RESEARCH REPORT

1. Name: Mr Thomas Betts (ID No.: SP04101)

2. Current affiliation: CREST, Loughborough University, UK

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

4. Host institution: Toyota Technological Institute, Nagoya

5. Host researcher: Prof. M. Yamaguchi, Dr. N. Ekins-Daukes

6. Description of your current research

I am currently in the final stages of a PhD investigating the effects of spectral variation of sunlight on solar photovoltaic energy systems. The experimental aspect of the work has been the further development of the outdoor photovoltaic (PV) monitoring system at CREST, which is unusual in that it includes equipment for spectral irradiance measurements. This system has provided a wealth of long-term meteorological and PV performance data, from modules representing a wide variety of commercial and prototype PV technologies.

The work of the CREST PV systems group is to improve the understanding of how various environmental factors affect the energy production from different PV materials, through the analysis of this measured data. My role is in the characterization and quantification of the spectral effect and how this contributes to the seasonal efficiency patterns observed for installed systems.

Analysis of data measured outdoors is complicated by the strong correlations between the driving environmental factors such as solar irradiance, temperature and spectral variation due to solar zenith angle. Hence my work has involved the use of a range of analytical and modeling approaches, including database data quality analysis and spectral irradiance modeling for all sky types.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Spectral Irradiance Modeling for a Novel PV Concentrator Module.

Description of the research activities:

A collective of industry technologists and researchers from different companies and universities has successfully developed a high-efficiency photovoltaic concentrator module. To characterize the performance of the module and identify opportunities for further improvement, a system model has been developed at the Toyota Technological Institute (TTI), named 'Syracuse'.

This model simulates and predicts the PV module electrical parameters such as short-circuit current, open-circuit voltage, maximum power and efficiency from input meteorological parameters describing the module operating environment, such as sun position, solar irradiance and ambient temperature.

There are sub-models for the concentrator optics and the circuit configuration of the 36 cells in the module and also a simulation of spectral irradiance incident on the module. The spectral simulation is necessary as only broadband irradiance data are routinely logged by national meteorological agencies. The cells used in the concentrator have achieved record efficiencies through the use of a triple-junction structure: this allows greater use of the solar resource, but it is thought the structure has a stronger dependence on the spectrum.

My research on the JSPS Summer Programme has been to extend the spectral irradiance sub-model, to help improve the Syracuse simulation results. With accurate simulation, Syracuse can be used to identify areas for module design improvement and give insight into future development work.

Much interest has been shown in both the new concentrator module and the Syracuse system model, so the team leaders have decided to make the outdoor test measurements and the model freely available to the research community (http://www.syracuse-pv.webhop.org/).

8. Please add your comments (if any):

I consider myself to be very fortunate in having had the opportunity to work on a project interesting in both its technical detail and in the diverse backgrounds of the group members and hope to continue to make a contribution.

In addition to my specific research, I found TTI to be a highly stimulating work environment and have learned a little of many areas I might otherwise not have encountered, helped greatly by the explanations and patience of the staff at TTI – my thanks to them.

RESEARCH REPORT

1. Name: Matthew Gardner （ID No.: SP04102 ）

2. Current affiliation: University of Birmingham, UK

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

4. Host institution: RIKEN

5. Host researcher: Dr. WADA, Michiharu

6. Description of your current research

Laser spectroscopy of isotope chains, with regard to determination of mean-square charge radii, nuclear spins and electromagnetic moments.

To a simple approximation the nucleus can be considered to be an infinitely massive point-like object in whose potential the atomic electrons reside. The Schrödinger equation can be solved for this system, and the energy levels of the atom thus determined. The addition of a spin-orbit term, accounting for the interaction between the intrinsic spin of an electron and its orbital angular momentum, allows the fine structure of the atom to be predicted to an accuracy of ~meV. However, nuclei actually have a finite mass and non-zero size which cause perturbations of the order of μeV on the fine structure levels and give rise to isotope shifts. Further, if the nucleus has non-zero spin then an additional perturbation is caused by the interaction between this and the atomic electrons, and this causes the fine structure lines to be split into hyperfine multiplets.

It can clearly be seen that by studying the properties of the atomic energy levels, and changes therein, it is possible to extract information about the nuclear characteristics which caused said changes. This is done using laser spectroscopy.

A laser is used to excite an atomic transition between two energy levels of an isotope of the element to be studied. For most stable and many long-lived isotopes the energy spacing of the electrons, and hence the frequency of transitions between these levels is well known. However, the addition or subtraction of a neutron from the nucleus will change the spacing of the electron energy levels and the frequencies of the transitions in two main ways; via the mass shift and the field shift. Measurement of these new transition frequencies, and thus measurement of the mass and field shifts, allows the aforementioned charge radii, spins and electric quadrupoles/magnetic dipoles to be evaluated.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Planning and Set-Up for Upcoming Laser Spectroscopy Experiments

Description of the research activities:

The Atomic Physics group here at RIKEN is currently developing a set-up to carry out laser spectroscopy on several interesting elements. This set-up will include several advanced pieces of equipment designed, built and tested by the group. The first of these is a large gas stopper cell, designed to be able to stop high energy products of nuclear reactions, thus allowing for greater beam yields. Low beam emmittance is preserved by using a small extraction aperture and an advanced RF electric field carpet to prevent ions from colliding with the chamber walls. The second component is a high-resolution mass spectrometer, which has sufficient resolution to remove any "isobaric" contamination from the beam, whilst simultaneously having a small enough flight time to allow even short-lived isotopes to be studied. Thirdly, an ion trap will be used to carry out ultra-high precision measurements of beryllium, in an experiment that is set to be very interesting for the entire nuclear physics community. I have learned much from the group on these topics, and I will be able to apply this knowledge in my PhD work in Birmingham.

My work has consisted of helping with the set-up and testing of the collinear laser spectroscopy beam line that is needed for all of the planned experiments. This has involved everything from construction of the mounting frame and experimental chambers to installation of the steering and measurement components to testing and improving the vacuum system. On a more theoretical note, I have also developed ionisation schemes for several of the planned experiments, which will be used after the JSPS program is finished and I have left. I very much hope that I will be able to return to RIKEN to participate in some of these experiments, and to work with the group again.

9. (If any) Advisor's remarks:

Mr. Matthew Gardner has worked on two projects of our research group. One is the hyperfine structure spectroscopy of unstable beryllium isotope. Unfortunately, the on-line experiment has been postponed to September due to a problem of the accelerator, so that he could only participate to the off-line test experiments. The other is the collinear laser spectroscopy experiments of unstable nuclear beams. He assembled a new setup together with other collaborators from the Texas A&M university. He also evaluated possible optical transitions for nickel isotopes.

Since the period of JSPS summer program is limited, he could not get real scientific results. However, the experience in our institute would be helpful for his own work at home and his contribution to our future research is greatly appreciated. He would be able to harvest the fruits from his present contribution were he to come here again, as a JSPS postdoctoral fellow for instance. It is excellent that the present program provides an opportunity to ignite such an international collaboration for young scientists

RESEARCH REPORT

1. Name: Harry Hill (ID No.:SP04103)

2. Current affiliation: 2nd Year Phd Student Brunel University, Uxbridge, England

3. Research fields and specialties:

Mathematical and Physical Sciences

4. Host institution: Graduate School of Mathematical Sciences, The University of Tokyo.

5. Host researcher: Dr. Masahiro Yamamoto, Associate Professor, Graduate School of Mathematical Sciences

6. Description of your current research

Current research is based on deriving adaptive solution procedures for problems in computational mechanics, in particular for the deformation of viscoelastic bodies under prescribed actions and forces. Such systems are theoretically and computationally challenging and while there are many theoretical issues, the practical demands of engineering for quantitative solutions mean that adaptive solution techniques to minimize computer costs are required. Adaptive solution procedures have been used for the solution of a particular system by *a posteriori* error estimate driven adaptive finite element schemes. However recent developments in modeling error estimation make it feasible to consider a hierarchy of systems ranging from a model containing all relevant phenomena to what might be an extremely crude approximate model. A coupled modeling and discretization error estimate could then be used to drive an adaptive solution procedure so that the model of required accuracy is used in the relevant part of the domain, while the discretization is being adapted accordingly, thus keeping computational costs at a minimum

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Description of the research activities:

The relevant aspects of the modeling of large deformation kinematics, thermomechanics and constitutive theory were reviewed to set up a general model of viscoelasticity, the accurate numerical solution of which is the ultimate goal. Techniques of modeling error estimation were reviewed and assessed for their applicability to the scenario mentioned above. The most general method is the Dual Weighted Residual method, a method initially proposed for computing adaptive finite element solutions, however recent applications include modeling error estimation. It seems that this is the most viable option and will be the subject of further development in the future.

8. Please add your comments (if any):

The time spent at the University of Tokyo has been very enjoyable and beneficial to my research. Japan is an extremely interesting place and I am grateful for the opportunity to have carried out research, explored some of the cultural aspects and visited some of the many sights recommended to me by Dr. Yamamoto and Dr. Kim.

9. (If any) Advisor's remarks:

The research topic by Mr. Hill is concerned with the viscoelasticity with fading memory and especially he is going to complete the numerical analysis by the finite element method with error analyses. Viscoelasticity with memory is an important subject in the mathematical physics but I think that there are not many works which are satisfactory both from the theoretical and practical viewpoints. In that sense, the current research by Mr. Hill is quite hopeful. Moreover I hope that he will be able to develop his methods towards several related problems such as nonstationary viscoelasticity equation with memory terms.

RESEARCH REPORT

1. Name: Stephen Hillier (ID No.: SP04104)

2. Current affiliation: Bath University, 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: Kyushu University

5. Host researcher: Professor Shigeori Takenaka

6. Description of your current research:

In the post Human Genome era there has been a substantial amount of work on DNA sensing and the focus has shifted from DNA sequencing and screening to DNA detection, primarily for genes and sequence defects. Most of this sensor work had been done using established, fluorescence based technology, but this use of electrochemistry has a number of crucial advantages over this including cost, ease of miniaturisation and direct signal read-out. The recent work has been well reviewed by Barton and de-los-Santos-Alvarez Currently electrochemical detection is less sensitive than fluorescence. My PhD research aims to address this issue, through the design and synthesis of novel, electrochemical DNA probes.

J.K. Barton, Nature Biotech., 21, (2003) 1192.

P. de-los-Santos-Alvarez, Analytical & Bioanalytical Chemistry, 378, (2004) 104.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Improving the sensitivity of DNA SNP detection by the use of a dual intercalator system

Description of the research activities:

The detection of a single base mismatches (SNPs) in DNA is crucial for diagnosing the risks of common diseases, such as hypertension and diabetes.

Historically most techniques relied on hybridisation detection. Below a certain temperature (melting point, Tm) single stranded (ss) DNA can hybridise to its complementary sequence to form a duplex. If the complementary sequence contains a SNP, the duplex is less stable and a lower temperature is required for the duplex to form. By selecting a temperature between the two Tm values, only the complementary sequence will hybridise and this event can be visualised and detected. In practice there is often only a small difference between the Tm values and much careful work is required to get discrimination. To achieve the best sensitivity the initial ssDNA (probe) is immobilised on a surface which is exposed to the complementary (target) ssDNA.

Professor Takenaka's group have solved the Tm problem by using a novel intercalator (see Figure). The DNA solution is cooled to a temperature where both the target and SNP DNA will hybridise and then exposed to a solution containing the intercalator. The intercalator (FND) is an electroactive molecule which selectively binds to double stranded (ds) DNA, but cannot bind to mismatched (SNP) sites. As a fully complementary duplex can bind more intercalators, it will give a higher electrochemical response than the SNP sequence, so you can distinguish between the two.

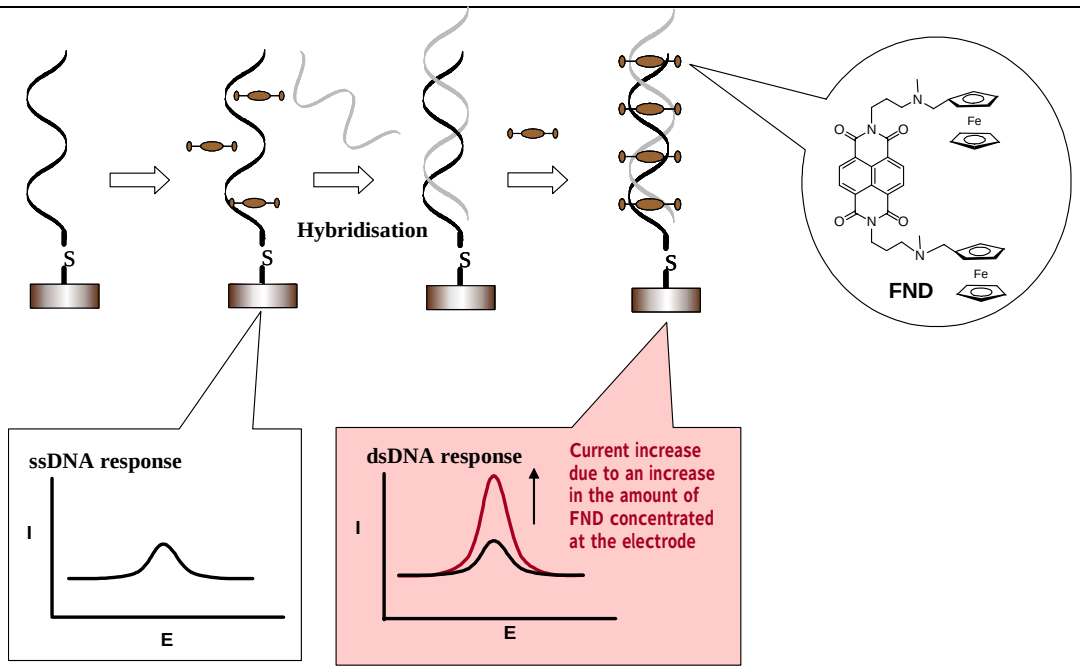


Figure 1 – FND Detection of duplex formation

Research

The sensitivity (defined as the ability to discriminate between fully complementary and SNP DNA) of the FND system is reasonable. However, the response for the SNP sequence is still significant. This is due to the response from the bound FND and non-specific effects. By using a combination of two different intercalators, with different binding characteristics, work was done to separate the response for the bound FND and the non-specific effects (two peaks), to improve sensitivity. The initial results have been very encouraging and the work will be pursued.

8. Please add your comments (if any):

Professor Takenaka's group are world experts on the use of intercalators for DNA sensing, a subject which is very close to my own research. My time in Japan has been invaluable for me both in terms of the research and the kindness and friendship which the group showed me throughout the placement. I am particularly grateful for all the help given to me by Shinobu Sato

RESEARCH REPORT

1. Name: Huw Robert McConochie (ID No.: SP04106)

2. Current affiliation: Research postgraduate at the University of Wales Aberystwyth,

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

4. Host institution:Laboratory of Functional Morphology, Faculty of Agriculture, Tohoku University, Aoba-Ku, Sendai 98o,

5. Host researcher: Professor Hiashi Aso

6. Description of your current research: The objective of my postgraduate research program is to develop an *in vitro* model of ruminant mammary development and lactation using cell culture methodology. It is hoped that the model developed during this research program can be used to improve our knowledge regarding key aspects of mammary gland development, tissue remodeling and *de novo* protein synthesis in the mammary gland.

In vitro culture systems depend largely on the presence of serum supplements in the cell culture media, however results from our experiments suggests that this milieu of undefined factors introduces a number of unquantifiable variables into the model system. Reproducing mammary specific function in the absence of serum has been one of the main difficulties in establishing this model, and is currently the main focus of my research.

In addition we are currently trying to develop our model system using cell culture insert methodology in place of three dimensional culture systems which have proved problematic in previous experimental work (figure 1.)

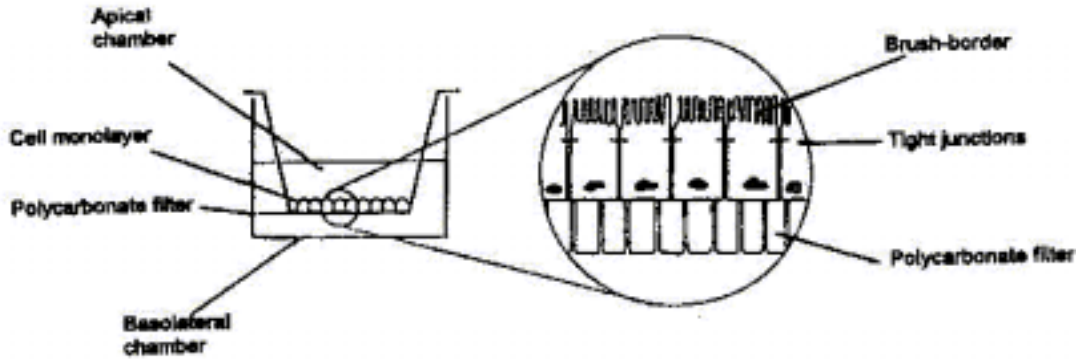


Figure 1. Diagrammatic representation of cell culture insert methodology.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan: Mammary specific function of a bovine mammary epithelial cell clone cultured on PET cell culture inserts.

Description of the research activities:

Background.

Previously we have shown that mammary epithelial cells are able to recreate their own *in vivo* environment *in vitro*, which is capable of stimulating mammary specific function. However, to date this has only been achieved when cells are cultured in the presence of exogenous extracellular matrix proteins. Recently we provided evidence that suggested that an exogenous supply of extracellular proteins was not required, and therefore we decided to design an experiment to test this hypothesis.

Materials and methods.

We cultured mammary epithelial cells on tissue culture PET membranes in the presence of lactogenic hormones (insulin, prolactin and dexamethasone) for 15 days. During this time we measured transepithelial resistance (TER), paracellular flux, milk protein gene expression and visualized the cell surface using scanning electron microscopy.

Results and discussion.

We demonstrated that cells cultured on PET inserts in the presence and absence of

lactogenic hormones are able to express milk protein genes for alpha casein, lactoferrin and beta lactoglobulin, although in the presence of lactogenic hormones there is an up regulation of milk protein gene expression. In the presence of lactogenic hormones MEC cultured on PET established an epithelial layer with high levels of TER, however, the addition of serum or collagen I or both and the omission of lactogenic hormones had negative effects on the integrity of the epithelial layer. Our results showed that the model was representative of the *in vivo* state in the absence of both serum and an exogenous supply of extracellular matrix proteins.

Milk protein gene expression was shown to be correlated with trans epithelial resistance, suggesting that TER together with milk protein gene expression is a good indicator of MEC differentiation *in vitro*. In addition, western blot analysis of cellular protein isolates showed the presence of extracellular matrix proteins necessary for milk protein gene expression *in vitro*.

Results of the paracellular flux assay showed that nutrients are able to diffuse from apical to basal compartments and that the rate of diffusion is dependent on the integrity of the mammary epithelial layer as determined by TER. This data provides an explanation for the presence of milk proteins in both apical and basal compartments experienced in previous experiments, and the absence of absolute compartmentalization between the apical and basal surface of the cell monolayer.

Images from the scanning electron micrograph demonstrated the importance of high cell density that is associated with high levels of TER. These cells displayed higher densities of microvilli on their cell surface as opposed to cells at lower densities.

We believe that this experiment has demonstrated the minimal requirements for *in vitro* differentiation of MEC, and has made significant advances in the development of an *in vitro* model of bovine mammary development and lactation.

8. Please add your comments (if any):

For the first time during my postgraduate research I had the chance to discuss aspects of my work with fellow research students and professors working in similar areas of reseach. I also had the opportunity to study new techniques. The standard of work and the level of output shown by the Japanese was also impressive and has had a big influence on my way of working. I have never been as motivated as I am after this experience.

RESEARCH REPORT

1. Name: chatna Rajput (ID No.: SP04107)

2. Current affiliation: University of Sheffield, Dainton building, Brookhill, Sheffield.

3. Research fields and specialties:

☐ Humanities ☐ Social sciences ☐ Mathematical and Physical Sciences

Y Chemistry ☐ Engineering Sciences Y Biological Sciences

☐ Agricultural Sciences ☐ Medical, Dental and Pharmaceutical Sciences

☐ Interdisciplinary and Frontier Sciences

4. Host institution: Kyoto University

5. Host researcher: Dr K. Nakatani

6. Description of your current research

The genetic material that codes for our characteristics are found in chromosomes. The end of each linear eukaryotic chromosome contains a single strand of tandemly repeated sequences composed of guanine rich bases. These sequences found in kilobases are called telomere, such as the [TTAGGG]*n* (the human telomere.) They are specialized nucleoprotein complexes that have important functions, primarily in the protection, replication, and stabilization of the chromosome ends. In normal healthy cells telomere losses up to 200bp on every cell division and eventually reaches a crucial point where insufficient amounts of DNA is inadequate for cell replication and so the cell enters a state of senescence and eventually the cell dies. However cancer cells are able to reproduce forever without limits. This is due to the fact that telomere does not loose its bases, but in fact adds telomere repeat sequences to the 3' end of DNA strands to maintain its length. The primary suspect responsible for this role is telomerase. Telomerase is a ribonucleoprotein complex with reverse transcriptase activity containing many integrated proteins that seem to play different roles but actually require one another to satisfy the overall telomerase performance. One of the major proteins is the RNA component, containing a template for the new additions.More importantly telomerase can only function on single stranded DNA(figure1)

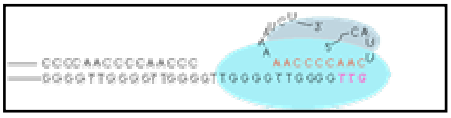


Figure 1: Telomerase function on G-rich single stranded DNA.

Between 80-90% of cancer cells, have expressed high levels telomerase activity. This remarkable event provides the most compelling evidence that telomerase and maintenance of telomere length are the key to

cell immortality and proliferation of cancer cells.

Notably, telomere sequence being rich in guanine bases, can adopt a fold in the structure in the presence of monovalent cations, so that telomere is no longer recognised by telomerase. This means that telomere length is no longer maintained and allows for cell death to occur. The folded structure forms a cyclic array of four guanines coordinated by hoogsteen type hydrogen bonding. This is known as a G-tetrad (figure 2a). A series of G-tetrads stacked upon each other is called G-quadruplex. G-quadruplex can be formed form four (figure 2b) or two (figure 2c) separate strands of DNA. A single strand in this case can also form G-quadruplex by inter-looping (figure 2d).

Figure 2: (a) G-tetrad (b) four separate strands (c) two separate strands (d) single strand forming G-quadruplex DNA.

We are looking for compounds that can stabilize G-quadruplex DNA so that telomerase is inhibited. Our compounds are designed to be flat to enable intercalation between successive G-tetrads, aromatic and extended in length to allow sufficient surface area for π–π stacking (figure 3). We hope that our compounds will be used in an anticancer therapeutic strategy.

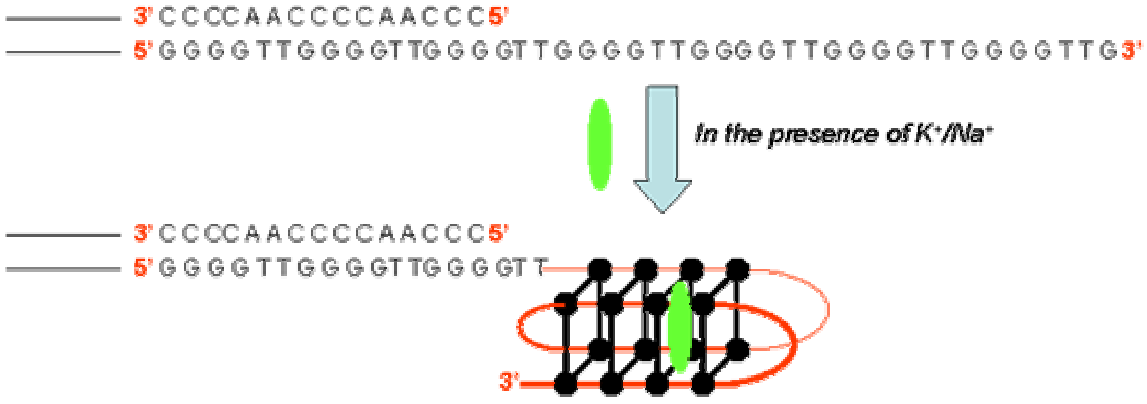


Figure 3: Possible mechanism by which the formation of G-quadruplex DNA interferes with telomerase activity.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

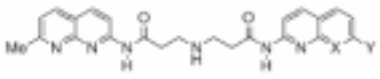
Title of your research plan:

Dimeric Naphthyridine binding to parallel G-quadruplex DNA.

Description of the research activities:

Over expression of the c-MYC oncogene is related to cellular proliferation of a wide range of human cancers. The NHE III_1 of the c-MYC promoter controls 80-90% of c-MYC transcriptional activity. The NHE III_1 is a 27 base pair sequence (rich in guanine bases) that is able to form the folded G-quadruplex DNA in the presence of monovalent cations. Studies have shown that stabilization of the G-quadruplex DNA suppresses c-MYC transcriptional activity.

In 2001, K.Nakatani and co-workers designed a compound that contained two Naphthyridine chromophores (**1**) linked by a single chain. They have shown this compound to bind to GG mismatch DNA in the order of a magnitude of $10^6 M^{-1}$.



(1) X= N, Y=Me

We have seen compound **1** bind to the G-rich sequence found in the c-MYC region. CD spectroscopy (circular dichroism) which measures absorbance of left and right handed circularly polarised light of DNA has been used. The difference between both absorbance's is plotted against the wavelength to give a unique spectrum that signifies the structure of the DNA. Spectrum of the G-quadruplex DNA in the absence and presence of **1** have been recorded. The distinct features observed imply that **1** binds to G-quadruplex DNA. Melting the G-quadruplex DNA in the absence and presence of **1** gives us an indication as to weather the compound has stabilized the DNA structure. UV spectroscopy (measures light absorbance in the ultra-violet region) is the most common technique used to determine the melting temperature of a drug-DNA complex. There appears to be two melting temperatures for the **1**-DNA which implies that an intermediate complex is possible. CD spectrums have also been recorded to observe structural changes upon heating the complex.

In summary, the drug-DNA complex, show two distinct complexes. The first complex, which melts at a low temperature, is the unfavorable complex. CD spectrum shows this possibly to be the G-quadruplex drug-DNA complex. The second complex, which melts at a higher temperature, is more favorable. CD spectrum shows this possibly to be the DNA-drug complex, preferable a hairpin duplex DNA structure bound by compound **1**. This assumption is further supported by the fact that compound **1** binds very strongly to GG mismatch duplex DNA. Currently, there is no sufficient evidence to support these suggestions. Further analyses are required to elucidate the final complex.

RESEARCH REPORT

1. Name: Lois Elenid Smallwood (ID No.: SP04108)

2. Current affiliation: Cardiff University, Wales, UK

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: Tokyo University

5. Host researcher: Prof. Makoto Kuwata-Gonokami

6. Description of your current research

I am studying the relaxation kinetics of excitons in semiconductors. Excitons are a bound complex of an electron and a hole, and are created by shining a laser onto the structure. They then cool down to the temperature of the lattice, which is kept at a low temperature (usually a few Kelvin), via LA-phonon scattering.

I model these systems by deriving equations and using Fortran90 programming. So far I have been studying 2-dimensional systems, - excitons in these systems have a much more efficient cooling mechanism than they do in 3D because of the lack of momentum conservation in one direction. There are many experiments being carried out that deal with these systems, and people are very interested to find out if it is possible to achieve Bose-Einstein condensation of the excitons. To get a Bose-Einstein condensate there needs to be an accumulation of a macroscopic number of Bose particles in the ground-state mode. These excitons are bound complexes of two fermions – an electron and a hole, and therefore have integer spin, and should obey Bose-Einstein statistics in the low-density limit.

Previously, I have been studying excitons in 2D – in GaAs/AlGaAs couple quantum wells. In my study in Japan, and in the near future, I will be working on the kinetics of excitons in bulk Cu_20 (a 3-dimensional system).

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Relaxation kinetics of a low-density exciton gas in Cu_20

Description of the research activities:

In Japan, I have been mostly learning about the 3D system that I will model. The group I am working with in the Applied Physics Department are carrying out experiments in this field, and I want to compare my theoretical results with their experimental results. I am studying how these particular kind of particles (which are called excitons) cool from their initial temperature down to the temperature of their surroundings.

I have begun to model an equation in energy space derived from the Quantum Boltzmann Equation. This equation describes how the energy of the particles changes as time progresses. This has been done already in published papers, but what I hope to do is to make the results even more comparable to experiments which are being carried out in this group. To do this I will include the pump that created the excitons, the decay of excitons and some conversion mechanisms that occur in experiments from one kind of particle to another (ortho-to-paraexciton conversion).

I have been writing a computer code for this equation and hopefully will obtain results in the near future.

8. Please add your comments (if any):

I have enjoyed my experience in Japan very much. Although 2 months sounds like a lot of time it has gone very quickly. I have had the opportunity to travel – to Kyoto and Nikko and many places in and around Tokyo. I have experienced many different kinds of Japanese cuisine and I love everything I tried! I learnt a lot about Japanese traditions and the way of life here in the last two months, and found it very interesting. I have enjoyed everything here apart from the heat and humidity! When I come back to Japan I will make sure that it won't be in summer...

9. (If any) Advisor's remarks:

It was a very good experience to have Miss Smallwood in my lab. My students learned much from working with a student from a foreign country. Scientific discussion and daily conversation in English were good practices for the students to improve their communication skill.

Miss Smallwood tried to formulate a theoretical model of exciton dynamics which we are performing experiments. Although two month was not long enough to complete the project, we were able to establish basis for further development. We would like to continue our international collaboration between theory and experiment.

RESEARCH REPORT

1. Name: LEE SPEAKMAN (ID No.: SP04109)

2. Current affiliation: University of Surrey, Guildford, UK

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*

4. Host institution: Niigata University

5. Host researcher: Professor Kenichi Mase

6. Description of your current research

I am currently exploring QoS (Quality of Service) issues in MANETs (Mobile Ad-hoc Networks) by looking at Cross-Layer Integration techniques.

A MANET is an ad-hoc collection of mobile nodes that are able to set up a wireless packet network. These nodes may be anything from tiny sensor devices, mobile phones type devices, PDAs and laptops, to integrated vehicular systems, be them manual, semi-automatic or robotic. Nodes out of direct radio range are still able to communicate as intermediate nodes are able to act as routers to direct the packets to their ultimate destination. Mobility is supported, as intermediate nodes move out of range then new routes to the destination are calculated dynamically with little disturbance to the communications channel.

In practice a number of issues arise which degrade the QoS of an end-to-end communication channel. In each node the data is passed from one layer to another before ultimately being broadcast from the physical hardware. The radio broadcast is then received by neighbouring nodes, processed and passed to higher layers where it is further processed for forward routing or for delivery to higher layers.

My research involves exploring new designs to improve the QoS of an end-to-end communications channel by increasing the cooperation between the PHY (Physical) Layer, DL (Data Link) Layer and the Network Layer which I believe has not been thoroughly explored in contrast to alternatives. Better integration between the layers will allow each

others processing algorithms to take advantage of additional metrics from the other layers to overall improve the quality of a network channel. A node's lower layers can then better adapt to a particular environment thus presenting an improved QoS to upper layers.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Improved QoS in Mobile Ad-hoc Networks through Cross-Layer Integration

Description of the research activities:

During my stay at Niigata University's Engineering Department, I finalized the details to a design specifically to increase integration between the Network and Data Link layers in a MANET (Mobile Ad-hoc Network) node. The design aimed to redistribute the network load along a flow more evenly both between the nodes and in each node over time.

The design was then implemented in the 'Glomosim' simulation suite. Modification to the DL (Data Link) frames were made in addition to the Backoff algorithm taking advantage of shared Network metrics.

The design and implementation was then testing on a number of simple simulations where the Backoff response could be closely observed. After some tweaking I then considered the algorithm good enough to test with real scenarios.

Results were obtained from real-world scenarios of medium to high mobility with a congested network. Analysis of the results showed significant improvement in goodput (reduced packet loss) and a dramatic reduction in end-to-end delay by 20%.

The technical algorithm design, implementation and results were then presented in front of fellow MANET researchers at the University of Niigata for comments and discussion which were very supportive.

RESEARCH REPORT

1. Name: Tim Carroll (ID No.: SP04110)

2. Current affiliation:

School of Environmental Sciences, University of East Anglia, Norwich, UK

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**

4. Host institution: University of the Ryukyus, Okinawa, Japan

5. Host researcher: Professor Michiko Iha

6. Description of your current research

I have spent the last three years evaluating environmental education programmes on behalf of Waste Watch (a UK Non-Governmental Organisation- www.wastewatch.org.uk) and Essex County Council (ECC, the local government for the county of Essex, UK- www.Essex.gov.uk). This research involves the assessment of waste minimisation activities, delivered by Waste Watch and ECC education officers, in schools and the wider community. The study is designed to evaluate the impact of these educational programmes on the waste related knowledge, understanding and behaviour of children and their parents in Essex.

During the past 2 years I have also been working as a resource advisor to the Schools Business Environment Network based at the University of East Anglia. This has involved researching and producing classroom resources for schools in the subject areas of waste minimisation, energy efficiency, renewable energy, climate change and carbon emission reduction. Examples of these resources can be found at www.uea.ac.uk/env/sben.

I am currently acting as an expert advisor for Harcourt Education (a division of Heinemann Publishers) on a series of six books entitled 'Planet Under Pressure' aimed at 12-16 year old school children. They are to be distributed in Australia, the U.S. and U.K. at the end of this year.

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

An evaluation of environmental education in Naha, Okinawa, Japan

Description of the research activities:

1. Background study of Japanese environmental law, policy and planning at national and local levels (web based plus information from host researcher and local stakeholders). This included an examination of The Basic Environment Law (1993), Waste Management and Public Cleansing Law (1970, amended 2001), Regulations of the Waste Management and Public Cleansing Law (1971, amended 2002), The Fundamental law for a Sustainable Material-Cycle Society (2002) and the Basic Policy on Promoting Green Purchasing (2004).

The Laws set out the objectives of National Government and are supplemented from time to time by various policy statements. Regulations are more comprehensive and set out requirements under the law, although in some areas regulation is open to interpretation. Implementation and compliance with Laws and Regulations in the area of environmental management is seen as a shared responsibility between National and Local Government, the corporate sector and citizens. Initial investigations suggest that strict regulation at a local level is poor. The reliance of National Government on local agencies, companies and citizens assuming responsibility is at odds with the hierarchy within Japanese society that looks for direction at every level. Decision makers at the highest level need to hand down clear guidance that includes systems of implementation and methods of ensuring compliance so that organisations and individuals know how to act.

2. Investigation of environmental education and management in Okinawa. Interviews with local stakeholders in environmental education including: School heads and teachers, members of local NPOs (Okinawa Citizens Recycling Group, Women's Environment Group),President of Okinawa University (Environmental management in Okinawa and Kids ISO), Naha City Council (Zero Emissions Naha (ZEN) and Naha Recycling Plaza), Okinawa Prefectural Government Education Board and Okinawa Public Health Association.

3. Visit to the materials recycling facility for Naha City and nearby Urasoe City. Waste materials segregation at source and collection services are very comprehensive throughout Japan. The post-collection management of waste does not always reflect the comprehensive collection system with some wastes being remixed. There is limited capacity within Okinawa for the use of reclaimed materials and materials such as aluminium and steel are exported to

mainland Japan or China. Recycling of some collected materials are particularly low (e.g. Glass) although figures on specific quantities were not available at this time. Large quantities of organic and paper and other 'burnable' waste are incinerated (approximately 250 tonnes per day at Naha City site). The current facility has no provision for energy recovery although a new plant under construction will have some limited facility for on-site use.

There is currently no research on the participation rate of households or compliance with the collection system. Staff at the Naha Waste Recycling Plaza suggested that the level of commingled or contaminated waste was significant. This has an impact on the suitability for recycling although this has not been quantified.

4. Evaluation of 4th Grade Elementary school pupils (135 pupil questionnaires completed) and their parents (106 questionnaires completed). Designed to investigate the behaviour, knowledge and understanding of waste management, carbon emissions and energy use in their local environment and daily lives. The evaluations were carried out in 2 schools, one with an environmental education programme and one without. Two classes were evaluated in each school (approx 34 pupils per class). Each pupil was given a questionnaire for their parents that were returned to school the following week.

Initial finding suggest that the level of environmental knowledge (factual information) is quite high amongst children and their parents. However, this is not necessarily reflected in their stated waste management behaviour. Children's' awareness of waste management activities at school and at home is variable. There appears to be a lack of connection between information and action/behaviour. This may reflect a social phenomena linked to social and cultural norms of behaviour and decision making that bear further examination.

8. Please add your comments (if any): Final report including the analysis of questionnaires will follow in the near future.

9. (If any) Advisor's remarks:

The finding from the investigation carried at two elementary schools is very unique and I highly regard your work on this matter. I am looking forward to see the comparison between England and Japan.

Michiko Iha

RESEARCH REPORT

1. Name: James E Davidson (ID No.: SP04111)

2. Current affiliation: Edinburgh 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
☐ Interdisciplinary and Frontier Sciences

4. Host institution: Osaka University

5. Host researcher: Prof H. Watarai

6. Description of your current research

Hydrometallurgical extraction from oxidic ores is a well-established industrial process used world wide to generate base metals, such as copper, nickel and zinc from a variety of metal oxidic and transition ores. Approximately 20% of the world's copper is provided by such extraction methods.

Conventional extraction reagents however give unsatisfactory performance when extracting the metal from sulfidic ores as their use leads to an accumulation of sulfuric acid in the industrial process. Our work is centred around the development of novel "metal-salt" extractants (see Figure 1) that are able to selectively extract nickel sulfate from solution and to show selectivity for nickel over other first row transition metals e.g. copper, zinc and cobalt and selectivity for sulfate over other anions such as chloride. This is difficult to achieve as it runs counter to the Hoffmeister series i.e. SO_4^{2-} is much more strongly hydrated than Cl^-.

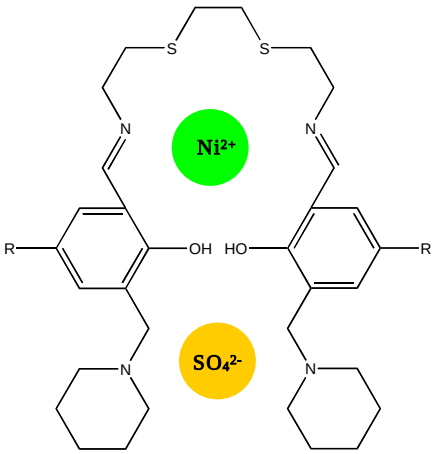


Figure 1 Schematic representation of a Ni(II) Sulfate salicyldimine complex

7. Research implementation and results under the program (As much as possible, describe the contents and results of your research in a manner that is easily understandable to a non-specialist in your field.):

Title of your research plan:

Structural and computational studies of model nickel salicyldimine metal salt extractants.

Description of the research activities:

The mode of action of these extractants (see Figure 1) requires that they are able to form a complex with aqueous nickel sulfate and then to dissolve in a hydrophobic organic solvent. For the extractants to be effective therefore it is necessary that they are soluble in both hydrophobic, organic solvents and water and are able to screen the sulfate anion from the water.

We have attempted to calculate the energy due to the interaction of solvent with the nickel sulfate salicyldimine complex by studying the two systems below (see Figure 2) using the methodology developed in the Watarai Laboratory. This methodology involved performing a Molecular Dynamics simulation to allow the solvent molecules to adopt a sensible configuration. After this the positions of the solvent molecules lying at a distance > 9Å from the centre of mass of the complex were fixed and the energy of the molecules in the "solvation sphere" was minimised and the resulting energy (E_1) was calculated. The complex was the moved to a vacuum and its energy was calculated (E_0'). The energy of the relaxed solvent was also calculated (E_2). The Energy due to the interaction of the solvent with the complex was calculated as $E_i = E_2 – E_1 – E_0$'. The values of E_i for water and chloroform were –1464.6 and –715.3 $kcalmol^{-1}$ respectively. This indicated that the complex would dissolve in the water in preference to the chloroform and so tend to extract Nickel Sulfate poorly. This is largely consistent with experimental results obtained in work carried out in our group at Edinburgh where nickel salts containing less hydrophilic ions are extracted in preference to nickel sulfate.

It was also believed that part of the difficulty in extracting nickel sulfate is the affinity of the sulfate anion for water and the inability of the complex to provide the sulfate with hydrogen bond donors and in doing so remove it from aqueous solution some work was carried out on investigating the conformational flexibility of the pendent amine arms to assess whether it was possible for both nitrogen atoms to act as hydrogen bond donors to a single sulfate anion. The work carried out so far

indicates that although this is possible it is not a particularly favourable configuration for the molecule.

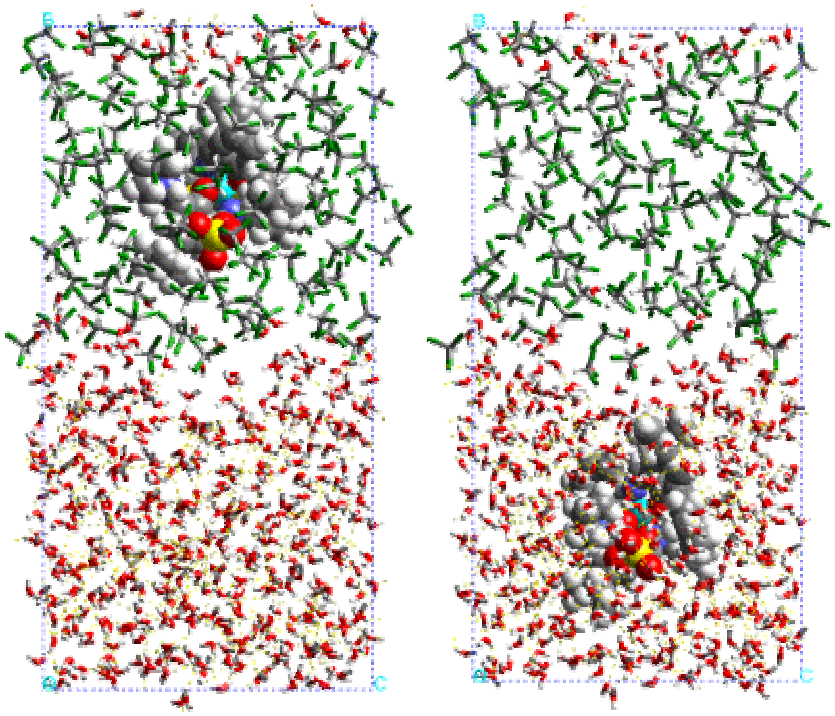


Figure 2 Periodic simulation models for the nickel sulfate salicyldimine complex in a two phase water-chloroform system. The chloroform molecules are coloured in green and black and the water molecules are shown in red and white. The atoms in the complex are shown as van der Waal radii spheres.

8. Please add your comments (if any):

The work that I have carried out at Osaka University has been very useful in that it opens up the possibility of “screening” potential extractant molecules by computer simulation before synthesis has been carried out.