-month research experience in the group of Ferdi Aryasetiawan I was able to complete steps 1) and 2). We further agreed on continuing our collaboration once I have moved back to Germany. A detailed plan has already been worked out to finish this project successfully.

8. Please add your comments (if any):

Within the first days after my arrival in Chiba we conducted a thorough analysis of the proposed research plan. Detailed discussions revealed some fundamental obstacles in the ansatz that questioned the success of the joint project. Therefore, we decided to change the plan to work on the project described above.

RESEARCH REPORT

1. Name: Stefan Güttel （ID No.: SP08306）

2. Current affiliation: Technische Universität Bergakademie Freiberg (Germany)

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Informatics (Tokyo)

5. Host researcher: Prof. Ken Hayami

6. Description of your current research

My current research is devoted to the numerical evaluation of matrix functions f(A)b where A is a square matrix of size n×n and the vector b is n×1. Typical applications are the solution of a linear system of equations where $f(z)=z^{-1}$, the solution of ordinary differential equations where f(z)=exp(z) or f(z)=(exp(z)-1)/z, the mapping of Dirichlet to Neumann boundary values in certain problems where f(z)=sqrt(z), and simulations in quantum physics where f(z)=sign(z). In those applications, the dimension n is very large and hence the matrix A should either be sparse (having only a few nonzero entries) or structured since otherwise we could not store it on a computer. It turns out that f(A)b=p(A)b for some polynomial p(z) of (high) degree smaller than n. In recent years Krylov subspace methods have become very popular to approximate f(A)b by implicitly constructing polynomials $p_{m-1}(z)$ of (low) degree m-1 such that $p_{m-1}(A)b \approx f(A)b$. The approximation $p_{m-1}(A)b$ is therefore an element of a Krylov space $K_m(A,b)=\text{span}\{b,Ab,...,A^{m-1}b\}$. It is known that there exists a minimal invariance index L such that $K_L(A,b)=K_{L+1}(A,b)=---$ If this index L is reached we know that f(A)b is contained in $K_L(A,b)$.

As the dimension of a Krylov space grows it may become necessary to restart the Krylov

approximation, meaning that after m steps of the Krylov algorithm almost all information of the current Krylov space (which consumes memory) is forgotten and a new Krylov space is built to update the previous Krylov approximation. Such a technique is well known for the solution of linear systems and has been generalized by [Eiermann&Ernst, 2006] for the approximation of matrix functions. A detailed study of the convergence of restarted Krylov approximations was given recently in two papers [Afanasjew&Eiermann&Ernst&G., 2008].

7. Research implementation and results under the program

Title of your research plan: The Structure of Rational Krylov spaces, Restarted Rational Krylov Methods for the Approximation of Matrix Functions

Description of the research activities:

Define a rational Krylov space as $K_{\mu,\sigma}(A,b)=\text{span}\{b,C_1,C_2C_1b,...,C_{m-1}\text{---}C_2C_1b\}$ where $C_j=(\sigma_jI-A)^{-1}(\mu_j\sigma_jA-I)$ are "continuation matrices", $\mu=(\mu_1,..,\mu_{m-1})$ are scaling factors and $\sigma=(\sigma_1,...,\sigma_{m-1})$ are poles which should not coincide with any eigenvalue of A. Note that the construction of $K_{\mu,\sigma}(A,b)$ involves the solution of m-1 large linear systems of equations (σ_jI-A). Now the following assertions hold

(i) $K_{\mu,\sigma}(A,b)$ is a subset of $[q(A)]^{-1}K_m(A,b)$ which is a subset of $K_L(A,b)$, $q(A)=(\sigma_1I-A)\text{---}(\sigma_{m-1}I-A)$.

(ii) There exist conditions on μ and σ such that $K_{\mu,\sigma}(A,b)=[q(A)]^{-1}K_m(A,b)$.

The important questions are therefore

(a) How to construct a good filter $[q(A)]^{-1}$ (i.e., find good poles σ) such that $K_{\mu,\sigma}(A,b)$ contains better approximations to f(A)b than $K_m(A,b)$ does?

(b) How to successfully extract these good approximations from $K_{\mu,\sigma}(A,b)$, e.g, by projection techniques?

Moreover, the following result is useful in understanding the structure of a rational Krylov space: Let J be a Jordan block with eigenvalue λ. Then the Jordan canonical form of f(J) consists of $\nu+1$ Jordan blocks if and only if $f'(\lambda)=\text{---}=f^{(\nu)}(\lambda)=0$. Note that C_j is actually a rational function r(A) and its first derivative is (constant) zero iff

$\mu_j = 1/\sigma_j^2$, which is a degenerated case since then C_j is a multiple of the identity matrix. Excluding this degenerated case therefore ensures that C_j has the same Jordan block structure as A, with eigenvalues λ transformed to $r(\lambda)$. Hence multiplication of b by a product of matrices C_j operates on the same Jordan structure as multiplications by A do (in the standard Krylov case).

We have not yet found general answers to (a) and (b), but we have implemented a rational Krylov algorithm in Matlab for further experimental investigations. Moreover, it can easily be shown that, when A is normal and one is using Ritz-Galerkin approximations in (b), a good criterion for (a) can be formulated in terms of a rational best approximation problem on the eigenvalues of A and Ritz values associated with $[q(A)]^{-1}K_m(A,b)$.

As the dimension m of a rational Krylov space grows, it may become a problem to store its full basis (m vectors of length n) and the computational costs, e.g. for the orthogonalization procedure, grows. We have confirmed that the restarting of rational Krylov approximations is possible, i.e., an update formula for the approximations exists. We have extended the notion of a standard restarted Arnoldi decomposition to a restarted rational Arnoldi decomposition. However, the feasibility of restarted rational Arnoldi decompositions has to be investigated.

8. Please add your comments (if any):

I would like to thank Professor Hayami for his kind support both in academic as well as in non-academic personal matters. During my stay, I have experienced a very pleasant and stimulating working environment. I also thank the JSPS for enabling this research.

9. Advisor's remarks (if any):

We have enjoyed having Mr. Guettel at our laboratory. His lecture and presentation on his research progress was interesting and stimulating. He has also participated in the discussions at our seminars with a positive attitude. He also took turn in our reading seminars, introducing a section of the book on solution of least squares problems by Bjorck.

RESEARCH REPORT

1. Name: Tobias Krauss （ID No.: SP08307）

2. Current affiliation: Max-Planck-Institute for Metals Research, Stuttgart

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute for Materials Science (NIMS), Tsukuba

5. Host researcher: Dr. Yutaka Wakayama

6. Description of your current research

The excitement in the field of organic electronics has sparked a vast amount of works during the past decade. Among the different explored semiconducting organic materials, small conjugated organic molecules have emerged showing encouraging performance in Organic Field Effect Transistors (OFETs), Organic Light Emitting Devices (OLEDs) and Organic Photovoltaic Cells (OVPs). So far, most of the studies have been engaged with devices based on thin films. However, one of the basic requirements for the design of novel nanoscale devices is the bottom-up growth of two dimensional (2D) and one-dimensional (1D) functional structures. This demands the understanding of self-assembly and growth phenomena of small conjugated organic molecules.

In our group, we combine Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM) and *in-situ* X-ray diffraction to elucidate the mechanisms of growth of heterostructures based on semiconducting small conjugated organic molecules. Our goal is to achieve the tailored growth of 1D, 2D and 3D organic architectures.

By sequential evaporation of *n*-type fluorinated copper-phthalocyanine (F_{16}CuPc) and *p*-type di-indenoperylene (DIP) molecules on silicon dioxide (SiO_2) we are able to control the growth mode and resulting morphologies ranging from well ordered layered heterostructures to highly crystalline DIP-islands with tunable size [1]. This control is a key aspect since planar *p*-*n*-junctions are desired architectures for organic ambipolar field effect transistors whereas organic solar cells require a crystalline island growth of nanodots.

One of our strategies to induce 1D growth is the use of SiO_2 substrates functionalized with gold nanoparticles as templates [2]. The growth of F_{16}CuPc molecules on these templates leads to the formation of F_{16}CuPc nanotubes with varying channel widths [3]. This opens the door for the design of nanoscale coaxial *p*-*n*-heterojunctions by filling the *n*-type nanotube with *p*-type materials.

By coevaporation of F_{16}CuPc and DIP molecules on metal surfaces, it is possible to design 2D binary organic monolayers which provide fascinating routes for organic functional surfaces and thin films with novel properties. In a recent collaboration with Dr. Yutaka Wakayama from the National Institute of Materials Science (NIMS) in Tsukuba, we were able to show by Scanning Tunneling Microscopy (STM) the successful 2D growth of binary DIP-F_{16}CuPc monolayers with extraordinary structural

order for different mixing ratios [4].

[1] D. G. de Oteyza, T. N. Krauss, E. Barrena, S. Sellner, H. Dosch, J. O. Ossó, *Appl. Phys. Lett.*, **2007** (90), 243104.
[2] B. N. Mbenkum, E. Barrena, X. Zhang, M. Kelsch, and H. Dosch, *Nano Lett.*, **2006** (6), 2852.
[3] Esther Barrena, Xue N. Zhang, Beri N. Mbenkum, Theobald Lohmueller, Tobias N. Krauss, Marion Kelsch, Peter A. van Aken, Joachim P. Spatz, and Helmut Dosch, *ChemPhysChem*, **2008** (9), 1114.
[4] Esther Barrena, Dimas G. de Oteyza, Helmut Dosch, and Yutaka Wakayama, *ChemPhysChem*, **2007** (8), 1915.

7. Research implementation and results under the program

Title of your research plan:

2D Supramolecular Self-Assembly of Coevaporated Pentacene and F_{16}CuPc Molecules on Cu(100)

Description of the research activities:

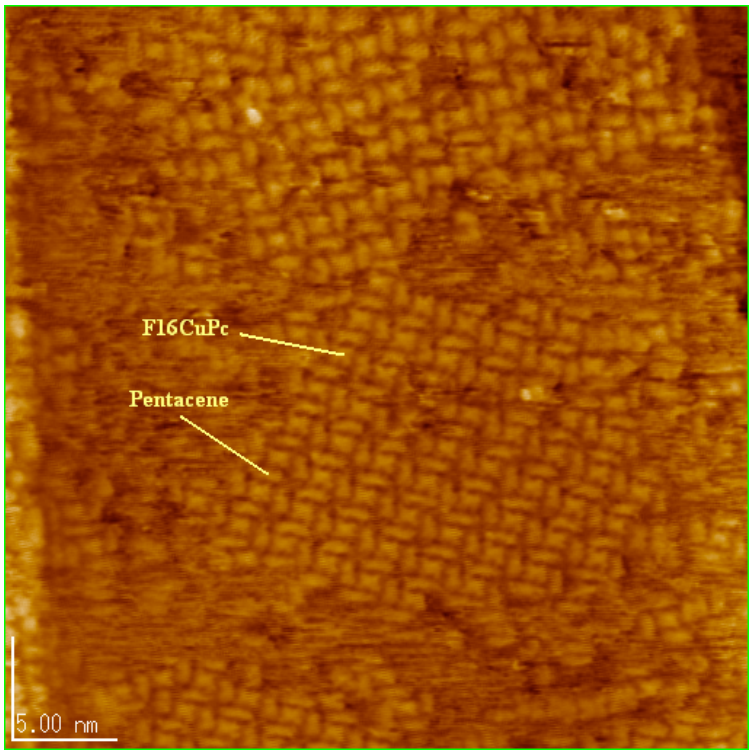
The idea of this project now was to investigate 2D systems consisting of pentacene and F16CuPc, two representatives of small conjugated organic molecules, deposited on a copper (100) surface. Pentacene is one of the most important semiconducting molecules due to a hole mobility in OFETs similar to that of amorphous silicon. F16CuPc is one of the few n-type semiconductors whose electronic properties are stable upon air-exposure making this molecule an interesting candidate for all those applications in which p- and n-type semiconductors are required.

In a first step, the Cu (100) surface had to be cleaned by successive cycles of Argon (Ar) sputtering and annealing under proper conditions in order to obtain atomically flat terraces. The sputtering was performed at Ar pressures of 1.5 to $2x10^{-4}$ mbar with an energy *E* of 800 to 900 eV. Subsequent annealing was carried out at temperatures of about 500 to 600 °C.

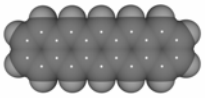
Prior to any coevaporation, the growth of pentacene on the Cu (100) crystal was investigated by STM. At room temperature, it could be observed that pentacene molecules are adsorbing in a lying down phase on the Cu (100) surface. The nucleation starts at the edges of the Cu crystal followed by a nucleation on the atomically flat terraces. No structural order could be found for a coverage of one monolayer.

Besides, the growth behavior of F_{16}CuPc was analyzed. As pentacene, F_{16}CuPc also nucleates at the Cu step edges before growing on the terraces. However, it can be seen that the molecules preferentially align along the step direction standing almost upright with their molecular plane being nearly parallel to the surface normal. On the terraces, the molecules are lying flat on the surface showing the presence of rotational domains with short range order at a coverage of one monolayer.

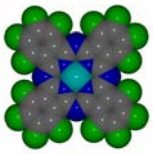
In the last step, both molecules were evaporated simultaneously on the Cu (100) surface in order to make a binary monolayer growth of pentacene and F_{16}CuPc possible. The calibration of the coevaporation allowed an exact mixing ratio of 1:1 between pentacene and F_{16}CuPc molecules. High resolution STM reveals well ordered binary packing. Both molecules can be excellently resolved as shown in the Figure below where the square shape of F_{16}CuPc can be perfectly distinguished from the rather elongated shape of the pentacene molecule. Furthermore, different



Pentacene:



F_{16}CuPc:



rotational domains are visible. At defect sites such as domain boundaries and step edges, locally disordered regions can be observed.

To conclude, it is shown that intermolecular interactions between pentacene and F_{16}CuPc lead to the formation of highly ordered mixed domains extending to sizes above several tens of nanometers.

8. Please add your comments (if any):

My special thanks go to my host supervisor, Dr. Yutaka Wakayama, who made a very pleasant stay possible. He was basically looking after all my problems I faced and showed enormous patience. He even found the time to let me dip into his beautiful country and into Japanese culture. I am also grateful to Prof. Dr. Toyohiro Chikyo and his department members for a warm welcome.

Last but not least, I also want to thank the JSPS Summer Program for this unforgettable research trip. Everything was very well organized and I can definitely recommend it to anybody else who tinkers with the idea of combining research with fabulous food, friendly people and a beautiful countryside.

9. Advisor's remarks (if any):

His STM study on binary molecular assembly has been done as a series of on-going collaboration between Max-Planck-Institute of Metals Research and National Institute for Materials Science. He found a new combination of molecules to form well-mixed arrays on Cu (100) surface. This work made a great contribution to our collaboration and created an opportunity of further experiments.

RESEARCH REPORT

1. Name: Emanuel Schneck （ID No.: SP08308）

2. Current affiliation:

Institute of Physical Chemistry, Heidelberg University, Germany

3. Research fields and specialties:

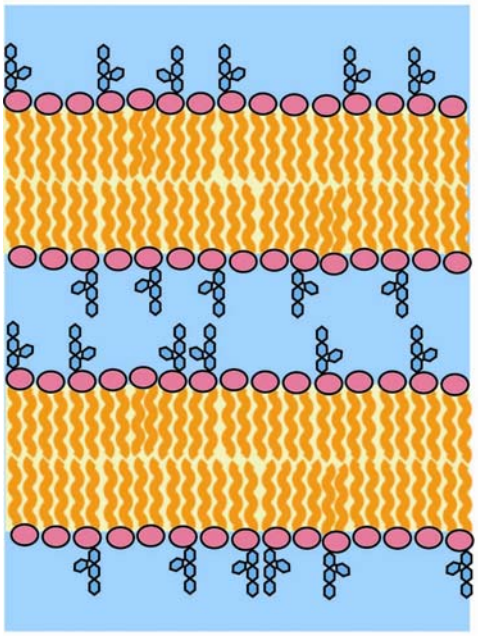
Mathematical and Physical Sciences

4. Host institution: Department of Physics, Kyoto University

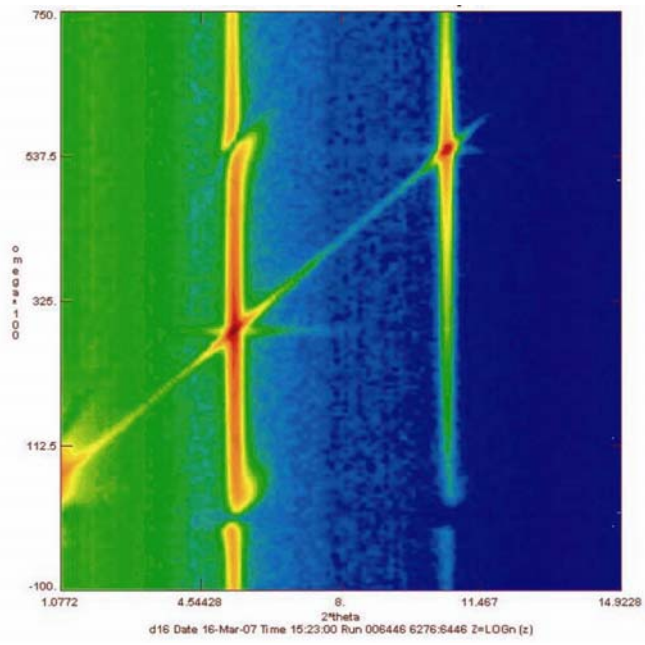
5. Host researcher: Prof. Yoshikawa, Prof. Ohta

6. Description of your current research

Currently my research is focused on simplified models of cell surfaces. Here, we study the role of membrane-associated carbohydrates which mediate cell-cell and cell-tisue contacts in nature. For this purpose we investigate solid-supported membranes and membrane multilayers containing membrane-anchored oligosaccharides.



Interacting Cell Surface Models



Reciprocal Space Map from Neutron Scattering

We carry out specular and off-specular x-ray and neutron scattering experiments to gian insight into carbohydrate-mediated intermembrane interactions and membrane-substrate interactions. Simulation of reciprocal space maps combined with continuum mechanical calculations are employed to extract quantitative information on inter-membrane potentials and mechanical membrane properties from the scattering signals. Recently we started doing

molecular dynamics simulations to gain deeper understanding of the structural origin of the measured parameters.

The same strategy is also applicable to more realistic models of bacterial surfaces prepared from Lipopolysaccharide mutants. Here, we are especially interested in measuring how ions influence the structure and mechanics of the membranes of Gram-negative bacteria. For it is known that these bacteria are protected from certain antimicrobial drugs in the presence of divalent cations.

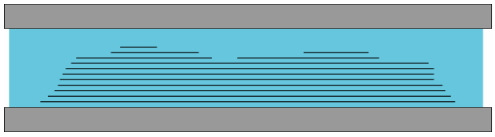
7. Research implementation and results under the program

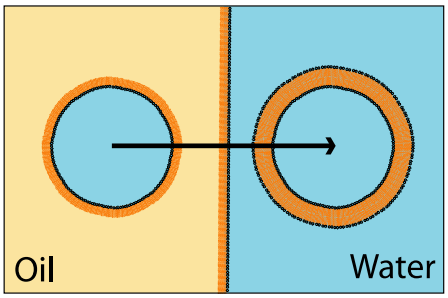
Title of your research plan:

Membrane-Anchored Carbohydrates in Models
of Cellular and Bacterial Surfaces

Description of the research activities

In Kyoto I carried out experiments with the goal to measure mechanical properties of model-membranes using giant unilamellar vesicles, an approach which is complementary to the scattering experiments mentioned above. For this purpose, I prepared giant unilamellar vesicles from phospholipids and bacterial glycolipids by different methods.

