RESEARCH REPORT

1. Name: Robert D. Adams （ID No.: SP06001）

2. Current affiliation: Eastern Michigan University

3. Research fields and specialties:

Biological Sciences

4. Host institution: Hokkaido University

5. Host researcher: Dr. Koji Maekawa

6. Description of your current research

The goal of my research at Eastern Michigan University was to quantitatively examine the sea lamprey attachment process and then to test whether the lampreys would seek out the surface that best promoted attachment. In the first set of laboratory experiments, the ability to attach depended on the interaction between a surface's characteristics and the sea lamprey's oral disk anatomy. The flexibility of the oral disk and fimbriae made the shape of the groove as important for suction maintenance as its cross-sectional area. Wider, rounder grooves allowed for the molding of the fimbriae to close off the intrusion, and thus maintain a tight suction seal. A narrow groove of 1-mm width and 3-mm depth prevented all lampreys from making a lasting suction attachment, despite the small cross-sectional area. For management applications where lamprey attachment is a concern, the procedure and metrics utilized in my experiments would be useful for testing candidate surfaces for passage-enhancing or -blocking structures. In the second experiment of the study, sea lampreys displayed little preference among surfaces with varying levels of texture. Repeating this experiment in a high sheer environment may be needed to clarify if a preference for certain surfaces exists and can be exploited for lamprey management purposes.

7. Research implementation and results under the program

Title of your research plan:

An Exploration of Invasive Species Ecology and Management

Description of the research activities:

I examined the interaction between native and invasive fish species in Hokkaido Streams. First investigated was the role of temperature on community composition, with emphasis on the invasive Brown trout and the native White-spotted char. Due to temperature optimums, it was expected that colder water temperatures would benefit the White-spotted char. Our field investigation confirmed this hypothesis. Secondly, a diet analysis was performed between the native Masu salmon and the invasive Rainbow trout. In this study, it was clear that the diets of both species overlap;

therefore, more research is required to examine the potential adverse effects of the Rainbow trout invasion in streams with resident Masu salmon.

8. Please add your comments (if any):

This was a very exciting opportunity to examine invasive species and their research in Hokkaido. This is especially important for my research, as these same species are invasive to Michigan streams. Further comparisons between regions would be a meaningful endeavor.

RESEARCH REPORT

1. Name: Christopher T. Angell （ID No.: SP06002）

2. Current affiliation: University of North Carolina at Chapel Hill

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: Konan University

5. Host researcher: Dr. Hiroaki Utsunomiya

6. Description of your current research

The goal of nucleosynthesis is to explain the origin of the elements: how and where they were created, and the conditions required. The creation of most nuclei can be accounted for in a process of lighter elements fusing together, or capturing neutrons. In either case, more and more nucleons are added on to a single nucleus to generate heavier elements. However, there exist 35 nuclei in the region between Fe and Pb which cannot be created via the addition of nucleons, only in the process of removing nucleons from pre-existing seed nuclei through a process of photo-disintegration. This process is referred to as the p-process, and occurs when the temperature of the stellar environment is on the order of $2x10^9$ K. This condition can be met in Type II supernova, or in the O/Ne layers of massive stars. The requirement of using heavy seed nuclei is supported by the observation that the p-nuclides abundances make up a relatively small (typically ~1%) part of the total abundances

The photodisintegrations involved in the p-process consist of (γ,n), (γ,p), and (γ,α) reactions on heavy seed nuclei. Modeling the p-process involves approximately 20000 reactions linking some 2000 nuclei, most of them being unstable. Direct measurements of photodisintegration reaction rates can only be carried out on stable targets, leaving most of the involved reactions to be determined solely by calculation using the Hauser-Feshbach statistical model. Necessarily, the nuclear physics ingredients into the calculations must be well understood. In addition to making direct measurements of the reaction rates, experiments also test the reliability of the model calculations. The current scarcity of experimental data relevant to the p-process presents a major difficulty in

understanding it.
Thus, direct measurement of photodisintegration cross-sections not only gives an immediate knowledge of the reaction rate for a given nucleus, but also serves to constrain the model parameters.

Nuclei in the stable mass region near the closed shell of 82 neutrons have been chosen for study. The theoretical predictions for this region predict a large change in the gamma-ray strength function, which is closely tied to an increase in the (γ,n) cross section, with increasing neutron number. In particular, the strength function for the Nd isotopes increases an order of magnitude from the closed neutron shell nucleus, ^{142}Nd, to the heaviest stable isotope, ^{150}Nd. There is currently a scarcity of available experimental data on the gamma-ray strength function for these isotopes. The (γ,n) cross section close to neutron separation energy for ^{150}Nd has never been measured to date. The (γ,n) cross sections measurements close to the separation energy for the isotopes ^{142}Nd and ^{150}Nd are thus needed in order to understand the nature of the increase in the gamma-ray strength function, as well as put constraints on the theoretical models.

7. Research implementation and results under the program

Title of your research plan:

Photodisintegration Cross-Sections in the p-process

Description of the research activities:

Direct measurements were made of the (γ,n) cross section for ^{150}Nd, ^{94}Zr, and ^{90}Zr close to neutron separation energy. This is the first measurement of the (γ,n) cross section for ^{150}Nd to date in the given energy region. The experiment was carried out at the National Institute of Advanced Industrial Science and Technology. The inverse-Compton scatter γ-ray beam line on the TERAS electron storage ring was used. A measurement on ^{142}Nd was not possible at this time due to insufficient beam time at the facility. However, the measurement on ^{94}Zr is particularly important while there is a signature of a sub-threshold resonance, making the study of this nucleus a top priority.

The neutron detector consisted of 20 proportional ^{3}He neutron detectors inserted into a polyethelene block. They were arranged in three concentric rings, with the target placed in the center. A NaI detector was used to monitor beam flux during the experiment. Additionally, a HPGe detector was used to measure the beam profile. The measurements are particularly sensitive to the flux, and beam profile, making accurate measurements of the two a necessity. The (γ,n) cross section for ^{150}Nd was measured at 20 different γ-ray beam energies ranging from 7.84 MeV, which is just

above the neutron separation energy, to 12.5 MeV. The (γ,n) cross section for ^{94}Zr was measured at 13 different energies ranging from 8.3 MeV to 12.5 MeV, again with 8.3 MeV being just above the neutron separation energy. Measurements were taken on ^{90}Zr for 7 different energies, from 12.02 MeV to 12.9 MeV.

The analysis of the data for the experiment was carried out. The 42 invdividual runs were analyzed. In addition to the 40 runs for ^{150}Nd, ^{94}Zr, and ^{90}Zr, 2 calibration runs were taken on Au. A run consists of a set of data corresponding to a particular nucleus and beam energy, which is an autonomous unit of data. Given the large volume of data, a set of programs were written to automate the analysis. The programs written allow for the analysis to proceed given a data file, and basic information such as beam energy, with minimal user intervention. This reduces the time required for analysis substantially. Factoring in the total time required to develop the programs, there was only a modest decrease in total time required for analysis. However, the analysis of data for future experiments will require significantly less time.

8. Please add your comments (if any):

Though the research plan called for measurements on ^{142}Nd, the possiblity of measurements on ^{94}Zr presented an interesting opportunity. Though the nucleus is different, the motivation for understanding remains the same. The sub-threshold resonance behavior of ^{94}Zr is unique enough, and important enough for understanding the theory, to warrant a modification of the research plan. ^{90}Zr was studied in conjunction with ^{94}Zr to study the change in resonance behavior with change in neutron number. Plans for making measurements on ^{142}Nd are already being prepared.

RESEARCH REPORT

1. Name: Christopher David Beers （ID No.: SP06003）

2. Current affiliation: Vanderbilt 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: Osaka University

5. Host researcher: Dr. Takashi Washio

6. Description of your current research

Hybrid embedded systems have become prevalent in today's engineering applications. The mixed continuous and discrete behavior inherent in such systems creates complexities that limit the applicability of traditional optimal control techniques, and require research into new theories and analysis methods to build optimal controllers. Moreover, the increasing complexity of such systems has been coupled with their use in safety- and mission-critical applications, creating a need for robust, reliable controllers that meet strict performance specifications.

In many cases, sparse or delayed feedback is available from the environment, such as a reward for meeting a specified goal, or a punishment for violating a constraint. Provided such feedback, much work has been done in the field of dynamic programming to find optimal control policies, and the more recent classes of reinforcement learning and neuro-dynamic programming methods to approximate the dynamic programming solution.

Since determining an optimal control policy using classic dynamic programming techniques is usually intractable, there is a need for viable approximations. Such approximations typically yield a suboptimal policy, yet remain practical for real-world applications. Our research is evaluating the applicability of such various approximate dynamic programming techniques to the design of hybrid embedded controllers.

7. Research implementation and results under the program

Title of your research plan:

Toward Optimal Control of Hybrid Embedded Systems

Description of the research activities:

Dynamic programming (DP), introduced by Richard Bellman in the fifties, is an indispensable tool in the theory of optimal control. DP solves optimization problems by saving the results of sub-problems rather than re-computing them. This technique is ideal for dealing with situations where decisions are made in stages, yet cannot be made in isolation since one must balance the positive current reward with the possible negative future costs.

The main dynamic programming technique used in optimal control is called value iteration. This technique iterates through the state space of the problem, constantly updating the values associated with each state. Over time, the value of each state will converge, and a greedy policy will be optimal. The key result is that after the values have converged, the optimal decision is that which maximizes the expected value of the current state + all future rewards starting from the next state (using the optimal policy). This result applies to both discrete and continuous system (as well as hybrids). In practice, determining an optimal control policy using classic dynamic programming techniques is intractable, due to the enormous size of the underlying state space (Bellman's "curse of dimensionality").

Since optimal solutions are computationally infeasible, there is a need for viable approximations. Such approximations typically yield a suboptimal policy, yet remain practical for real-world applications. This class of techniques is known as approximate dynamic programming (ADP). The key idea of ADP is using function approximators, such as a neural networks, in place of the various functions of the DP solution.

The first portion of the summer was spent sharing our research background with the host lab. After reading through many papers, and conducting several seminars at the host institution, we began investigating possible collaboration points. Our research investigated and evaluated the applicability of several ADP techniques to the design of hybrid embedded controllers, while attempting to integrate aspects of the host lab's data mining techniques, particularly those related to mining quantitative models from massive datasets.

As a result of this collaborative research, we have identified several commonalities between our approaches, and noted future collaboration points.

8. Please add your comments (if any):

I had a great experience in Japan this summer! The language barrier was much greater than I had originally anticipated, and in hindsight studding Japanese prior to the program would have been very beneficial. Additionally, I very much enjoyed experiencing Japanese culture firsthand. I hope to continue studying Japanese after I return to the United States, and will hopefully have an opportunity to return to Japan in the future. Thanks for this amazing opportunity!

9. Advisor's remarks (if any): n/a

RESEARCH REPORT

1. Name: Matthew Berends （ID No.: SP06004）

2. Current affiliation: Northwestern University, Department of Linguistics

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: Kyoto University

5. Host researcher: Yukinori Takubo

6. Description of your current research

The central theme of this linguistics research project is the relationship between sentence structure and word meaning. The project examines two distinct interpretations for *only* and *even* in English, and their correlates in Japanese. These are the *exclusive* and *scalar* readings, and are exemplified (for *only*) in (1).

(1) John only has a ten of hearts in his hand

On the exclusive reading, (1) means that John has no other card but a ten of hearts in his hand. In contrast, the scalar reading conveys that a *ten of hearts* is the highest card John holds, regardless of the number of cards he actually holds. This project addresses whether the above readings are derived from distinct words that happen to share a pronunciation (like the two meanings of *bat*) or whether the difference arises from their context of occurrence. Japanese may offer support for the ambiguity hypothesis, as two different words, *sae* (scalar) and *dake* (exclusive), appear to represent the readings. This research examines the following questions. Is it always the case that *sae* carries the scalar reading, and *dake* the exclusive? Are there particular sentence types that support the readings in each case? If so, what are the relevant properties of those sentence types?

7. Research implementation and results under the program

Title of your research plan:

Sentence Structure and the Meanings of “Even” and “Only”

Description of the research activities:

The Japanese focus particle *sae* has been claimed to have a scalar interpretation when it occurs within the antecedent (*if*-clause equivalent) of a conditional (*if-then* sentence), and a non-scalar interpretation when it appears outside of a conditional. This project’s chief aim was to discover whether *sae* is indeed best described as having two meanings, or whether the apparent divergence in meaning stems from the properties of the constructions in which *sae* appears.

Work on the project proceeded in two steps. The first involved constructing an adequate descriptive account of *sae* ‘s behavior. Accordingly, I reviewed past literature on the topic, put together a database of sentences containing *sae*, and solicited the observations of linguists who are also native speakers of Japanese. A crucial part of the descriptive account involved gathering data on words that are similar to *sae*, in the hope of both generating insights regarding classes of focus particles and illuminating the particular properties of *sae*. Subsequently, I attempted to design a formal compositional account, drawing upon the mechanism of function application to explain how the meaning of *sae* is generated. Ultimately, the data I gathered points toward an explanation in which the scalar meaning of *sae* is present across all contexts. The special reading which *sae* is noted to receive in conditionals, I explain as the result of pragmatic features of the construction, arising in particular whenever the consequent can be understood as a goal of some individual involved the discourse.

RESEARCH REPORT

1. Name: Emilie Bess （ID No.: SP06005）

2. Current affiliation: University of Illinois

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. Shin-ichi Akimoto, Dr. Kazunori Yoshizawa

6. Description of your current research

The bark louse genus *Ptycta* contains nearly 200 described species, only two of which are native to Japan. We have described two new species from Japan, *Ptycta recava*, Bess & Yoshizawa, from central to northern Honshu, and *Ptycta conforma*, Bess & Yoshizawa, which occurs from Okinanawajima to Kyushu. We are redefining the genus *Ptycta* to include only species with a combination of three morphological characters. *Ptycta* has been considered a "holding genus," containing many species that belong elsewhere. The new definition of *Ptycta* will "clean up" the genus, by establishing a basal limit and excluding those species that do not display the distinctive morphology of *Ptycta*.

7. Research implementation and results under the program

Title of your research plan:

Redefinition of *Ptycta* Enderlein (Psocodea: 'Psocoptera': Psocidae) and a Taxonomic Revision of the Japanese Species

Description of the research activities:

During the eight weeks at Hokkaido University, Dr. Yoshizawa and I worked on a manuscript describing the Japanese species in the bark louse genus *Ptycta*. We are naming two new species from Japan and redefining the genus based on newly described morphological characters. We will submit the manuscript to Entomological Science, the journal of the Entomological Society of Japan.

I also accompanied Drs. Yoshizawa and Akimoto on collecting trips in Hokkaido and Kyushu. We collected insects for taxonomic study and photographed the insects for use on the Tree of Life web project.

RESEARCH REPORT

1. Name: Christopher M. Bourke （ID No.: SP06006）

2. Current affiliation: University of Nebraska – Lincoln

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 Institute of Technology

5. Host researcher: Dr. Osamu Watanabe

6. Description of your current research

Computational Complexity Theory is a branch of Computer Science that attempts to establish the inherent difficulty of computational problems via inclusions and separations of complexity classes. Recently, I have worked on two separate topics in this area, time-space lower bounds and average-case complexity.

Time-space lower bounds involve establishing that certain problems inherently require a high amount of computational resources. In this case, we look at simultaneous time and space resource bound restrictions to show that certain problems cannot be solved with various parameters.

The second topic, average-case complexity, attempts to examine a different resource measure; the amount of resources a problem should require “on average.” This research area has fundamental implications for many practical areas of Computer Science including cryptography, VLSI and pseudorandomness.

7. Research implementation and results under the program

Title of your research plan:

Exploring New Directions for Time-Space Lower Bounds and Average-Case Complexity

Description of the research activities:

In my time at the Tokyo Institute of Technology, I've had the opportunity to present my research ideas and current problems to various faculty members. Likewise, they have presented their research as well. This has led to several interesting discussions on both ends, with the possibility of future research topics and perhaps collaborations. Moreover, I was invited to the University of Tokyo (Hongo) to present my research in a regular seminar series.

Daily research activities have included reading and discussing current research papers with my immediate advisor and several other graduate students. I have also made several technical write-ups that have served as continued communication with my own advisor and which may serve as a basis for research papers to come.

In addition, in the course of visiting Dr. Watanabe, I have been presented with two new, very interesting research topics which I intend to continue to work on even after returning to my own country. One of these topics deals with “stringent relativization”, a relatively new idea in oracle relativizing techniques in Complexity Theory initiated by Dr. Watanabe and collaborator, Dr. Cai. The other topic involves improving exponential-time algorithms for NP-hard problems as well as examining the possible limits of such techniques.

Overall, the research experience has been successful. I've managed to explore several new topics for research and establish research relations possibly leading to future collaborations.

8. Please add your comments (if any):

I had a lot of fun visiting Dr. Watanabe and his research group as well as his colleagues. I felt that it was time well spent and will certainly aide me in my current and future research. It has been a valuable experience. I am grateful to Dr. Watanabe, JSPS and NSF for making it possible.

RESEARCH REPORT

1. Name: Adina M. Boyd （ID No.: SP06007）

2. Current affiliation: Rice 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. Eiichi Nakamura

6. Description of your current research

My research focuses on the preparation and characterization C_{60} water suspensions and the investigation of their photocatalytic properties for water treatment applications. Although C_{60} is hydrophobic, via a solvent exchange process it can form stable nanocrystals in water. These C_{60} colloids have been shown to exhibit toxicity towards cells in culture and some lower organisms. However, these materials can also be easily extracted from water by the addition of bleach, or they can be functionalized to reduce their toxicity. Furthermore, there are many potential benefits of having C_{60} available in water in a pristine state especially for medical and environmental applications.

7. Research implementation and results under the program

Title of your research plan:

"Peptide-CNT Conjugates: Effect of Surface Chemistry of Carbon Nanotube Aggregate on Cytotoxicity and Cellular Uptake"

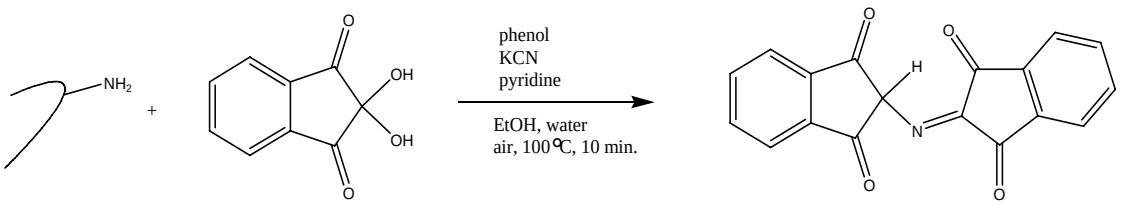
Description of the research activities:

Carbon nanohorns are aggregates or nanoparticle assemblies of short, capped carbon nanotubes. These carbon nanohorn aggregates can be made soluble in water by functionalization with amino chemical moieties. Previously the Nakamura group has characterized the cytotoxicity of the amino-carbon nanohorn aggregates (a-NHA) and found them to be nontoxic, shedding new light on carbon nanotube toxicity. The cytotoxicity of carbon nanotubes has been unclear because many different sample types

can be generated with variations on tube diameter, length, and level of impurities. Amino-carbon nanohorn aggregates are free of the metal catalyst impurities often found in nanotube samples and thus provide an excellent model of carbon nanotube properties in biological environments without the complication of unwanted metals.

In order to extend our understanding of the interactions between carbon nanohorn particles and biological environments, the goal of this project was to generate a-NHA samples with different surface chemistries and submit them for evaluation of cytotoxicity. To assist in detection of chemical modification, the first aspect of the project was to develop an analytical test for the quantification of amino residues on the a-NHA. The Ninhydrin Test is commonly used in solid-phase synthesis to determine the amount of amino groups bound to the resin. Upon reaction with an amino group, ninhydrin generates Ruhemann's purple, a dye easily monitored by UV-vis spectroscopy (Scheme 1).

Scheme 1



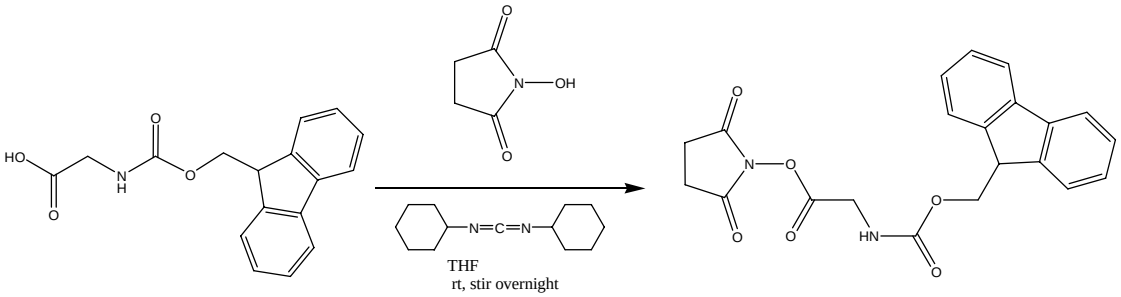
Ruhemann's purple

This objective was successfully completed by adapting the Ninhydrin Test to a-NHA confirming the presence of amino residues (0.2415 ± 0.0932 μmol/mg $–NH_2$/a-NHA) and the results found by two other similar methods (0.102-0.22 μmol/mg $–NH_2$/a-NHA by picric acid and dinitrophenyl based tests).

Interestingly, the established mechanism for the Ninhydrin Test indicates that it should not work with an amino group covalently bonded to a nanohorn aggregate like the a-NHA. Therefore it seems to indicate a greater mobility of amino groups on the aggregate than is typical for organic molecules. This insight could prove useful to future chemistry with these materials.

The second aspect of the project uses peptide chemistry to add amino acid residues to the a-NHA, thereby producing samples with a variety of surface chemistries. The first of these desired products is glycine modified a-NHA. Compound [1] was prepared as the initial step in this process (Scheme 3).

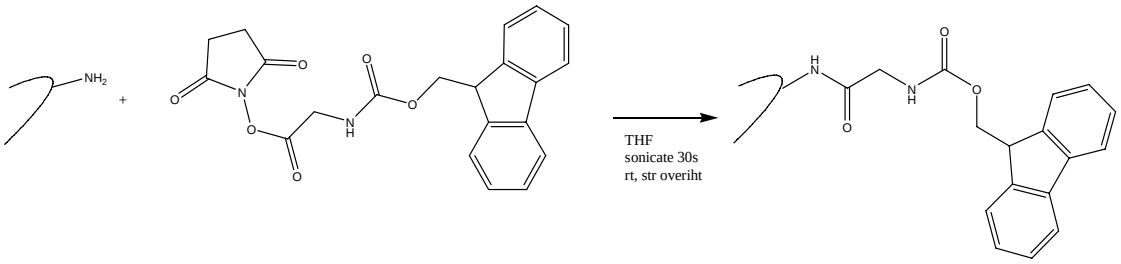
Scheme 3



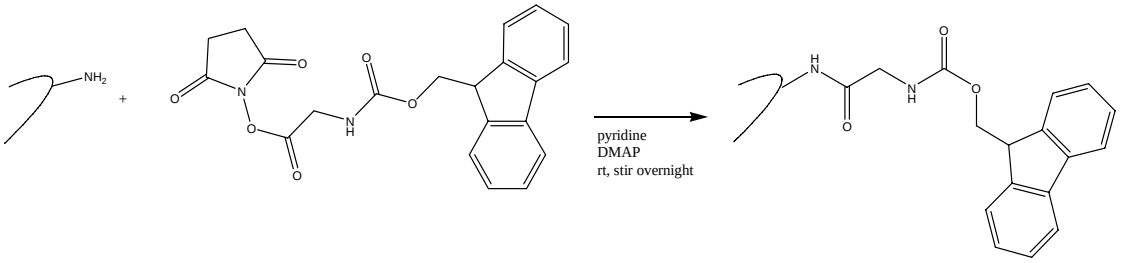
[1]

The addition of compound [1] to a-NHA was performed under a series of reaction conditions. The two best conditions are shown in Schemes 4 and 5.

Scheme 4



Scheme 5



UV-vis spectroscopy confirmed the presence of the desired product for Scheme 4 and tentatively for Scheme 5. Future work will involve further characterization of the products and optimization of reaction conditions for other amino acid a-NHA derivatives.

RESEARCH REPORT

1. Name: Matthew Brandley （ID No.: SP06008）

2. Current affiliation: University of California, Berkeley

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 the Ryukyus

5. Host researcher: Dr. Hidetoshi Ota

6. Description of your current research

One of the most striking examples of a major body plan modification is the repeated evolution of limb reduction within squamate reptiles (lizards and snakes). As walking is the primary means of locomotion for almost all non-avian tetrapods, it may be surprising that limb reduction is not a rare phenomenon among squamates. In fact, limb reduction, here defined as everything from the loss of a single finger or toe bone to complete loss of limbs over evolutionary time, has independently evolved at least 22-28 times within squamates (Wiens, Brandley, and Reeder, 2006). Previous research (e.g., Gans, 1975; Wiens and Slingluff, 2002; Wiens et al., 2006) has focused on some of the evolutionary pressures that result in limb reduction but many other questions currently lack adequately tested hypotheses. Perhaps the most prominent of these is "Why does limb reduction evolve in some groups, but not others?" I.e., what are the morphological and ecological prerequisites of limb reduction? My research focuses on these, and other questions in the lizard genus *Plestiodon*. *Plestiodon* inhabits East Asia and North America and the species differ from each other primarily by pre-sacral trunk length, tail length, and relative limb length. All of these variables have been implicated as morphological features that would be most affected by selection for limb reduction. One species, *P. reynoldsi* has a body plan so radically different from its congeners that it was formerly placed in a separate genus (*Neoseps*). Recent phylogenetic analyses of the family Scincidae conclusively demonstrate its placement deep within North American *Plestiodon* (Brandley et al., 2005; Richmond and Reeder, 2002), however these studies included woefully few Asian species. *Plestiodon reynoldsi* has very short limbs; only a single digit remains on the hands with one or two digits on the foot. The head is

shovel-like with reduced eyes and no external ear opening. All of these are likely adaptations for burrowing in the sandy soil of Central Florida. Because the morphology of *P. reynoldsi* is so distinctive compared to other species in the genus, it provides an opportunity for rigorous testing of the circumstances under which limb reduction is favored. Although *P. reynoldsi* lives in North America, it is critical to include Asian representatives in any analysis for two reasons. First, to study deviations from a "normal" *Plestiodon* morphology, one must define what "normal" really is. The most thorough way to do this is to examine every species, and Asia is home to approximately one-third of *Plestiodon* species. Second, there exist habitats in Japan and China that are favorable to the evolution of limb reduction yet this morphological condition did not evolve. Depending on the outcome of the final analyses, I may be able to elucidate why this *did not* occur and will thus shed light upon why limb reduction *did* occur in the ancestors of *P. reynoldsi*.

Successful completion of these research goals requires two important endeavors, 1) the collection of morphological measurements (such as limb lengths, body lengths, etc.) of all species of *Plestiodon* and 2) determining the evolutionary history ("phylogeny") of the genus using analysis of DNA. A group's evolutionary history results in a certain set of characteristics that constrain the evolution of other characteristics. For example, humans will not suddenly evolve feathered wings because over 200 million years of mammal evolution has the constrained genetic ability to efficiently develop such a structure. In other words, a species' past is the best predictor of its future. To determine why some species evolve limb reduction, then one must also determine the characteristics of its ancestors and relatives.

The multi-continent distribution of *Plestiodon* has impeded extensive study of the group in a single, comprehensive analysis. Furthermore, because one quarter of *Plestiodon* species inhabit Japan, these species are critical pieces in the genus' evolutionary puzzle. The current study represents the first review of *Plestiodon* evolution and phylogeny in 70 years (Taylor, 1935), the first to employ a DNA analysis including both North American and Asian species.

7. Research implementation and results under the program

During my stay at the University of Ryukyus and collaboration with Dr. Hidetoshi Ota, I have used a majority of my time to collect DNA samples from wild *Plestiodon* populations. I successfully captured all Japanese and Taiwanese *Plestiodon* species (Nine species). I have visited nine separate islands throughout the Ryukyus and Taiwan and thus experienced the full range of Ryukyu Island Group biodiversity. Through the course of my fieldwork, I collected general ecological data for each species. I have also collected morphological measurement data for museum specimens in the Okinawa Prefectural Museum and Kyoto University. A rigorous, quantitative analysis of my

results awaits more data, but several qualitative observations can be made. There are three general morphologies, hereafter called “ecomorphs”, that I term terrestrial, semi-fossorial, and fossorial. These three ecomorphs differ primarily in the length of their body and limbs. The terrestrial ecomorph is by far the most common and is strikingly similar in species in both North America and Asia. Curiously, all species inhabiting Japan, China, and Taiwan are terrestrial ecomorphs. With the inclusion of preliminary phylogenetic information, it appears that the terrestrial ecomorph evolved very early in the group and that other ecomorphs evolved from this ancestral body plan. Why these other two ecomorphs are restricted to North America deserves further analysis.

In addition, my work in Japan has been a valuable cultural experience as I have had the opportunity to interact with many Japanese scientists including graduate students and professors. Besides trading scientific interest, I have also learned much about Japanese customs and language. I hope to continue these professional relationships so that I may pursue more collaborative research in the future.

Title of your research plan:

Limb reduction, morphological determinism, and tempo of phenotypic change in squamate reptiles.

Description of the research activities:

My activities primarily consisted of conducting fieldwork in many areas of the Japanese archipelago in order to collect DNA samples and record ecological data for every species of *Plestiodon* in Japan. This was successfully accomplished through the help and expertise of my host, Hidetoshi Ota, and his graduate students that assisted me in the field. My second primary task was to collect morphological measurement data from museum specimens in the Okinawa Prefectural Museum and Kyoto University. I was able to collect data from hundreds of specimens not available in museums in the United States.

8. Please add your comments (if any):

I wish to emphasize that my entire PhD research program would be impossible without the generous assistance of the JSPS and NSF. Not only would I not have funding for fieldwork (I spent approximately ¥700,000 on travel and associated research expenses), but I otherwise would have little opportunity to interact with Japanese researchers. It was truly a wonderful and educational experience.

RESEARCH REPORT

1. Name: Nicholas John Butko （ID No.: SP06009）

2. Current affiliation: University of California, San Diego

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: ATR (Advanced Telecommunications Research)

5. Host researcher: Michael Lyons

6. Description of your current research

My field can broadly be described as Artificial Intelligence. I research ways to make intelligent computational agents and robots that have to operate in the uncertainty and constantly changing real world. To this end, I have previously developed a system that learns to do visual classification tasks simply by interacting with the environment. By forcing a robot to learn in its environment, we can assure that whatever will be learned will be appropriate for that environment, and it will necessarily operate effectively in the real world (outside of the laboratory).

This summer I have been considering the problem of social interaction, in which the world is especially uncertain, changing very rapidly, and timing is critical. Humans are good at "reading the minds" of other humans – discerning when they are interested or bored, and finding the optimal way to engage their social partners. This summer, we began to investigate ways in which the techniques of machine learning, computer vision, and reinforcement learning could be combined to address this difficult problem.

My research spans many fields. The theory behind our dynamic learning models is very mathematical, relying on mathematics from the fields of statistics, linear algebra, and calculus. To learn from the world, we use techniques developed in Artificial Intelligence. To interact with a dynamic world, we use techniques developed for cybernetics, and improved by the motor control and reinforcement learning communities. The approach is inspired by the abilities and properties of biological and neurological systems. The results are validated using a psychophysics style approach. This is truly interdisciplinary research, true to the spirit of the field of cognitive science.

7. Research implementation and results under the program

Title of your research plan:

Learning to Interact: observer-attention cued reinforcement learning.

Description of the research activities:

The goal of this project was to optimize the “interest” of an animated avatar. That is, we wanted to use Machine Learning techniques to make something as interesting as possible to observers. The animated avatar had a set of routines that it could perform. The task was to choose the routine at any moment in time that would keep the observer watching. Such a task is ideally suited to the technique of “reinforcement learning,” where the reward is based on the time spent attending to the animated avatar. Computer vision systems were used to determine whether or not a subject was looking at the character, as well as other properties of the observer’s behavior. From this data, a “transition model” was learned. That is, the system learned to predict the state of the near future, based on the present. Based on this model, reinforcement learning techniques determined the causal chains that would cause the observer to be most likely to keep observing the stimulus, and the animated avatar performed routines accordingly.

8. Please add your comments (if any):

The JSPS summer program was extremely valuable for me. I began a very interesting line of research that will be very useful for my Ph.D. thesis, which I was able to do because of the computer vision and animation tools available at my host laboratory. I also learned many valuable things about researching and living in Japan. I even joined a Go club and have become much stronger at the game of Go since I have been in Japan. The stipend provided was just right to cover living expenses including the cost of housing and commuting.

9. Advisor’s remarks (if any):

Soon after his arrival, Mr. Butko took an active role in determining how best to apply his skills to a project of mutual interest. We settled on the groundbreaking problem of applying re-inforcement learning techniques to interactive animated characters. Mr. Butko implemented a working learning algorithm and conducted preliminary experiments with the system. The work will result in at least one conference publication, and possibly a journal publication – a good outcome for such a brief internship, reflecting Mr. Butko’s strong talents and high level of motivation.

RESEARCH REPORT

1. Name: Lisa A Capriotti （ID No.: SP06010）

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

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: Nara Institute of Science and Technology, Graduate School of Materials Science

5. Host researcher: Masao Tanihara

6. Description of your current research

Surface modification can imbue tissue scaffolds with precise biological functionality. Scaffolds may be rendered to carry drugs, to be biomimetic, or to recruit cell adhesion and differentiation. We are developing peptides which function as ligand-delivery vehicles that bind specifically to hydroxyapatite (HA, the mineral component of bone) for the modification of bone and bone-like implants. Peptides carrying ligands intended for cell receptors are designed to be unstructured (inactive) in physiological solution, but undergo a folding transition upon binding to the surface of bone, thereby adopting a bioactive conformation which directs ligands away from the surface. This peptide-based ligand-delivery mechanism has many benefits which include 1) localized drug delivery to calcified tissue with limited diffusion, 2) increased drug half-life and retention, and 3) amenability to low-molecular-weight and water-soluble drugs. The focus of the present study will be to design peptides which display ligands that can initiate cell differentiation only upon binding to HA. First, peptides will be designed which combine an HA-binding peptide with peptides that initiate osteoblastic differentiation. Next, differentiation will be monitored using mRNA detection and alkaline phosphatase activity.

7. Research implementation and results under the program

Title of your research plan:

Surface-Induced Peptide Folding as a Potential Tool in Bone Repair

Description of the research activities:

Bone-like hydroxyapatite coatings were deposited on cell-culture treated cover slips by a biomimetic process from concentration simulated biological fluid at 36.5 °C. This hydroxyapatite coating was characterized by X-ray diffraction to verify the composition and scanning electron microscopy to analyze the morphological character. The hydroxyapatite binding peptide, HAB3, was synthesized by automated solid-phase peptide synthesis. Binding of the purified peptide to hydroxyapatite was ascertained and the cell-differentiating peptide, BFP4, was conjugated to the free amines of the HAB3 peptide while bound to the hydroxyapatite coating. Mesenchymal stem cells were cultured on HAB3-BFP4 coated hydroxyapatite deposited on cover slips. Osteogenic differentiation was analyzed using alkaline phosphatase staining and reverse transcription polymerase chain reaction of osteocalcin mRNA.

8. Please add your comments (if any):

This research experience has been a wonderful opportunity to interact with Japanese scientists and to learn new research techniques that are not currently practiced in my laboratory.

RESEARCH REPORT

1. Name: James F. Carroll III （ID No.: SP06011）

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: The University of Tokyo

5. Host researcher: Professor Masaru Miyayama

6. Description of your current research

The material's system sodium potassium bismuth titanate (NKBT) exhibits complex and intriguing dielectric and ferroelectric properties that may enable the next generation of Pb-free piezoelectrics for medical ultrasonics. Previous work identified a processing route that produced dense, insulating, and stoichiometric ceramics suitable for reliable measurements. Dielectric analysis revealed two distinct regions as a function of temperature: [1] a low-temperature, frequency dependent "relaxor" region and [2] a high-temperature, diffuse, but frequency independent region. Ferroelectric and anti-ferroelectric behavioral characteristics have been identified as a function of temperature, but the effects of electric field (phase switching and cooling effects) on these characteristics have not been studied for the system. Investigations on the effects of electric work on the frequency in/dependent regions and the development of a thermodynamic stability model for competing ferroelectric and anti-ferroelectric phases are proposed.

7. Research implementation and results under the program

Title of your research plan:

Electric-Field Effects on the Properties of Sodium Potassium Bismuth Titanate Ceramics

Description of the research activities:

Completed investigations include the high temperature: dielectric spectroscopy, electric field induced strain characteristics and xray diffraction. The completion of high temperature spectroscopy allowed for observations of polarization mechanisms at several key characteristic regions. Field induced studies indicated competitive properties that may serve as a potential lead free system in the near future. Complementing dielectric studies with a structural investigation allowed for identification of ideal working temperature ranges for potential actuation applications and development of a thermodynamic phenomenological model.

RESEARCH REPORT

1. Name: William Chen （ID No.: SP06012）

2. Current affiliation: Harvard University, Department of Biophysics

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: Dr. Kunihiko Kaneko

6. Description of your current research

Tissue data obtained from microarrays were decided to be unsuitable as a basis for a detailed theoretical and computational study of gene expression dynamics, due to substantial known and uncontrollable artifacts. Instead, the research goal was given a more theoretical orientation: what are the general, statistical properties of transcriptional networks that give rise to multistable behavior? To this end, two approaches were brought to bear upon the question. The first approach is the development of computer code for the simulation of dynamics on two fronts: the dynamics of the realization of one random, transcriptional network (the gene expression dynamics), and the dynamics of "evolution" of these networks to acquire the desired multistability (the evolutionary dynamics). We investigated appropriate mathematical formulations of upregulation and downregulation couplings in transcriptional networks, maximum connectivity to any one *in silico* "gene", a fitness function that could capture fitness due to multistability, and other issues in creating a simple, but non-trivial, representation of a transcriptional network. The second approach to understanding multistability was a purely theoretical one. The research concerning the theoretical dynamics of spin glasses with asymmetric couplings was used as a formalism for describing the dynamics of transcriptional networks. In this mapping between a transcriptional network and a spin glass, the following correspondences were made: continuous spin value of one spin represents the gene expression level of one gene, couplings between spins represent the upregulatory or downregulatory effect between two genes, the Langevin formulation of spin glass dynamics was used to represent dynamics of a network of genes stochastically affecting each other in time.

7. Research implementation and results under the program

Title of your research plan:

Dynamics, quasi-stable states, and tissues in human gene networks

Description of the research activities:

Within the last two months, the code for evolving small networks with asymmetric couplings was written and used to evolve a variety of networks with one, two, or three stable states. The size of the networks was restricted to a maximum of 15 nodes, each representing a single gene. The evolution of multistable networks involves running long-time dynamics trajectories to explore the stable states of a network, modification of said network with a new attribute, calculation of the fitness function value, and survival or death of organism with the new attribute. Each evolutionary step involved the addition or subtraction of an upregulatory or downregulatory edge between any two genes. Resulting evolved networks were examined visually by the *dot* graph display language, and also by statistical methods. It was found that as the number of stable states in the target fitness was increased from one to three, the difficulty in finding networks also increased. Furthermore, it was found that multistability arises most generally through a very intuitive process: the network fragments into small clusters, each cluster being highly connected within by cross-activating couplings. This leads to each cluster representing each one of the stable states in the target fitness function. In order for each cluster to be activated while the others are not, cross-repression from any cluster to any other cluster also evolved naturally.

Some progress was also made on the theoretical description of transcriptional networks with asymmetric couplings. While the correspondence between the computational networks and the spin-glass type networks are inexact, it is expected that the results from the latter would provide physical insight into understanding the former, even if the understanding would be coarse. A diagrammatic technique known as the MSR technique (Martin-Siggia-Rose) for describing noisy dynamics was solved for simple one-body cases. Further work remains contingent upon extending the MSR technique to the many-gene case, and computing perturbative expansions for the case of the many-gene and many-coupling case. This technique is complemented by a related Langevin theoretical apparatus, in which the propagator for an asymmetrically coupled system can be solved exactly (upon to an integral). A systematic perturbative expansion, however, has thus far not been found. What is desired is a general, physical understanding of how dynamics proceeds to the stable states depends upon the coupling matrix between the genes.

RESEARCH REPORT

1. Name: Carolyn Conlee （ID No.: SP06013）

2. Current affiliation: Drexel 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: Tokyo University

5. Host researcher: Professor Ikuo Towhata

6. Description of your current research

Earthquakes can cause catastrophic damage to seismically active regions worldwide. One major cause of damage can be attributed to soil liquefaction. When a soil is subjeced to seismic shaking, a build-up of excess pore water pressures may occur resulting in liquefaction. This phenomenon causes a sudden loss in strength and stiffness of the ground. Case histories in developed areas have shown excessive settlement, tilting, and collapse of structures due to earthquake-induced liquefaction and in the past, have affected structures such as buildings, bridges, earth embankments, and retaining walls.
Traditional ground improvement techniques commonly used today are not feasible in developed areas and therefore, a relatively new concept, termed passive site stabilization can serve as a potential mitigation strategy for stabilizing the ground at developed sites, prevent earthquake induced liquefaction from occurring, and subsequently, protect overlying structures. Passive site stabilization is based on the concept of slow injection of a stabilizing material through the subsurface at the edge of a developed site. The stabilizer solution is then transported through the subsurface by natural or augmented groundwater flow to reach target locations that are susceptible to liquefaction. Once the stabilizer solution reaches the desired location, it gels to stabilized the formation. The stabilizing material for this technique must have a low, initial viscosity with controllable gel times so that when injected, it can flow into the liquefiable formation for a sufficient amount of time to reach the target location. In addition, the solution should also be permanent, non-toxic, and cost-effective. My current research in this area focuses on a particular potential stabilizer solution called colloidal silica. Laboratory, bench-scale, and centrifuge testing from various researchers have all demonstrated the ability of dilute

colloidal silica to mitigate the liquefaction potential of loose sands and to significantly reduce the settlement in treated sands subjected to simulated earthquake shaking.

In geotechnical earthquake engineering, model testing is essential for gaining an understanding on soil behavior because the prototype behavior is complex. Furthermore, acquiring relevant and sufficient data from a real earthquake event is extremely difficult and sometimes impossible. For example, shaking table testing can overcome the limitation of case history studies where subsurface deformations are impossible to observe. When soil behavior under earthquake loading is better understood through such model tests, mitigation techniques can be more effectively modified to optimize ground improvement and help protect surrounding structures.

7. Research implementation and results under the program

Shaking table test for the Analysis on Dynamic Failure Response of Liquefiable Slopes and its mitigation by colloidal silica

Under this research program, a shaking table test was conducted at the University of Tokyo to study the effects of a loose, saturated sand treated with colloidal silica. The purpose of this study was to gain an understanding of the basic failure mechanisms of a sandy slope to model an earth embankment undergoing liquefaction from simulated earthquake shaking and to compare the response with a partially treated slope using colloidal silica.

The model consisted of two slopes of loose, saturated Toyoura sand with a relative density of 40%. The slopes were both inclined at an angle of 21 degrees and of approximately equal length (100 cm), width (40 cm), and height (40 cm). The improved sand zone was located at the toe of one of the slopes inclined at 21 degrees with a length of 37.5 cm and a height of 15 cm. The geometry of the treated zone was chosen to study the effects when approximately 1/3 of the slope is treated. The improved sand zone was prepared as a mold in a small, separate container. The container was first filled with 6.5 wt% colloidal silica solution and Toyoura sand was then slowly poured into it to achieve an overall density of approximately 40%. The colloidal silica solution used in this study required approximately 28 days for curing to achieve its maximum strength. Therefore, the treated sand mold was prepared 4 weeks prior to testing. After curing, the mold was cut out of the box, placed in the shake table box, and trimmed to the appropriate geometry. During placement of the slopes in the shake table model, a grid pattern was employed along the cross section of the model using colored sand in order to study the deformation and displacement of the liquefied sand through visual inspection. In addition, instrumentation was installed throughout the model to monitor pore water pressure and acceleration as a function of time. One laser transducer was also placed at the

top of each of the slopes to monitor lateral displacement as a function of time. Once the preparation of the model was completed, lateral shaking was subjected to the model by increasing the acceleration from 0 to 500-Gal (or 0.5g's) at a frequency of 10 Hz for 48 seconds.

Based strictly on visual inspection, it appears that the geometry of the improved sand zone was insufficient to show any significant evidence of improvement. The marked grid-lines that were placed during model preparation moved both laterally and vertically during shaking for both slopes. It was observed, however, that the colloidal silica sand mold experienced no displacement both during and after shaking. As was expected, the treated sand block did not undergo liquefaction. Furthermore, lateral spreading at the toe of the slope was reduced from about 5 cm to 0 cm for the improved slope. Lateral spreading was also reduced near the treated area by approximately 7cm (a distance of 1/3 from the toe of the slope). On the other hand, data recordings from the laser transducers that were placed at the top of each of the slopes indicate that the lateral displacement at this location was about the same (18 cm). Maximum vertical displacement at the top of each of the slopes were also about the same (10 cm) based on visual inspection. It appeared during shaking that liquefaction first occurred at the top of the slopes and failure was initiated at this same location. Failure was mainly observed as lateral spreading with subsequent vertical displacement due to gravity. The untreated slope deformed uniformly throughout as a combination of vertical downward movement and lateral movement towards the toe of the slope. On the other hand, deformation for the treated slope was non-uniform. Due to the fact that the treated sand zone near the toe of the slope did not displace during shaking, the colloidal silica mold acted as a solid block and prevented lateral movement from occurring at this location. As a result, deformation occurred as a combination of downward movement, lateral movement towards the toe of the slope, and vertical upward movement as the displaced material from the top of the slope approached the treated sand zone.

Extensive data analysis, including results of pore water pressure and acceleration as a function of time, has not yet been explored. It is anticipated that data analysis may give insight into basic failure mechanisms and reveal the relative contributions of pore pressures due to: (1) liquefaction; (2) static shear stresses/strains of soil particles due to shaking; (3) cyclic dilatancy and contraction of the soil due to cyclic loading and (4) collision forces of the liquefied sand with the unliquefied, colloidal silica sand block. In addition to pore pressure data, acceleration time histories will provide more accurate and detailed information regarding displacement within the slopes as a function of cyclic loading and time. Finally, it will be interesting to explore different geometries of treated sand zones for slopes in similar shaking table tests in the future. For example, in addition to treating the toe of the

slope as a single sand-block, a series of treated vertical columns along the slope may be a more effective mitigation strategy. Much research is still needed for this particular application and this will include model testing (e.g. centrifuge and shaking table) and field testing using colloidal silica in a similar manner.

RESEARCH REPORT

1. Name: Benessa Marie Defend （ID No.: SP06014）

2. Current affiliation: University of Massachusetts Amherst

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: Kyushu University

5. Host researcher: Dr. Sozo Inoue

6. Description of your current research

My research involves using anonymous credentials with biometric authentication in RFID-enabled cell phones. RFID (Radio Frequency Identification) is used as a contactless form of authentication for various applications such as toll payment, credit cards, and building access. Modern transit passes, such as the JR Suica card, also use RFID. Common forms of biometric authentication include fingerprints, facial recognition, and retina scans.

Some models of RFID-enabled cell phones have embedded fingerprint readers to authenticate the owner. The fingerprint scanner could be used to authorize transactions made with the cell phone, such as entering a transit system or a company office building. Anonymous credentials allow a person to authenticate herself without revealing identifying information, e.g. a transit agency will know that a person with a valid pass entered the subway, but it will not know her identity. Also, anonymous credentials do not allow the agency to identify that different trips were made by the same person. Biometric authentication can be used to activate the process of showing an anonymous credential without revealing the biometric data itself. For example, an employee might want to enter an office building without revealing sensitive personal information, such as her fingerprint. We explore techniques that allow a person to anonymously prove that she is authorized to gain access to a resource without actually revealing her biometric data to the organization.

7. Research implementation and results under the program

Title of your research plan:

Biometric Authentication with Anonymous Credentials for Cell Phones

Description of the research activities:

I surveyed multiple anonymous credentials systems, which are used to allow a person to access a resource without providing personally identifying information. There are two systems that may be useful for mobile phone applications. The first is based on the strong RSA assumption and requires proofs of knowledge that may exceed the computational abilities of current mobile phones. The other system uses elliptic curve groups with bilinear maps, and does not involve the same computationally expensive proofs of knowledge as the first scheme. However, calculating elliptic curve groups and efficient bilinear map functions may be beyond the current capabilities of mobile phones.

My project involves implementing an anonymous credentials system in a mobile phone environment, which has limited computational resources and memory. We used NTT DoCoMo F902iS and F902i phones, which have embedded fingerprint scanners and run Java 2 MicroEdition "J2ME," which is a less robust Java platform designed for mobile devices. Although it is possible to perform cryptographic calculations, it is unknown whether it is possible to compute elliptic curve groups and bilinear maps in the J2ME environment, or if these phones are capable of RSA cryptography. We investigated utilizing a gateway device to perform computationally expensive operations, e.g. elliptic curve functions, and send the results back to the phone or forward them to the server on behalf of the mobile phone.

The phones we used also contain embedded RFID FeliCa tags. I wrote programs to utilize the FeliCa functions of the phones, and to authenticate scanned fingerprints and identify previously stored fingerprints. These programs will serve as a basis for full implementation of the anonymous credentials system.

8. Please add your comments (if any):

8 weeks is not nearly enough time to begin and conclude an in-depth research project. Much of my time was spent familiarizing myself with the technologies available only in Japan. Japanese cell phones are much more advanced than phones in the United States; they have more features and capabilities, such as fingerprint scanners and embedded RFID tags. This summer gave me the opportunity to learn more about Japanese mobile phones, the mobile phone software development process, and RFID reader software. I can now

share this knowledge with my lab at UMass, and our labs plan to continue our collaboration on a long-term basis.

9. Advisor's remarks (if any):

In Ms. Defend's stay in our lab, she introduced the advanced concept of information security and privacy called "anonymous credentials" to our lab. Massachusetts, including UMass, is one of the most advanced spots of information security research in the world. The idea she introduced implied the idea of the next generation mobile phone applications.

She also adapted herself well to the laboratory circumstances, and the students in our lab have affected well toward international researchers. This must be a trigger to a long-term collaboration.

RESEARCH REPORT

1. Name: Andrew DICK （ID No.: SP06015）

2. Current affiliation: University of Maryland

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 Tsukuba (and AIST)

5. Host researcher: Professor Hiroshi YABUNO (and Dr. Masaharu KURODA, AIST)

6. Description of your current research

Atomic force microscopy (AFM) is a relatively new imaging technology that can be used to examine the surface of an object with nano-scale precision. This method has advantages over scanning electron microscopy (SEM) because it can operate at atmospheric pressure and can be used to easily study non-metallic objects, such as organic material. This technology is used in many different fields of research to study many different types of materials including minerals, plants, and other biological matter. By using a micro-scale cantilever probe, AFM utilizes the affects of the interaction forces between the sample surface and the probe to discern the surface characteristics of the object. One method of operation called “tapping” mode AFM requires that the cantilever probe come in contact with the sample surface once per cycle. This introduces a nonlinearity into the system in the form of a discontinuous force. The presence of this nonlinearity can cause the cantilever to experience various types of unique behavior. While “tapping” mode AFM allows for the study of biological materials much more readily than other methods, there still exists the possibility that collisions between the probe and the sample surface may occur with large enough impact velocities to damage a delicate biological sample. Optimal conditions for this manner of AFM operation would correspond to zero velocity contact between the sample surface and the probe, an event called *grazing*. The focus of this research is to develop a method that will minimize the magnitude of the contact force to produce near grazing behavior. By study the nonlinear phenomena of this system, a method must be developed to determine precisely when impacts begin to occur by using the measurable behavior of the probe.

7. Research implementation and results under the program

Title of your research plan:

Utilizing response bifurcation to locate grazing in atomic force microscopy

Description of the research activities:

The initial stage of this work consists of the development of an analytical model of the system. The system is modeled as a nonlinear beam using a discontinuous force to represent the collisions that occur between the probe and the sample surface. The spatial dependence of the model is eliminated by assuming that the spatial behavior can be represented by a combination of a number of profiles that are characteristic of the structure. The resulting equation, which is only a function of time, is then used to numerically simulate the system's response for a number of operating conditions. The system model and the results of these simulations are then analyzed. By using an excitation frequency of slightly more than the first characteristic frequency of the structure, the simulation results suggest that very little difference can be seen when comparing non-impact and impact results. This excitation condition, which is currently used by AFM operators, results in only a small change in the magnitude of the response when impacts occur. Further analysis reveals that for some excitation frequencies between the first and second characteristic frequencies of the structure, the occurrence of impacts is accompanied by a dramatic change in behavior. While the response of the beam repeats with the same periodicity of the excitation prior to the occurrence of impacts, in the presence of impacts the response requires twice as much time as the excitation to repeat. This 'period-two' behavior can easily be observed in the displacement time series. When the frequencies components of the data are examined, a new peak at half the excitation frequency also indicates the presence of the period-two behavior. Since a very dramatic change is seen in the behavior for this higher excitation frequency when impacts occur, the experimental work focuses on verifying these results.

Because of the difficulty in observing the behavior of the micro-scale AFM system, experiments are initially conducted with a larger macro-scale experimental apparatus. This device, designed to be about one thousand times the size of the AFM system, allows for much easier observation of the system's behavior. The macro-scale test apparatus is configured to study the systems response to impacts with 'soft' material and excited under conditions comparable to the AFM system. A high resolution manual stage is used to position the contact surface relative to the beam and laser displacement sensors are used to monitor the response. Experiments are conducted with excitation frequencies inspired by the simulation results. Analysis

of the data collected reveals the predicted period-two behavior in the case of the higher excitation frequency, supporting the results of the numerical simulations. Data from different stage positions is analyzed to study how the response changes as the sample surface is positioned closer to the cantilever probe for impact behavior.

Following a series of experiments with the macro-scale test apparatus, additional experiments are conducted with an atomic force microscope at an AIST laboratory in Tsukuba. The time series of the AFM probe's response is recorded for a number of different operating conditions. By positioning the sample stage incrementally closer to the probe, changes in the behavior of the probe can be studied for the two excitation frequencies of interest. As predicted by the numerical simulation and the macro-scale experiment, period-two behavior is observed for the higher excitation frequency when the probe begins to impact the sample surface. Different materials are examined using the atomic force microscope. While examining a soft rubber material proves to be fairly difficult when using the normal operating procedure with an excitation frequency slightly greater than the system's first characteristic frequency, the response for the higher excitation frequency displays the period-two behavior as soon it comes in contact with the sample. The results of this research suggest that by using a higher excitation frequency and monitoring the appropriate frequency component, it will be possible to determine when the probe come in contact with the sample material more effectively than the method currently used.

8. Please add your comments (if any):

Base on this work, a control method has been proposed to monitor the unique behavior and promote near grazing behavior for tapping mode AFM. This work will be continued following the Summer Institute program. Plans also exist to produce a journal paper detailing the work of this research project.

RESEARCH REPORT

1. Name: Masao Jerome Drexel （ID No.: SP06016）

2. Current affiliation: San Jose 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: University of Tsukuba

5. Host researcher: Professor Shuichi Miyazaki

6. Description of your current research:

This research investigates the effect of crystallization temperature on the thermo-mechanical properties of sputter deposited Ni-Ti microtubes. Due to its large recovery strain and force, the Shape Memory Alloy (SMA) Ni-Ti is a promising candidate material for actuation in Micro-Electro-Mechanical Systems (MEMS). First, however, a reliable processing technique must be found for producing complex geometry Ni-Ti films. This project utilized a novel technique for the sputter deposition of nominal 100μm inner diameter microtubes and demonstrated their themo-mechanical properties after crystallization at a range of temperatures. Further, the post crystallization microstructures were observed and related to the materials thermo-mechanical behavior.

7. Research implementation and results under the program

Title of your research plan:

High Temperature SMAs, Nitinol Thin Films, and Ni-free SMAs for Biomedical Applications

Description of the research activities:

Thin films of Ni-Ti were deposited onto nominal 100μm outer-diameter Cu wires. During deposition a fixture was utilized that rotated the Cu wire at 15 RPM to facilitate even coverage. Ti chips were placed onto an equiatomic Ni-Ti sputter

target to obtain the desired tube composition. A tube composition of Ti-51.5at%Ni was obtained.

After deposition, the Cu wires were etched out of the tube cores using a nitric acid etching solution. An average inner diameter and wall thickness of 105μm and 7μm, respectively, were obtained. To reduce oxidation during heat treatment the tubes were encapsulated in quartz tubing backfilled with argon gas. One-hour heat treatments were performed at 400, 450, 500, 550, 600, and 700°C. The tube transformational and mechanical properties were characterized with a Thermo-Mechanical Analyzer (TMA). Strain-temperature and stress-strain plots were constructed to evaluate the tubes shape-memory and superelastic properties.

Tube properties were found to be strongly dependent on crystallization temperature. No transformation was observed after heat treatment at 400°C indicating that crystallization had not occurred. Heat treatment at 450 and 500°C resulted in a two-stage transformation, suggesting the presence of Ni-rich precipitates straining the lattice and stabilizing the intermediate R-phase. The austenite-to-martensite transformation temperature was higher after heat treatments at 450-600°C further supporting the existence Ni-rich precipitates, which increase the transformation temperature by depleting Ni from the surrounding matrix.

To determine the underlying structural changes taking place the post crystallization microstructure was investigated using Transition Electron Microscopy.

To accomplish this, thin films with similar processing conditions and composition were deposited, crystallized and jet polished. Indeed, the microstructure of the films crystallized at 450 and 500C showed evidence of Ti_3Ni_4 precipitates within the grains and high levels of strain. Heat treatment at 600 and 700C resulted in a course precipitate structure outside the grains and relatively strain free grain interiors.

8. Please add your comments (if any):

I would like to thank JSPS, the NSF, and my host, Professor Shuichi Miyazaki, for making this opportunity possible.

9. Advisor's remarks (if any):

Mr. Masao J. Drexel's performance and research results in my laboratory are

excellent, both being more than my expectation. Since his research results reveal systematic accumulation of data and originality, I am encouraging him to write a manuscript on his results to submit to an international scientific journal.

RESEARCH REPORT

1. Name: Robert Fairchild （ID No.: SP06017）

2. Current affiliation: Georgetown 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

5. Host researcher: Dr. Susumu Kitagawa

6. Description of your current research

My research involves the utilization of the organometallic species Cp*Ru- in a variety of applications that result from this species high affinity for arene species. The recent discovery by our group of a facile water-based metalation technique has afforded routes to a variety of new materials previously inaccessible. $Cp^*Ru(arene)^+$ complexes are highly robust sandwich complexes that can easily be demetalated in the presence of UV radiation and appropriate solvent. The radioactive isotopes of Ruthenium make this compound particularly amenable to imaging and targeted radiotherapy applications. This property, combined with its high arenophilicity and ability to metalate in water, make it ideally suited for biomolecular tagging. Cp*Ru- has also been utilized in numerous catalytic applications and its use in coordination polymers for “catalysis within framework” type chemistry is being explored.

7. Research implementation and results under the program

The synthesis of coordination polymers utilizing Cp*Ru- moieties was attempted using evaporation, vapor diffusion, base vapor diffusion, liquid diffusion and solvothermal (45°C and 120°C) methods. From this, 110 combinations of ligands, metals, peroxide and various crystallization techniques yielded ~16 x-ray quality crystals. Due to time constraints involved with x-ray analysis, ~ 8 of these crystals were run and their structures solved. Two of the eight crystals were redundant structures (determined by unit cell similarity and chemical composition) and two other crystals were the zwitterionic forms, Cp*Ru[η6-(3-carboxybenzoic acid)] and Cp*Ru[η6-(3,5-dicarboxybenzoic acid)], of the each ligand only (previously undetermined).

Crystals **125 - Cd[Cp*Ru(η^6-Isophthalate)]$_2$·(H_2O)$_6$** and **133 - Cd[Cp*Ru(η^6-Terephthalate)]$_2$·(H_2O)$_6$**, were determined to be 2D and 3D (interpenetrated) coordination polymers respectively. Although the structures incorporate ligands with rigidly different angular preferences, striking similarities exist. In both structures the organometallic sandwich moieties prefer to sit face-to-face, with the Cp* moieties in contact with each other (plane-to-plane distances **133** = 3.75 Å, **125** = 3.56Å). Both structures were determined to have identical unit cell stoichiometries including solvent molecules. The incorporation of 4,4'-bipyridine lead to crystals **[Co(Cp*Ru{η^6-Trimesate})(4,4'-Bipyridine)]·(H_2O)$_x$·(DMF)$_x$ (118)** and **[Ni(Cp*Ru{η^6-Trimesate})(4,4'-Bipyridine)]·(H_2O)$_x$·(DMF)$_x$ (115)**. These crystals are isostructural, demonstrating small angular differences due to the incorporation of Co^{2+} and Ni^{2+} respectively (both P-1). The extended hydrogen-bonding network forms square grids in which bipyridine and **2** occupy each side adjacent sides. The packing in these two structures takes advantage of both Cp*-Cp* and arene-arene interactions with **118** giving 3.77Å, 3.36Å and **115** giving 3.74Å, 3.21Å respectively.

Although these structures are not of any particular interest, important conclusions can be drawn about the behavior of the metalated ligands. Firstly, the stability of the ligands has been clearly demonstrated with no decomposition or demetalation occurring. Secondly, unlike the non-metalated precursors terephthalic, isophthalic and trimesic acids, the $^+1$ charge associated with the Cp*Ru- moiety effectively changes the ligands to -1, -1, and -2 in their fully deprotonated state, respectively. This has implications in the charge balancing that is necessitated when designing coordination polymers. For example, **125** and **133** fully saturate the Cadmium centers and result in a crystal that is absent of anions, which would not be the case if, the Cp*Ru- was not present. Lastly, these ligands have a clear face-face stacking preference. With these factors in mind, the design of more interesting coordination polymers that incorporate the Cp*Ru(η^6-arene)Cl is possible.

Title of your research plan:

Investigation of Cp*Ru(arenes)$^+$ as Ligands in Coordination Polymers

Description of the research activities:

Organometallic synthesis (glove box) of Cp*Ru- precursor

Metalation of various di- and tri- arenecarboxylates

Synthesis of coordination polymers (crystals suitable for characterization)-

Hydrothermal, Base diffusion, Vapor Diffusion and Evaporation

Characterization of materials utilizing-

NMR, X-ray crystallography, Sorption analyzer, Powder XRD, Thermogravometric Analysis and other techniques.

Compilation and analysis of data

Presentation at local materials science conference

RESEARCH REPORT

1. Name: Megan C. Fencil （ID No.: SP06018）

2. Current affiliation: The University of Texas at Austin

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: Maizuru Fisheries Research Station; Kyoto University

5. Host researcher: Dr. Yoh Yamashita; also assisted by Dr. Reiji Masuda (experimental guidance); Dr. Masaru Tanaka (arrangement of host institution)

6. Description of your current research

For many fish species, the number of individuals surviving the settlement stage is correlated to the eventual abundance of juveniles or adults in a given year class. Because juvenile recruitment depends upon survival during larval settlement, it would be useful to understand factors that contribute to variability in settlement. Larval fishes generally suffer extremely high mortality rates due to predation, starvation, environmental stress, and advection away from suitable habitat. Along the coast of Texas, seagrass beds are known to serve as nursery habitat to many species of larval fishes and invertebrates. My specific areas of interest are:

Spatial and temporal variability in settlement: An understanding of how organisms use habitat in time and space is required to accurately predict year class strength and delineate nursery habitat. My main study organism at my home institution is the red drum *Sciaenops ocellatus*, a commercially and recreationally species with a complex life history that is dependent upon both coastal and seagrass habitats. Many studies have compared fish abundance or assemblage structure between distinct habitat types (e.g. seagrass, marsh, bare sand, etc.), yet little is known about why larval fish abundance or assemblage structure varies within seemingly homogeneous habitat. This is of critical interest for identifying essential fish habitat and for marine reserve design. The inherent variability within larval and juvenile habitats of estuarine-dependent fishes may be as important, if not more so, than the variability between habitats. The quality and extent of seagrass coverage varies around the

world, country, regionally, locally, and even within an individual seagrass meadow. Research is needed to determine not only which habitats the young individuals of a particular species inhabit, but also how their abundance, growth, survival, and recruitment differ both within and among habitats.

Intra- and interspecific interactions among red drum: Many sizes of red drum larvae and juveniles co-occur in seagrass beds. Larger fish may limit the success of smaller conspecifics by preemptively using resources or by cannibalism. I have begun to study how life history traits are affected by competition and the endpoints that I am currently examining are growth, survival, and body condition. However, I am also very interested in how the behavioral interactions among conspecifics and heterospecifics lead to changes in population size. The structural complexity of seagrass may mediate interactions among individuals and I am currently investigating this through mesocosm and field enclosure trials.

7. Research implementation and results under the program

Title of your research plan:

Development of schooling and aggressive behavior during early ontogeny of red sea bream *Pagrus major* and black sea bream *Acanthopagrus schlegeli*

Description of the research activities:

Fishing and aquaculture are major industries in Japan. Two species of economic importance are red sea bream *Pagrus major* and black sea bream *Acanthopagrus schlegeli*. Adults of both species have overlapping spawning seasons, which causes the larvae to co-occur in time and space, but the distributions are more distinctly separated by the juvenile stage. Black sea bream live in shallow waters above 15 m, while young red sea bream are found at 10 to 50 m depth. Red sea bream juveniles are typically more aggressive and territorial, while black sea bream are shy and form schools. Each bream has preferred prey items whose depth distribution is related to the observed fish depth. Black sea bream have more tolerance to UV radiation, which may explain why they are able to live closer to the surface. It is not yet understood whether competition during the early life stages is responsible for the different distributions.

The goal of my study was to examine how schooling and aggressive behavior develop during the early ontogeny of these two species. I used video analysis to collect data about nearest neighbor distance, depth, and aggressive behavior.

The results show that both species tighten their aggregations between days 33 and 69 post-hatch. However, their depth preferences are quite different. Red sea bream begin shallow, then move deeper and back to shallow, while black sea bream move consistently deeper. Black sea bream were more aggressive, but a mixture of red and black sea bream showed higher aggression than either species alone. This study helped me to develop observational skills and provides insight into the processes that shape distribution of sea breams.

8. Please add your comments (if any):

My main goal was to learn to use video analysis to study behavior. I was able to accomplish this through the help of my hosts and other students, and I was also excited to complete a research project using this new skill. This has been a very supportive place to study and everyone has been most helpful personally and professionally. I enjoyed several laboratory visits that were arranged by my host and was glad to have the opportunity to see other research programs in Japan and make new contacts.

9. Advisor's remarks (if any):

Overall, experiment and observation conducted by Megan Fencil were very successful. She completed video tape analysis during her stay and then presented the results in a seminar. She also worked cooperatively with graduate students in our Institute on routine works for hatchery maintenance, and this indeed improved communication capability of our students.

RESEARCH REPORT

1. Name: Alexander K. Fremier （ID No.: SP06019）

2. Current affiliation: University of California, Davis

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: Hokkaido University

5. Host researcher: NAKAMURA, Futoshi

6. Description of your current research:

Intense awareness exists worldwide to reduce human risks and financial costs caused by natural disturbances such as floods, fires and hurricanes. For reducing flood effects, planners are involved in employing natural environmental dampening mechanisms (floodplains & wetland buffers) rather than human control structures (levees & dams). As such, intact floodplains preserve biodiversity and provide an array of ecosystem services, e.g., disturbance regulation, water supply, and waste treatment (nitrogen removal).

Biological conservation management of river corridors requires fostering natural disturbance within areas typically highly controlled by conveyance facilities and river channelization structures. River channel migration, in particular, is a dominant land and habitat forming process. Active channel migration establishes and maintains natural riparian, oxbow lake, and river ecosystems. This research asks, “What are the necessary rates and spatial patterns of river channel migration that support the full range of habitat types over long periods of time”? This research tries to advance management interested in promoting lateral river migration while conserving farmland and damage to human infrastructure.

Using a mechanistic model of channel meander migration to quantify the spatial patterns of erosion and deposition over many centuries (500+ years), this research simulates river channel movement and habitat formation under various scenarios of flow regulation and floodplain development. Results will make it possible to draw general conclusions about the susceptibility of particular habitats to extirpation and the minimum fluvial dynamics necessary to conserve dynamic landscape processes within the built environment.

7. Research implementation and results under the program

Title of your research plan:

River Channel Meander Migration: How Much is Enough for Long-term Biological Conservation?

Description of the research activities:

My research this summer involved simulating a river channel migration using a mechanistic model of fluvial process. Once the model was setup various scenarios were run to test the significance of active channel migration for the restoration of riparian plant communities, explicitly accounting for temporal and spatial patterns of floodplain development. The overall goal was to inform managers on the amount of land necessary to sustain ecological communities over hundreds of years by incorporating the physical process of habitat turnover caused by a fluvial disturbance. The simulation model and concomitant analysis code were improved and created and then tested. Scenarios were selected after discussions with contributing authors. Simulations and analyses are still being completed; however, the bulk of the modeling research has been completed (code generation and testing). The research paper will be submitted before the end of the year as a chapter in my dissertation thesis at UC Davis.

The major finding of the simulation model thus far has been in understanding how river meander migration patterns change with altered patterns of the erosion field. Simulations have shown that older lands are eroded at a proportionally higher rate than younger. This is the opposite result found in braided stream systems, where only in extreme flood events are older lands reworked by channel movement. In addition, when the width of the floodplain corridor is reduced, mid-aged lands are eroded at a higher rate than under 'natural' conditions. This intuitively makes sense and is potentially a unique finding that has conservation implications. Mid-serial vegetation communities are therefore presumed to be most affected by floodplain width reduction.

In addition to computer modeling, I have been apart of the Nakamura lab's activities here in Hokkaido. I have taken part in many field trips to river restoration sites, including a restoration of a meander bend on the Shibetsu River in northern Hokkaido. This work is the first of its kind in Japan and potentially the world. Field visits greatly improved my understanding of Japanese river ecology and allowed comparison with Californian river systems. Moreover, seeing and hearing fellow labmate's research is vital to understanding research interests and modes of inquiry here in Japan. During my time here I also had the chance to visit the hydraulic center

and to discuss river restoration with various engineering students. Our similar research interests, yet varied scientific approach, lead to fruitful conversations and potential future collaborations. Ultimately, ecosystem management must become an integrated science of engineers and ecologists.

Finally I will be participating in Ecological Modeling conference in Yamaguchi after the program's completion on August 22nd. Here I will be presenting my summer research. This type of communication is necessary to the fusion of ideas between Japan and other countries. I plan to apply to JSPS for post-doc funding to continue this type of river restoration research and international scientific communication.

RESEARCH REPORT

1. Name: Keith W. Fridel （ID No.: SP06020）

2. Current affiliation: The University of Arizona

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: Shiga University of Medical Sciences

5. Host researcher: Dr. Masako Okawa, M.D.

6. Description of your current research

One of the most prevalent causes of sleep disturbances in the world is sleep apnea and other forms of sleep disordered breathing (SDB). The most common type of sleep apnea is obstructive sleep apnea (OSA) which is caused by a collapse of the air passageways causing an obstruction in the upper respiratory tract. During sleep, the cessation of airflow is accompanied by continued respiratory effort that increases in amplitude and ends with a physiological arousal. Repetitive respiratory-related event arousals cause chronic sleep fragmentation and cerebral hypoxia that often results in excessive daytime sleepiness, neuropsychological impairment, mood and anxiety disorders and reduced quality of life.

It is estimated that more than half of OSA patients have twice as many apnea events when in a supine position and thus are considered to be positional patients (PP). For these patients, sleeping in a non-supine position decreases the frequency and severity of the obstructive respiratory events. To reduce the amount of sleep in the supine position, a behavioral therapy called positional therapy (PT) has been demonstrated to be efficacious in the treatment of PP patients. Despite promising results, there is a paucity of evidence attesting to the long-term efficacy and compliance to this treatment and the extent that neuro-cognitive consequences of sleep apnea can be reduced by positional therapy. The effectiveness and impact of positional therapy on mild to moderate obstructive sleep apnea patients here in Japan was investigated and will continue to be for a doctoral dissertation project at the University of Arizona. The summer research project at the Shiga University of Medical Sciences has provided an opportunity to run some pilot subjects and to develop measures that will estimate reductions in daytime sleepiness and cognitive

functioning in addition to changes in sleep disruption. The precise positional therapy technology utilized in the treatment of these participants is of Japanese origin and produced by a Japanese manufacturer. The device is worn like a belt where a protruding obtrusive object lies vertically along the spine in the center of the back. When patients are sleeping and attempt to move into the supine position, they feel the pressure and automatically change to a lateral or prone position. Positional therapy is a simple, non-invasive, inexpensive and effective form of treatment for many positional OSA patients with no reported side effects. Such a therapy is likely to have better compliance than other current treatments for OSA (such as continuous positive airway pressure) and its continued use may avoid the deleterious clinical consequences of untreated OSA.

7. Research implementation and results under the program

Title of your research plan:

Adherence to Positional Therapy for Obstructive Sleep Apnea Syndrome

Description of the research activities:

Several PP pilot subjects were studied using a Japanese-made positional therapeutic device. The participant's were monitored for their clinical progress that investigated the effectiveness and impact of positional therapy on their mild to moderate obstructive sleep apnea. Using techniques and instruments developed by the host institution, measures of daytime sleepiness and cognitive functioning were collected. In addition, changes in sleep disruption comparing pre-treatment status and treatment were collected. Preliminary data suggests that the positional apparatus is effective and well-tolerated with these participants. For these participants, positional therapy reduced daytime sleepiness and resulted in reported increases in daytime functioning. Positional therapy also reduced reported sleep disruption. Further investigation, statistical analyses of the data and reporting of the findings will continue.

The Japanese hosts at the Department of Psychiatry and the Department of Sleep Medicine at the Shiga University of Medical Sciences were inclusive and supportive of the research project activities in their respective departments. Notably, there is a commitment from them to continue to collaborate as a co-institution on the current research project that will continue into the next year. Contributions were also made to the on-going research projects at the Shiga University Medical Center's Sleep Medicine Department as an invited co-author for a study within the broader field of behavioral sleep medicine. Assistance with data analysis, writing and editing were

provided to the co-authors. From this collective effort, a manuscript will be submitted for publication before the end of the year on the topic of a novel treatment of a sleep disorder known as Delayed Sleep Phase Syndrome.

Other research activities included speaking engagements on five separate occasions during the summer at various clinical research seminars about the current research project and more broadly on topics related to the field of behavioral sleep medicine. This included an invitation as symposium guest lecturer at the 31st annual Japanese Sleep Research Societies (JSSR) meeting that was held in Otsu, Japan from June 29-20, 2006. Due to the enthusiastic response at the JSSR meeting, the host institution arranged subsequent clinical research presentations at the Nagoya Institute of Technology, the Jikei Medical University and the Shiga University of Medical Sciences.

8. Please add your comments (if any):

Research conducted in the field of behavioral sleep medicine first requires Institutional Review Board (Human Subject's Committee) approval from the home institution at the University of Arizona. This was not able to be accomplished before the start of the summer research program in Japan and it necessarily affected the ability to study more participants during the summer research project allotted time. However, this was no impediment to laying a very solid groundwork for the research project that included collection of pilot data and the evaluation of new techniques in this specific area of research as part of the ongoing activities of my host institution. A dissertation research proposal will be submitted to the University of Arizona's Institutional Review Board and also their counterpart at the Shiga University of Medical Sciences for the proposed continuation of this collaborative research project between these universities.

RESEARCH REPORT

1. Name: Kenneth Sterling Garmon, Jr. （ID No.: SP06021）

2. Current affiliation: University of Texas at Austin

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 Prefecture University

5. Host researcher: Dr. Satoshi Tanaka

6. Description of your current research

In my current research, I am theoretically analyzing the time evolution properties of an electron inside of a one-dimensional semiconductor superlattice, a modern nano-scale device which can most easily be visualized as a structure composed of repeating layers of nano-scale metal alloy wafers, most likely GaInAs and AlInAs. One of the most interesting properties of the system is the low dimensionality. Since the height and width of the wafers are much smaller than the mean free path of the electron, the electron is effectively unable to move in these dimensions. This means that the electron is only free to travel from one wafer to the next, confining it to one-dimensional motion. In our research, we assume that one or more of the wafers is doped with an impurity, in order to introduce electron donor or electron acceptor layers.

We can describe the one-electron system theoretically using the well-known tight-binding Hamiltonian with a single impurity or multiple impurities. Because the electron may transfer or “hop” from one layer to the next, a continuous energy mini-band is formed inside of the superlattice, which is bounded from above and below. These upper and lower bounds combined with the low dimensionality of the system cause an essential singularity to appear in the density of electron states at either band edge. Because of this divergent singularity, ordinary perturbation theory breaks down when the electron donor impurity energy lies near either edge of the mini-band. Normally, perturbation theory predicts that the decay process for a discrete state (in this case the charge transfer from the donor impurity site into the continuous energy mini-band) is proportional to the square of the coupling constant g. Because we are able to solve our Hamiltonian explicitly, we

were able to show that the charge transfer process is actually proportional to the $g^{4/3}$ power of the coupling constant, which results in a massive amplification of this process.

In order to further our understanding of the time evolution, we have calculated other properties of the system including the optical absorption spectrum for monochromatic light falling on a core electron state inside of the impurity layer of the superlattice. Our results for this calculation are similar to those for Fano's well-known calculation for the optical absorption spectrum for Helium, in which he showed that the asymmetry that is detected in the absorption profile is due to quantum interference between two different transition channels. We were able to predict a similar effect in the superlattice system.

We have also extended our analysis for the one-dimensional superlattice with a single impurity to other systems, including a superlattice with two discrete impurity states and a superlattice "ladder" with two superlattices which share a single impurity.

7. Research implementation and results under the program

Title of your research plan:
Anomalous Charge Transfer in Low-dimensional Nano Semiconductor Superlattice Systems

Description of the research activities:

During the program I have focused on the superlattice system with two impurity sites, mentioned above. Within this system, I have completed two major steps in my research project and made significant progress on a third. The first of these is the analysis of the background integral for a particular case of the double impurity system. The background integral is an effect which is separate from the decay rate in determining the time-evolution of the system. Unlike the decay rate, which results in an exponential decay for the electron that is time irreversible, the background integral results in a power law decay which is invariant under time reversal symmetry and is relatively poorly understood. For a particular case of the double-donor system, I have been able to show that the decay rate disappears from the system, such that the background integral alone determines the time evolution of the system. During the program, I have explicitly calculated the background integral for this system using numerous approximation techniques. I have discovered that the time dependence of the power law decay depends on the energy of the impurity sites. In particular, there is a time scale for the system below which the power law falls off as $t^{-1/2}$, in which t represents the time parameter. Above this

time scale, the power law falls off as $t^{-3/2}$. The time scale itself depends upon the energy of the impurity sites, and as the energy approaches the energy value at which the stable state in the first Riemann sheet passes into the second Riemann sheet, the time scale becomes larger such that the $t^{-1/2}$ behavior becomes more significant.

The second step of my project which I completed was to write a full first draft of all of our results for the double-impurity system. The final form of this draft will be a part of my Ph.D. thesis, as well as the major component of at least two publications.

The third step of my project is the calculation of the optical absorption spectrum for the double-impurity system. I have completed most of the calculations and am now working on analysis of the problem for the wide range of possible configurations of the system.

8. Please add your comments (if any):

This program was very effective for me in terms of giving me time to work with my host advisor, Dr. Satoshi Tanaka, and giving me the opportunity to experience the scientific culture of Japan, as well as the Japanese culture as a whole.

9. Advisor's remarks (if any):

During the program, Mr. Garmon gave research presentations at both Tokyo University and Osaka Prefecture University. He also summarized his work in a paper which we are now preparing for publication. Overall, he has made a lot of progress on his research topic: he succeeded in deriving a complete solution for the time evolution of the system and its optical response. It was stimulating for me and the other members of my lab to work with him, and I am greatly satisfied with his accomplishments during his stay.

RESEARCH REPORT

1. Name: Jason Robert Gaudet （ID No.: SP06022）

2. Current affiliation: Department of Chemical Engineering, Virginia Tech

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: AIST Tsukuba

5. Host researcher: Dr. Tadahiro Fujitani

6. Description of your current research

My field is heterogeneous catalysis, a subset of chemical reaction engineering. A heterogeneous catalyst is a solid material which, when exposed to a fluid, allows chemicals in that fluid to react and form certain desired products. A catalyst allows a desired chemical to be produced from feedstock in a chemical reaction which, if not for the catalyst, might otherwise be economically unfeasible or physically impossible. The field of catalysis is focused on the increased understanding of how gas-phase and liquid-phase chemicals interact with solid-phase catalytic materials, primarily metals and metal oxides. Though the catalysis field is primarily driven by economics, improvements in catalysis allow industrial processes to become more efficient, consuming less energy and chemical feedstock and producing less waste. Additionally, many catalysts are developed for the sole purpose of destroying pollutants – the three-way catalyst (TWC) which cleans the exhaust of every modern automobile is a very common example. Thus, improvements in catalysis offer substantial environmental benefits.

My Ph.D. research is focused on a select number of catalysts which promote the partial

oxidation of volatile organics, forming aldehydes and epoxides that are highly desired and widely used in industry as intermediates for hundreds of end-user chemicals. My work is a mechanistic study, using spectroscopic techniques to identify and quantify surface species on these catalysts. Probing the catalyst surface with these techniques and watching how the surface responds to changes in reaction conditions allows me to interpret the mechanism by which the reaction proceeds.

7. Research implementation and results under the program

Title of your research plan:

Support and Structure Effects of Heterogeneous Catalysts for the Selective Oxidation of Methanol, Ethylene, and Propylene

Description of the research activities:

The research program covered three sub-projects. In the first project, I investigated a new silicon carbide material for use in a Ag/SiC catalyst for the epoxidation of ethylene. After synthesis and catalytic testing using a purpose-built reactor and GC array to analyze products, I determined that for this purpose the silicon carbide material was inferior when compared to a control catalyst of Ag/Al_2O_3. In the second project, I was trained in the synthesis of Au/TS-1, a novel propylene epoxidation catalyst which is notoriously difficult to synthesize. Catalytic testing showed I was successful in making this material. In the third project, I used the same Au/TS-1 synthesis method to make materials for in-situ FTIR study to locate non-transient surface species.

RESEARCH REPORT

1. Name: Brian P. Henry （ID No.: SP06023）

2. Current affiliation: Michigan Technological 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: University of Tokyo

5. Host researcher: Dr. Kazuhiko Takeuchi & Yuji Hara

6. Description of your current research

TREE HEALTH AS A PREDICTOR OF MONTEREY PINE (*PINUS RADIATA*) STREET TREE REMOVAL FROM AN URBAN FOREST

The urban forest of Carmel-by-the-Sea, California, provides an array of benefits for residents and tourists including improving local air quality and promoting human health. Of publicly owned trees, 34% are Monterey pine (*Pinus radiata* D. Don). Data collected in 2005 from 285 Monterey pine street trees was integrated with a database dating back to 1988 to evaluate which biological and environmental factors were predictive of tree removal. Since 1994, this forest has been increasingly impacted by pitch canker, a disease caused by an exotic pathogen. The height and diameter in 1988 of trees that had been removed by 2005 were significantly greater than trees not removed and the presence of red turpentine beetles (Coleoptera: Scolytidae) in 1992 was a significant indicator of tree removal. Trees that developed pitch canker by 2005 were shorter in 1988, were more likely to have pitch moth and had a greater number of pitch moth attacks in 1988 than were trees which did not develop pitch canker by 2005. Measurements of tree heights and diameters, as well as attacks by the red turpentine beetle are useful predictors of future tree removal.

7. Research implementation and results under the program

Title of your research plan:

HEALTH ASSESSMENT AND MANAGEMENT RECOMMENDATIONS FOR FLOWERING DOGWOOD (*CORNUS FLORIDA*) STREET TREES IN TOKYO, JAPAN

Description of the research activities:

Street tree data provided by the Tokyo Metropolitan Government indicates a planting preference for aesthetically pleasing species. Specifically, over the past ten years flowering dogwood showed the greatest overall increase as the primary species selected for newly renovated streets and development on the urban fringe. In the summer of 2006, sixty dogwoods were sampled in each of Tokyo's 23 wards. Detailed data collected for each tree can be categorized in the following three classes; biological and environmental stresses, physiological characteristics and adjacent land use. In addition, interviews were conducted with street tree managers from ward, city and national agencies. Statistical analysis is yet to be performed, but basic interpretation of the data shows disease symptoms of anthracnose and powdery mildew present on a significant proportion of trees sampled in all 23 wards. In Japan, anthracnose was previously known to be caused by *Microsphaeropsis spp.* Pathogenicity tests on random leaf samples collected in the field revealed a suite of causal agents, one of which is the first record on a new host in Japan and the remaining agents are still being identified. The presence of anthracnose and humid summer conditions can lead to significant dieback in the urban forest creating a critical management issue. Based on the findings of this research, guidelines are being developed for street tree management in Tokyo.

9. Advisor's remarks (if any):

Brian Henry has been conducting a health assessment of dogwood street trees in each of Tokyo's 23 wards. In terms of street tree management, his viewpoint is quite significant for landscape architects in Japan. His results will be suitable for publication in the near future, which will impact Tokyo's street tree management policy. Consequently his visit was quite useful for us and we look forward to future collaboration on research projects.

RESEARCH REPORT

1. Name: Stephan Hruszkewycz （ID No.: SP06024）

2. Current affiliation: Johns Hopkins University, Baltimore MD, USA

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: Tohoku University, Sendai, JP

5. Host researcher: Prof. Mingwei Chen

6. Description of your current research

Bulk metallic glasses (amorphous metal alloys) combine high strengths and high elastic limits with processing flexibility similar to traditionally oxide glasses, making them potentially useful for a variety of load-bearing applications.

As is true with any material, understanding the atomic-scale structure of a glass provides an avenue for understanding macroscopically observable phenomena. Glasses display no long-range atomic order (as is seen in crystals) but they do have a subtle local atomic structure that can be studied statistically. This nanometer and sub-nanometer scale structure in glasses plays an important role in plastic deformation and crystallization in metallic glass systems. Direct experimental observation of amorphous atomic structure between one and two nanometers is possible using recent advances in electron microscopy techniques. Combining experimental results from these new experiments with data from similar, more well established structural characterization techniques gives us an opportunity to better understand the nanometer structure of metallic glasses.

The focus of the research done at Tohoku University in Japan was on using state of the art electron scattering equipment to perform fluctuation microscopy on bulk metallic glasses, providing a unique look at nanometer-scale structure in metallic glasses. Preliminary computer simulations were also done to verify the results observed by electron microscopy.

7. Research implementation and results under the program

Title of your research plan:

Studying the Structure of Metallic Glasses by Electron Microscopy and Computer Modeling Techniques

Description of the research activities:

Several transmission electron microscopy (TEM) techniques were used to observe the structure of $Pd_{40}Ni_{40}P_{20}$ bulk metallic glass specimens using the TEM resources at Tohoku University. Supercomputing resources available at Tohoku University were used to develop a preliminary atomic structural model of the glass that is consistent with the microscopy results.

Fluctuation electron microscopy (FEM) is a new TEM technique that can be used to experimentally obtain information about the nanometer-scale atomic structure in metallic glasses. At Tohoku University, FEM in imaging mode was successfully performed using a 200 keV JEOL microscope. The results of these experiments showed evidence of medium range atomic ordering in the glass system observed. To corroborate these results, FEM experiments were conducted in diffraction mode using a JEOL 300 keV microscope, probing the same samples that were tested in imaging mode. The results were consistent with the earlier results, further verifying that medium range ordering exists in the Pd-Ni-P metallic glass system.

Since fluctuation electron microscopy is a statistical technique that gives convoluted qualitative information rather than specific structural solutions, computer modeling must be employed in order to fully understand the information contained in FEM experimental results. One such method is reverse monte carlo modeling which creates an atomic structure that is consistent with experimentally observed data in an amorphous system. This technique was employed to generate a simulated atomic structure for the Pd-Ni-P system using the supercomputing cluster at Tohoku University. The atomic configuration was used to simulate high resolution TEM (HRTEM) images, which were compared to experimental HRTEM images obtained at Tohoku University. The simulated and experimental results matched well, shedding more light on the nature of nanometer scale atomic ordering in metallic glass systems.

RESEARCH REPORT

1. Name: Alexander R. Hutko （ID No.: SP06025）

2. Current affiliation: University of California Santa Cruz

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 Research Institute for Earth Science and Disaster Prevention (NIED)

5. Host researcher: Dr. Kazushige Obara

6. Description of your current research

My current research at UCSC focuses on imaging the deep Earth, especially the boundary between the molten iron core and the rocky silicate mantle. We apply a technique, Kirchhoff migration, which has been in use by the oil exploration industry for decades, to image the reflectors and scatterers present in the mantle. Our imaging technique produces three-dimensional images of structures in the mantle from scale lengths between 20 and 1000 km. Seismic scattering is caused by interaction of seismic waves with velocity or density heterogeneities in the mantle. These heterogeneities are caused by either temperature or chemical composition differences relative to the surrounding mantle. By better understanding the distribution and characteristics of heterogeneities in the mantle, we gain insight into fundamental questions such as what is the Earth made of and how did it reach its current state after 4.5 billion years of cooling.

7. Research implementation and results under the program

Title of your research plan:

Imaging the deep Earth using Hi-net data.

Description of the research activities:

While at NIED, I was able to collect an incredible data set of about 5000 earthquakes recorded by Hi-net. Hi-net is a network of 700 high quality short period seismographs operated by the National Research Institute for Earth Science and Disaster Prevention (NIED) of Japan. This is the largest densely spaced network in the world. Ground motion is recorded on a vertical component as well as two horizontal components that allows seismologists to image S wave structure independently from P wave structure. Having separate P and S wave images helps constrain the physical properties of scatterers, which helps with interpreting their composition and/or temperature based on mineral physics experiments.

Processing such a large data set (4TB) takes many CPU months and new projects will likely arise upon more detailed inspection of the data. However, there are two projects, which will likely produce unique and insightful results. The first is an extension of my current thesis work on making deterministic images of the Earth's mantle by studying scattered seismic waves. The second uses great numbers of data to statistically characterize the scattering properties of Earth's mantle. We plan to achieve this by grouping data according to the distance of the source, an earthquake, to the distance of the receiver, a Hi-net station. By stacking, or summing, the data we are able to raise very weak signals above background noise levels and observe many different waves that travel through the Earth. For example, waves that bounce off of the core-mantle boundary illuminate layering in the deepest mantle, while waves that bounce off of the bottom of reflectors give insight into the topography of phase transformations in rocks, which can be used as a proxy for temperature in the mantle. A new twist we plan to apply to this type of study is to observe the length and the speed of propagation of the ringing that follows arrivals, coda, caused by scattering. This will allow us to describe the origin and strength of scattering heterogeneities in different parts of the mantle.

Collecting data for 5000 earthquakes far exceeded my expectations and will no doubt lead to many treasures when the processing is finally complete.

8. Please add your comments (if any):

This was an excellent program. Thank you very much to all who made this possible!

RESEARCH REPORT

1. Name: Johanna M. Kraus （ID No.: SP06026）

2. Current affiliation: University of Virginia

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 Yamanashi

5. Host researcher: Dr. Tomoya IWATA (actual), Dr. Satoshi TAKEUCHI (official)

6. Description of your current research

Resources that move across ecosystem boundaries subsidize recipient consumers and have complex consequences for recipient food webs. Emergence of aquatic insects onto land and accidental input of terrestrial arthropods into water are two important pathways by which protein-rich resources, or subsidies, move between freshwater and terrestrial habitats. Few studies, however, have used an experimental approach to examine whether subsidies affect community dynamics. And almost no studies examine how subsidies may link aquatic and terrestrial predator dynamics across lentic-terrestrial boundaries. In my doctoral dissertation, I used field observations, conceptual modeling, field experiments and stable isotopes to understand the role of arthropod prey movement between a pond and forest habitat. I explored how this movement generated the temporal and spatial patterns of predator abundance, size, reproduction and diet seen on land and in the water. The wolf spiders, ground beetles, dragonfly larvae, newts and crayfish living in and around two small ponds in the southern Appalachians were a well-defined system within which to examine these ideas.

My results indicate that resource subsidies play a moderate role in defining the distribution and abundance of wolf spiders and dragonfly larvae. These effects are mediated by the physiological constraints of the focal predator and the interactions among predators in the food web. Furthermore, the availability of subsidy changes over time and space. It also appears to differ in its impact on terrestrial and aquatic food webs. Finally, theoretical work suggests that the ratio of donor to recipient food web productivity may generate the qualitative pattern of effects of subsidies on food webs at terrestrial-aquatic interfaces. The results from this work shed light on the landscape context of food webs and the impact of resource flow across terrestrial-lentic boundaries on predatory arthropods and amphibians.

7. Research implementation and results under the program

Title of your research plan:

Impacts of damming on riparian arthropod food webs

Description of the research activities:

Food web linkages between terrestrial and aquatic habitats influence the abundance and distribution of consumers on land and in the water (Polis et al. 1997, Nakano and Murikami 2001, Iwata et al. 2003, Baxter et al. 2005). Dams can affect these linkages by altering water flow and the availability of terrestrial carbon to downstream food webs (Cortes et al. 2002, Friedl and Wüest 2002). In this study, we examined whether dams altered the diet of downstream terrestrial predators, specifically long jawed orb-weaving spiders (Tetragnathidae), compared with upstream reaches.

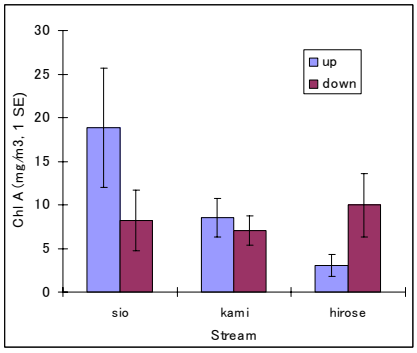


Figure 1 – Algal standing crop up and downstream of all dams

We collected spiders and the potential basal sources of their diets (algae, phytoplankton and riparian tree leaves) up and downstream of three dams (Siokawa, Kamihikawa and Hirose) surrounding Fujikawa basin in Yamanashi Prefecture, Japan. Using stable isotopes to trace food source, we found that each dam had a different effect on spider diet, most likely due to differences in flow regimes and between dams and stream order. Compared with upstream reaches, algal standing crop decreased downstream of Siokawa dam, increased downstream of Hirose dam and remained relatively stable downstream of Kamihikawa dam (Fig. 1). Proportion of spider diet that originated from algal carbon changed accordingly (Fig. 2). The low abundance of algae downstream of Siokawa dam appeared to be caused by grazing pressure of freshwater snails that are able to thrive in the relatively slow and stable water flow below the dam. Spiders do not rely heavily on algal carbon up or downstream at Kamihikawa dam, despite a standing crop comparable to Hirose dam. Because Kamihikawa dam is located further up in the watershed than the other two dams emerging insect phenology might differ and the spiders could potentially be relying on filter feeding (which eat FPOM) more than grazing macroinvertebrates (which eat algae) at this time of year. Although all dams lowered the amount of terrestrial leaf litter downstream (~2 -10 times), and 2 of 3 dams increased the amount of phytoplankton in the stream (~2.5 - 7 times) because of blooms in the reservoir, spiders diet appeared to be mostly unaffected by these changes (Fig. 2). This result supports the theory that these riparian spiders rely mostly on aquatic production to survive.

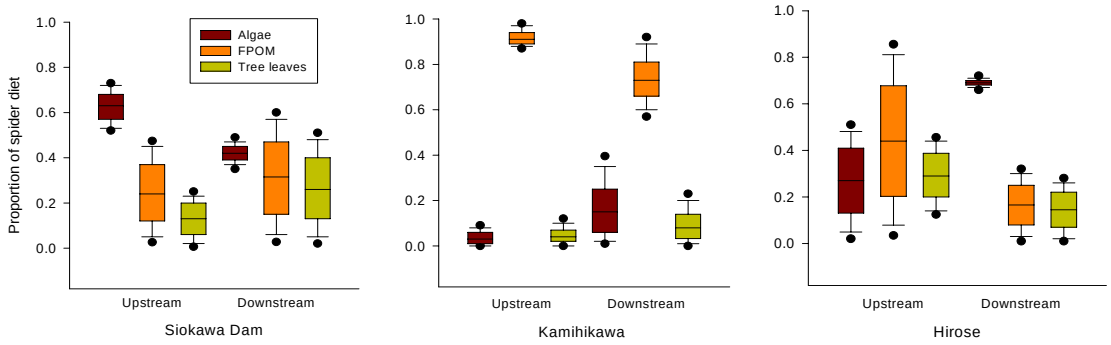


Figure 2 – Proportion of diet of tetragnathid spiders based on 3 carbon source mixing model up and downstream of all three dams. Statistical software Iso-Source was used to calculate the most probable combination of each source in the diet. Median, 5, 10, 25, 75, 90 and 95%tiles are shown.

Our results support the findings that dams do affect the diet source of downstream terrestrial predators, but suggest that mechanism of this effect can depend on dam flow regime and where the dam is located in the watershed. The results also suggest that reduced flow can allow strong cascading effects of aquatic grazers on terrestrial predators. An understanding of how dams impact downstream terrestrial food webs can help us to predict the effects of water management on natural communities.

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8. Please add your comments (if any):

I had an excellent research experience as a JSPS fellow. The program was well run, the funding was generous and I have a very great amount of respect for the research and advisory abilities of my host researcher, Dr. Iwata and Japanese science in general. In terms of the JSPS staff, I especially want to thank Ms. Chiba for her help on many occasions.

RESEARCH REPORT

1. Name: Selina Lee （ID No.: SP06027）

2. Current affiliation: Cornell University, School of Civil and Environmental Engineering

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: Dr. Charles Scawthorn, Department of Urban Management

6. Description of your current research

As demonstrated by history, social and economic damages due to fires following earthquakes (FFE) have caused tremendous harm to cities all over the world. They pose a serious problem because many fires occur simultaneously at the same time that fire suppression capabilities are diminished. For instance, fire engines may be less able to maneuver on a damaged transportation network, and fire fighters may be less able to coordinate due to damaged communications systems and less able to fight fires if the water supply system is damaged. Therefore, if the relationships among lifeline performance, meteorological conditions, building, and seismic conditions are better understood and incorporated into a FFE model, coordination of risk assessment and emergency operation efforts can be improved.

The goal of my dissertation is to improve the understanding of and the ability to manage FFE by developing a computer simulation model that will estimate FFE damage in a city and evaluate potential risk reduction efforts. This simulation is being developed to produce probabilistic, not just scenario-based results and will include estimates of uncertainty in the output. By using this model, the total area burnt, the number buildings burnt and the burn state (e.g., mildly, severely) may be determined. These metrics are essential in calculating the direct and indirect damage caused due to the earthquake and by developing a simulation model, various mitigation, response and recovery strategies may be staged to determine their effects before implementing these in the real-world.

7. Research implementation and results under the program

Title of your research plan:

Modeling of fire following earthquakes

Description of the research activities:

Working along side Ohnishi Norihito, a Master's student also studying fire following earthquakes, we researched FEE models developed in Japan, China, New Zealand, Germany and the United States. The purpose of this work is to provide an overview of research in this area. My host-advisor and I felt that this was important since papers published in the FFE area rarely reference each other. In the process of writing this paper, multiple site visits to institutions and universities involved in FFE work were visited.

Results: A 98-page working paper draft which is being edited. Out of this working paper, 2 articles (1 in Japanese to be published in a Japanese journal, and 1 in English, to be published in an American journal) will result. The English version will be submitted for review by the end of September.

8. Please add your comments (if any):

I had a wonderful time in Kyoto, and wished that the program can be longer.

RESEARCH REPORT

1. Name: Qiao Liang （ID No.: SP06028）

2. Current affiliation: University of New Mexico

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: Hiroshima University, Nara Women's University, Kyushu University

5. Host researcher: Professor Seno Hiromi, Professor Takasu Fugo, Professor Yoh Iwasa, and Professor Kakehashi Masayuki

6. Description of your current research

Studying basic Susceptible-Infected-Recovered (SIR) population dynamics.

7. Research implementation and results under the program

Title of your research plan:

A Vaccinated model with multiple strains of Virus for Transmission Dynamics of Avian Influenza among Poultry

Description of the research activities:

This project uses a status-based formulation to develop a vaccinated SI model for multiple strains of virus, and to determine the criteria for existence of endemic and for the eradication of the virus.

$$S' = h - \gamma S + \omega V - \sum_{i=1}^{n} \delta_i S I_i - \mu S;$$

$$V' = \gamma S - \omega V - \sum_{i=1}^{n} (1-\sigma_i)\delta_i V I_i - \mu V;$$

$$I_i' = \delta_i S I_i + (1-\sigma_i)\delta_i V I_i - d I_i;$$

Where $i = 0, 1, 2, \ldots, n$, and S is the susceptible population; V is the vaccinated population; I is the infected population; h is total recruitment rate of individuals, δ_i is rate of the infection to the strain i virus, γ is vaccination rate, σ_i is vaccination efficacy against strain i virus, ω is rate of vaccine-based immunity wanes, μ is rate of population loss within the susceptible and vaccinated group, and d is the rate of population loss within the infected group. All parameters are positive, and $0 < \sigma_i < 1$, $\mu < d$.

The system has a disease free equilibrium state (DFE) at

$$(S, V, \{I_i\}) = (S_0^*, V_0^*, 0) = \left(\frac{(\mu+\omega)h}{(\mu+\omega+\gamma)\mu}, \frac{\gamma h}{(\mu+\omega+\gamma)\mu}, 0\right),$$

and the reproductive number is found to be,

$$R_{o/n} = \frac{h}{\mu d} \max_i \left[\frac{\mu+\omega}{\mu+\gamma+\omega}\delta_i + \frac{\gamma}{\mu+\gamma+\omega}(1-\sigma_i)\delta_i\right].$$

$R_{o/n}$ has a lower bound at

$$\tilde{R}_{o/n} = \frac{h}{\mu d} \max_i [(1-\sigma_i)\delta_i].$$

If $\tilde{R}_{0/n} > 1$, no amount of vaccination can eliminate the disease, and it eventually becomes endemic with some strains that have sufficiently large value of $(1-\sigma)\delta$.

The basic reproductive number is found to be,

$$r_{o/n} = \frac{h}{\mu d} \max_i \delta_i < 1.$$

If $r_{o/n} < 1$, DFE is guaranteed even without vaccination.

For a single strain case, if the following conditions

$$\tilde{R}_{0/1} < 1, \text{ and } \gamma > \gamma_c = \frac{r_{0/1} - 1}{1 - \tilde{R}_{o/1}}(\mu+\omega)$$

are met simultaneously, DFE is locally stable, and the disease can be eradicated.

On the other hand, existence of the endemic equilibrium (EE) must satisfy the following conditions:

i) $\gamma < \mu(r_{0/1} - 1)$ or

ii) $\gamma > \mu(r_{0/1} - 1)$; and $(1 - \tilde{R}_{0/1})\gamma < (r_{0/1} - 1)(\mu + \omega)$

For the multiple strain case, at most two strains of virus can coexist, namely, I1 and I2. Their coexistence must satisfy the following 4 conditions simultaneously:

i) *$\delta 1 > \delta 2$, and $\sigma 1 > \sigma 2$;*

ii) $[(1-\sigma_1)\delta_1 - (1-\sigma_2)\delta_2](\delta_1 - \delta_2) < 0$;

iii) $r_{0/2} > \dfrac{\sigma_1\delta_1 - \sigma_2\delta_2}{(\sigma_1 - \sigma_2)\delta_2}$;

iv)
$$\gamma > \tilde{\gamma}_c + \frac{(1-\sigma_1)(\delta_1 - \delta_2)\mu}{(1-\sigma_2)\delta_2 - (1-\sigma_1)\delta_1}[r_{0/2} - \frac{\sigma_1\delta_1 - \sigma_2\delta_2}{(\sigma_1 - \sigma_2)\delta_2}];$$
$$\gamma < \tilde{\gamma}_c + \frac{(1-\sigma_2)(\delta_1 - \delta_2)\mu(\delta_2/\delta_1)}{(1-\sigma_2)\delta_2 - (1-\sigma_1)\delta_1}[r_{0/2} - \frac{\sigma_1\delta_1 - \sigma_2\delta_2}{(\sigma_1 - \sigma_2)\delta_2}];$$

where $\tilde{\gamma}_c = \dfrac{\delta_1 - \delta_2}{(1-\sigma_2)\delta_2 - (1-\sigma_1)\delta_1}(\mu + \omega).$

Therefore, two strains of virus can coexist for an intermediate range of the vaccination rate.

8. Please add your comments (if any):

This program has given me a lot more insight on mathematical biology, and research experience in general. I am deeply thankful to my host researchers. They have showed me great hospitality as well as providing me lots of direction and help on research. As I spent most of the summer with Professor Seno Hiromi in Hiroshima University, and Professor Takasu Fugo in Nara Women's University, I also had the opportunity to visit Professor Yoh Iwasa's lab at Kyushu University, and Professor Kakehashi Masayuki from Hiroshima University's Medical school. I also had an extraordinary experience through the exchange of cultural and professional opinions with Japanese graduate students. I hope this program will run successfully in the future, to allow more graduate students to have the opportunity to study abroad.

RESEARCH REPORT

1. Name: Christopher Liao （ID No.: SP06029）

2. Current affiliation: University of California, Berkeley.
Lawrence Berkeley National Laboratory

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: Professor Kohei M. Itoh

6. Description of your current research

The research involves the studies of Si and O self-diffusion in SiO_2 as a function of the oxide thickness. It has been shown by Prof. Itoh's group and their collaborators using isotope heterostructure that the self-diffusion of Si in SiO_2 depends on the oxide thickness on Si substrate, in other words, the distance from the Si/SiO_2 interface. They found that the Si diffuses faster in thinner oxide and attributed this to the possible SiO molecules emission from the Si/SiO_2 interface. This study extends the previous experiments by studying the self-diffusion of O in SiO_2 as a function of oxide thickness. This will further clarify the diffusion mechanism of Si and O self-diffusion in SiO_2 and the effect of Si/SiO_2 interface.

7. Research implementation and results under the program

Title of your research plan:

Study of oxygen self-diffusion in SiO_2 as a function of oxide thickness

Description of the research activities:

The summer research activities can be broken down into parts. The first part involves the installation and implementation of a computer program for diffusion simulation.

The diffusion of atoms inside a solid can be described by Fick's laws, a set of differential equations describing the concentration of diffusing atoms, ions, or molecules as a function of distance and time in the solid matrix. The equations can only be solved analytically in a few simple cases. In more complex situations, such as the differential equations used to describe the diffusion of O and Si in SiO_2,

require solving coupled differential equations numerically. In the first part of this summer research, a numerical differential equation solver, ZOMBIE, which is specifically designed to solve diffusion equations, is installed in a Linux system. The process of installation and debugging yields valuable knowledge of how ZOMBIE handles coupled differential equations. This is an extremely useful learning process to help utilize the program, which is used in my home institute to simulate diffusion processes as well.

The second part of the summer research activities is the experiments performed to determine the self-diffusion coefficient of O in SiO_2. This is achieved using the isotope heterostructure technique. Two layers of oxide, one with natural oxygen (consists mostly of ^{16}O) and the other with ^{18}O, with varying thicknesses are thermally grown on standard Si wafers. The samples are then annealed at different diffusion temperatures. Secondary Ion Mass Spectroscopy (SIMS) is then performed to determine the concentration of ^{16}O and ^{18}O as a function of depth in the oxide for samples annealed at different temperature.

The SIMS results show inconsistency between samples with different thicknesses and different annealing temperature. Further, some intermixing of ^{16}O and ^{18}O during the thermal oxidation before the diffusion anneals are observed, complicating the analysis of diffusion profile after annealing. For these reasons, the study is still inconclusive. Some alternative experiments are devised.

One of the proposed alternative methods to obtain a sharper $Si^{16}O_2$ and $Si^{18}O_2$ interface is to utilize the Silicon-On-Insulator (SOI) wafers. The SOI wafers are obtained from Lawrence Berkeley National Laboratory, my home institute, and the top layer of Si is converted into $Si^{18}O_2$ while the buried oxide layer remain natural SiO_2 (mostly $Si^{16}O_2$). The samples are then annealed at the diffusion temperatures. Again, the SIMS results show some degree of intermixing between the two oxide layers during the oxidation process. Again, conclusive results cannot be obtained.

Further experiments are necessary to continue the study of O self-diffusion in SiO_2.

8. Please add your comments (if any):

Due to the unfamiliarity of the equipments and the safety concerns, most experiments are performed by the staff and the students working on the same project. The discussion with the staff and the students are always very positive with fruitful results.

Overall, the Prof. Itoh's group is fairly similar to my group at my home institute where the students received a great deal of autonomy. This makes the research environment very easy to adapt since the very beginning. Further, the friendly and helpful staffs and students really make this research experience very rewarding.

RESEARCH REPORT

1. Name: Abbie B. Liel （ID No.: SP06030）

2. Current affiliation: Stanford 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: Earthquake Research Institute, University of Tokyo

5. Host researcher: Professor Toshimi Kabeyasawa

6. Description of your current research

The objective of my doctoral research at Stanford University is to answer the question of why some existing reinforced concrete structures in California may need to be seismically retrofitted. I have focused on explicitly quantifying the collapse risk of non-ductile concrete structures constructed between 1960 and 1975, before significant changes in building code design and detailing requirements were instituted to increase ductility and improve seismic resistance. This investigation necessarily links earthquake engineering and policy through its direct consideration of the public safety of engineered structures.

The seismic performance predictions for collapse risk are based on methodologies recently developed for performance-based earthquake engineering. These methods use computational models of idealized structures to make predictions about structural performance during seismic events. To simulate collapse, the modeled structure is subjected to a series of real earthquake records to determine the median ground motion intensity corresponding to collapse of that structure, as well as the uncertainty associated with that prediction. A part of my work is the ongoing validation of these analytical models with experimental test data.

I am investigating the collapse risk associated with a variety of “typical” structures representative of existing reinforced concrete construction in California. This detailed examination of older buildings can be compared to complementary research by others that benchmarks the safety provided by new building codes to provide a comprehensive evaluation of seismic safety.

7. Research implementation and results under the program

Title of your research plan:

Developing Performance-Based Guidelines for Earthquake Resistant Reinforced Concrete Buildings: the Japanese Approach, and Opportunities for Collaboration

Description of the research activities:

I served as a consultant on the English version of *Guidelines for Performance Evaluation of Earthquake Resistant Reinforced Concrete Buildings,* to be published by the Architectural Institute of Japan. The completion of the English version of this document will facilitate conversation and collaboration among American and Japanese researchers, who are striving to modify current prescriptive building codes that ensure seismic safety to a more flexible approach based on direct assessment of structural performance. My work included:

- Extensively familiarizing myself with the draft documents: Level 1 *Evaluation Concepts*, Level 2 *Evaluation Methods in Practice*, and *Design Guidelines for Earthquake Resistant Reinforced Concrete Buildings based on Inelastic Displacement Concept*.
- Conducting meetings with the contributing authors of each chapter of the *Guidelines.* These authors are members of the AIJ Committee on Reinforced Concrete Structures, Sub-committee on Performance Evaluation and Limit states. With each author I discussed the presentation of the material in English, possible improvements to sections that were technically unclear, and the theoretical basis for the equations, regulations, etc. outlined in the documents. We also discussed the role of future research in improving the next generation of performance-based earthquake engineering documents, with specific emphasis on their area of expertise. When possible, we exchanged more general ideas regarding the similarities and differences in American and Japanese performance-based guidelines, and possible improvements to each.
- Suggesting changes to improve the clarity of presentation of technical ideas in English, including corrections to English sentence structure and word choice, and organization of main and supporting ideas. Because of the complex nature of the technical content of these documents, this work challenged my skills both as an engineer and as a writer.
- Presenting both my doctoral research and my work (in the U.S.) for the Applied Technology Council on building code development to interested Japanese researchers. I emphasized potential applications of

performance-based earthquake engineering in the U.S., and possible barriers to implementation.

This project enabled me to become deeply engaged in the process of developing guidelines for seismic safety in Japan. Broader than a typical research project, I had the opportunity to discuss seismic engineering and reinforced concrete construction in Japan with a wide variety of professionals, including professors, practicing engineers and corporate researchers. Performance-based guidelines represent a significant change in how building safety is regulated, and I hope that the forthcoming completion of the English-language version of these documents will foster communication and dialogue among earthquake engineering professionals worldwide.

8. Please add your comments (if any):

I am very grateful to both NSF and JSPS for sponsoring my work this summer in Japan. Thank you for the research and cultural experiences this program has to offer! I would highly recommend the JSPS Summer Program to other students.

RESEARCH REPORT

1. Name: Matthew Lloyd （ID No.: SP06031）

2. Current affiliation: Cornell University, Ithaca, New York

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: Panasonic

5. Host researcher: Mr. Kazunori Komori

6. Description of your current research

I carry out research in the field of photovoltaics, which is to say I investigate ways to efficiently turn sunlight into electrical energy. There are two important reasons to continue to improve photovoltaic technology. Firstly, world-wide fossil fuel reserves, from which we now extract a significant source of energy, face imminent exhaustion. Secondly, to meet the projected energy needs (not to mention the clean air requirements) of future generations, power generation will have to come from a variety of sources in addition to coal and nuclear sources on which we heavily rely today.

Photovoltaic technology today relies entirely on silicon as the material that actively absorbs and converts solar radiation to electrical current. Although it is one of the most plentiful elements on earth, the refinement of high purity silicon requires a considerable about of energy. Consequently, it takes many years of use by the consumer before silicon solar panels generate more energy beyond what was required for the panel's initial fabrication. Due in part to the large energy investment and in part to complex fabrication processes, silicon solar panels are a fair expensive means of power generation. Thus, they see limited use by consumers and power companies alike.

In 1985, organic materials (specifically, carbon-based small molecules) were first used to produce a solar cell with a power conversion efficiency that was not insignificant. The discovery spawned a flurry of research activity, which over the ensuing years, has increase the efficiency of organic photovoltaics to the point of commercial viability. With fabrication processing that is more akin to common house paint than computer chips, carbon-based cells offer huge cost saving advantages over silicon cells.

My research aims to increase the efficiency of such organic photovoltaics. There are four fundamental mechanisms at work in organic solar cells: light absorption, exciton

dissociation, charge transport, and charge collection at the anode and cathode. When investigating the potential of novel organic materials, each of these processes are at work in a functioning cell. One method of study is to isolate the mechanism of interest and measure, using a variety of techniques, the degree to which a material will support that mechanism. In charge transport measurements, for example, a laser pulse is absorbed near the edge of a thin organic film contained between two electrodes. Subsequently, photo-excited charge carriers traverse the film to arrive at an electrode at a rate that is monitored by an oscilloscope. The rate at which the charge carriers arrive defines the charge carrier mobility with the material and indicates whether the material exhibits dispersive or nondispersive transport behavior. With such measurements, one can characterize how well a given material will perform a requisite task when employed in a solar cell. Ultimately, the information gathered about the discrete functionality of each component is utilized to assemble and characterize complete solar cells to be tested under simulated solar exposure conditions.

7. Research implementation and results under the program

Title of your research plan:
The development of organic field effect transistors for next-generation displays

Description of the research activities:

Panasonic is engaged in research and development of an emerging technology based on organic semiconducting and light-emitting materials. The research division, known as the Next-Generation Display group (NGD), is creating a new type of display that supersedes what is possible with present-day imaging technology. The research efforts of the NGD group will not be appreciated by the general public for an estimated five years from now, when the display is slated for production.

Organic displays offer several unique features and advantages that make the technology desirable for a range of electronic devices. Unlike conventional liquid crystal displays (LCDs) found on today's laptops and cell phones, organic displays require no back-lighting. This fact leads to higher power efficiency (i.e. longer battery life) in organic displays and facilitates the manufacture of flexible or roll-able displays. The height of the "pixel stack", lacking a backlight, is significantly thinner than a comparably bright LCD. This has helped organic displays find their way into a few of today's slimmest cellular phones (including mine). Organic displays also provide high contrast ratios, 180 degree viewing angles, and excellent color purity. Since the materials are usually polymeric in nature, the displays are fabricated with low-temperature, solution processing techniques, such as screen-printing and inkjet-printing. As with many novel technologies, wide-spread adoption is often slow to occur. This is especially true for organic materials in the

face of a competitive display market. Cathode ray tubes are quickly heading to extinction as research in LCD technology has driven down costs and eliminated the once problematic single pixel faults. Organic displays will have to compete with ever decreasing LCD prices, as well as battle some of there own internal issues such as device longevity and moisture sensitivity.

In an active matrix display, behind (or beside as the case may be) each pixel, is a transistor that serves as a simple switch to modulate the current flow to the light emitting diode (LED). In Panasonic's display design, the transistor will be of the thin film variety, fabricated from polymeric materials. In a thin film transistor (TFT), current flows from a "source" electrode to a "drain" electrode, when a voltage is applied to a third "gate" electrode. In an organic TFT, the current flows though a polymeric semiconducting material located between the electrodes, within the "channel". It is this layer that most influences how the TFT will perform, and it is here I spent most of my investigation.

In my research project, the semiconducting layer is deposited from solution onto a glass substrate in a process known as "spin-coating". The semiconductor film is of uniform thickness across the substrate and covers the metal source and drain electrodes. When a voltage is applied between the electrodes, current is "injected" into the semiconductor and charge is transported across the channel. The ease with which the charge is injected and transported is largely determined by the conformation the organic film after spin-coating. Interactions at the electrode/semiconductor interface can restrict the amount of current that the device demands, making the device "injection limited". Likewise, the condition of the bare substrate/semiconductor interface influences how much resistance charge carriers will see when traversing the channel. If the contacts can supply more than the channel can support the transistor is said to be "bulk limited". One of the experiments I conducted investigated how the substrate processing history affects device performance. By systematically eliminating steps in the standard substrate cleaning process, I found those that most strongly impacted device performance. Specifically, I used contact angle measurements, atomic force microscopy, and device characterization to correlate surface energy and topography with TFT charge carrier mobility.

8. Please add your comments (if any):

I would like to thank the IDDC for graciously providing a chance for me to gain valuable research experience in the industrial sector. I would like to thank Mr. Komori for arranging my research project, Dr. Ito for patiently guiding me though many experiments, and all of my Panasonic colleagues for their exceptional generosity and assistance.

RESEARCH REPORT

1. Name: Vanessa Lopez-Pajares （ID No.: SP06032）

2. Current affiliation: Harvard 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: Hiroshima University, Institute for Radiation Biology and Medicine

5. Host researcher: Dr. Fumio Suzuki

6. Description of your current research

The focus of my current research is on the p53 tumor suppressor protein. p53 is an important transcription factor whose function is compromised in all cancers, either through mutation of the gene or functional inactivation. The function of p53 is to control cell cycle progression and respond to cellular stresses, such as ionizing radiation. Under such cellular insults, p53 is transcriptionally activated and the response can be potent, leading to cell cycle arrest or cell death. Due to the possible outcomes of p53 activation, the cell has mechanisms to tightly control its function post-translationally through degradation and/or inhibition of transcriptional activity. One mechanism is through a negative feedback loop. An important negative regulator of p53 is the MDM2 protein, which functions as its E3 ligase targeting p53 for degradation and also blocks its transactivation domain, preventing its transcriptional activity. The function of p53 is controlled through its tetramerization, therefore abundance of p53 protein is important for a potent response. MDM2 is also a downstream target of p53, therefore, upon activation, p53 facilitates the production of MDM2 leading to its own degradation as well as MDM2 degradation, hence the negative feedback loop.

We are interested in studying another negative regulator of p53 that also appears to be critical for p53 regulation. The negative regulator, MDMX, is a homolog of MDM2. While it retains similar characteristics as MDM2, the main difference between the two proteins is that MDMX lacks the ability to degrade p53 by itself. However, it appears that MDM2 and MDMX function together in a complex to fully inactivate p53 possibly through degradation. Our work hopes to further elucidate the mechanism by which MDMX negatively regulates p53 and how it contributes to the function of MDM2.

We propose to study the differences between MDMX and MDM2 and specifically how the RING domain of MDMX, a region which contributes to E3 ligase activity in MDM2 and facilitates binding between the two proteins, is involved in the process of p53 degradation. To this end, we have generated an MDMX mutant that cannot bind to MDM2, to determine the contribution of MDMX to the MDM2:MDMX complex in p53 degradation.

We are also interested in regulation of MDMX itself. Our previous work has shown that MDMX is regulated by the oncogenic signaling pathway of Akt, a serine/threonine kinase, which appears to stabilize the MDMX protein. Upon phosphorylation by Akt, a binding site for an adapter protein, 14-3-3, is generated. The exact function of the adapter protein is not fully understood, therefore, mutant proteins of MDMX have been generated. These mutants are either non-phosphorylatable proteins, or proteins that abolish the adapter binding site. We believe that the effects of Akt on MDMX may contribute to the functional inactivation of p53 under these oncogenic conditions. The goal of our research plan is to generate cell lines that express these MDMX mutant proteins to further understand the role of MDMX in p53 degradation, in particular assessing is functional cooperation with MDM2.

7. Research implementation and results under the program

Title of your research plan:

Regulation of the p53 tumor suppressor by mutants of MDMX, a p53 negative regulator

Description of the research activities:

We were interested in generating epitope-tagged proteins for a variety of MDMX mutants: two non-phosphorylatable mutants, S342A and S367A which abolish Akt phosphorylation sites; P369R mutant, which prevents 14-3-3 binding; and C463A, which prevents MDM2 binding. We used the Invitrogen gateway system and first generated an entry clone containing the MDMX wild-type gene as well as all of the point mutants. We then used this entry clone to make green fluorescent protein (GFP)-tagged and biotin-tagged proteins. We will utilize the GFP-tagged proteins to determine localization of these mutants under different conditions, such as Akt activation or DNA damage. The biotin-tagged proteins will be used for an affinity purification study to determine if there are other molecules that bind to MDMX that may potentially facilitate its function in p53 degradation. After using the Invitrogen system and creating N-terminally tagged proteins, we tested the expression of the mutants in 293T cells. We verified the expression of the tag and the protein by Western blotting using antibodies specific for MDMX and either the GFP or biotin

tag.After confirming the plasmids were correct, we transfected them into a p53 mutant mouse lymphocytic cell line, mutant 3SB, to establish stable cell lines expressing these mutants. At the end of the summer term, we were in the process of selecting stably expressing cells. In the future, these stable cell lines will be utilized in experiments to determine the effects of MDMX mutants on p53 in response to DNA damage or Akt activation. Stable cell lines will also be utilized for affinity purification to identify novel binding partners of MDMX in this cell line.

As briefly described above, Dr. Suzuki's laboratory has a mouse lymphocytic cell line which has been characterized to contain a p53 point mutation rendering the protein incapable of transcriptional activity. Surprisingly, p53 can still be regulated at the protein level, despite the mutation, making this an appealing setting to determine the function of the MDM2:MDMX complex in p53 degradation in response to DNA damage without the consequences of cell cycle arrest or cell death. We first wanted to more fully characterize this cell line. In order to do this, we cultured 3SB wild-type and mutant cell lines and treated with bleomycin, a DNA damaging agent, to elicit a p53 response. This experiment was done in a time course, where samples were treated once in 1.5 hour intervals for 6 hours. We then harvested and lysed cells and performed Western blot analysis to determine p53 response by observing protein levels of p53 and downstream targets such as MDM2 and p21. We found that p53 was activated in response to bleomycin treatment as indicated by the increase in protein level of p53 itself and its downstream target p21 in the 3SB wild-type cells and observed an increase in p53 protein level in the 3SB mutant cell line in response to bleomycin treatment without activation of downstream targets, as expected. Unfortunately, we could not conclusively determine the states of MDM2 or MDMX protein, as the antibodies used to detect these proteins did not appear to fully recognize the mouse form of the protein. Further experiments will be done with newly acquired antibodies to determine if MDM2 and MDMX are important players in p53 regulation in this cell line.

RESEARCH REPORT

1. Name: Morgana Martin （ID No.: SP06033）

2. Current affiliation: School of Materials Science and Engineering,
Georgia Institute of Technology

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 for Materials Science (NIMS) in Tsukuba, Japan

5. Host researcher: Dr. Toshimori Sekine

6. Description of your current research:

My research is aimed at investigation of the high-strain-rate mechanical properties, deformation mechanisms, and fracture characteristics of a composite, consisting of an amorphous $Zr_{57}Nb_5Cu_{15.4}Ni_{12.6}Al_{10}$ (LM106m) matrix with crystalline tungsten reinforcement particles, through the use of controlled impact experiments and constitutive modeling. Bulk metallic glasses (BMGs) exhibit high strength and deform by shear banding, however they undergo catastrophic failure due to localized deformation. Thus, methods to restrict or control shear band propagation need to be developed via addition of reinforcement particles or alteration of microstructure by partial crystallization. The possibility of exploiting the mechanical properties of BMGs is the motivation for my work. The high-strain-rate mechanical properties of the BMG-matrix composite are investigated using dynamic compression (reverse Taylor) and tension (spall) impact experiments performed using a gas gun instrumented with velocity interferometry and high-speed digital photography. These experiments provide information about dynamic strength and deformation modes and allow for validation of constitutive models. All specimens are recovered for post-impact microstructural analysis to gain information about the mechanisms of dynamic deformation and fracture, and to examine for possible shock-induced crystallization of the amorphous phase. The ultimate goal is to model the mechanical properties and deformation and failure mechanisms and correlate these with the structure and processing conditions. The resulting structure-property relationships can be implemented for design and synthesis of high-strength metallic glass composites with specifically tailored mechanical properties.

7. Research implementation and results under the program

Title of your research plan:

High Pressure Equation of State of a Zr-Based Bulk Metallic Glass

Description of the research activities:

The goal of my summer work was to determine the high pressure U_s-U_p Hugoniot equation of state (EOS) of $Zr_{57}Nb_5Cu_{15.4}Ni_{12.6}Al_{10}$ BMG using the inclined mirror method to simultaneously measure the shock velocity and free surface velocity over a range of pressures (~20-200 GPa). The experiments were performed in a plate impact configuration on disk-shaped samples of 10mm diameter and 2mm thickness using the NIMS two-stage light-gas gun. The experimental conditions for the EOS experiments are given in Table 1. A streak camera was used to record the reflection of light off of the five mirrors. A schematic diagram of the streak camera setup is shown in Figure 1(a) and an example of a streak photograph from shot # 202 is shown in Figure 1(b). The extinction of each reflection gives the time of arrival of the shock wave at that particular surface. Shock velocity is then determined by dividing the sample thickness by the difference in arrival times of the shock wave at mirrors M2/M3 and mirrors M1/M4. The free surface velocity of the specimen was related to the light reflected off the inclined mirror by $U_{fs} = \frac{W}{M}\frac{\tan\alpha}{\tan\gamma}$, where W is the camera streak rate, M is the magnification of the streak camera image, a is the angle between the inclined mirror and the sample, and g, the streak angle from the extinction of the light reflected off of the inclined mirror (IM), is measured from the streak camera image. The particle velocity is given by $U_p \approx \frac{1}{2}U_{fs}$. These experiments give a U_s-U_p Hugoniot EOS, which is also compared with calculations utilizing the impedance matching technique. These experiments also provide information on the high pressure stability of the bulk metallic glass. The data from the EOS measurements is presented in Figure 2. Figure 2(a) shows a plot of shock velocity as a function of particle velocity and the data seems to indicate a non-linear trend (grey dashed line), which is a sign of a phase transformation. Figure 2(b) is a plot of pressure as a function of density and also includes a curve calculated using the Birch-Murnaghan equation, which is applicable only in the case of no reaction. Some of the data points are clearly deviating from the Birch-Murnaghan curve, which is another indication that a phase transformation has occurred at high pressure. Again, a schematic of a possible trendline, indicating phase transformation, is shown.

Five recovery experiments were performed using the single-stage gas gun at NIMS at pressures of ~8-60 GPa. The capsules containing the samples were recovered

following impact, and are shown in Figure 3 along with the conditions for each experiment. The specimens have been removed from the capsules for future analysis and characterization using x-ray diffraction, TEM, and SEM. The information from these experiments will be used to determine the phase transformation behavior of this metallic glass under extreme loading conditions.

Table 1: Shot conditions for EOS experiments.

Shot #	Impact Velocity (m/s)	Flyer Material	Impedance Matching Pressure (GPa)	Streak Camera Pressure (GPa)
201	3149	Al	40	24
202	3015	304 SS	67	54, 78
206	4125	304 SS	104	126

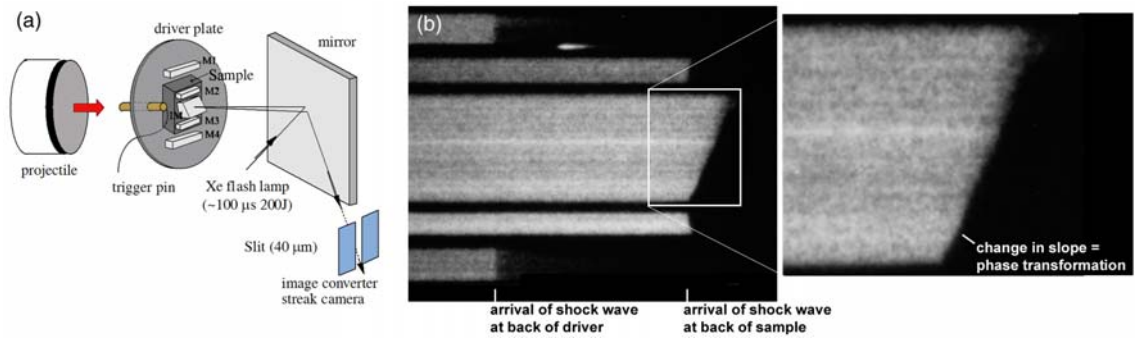


Figure 1: (a) Schematic of setup of sample-mirror assembly and streak camera. (b) Streak camera image from shot # 202. The change in slope of the light reflected from the inclined mirror shows evidence of a phase transformation.

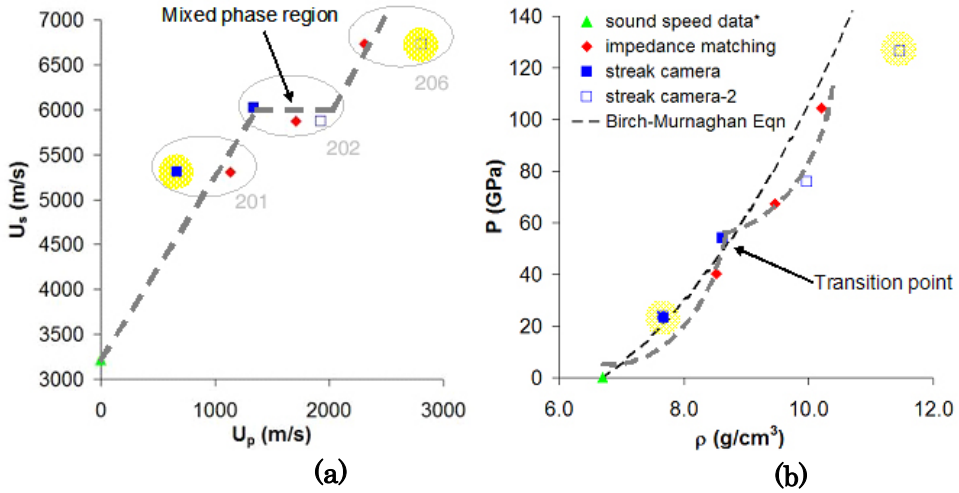


Figure 2: EOS data. (a) Shock velocity as a function of particle velocity. (b) Pressure as a function of density. Also plotted is the Burch-Murnaghan predicted pressure-density relationship which is only applicable in the case of no reaction. The data shows clear deviation from the Birch-Murnaghan curve, indicating phase transformation. In both plots, a possible trendline is shown schematically with gray dashed lines and both appear to indicate phase transformation. Data points which are slightly inaccurate due to misalignment of the projectile on impact are highlighted and neglected in drawing of the schematic line.

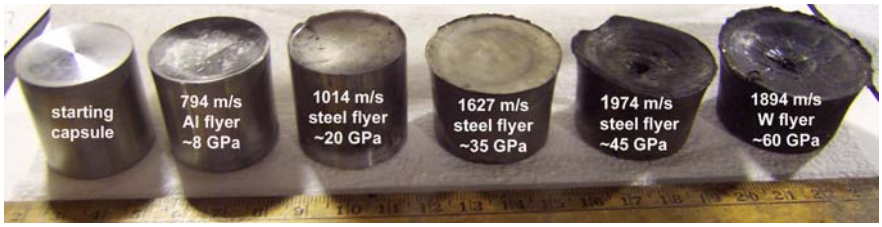


Figure 3: Deformed capsules recovered after experiments. The BMG sample material is inside the capsules.

8. Please add your comments (if any):

Due to technical difficulties with the streak camera, only three out of seven EOS experiments performed were successful. However, this collaboration will continue and the experiments will be completed once the problem has been resolved.

RESEARCH REPORT

1. Name: Jennifer E. McDowell （ID No.: SP06034）

2. Current affiliation: University of Pittsburgh

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: Tohoku University

5. Host researcher: Dr. Ichiro Numazaki

6. Description of your current research

This summer I conducted preliminary field research in the city of Sendai, Japan and the surrounding Miyagi Prefecture towards later Ph.D. dissertation fieldwork. My primary research goal was to establish the validity of potential research questions, improve upon my spoken and written Japanese, and gain future contacts for dissertation fieldwork.

The objective of my project was to answer two questions: (1) how does current production of folk art differ from perceived past production techniques to encourage tourist sales; and (2) how has consumption within Japan and on the Internet changed the perceived use and meaning of the *kokeshi* doll, (a Japanese wooden doll), and what are those perceived uses and meanings that people hold for this doll. To fulfill these objectives, evidence of who was purchasing *kokeshi* dolls and for what reasons was documented. While the Japanese Government usually keeps detailed statistics on all aspects of Japanese life, individual production outputs and sales of folk art in Japan are unavailable. It was important to collect statistics in order to see the trends in folk art production within Japan. Once collected, this information would allow communities to track trends in *kokeshi* sales and be able to adapt to changes in those trends.

7. Research implementation and results under the program

Title of your research plan:

Perceived Uses and Meanings of the *Kokeshi* Doll

Description of the research activities:

The boundaries that once made up a study community for Cultural Anthropological research are no longer so neatly drawn. This summer I logged over 150 hours of train and bus travel in order to reach *kokeshi* doll producing and selling areas outside of Sendai. I also conducted seven in-depth interviews lasting a minimum of an hour with producers and collectors, and informally interviewed forty customers and five employees at the only two stores in Sendai that still sell both traditional and creative *kokeshi*.

Through formal and informal conversations with collectors and producers, *kokeshi* labeled as "traditional" were deemed most important because they represented the longevity of the folk art, a producer being able to point to at least three generations of family members who had also made *kokeshi*. When I would inquire about the creative *kokeshi* sold in producers' shops, they told me that they really did not like this type of doll, but that the tourists did because they were not interested in the preservation of a particular style of *kokeshi*, only aesthetics and the "cuteness" of a doll. When questions of the Internet were broached as a way in which to help improve the overall sales of traditional *kokeshi*, all but one producer stated that it would be difficult to set up a web page, and Japanese consumers would never order a doll off the Internet. The reason being that a collector must see the doll and touch the doll before they buy it. The one producer who did sell his dolls via the Internet stated that his website was utilized by customers in other countries, but that Japanese customers see his site as a catalogue of potential dolls to buy. They pick out a doll they like and then go to his shop, sometimes traveling as far away as Kyushu.

For the collectors and producers of traditional *kokeshi*, creative *kokeshi* where seen in direct opposition to everything that the traditional *kokeshi* stood for. Anyone could become a creative *kokeshi* doll maker or be a designer for the mass-produced souvenir *kokeshi* dolls, but only a person with family members before them or, who had trained under a master *kokeshi* producer could become a traditional *kokeshi* doll maker. A long family connection with the craft was a main factor in the awarding of prizes at *kokeshi* competitions, and reason for praise among producers and collectors alike.

Despite the reverence that collectors seem to have for traditional *kokeshi*, sales have decreased dramatically since 1980, and the emphasis that Sendai city once placed on *kokeshi* doll production has faded. I was told that many young producers of the doll have turned to other forms of employment like that of taxi driver in order to supplement their incomes, or have given up on the craft altogether. Because of the overall decline in sales, those producers who are still active are reluctant to share basic statistics on how many *kokeshi* dolls are sold per year and how much they make off of those sales. At one *kokeshi* doll sale, I noted that collectors, like average consumers, are also biased towards dolls that are esthetically appealing, often ignoring dolls that have been made for several generations. The most popular *kokeshi* doll producer of the moment sold all of her dolls within twenty minutes of a three-day sale, while others had sold none of their dolls by the end of the day.

To make up for lapsed sales, or general disinterest in their dolls by collectors and consumers, traditional *kokeshi* doll producers have been turning to a younger consumer market by making baby sized *kokeshi* dolls. Families can order a *kokeshi* doll in the exact weight and height of their new-born baby for around $100.00. You can also include a message to your child within the body of the *kokeshi* for around $150.00. It is emphasized on the order form that this doll will be a marker of how the child grows through the years, a cherished memento to be passed on through the generations. Other producers, along with traditional dolls, produce slightly creative *kokeshi* with varying facial expressions. I watched as several business men joked over the fact they could get a grumpy or sad faced *kokeshi* doll to put on their desk at work to express their feelings on that particular day.

For the average consumer of *kokeshi* who is not so deeply connected with the history of the doll, the meaning of the word "*kokeshi*" still draws speculation, and the differences between traditional and creative *kokeshi* are not so deeply felt. While collectors are quick to point out that the traditional *kokeshi* doll has no link with early infanticide in Japan (*ko* = child and *keshi* = erasing), some consumers do believe that there is a link with children and the *kokeshi* doll. The doll can be seen next to statues at abortion temples, and is often purchased for the protection of children and the home. One seller of *kokeshi* dolls at the Tanabata Festival captured the perceived mysterious meaning of the *kokeshi* doll by making a play one the word *kokeshi* with the word "*kokoro*", (one meaning for the word being heart). Indicating that this was a doll made from the heart and imbued with all the warmth and love that that word may mean in the consumer's mind.

RESEARCH REPORT

1. Name: David Brandon McNeil （ID No.: SP06035）

2. Current affiliation: University of North Texas

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: Tsukuba Advanced Research Alliance, University of Tsukuba

5. Host researcher: Dr. Kiyoshi Asakawa

6. Description of your current research

I am currently investigating the effect of anisotropic substrates and metallic layers on the propagation of *anisotropic* surface plasmon polaritons (SPPs). SPPs are effectively small bundles of light bound into polarized surface modes between the interface of a positive dielectric, such as silicon or gallium-arsenide, and a negative dielectric, usually a metal like aluminum or silver. Usually, theoreticians assume plasmon substrates are **isotropic**; the dielectric tensor of the substrate is reducible to a single eigenvalue, i.e. the dielectric constant is the same in all directions of propagation. However, in some materials, for instance zinc-oxide, this is not the case; these are **anisotropic** systems with differing dielectric constants in the parallel and perpendicular directions. We also realized early on as we began developing the theory that there is another type of system with varying dielectric constants: photonic crystals. Additionally, photonic crystals can have much more extreme variations in their dielectric tensors, thus further stressing the differences between the iso- and anisotropic systems.

Prior to traveling to Japan, I developed a theoretical model for such a system, using as few approximations as possible to avoid blurring the effects we expect to appear in an anisotropic system. As in most surface plasmon theory, we start by solving for a dispersion equation and everything else derives from there. In the anisotropic case, the dispersion equation becomes so complicated that a numerical solution becomes the only option. Using an extremely large data set, I've plotted a theoretical dispersion curve that I plan to verify using real world systems. Then I would like to illustrate there are actually some practical, real-world applications that can be exploited from this system.

7. Research implementation and results under the program

Title of your research plan:

Surface Plasmon Enhanced Nanodevices

Description of the research activities:

I arrived in Japan with an idea of the device I wanted to fabricate to test my surface plasmon theory. Unfortunately, it turned out that this was too complicated to fabricate. So, I spent the first portion of my time in Japan redesigning to find a photonic crystal that had potential to be fabricated. I also needed to adjust my theoretical calculations some to adapt to the specifics of their system. We brought the proposed structure to the growth group to be made, but they claimed it was too difficult. Despite numerous small modifications to attempt to make things easier, we were still unable to fabricate an effective crystal.

While we attempted to create our crystal, I spent a large portion of my time in the characterization lab in TARA. I learned a lot about their characterization techniques: both the underlying theory and the actual methodology they used. I also assisted them as they attempted to get a new type of setup working; however, insufficient data on one of the supplied components prevented us from finishing more than an initial setup (though the final steps should be easy from this point on).

As we began to realize that we would be unable to fabricate the sample I would need, Dr. Asakawa turned me to a different project. Since he knew that I have theoretical experience, he began having a member of his group, Dr. Ozaki, train me to use a piece of software called RSoft, used for calculating the band structures of photonic crystal type devices. Learning RSoft not only enabled me to help out Dr. Asakawa's group, but, in addition, my group at the University of North Texas has been planning on buying RSoft – so knowing how to use the program will be useful when I return.

Since RSoft is a very complicated program, learning the details on how to create a useful simulation took about two weeks. During this training period, I spoke often with Dr. Ozaki about what they had already done and what sort of structures they would like analyze in the near future. When I finished learning how to use RSoft, I created a fairly flexible simulation whose parameters could easily be varied to create a wide range of structures.

As I was beginning to run low on time at this point, I decided on two sets of tests to run that I could most likely finish in time. The first was a set of 54 simulations varying 4 different parameters. I was only looking at getting a general overview of what the large picture could look like, so I ran my tests with 10 division points, a

fairly low number compared to what we used in most of my training, but significantly faster to compute. For my second test, I knew that Dr. Ozaki was uncertain as to how accurate the test would be with a smaller number of division points. As I was using this myself, I wanted to verify that the data I was getting was still accurate enough to be able to pull larger conclusions from. Thus, in the future (if I was able to prove the smaller number of division points was accurate), Dr. Ozaki would be able to run a series of quick calculation to find roughly the correct area to optimize before running a much longer test. For this second test, I picked three of the data sets from the first test and ran longer simulations, this time with a fairly standard 500 division points, and put the graphs side by side. As expected, the smaller set is fairly accurate. It seems that, while the smaller set might deduce what we call "false bandgaps" easier than the larger data set, a careful human eye should be able to spot any problems fairly easily. ("False bandgaps" are created when on band crosses another band. RSoft is too simple to notice these crossovers and simply switches which line it follows.)

Dr. Ozaki has already taken my general overview data set and presented it to a larger group of researchers that work together with my host group at TARA. There was some interesting feedback of ideas that he plans to explore after I leave (perhaps with my help once my home institution has picked up the software).

Additionally, while I've been in Japan, I took a couple days to visit Dr. Teruya Ishihara's Exciton Engineering Laboratory, a part of the Frontier Research Group at RIKEN. While there, I learned how to operate a streak camera to perform time resolved photoluminescence measurements. I ran several tests on a sample I had sent from home, as well as a very simple control sample we prepared in Dr. Ishihara's lab. The initial data looked interesting, but it will take much more careful study when I return to North Texas to see exactly how good (or useful) the information is.

8. Please add your comments (if any):

I learned much here in Japan that should prove very useful as I continue working on my PhD in America. Also, despite being unable to fabricate my sample this summer, Dr. Asakwa has offered that, if possible, he will continue trying to get it made for me, perhaps when another instrument is put back into working condition in the next month or two. Hopefully I will then be able to finally verify my theory!

RESEARCH REPORT

1. Name: Adam Mendelsohn （ID No.: SP06036）

2. Current affiliation: UC San Francisco/UC Berkeley Joint Graduate Group in Bioengineering

3. Research fields and specialties:

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

4. Host institution: Kyoto University

5. Host researcher: Professor Mitsuru Hashida, Department of Drug Delivery Research

6. Description of your current research

Tumor metastasis is the leading cause of death in cancer patients. During metastasis, the interaction of dissociated tumor cells with normal cells increases the production of reactive oxygen species (ROS), particularly hydrogen peroxide. Sufficient ROS is lethal to both normal and cancerous cells. However, at sub lethal concentrations ROS activates genes that promote tumor metastasis. Detoxification of ROS can be achieved through targeted delivery of catalase, an enzyme that detoxifies hydrogen peroxide. Experiments targeting catalase to metastatic colonies in the lung and liver have been achieved through intravenous injection of catalase and chemically-modified derivatives. These experiments suggest significant reduction in the number of surviving metastatic colonies. One limitation of injection is sustaining an effective catalase presence. The purpose of this research will be to investigate the use of gelatin hydrogels as a sustained delivery method of chemically-modified catalase.

7. Research implementation and results under the program

Title of your research plan:

Sustained Release of Chemically-modified Catalase from Gelatin Hydrogels for Inhibition of Tumor Metastasis

Description of the research activities:

Experiment #1: Chemically-modified catalase hydrogel release profile and biodistribution from mouse back subcutis implantation

- Evaluation of pegylated-catalase (PEG-CAT) and ethylenediamine-catalase (ED-CAT) from a gelatin biodegradable hydrogel.
    - 12 mice each received ^{111}In-PEG-CAT and ^{111}In-ED-CAT hydrogels with isoelectric points 9.0 and 5.0, respectively. ^{111}In is a gamma emitter, and when attached to catalase, helps determine the amount of catalase by counting the number of particlesgamma rays emitted per unit time.
    - At each of 4 different time points: 1, 4, 7, and 14 days, the amount of catalase remaining in the hydrogels, as well as the amount accumulated in the lungs, liver, kidneys, and blood of 3 mice were counted. From this information the release profile and the biodistribution in organs of interest can be established.
- Results: ^{111}In-PEG-CAT hydrogel release data suggested near complete release from the hydrogel within the first day and insignificant accumulation in any of the organs. These results may be due to unstable labeling of Indium. This experiment should be repeated and labeling stability should be evaluated. ^{111}In-ED-CAT hydrogel release data suggested a more reasonable release profile (~9% remaining at 14 days with zero-order kinetics) and organ accumulation. Specifically, the ED-CAT appeared to accumulate over time in the liver, suggesting usefulness in preventing hepatic metastasis (see experiment #4).

Experiment #2: Effect of PEG-CAT Hydrogel implanted in mouse back subcutis on spontaneous metastasis following footpad tumor inoculation

- 16 mice (C57/BL6 4 weeks male) received $2 \cdot 10^5$ murine melanoma cancer cells (B16-BL6/Luc) labeled with luciferase in 20 μL of Hanks Balanced Salt Solution (HBSS) into their footpad.
- One week after tumor inoculation, 4 mice each received the following treatments: PEG-CAT hydrogel, free PEG-CAT, BSA hydrogel, free saline.
- Three weeks after tumor inoculation, luciferase assay was used to determine the number of cancer cells in the lung. When exposed to luciferin, luciferase emits light that is measured and correlates to the number of cells.
- Results: Free saline and all but one BSA hydrogel mice did not exhibit significant tumors in the lungs. One of the BSA hydrogel mice had a slightly larger number of tumor cells, and one of the PEG-CAT hydrogel

mice had by far the highest number of tumor cells. These results may be explainable by the vein being injured during tumor inoculation increasing metastasis. Unexpectedly, the control mice did not exhibit lung metastasis. A previous experiment identical except that saline was intravenously introduced showed significant lung tumor accumulation. These results should be studied further. Additionally, in 1981 Shapiro and Jersky demonstrated a significant anesthetic effect on an identical model of tumor metastasis, a variable that was uncontrolled during this experiment.

Experiment #3: Peritoneal dissemination inhibition by PEG-CAT hydrogel implantation in mouse peritoneal cavity.

- Clinically, surgical removal of a gastrointestinal tumor increases metastasis to other abdominal organs. This model is simulated by peritoneal inoculation of cancer cells (colon26/Luc). 16 mice (Balb/C 5 weeks male) received 10^5 cells. Immediately before inoculation, in groups of 4, the mice received: PEG-CAT hydrogel, ED-CAT hydrogel, free PEG-CAT, free saline.
- One week after inoculation, luciferase assay was used to measure the tumor accumulation in the following organs: greater omentum, liver, kidneys, spleen, and peritoneum.
- Results: With one aberration, PEG-CAT hydrogel showed significant decrease of metastasis. Interestingly, free PEG-CAT showed increased metastasis in the spleen, reminiscent of a previous experiment which showed the same for free native CAT. The sum of all organ metastasis, including the one aberration, result in no statistical difference between the treatments. However, some factors may have contributed to the result such as injury to organs during tumor inoculation. The results are promising and the experiment should be repeated and studied further.

Experiment 4: Experimental hepatic metastasis inhibition by ED-CAT hydrogel implantation in mouse back subcutis.

- 10^5 tumor cells (colon26/luc) in 100 μL HBSS were inoculated into the portal vein of 16 mice (Balb/C 5 weeks male). In groups of 4, the mice received: ED-CAT hydrogel, free ED-CAT, BSA hydrogel, free saline.
- Two weeks after inoculation, luciferase assay was used to measure the tumor accumulation in the liver.
- Results: ED-CAT hydrogel results suggested an improvement in metastasis from all other treatments, however a larger study is needed to prove statistical significance. Interestingly, BSA hydrogel exhibited the most amount of metastasis.

8. Please add your comments (if any):

Wonderful, enjoyable, educational experience.

RESEARCH REPORT

1. Name: Lindsey K. Moritz （ID No.: SP06037）

2. Current affiliation: University of Wisconsin – Madison

3. Research fields and specialties:

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

4. Host institution: Kyoto University – Center for Ecological Research

5. Host researcher: Kanehiro Kitayama

6. Description of your current research

Soil carbon cycling is a complex process that has the potential to tremendously impact the future course of global climate change. It is unknown whether soil will serve as a net carbon source, thereby amplifying global warming, or if soil will act as a carbon sink, thus negating the effects of increasing atmospheric carbon dioxide. The missing link in this controversy may be found in the dynamics of carbon turnover in deeper soil, where up to 70% of the carbon stored in soils is found (>20cm). Therefore, the response of soil carbon to turnover at different depths within the profile is critical in predicting the response of ecosystems to global climate change. The purpose of our research is to investigate the potential mechanisms involved in the turnover of deep soil carbon and compare these findings to surface processes in an old world tropical rainforest. The links between microbial community composition, enzyme activity, soil texture, and soil carbon fractions throughout the soil profile (up to 2 meters) are being investigated at Mount Kinabalu, Borneo on two differing geologic substrates (ultrabasic and sedimentary origin). Enzyme analyses for polyphenol oxidase and beta-glucosidase have been performed on bulk soils for all depths. Soil will be separated using particle separation and density fractionation procedures. Subsequent microbial analyses will be conducted on bulk, particle, and density fractions using phospholipid fatty acid (PLFA) and amino sugar techniques to assess the past and present microbial community compositions. Results are anticipated to provide valuable information pertinent to global change modeling efforts and improve predictions of global climate change by clarifying the relationships between soil microorganisms and carbon fraction pools at varying soil depths.

7. Research implementation and results under the program

Title of your research plan:

The role of microbial dynamics in deep soil carbon storage and turnover.

Description of the research activities:

The first five weeks of this program I was at the Center for Ecological Research at Kyoto University. During my time there I gave several seminars, constructed my research proposal, and learned and refined several laboratory techniques, including enzyme assays and density separation, which are critical methods in my research. I also visited a soil science laboratory at Kyoto University's main campus to investigate methods in soil particle separation that I may employ upon returning to the University of Wisconsin.

During the remainder of the program, I participated in a tropical ecology field course, conducted my field sampling, and completed several laboratory measurements on my soil samples at the research station at Mt. Kinabalu, Borneo. My soil samples were freeze-dried and are being shipped to the United States, where I will continue with my research and conduct further microbial analyses.

8. Please add your comments (if any):

I stayed with a host family while in Japan and they were the most kind, helpful, and thoughtful people I have ever had the pleasure of encountering. Both my cultural and research experiences were enriched because of the support and generosity of the Kimura family. I am truly appreciative and indebted to their kindness. Thank you.

RESEARCH REPORT

1. Name: James P. Morris （ID No.: SP06038）

2. Current affiliation: Ohio 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: KEK: High Energy Accelerator Research Organization

5. Host researcher: Dr. Masashi Hazumi

6. Description of your current research

Experimental particle physics involves assembling many pieces to the puzzle of what is known as the "Standard Model." In said model, tens of thousands of decay modes need to be described in order to fully understand interactions at the most fundamental levels.

To this end, I study various decay modes for the BaBar experiment at Stanford Linear Accelerator (SLAC). These modes include semileptonic modes including D-> rho gamma and charm modes including D->Kpi.

7. Research implementation and results under the program

Research was performed at KEK Accelerator Research Facility in Tsukuba, Japan. Research involved simulation using GEANT4 software.

Title of your research plan:

GEANT4 Simulation of KEK EFC performance in preparation of SuperKEK upgrade

Description of the research activities:

Current research involved simulation of Belle environment through the, as of yet, unused Extreme Forward Calorimeter (EFC) to determine the necessary luminosity for the future upgrade of KEK/Belle to SuperKEK/SuperBelle. The simulation involved constructiong the EFC in GEANT4 software, integrating this with the current Belle Detector.

8. Please add your comments (if any):

This experience was invaluable for my future as a researcher and as a human being. The experience garnered here will help me for future employment and as a scientist. I would highly recommend this program to any other researchers.

RESEARCH REPORT

1. Name: Timothy B. O'Hara （ID No.: SP06039）

2. Current affiliation: University of Illinois

3. Research fields and specialties:

Humanities Social Sciences XX 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. Yasushi Suto

6. Description of your current research

Galaxy cluster surveys provide a powerful means for studying the evolution of the universe. My research is concerned with understanding scaling relations (relationships between various properties of clusters such as luminosity and temperature), and the application of that understanding to cluster cosmology surveys.

The first major component of this work involves studying the scaling relations themselves. Of particular interest to us is the nature of scatter about these relations, and how this scatter is correlated with indicators of cluster evolution such as X-ray morphology and development of cool, dense cluster cores. As X-ray luminosity will be used as a proxy for cluster mass in surveys of thousands of clusters, this work is necessary for the understanding of biases that may be introduced into cosmological measurements. We have already carried out a study of the scatter about cluster scaling relations using a sample of nearby galaxy clusters. The next stage involves the reduction of data for a large sample of intermediate-redshift clusters observed with the *Chandra* X-ray observatory, and the study of evolution of scaling relation scatter over cosmic time.

The other component of this investigation will be a reanalysis of a sample of ~400 nearby galaxy clusters observed with the *ROSAT* X-ray observatory. As the data has already been reduced by collaborators, relatively little work will be needed to prepare for the cosmological analysis. We will be able to use our newfound knowledge of cluster scaling

relations to better quantify biases in measured cosmological parameters. We will also test other techniques not yet used in such studies, such as determination of certain quantities via “self-calibration” from the data itself, rather than externally imposing them.

This was the planned work for the EAPSI project.

7. Research implementation and results under the program

Title of your research plan:

Overcoming Systematics in Cluster-Based Studies of Cosmology

Description of the research activities:

Owing to delays in receiving needed data from collaborators, the work initially planned for the summer (i.e., the reanalysis of cluster parameters using a nearby cluster sample) was infeasible. Instead, my work during the summer was focused on the first part of the work outlined above, i.e., the intermediate-redshift sample. At this point most of the work on this project is simply data reduction, so relatively little interaction was necessary or beneficial. However, I engaged in science discussions with researchers at my host institution and elsewhere that have stimulated new research ideas, and laid some groundwork for future collaboration on various aspects of galaxy cluster structure.

8. Please add your comments (if any):

While the planned research could not be carried out, the EAPSI program was nonetheless quite worthwhile. It provided an interesting view into the interaction between researchers in another country and culture, in addition to simply facilitating a helpful exchange of ideas with scientists with whom I was not previously in contact.

RESEARCH REPORT

1. Name: Keiko Petrosky （ID No.: SP06040）

2. Current affiliation: University of California, San Francisco

3. Research fields and specialties:

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

4. Host institution: Laboratory of Animal Breeding/Veterinary Medical Science/
Graduate School of Agriculture and Life Sciences/
The University of Tokyo

5. Host researcher: Professor Kazuhiko Imakawa

6. Description of your current research

MECHANISM UNDERLYING DIRECTED ASSEMBLY OF SUPRAMOLECULAR MAGUK SCAFFOLD COMPLEXES

In multicellular organisms, accurate transmission of cellular signals is achieved using membrane-associated signaling complexes that transmit and receive cellular communication. One way signaling complexes achieve high specificity in the face of dynamic changes in signaling requirements is the use of scaffold proteins that bind and recruit members of the relevant signaling pathway. My thesis work focuses on molecular recognition and the mechanism by which modular domains in Membrane Associated Guanylate Kinase-like (MAGUK) scaffold proteins assemble functional signaling complexes.

MAGUK family scaffolds are multi-domain membrane associated proteins that couple extracellular stimuli to intracellular signaling pathways. Composed of protein-protein interaction domains, MAGUK scaffolds organize signaling complexes by binding receptors, channels, signaling factors, and cytoskeletal elements. MAGUK scaffold proteins are found in diverse sites of polarized cell-cell contact such as neuronal synapses, epithelial tight junctions, and immune synapses. I take a biochemical and structural approach to study the regulation of MAGUK scaffold multimerization and assembly with scaffold protein 4.1, a membrane-associated scaffold protein found in neuronal synapses, epithelial tight junctions, and other sites of cellular polarity.

Modular protein-protein interaction domains play a key role in regulating the

organization of the macromolecular signaling complexes assembled by MAGUK scaffold proteins. My thesis work demonstrates the regulatory power of modular design in controlling assembly of macromolecular complexes.

7. Research implementation and results under the program

Title of your research plan:

Detection of transcription factors expressed in nucleus of trophoblast-derived cell lines

Description of the research activities:

Professor Imakawa's laboratory studies the mechanisms regulating expression of interferon-tau gene expression, the pregnancy recognition hormone in ruminant ungulates (sheep, cattle, goats). Many transcription factors (proteins that bind DNA and play a role in gene regulation) have been identified as important in the differentiation between embryo and trophoblast (a layer of cells that attaches the fertilized ovum to the uterine wall and serves as a nutritive pathway for the embryo).

I attempted to determine whether transcription factors identified in regulating embryonic development and others known to regulate interferon-tau gene expression interacted with each other directly. I assayed the following transcription factors for binding: Cdx-2 (implicated in the control of trophectoderm differentiation) and Eomes (also found in the trophoblast); Oct-3/4 (a pluripotency gene) and Nanog (epiblast specifying transcription factor), which play an important role specificying embryonic lineage; Ets-2 and C-jun (ubiquitous transcription factors).

Using the technique of immuno-precipitation, a "prey" protein is "fished" from cell lysate if it interacts with a "bait" antigen with a specific antibody. I used lysates from bovine trophoblast-derived cells. Detection of binding partners was done by Western Blot, a technique in which antibodies are used to conjugate a molecular probe to the protein of interest. Though preliminary studies indicate that C-jun and nanog may interact, I was unable to obtain data due to technical difficulties, and further research is needed.

8. Please add your comments (if any):

I would like to thank members of the Laboratory of Animal Breeding, especially Professors Sakai and Imakawa for hosting me, and Dr. Nagaoka for technical assistance. Most importantly for my professional development, I learned about veterinary medicine in Japan. In particular my exposure to Japanese laboratory animal medicine has greatly influenced my future career in American laboratory animal medicine. I would like to thank the many veterinarians that gave me tours, offered me advice, and allowed me to participate in their seminars and clinics at the following institutes: University of Tokyo Veterinary Hospital, Center for Disease Biology and Integrative Medicine at the University of Tokyo Graduate School of Medicine, the Central Institute for Experimental Animals, and the National Institute of Animal Health. Thank you JSPS and NSF for funding and organizing this important exchange program.

RESEARCH REPORT

1. Name: Rodney Dewayne Priestley （ID No.: SP06041）

2. Current affiliation: Northwestern 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 Institute of Technology

5. Host researcher: Dr. Koji Fukao

6. Description of your current research

My current research is the investigation of polymer structural relaxation below the glass transition temperature. The glass transition temperature (Tg) of amorphous polymers is associated with the reduction of molecular mobility of the molecules into a non-equilibrium solid form without the formation of ordered crystals. Accompanying the formation of the glass is the slow conformational rearrangement (physical aging) of the molecules to obtain structural equilibrium. My current research involves investigating the impact of nanoconfinement, surfaces and interfaces on the physical aging response of glass formers. Using novel fluorescence methods I have examined the impact of polymer-substrate interactions on the physical aging response of ultrathin polymer films. Recently, I have probed the effects of the air-polymer interface and the substrate on the distribution of physical aging rates in bulk glass formers. I have found that at both the air-polymer interface and the substrate the physical aging response is retarded.

7. Research implementation and results under the program

Title of your research plan:

Confinement Effects on the Distribution of Alpha Relaxation Times in Ultrathin Polymer Films and Polymer Nanocomposites

Description of the research activities:

My summer research involved using dielectric relaxation spectroscopy to determine the distribution of alpha relaxation times in ultrathin single layer polymer films, thin multilayer polymer films, and polymer nanocomposites. With decreasing polymer film thickness it was observed that the distribution of alpha relaxation times broaden compared to a thick film. Using a novel multilayer method in which the distribution of alpha relaxation times was measured at discrete locations within a thin polymer film, we observed that at the air-polymer interface of a thin polymer film the distribution of alpha relaxation times is broader than in the thin interior.

With the addition of a small amount of nanoparticles into a polymer film we observed that the distribution of alpha relaxation times was also broaden. We also observed an increase in the glass transition temperature of polymer films with the addition of nanoparticles into the film. Lastly, the addition of nanoparticles into the polymer films results in a reduction the beta transition temperature of the polymer films.

RESEARCH REPORT

1. Name: Misty C. Richards （ID No.: SP06042）

2. Current affiliation: Albany Medical College

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 Center of Neurology and Psychiatry (NCNP)

5. Host researcher: Dr. Hiroshi Kunugi, M.D., Ph.D.

6. Description of your current research

Schizophrenia is a debilitating psychiatric disorder that affects approximately 1% of the world's population. While the contributing genes and pathophysiological mechanisms remain elusive, identifying the susceptibility genes is essential in discovering the true pathogenesis of the disease. Thus far, linkage and association studies have been the main approaches in searching for complex disease genes. Such studies have identified the Epsin4 gene (also referred to as ENTH) as well as the vesicular monoamine transporter 1 gene (VMAT1) as potential schizophrenia susceptibility genes. Our objective this summer is to understand the role of the Epsin4 and VMAT1 genes in the pathophysiology of schizophrenia and to discover if genetic susceptibility within these genes varies across populations. We aim to replicate two studies on VMAT1 and Epsin4 genes, completed by Bly et al. and Pimm et al. respectively, and to potentially discover new single nucleotide polymorphisms (SNPs) and non-synonymous polymorphisms.

EPSIN4 GENE

A recent association study on the Epsin4 gene found it to be a strong candidate for schizophrenia susceptibility in English, Irish, Welsh, and Scottish populations (Pimm et al.). Four associated polymorphisms were discovered at the 5' end of Epsin4, a gene encoding the clathrin-associated protein enthoprotin. These included two microsatellite markers, D5S1403 and AAAT11 and two single-nucleotide-polymorphism (SNP) markers within the Epsin4 gene, rs10046055 and rs254664. Enthoprotin plays a role in transport and stability of neurotransmitter vesicles and may be responsible for genetic susceptibility to a subtype of schizophrenia on chromosome 5q33.3.

Given the critical biological role of the Epsin4 gene in neurons, two replication studies have been conducted by different laboratories resulting in one positive and one equivocal finding. Tang et al. found the presence of a locus near the 5' end of Epsin4 in Chinese family trios, supporting the role of Epsin4 as a contributor to genetic risk in schizophrenia. Liou et al, however, analyzed 9 single nucleotide polymorphisms (SNPs) on Epsin4 in a Han Chinese population and failed to obtain robust evidence for associations. In an attempt to replicate Pimm et al's original findings, our laboratory studied the genetic variations of the Epsin4 gene in a Japanese population. In addition, we sequenced the promoter region of the gene to look for novel SNPs that may be associated with schizophrenia susceptibility.

VMAT1 GENE

VMAT1 is also an attractive candidate gene for schizophrenia not only because it plays a critical role in the maintenance of monoaminergic endocrine systems but also it maps to chromosome 8p21.3 (Peter et al., 1995), a locus with strong evidence for linkage with schizophrenia. A recent study reported that a polymorphism in exon 3 of VMAT1 that results in an amino acid change (277C>A resulting in Thr4Pro) was significantly associated with schizophrenia (Bly, 2005). The C/C genotype (homozygosity for proline residue at codon 4) occurred in 21.4% of the schizophrenic group and only 2.6% of the control group. The A/A genotype (homozygosity for threonine), on the other hand, occurred in 28.6% of the schizophrenic group and 73.6% of the control group. Such a dramatic difference in one polymorphism of the VMAT1 gene in a Caucasian population prompted us to attempt replication of this finding in a Japanese population. In addition, we examined 3 other non-synonymous polymorphisms in the VMAT1 gene for potential association with schizophrenia.

7. Research implementation and results under the program

EPSIN4 GENE

We failed to replicate the finding of Pimm (2006) in the Japanese population. Regarding the two SNPs found to be significant in the Caucasian population (rs10046055 and rs254664), we found no significant difference between the schizophrenic and control populations. We have not yet analyzed the 2 microsatellites found to be significant in the Caucasian population. Furthermore, we analyzed 9 additional SNPs in the Epsin4 gene and found no significant association with schizophrenia susceptibility. After sequencing the promoter region, however, we were able to discover two novel SNPs that were not registered in the National Center for Biotechnology Information (NCBI) database. We have registered these SNPs and further analysis is being conducted.

VMAT1 GENE

We failed to replicate the finding of Bly (2005) in our sample. For the remaining non-synonymous polymorphisms (referred to as SNPs from this point forward), however, we found a significant difference in genotype and allele distributions in SNP2, but not in

SNP3 or SNP4, between patients and controls. For SNP2, the Thr98 allele (C) was significantly more common in patients than in controls (P = 0.01, odds ratio=1.39, 95% CI 1.09-1.77). Haplotype analysis with two markers consisting of SNP2 and SNP3 showed a significant association (permutation p = 0.019).

Our failure to replicate the finding of Bly (2005) may be attributable to ethnic differences between Caucasians and Asians with respect to SNP1. Our finding, however, that SNP2 is significantly different between schizophrenics and controls suggests that the greater frequency of the 98Ser allele in the control population may have a protective effect against the development of schizophrenia. Haplotype-based analyses also yielded several significant differences in haplotype frequencies between patients and controls only when SNP2 was included in the analysis, providing further support for the possible role of SNP2. However, the possibility remains that unknown polymorphisms nearby which are in linkage disequilibrium to SNP2 might be "truly" responsible in giving susceptibility to schizophrenia.

Title of your research plan:

1.) THE ROLE OF THE EPSIN4 GENE ON CHROMOSOME 5q IN THE GENETIC SUSCEPTIBILITY TO SCHIZOPHRENIA

2.) POSSIBLE ASSOCIATION OF THE VESICULAR MONOAMINE TRANSPORTER 1 (VMAT1) GENE AND SCHIZOPHRENIA IN A JAPANESE POPULATION

Description of the research activities:

Many laboratory techniques were learned and applied: 1.) National Center for Biotechnology Information (NCBI) database searching, 2.) Genotyping all SNPs using TaqMan Polymerase Chain Reaction (PCR) experiments, 4.) Isolating and sequencing the promoter region of a gene, 4.) Identifying novel SNPs through use of sequencing data output, 5.) Fragment analysis of microsatellites, 6.) Gel electrophoresis, 7.) DNA purification, and 8.) Analyzing results with various genetics software programs (Haploview, COCAPHASE, etc).

8. Please add your comments (if any):

I have learned a tremendous amount about research and genetics this summer. From project design and implementation to manuscript writing, this laboratory has allowed me to participate in a wide array of processes. I feel fortunate to have been part of such a meaningful project and to have worked with such talented individuals.

9. Advisor's remarks (if any):

During the stay, Miss Misty Richards has been working very hard and good terms with people in the laboratory, which have enabled her to learn a lot of laboratory techniques and statistics of modern psychiatric genetics. She has already written a brief research paper on VMAT1 gene and schizophrenia which will be submitted soon to Am J Med Genet. Now she goes on to prepare another paper on the epsin 4 gene. I am sure that her stay has been very fruitful for her and our laboratory also.

RESEARCH REPORT

1. Name: Juliana M. Rokosky （ID No.: SP06043）

2. Current affiliation: Earth and Planetary Sciences Dept.,
University of California, Santa Cruz

3. Research fields and specialties:

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

4. Host institution: National Research Institute for the Earthquake Science and Disaster Prevention

5. Host researcher: Dr. Kazushige Obara

6. Description of your current research

At my home institution, the University of California Santa Cruz, my dissertation research consists of two major projects:

(1) I study seismic anisotropy in the deep mantle of the earth to provide insight into the dynamics of the region. My research has focused on the deep earth beneath the Central Pacific and west of Central America, two regions with distinct velocity structures, to characterize the geometry of anisotropic structures and scale lengths over which they vary. This information will provide important constraints for dynamic modelers and mineral physicists in their work to better characterize the mineralogy and dynamics of this lower mantle region, which in turn has important implications both for current early Earth history and current mantle circulation.

I have developed a technique for probing deep mantle anisotropy that is currently the best equipped to isolate the effect of deep mantle structures on seismic waves traversing long paths through the planet's interior. As part of my dissertation I hope to expand this methodology to several more regions of the deep mantle to provide a more complete picture of the variety of anisotropic structures present in the deep mantle.

(2) My second project, which motivated my travel to Japan, surrounds the recently discovered phenomena of slow slip earthquakes and correlated tremor on subduction zones. These events are of interest to scientists (and the public at large) because they may affect the potential for large subduction earthquakes that pose significant human risk. I am broadly interested in understanding how these slow slip events effect seismicity on and

near the subduction plate interface. One important clue to the origin and effect of slow slip events is to study the associated phenomenon of subduction tremor. At UC Santa Cruz I have investigated seismic records from Costa Rica, Cascadia, and Japan to understand the variability in tremor signals. We are in the process of deploying a seismic and geodetic array in Costa Rica, which will give us the ability to capture clearer signals of slow slip and tremor in this region. As we wait for this data to be collected, I am working to expand my understanding of the phenomena globally and to hone my processing skills, so that I will be well equipped to fully analyze the new Costa Rica data. This work and the research begun this summer on Japanese tremor data will compose a significant portion of my doctoral dissertation.

7. Research implementation and results under the program

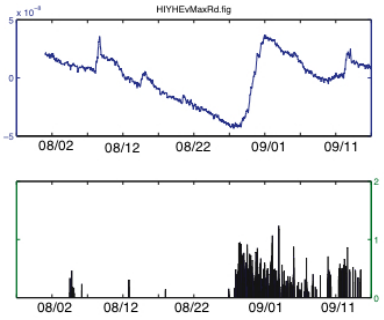
Title of your research plan:

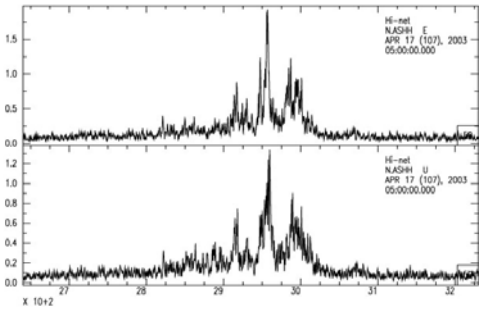
INVESTIGATING SEISMIC SIGNALS ASSOCIATED WITH SLOW SLIP

Description of the research activities:

I had a myriad of goals for this summer, but the main purpose of my stay the National Institute of Earth Science and Disaster Prevention (NIED) was to gain a better understanding of tremor phenomena in Japan by speaking with experts at the Institute and spending time looking at and processing the exceptional HiNet seismic data set. The bulk of the research I accomplished this summer centered on calculating and comparing the reduced displacement for tremor in 10 events spread over three regions in Japan (Shikoku island and the Kii and Tokai Peninsulas). Reduced displacement is a parameter first defined by Aki and Koyanagi (1981) to investigate the distribution of amplitudes in volcanic tremor. Reduced displacement has been regularly used since the early 1980s to compare the amplitude of tremor signals at different volcanoes around the globe. Making similar calculations for subduction tremor can help us understand if differences exist between episodes and source regions of tremor. I compared tremor amplitudes between stations, events, and source regions and found surprising consistency in tremor amplitude between events and source regions, suggesting that the character of slow slip does not affect the magnitude of tremor produced. This is similar to results from work done in the Cascadia subduction zone (McCausland et al., 2005) where subduction tremor and slow slip are also observed. The combination of these results suggest that tremor and slow slip are distinct phenomena. However, preliminary results from Japan do suggest that tremor amplitudes peak during peak slip bolstering claims that slow slip directly triggers tremor activity.

The average value of tremor reduced displacements in Japan is 0.44 cm^2, only slightly larger than tremor in Cascadia. However, peak values in Japan are significantly higher, which may be related to the presence of impulsive arrivals embedded in Japanese tremor. Such arrivals have yet to be observed in Cascadia and this result may suggest they do not exist.





(Left) Example comparison of tilt record of a slow slip event and a histogram of tremor Rd, for the August 2003 event. (Right) Envelope function of a tremor burst recorded at one station, converted to reduced displacement. Top is the east horizontal component and the bottom is the vertical

During the summer I also spent significant time collecting and converting data to bring home to UC Santa Cruz, which I will use to further investigate tremor phenomena. I have begun investigating the frequency spectra of different tremor episodes in Japan and other regions and these results suggest that there may be important difference between regions, which are not illuminated via reduced displacement comparisons. Japanese tremor more closely resemble small earthquakes than noise, bolstering the idea that tremor is the superposition of many micro-earthquakes. However, my access to greater numbers of tremor data at NIED has suggested significant heterogeneity in tremor spectra between events and stations. I am currently working on modifying spectral division techniques that seek to isolate differences in source spectra from differences in path effects. I will continue this work when I return to the States.

In addition, I am excited that I will be able to use earthquake data collected at NIED in my deep earth studies, which adds to the value of this summer experience.

8. Please add your comments (if any):

I would like to thank the JSPS, the NSF, and NIED for providing me with this wonderful opportunity. I greatly appreciate how kind and patient my Japanese hosts were with me over the summer. The expertise at NIED is immense and I value the opportunity I had to discuss a variety of research projects that the Institute's scientists are engaged in. The lab's generosity in allowing me collect and analyze their amazing data will be an enormous

boost to my research well into the future. I am excited to tackle the long list of tasks I have envisioned for data that I have only begun to probe this summer. Finally, the program provided me with valuable experience in conducting research in a foreign country. The knowledge I gained about the joys and travails of this process will undoubtedly help me be a more productive researcher, as well as a more effective collaborator, far into the future.

RESEARCH REPORT

1. Name: Kenji Alexander Sasaki （ID No.: SP06044）

2. Current affiliation: California Institute of Technology

3. Research fields and specialties:

Humanities Social Sciences X 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 Yasuhiro AWAKURA

6. Description of your current research

My current research, at the California Institute of Technology, concerns the synthesis, characterization and optimization of electrodes for use in Solid Acid Fuel cells. Fuel Cells, given their fuel flexibility and potentially high efficiency are attractive options for energy conversion devices. There are two primary commercially available types of Fuel cells (defined by electrolyte material): PEMFCs and SOFCs, which work in low temperatures (<100 ºC) and high temperatures (>600 ºC), respectively. Each has their own expense. For PEMFCs, the primary cost is the platinum-based catalyst – necessary because alternative catalysts function poorly at the PEMFCs operating temperature. For SOFCs, costs are primarily tied to the fabrication and processing, in addition to necessary refractory material infrastructure.

With the discovery of Solid Acid Fuel Cells, whose operating temperature is approximately 250 ºC, we have the possibilty of engineering a fuel cell that is an economically viable energy conversion device, in terms of cost per kilowatt.

To pursue this research, standard electrochemical techniques are employed to investigate the performance of platinum-based catalysts for SAFCs; Galvanostatic Current interrupt to probe charge transfer coefficients and exchange currents, Impedance Spectroscopy to isolate mechanisms, and symmetric 3-electrode measurements to isolate cathodic and anodic behavior.

Using the platinum-based catalysts as a benchmark, alternative catalysts candidates are identified and characterized, and based on the identified catalysis mechanism, their potential for further optimization is assessed. Optimization procedure options are diverse,

ranging from microstructural engineering, to surface preparation, to material alloying.

7. Research implementation and results under the program

Title of your research plan:

Hydrogen Permeable Membrane Anode for Solid Acid Fuel Cells

Description of the research activities:

Under the JSPS EAPSI program, I have been investigating the performance of a known hydrogen permeable membrane material, namely Palladium (Pd), as an anode for Cesium Dihydrogen Phosphate-based SAFCs. Given that Pd is isoelectronic with platinum, and an excellent conductor of hydrogen, we expected its performance as an anode to be quite high. In addition, since it is hydrogen permeable, a dense Pd foil could be used to support a very thin electrolyte, resulting in low anodic losses, as well as low ohmic losses at the electrolyte.

The first part of my research was investigating powder Pd as a catalyst.Symmetric gas tests were conducted using impedance spectroscopy to probe Pd performance in a Hydrogen gas environment. A cell was prepared with Pd powder for both electrodes, and the performance was exceptional, with only a slightly higher resistance than that of Platinum. As there was a question as to whether Pd would work on the cathode as well as on the anode, a full fuel cell was prepared using only Pd powder as the electrode materials. This fuel cell had a performance – measured in watts per cm2 – almost 50% higher than an identically prepared platinum-based cell. Catalyst cost was reduced to ~25% and performance boosted by ~50%.

Since Pd oxidizes, however, performance quickly decreased, meaning that pure Pd is not a viable cathode material. A great deal was learned, however, and the potential for optimization still exists.

The second part of my research involved characterizing Pd 77% - Ag 23% foil – which literature suggests is a) the Pd-Ag alloy with the highest hydrogen permeability, and b) more resistant to deformations caused by the Pd-PdH transition.

Resistance in hydrogen was significantly higher than the powder form of Pd, most likely attributable to the planar microstructure – with fewer electrolyte-electrode interfaces. Though surface oxidation might have influenced charge transfer.

Activation energies were obtained for 3 foil thicknesses, to determine the rate limiting factor in Pd-Ag23 foil’s catalytic activity.

RESEARCH REPORT

1. Name: Jan Schellenberger （ID No.: SP06045）

2. Current affiliation: University of California, San Diego

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: Institute of Advanced Biosciences at Keio University

5. Host researcher: Dr. Masaru Tomita

6. Description of your current research

Systems biology aims to develop methods for incorporating high throughput data types into computational models. These models often contain thousands of parts and therefore require a different set of analysis techniques than traditional biology. By comparing the predictions from these models to experimental data (often high throughput data – generating thousands of measured quantities), it is possible to point out the discrepancies in the model and correct them. This cycle of model updates is done for different sets of data improving the model in the hopes of eventually converging to the truth.

The main focus at the Systems Biology Research Group at UCSD is the curation and interrogation of genome scale metabolic networks for various organisms. These network reconstructions can contain more than 1000 chemical reactions that form the basis of the organism's metabolism. They are high quality reconstructions which account for both mass and charge balance. Using a technique called Flux Balance Analysis (FBA) it is possible to predict an organisms growth rate or capacity to drive certain reactions. These models combined with FBA have proven useful to predicting phenotypes, predicting the endpoint of adaptive evolution experiments and as a scaffold for analysis of high throughput data. Current research is focused on expanding these models in several ways. For example, the inclusion of Boolean logic for regulation has enhanced our ability to interpret certain gene knockout experiments. