

JSPS FELLOWSHIP FOR RESEARCH IN JAPAN

RESEARCH REPORT

Name of fellow: Joseph E. SHEPHERD

Affiliation: California Institute of Technology

Name of Host Institution: Nagoya University

Name of Host Researcher: Jiro KASAHARA, Professor, Nagoya University

Fellowship Period: From August 6, 2015 to September 6, 2015

Title of Research in Japan: Study on Detonation Propulsion Application and Hydrogen Explosion Safety for Nuclear Power Plant

Date: October 3, 2015



Fellow's Signature _____

Academic Activities

Activities at Nagoya University

At Nagoya University, beginning on August 6 and continuing throughout my visit, I had technical discussions with Prof. Jiro KASAHARA, Associate Prof. NAGANO, Assistant Prof. Ken MATSUOKA and their students. They are working to develop aerospace applications of pulse and rotating detonation technology as well as studying fundamental properties of detonation. I participated in group meetings and provided feedback on ongoing research projects, visited the laboratory and collaborated with Prof. KASAHARA on a joint publication. I also met with Prof. YOSHIKAWA several times to discuss his activities in hydrogen combustion as applied to nuclear power plant and industrial safety. On Friday August 28, I presented a special lecture “Hypervelocity flow, Heat Transfer and Boundary Layer Transition on Aerospace Vehicles” to the students and faculty as well as visitors from JAXA and Shizuoka University. I had discussions with Prof. MORI and his student Masato TAGUCHI about his visiting Caltech to carry out research on hypersonic aerodynamics as visiting student. I met with Prof. Akihiro SASOH, Vice-Dean Graduate School of Engineering and discussed our mutual research interests in laser propulsion, shock wave science), composite materials and shock wave-turbulence interaction.

Visit to Tokyo Institute of Technology

On August 17-18, I visited the Tokyo Institute of Technology; my host was Associate Professor Kazuaki INABA. I had technical discussions with Prof. INABA, Assistant Professor Kosuke TAKAHASHI and their students. They are working on fluid-structure interaction problems, cavitation damage, and material properties. I heard presentations from the students, visited the laboratories, observed experiments and discussed their research projects.

I visited Prof. TANAHASHI laboratory with Assistant Professor Yoshitsugu NAKA and discussed his research on turbulent combustion. I met Yuuki KISHITA, a MS student and discussed the possibility for him work in my lab at Caltech through the Tokyo Tech TiROP Outward Bound program.

I met with Prof. Jeffery CROSS and colleagues regarding the educational exchange programs between Caltech and Tokyo Institute of Technology. We discussed a new program that will be replacing TIER and the possibility of future student exchanges.

I presented a lecture “Research Activities in the Shepherd Laboratory and Structural Response to Detonations” and answered questions for an audience of students and faculty.

Visit to University of Tokyo

On August 19, together with Prof. KASAHARA, I visited the University of Tokyo, received an introduction to the research activities of Prof. DOBASHI and Associate Professor MOGI. I visited their laboratory and presented a lecture: “Hydrogen Combustion Issues and Fukushima NPP” to an audience of students, faculty and visitors including Associate Professor Shinji NAKAYA Professor Mitsuru ARAI (Chairman of Japan Explosives Society), and Dr Yuji OGATA, Deputy Director of RISS at AIST,

Visit to Keio University

On August 20, together with Prof. MATSUOKA I visited Keio University and met with Prof. Akiko MATSUO and her students. I had individual discussions with her students about their research projects on vapor cloud explosion, hypersonic aerodynamics, optimizing hypersonic propulsion systems, coal dust lofting and explosion, computation of sphere-induced oscillatory combustion, detonation propagation and boundary layer interaction. I sat in on reviews of joint projects with the KASAHARA lab on modeling of detonations and applications to propulsion systems. I also visited the laboratory of Assistant Prof. Keita ANDO and discussed with his students their research on bubble dynamics and cavitation. I presented a lecture to the students and faculty on “Research Activities in the Shepherd Laboratory”.

Visit to JAEA Oarai and Tokai Facilities

On August 24 and 25, I visited JAEA facilities in Ibaraki Prefecture. Dr. Ryutoro HINO was my host and introduced me to researchers at the Oarai and Tokai facilities. At Oarai, we visited the laboratory where testing is taking place on using ultrasonic waves for sound speed measurement to infer hydrogen concentration, and had discussions about the recent and planning testing activities. We also visited Dr. HINO's laboratory which is carrying out testing on catalytic combustion for PARS, small scale mixing experiments using helium to simulate hydrogen, and measurements of the fluid dynamics of buoyancy-driven mixing for calibrating subgrid-scale models of turbulence.

At Tokai, I met with Prof. Toru OGAWA, the Director of the Collaborative Laboratory for Advanced Decommissioning Science (CLADS), held discussions with the staff and presented a lecture: "Lessons Learned from Fukushima Nuclear Power Plant Accident - Hydrogen Combustion and Explosion Aspects". I heard presentations from Dr. Ikken SATO on core relocation integral testing program. I visited the Nuclear Safety Research Center and met with Dr. Hideo NAKAMURA, Deputy Director General. I heard presentations by Dr. Satoshi ABE on modeling buoyancy-driven turbulent mixing and Dr. Yu MARUYAMA on modeling hydrogen combustion. We visited the Containment InteGral Measurement Apparatus: CIGMA and discussed planned experiments on mixing and steam condensation that will be carried out in this facility. We were joined in the visit and discussions by Dr. Yasuo NISHIHATA of JAEA Spring-8.

Visit to Akita Prefectural University

On August 26 and 27, I visited Akita and was hosted by Prof. Takashi TSURUDA. I met with and discussed the research activities of Prof. TSURUDA, Associate Prof. Yushiro OGAMI, research associate Tadafume DAITAKU and the students in thermal fluid sciences group. I also met with the Dean of Engineering, Prof. Shin-ichi MATSUMOTO and Ms. Aki ASADA, who organizes the international programs. I presented a lecture "Research Activities in the Shepherd Laboratory" to students and faculty.

Visit to Nagaoka Technological University

On August 31 and September 1, I visited Nagaoka Technological University with Prof. KASAHARA. We were hosted by Prof. Satoshi KADOWAKI, who gave us an introduction to the university and his research activities. Prof. KADOWAKI and Assistant Prof. Toshiyuki KATSUMI gave a tour of the laboratories and the activities of the research students. We were joined by Prof. Toru OGAWA for my presentation "Lessons Learned from the Fukushima Nuclear Accident for Improving the Safety of US Nuclear Plants" We held very active discussions on hydrogen combustion research and nuclear power plant safety.

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Visit to MHI Komaki City

On September 2, I visited the MHI production facilities with Prof. MATSUOKA and Prof. KASAHARA. We were given an introduction to MHI and a tour of the factory. We were introduced to Hiroki CHIBA, Tetsuya KAMOSHIDA, Takashi NISHIWAKI, Masaharu (Matt) NAKAMURA and Dr. Hideki MORIAI. I presented a lecture "Introduction to Caltech and Hypersonics Research" to the staff of MHI.

Attendance at 10th Annual summer school on Detonation

On September 5, I traveled to Kyoto with Prof. KASAHARA and Prof. MATSUOKA to attend the summer school on detonation. About 70 students, faculty and alumni of previous schools were in attendance. I presented the opening lecture "Fundamentals of Detonation in Gases", participated in discussions and attended the social activities in the evening.

Photographs



Presenting my lecture at Nagaoka Technological University



Being greeted by the Namahage after dinner in Akita