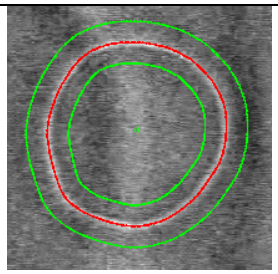




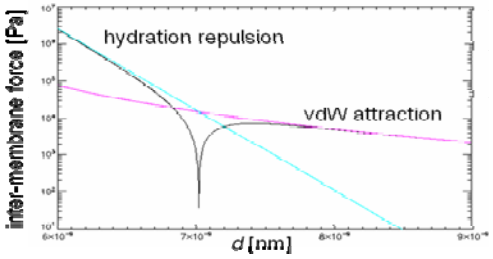
1.) Electroformation Method 2.) Water in Oil Droplet Method

To measure mechanical properties of the model membranes I analyzed the shape-fluctuations of the giant vesicles recorded by phase contrast microscopy.

In parallel I worked on deepening the theoretical basis to describe the influence of the studied oligosaccharides on inter-membrane interactions in multilayer systems.



shape-tracking of a vesicle recorded by phase contrast microscopy



simulation of membrane interactions in multilayered systems

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Ulrike Schötz （ID No.: SP08309 ）

2. Current affiliation:

Helmholtz Zentrum München, Institute of Radiation Genetics; Germany

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Department of Radiation Genetics, Graduate School of Medicine; Kyoto University

5. Host researcher: Professor Shunichi Takeda

6. Description of your current research

The main goal is to understand the locus specificity of AID mediated immunoglobulin (Ig) gene diversification. This basic research is of medical relevance, because unregulated AID action leads to genomic hypermutation and lymphoma formation.
One of the crucial questions is the relationship between Ig diversification and transcription. We assume that for immunoglobulin substrate specificity AID recruitment to DNA involves Ig specific cis-elements and trans- acting factors, which lead AID to the DNA and transport it to the transcription start site (Fig.1).

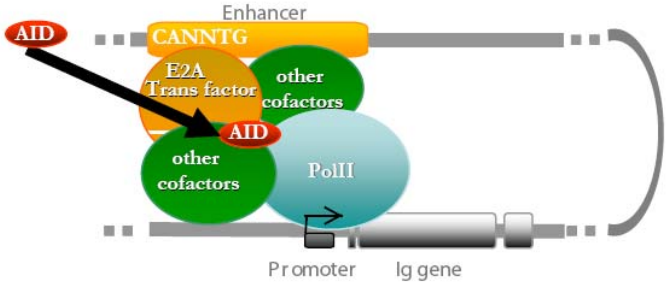


Fig.1 Hypothetic model for AID recruitment to the transcription start. Our results suggest an involvement of E2A transcription factor and the cis-element called EBox.

In our studies, we describe a GFP reporter transgene crippled by hypermutation when inserted into or near the Ig light chain locus of the DT40 B cell line, yet stably expressed when inserted into other chromosomal positions. Step-wise deletions of the IgL locus revealed that a sequence extending for 9.8 kilobases downstream of the IgL transcription start site confers the hypermutation activity. This sequence, short named DIVAC for diversification activator, efficiently activates hypermutation when inserted at non-Ig loci.

These results provide first conclusive evidence that cis-regulatory sequences target AID-mediated gene diversification to the Ig loci.
The DIVAC element contains the enhancer sequence of the Ig light chain locus. One important motif of the enhancer is the E Box, where E2A transcription factors are binding. In another study, we report that the inactivation of the E2A gene strongly reduces the rate of Ig L chain mutations in the chicken B cell line DT40 without affecting the levels of surface Ig or AID expression.
The results suggest that E2A-encoded proteins enhance Ig hypermutation by recruitment of AID to the Ig loci.

7. Research implementation and results under the program

Title of your research plan:

Establishment of a method to study AID action independently from transcription factors and cis-elements

Description of the research activities:

Concerning the present research, it is of great interest, to confirm this important role of transcription factors and cis-elements on AID action. To recruit AID independently from such factors, we want to use a LacO array together with AID-lacR fusion protein to rescue hypermutation in DT40 cell mutants deficient for cis elements and/or transcription factors.
We introduce a LacO array to the Ig light chain locus in the chicken B cell line DT40 (Fig.2) for (1) artificial recruitment of protein and (2) visualization of the Ig locus.

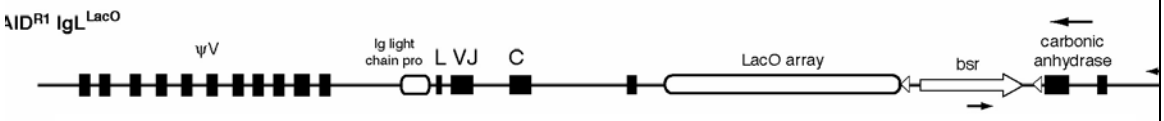


Fig.2 Modified cell line containing a LacO array at the rearranged Ig light chain locus (Hiroshi Arakawa)

The LacO array contains a tandem cluster (256 repeats) of the Lac Operator region of the lac Operon. Fusion proteins of a desired protein with the Lac Repressor DNA-binding domain will bind to the LacO array. The system can be used for artificial recruitment of any protein to the Ig locus.
To establish the method, we use a GFP-lacR fusion protein. The GFP can be easily detected using fluorescent microscopy as well as flow cytometry.
In a first step, a vector was designed and cloned to express GFP-lacR using a β-actin promoter (Fig.3A). A drug selection marker is expressed by the same promoter using an internal ribosomal entry site (IRES). The vector was stably transfected to a DT40 mutant

containing the lacO array at the rearranged Ig light chain locus. Clones were screened after two weeks culture for their GFP expression level. Using flow cytometry, the GFP expression was detectable.

So we went ahead and examined whether the GFP is specifically recruited to the LacO array at the Ig light chain locus. At the same time we prepared an antibody staining of Rad51. Rad51 protein is a hallmark for DNA repair and we wanted to covisualize spots of DNA repair and the GFP bound to the lacO array. However, GFP fluorescence was not enough and we were not able to detect a clear spot.

As the expression was very low, we decided to change strategy and to design a vector using retroviral infection of the GFP-lacR into the DT40 cell line (Fig.3B).

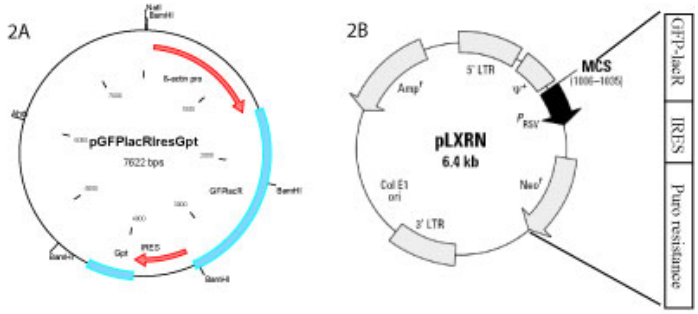


Fig.3 A) GFP-lacR expression plasmid expressed by a ß-actin promoter. B) Retroviral vector. The promoter and Neomycin resistance are resubstituted by the GFP-lacR and a puromycin resistance. The 5'LTR contains a promoter/enhancer sequence to express the fusion protein.

This method is well established in Professor Takedas lab and is known to give higher expression levels. The vector contains the GFP-lacR fusion protein and it is expressed using the promoter/enhancer sequences in the 5' viral LTR. Results of the transfection are still outstanding at the moment. I will be happy to keep the collaboration with Professor Takeda and we will finish the experiment within the next months.

8. Please add your comments (if any):

I thank the JSPS for enabling me to spend two valuable months at Kyoto university. I thank Professor Takeda and his lab for supporting my research and I am pleased that I found friends in Japan.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Stefan Stadlbauer （ID No.: SP08310）

2. Current affiliation: Faculty of Chemistry and Pharmacy, University of Regensburg

3. Research fields and specialties:

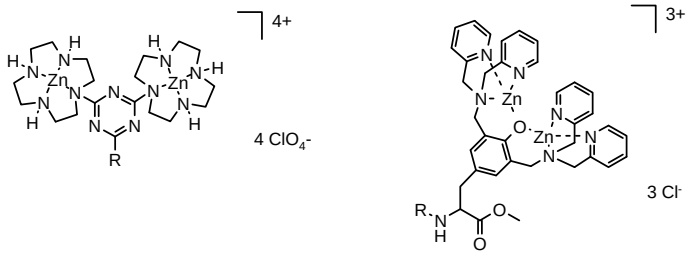
Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University, Katsura Campus, Department of Synthetic chemistry and Biological Chemistry, Graduate School of Engineering

5. Host researcher: Prof. Itaru Hamachi

6. Description of your current research

Protein labeling with functional molecules such as luminescent dyes or affinity tags for their purification is a widely used challenging task. A pair of a peptide tag incorporated into a protein and its complementary smaller molecule is a widely used and efficient analytical tool for a broad field of biological applications. One well known separation and purification technique for proteins is the immobilized metal affinity chromatography (IMAC) with a histidine tag combined with a Ni(II)-NTA (nitrilotriacetic acid) as the most prominent example. Hamachi *et al* designed a new peptide tag / artificial probe pair, which is orthogonal to the His tag / Ni(II)-NTA pair, using multivalent coordination chemistry between an oligo-aspartate sequence (D_4 tag) and the corresponding multinuclear Zn(II) complex (Zn(II)-Dpa Tyr). Due to analogous properties of *Hamachi´s* tyrosine based Zn-complexes and *König´s* Zn(II)-cyclen derivatives, which (a) are both positive charged dinuclear Zn(II)-complexes with high affinity towards phosphates and (b) both could be used as chemosensors for phosphate anions, we suppose them to have the ability to act as alternative artificial probe for the system of Hamachi *et al*. (see scheme 1) Although their coordination geometry is different, comparable binding affinities to the D_4 tag of the Zn(II)-cyclen derivatives are anticipated.



a b

Scheme 1. *König´s* Zn(II)-cyclen (a) and *Hamachi´s* tyrosine based Zn-Dpa complex.

7. Research implementation and results under the program

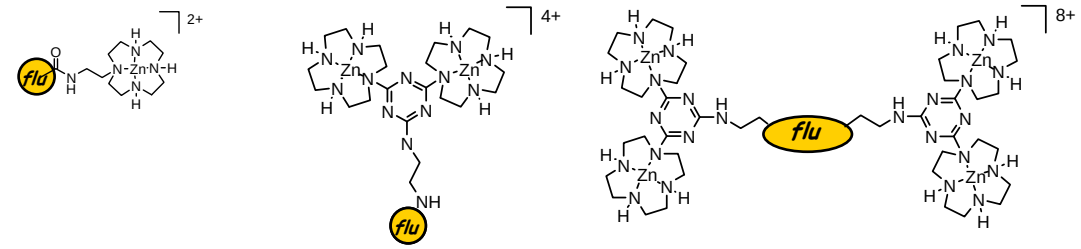
Title of your research plan:

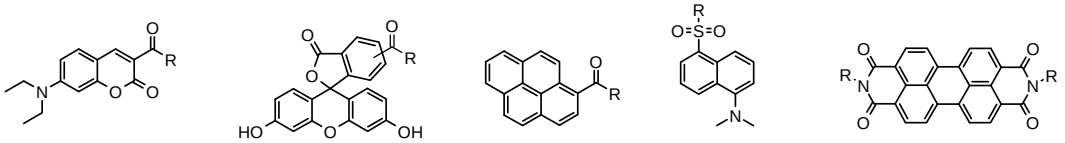
Fluorescent 1,4,7,10-Tetraazacyclododecane Zn(II) Complexes as Potential Non-Covalent Protein Markers

Description of the research activities:

Synthesis (preliminary work in Germany)

Based on the idea of analogous properties of the *König´s* Zn(II)-cyclen and *Hamachi´s* tyrosine based Zn-Dpa complex, we designed and synthesized a set of different cyclen derivatives labeled with various fluorescent dyes, as shown in scheme 2.





Scheme 2. (a) mono-Zn(II) cyclen derivatives, (b) bis-Zn(II) cyclen derivatives and (c) bis-Zn(II) cyclen dimer and the various fluorescent dyes for the labeling.

Following dyes were introduced to the derivatives as fluorescent labels:

For the mono- and bis-cyclen derivatives: a coumarin derivative (d) (λ_{ex} = 430 nm), a fluorescein derivative (e) (λ_{ex} = 490 nm) and a pyrene (f) (λ_{ex} = 344 nm) was introduced while the dansyl group (g) (λ_{ex} = 330 nm) was introduced only to the bis-cyclen. The dimer was linked by a perylene derivative (h) (λ_{ex} = 540 nm).

Determination of the binding affinity:

The main goal of the two months research stay at the Hamachi group was to screen and determine the affinity of the shown fluorescent labeled derivatives on their protein tags. In order to evaluate whether the designed compounds could be used as alternative artificial probe for Hamachi´s designed peptide tags the orthogonality towards the His-tag had to be verified as well

To determine the binding affinity under physiological conditions in aqueous buffered solution (HEPES pH 7.4, 25 mM, 25 °C) towards the tag-proteins D_4, E_4, His-tag and D_4-Dimer-tag fluorescence titration, UV titration and isothermal titration calroimetry were the methods of choice. Job´s plot analysis was used to investigate the stoichiometry of the aggregate of the designed cyclen receptor and the protein tag.

In a first screening approach by fluorescence titration all compounds were tested for their affinity towards the Asp_4-tag and the Glu_4-tag. While the mono-Zn(II) cyclen derivatives and bis-Zn(II) cyclen derivatives showed only a weak affinity of about a milli molar range towards the tags, the bis-Zn(II) dimer was found to have a nearly micro molar affinity. Thus in a set of precise fluorescence- and UV-titration experiments with a concentration of 50 µM Dimer and 10 µM respectively, the apparent binding constant for both tags (D_4, E_4) was determined by non linear fitting

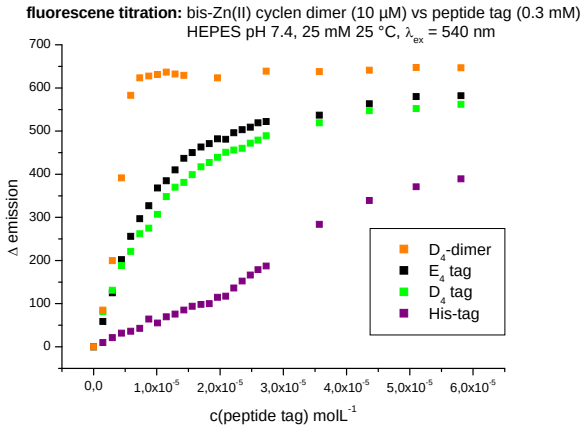
methods to log*K* = 5.4. The stoichiometry of the receptor - peptide tag aggregate was determined to be 1:1 by Job´s plot analysis.

As expected the bis-Zn(II) cyclen dimer showed a higher affinity towards the D_4-Dimer-tag with a change in the stoichiometry to 2:1 in respect of the peptide. This change is quite reasonable due to the two D_4 motifs in the peptide tag. Surprisingly the binding constant increased by eight orders of magnitudes and was investigated by fluorescence titration (concentration dimer 5 µM) to log*K* = 14. Unfortunately, due to the short time of the summer program this result could not be verified by another method so far. Further it was not possible to do the experiment at a lower concentration because we reached the fluorescence detection limit.

The orthogonality of the bis-Zn(II) dimer towards His-tag could be proofed by analogous measurements at same conditions.

Verification of the binding constants obtained form fluorescence and UV data by isothermal titration calorimetry was not possible so far, but will be further investigated.

Scheme 3 shows a comparison of the binding isotherms of the bis-Zn(II) cyclen dimer towards the different peptide tags.



Scheme 3. Representative fluorescence titrations of the bis-Zn(II) cyclen dimer and the peptide tags.

Summarized, we found one promising new artificial probe with high affinity for the peptide tags designed by Hamachi *et al* out of the set of prepared fluorescent Zn(II)-cyclen derivatives. Unfortunately up on binding of the dimer to the peptide tag (D_4, E_4, D_4-dimer) the fluorescence of the dimer decreased, which is not favored for bioimaging or labeling. Thus we focus in an ongoing cooperation on the synthesis of a new fluorescent dimer, which shows an increase in its fluorescence up on binding or at least shows no decrease in its emission. Further we will do more detailed investigations to determine and proof the high binding affinity of the bis-Zn(II)-cyclen dimer towards the D_4-dimer.

8. Please add your comments (if any):

First of all I would like to thank the JSPS for the fellowship for the summer program 2008, which enabled me to conduct my research in the group of Prof. Hamachi. Also, I wish to thank my supervisors Prof. Hamachi, lecturer Dr. Ojida and all other members of the Hamachi group for welcoming and helping me in such a friendly way in the laboratory as well as in the daily life. Finally I would like to thank family Sugahara for the nice homestay experience and hospitality. Despite its short length, the JSPS Summer Program provided me not only an invaluable experience in science, but also allowed me an insight into the Japanese culture.

RESEARCH REPORT

1. Name: Ilona Straub （ID No.: SP08311）

2. Current affiliation: Ph.D. Student of Communication Science at the University of Duisburg-Essen

3. Research fields and specialties:

X Humanities X Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: NTT Human and Information Science Laboratories

5. Host researcher: Dr. Makio Kashino

6. Description of your current research

My dissertation concerns the connection between human communication and cognition, though the term communication is investigated here in a social manner. The main focus of my dissertation is set on face-to-face communication situations experienced by human.
Within this project an integrated view of humanities, social, and natural sciences is intended. In contemporary scientific inspections a threefold of theories – dealing with the relationship of human communication and cognition, or ‚social cognition' - can be observed:

1. *phenomenological approaches* as seen in philosophy or psychology, where social emotions or experiences are described as individual feelings or individual experiences
2. *physiological approaches* in neuroscience or brain sciences, where social, behavioral, cognitive or emotional events are mirrored in neuronal or biophysiological aspects of cognition
3. *technological approaches* in cognitive sciences for the simulation of humanlike behavior and correlations to human mind via technical devices, to construct e.g. embodied conversational agents or humanoid robots/ androids

The comparison of the phenomenal, physiological and technological perspectives on the interrelation of communication and cognition offers fundamental insights into the *physical, psychological and social conditions* of communication processes.

My aim is to integrate those three perspectives by interdisciplinary work. On a theoretical level those perspectives shell be combined and additionally find its verification on an empirical level.

7. Research implementation and results under the program

Title of your research plan:

'Psychophysiological Measurements of Emotions in Individuals during Solitude and Communication – considerations to improve the analysis of experimental settings'

Description of the research activities:

During my stay in Japan I was located at the *‚NTT Human and Information Science Laboratories'* in Atsugi and became part of the Sensory and Motor Research Group under the guidance of Dr. Makio Kashino and Dr. Tatsuto Takeuchi.

The aim of the Sensory and Motor Research Group is to investigate the fundamental bodily mechanisms (not dependent on highly complex information processing in the brain) by modeling psychophysiological, neurophysiological, and mechanical mechanisms of human information processing - like perception and behavior - to improve communication technologies.
Within the past 2 month I could investigate physiological and technological approaches dealing with the interrelation of communication and cognition. Mainly I investigated physiological activities linked to mental events, like emotions, these physiological activites are also known as psychophysiologic activities.

NTT provides physiological measurement tools for recordings of the central, autonomic and sensorimotor systems of the human mind-body interface. This means activities of the brain (central nervous system) and from the autonomic nervous system as electrodermal, cardiovascular and other muscular systems of the body are recordable.
Recordings of those psychophysiological events may reveal effects of mental states, like emotional or affective processes (stress or arousal), not observable in overt behavior or in verbal reports. This means subtle changes in cognitive and emotional efficiency may have somatic effects which can be measured in the periphery of the body response system.
A closer look at that interdependency of those somatic effects evoked by mental states gives clues to the mind-body relationship as integrated one, also entitled as

embodiment.

As main project I was involved in the creation of a new experimental setting which should expose the emotional psychophysiologic activities during differing social situational circumstances measured via GSR and PPG:

1.) **of a person in solitude**
2.) **during mere social presence**
3.) **during social interaction/ communication**

It is important to differentiate between the behavior of a person alone, within the presence of others, and in a communicative situation.
A social situation in general and a communicative situation in special have its own emergent complexity as screened for example by nonverbal cues as: bodily motions, gaze and eye-contact or the synchronization of body posture, and proxemics. Besides the nonverbal cues foremost verbal addressings of a person, with the modulations of voice (loudness, distinctness, choice of words) give a hint to the communicative intent or relationship of the verbally communicating persons.

While analyzing the psychophysiological data and comparing it with the verbal, paraverbal and nonverbal actions in audiovisual material, the idea appeared to create a manual calculation of the body-movements, eye-gaze, mimic, gestic, laughter, talking and nodding of both subject and experimenter.

In a next step my partner Dr. Tatsuto Takeuchi calculated that manual chart with the Matlab software and transformed them into individual waveforms of the variables and the subject.

Analyzing psychophysiological data along with behavioral data seems to be very promising. With our new method to create a timeserial waveform data of behavioral sequences allows a direct comparison about the correlation of the participating subjects.

With the psychophysiological data along with a video analysis of observable nonverbal behavior, the transcription and analysis of verbal utterances and an additional survey of subjective experiences by a qualitative questionnaire, a huge set of empirical data can be collected and in a second step also be compared to approach the specific emotional quality of sociality.

RESEARCH REPORT

1. Name: Miriam Unger （ID No.: SP08312 ）

2. Current affiliation:

University of Duisburg-Essen

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

X Chemistry Engineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Kwansei-Gakuin University

5. Host researcher: Prof. Dr. Yukihiro Ozaki

6. Description of your current research

Thermal and Mechanical Properties of Biodegradable Polymers as Studied by FT-IR Spectroscopy

Biodegradable Polymers can be produced from raw materials of the agricultural production chain or by the action of microorganisms and rapidly gain economic importance due to the increasing demand for saving fossile raw materials and recycling short-lived products. Nevertheless, such biological and biodegradable polymers have to fulfill the same user specifications in terms of their thermal and mechanical end-use properties as the standard plastics which presently dominate the world market.

The present research for my PhD thesis focuses on detailed structural investigations of poly(3-hydroxybutyrate), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) copolymers with different hydroxyvalerate content and poly(3-hydroxybutyrate)/poly(caprolactone) blends with varying compositions.

Principally, the work plan is split up in several topics:

1. **Variable-temperature FT-IR** investigations have provided a first insight into the crystallinity and conformational changes of different PHAs in heating/cooling cycles and allowed the assignment of state-of-order specific absorption bands in the investigated spectra.
2. **Thermogravimetric Analysis (TGA)** coupled with FT-IR spectroscopy has allowed to study the thermal degradation of biodegradable polymers in different environments (e.g. nitrogen or oxygen). In principle a sample is heated beyond the decomposition temperature and the weight loss of the polymer is recorded.

Simultaneously, the gaseous decomposition products are measured by gas-phase mid-IR spectroscopy.

3. **Rheo-optical FT-IR spectroscopy** is a technique where a polymer sample is subjected to a mechanical treatment (e.g. stress-strain test) and simultaneously investigated by FT-IR spectroscopy with radiation polarized parallel and perpendicular to the drawing direction. This method has provided information on the correlation of structure and mechanical properties of the investigated polymer, copolymer and blend systems during uniaxial elongation.

7. Research implementation and results under the program

Title of your research plan:

Variable-Temperature Investigations of a Blend of Poly(3-hydroxybutyrate) and Poly(ε-caprolactone) as Studied by FT-IR Spectroscopy with Perturbation-Correlation Moving-Window 2D Correlation Analysis

Description of the research activities:

In the present study, temperature-dependent FT-infrared spectroscopic investigations of a blend of Poly(3-hydroxybutyrate) (PHB) and Poly(ε-caprolactone) (PCL) were analyzed by generalized two-dimensional correlation spectroscopy (2DCOS) and perturbation-correlation moving-window two-dimensional (PCMW2D) correlation spectroscopy.

The PCMW2D correlation spectroscopy is a development from Morita in 2006 and belongs to generalized two-dimensional correlation spectroscopy (2DCOS) proposed by Noda 1993 and to the mowing-window 2D analysis method by Thomas and Richardson in 2000. The generalized 2D correlation spectroscopy is a very versatile evaluation technique for spectroscopic data sets which have been acquired from systems under the influence of an external perturbation, such as temperature, stress, concentration, voltage or time. In the 2D correlation spectra, the spectral intensities are plotted in two spectral variables (here wavenumber). The PCMW2D correlation methods provides a pair of a synchronous and asynchronous spectra, which belong to the first and the second derivative and is plotted on a plane between a spectral variable (here wavenumber) axis and a perturbation (here temperature) axis. Thus, this analysis method has the advantage that it is straightforward to analyze complicated spectral variation like overlapping bands or peak shifts etc. in compare to the generalized 2D correlation spectroscopy.

In the present research the melt-crystallization process of a blend of poly(3-hydroxybutyrate) (PHB) and Poly(ε-caprolactone) (PCL) with a composition of (50:50) is studied. The C=O stretching-vibration was employed to explore the structural changes during the heating process (30-200 °C). The PCMW2D correlation analysis revealed that there a four characteristic bands in the C=O stretching region, though only two bands are found with the generalized 2D correlation method and in the original set of conventional 1D FT-IR spectra. It is observed that the PCMW2D correlation spectroscopy allows to separate the crystalline and amorphous of the C=O stretching vibrations of PHB and PCL during the heating process. In this case the PCMW2D correlation analysis diagrams show during the variable temperature measurements at first the changes in crystallization of PCL (T_m=60 °C) and after this of PHB (T_m=180 °C), which is observed for PCL the crystalline C=O stretching vibration at 1724 cm^{-1} and the amorphous at 1736 cm^{-1} and for the PHB the crystalline at 1726 $cm^{-1}$and the amorphous at 1750 cm^{-1}. In the original spectras are only indentified that there a two C=O stretching vibration absorption bands, one belongs to the crystalline (1724 cm^{-1}) and the other to the amorphous (1738 cm^{-1}) part.

8. Please add your comments (if any):

I would like to thank JSPS and DAAD for giving me the opportunity to conduct research at a Japanese host institute within the framework of the JSPS Summer Program 2008. Also I want to thank my host researcher Prof. Dr. Yukihiro Ozaki and all members at the institute to welcoming me in such a friendly way and making my stay as an unforgettable experience.

9. Advisor's remarks (if any):

We are now preparing two publications together; the follows are tentative titles and coauthors.

1. Miriam Unger, Shigeaki Morita, Yukihiro Ozaki and Heinz W. Siesler, *Variable-Temperature Investigations of a Blend of Poly(3-hydroxybutyrate) and Poly(ε-caprolactone) as Studied by FT-IR Spectroscopy with Perturbation-Correlation Moving-Window 2D Correlation Analysis*
2. Miriam Unger, Shigeaki Morita, Yukihiro Ozaki and Heinz W. Siesler, *Study of Polymer Orientation of a Blend of Poly(3-hydroxybutyrate) and Poly(ε-caprolactone)by Rheo-Optical FT-IR Spectroscopy with Perturbation-Correlation Moving-Window 2D Correlation Analysis*

RESEARCH REPORT

1. Name: Norbert Mueller （ID No.: SP08313）

2. Current affiliation:

IAP Goethe University, Frankfurt

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: RIKEN; Nishina Center for Accelerator-Based Science

5. Host researcher: Dr. T. Nakagawa

6. Description of your current research

The maximum beam current of a linear particle accelerator (linac) is limited by the beam transport capability at the low energy end of the linac: For a given ion source current and emittance the linac current limit is proportional to $\beta = v/c$ for electric and to $\beta 3$ for magnetic focusing channels and ideal emittance conservation. The funneling scheme is making use of the higher current limits at higher beam energies by doubling the beam current combining two bunched beams preaccelerated at a frequency $f0$ with

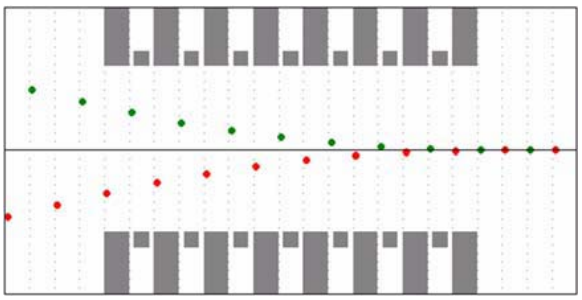


Fig. 1: Bunch trace through the funneling deflector in top view.

an rf-deflector to a common axis and injecting into another rf-accelerator at frequency $2 \cdot f0$ as shown in figure 1. Ideally the beam emittance could be staying as low as for one single beam. Extracting twice the beam from a single ion source would result in at least twice the emittance for the following accelerators.

7. Research implementation and results under the program

Title of your research plan:

Emittance measurement from RIKEN 18 GHz ECRIS(Electron Cyclotron Resonanz Ion Source) for heavy ion beams with an Einzel-lens as part of the LEBT-system

Description of the research activities:

Since the middle of the 1990s, RIKEN has undertaken the construction of a new accelerator complex for the RIBF (Radio Isotope Beam Factory) project. In this project, the production of intense heavy ion beams is an important issue to produce the intense RI beam using projectile like fragmentation. For these reasons, there tried to increase the beam intensity of medium charge-state, heavy ions, such as Ar8+, Kr13+, and Xe20+, for the RIBF project. The final goal of this project is to produce at least 1 pμA on target from p to U beam. To meet this requirement, there had to make further development of the performance of the ECRIS. To increase the beam intensity from the accelerator, it is obvious that the emittance is also an important physical value for the ECRIS. The emittance of the intense beam should be enlarged by the space charge effect. To investigate this effect on the emittance and optimize the transmission coefficient of heavy ion beams from the RIKEN 18 GHz ECRIS to the heavy ion linac, we measured the emittance of the intense beam under various conditions. We use an Einzel lens as LEBT (Low Energy Beam Transportation) system to degrease the emittance and make measurements of size of emittance as a function of the voltage of the lens (from 0V to several 100V).

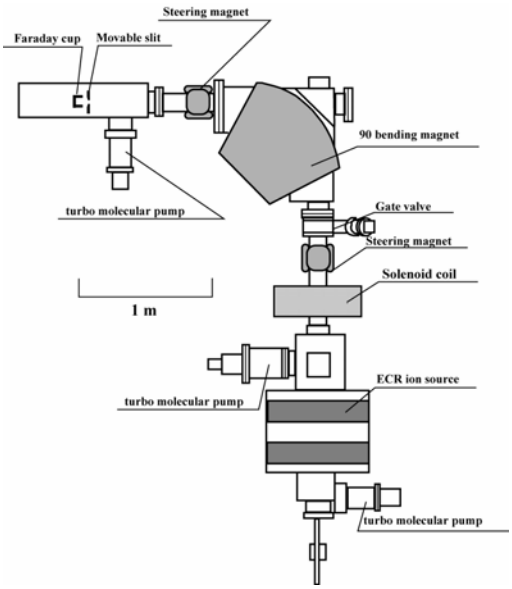


Fig. 2 schematic drawing of the experimental set up

In this case, Einzel lens dose not work as a focusing lense, because of the very low voltage. What we manipulate with the voltage of the Einzel lens is the space charge effect and the beam neutralization by electrons.

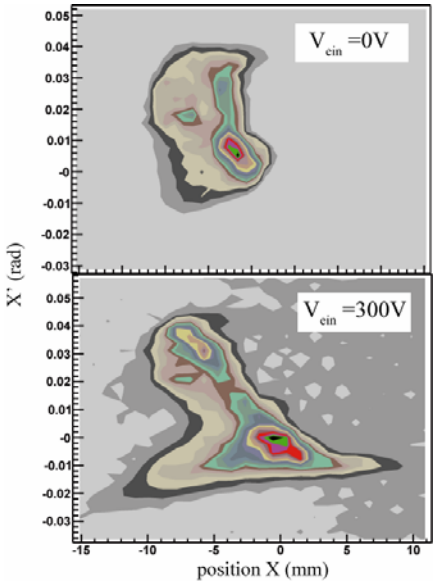


Fig. 3 Emittance of a Xe 20+ beam

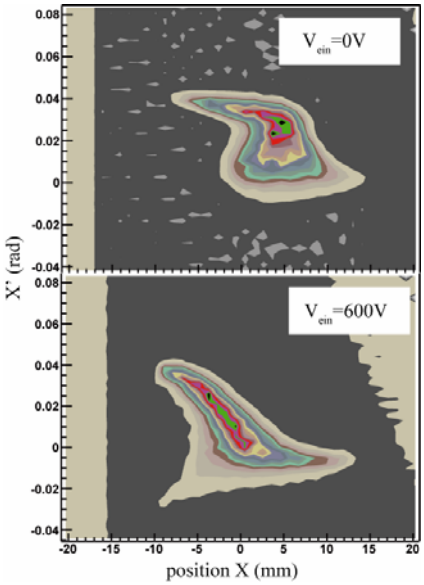


Fig. 4 Emittance of a Kr 18+ beam

For example in Figure 3 and 4 are shown emittance measurements from different beams and Einzel lens voltages. Figure 3 shows the emittance of Xe20+ beam at the Einzle lens voltage of 0 and 300V. The measurement shows a changing of the emittance when the voltage from the Einzel lens is modified. These are an indicate for a self generated beam neutralization by electrons.

For a better understanding of these effects we need more measurements and simulations.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Karsten Senkbeil （ID No.: SP08314 ）

2. Current affiliation: Heidelberg Center for American Studies (HCA), University of Heidelberg, Germany

3. Research fields and specialties:

X Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:
Graduate School of American Studies (GAS), Doshisha University, Kyoto

5. Host researcher: Prof. Takashi Sasaki

6. Description of your current research

The aim of my dissertation project is an interdisciplinary linking of Cultural Studies with a discourse analytical linguistic methodology to examine today's American sport language. The basic hypothesis of this dissertation is that the discourse of sport in the USA (especially sport journalism) includes and reflects various typical American world views and ideological patterns. As such, sport discourse as a part of popular culture is socio-politically relevant regarding national self-understanding and dominant (as well as subaltern) political ideologies in the USA. Hence, sport only appears to be un-political. If values of certain political ideologies can be found in sports discourse, these values are consumed and maybe also distributed subconsciously. This is even more revealing according to dominant popular beliefs, attitudes and hegemonic structures in the society in which the discourse is produced. The methodological approach for this project bases on an innovative bridging of computer-based Corpus Linguistic and Critical Discourse Analysis. With the help of a voluminous text corpus consisting of journalistic articles on American sports examined with linguistic software I will be able to find, quantify and interpret repetitive rhetorical patterns, metaphors and various semantic and syntactic formations. In a further step, this network of linguistic findings will be brought into contact with recent theories of culture to put the quantitative results from Corpus Linguistic into a Cultural Studies perspective. Concepts like 'Discourse' (Foucault), 'Interdiscourse' (Link), and 'Hegemony' (Gramsci, Hall) form a framework that considers cultural texts (here journalistic texts) as both systems of symbols and systems of social interaction. Central research questions for the Cultural Studies agenda of this work have direct reference to the situation of US American society in the early 21st century. They include, but are not restricted to: globalization and capitalism; militarism and terrorism; interculturalism and xenophobia; individualism, hero-images and collective effort; images of fighting, bravery & masculinity. Resulting from the abovementioned linking, the intersection of sport discourse with the rhetoric of national and international politics as well as their mutual influences will reveal insight to US culture today, its ideology, and sport's relation to contemporary socio-political issues.

7. Research implementation and results under the program

Title of your research plan:
Baseball in Japan and the United States – Transcultural Exchange and Patterns of Inclusion and Exclusion.

Description of the research activities:

Summarizing my research during the summer in Japan, I would like to emphasize three different activities that complemented each other and helped me gain insight into my research topic from different angles. First, extensive library research with the resources of Doshisha's library provided me with a deeper understanding of Japan's sport history, the socio-cultural implications of a sport such as baseball, and modern readings in Japanese popular culture in general. In combination with my existing knowledge on U.S. American sport culture, this laid the foundation to further case studies (see below). Second, apart from aiding my research with his great expertise in American Studies, Professor Sasaki introduced me to several renowned scholars in the field of my studies here in Kyoto. I am immensely grateful to these distinguished professors who took their time for long conversations about my research topic and contributed very valuable insight and constructive comments on my current analyses. From Doshisha University, I would like to mention Prof. Higuchi (expert on American culture and sport) and Prof. Tazuke (sport studies scholar and expert on international sports). Moreover, I had the opportunity to talk to Prof. Allen Guttmann from Amherst College, the leading sport historian worldwide, who happened to visit Kyoto at the same time as myself. Prof. Guttmann's books on sport in the USA and Japan have informed much of my research in the past. Now talking to him in person on various occasions and discussing issues and topics of my own research gave me valuable insight and great new ideas.
Third, Prof. Sasaki and other scholars from the Cultural Studies have advised me that for a scholar to truly understand cultural practices, he/she must engage and partake in these practices in a first hand approach, to avoid becoming overly theoretical and "bookish" in one's conclusions. Thus, I visited several baseball events on professional, amateur and on high school level ("Summer Koshien"), to observe and analyze my topic in its immediate environment. Cultural Studies and anthropology should be anxious to keep in touch with culture as it exists in the 'real world', so in my opinion this third approach is by no means less valuable or negligible compared to the abovementioned academic work.

Resulting from this threefold approach to my research questions, I have collected enough information for a case study on how the media perceives the transpacific baseball exchange in the last years. On the one hand, my already existing corpus of American sport language, which I use for my dissertation, provides me with plenty of articles from American sport discourse involving Japanese stars such as Ichiro Suzuki or Hideki Matsui. On the other hand, Ichiro Suzuki's groundbreaking 3,000th career hit recently (July 29, 2008) provoked excited commentary in newspapers in both Japan and the USA. These reactions reveal much about the public esteem of Japanese baseball in the USA, Americans' preconceptions of Japanese ballplayers, and also Japanese reactions, articulated both in Japanese and English language newspaper articles.

I am currently working on a Critical Discourse Analysis of a sample of these texts from both countries in a comparative approach. While it is too early to predict when this study will be complete (at the point of writing this report: 16 August 2008), I am optimistic to translate the notes so far into a manuscript that will either become a

central part of a chapter of my dissertation or possibly even an independent essay for publication in the future.
The notable progress in my research and the valuable information I gathered in and around Doshisha University has been made possible by the JSPS Summer Program 2008, for which I am very grateful.

8. Please add your comments (if any):

While this is not directly concerning my own research, I would like to note another advantageous result of my travel to Japan. I met with students of Professor Sasaki's and we have talked about the work environment at the Heidelberg Center for American Studies (HCA), and life at a German university in general. It is likely that one of them will come to my home institute in Heidelberg for a return visit soon. If my stay in Japan has contributed a little bit to future academic exchange between Doshisha and Heidelberg, I believe this is also a noteworthy benefit for both sides, owed to the Summer Program of the JSPS.

9. Advisor's remarks (if any):

It was our great pleasure to have Mr. Karsten Senkbeil, a Ph.D. student of Heidelberg Center for American Studies (HCA), University of Heidelberg, Germany, as a visiting scholar at Doshisha this summer under the sponsorship of the JSPS.

Although I am not a specialist of sports studies, I am very happy that my colleagues at Doshisha, Professors Higuchi and Tazuke (both are specialists in sports studies) could help him. It was also lucky for Mr. Senkbeil to meet and discuss with our friend Professor Allen Guttmann, a prominent sports historian, while he was staying on Doshisha campus.

With the help of these experts I am very happy to learn that Mr. Senkbeil has collected a heap of materials for his dissertation, besides engaging in a first hand approach by observing several baseball games, both professional and amateur.

Furthermore, it was our great pleasure that Mr. Karsten kindly met one of our former students who is thinking of going to Heidlberg for her further study. I hope that my friendship with Professor Detlef Junker of Heidelberg will develop into students' level.

-- Takashi Sasaki, Doshisha University.

RESEARCH REPORT

1. Name: James S. M. Anderson （ID No.: SP08401）

2. Current affiliation: McMaster University

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
X Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Quantum Chemistry Research Institute and Kyoto University

5. Host researcher: Prof. Hiroshi Nakatsuji and Prof. Masahiro Ehara

6. Description of your current research

This project is to develop efficient multi-dimensional grids for solving the electronic-Schrödinger equation. The method works by employing tensor-product techniques to construct multi-dimensional grids from lower-dimensional grids. This method will employ efficient schemes for evaluating linear operators in one dimension on the unit interval to efficiently construct a multi-dimensional scheme on the unit hypercube. Then a real space grid that places more points in the regions where the wavefunction changes most rapidly and fewer where the wavefunction changes slowest is constructed from the hypercube grid. The real-space grid is where we intend to perform computations in electronic structure.

The novel part of this research is the grid. This grid has the special property that the points only increase polynomially with respect to dimension. So, for example, if we had a grid of n points in one-dimension the naïve way of constructing a d-dimensional grid would have n^d points. Fortunately, advances by Smolyak and others have introduced efficient tensor-product schemes for constructing multi-dimensional grids. Of particular interest to us is the Smolyak scheme. This scheme constructs grid of the same accuracy as the n^d grid but with only d^n points! This is advantageous because there are many efficient algorithms known for differentiating and integrating on a one-dimensional grid over a finite interval, which, via the Smolyak algorithm, can differentiate and integrate efficiently on the unit hypercube of any dimension.

Molecules do not lie on a cube, they lie in real space. Hence, we need a way to map the points off the cube to real space; moreover, grids are most efficient when points are located where the function is changing most rapidly, and ideally a map would be robust enough that it can be used for any molecule. Hence, in a molecule one would want points to be clustered near the nuclei and valence regions and few in the tail regions. As a result we are employing a transformation of coordinates that maps points with respect to some weight function. This would suggest that the electron density as a weight

function would be well suited. Of course, the exact electron density is not known until after the calculation. However, we also know that atomic electron densities are highly transferable from one molecule to the next. Thus we can approximate the molecular electron density with the promolecular density - the sum of atomic densities.

This grid construction coupled with the transformation results in everything needed to perform electronic structure computations on a grid. Clearly the fewer the points the faster it is to perform calculations. As such we'd like to prune away as many points as possible. This is where the antisymmetry will be advantageous (rather than a computational burden). First we can eliminate the Pauli excluded points, i.e. where the like-spin electrons are at the same place. In addition we know the value of the wavefunction at different points is related through electron permutations, that is, $\Psi\left(r_1,\ldots,r_i,\ldots,r_j,\ldots,r_{N_\alpha};r_1,\ldots,r_{N_\beta}\right)=-\Psi\left(r_1,\ldots,r_j,\ldots,r_i,\ldots,r_{N_\alpha};r_1,\ldots,r_{N_\beta}\right)$. This results in, after removing the Pauli excluded points, $N_\alpha!N_\beta!$ fewer points.

On this antisymmetrised grid we are ready to perform electronic structure calculations. One of the difficulties in grid based methods is the singularities in the Coulomb Hamiltonian. A way of avoiding this difficulty is to solve the scaled-Schrödinger equation, which is the Schrödinger equation with both sides multiplied by $g\equiv\frac{1}{V_{ne}+V_{ee}}=\left(\frac{1}{\sum_{i=1}^{N}\sum_{\alpha=1}^{P}\frac{-Z_\alpha}{|r_i-R_\alpha|}+\sum_{i=1}^{N-1}\sum_{j=1+i}^{N}\frac{1}{|r_i-r_j|}}\right)$. The scaled-Schrödinger has the same (right-side) eigenfunctions as the regular Schrödinger equation, but has removed the singularities. This would be the first thing to try. However, the operator gH is not Hermitian, which makes the method a bit more computationally expensive. Also now each component of the operator depends on every electron.

Another way of removing the difficulty of the singularity is to rewrite the Coulomb potential in terms of a long range and short range portion in a way that analytically removes the singularities analytically, that is, rewrite the Coulomb potential in the form $\frac{1}{|\mathbf{r}_i-\mathbf{r}_j|}=\underbrace{\frac{erf(\mu|\mathbf{r}_i-\mathbf{r}_j|)}{|\mathbf{r}_i-\mathbf{r}_j|}-\frac{2\mu}{\sqrt{\pi}}e^{-\frac{\mu^2r^2}{3}}}_{long\ \ range}+\underbrace{\left(\frac{1-erf(\mu|\mathbf{r}_i-\mathbf{r}_j|)}{|\mathbf{r}_i-\mathbf{r}_j|}+\frac{2\mu}{\sqrt{\pi}}e^{-\frac{\mu^2r^2}{3}}\right)}_{short\ \ range}$. This form not only removes the singularities, but also only depends on at most two electrons. I am also eager to develop other alternatives.

7. Research implementation and results under the program

Title of your research plan: Developing a systematic and efficient rational sampling method for utilisation in the Local Schrödinger Equation

Description of the research activities: The local Schrödinger equation is a method of solving the electronic Schrödinger equation that utilises the iterative configuration interaction method with the scaled-Schrödinger equation and eliminates the need for integration. Hence rather than integration the wavefunction is sampled at several points and using these points the coefficients are optimized. The procedure is as follows.

Choose an initial function $\Psi_{n+1} = \sum_i c_i \phi_i$ where $\{c_i\}$ are constants and $\{\phi_i\}$ are linearly independent functions. Next we solve **HC = ESC** , where $H_{ij} = \sum_\mu \phi_i^* (r_\mu) \hat{H} \phi_j (r_\mu)$ where $\{r_\mu\}$ is the set of points the wavefunction is evaluated at, and $\hat{H}$ is the electronic Hamiltonian. Similarly, $S_{ij} = \sum_\mu \phi_i^* (r_\mu) \phi_j (r_\mu)$. **C** is the matrix of coefficients , and **E** is the diagonal matrix of eigenvalues. We choose Ψ_{n+1} by gathering the linearly independent terms of $\left[1 + C_n g\left(\hat{H} - E_n\right)\right]\Psi_n$ (the method above determines the coefficients). Ψ_0 can be chosen freely. When diverging terms appear they are simply removed since they are not physically meaningful.

My contribution was concerned with finding the best set of points $\{r_\mu\}$. Clearly evaluating the matrices is determined by the number of points, and as such, the fewer the number of points the faster the calculation. Hence, we want to find the fewest points that give accurate eigenvalues (comparable to the infinite point limit). This is what is referred to as rational sampling. The Smolyak grid and transformation were utilised for this purpose constructing this grid. Preliminary results are encouraging. We found that for this purpose that we could find for the case of Helium a transformed Smolyak grid that had comparable or even fewer points than the Monte-Carlo method. We have more test examples to run, e.g. Lithium. If the method is efficient we will apply it to larger chemical systems. This work will be finished when I return to Canada.

8. Please add your comments (if any): I thoroughly enjoyed this program. I was exposed to interesting research, and people that I hope to continue to collaborate with in the future. I also enjoyed being exposed to Japanese society, the sights, and the rich history. I would like to say thank you for the opportunity and I hope to return to Japan soon.

RESEARCH REPORT

1. Name: Roxana Behruzi （ID No.: SP08402 ）

2. Current affiliation: Universite de Montreal

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences X Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tsuda College

5. Host researcher: Professor Dr. Chizuru Misago

6. Description of your current research

One of my research interests in public health area is “Humanization of childbirth in highly medicalized setting.” While the literature is abundant regarding the humanization childbirth in low risk pregnancies, the context of highly specialized hospitals, where most of pregnancies are at high risk and have special needs that request special attention, are less addressed. My current research in Canada is about component of humanized childbirth in highly specialized hospital. The aims of this research is 1) to define the specific components of the humanized care that brings satisfaction to the concerned population and 2) to explore the organizational and cultural dimensions in the institutional framework which would act as barriers or facilitators for birth practices ensuring such humanizing care in a highly specialized, and university affiliated hospital in Quebec.

The aim of my present research in Japan was to develop my knowledge about humanized child birth practice at Japanese highly specialized hospital, where humanization of childbirth may have been the main concept of the institution’s mission. However, to achieve this main aim, I needed to visit different levels hospitals as well as clinic and birthing home to observe the child birth practice in different environments and to meet different culture and point of view on humanized childbirth practice in Japan. The main research question was; what are the factors that could have acted as facilitators or barriers in the process of implementing a humanized childbirth practice in highly specialized hospitals in Japan? The specific research question was:

How do the clinical and academic professionals as well as women in different childbirth setting perceive humanization of childbirth in Japan?

7. Research implementation and results under the program

Title of your research plan:

Humanized childbirth experience at highly specialized hospitals in Japan

Description of the research activities:

Field work of this research was carried out between Jun 24th and August 5th, 2008. During this period, two 4th level, three 3th level, two second level hospitals, a clinic and a birthing home were visited. These centers were chosen purposefully to ensure that we included a diverse set of hospitals that supposed to have already implemented humanized childbirth care. Only the data of 3th and 4th level hospitals were used to respond the main research question. The study population consisted of academic and clinical midwives and health educator, obstetricians, nurse-midwife, as well as women. Women participant and most of midwives were chosen randomly, but some midwives, all obstetricians and academic professionals were chosen purposefully as they have already experienced or worked in many humanization of childbirth projects. Data were collected through observations and field notes and in depth open-ended interviews with participants, both individually and in focus groups. A translator accompanied investigator in all the visits as well as interviews with participants. Total number of 5 focus groups and 8 individual interviews with midwives, professional and women were done. All interviews were tape-recorded and transcripted with participants' agreement confidentially. Atlas-ti software was used for analysis of data. A mixed coding was used in this study. The coding and coding- inverse were conducted by investigator and reviewed by Dr. Misago. The code structure was reviewed 3 times by both Dr. Misago and investigator. Prior to analysis and interpretation of data for answer the main research question, the criteria for humanization of childbirth identified by reviewing of literature and discussion with Dr. Misago who has enormous experience as well as research in this concept. Then, all the documents examined a traverse these identification and many times discussed about accuracy of them.

Results: according to the analysis of data, the main factors that could act as barrier and facilitator in humanization of childbirth practice in Japan are listed as followings:

The main barriers in humanization of childbirth practice in highly specialized hospitals

Lack of full presence of midwives during labour; existence of some unnecessary interventions such as episiotomy in some hospitals; obstetrician's authority; lack of good communication between obstetricians and nurse- midwives as well as women; lack of midwives' confidence on their professional ; lack of midwives' autonomy; lack of continuity of care; lack of accompanies during postpartum; shortages of personnel especially at night shifts and over charge at work; conditional assistance of father in labour and delivery; separation of baby and mother in first day of delivery in some hospitals; lack of birth pool in some hospitals; lack of decision making or consciously decision making by women; father banned to assist in cesarean section delivery; lack of LDR room in some hospitals; legal issue; obstetrician's way of educating and training; lack of accompanies during inpatient period in high risk pregnancy, and forbidden free style in high risk pregnancy.

The main facilitators in humanization of childbirth practice in highly

specialized hospitals

Well support to women in pre-intra-post partum period by midwives; use of natural methods of relieving pain such as aromatherapy, massage, warm up women's foot or back, pool, breathing techniques; women's culture and the way of thinking about pain; Kangaroo baby care; management of stress and proper action according to degree of stress; psychologically and physiologically preparation of women during pregnancy by midwives; Tatami rooms in most of hospital; comfortable and beautiful physical environment for women and her family; providing a friendly environment for women; staying baby with mother most of the times; designing a birth plan by pregnant women; respect women and family's privacy; limited use of Electronic foetal Monitoring; avoiding use of epidural and limited use of to specific cases; limited use of infusion; free style position in normal pregnancy; eating and drinking during labour even in high risk pregnancy; avoiding labour augmentation; advocating humanization of birth by most of health care Providers.

These factors were excerpted from transcripted data and further analysis would be carried out after my return to Canada.

Definition of humanization of childbirth

Both obstetricians and academic professionals believed that humanization of childbirth is a changing process and there is no specific definitions exist for humanization of childbirth. However, both clinical midwives and women believed that humanization of childbirth is respecting mother's dignity, autonomy and control on body, and providing comfortable physical and emotional environment.

This concept framework would be explored further incoming months.

8. Please add your comments (if any):

I would like to express my great gratitude to the JSPS and CIHR for their support and this unique research experience. I would like to thank my PhD supervisor, Professor Dr. Hatem for encouraging and supporting me to participate in this program. My sincere gratitude also goes to my host researcher, Professor Dr. Misago. She was always there to ensure I was doing fine. She enabled me to meet different people and attend to several hospitals in Japan and she provided me with all the required resources to advance in my research. I specially thank Mrs. Watanabe, one of Dr. Misago's students, who accompanied me as translator in all visits. I wish to thank Professor Dr. Ii at Hitotsubashi university for welcoming and supporting me in such a friendly way and making my stay in Japan an unforgettable experience.

9. Advisor's remarks (if any):

Japan has a unique system of childbirth characterized by free choice of institutions for birthing mothers, mix of American type of obstetric care and traditional autonomous midwifery care and strong preference among women and professionals for normal childbirth. I hope Ms.Behruzi has enojoyed her stay in Japan and enhanced her research scope in this area Ms.Behruzi is such a talented and hard working researcher with pleasant and sympathetic personality that she was very well received by Japanese professionals. I also enjoyed very much working with her. I am looking forward to having her progress in academic research and contribution to childbirth studies. I thank JSPS for this opportunity to meet the wonderful and promising young researcher like Ms Behruzi.

RESEARCH REPORT

1. Name: Adam Peter Hitchcock （ID No.: SP08404）

2. Current affiliation: University of Toronto

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Prof. Shigeo Yoden

6. Description of your current research

I am interested in the large scale dynamics of the middle atmosphere (roughly 15 to 80 km above the Earth's surface). These dynamics are relevant to the maintenance of the Earth's ozone layer, and play an important role in the formation of the ozone hole above Antarctica. Increasingly, the middle atmosphere is also thought to have important effects on surface climate. My group in Toronto is strongly involved with the Canadian Middle Atmosphere Model (CMAM), a full-scale coupled Chemistry-Climate Model (CCM) which includes, amongst other things, the effects of ozone depleting substances and green-house gases.

Specifically, I have been interested in winter-time temperatures in the Arctic stratosphere, which are important for the chemical reactions that lead to ozone destruction. The winter stratosphere is characterized by strong westerly winds that circle the pole, with the strongest winds at about the 60^{th} latitude. The temperatures inside this polar vortex are set by a balance between the emission of long-wave radiation from ozone and carbon dioxide and adiabatic warming from down-welling air. They can fluctuate strongly, however, in dramatic events known as stratospheric sudden warmings, when planetary scale waves propagating upwards from the lower atmosphere reverse the vortex and warm it by tens of degrees in a period of days.

I have been analyzing model data from three, 150-year integrations of the CMAM, trying to understand how these processes will change over the next century as the halogen loading of the stratosphere subsides and greenhouse gas concentrations increase. I am currently focusing on the dynamically driven month-to-month and year-to-year variability.

7. Research implementation and results under the program

Title of your research plan:

Modeling Internal Variability in the Arctic Stratosphere

Description of the research activities:

I have been analyzing the dominant modes of variability of modeled Arctic polar temperatures using a statistical technique called Empirical Orthogonal Functions. Similar previous analyses of observations of the real stratosphere have suggested the presence of slower, downward propagating wind and temperature anomalies (with time scales of months instead of the weeks for stratospheric sudden warmings). This slower mode was termed the Polar Jet Oscillation, or PJO (Kuroda and Kodera JGR 2000). Since the large-scale dynamics of the stratosphere vary strongly from winter to winter (the summer dynamics are relatively quiescent), the many years of data from long CMAM runs makes it an ideal dataset to characterize this mode, and generate hypotheses that can be tested against observations. There were two primary goals: firstly to categorize types of evolution of the polar vortex from the point of view of this analysis, and secondly to evaluate the statistical significance of a two-decade anomaly noticed in CMAM that appears to be related to these modes. My research involved weekly meetings with Prof. Shigeo Yoden and his post-doc, Dr. Seiya Nishizawa, who carried out some similar analyses of a 15,000 year data set from a mechanistic model of the stratosphere.

A subjective analysis of the CMAM dataset revealed at least two distinct types of events in the evolution of polar temperatures with similar features at their onset (analogous to sudden warmings with timescales on the order of days), but drastically different timescales in their subsequent evolution. In the first type, after an initial warming of the upper stratosphere, a cold anomaly develops and slowly descends to the lower stratosphere on the time scale of two to three months, reminiscent of the PJO. In the second type, after the initial warming the upper stratosphere rapidly returns to its climatological state in a similar 2-3 day timescale. Preliminary dynamical analyses of the first type of event suggest that while the initial warming is due to a strong amplification of wave activity in the polar region (agreeing with the current dynamical understanding of sudden warming events), the subsequent descent of the cold anomaly is related to relaxational radiative processes, not to further wave-mean flow interaction. The long time scale of the descent is associated with the suppression of further wave propagation in the polar stratosphere, which seems to occur in the first type of event but not in the second. Further analysis will have to be carried out to understand the reasons for this difference.

Although the types of events described above appear to happen at any time during the cold season (November through March), for two-decades during the ensemble of 150-year integrations of CMAM they appear occur more frequently during the later part of the winter. This results in apparent trends (which then reverse) in polar stratospheric temperatures, much stronger than those due to climate change. In the second avenue of research, I have been developing a statistical model to evaluate the significance of this two-decade anomaly. With Dr. Nishizawa, I have been investigating several approaches, comparing this variability to that produced by the long mechanistic model run performed at Kyoto and to a simple statistical model. Results suggest that this event would happen by chance only about once in 50 such ensembles. This suggests it is a response to some change in external conditions, but it is not at present clear what would that cause may be.

In addition to the research, I gave two talks while at Kyoto – a seminar presentation to the group of Prof. Yoden on some previous work, and a brief presentation at a workshop on Stratosphere-Troposphere coupling hosted by Prof. Yoden at the end of July.

8. Please add your comments (if any):

Since I am still in the early stages of my PhD program, one of my goals this summer was to generate new ideas and questions to pursue further over the course of my doctorate degree. This summer has been extremely successful in that aspect. I particularly enjoyed the weekly (sometimes more often!) scientific discussions with Prof. Yoden and Dr. Nishizawa, and am grateful for their generosity in sharing their time with me.

9. Advisor's remarks (if any):

It was a nice experience for me to be the host of Mr. Peter Hitchcock for the JSPS Summer Program. The weekly discussions were very stimulating because he analyzed the CMAM datasets vey efficiently, which are one of the most advanced Chemistry-Climate Model products. I hope these two months were fruitful for Mr. Hitchcock in his PhD program.

Shigeo Yoden (Professor of Meteorology, Kyoto University)

RESEARCH REPORT

1. Name: Salima JANMOHAMED （ID No.: SP08405）

2. Current affiliation: University of Toronto, University Health Network, Canada

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry Engineering Sciences X Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Department of Stem Cell Biology, Research Institute for Radiation Biology and Medicine, Hiroshima University, Japan

5. Host researcher: Dr. Yoshihiro Takihara

6. Description of your current research: Hematopoietic stem cells (HSC) sustain the hematopoietic system by dividing to give rise to cells that differentiate into the white and red blood cells. Crucially, this process is maintained throughout life by the process of self-renewal, in which HSC also divide to give rise to cells that remain stem cells. The aim of my PhD project is to shed light on the mechanisms that may regulate the ability of murine HSCs to sustain self-renewal, and thus their identity, into the long term. As a tool to identify candidate genes involved in this process, our lab has isolated two populations of cells that differ in their self-renewal ability: long-term HSCs (LT-HSC) and short-term cells (STC). Both can give rise to all hematopoietic lineages and can at least initially self-renew. However, LT-HSC permanently maintain hematopoiesis, whereas STC only do so transiently. Though the mechanisms to sustain SR are not well understood, the Hox transcription factors have been strongly implicated in supporting HSC SR divisions, where overexpressing HoxB4 or HoxA9 enhances HSC SR. Furthermore, we have found that cycling LT-HSCs and STCs, but not more advanced cycling progenitors, express similar levels of particular Hox transcripts, which is consistent with the ability of both these cell types to initially self-renew, but it does not explain their differing capacities to *sustain* SR. Instead, the two cell types may differentially express genes responsible for the *maintenance* of Hox expression patterns over time. I have focused my work on the Polycomb-Group genes (PcG), which may be involved in this mechanism. The PcG complexes are composed of over 30 proteins from a set of homolog families, and proteins from each homolog group can contribute to the formation of a diverse array of complexes. PcG complexes regulate the transcription of Hox genes by epigenetic mechanisms, such as histone methylation and ubiquitination. PcG complexes also regulate the Ink4a/Arf locus. However, PcG complexes have also been shown to catalyze modifications of non-histone proteins. Loss-of-function studies have already implicated three PcG genes, Rae28, Bmi-1, and Mel-18, in HSC function. However, the precise role of each of these proteins is far

from clear, and it is not known how they would operate with respect to the rest of the complex constituents. To begin to assess which subset of PcG proteins might be important in LT-HSC, I have measured their transcript-level expression in LT-HSC and STC by quantitative real-time PCR. I observed that RING1A is expressed eight-fold greater in LT-HSC versus STC, whereas its homolog RING1B is expressed at similar levels in both cell types. I have also measured the transcript-level expression of PcG genes in hematopoietic progenitors and mature cells. RING1A is strongly down-regulated in differentiating cells. Thus, RING1A may represent a PcG gene that is specific for primitive cell types. RING1A and B contain the domain responsible for the E3 ubiquitin ligase activity towards histone H2A.

7. Research implementation and results under the program

Title of your research plan: Investigating the role of Polycomb-Group complexes and Hox proteins in the ubiquitination of Geminin: clarifying the mechanisms of these proteins in hematopoietic stem cell function.

Description of the research activities: Dr. Takihara's laboratory has shown that the non-histone protein Geminin is targeted for ubiquitination and degradation by a PcG complex composed of Bmi1, Phc1, Scmh1, and Ring1B. They have also shown that the levels of Geminin are crucial for the proper functioning of HSC. I have found that Bmi1, Phc1, Scmh1 are expressed in LT-HSC and STC, and thus this complex could form in primitive hematopoietic cells. However, the E3 ligase activity of RING1A towards Geminin has not yet been shown. Thus, I set out to test whether LT-HSC-specific PcG complexes, containing RING1A, have enzymatic activities that differ from complexes containing RING1B. We cloned the RING1A cDNA into the pV-IKS vector and successfully produced baculovirus expressing GST-RING1A protein in SF9 cells. To produce the PcG complex in vitro, this virus was used to co-infect SF9 cells along with viruses expressing Bmi1, Phc1, Scmh1 that had already been generated in the laboratory. We successfully isolated the complex by glutathione affinity purification and showed that all four proteins were present in a complex. However, the amounts of protein need to be optimized before proceeding to the ubiquitination assay, and these experiments will be conducted in collaborative efforts in the near future. I also worked on a second project in the Takihara laboratory, investigating a novel function of Hox proteins in ubiquitinating Geminin. Hox proteins have been long believed to function as transcriptional regulators. However, recently it has been shown that Hox proteins can bind directly to Geminin, and in a separate report, Hox proteins were shown to bind the Cul4a ubiquitylation machinery. Dr. Takihara's lab has evidence that the Cul4a complex can bind to HoxB4 and mediate the ubiquitination of Geminin. During my stay in the lab, we set out to show whether HoxA9 or Nup98-HoxA9 may have differing activities for ubiquitinating Geminin in vitro and in vivo. It has already been shown that the Nup98-HoxA9 fusion protein, which is found in acute myelogenous leukemia, is more stable than wildtype HoxA9. Thus, we predict that the

Nup98-HoxA9 protein may have a stronger activity for ubiquitinating Geminin. We cloned these cDNAs into vectors for the production of these proteins by baculoviruses in SF9 cells. We successfully produced high levels of HoxA9 and Nup98-HoxA9 by this method. We first attempted an in vitro assay to test whether HoxA9 could ubiquitinate Geminin, when incubated with the Cul4a complex. Preliminary results suggest that HoxA9 does have this activity. However, we will need to further optimize the reaction conditions to detect whether there is a difference in activity between HoxB4 and HoxA9. We are currently assaying the activity of Nup98-HoxA9. To investigate the role of these Hox proteins in the stability of Geminin in vivo, we cloned the cDNAs into vectors for the production of retroviruses. We created stable cell lines producing high titres of retroviruses encoding HoxA9 and Nup98-HoxA9. In future collaborations, we will infect HSC with these viruses to test whether the overexpression of HoxA9 or Nup98-HoxA9 have differential effects on Geminin protein stability in vivo.

8. Please add your comments: I am very fortunate to have had the opportunity to work in Dr. Takihara's lab. I am grateful to Dr. Takihara, who has gone out of his way to arrange the details of my stay in Hiroshima. I am also indebted to the members of his laboratory, who have taken the time to teach me the techniques of which they are experts. I am happy to be able to call all of them friends. I will return to Canada with a deep respect for the Japanese culture and work-ethic.

9. Advisor's remarks: Ms. Salima Janmohamed has joined my laboratory for 2 months since June 24, 2008. She has been working in Prof. Norman Iscove's laboratory on molecular mechanisms governing hematopoietic stem cells (HSCs) especially focusing on isoform members of Polycomb-group genes, and she gave us a curious lecture on her project July 24 in our institute. Currently it is believed that PcG complex 1 sustains stem cell activity including HSCs through the repression of the Ink4A locus. We recently further demonstrated an additional activity for PcG complex 1, *i.e.*, PcG complex 1 acts as an E3 ubiquitin ligase for Geminin, an inhibitor of DNA replication licensing factor, and regulates HSC through the regulation of Geminin. This is the reason why she has been interested in the activity of PcG complex 1 with different isoform members. She constructed vector plasmids for retrovirus- and baculovirus-mediated gene transduction to compare the activity in the recombinant complexes with different isoform members. She also prepared for vector plasmids for transducing Hox, the other essential molecules for HSC regulation. She has already started to prepare for the complexes. And the in vitro assay is now in progress to examine the E3 ubiquitin ligase activity for Geminin. Although the period of the JSPS summer program is limited to 2 months, these preliminary results help continue our future collaboration studies. Since this is her first visiting Japan, I would be pleased if the JSPS summer program also helps deepen her understanding Japan and Japanese culture.

RESEARCH REPORT

1. Name: David Joly （ID No.: SP08406）

2. Current affiliation: Université du Québec à Trois-Rivières, Trois-Rivières (Québec), Canada

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Okayama University, Okayama

5. Host researcher: Yasusi Yamamoto

6. Description of your current research

Photosynthesis is the conversion of light energy into chemical energy by living organisms. It occurs in cyanobacteria, algae and plants and is the most important biochemical pathway on Earth. In higher plants, it results in CO_2 consumption and produces oxygen and carbohydrates. Chloroplasts are the organelles that conduct photosynthesis. Their internal membrane (thylakoid) contains large pigments/protein complexes called photosystems which will initiate charge separation and a subsequent electron transfer chain upon excitation by light.

Photons absorbed by photosystems are not always efficiently used for photochemistry. Heat production and fluorescence (light emission) are the two main dissipative pathways in competition and equilibrium with photochemistry. Chloroplasts have many mechanisms to change the balance between these dissipative pathways which are very important for plant adaptation to various light intensities or to different stress conditions.

Photosystem II (PSII) fluorescence is particularly sensitive to small changes in the photochemical yield and heat dissipation. When dark-adapted leaves are illuminated by strong light, reduction of PSII acceptor side within one second can be monitored by a triphasic fluorescence rise called “fluorescence induction”. Any change in electron transfer

kinetics around PSII will have a specific consequence on the fluorescence induction kinetics. If we understand clearly PSII fluorescence induction, it can therefore become a powerful tool to understand specific effects of inhibitors, pollutants and stress conditions.

The goal of my current research project is to study relation between fluorescence and structure/function of PSII. Most of previous work about fluorescence induction was done with isolated thylakoids from higher plants, which is an incomplete system and behaves differently than entire leaves and intact chloroplasts. I am therefore studying electron transfer and fluorescence in intact chloroplasts and leaves under various stress conditions or specific inhibitor treatments.

7. Research implementation and results under the program

Title of your research plan:

Analysis of the distribution and role of FtsH proteases in light-induced proteolysis of D1 protein in higher plants

Description of the research activities:

D1 protein is one of the main subunit of photosystem II (PSII). Under various environmental stresses, it can be damaged and therefore needs to be degraded and replaced. The FtsH proteases play an important role in this process as they recognize and digest photo-or heat-induced-damaged D1 protein of PSII. The project consisted in analyzing the cleavage of D1 protein by FtsH proteases under light stress. Primary degradation fragments of 23-kDa and 9-kDa have already been found in isolated thylakoids, but further degradation products were hardly detected. The secondary degradation process is largely unknown and was then compared between intact chloroplasts and isolated thylakoids under various conditions to regulate proteolysis.

We first found what can be new D1 fragments in intact chloroplasts photoinhibited for 1h at 10 and 20 ^{o}C under very high light intensity. This will need to be confirmed by future research. Also, our results show that isolated thylakoids are much more

sensitive to photoinhibition than intact chloroplasts. This can be investigated in my lab in Canada with the help of fluorescence measurements.

We also have study photoinhibition of isolated thylakoids and intact chloroplasts under high light at low temperature (4^{o}C) for 30 min followed by dark incubation at temperatures ranging from 4^{o}C to 30^{o}C. We found that photoinhibition at low temperature induced important aggregation of D1 protein, which was not reported in the literature. Membrane fluidity and stacking are affected by temperature and may play a key role in this process. We also found that CP47 and CP43 subunit of PSII are damaged in isolated thylakoids under these stress conditions.

8. Please add your comments (if any):

This work in Japan will lead to good collaboration between my host lab in Japan and my current lab in Canada. The main tools used in each lab are complementary (biochemistry in Japan, biophysics in Canada) and research topics are similar and linked.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Samantha Kasloff （ID No.: SP08407 ）

2. Current affiliation: University of Manitoba

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Hokkaido University

5. Host researcher: Dr. Ayato Takada

6. Description of your current research

Influenza A viruses are naturally circulating viruses of aquatic birds, however the emergence of highly pathogenic strains poses a pandemic threat if they are successfully introduced into the human population. Pigs may play an important role in this process as cells lining their respiratory tract contain both α-2,3-linked and α-2,6-linked sialic acid receptors for avian-tropic and human-tropic viruses, respectively. Both human and avian influenza viruses can therefore infect porcine cells, generating isolates with altered receptor specificity or recombinant viruses that can cross the species barrier. Such viruses must possess human receptor specificity as well as the ability to replicate at human respiratory tract temperatures ranging from 33 ^{o}C - 37 ^{o}C, compared to the avian core temperature of 41C. PB2, a protein in the viral polymerase complex, is implicated in determining the temperature sensitive phenotype, with residue 627 playing a key role. Using the immortalized porcine alveolar macrophage cell line 3D4-31, seven viruses from varied species origin, including two human, one swine, and three avian viruses, were tested for their ability to replicate at 33 ^{o}C, 37 ^{o}C, and 41 ^{o}C over a 48-hour time-course. Experimental viruses included A/WS/33 (H1N1), A/SouthCarolina/1918/ (H1N1), A/Swine/Iowa/15/1930 (H1N1), A/Chicken/Vietnam/14/2005 (H5N1), A/Emu/Texas/39924/93 (H5N2), and A/Chicken/BC/514/2004 (H7N3). Real-time RT-PCR results showed that all avian viruses grew to equal titers at 37C and 41C. The 1918 human pandemic virus also grew well at 41, while the WS/33 human isolate did not. Additionally, while avian viruses were expected to grow poorly at 33C, the BC isolate, an avian isolate which caused two cases of conjunctivitis in humans, reached similar titers at 33C and 37C by 48 hours post-infection. The ability of viruses to replicate at different physiological temperatures is not always predictable based on the host species from which the virus was isolated. A closer look at the PB2 genes of these isolates may provide more details as to why some can replicate at certain temperatures over others, however it is likely that additional complex requirements are necessary

7. Research implementation and results under the program

Title of your research plan:

1. Mutagenesis of PB2 residue 627 of 1918 (H1N1) and VN1203 (H5N1) Influenza Virus
2. Cloning of Marburgvirus Angola strain VP40
3. Generation of his-tagged Marburgvirus Angola strain GPs

Description of the research activities:

1. Mutagenic primers were designed for each of the two influenza genes to introduce a point mutation. PCR was performed on both genes within their vectors and many clones were sequenced in order to determine whether the correct mutation was introduced. This work was carried out to completion for both viruses and the mutated genes will be brought back to Canada.
2. VP40 was cloned into pATX vector using PCR primers that introduced restriction enzyme sites into the 5' and 3' ends of the gene, making it compatible with the pATX vector. Several clones were screened and then sequenced however there was concern over the integrity of the stock RNA, so the genes were not further subcloned into the PCAGGS vector as originally planned.
3. His tag-containing primers were designed for Marburgvirus Angola strain GP in order to generate two different his-tagged GP constructs. After PCR purification the tagged genes were cloned into PATX vector, sequenced, and then successfully subcloned into the PCAGGS vector. Further work to analyze protein expression will be carried out by other laboratory members.

8. Please add your comments (if any):

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Ran Klein （ID No.: SP08409 ）

2. Current affiliation:

University of Ottawa

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X **Engineering Sciences** Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: University of Hokkaido, School of Medicine

5. Host researcher: Dr. Nagara Tamaki and Dr. Chietsugu Katoh

6. Description of your current research

Cardiac artery disease is the leading cause of death is western society and is becoming increasingly common in developing nations too. It is estimated that in 2006 cardiac disease cost the US economy $400 billion in direct expenses and loss of work. Early diagnosis and proper disease management are vital to improving patient outcome.

In this project we conduct a comparative study of three different methods to analyze positron emission tomography (PET) using 82-Rubiudum (^{82}Rb) to measure blood flow to the heart muscle (MBF). The results were compared to measurements made with PET using 15-Oxygen water, which is a very accurate method, but is technically difficult and expensive to perform. ^{82}Rb is much easier to operate and, with sufficient patient volume, can be much cheaper to operate. However, ^{82}Rb has biochemical and physical properties that are not ideal for blood flow measurement. Advances in image analysis software are aimed at improving the accuracy of MBF measurement from ^{82}Rb PET.

The three analysis methods that were compared included:

1) Manual software developed at Hokkaido University by Dr. Katoh.
2) Automated commercial software developed at the University of Ottawa Heart Institute (FlowQuant).
3) Automated software using an approach called factor analysis which is the focus of my doctorate research. Factor analysis is a new approach that attempts to resolve the main shortcoming method 2 – signal mixing due to the limited resolution of PET.

7. Research implementation and results under the program

Title of your research plan:

Comparison of Myocardial Blood Flow Quantification using PET with ^{82}Rb and ^{15}O-water

Description of the research activities:

- Touring of host institution and learning of in house techniques
    - 15O-water PET imaging and image analysis
    - 82Rb PET image processing techniques)
- Data collection.
- Software development.
- Data analysis.
- Presentations of research and clinical work at home institution.
- Presentation of project and results.
- Attending internal conferences regarding host institutions research.
- Discussion of future work and future collaboration opportunities.

8. Please add your comments (if any):

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Louis Laberge Lebel （ID No.: SP08410 ）

2. Current affiliation: École Polytechnique of Montréal, Québec, Canada.

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences

Chemistry XEngineering Sciences Biological Sciences

Agricultural Sciences Medical, Dental and Pharmaceutical Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto Institute of Technology

5. Host researcher: Dr. Asami Nakai

6. Description of your current research

Single-walled carbon nanotubes (C-SWNT), with their high aspect ratio and their excellent mechanical and electrical properties, are prime candidates to improve the mechanical and electrical characteristics of polymers. Several challenges have to be addressed in order to obtain a functional product using C-SWNT reinforced polymer nanocomposites: purification of the as-grown C-SWNTs, dispersion in a polymer matrix, chemical interaction with the matrix polymer chains, and finally, spatial orientation and disposition of the axisymmetric reinforcement in a product. Various manufacturing techniques already exist to constrain the C-SWNTs orientation in fibers (one dimension, 1D) or films (two dimensions, 2D). However, none of those techniques is able to directly produce a final product with a spatial control in three dimensions (3D) on the orientation and localization of the nanotube reinforcement. Tailored disposition of the nanocomposite films or fibers in a subsequent manufacturing step is necessary.

My research objective is to develop a manufacturing technique providing a control on the 3D micro-structure of a nanocomposite product in one manufacturing step. UV-assisted direct-write fabrication (UV-DWF) approach consists of the robotised micro-extrusion of the C-SWNT-polymer nanocomposite under UV exposure. By choosing the appropriate nanocomposite viscosity, cylindrical micro-rods are deposited in a layer-by-layer mode in order to achieve the desired 3D microstructure with spatial control on the orientation and the localization of the C-SWNT reinforcement.

The C-SWNTs are produced using the laser ablation method of a graphite pellet and purified by immersing them in boiling nitric acid. The nanotubes are incorporated to a polyurethane matrix using a surfactant and a 3-roll mixing mill.

Nanocomposite parts produced using UV-DWF are characterized mechanically to see the effect of the C-SWNTs and manufacturing conditions on the overall performance of a macroscopic product. Also, electrical properties are evaluated to asses the potential of theses manufacturing techniques for micro-electro-mechanical systems.

7. Research implementation and results under the program

Title of your research plan:

Characterization of Single Walled Carbon Nanotube/Polyurethane nanocomposite microstructures made by Ultraviolet Assisted Direct Write

Description of the research activities:

Prior to the arrival in Japan, mechanical testing coupon consisting of three cylindrical microbeams deposited over the gap between two pads were manufactured using the UV assisted direct write manufacturing technique (see Figure 1a). The middle microbeams were tested in tension using a dynamic mechanical analyzer and after cutting the external fibers (Figure 1b).

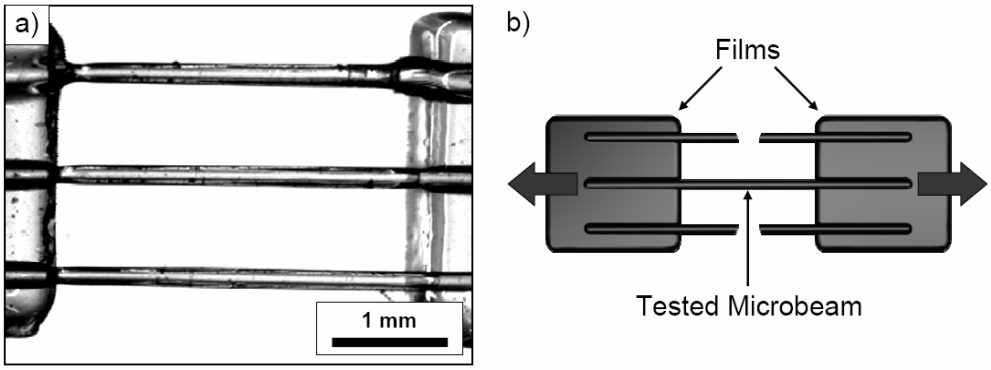


Figure 1 Microbeam mechanical test coupon: a) Three deposited microbeams; b) Mechanical testing in tension of the middle microbeam.

Three nanocomposite blending conditions were tested: pure polyurethane resin, a blend of 0,5% in weight of nanotubes in their as-grown form inside the polyurethane resin (0,5wt% AG) , and finally, a blend of 0,5% in weight of purified nanotubes inside the same resin (0,5wt% PU). Mechanical results are presented in Figure 2. The stiffness increased 12 times for the as-grown carbon nanotube blend and 16 times for the purified nanotube blend. The increase in strength was approximately the same for the two nanocomposite blends compared to the pure resin. The elongation at break significantly reduced for the nanocomposites samples compared to the pure resin. The amount of energy required for rupture also reduced significantly for the nanocomposite samples. The observation of the fracture plane under optical microscopy showed that the fracture was triggered by carbonaceous aggregates responsible for stress concentrations.

In conclusion, the C-SWNT production and purification method, the blending procedure and the UV assisted direct write fabrication approach were used to produce composite cylindrical microbeams. The mechanical characterization demonstrated that the nanocomposite material significantly changed from a soft elastomer to a stiff plastic behavior adding 0,5 wt% of C-SWNT. Observation of the fracture plane showed that the rupture of the microbeams was triggered by carbonaceous aggregates.

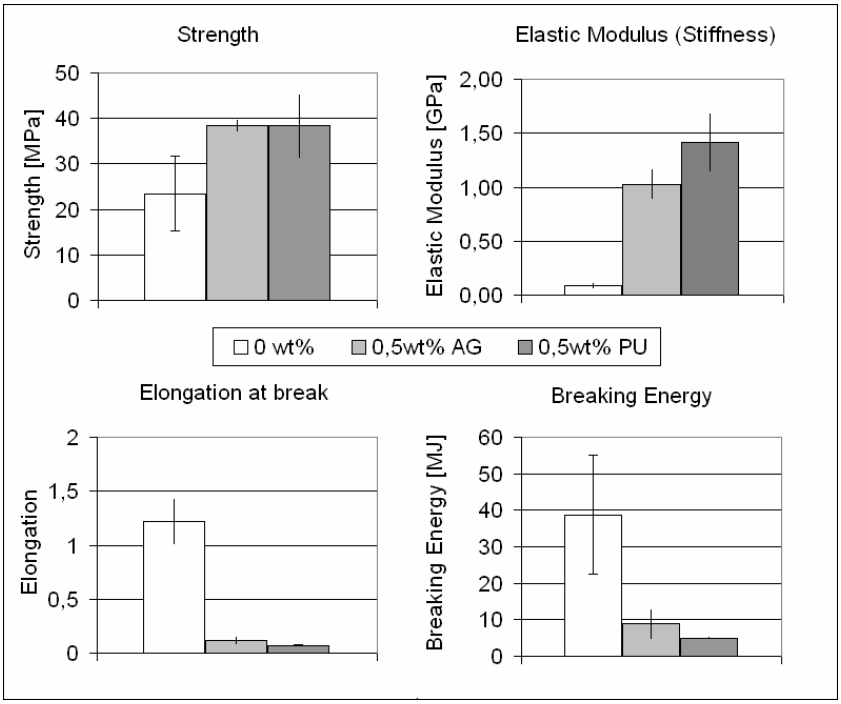


Figure 2 Mechanical properties of tested pure resin and nanocomposite micro beams.

The work conducted in Japan has confirmed the practicality of the UV-DWF technique for nanocomposite structures. In the near future, 3D structures will be constructed and characterized. In the far future, the UV-DWF technique could be used for fabrication of MEMS, electromagnetic shielding of microelectronic devices, tissue engineering and also organic electronic devices.

8. Please add your comments (if any):

The summer at Kyoto Institute of Technology allowed me to work under the direction of the strong team of researchers in the Advanced Fibro-Science department, namely Prof. Hamada, Associate Prof. Nakai and Assistant Prof. Leong. I was part of a great team of devoted and hard-working students that provided enormous help and support. I wish to express my deep gratitude to all of them. I am looking forward to meet and collaborate with them again in the future.

Finally, I also want to thank the Japanese Society for Promotion of Science for having given me this opportunity.

9. Advisor's remarks (if any):

The visit of M. Laberge Lebel in Kyoto Institute of Technology this summer profited to all the research team in the Advance Fibro-Science department both on academic and personal levels. Interesting discussions aroused from its conducted research on nanocomposite micro structure manufacturing method. Also, the interactions with the students were respectful and friendly. I would like to wish to M. Laberge Lebel good luck for the end of his PhD thesis.

RESEARCH REPORT

1. Name: Kyle J. Martin （ID No.: SP08411 ）

2. Current affiliation: University of Ottawa

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Center for Developmental Biology, RIKEN Kobe Institute

5. Host researcher: Dr. Shigeru Kuratani

6. Description of your current research

Evolutionary modification of developmental programs is a major mechanism through which the body plan of vertebrates is altered. *Dlx* genes belong to a family of transcription factors indispensable for normal embryonic development of vertebrate characteristics including the central nervous system, limbs, and branchial arches. Gnathostomes (jawed vertebrates) possess at least 6 *Dlx* genes organized in tightly linked bi-gene clusters, a physical arrangement which affects their expression during development through the use of highly conserved enhancer elements. It is hypothesized that changes in the expression patterns of *Dlx* genes has contributed to the evolution of vertebrate novelties including the jaw. Cyclostomes (jawless vertebrates) include the hafishes and the lampreys, and represent a key reference genome with which to compare the organization and developmental expression pattern of important genes with Gnathostomes. I identified 4 members of the *Dlx* gene family in the Pacific hagfish, *Eptatretus stoutii*, and confirmed the presence of 6 *Dlx* genes in the sea lamprey, *Petromyzon marinus*. Interestingly, I found that the genomic organization of these genes is significantly different than in all other vertebrates examined. This has significant implications for research into how the current archetypal organization of Gnathostome vertebrate genomes originally arose. Current and future research in this field is focused on attempting to resolve orthology relationships between Cyclostome and Gnathostome *Dlx* genes, determining the physical arrangement of *Dlx* genes in the Cyclostome genome, and examining how Cyclostome *Dlx* genes are regulated.

7. Research implementation and results under the program

Title of your research plan:

Physical Mapping of Hagfish *Dlx* Genes by Fluorescent in situ Hybridization (FISH)

Description of the research activities:

In collaboration with Dr. Kinya Ota and Dr. Shigeru Kuratani I developed a method for the physical mapping of genes in the genome of a non-model Craniate which occupies a key position in the phylogeny of the Chordates: the Japanese inshore hagfish, *Eptatretus burgeri*. Using Fluorescent in situ Hybridization (FISH), cloned genomic fragments including large 100kb insert Bacterial Artificial Chromosomes (BACs) can be labeled with fluorophores and directly hybridized to metaphase chromosomes allowing their location in the genome to be discovered. This is of significant interest because by mapping the genomic organization of genes of particular interest in the hagfish we gain insight into the ancestral condition of the chordate genome and can trace the changes which gave rise to the genomic organization of Gnathostomes, including Humans.

By optimizing this protocol for genomic fragments of different size and composition we were able to perform FISH analysis on a wide range of different chromosomal loci. We were able to localize the *Eptatretus burgeri* 18S rDNA cluster to a specific chromosome, indicating that *E. burgeri* diverged from the chordate lineage before the evolution of multiple 18S rDNA clusters that are present in other vertebrates. Using large insert BAC clones we were also able to detect the genomic location of a single copy gene. This advance makes the protocol applicable to nearly any region of interest in the hagfish genome. We used this method to map the chromosomal location of 2 hagfish *Dlx* genes. The results from this experiment supported and strengthened conclusions derived from previous work I performed using traditional molecular biological approaches and indicates that there are significant differences between the organization of the genome of the hagfish and Gnathostome vertebrates. In the future we will use this method to map all hagfish *Dlx* genes to specific chromosomes, and to characterize the genomic location of other genes of interest in the hagfish.

8. Please add your comments (if any):

This collaboration has been absolutely essential to complete and unify independent studies that were begun in both Canada and Japan. I thoroughly appreciate the opportunity to work directly with other scientists interested in the same research field, ignoring the physical barriers which separate us. Both scientifically and culturally I learnt an enormous amount during my stay in Japan and I hope to return again someday for work in the future.

RESEARCH REPORT

1. Name: Lynn G.L. Richardson （ID No.: SP08412）

2. Current affiliation: Department of Biology, University of Waterloo

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution:

21st Century COE Program, Cryobiosystems Research Centre, Iwate University, Morioka, Japan

5. Host researcher: Takehito Inaba

6. Description of your current research

A main feature distinguishing plant cells from other eukaryotic cells is the presence of plastids - a diverse group of organelles responsible for many important cellular functions, most notably, photosynthesis which takes place in the chloroplast. Approximately 95% of chloroplast proteins are encoded in the nucleus, translated in the cytosol, and subsequently targeted to the chloroplast. Most proteins enter the chloroplast via a general import pathway that begins with preprotein recognition by the translocon at the outer envelope membrane of chloroplasts (Toc). In Arabidopsis, the Toc159 family of receptors (including atToc159, atToc132 and atToc120) are the primary receptors recognizing chloroplast-destined preproteins. Structurally and functionally distinct Toc complexes exist that represent distinct pathways for chloroplast protein import, where Toc complexes containing atToc159 are responsible for the import of mainly photosynthetic proteins, and atToc132/120-containing complexes import proteins required for basic plastid functioning. My current research involves a structure-function analysis of the family of Toc159 receptors, focusing on the highly variable N-terminal acidic region of each receptor, and addressing two fundamental questions: 1) How are members of this family of receptors targeted to structurally distinct Toc complexes during initial Toc complex assembly; and 2) how are they able to preferentially recognize different groups of proteins. Multiple protein import pathways are an important mechanism for chloroplasts to regulate protein import during different stages of plant development and under conditions of stress.

7. Research implementation and results under the program

Title of your research plan:

Role of light-signaling pathways in the regulation of chloroplast protein import

Description of the research activities:

Chloroplast protein import is highly flexible and helps the cell adapt to fluctuating environmental conditions, as evidenced by the presence of multiple, substrate-specific protein import pathways (see "current research")[1]. Defects in chloroplast protein import have been shown to affect the expression of photosynthetic nuclear genes, underscoring the importance of protein import to photosynthesis[2].

Objectives and Experimental Approach

Due to the important role that chloroplast protein import plays in photosynthesis, and the tight regulation of photosynthesis by light, the aim of my research while in Japan was to investigate how chloroplast protein import pathways may be regulated by light-signaling pathways. Specific research questions were: 1) Are expression levels of chloroplast protein import translocon components regulated by light? 2) Do defects in chloroplast protein import affect how photosynthetic genes are expressed in response to light?

To address these questions, I exposed dark-grown wild-type (WT) Arabidopsis (ecotype Wassilewskija), and *ppi2* (the atToc159 knockout mutant) Arabidopsis plants to continuous light in the red, far-red or blue spectra and measured expression levels of several nuclear-encoded photosynthetic genes (LCHB1, SSU1A, OE23) and/or import translocon components (TOC159, TIC110 and TOC132) at several time points ranging from 0 to 24 hours of light exposure.

Results

Results suggest that expression of certain components of the import translocon is light-induced. In addition, defects in protein import result in impairment of light-induction of nuclear-encoded photosynthetic genes investigated (LCHB1, SSU1A and OE23). This suggests that functional plastid protein import pathways are essential for proper light-induced expression of photosynthetic, chloroplast-destined proteins. This response is presumed to be mediated by plastid signals generated in

response to protein import defects; however, these plastids signals need to be further characterized to determine if they represent a plastid protein import- specific response, or arise from secondary plastid defects. On-going work in the Inaba lab is aimed at characterizing plastid signals that are linked to the status of the chloroplast protein import machinery in Arabidopsis[2].

Summary

Overall this study clearly presents a link between chloroplast protein import and light-signaling pathways. This is significant as it further demonstrates the importance of protein import to the dynamic nature of plastids and how they are able to efficiently adapt to their constantly changing cellular and extracellular environments. In addition, it contributes to our understanding of how chloroplasts develop upon initial exposure to light, which is a critical event in plant development.

1. Inaba, T. and Schnell, D.J. 2008. Protein trafficking to plastids: one theme, many variations. *Biochem. J.* 413:15-28.

2. Kakizaki, T., Matsumura, H., Nakayama, K. Che, F-S., Terauchi, R., and Inaba, T. Coordination of plastid protein import and nuclear gene expression by the plastid signaling pathway involves the transcription factor GLK1. Submitted to Plant Cell, August, 2008.

8. Please add your comments (if any):

I would first like to thank my host researcher, Dr. Takehito Inaba, for allowing me to work in his lab this summer, and all of his help in getting settled upon my initial arrival in Japan. I would also like to thank Dr. Inaba and Tomohiro Kakizaki for their patience in explaining techniques and answering my many questions. I would also like to thank Katsuhiro Nakayama and Yuko Suzuki for their help in getting oriented in the lab and all members of the 21st COE Program at Iwate University who made me feel welcome during my stay and made my experience in Morioka very pleasant. My experience in Japan has been very positive and I highly recommend this program to other young Canadian researchers. Thank you to JSPS, the Canadian Embassy in Japan and NSERC for coordinating such a great program!

RESEARCH REPORT

1. Name: Natalie Riediger （ID No.: SP08413）

2. Current affiliation: University of Manitoba

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
X Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tohoku University

5. Host researcher: Dr. Masaaki Toyomizu
Professor of Animal Nutrition
Graduate School of Agricultural Science,
Tohoku University
e-mail: toyomizu@bios.tohoku.ac.jp
Tel: +81-22-717-8688

6. Description of your current research

At the University of Manitoba and St Boniface Hospital Research Centre, my Masters research activities included work on n-3 fatty acids and cardiovascular risk. Health benefits from a low dietary n-6:n-3 fatty acid (FA) ratio on cardiovascular risk have been reported. However, the importance and influence of the source of n-3 FA has not been fully investigated. Thus the purpose of my masters work was to investigate cardiovascular benefits of 'designer' oils with a low dietary ratio of n-6:n-3 FA, but different sources of n-3 FA, either fish- or flaxseed oil, in C57BL/6 mice. Twenty-one male mice were divided into 3 groups (n=7) and fed a diet supplemented with either a fish or flaxseed oil-based 'designer oils' with an approximate dietary n-6:n-3 FA ratio of 2:1 or with a safflower-oil-based diet with a ratio of 25:1 (control), for 16 weeks. All diets were considered high-fat and high cholesterol to induce hypercholesterolemia in this atherosclerosis resistant mouse model. Plasma lipids and fatty acid profile of the liver and heart tissue were determined. Histological evaluation of liver was conducted. Finally, we conducted a preliminary assessment of inflammatory profile. Results showed no significant differences in body weight throughout the study course. However, food intake was significantly increased in the fish and flax group compared to control. Compared to baseline, plasma triacylglycerol levels declined (>50%) in all groups by week 4. Plasma cholesterol levels were reduced in both fish and flax groups by 27% and 36%, respectively, as compared to controls at endpoint. The levels of EPA and DHA in liver phospholipids were significantly increased in both fish and flax groups compared to the control group, with more profound increases in the fish group. Arachidonic acid (n-6 FA) levels were similarly decreased in the liver tissues from both fish and flax groups as compared to controls. The n-6:n-3 fatty acid ratio

in the heart phospholipids was significantly lowered in the fish group compared to control, but no difference between flax and either of the other groups was detected. Lastly, pathological analysis revealed significantly reduced appearance of liver steatosis in the fish and flax groups compared to control. Moreover, glycogen content was significantly increased in the flax group compared to control and further significantly increased in the fish group compared to both flax and control. Our results suggest thus far that cardiovascular and metabolic benefits may be attained by reducing dietary n-6:n-3 FA ratio even in a high fat diet medium..

7. Research implementation and results under the program

Title of your research plan: Investigating the effect of dietary olive oil and palm oil on mitochondrial proton leak in chicken muscle

Description of the research activities:

Production and quality loss in chickens due to increased oxidative stress is a concern. Current research suggests dietary olive oil may improve this situation; however the mechanism is not clear. Our purpose was to investigate the effects of dietary olive oil on several markers of oxidative stress in chunky chicken. Chickens were divided into two groups, olive oil (n=9) and palm oil (n=9), and fed their respective diets for 8-10 days. Basal mitochondrial proton leak was assessed in palm oil and olive oil fed birds, as well as in the presence of either palmitate or oleate and during inhibition of avian uncoupling protein (avUCP) with GDP, inhibition of avian adenine nucleotide translocase (avANT) with CAT, or both. Results indicated no significant differences in body weight, feed intake or feed efficiency between experimental groups. Proton leak was increased in both groups in the presence of either palmitate or oleate. Both groups in the presence of oleate and CAT displayed less proton leak compared to oleate alone and oleate plus GDP. This indicates the role of avANT in mitochondrial proton leak. Furthermore, avANT apparently played a greater role in proton leak compared to that of avUCP in both groups. Both GDP and CAT inhibited proton leak in both groups in the presence of palmitate. However, in the palm oil group, CAT showed greater inhibition of proton leak compared to GDP, whereas in the olive oil group both GDP and CAT showed a comparable effect on proton leak. This may indicate differing function of avANT or avUCP in the presence of varying fatty acids.

In the palm oil group, both palmitate and oleate administration had similar effects on mitochondrial proton leak. However more profound influences of GDP and CAT were observed in mitochondria in the presence of palmitate, signifying that either oleate may be a stronger inducer of proton leak, regardless of inhibition of avUCP or avANT, or avUCP and avANT function may be upregulated in palm oil fed chickens. In the olive oil group, palmitate and oleate administration had differing

effects on GDP and CAT results. With palmitate administration, the olive oil group showed that both GDP and CAT had a comparable influence on proton leak. Whereas, oleate administration displayed substantial differences in GDP and CAT effect on proton leak in olive oil group.

With the completion of more experiments, we can fully interpret the data already collected and discern differences between the groups. However, early indications show a role for both avUCP and avANT in mitochondrial proton leak in chickens.

8. Please add your comments (if any): I enjoyed my time and work at my host institution. My host researcher and fellow students were extremely friendly and easy to work with. I learned a lot about Japanese culture and research proceedings here. I will highly recommend this enriching experience to other graduate students.

9. Advisor’s remarks (if any)

Riediger Natalie さんは、研究目的を達成するために、来日直後より熱心に実験準備にとりかかり、努力を惜しまず研究に取り組んできた。さらに、学部生・大学院生にそれぞれ英語による講義や研究発表を行い、実験研究をともに進めてきた大学院生ならず、本学農学研究科キャンパスで学ぶ学生・院生との交流を深め、極めて有意義な機会を双方で共有できた。ここにＪＳＰＳに感謝いたします。

東北大学農学研究科動物栄養生化学分野　教授　豊水正昭

RESEARCH REPORT

1. Name: Kenneth A. Townsend （ID No.: SP08414）

2. Current affiliation:

TRLabs, Department of Electrical and Computer Engineering, Shulich School of Engineering, University of Calgary

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Institute of Technology

5. Host researcher: Professor Akira Matsuzawa

6. Description of your current research

Background and Significance of Current Research:

There is significant interest in the development of wireless noninvasive devices for monitoring of human health. Ultimately, such "Wireless Band-Aid" technologies must have operational lifetimes of several weeks, be of low cost, and resistant to interference in the medical channel. The Calgary Health Region launched in 2004 the "Ward of the 21st Century" initiative. This project is designed to support multidisciplinary collaboration with knowledge translation and commercialization as research outcomes; it is the intended beneficiary of this research.

Objectives of Current Research:

The goal of my research is to develop novel approaches to the design of low-power, interference resistance Radio-Frequency (RF) "Band-Aid" receivers for low data-rate medical sensing through integration of (1) Ultra-Wideband (UWB) and (2) Microelectromechanical Structures (MEMS) Microsystems.

Anticipated Research Outcomes:

Contributions will be made to the research community via the publication of new methodologies for RF medical system-on-a-chip design. Circuits necessary for implementation of a fully integrated Transmitted-Reference UWB Autocorrelation Receiver (TR-UWB AcR) will be designed. System-level specifications will be developed to guide future advancements in this type of receiver design.

7. Research implementation and results under the program

Title of your research plan:

System-Level Analysis and Simulation of a Transmitted-Reference Ultra-Wideband Autocorrelation Receiver for Low-Power Low-Data-Rate Applications.

Description of the research activities:

JSPS Summer Program Research Objectives:

The primary advantages of UWB are (1) it is able to convey significantly more data over short distances than narrowband systems, or alternatively (2) it can convey less data but at significantly lower levels of power consumption. The second characteristic is of interest to the "Band-Aid." Unfortunately, this type of system is susceptible to interference from existing narrowband signals. My work at the Tokyo Institute of Technology has been focused on constructing a system-level model of the TR-UWB AcR that considers the effects of the radio channel, noise, and interference on receiver performance. Typically when characterizing the performance of any wireless system, a communications engineer develops specifications for the system that describe the number of bit errors that occur for a given signal-to-noise ratio; this metric is known as the Bit-Error-Rate (BER). My primary objective in Japan was to develop BER curves that characterize receiver performance. A secondary objective of my time in Japan was to examine the effect of effect of quantization errors in high-speed sampling of the UWB signal on receiver BER. Analog-to-Digital Converters are a research focus of the Matsuzawa-Okada Laboratory.

JSPS Summer Program Research Progress:

Unfortunately, my progress on this research project has been slower than anticipated. The computational complexity of the BER calculations is high, and therefore simulation time is significant. Initial data has been generated to describe performance of the TR-AcR when exposed to simple while noise in the radio channel, as well as under non-ideal direct line-of-sight multipath conditions. The impact of narrowband interference on BER has been determined. Notch filtering is used to mitigate problems associated with BER degradation in the presence of narrowband noise; the effect of filter quality on BER is of critical importance. The BER curves that describe the effect of notch filtering have not yet been created. In addition, the effect of quantization has not yet been considered.

JSPS Summer Program Outcomes:

While progress has not been as significant as hoped, there are a number of positive outcomes to my collaborative work at the Tokyo Institute of Technology. Firstly, the work that has been completed forms the basis for future research in Canada. JSPS summer research will be included in a future publication that describes system performance. Secondly, I have been able to learn a great deal regarding Analog-to-Digital Converter design from fellow students in the Matsuzawa-Okada Laboratory. This new knowledge has enabled me to better understand the requirements of my own system, and given me insight into how I must proceed with future design. Lastly, I have been able to communicate information on my own research and that of my Canadian peers to students in Japan. This has been done on both an informal and formal basis, via casual conversation and a more structured seminar format.

8. Please add your comments (if any):

The JSPS Summer Program is an excellent opportunity for young foreign students to both experience Japanese culture and conduct advanced research at Japanese Institutions. It was a great honour for me to receive this Fellowship. I would like to thank Dr. Akira Matsuzawa and Dr. Kenichi Okada for allowing me to spend time in their Laboratory, and my fellow graduate students for making me feel welcome. I hope that my new friends were able to learn a little about Canada and my own research, just as I learned from them.

9. Advisor’s remarks (if any):

RESEARCH REPORT

1. Name: Bryan M. B. VanSchouwen （ID No.: SP08415）

2. Current affiliation: Department of Chemistry and Centre for Biotechnology, Brock University, 500 Glenridge Avenue, St. Catharines, Ontario L2S 3A1, Canada

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Graduate School of Human Development and Environment, Kobe University

5. Host researcher: Dr. Shigenori Tanaka

6. Description of your current research

My current research deals with polyglutamine structure. Polyglutamine is a naturally occurring peptide found within several proteins in neuronal cells of the brain, and its aggregation has been implicated in several neurodegenerative diseases, including Huntington's disease (HD). Such aggregation typically occurs when the polyglutamine sequence exceeds 37 glutamine residues in length, and results in the formation of fibrils that contribute (by mechanisms not fully understood) to the neuronal cell death associated with HD. The fibrils have been demonstrated to possess beta-sheet structure, with the constituent beta-strands arranged perpendicular to the long axis of the fibril ("cross-beta" structure), and aggregation has been shown to start with a single misfolded peptide.

As a graduate student at Brock University, I am computationally examining the structural tendencies of three mutated polyglutamine peptides that were shown experimentally to aggregate with varying efficiencies:

PGQ_9: K_2-Q_9-PG-Q_9-PG-Q_9-PG-Q_9-K_2 [efficient aggregation]

$PGQ_9(P^1)$: K_2-Q_4PQ_4-PG-Q_9-PG-Q_9-PG-Q_9-K_2 [slowed aggregation]

$PGQ_9(P^{2,3})$: K_2-Q_9-PG-Q_4PQ_4-PG-Q_4PQ_4-PG-Q_9-K_2 [no aggregation]

Low-energy structures have been generated for each peptide by simulated annealing molecular dynamics, and will be analyzed quantitatively by various means. Based on this work, I hope to elucidate a structural explanation for the observed pattern in inhibition of aggregation.

7. Research implementation and results under the program

Title of your research plan:

Fragment Molecular Orbital Assessment of the Non-Bonded Interactions and Structural Tendencies of Mutant Polyglutamine Peptides

Description of the research activities:

First, structures representative of the structural tendencies for each polyglutamine peptide were identified from the structures generated by simulated annealing molecular dynamics. This was done using an analysis technique known as automated histogram filtering (AHF) cluster analysis, which divides the generated structures into groups ("clusters") of related structures based on geometric similarity, and identifies the most representative structure for each cluster based on similarity to all other structures in that cluster. During this stage of the project, it was noted that $PGQ_9(P^{2,3})$ – the peptide that did not aggregate experimentally – yielded appreciably more clusters than either of the other two peptides. This observation suggested the occurrence of a considerably less continuous range of possible structures for $PGQ_9(P^{2,3})$ than for the other two peptides, and thus, the existence of substantial structure rigidity effects imposed by the intrinsic proline residues of $PGQ_9(P^{2,3})$. In addition, visualization of the representative structures for each peptide seemed to indicate good tendency for beta-sheet structure in the case of PGQ_9 and $PGQ_9(P^1)$, although $PGQ_9(P^1)$ demonstrated a somewhat different arrangement of structure elements – presumably in order to accommodate the extra proline residue near its amino terminus. However, poor tendency for beta-sheet structure, and strengthened tendency for random coil structure, was observed in the case of $PGQ_9(P^{2,3})$. Together, the results suggested an inhibition of beta-sheet structure formation by $PGQ_9(P^{2,3})$ due to direct conformational constraint by the prolines within this peptide, while PGQ_9 and $PGQ_9(P^1)$ are both able to form beta-sheet structures due to lack of appreciable conformational constraint by their prolines.

Next, the representative structures for each peptide were subjected to analysis by fragment molecular orbital (FMO) quantum-mechanical calculations, to examine non-bonded interaction patterns within the structures. This analysis was performed using the ABINIT-MP program which was pioneered for protein molecules in my host research laboratory. The non-bonded interaction energies calculated between all pairs of amino acid residues were plotted as two-dimensional graphs to visualize the interaction patterns for each structure, with the electrostatic and dispersion energies graphed separately to permit examination of the contributions of these two

interaction types. The results indicated the consistent occurrence in all structures of overlapping patterns of attractive electrostatic and dispersion energies, which is consistent with the occurrence of extensive intramolecular hydrogen bonding in all polyglutamine structure types – both random coil and beta-sheet-like. In addition, a comparison of the non-bonded energy results for the structures from each peptide's dominant cluster – i.e. the cluster containing the majority of the structures for the peptide – indicated that $PGQ_9(P^1)$ has an energetic tendency to form structures with a similar extent and pattern of intrinsic order to that of PGQ_9. However, $PGQ_9(P^{2,3})$ was found to have a tendency for appreciably more disordered structures, thus emphasizing a large-scale shift of this peptide toward random coil structures – as initially suggested from the cluster analysis results. Further examination of the FMO results is ongoing.

Having learned how to perform FMO analysis with the ABINIT-MP software, I will now be able to perform this analysis on other proteins and peptides, which will allow me to obtain information on key intramolecular interactions and other electronic attributes of proteins and peptides that I investigate in my future research projects. In exchange for learning how to use this software, I have educated the members of my host research group on how to use the AHF cluster analysis software, which was developed in my home research laboratory, and will assist my host research group in examining the structural properties of their subject proteins in a very rational manner.

8. Please add your comments (if any):

The primary objective of my stay at Kobe University was to exchange useful software for analysis of protein molecular structure, and knowledge of how to use the software, with my host research group – an objective that, in my opinion, has been fulfilled through the summer research program.

9. Advisor's remarks (if any):

RESEARCH REPORT

1. Name: Mark Anthony Mateo （ID No.: SP08416）

2. Current affiliation: Department of Computer Science, University of Manitoba

3. Research fields and specialties:

Humanities Social Sciences X Mathematical and Physical Sciences
Chemistry Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Informatics

5. Host researcher: Dr. Asanobu Kitamoto

6. Description of your current research

In the province of Manitoba in Central Canada, the provincial Ministry of Agriculture operates various decision support tools that guide farmers in their management practices. These support tools namely Potato Disease Severity Models (DSV) and Corn Crop Heat Models (CH) are numerically-driven models that rely on raw weather data as their inputs. Sometimes, data recorded by weather stations are absurd, erroneous and inconsistent. The presence of absurd, erroneous and inconsistent data impacts our models as their quality depends upon the quality of the data inputted for their operation. Hence, to ensure reliable decision support tools, it is crucial to have a clean set of data free from errors and inaccuracies. To this end, data mining can be used to extract implicit, previously unknown and potentially useful information from agro-meteorological data.

In my MSc work at the University of Manitoba, I worked on the quality control of agro-meteorological data in Western Canada. To perform quality control tasks, I developed a three-layer data quality control and assurance tool that applies outlier detection methods to automatically scrutinize the quality of weather data. To elaborate, the first layer – internal layer ensures that the observed data are valid and their values fall within reasonable ranges. The temporal layer ensures that data are consistent with some seasonal behaviour. The third layer, spatial layer ensures that measurements are consistent with neighbouring locations. It is important to note that the tool is comprehensive encompassing all pertinent weather parameters such as rain, temperature and humidity.

7. Research implementation and results under the program

Title of your research plan:

Time Series Image Analysis for Event and Trend Detection from Agricultural Sensors

Description of the research activities:

As part of the *Data Integration and Analysis System* (DIAS) project, agricultural "field sensors" were deployed at several farms around Japan and key locations overseas. These automated sensors operate with minimal supervision harnessing solar power to monitor temperature, precipitation and humidity along with an image of the agricultural field every two minutes. These images, together with the other data are transmitted to a central server which forms our time series image database.

In this research, we aim to help farmers and agricultural researchers monitor the farmers' agricultural practices based on their activities in the farm as captured by our time series images. Monitoring the farmers' activities will allow researchers to have a record of the specific agricultural practice applied on the farm which could be used to evaluate its effectiveness and in making suggestions to other farmers to further improve their farming techniques.

During my time at NII-Tokyo, I worked on event detection in a cabbage farm. To detect the occurrence of events, I used change detection techniques through image subtraction and analyzing colour changes between sequences of images. Specifically, I experimented on different colour representation system and distance functions to detect changes in the image.

During the implementation, the biggest challenge encountered in event detection is the changes brought about by illumination in the image sequence. This problem is particularly widespread in farm images are they are shot outdoors. Due to illumination changes, the cabbage's colour artificially changes. In some cases, this colour change is detected as a "change" by our algorithm thereby resulting in the detection of false positives.

As a future step to solve this problem, we can use other elements on the image besides colour as an indicator of change. The idea is to look for new edges as a new

object introduced into an image will create a new set of edges absent from a previous image.

8. Please add your comments (if any):

I would definitely recommend the JSPS summer program especially for those students who have a special interest in Japan and Japanese culture. Besides experiencing the academic and research environment in Japan, I was able to establish contacts not only with Japanese academics but also with researchers from other participating countries of the summer fellowship as well. I wish to thank my supervisor, Dr. Asanobu Kitamoto for his helpful guidance in both academic and non-academic matters. Special thanks to NII staff particularly Ms. Yuriko Kiyokawa for their assistance on accommodation which made settling in Japan a lot easier. Finally, thanks to JSPS and NSERC Canada for their excellent program organization and generous support that made living in Tokyo, one of the world's expensive cities, possible.

9. Advisor's remarks (if any):

Mr. Mark Mateo has been working hard to study the research topic of image processing, in which he did not have any experiences before the JSPS summer program. The program was a good opportunity not only for experiencing Japanese culture, but also for experiencing research fields outside of his graduate research. Although the period of stay was too short to finish something, I believe this program is effective for both students and advisors.

RESEARCH REPORT

1. Name: MD Anwarul Hasan (ID No.: SP08417)

2. Current affiliation: PhD Student

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University**, and Kyoto University*

5. Host researcher: **Professor Toshiyuki Shikata, and *Professor Ryoichi Yamamoto

6. Description of your current research

The particle-particle interaction plays an important role in determining the viscoelastic behavior of colloidal dispersions. In this research, we investigated the effect of particle-particle interactions on the structure and viscoelastic properties of colloidal dispersions. Monodisperse silica particles of size 10 nm, 50 nm, and 100 nm in ethylene glycol were studied. Polyethylene glycol of molecular weight, M_w = 100, 300, 400, 600, 1000, and 6000 were added to the dispersions to change the affinity of the continuous medium for the silica particles, and hence the particle-particle interactions. The viscoelastic properties were investigated by varying the frequency (0.01 rad/sec to 628 rad/sec), solid volume fraction (φ = 0% to 40%), temperature (-10 C to +25 C), molecular weight of polyethylene glycol (PEG) (M_w = 100 to 6000) and percentage of PEG (0 to 25%). The results are interpreted in terms of changes in nano-microstructure of the systems. Numerical simulations were performed using a recently developed hybrid type numerical simulation code based on direct numerical simulation (DNS) that solves the Newton's laws of motion for the dispersed particles and Navier-Stokes equation for the continuous medium. The particle-particle interactions used in the simulation were the Lenard-Jones potential of two types, namely truncated LJ potential or purely repulsive potential (representing ideal hard sphere systems) and attractive-repulsive potential. The simulations with the purely repulsive potential showed an excellent agreement with the theory and experimental results of hard sphere dispersions. The attractive-repulsive potential revealed interesting behavior with substantially high viscosity at moderate temperatures and Peclet numbers, and negligible effect at very high temperature and very high or very low values of Peclet number.

7. Research implementation and results under the program

Title of your research plan:

Dependence of viscoelastic properties on the inter-particle interactions in colloidal dispersions

Description of the research activities:

Materials and Experiment: 10, 50, and 100 nm silica particles dispersed in ethylene glycol was obtained from Nissan chemical LTD (Tokyo, Japan) at volume fractions φ = 11.89% (20 wt.%), 17.4% (30 wt.%) and 17.4% (30 wt.%) respectively. The silica suspensions were concentrated using a rotary evaporator. Samples of different volume fractions were then prepared by adding pure ethylene glycol to the concentrated samples in different proportions as required. The viscoelastic properties of the suspensions were measured using oscillatory type measurement at 25C, 10C, 0C and -10C, and a frequency range 0.01 to 100 rad/s. All measurements were performed using an Anton Parr rheometer, with parallel plate (d = 50 mm) geometry.

Results and Discussion:

Fig.1 shows a typical frequency (ωa_T) dependence of G' and G'' for a suspension of 100 nm silica particles in pure ethylene glycol at a volume fraction, φ = 37.45%. The short term behavior of G' and G'' curves correspond to the high frequency portion in Fig.1 and vice versa. The curves show a terminal zone in the low frequency region, a plateau zone at intermediate frequencies, and a transition zone at high frequencies. Since viscosity can be defined as $\eta = G''/\omega$, the zero-shear viscosity (η_0) was determined from the slope of G'' curves in the terminal zone at ωa_T =1 rad/s. Fig.2 shows the zero-shear viscosity of the samples in terms of relative viscosity versus volume fraction graph along with a hard

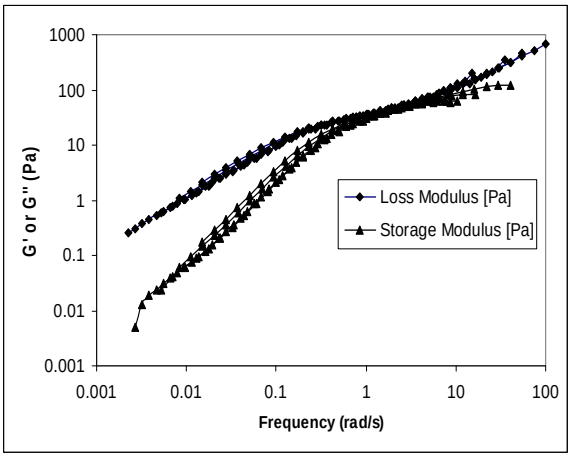


Fig.1 G', G" master curves for 100 nm silica particles in ethylene glycol (φ = 37.5%).

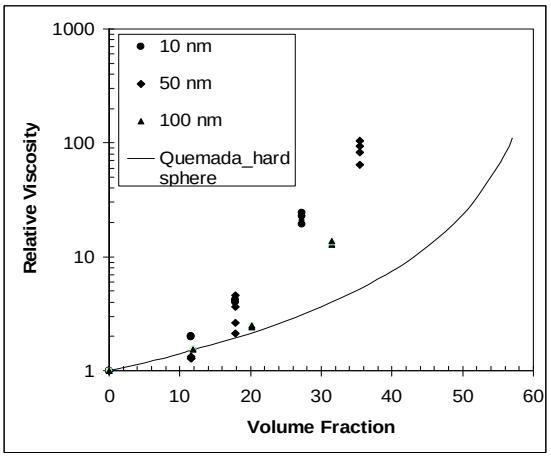


Fig.2 Relative viscosity vs volume fraction graph for silica particles in ethylene glycol

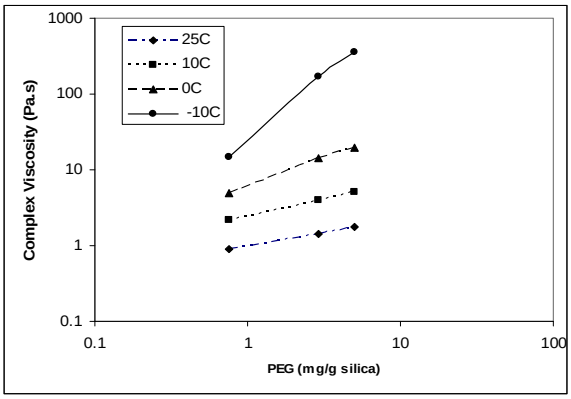


Fig. 3 Viscosity of silica in ethylene glycol

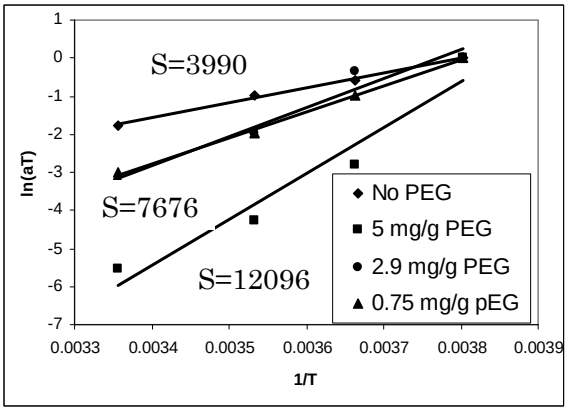


Fig.4 Ln(a_T) vs. 1/T graphs (S = Slope)

sphere model curve using Quemada's equation. At low volume fractions (up to about φ = 12%) all particles followed the hard sphere model curve, but as the volume fraction increased further, the behavior of the suspensions deviated from the hard sphere behavior. Fig.3 shows the complex viscosity of the suspensions as a function of polyethylene glycol (PEG 6000) concentration. The complex viscosity increased as the concentration of PEG increased. The slopes of the ln(a_T) vs. 1/T graphs in Fig.4 give the activation energy of flow of the samples. The activation energy of the suspensions without PEG was similar to that of pure ethylene glycol but Fig.4 shows that the activation energy of the samples increased with increase in PEG concentration. This indicates that the addition of PEG increases the aggregation/flocculation of the particles resulting in increase of viscosity.

Fig.5 shows the model used for simulation while Fig.6 presents the comparison of simulation results with theory and literature data for purely repulsive interaction.The simulations with the repulsive potential showed good agreement with the theory and experimental results of hard sphere dispersions upto φ = 0.3. For attractive – repulsive potential the obtained viscosities were higher.

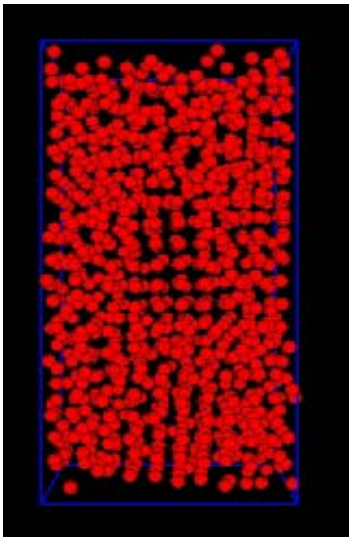


Fig.5 Simulation model

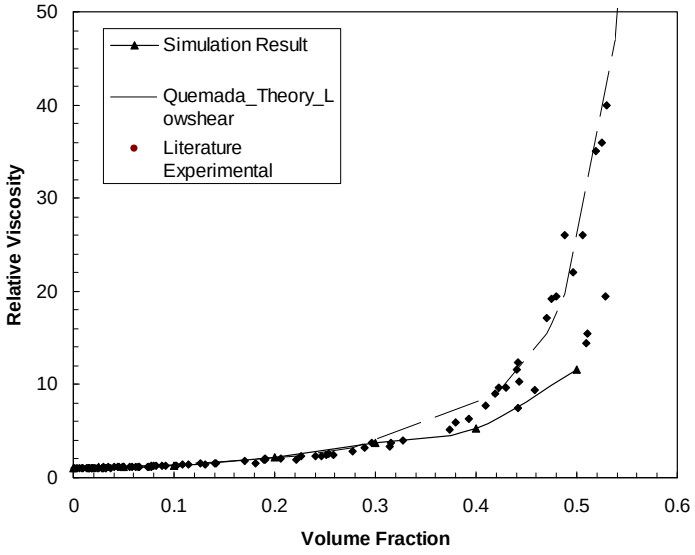


Fig.6 Sample simulation result

8. Please add your comments (if any):

For complete results of this study please see the Proceedings of the 2nd International Conference on Chemical Engineering, BUET, Dhaka, Bangladesh, **29-30 Dec 2008**.

RESEARCH REPORT

1. Name: Caroline Roxanne Cloutier （ID No.: SP08418）

2. Current affiliation: The University of British Columbia

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Yokohama National University

5. Host researcher: Dr. Ken-Ichiro Ota

6. Description of your current research

It is acknowledged that hydrogen (H_2) is one of the best fuel options for the future. Currently, limitations to its large-scale adoption are the lack of a practical storage method, the lack of infrastructure, and concerns regarding its safe handling. The transition between gasoline and H_2 could be facilitated by using non-volatile liquids at ambient conditions, which can be conveniently and safely stored and transported using the existing gasoline infrastructure, and which could then be used to generate H_2.

I am presently studying the electrochemical production of H_2 from water and methanol in acidic media at low temperatures over a wide range of conditions. Phenomena which may result in electrochemical H_2 production current efficiencies beyond what can be predicted by Faraday's law will be investigated to improve the efficiency of the electro-oxidation.

Researchers have observed an excess of gas production when plasma electrolysis is carried out compared to that predicted by Faraday's law for the case of liquid phase electrolysis. In addition, an excess of heat generation was reported as a possibility. This novel co-generative energy resource is the subject of my research at Yokohama National University.

7. Research implementation and results under the program

Title of your research plan: Contact Glow Discharge Electrolysis of Water.

Description of the research activities:

Plasma phase electrolysis, also referred to as contact glow discharge electrolysis, was carried out using an alkaline aqueous solution at low (18.2MΩ water) temperatures and atmospheric pressure in an electrochemical flow cell. Different electrolytes (Na_2CO_3, K_2CO_3), electrolyte concentrations (0.2, 0.4 M), and electrolyte temperatures (26, 38, 50$^oC \pm 2C$) were investigated over controlled constant plasma voltage inputs between 80 and 120 V. This is because the minimum input voltage required to induce the plasma phase varies with temperature and the electrolyte solution employed. The average electrolyte flow rate was 15 ml/s ± 5 ml/s. The cathode consisted of a pure tungsten rod, which was placed in the center of a cylindrical platinum mesh anode. The plasma phase electrolysis experiments were carried out for two hours, during which the electrolyte temperature was recorded, and the rate of gas generated during the electrolysis was measured at regular time intervals. Due to time constraints, no replication of the experiments could be conducted to verify the reproducibility and repeatability of the results for the experiments carried out at 38 and 50^{o}C.

Figure 1 shows the typical variation of the energy available from H_2 with time during the plasma electrolysis.

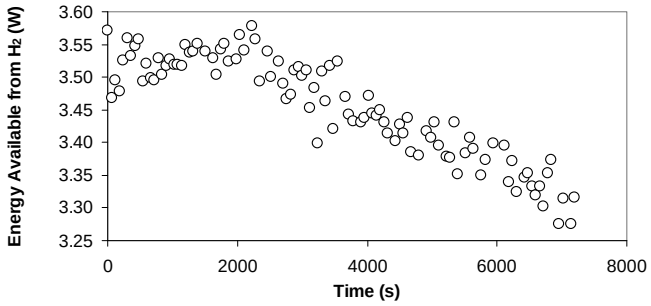


Fig. 1: Energy Available from H_2 as a Function of Time (Plasma Maintenance Voltage of 80 V, Na_2CO_3 0.4 M, 50^{o}C).

More energy is available upon the plasma reactor start-up. A slight decrease in available energy from H_2 is observed as the cathode degrades during the plasma electrolysis over time. Figure 2 shows an example of the energy balance and mass gas balance, on a dry H_2 and O_2 basis, obtained during plasma electrolysis at various temperatures.

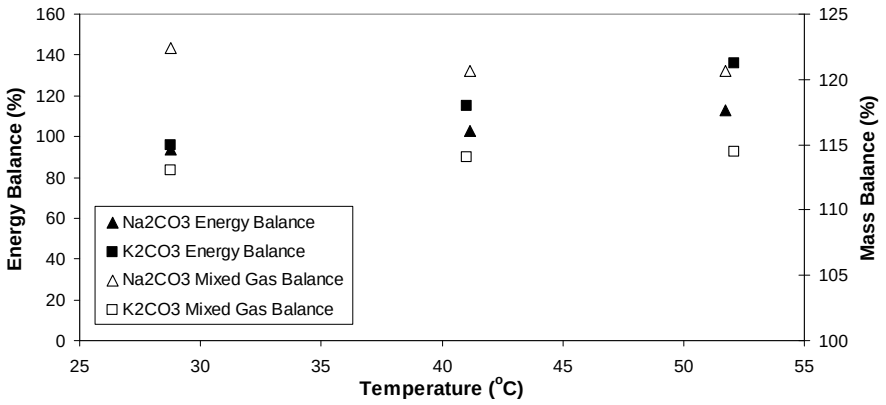


Fig. 2: Energy and Mass Balance as a Function of Temperature. (Plasma Maintenance Voltage of 110 V, Electrolyte Concentration of 0.2 M).

As can be seen, the energy balance and the mass gas balance both exceeded 100% at 50°C. In fact, it was demonstrated that the amount of gas generated exceeded what can be predicted by Faraday's Law at all experimental conditions studied. The heat energy observed exceeded the amount expected from theory, at 50°C for all electrolyte types and concentrations. The exact cause of the excessive heat remains to be explained. Future work should include investigation of the effect of electrolyte flow rate.

8. Please add your comments (if any):

Due to unforeseen circumstances, the experimental plan could not be completed and only preliminary analysis of the data available could be carried-out during the short time-frame of the program. However, it is hoped that the publication of a joint article will be possible at a later date. I greatly appreciated having the opportunity to present in the annual research group's conference before other students, professors, and researchers from various Japanese Institutions and Companies. The knowledge and experience I acquired during this summer will certainly be useful in my future endeavors.

I would like to acknowledge Prof. K. Ota, Associate Prof. S. Mitsushima, and T. Jang for their guidance and assistance, as well as the rest of the research team for their help. I also would like to thank JSPS and NSERC for financial support and express my gratitude to Prof. D. P. Wilkinson for allowing my participation in this Summer Research Program.

9. Advisor's remarks (if any):

Although Ms Cloutier's stay in Yokohama is very short, she worked very hard and I am happy to hear that she has got some strange results during plasma electrolysis. I hope that she got a good impression of Japan and further collaboration will start between our university and UBC in the field of hydrogen energy.

RESEARCH REPORT

1. Name: Guillaume Desjardins （ID No.: SP08419 ）

2. Current affiliation: Ecole Polytechnique de Montreal

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry Engineering Sciences X Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Tokyo Institute of Technology

5. Host researcher: Prof. Yukio Kosugi

6. Description of your current research

My research activities at the Ecole Polytechnique de Montreal are focused on the development and improvement of machine learning (ML) algorithms. Machine learning is a branch of computer science which aims to understand the algorithmic nature of learning, in order for us to build computers which can learn by example. During the past decades, many efforts have focused on Artificial Neural Networks (ANN), which mimic at a high-level, the behavior of biological neurons. Although much progress was done and their use became widespread in many fields of application, ANNs have several significant drawbacks. Backpropagation seems to get trapped in local minima. This is especially true for deep architectures, with many hidden layers, which seem key to achieving more powerful AI. Backpropagation also works in supervised manner only, while labeled data is both scarce and expensive to obtain.

My master's project therefore focuses on a new family of algorithms to train deep architectures, more specifically Deep Belief Networks (DBN), which use the Restricted Boltzmann Machine (RBM) as its building block. RBMs can be trained greedily in an unsupervised manner using Contrastive Divergence (CD), and stacked to form a DBN. The resulting network can then be used to initialize a deep ANN and fine-tuned using backpropagation. My specific objective is to develop and explore the use of convolutional RBMs in vision applications. The convolutional nature of these architectures and inherent weight sharing makes them attractive from a computational point of view. This reduced complexity should in turn allow for greater generalization capabilities. Finally, their architecture has been shown to extract local, translation invariant features, which makes them very well suited to applications with strong local correlations.

7. Research implementation and results under the program

Title of your research plan:

Deep Belief Networks and their Application to Hyperspectral Satellite Imagery

Description of the research activities:

ANNs have a long history in remote sensing applications. This is especially true for land-cover classification, where the goal is to segment satellite imagery into various types of terrain. A challenge when working with hyperspectral data sets is the large size of pixels, which results in single pixel measurements being a mixture of multiple spectra from various plants and trees. Several methods exist to extract these individual spectral components; however, better performance can be achieved if we have a priori knowledge of these "pure spectral curves". To this end, recent work in the Kosugi laboratory had focused on the classification of individual tree twigs and grass types from low-altitude measurements at the Naruko Integrated Field of Tohoku University.

Very good results were obtained for the grass classification task. However, the results for the tree classification had been much less conclusive. My work therefore focused on applying DBNs to the classification of eight different tree types commonly found in Japan, using their spectral profile as input.

Since the end goal was to achieve pixel-level classification, the project was quickly adapted by dropping the convolution aspect of the project in favor of a fully-connected architecture. Each pixel was thus treated as a separate training sample of dimensions equal to the number of wavelengths measured by the hyperspectral sensor. This resulted in a training set of 20,000 training points and 5,000 tests points for all of the eight classes. Samples were selected for training based on their high NDVI value (vegetation index) and high reflectance. Various "deep" architectures were evaluated mainly Deep Belief Networks and Deep Auto-Encoders. For each architecture we varied the number of hidden layers, the number of units per layers, as well as the type of units used. Since hyperspectral data is very noisy, various preprocessing strategies were also tested such as normalization, differentiation and continuum removal. Unfortunately, due to time constraints results thus far have been inconclusive. The best results achieved a test classification accuracy of around 80%, a theoretical improvement compared to the previous result of 70%. However, applying the resulting network to the entire hyperspectral image yielded a classification map of poor quality, which seems to indicate over-fitting (despite using separate training and testing data sets). More

work would therefore be needed to carefully review the experimental protocol, incorporating other data sets, as well as performing a more thorough scan of the various hyper-parameters of the algorithm.

I was also fortunate enough to participate in the 6th International Symposium on Integrated Field Science at Tohoku University. This was a very valuable experience as it gave me a chance to see machine learning from an end-user's perspective. Working on the application side of machine learning during this internship, also gave me better insight into some of the shortcomings of some ML algorithms, the need for robust performance metrics to track progress and compare algorithms, as well as the importance of heuristics and expert domain-level knowledge.

8. Please add your comments (if any):

Overall my research experience in Japan was very rewarding, both personally and professionally. Although I did not accomplish all of the goals I had set out for the summer, the JSPS Summer Program allowed me to branch out and work in a new and exciting field of application, of definite interest to myself and machine learning. This experience would have been all but impossible if not for the JSPS Summer Program. Finally, performing research in an international setting was a very eye-opening experience; one which I believe will have a positive impact on my future academic career.

9. Advisor’s remarks (if any):

Even in a short time visit, Mr. Guillaume Desjardins made some fruitful experiments; some of the preliminary results were presented in an International Conference held in Sendai. His existence truly stimulated Japanese students, through daily laboratory activities including academic discussions, field experiments as well as gate-ball games.

In addition to his research activities, he also contributed to teach high-school students in “Hirameki-Tokimeki Science program” sponsored by JSPS.

I believe, the JSPS Summer Program was very fruitful for both counties’ students.

RESEARCH REPORT

1. Name: Thomas Kenji Uchida （ID No.: SP08420）

2. Current affiliation: Systems Design Engineering, University of Waterloo, CANADA

3. Research fields and specialties:

Humanities Social Sciences Mathematical and Physical Sciences
Chemistry X Engineering Sciences Biological Sciences
Agricultural Sciences Medical, Dental and Pharmaceutical Sciences
Interdisciplinary and Frontier Sciences

4. Host institution: Institute of Industrial Science, University of Tokyo

5. Host researcher: Dr. Yoshihiro Suda, Professor

6. Description of your current research

Real-time Dynamic Simulation of Multibody Mechatronic Systems Containing Closed Kinematic Chains

Multibody dynamics is the branch of physics concerned with the motion of interconnected rigid or flexible bodies and the forces that are responsible for this motion. One of the fundamental objectives in this field is the automatic generation of the governing equations of motion for a system, given a description of its components and the interconnections between them, or its topology. The form of the system equations can vary greatly depending on the characteristics of the system under investigation, the formulation procedure that has been used to generate the equations, and the method in which said procedure has been applied. Though mathematically equivalent, the various forms of these equations are suitable for different simulation environments. The main objective of my current research is to develop a framework for the automatic generation of systems of equations that are well-suited for real-time applications – that is, applications in which the dynamic equations must be solved faster than the physical system would evolve in reality.

Real-time hardware-in-the-loop (HIL) simulation can be used to test electronic and mechanical components of a multibody mechatronic system in isolation, and its use in industry is growing rapidly. HIL simulation refers to the replacement of one or more components of a software model with the analogous hardware component, which communicates with the model throughout the simulation. Operator-in-the-loop simulation is similar, except that a human provides some of the system inputs and senses some of the system outputs during the simulation. HIL simulation can often be used in place of costly field experiments in inconvenient or potentially hazardous environments, and protects the

other system components in the event of failure.

In this work, linear graph theory and symbolic computation are being used to generate hardware- and operator-in-the-loop-ready models. Specifically, the application to multibody systems containing closed kinematic chains is being studied. A closed kinematic chain is a series of connected bodies in which the last body is also connected to the first body. Closed kinematic chains add nonlinear algebraic constraint equations to the ordinary differential equations of motion, thereby producing a set of differential-algebraic equations that may be difficult to solve in real-time. The current research is focused on transforming the system of nonlinear algebraic constraint equations into a form that can be solved quickly.

This research has the potential to be applied to several fields, one of which is the design of vehicle control and safety systems. Such systems use real-time models to predict the motion of the vehicle given its current state. Real-time vehicle models are also used to test the control algorithms before they are implemented on an actual vehicle. An active area of research is the design of advanced electronic stability control (ESC) systems which, even in their current form, have been shown to significantly reduce the number of single-vehicle accidents. It is for this reason that the U.S. National Highway Traffic Safety Administration will be making ESC mandatory on all light vehicles by 2011, with a phase-in period beginning in 2009.

7. Research implementation and results under the program

Title of your research plan:

1. Analysis of the Driving Simulator Turntable Mechanism
2. Development of a Symbolic Double-wishbone Suspension Model

Description of the research activities:

The objective of the first project was to determine the frequency response of the driving simulator turntable mechanism. Several experiments were conducted, and dynamic simulations were performed to estimate the motor torque required to produce the input trajectories used in the experiments, noting in particular the effect of an offset center of mass. Since the motor torque requirements increase quadratically relative to the distance between the center of mass and the axis of rotation, minimizing the offset distance will maximize the bandwidth of the system for a given actuator.

The second project involved developing a symbolic multibody dynamic

model of a vehicle with double-wishbone suspensions on the front and rear axles. Linear graph theory and symbolic computation were used to generate the governing dynamic equations symbolically. Both kinematic and dynamic simulations were performed to test the model, and plots and animations were used to validate the results. The current model is not suitable for real-time applications; however, it will be used to test the algorithms currently under development for optimizing the solution of constraint equations, with the ultimate goal of real-time performance.

8. Please add your comments (if any):

The JSPS Summer Program has been a truly enriching experience. I have been exposed to some of the most advanced vehicle dynamic research facilities in the world, and have met with some of the leading researchers in the field. I have also gained first-hand experience working and living in entirely new environments, which I am sure will continue to influence my perspectives on culture and life in Canada.

9. Advisor’s remarks (if any):

Mr. Thomas Kenji Uchida worked two subjects in my laboratory for JSPS Summer Program. One subject is related in his original works and he got good results and I hope this will help for his project in his university. The other subject is truly new one and experimental works using our driving simulator. He made plan of experiments and conducted experiments and analysis. I value his research abilities. In addition, for my laboratory staffs and students, the collaboration with foreign student is very valuable so this program is also useful for our laboratory.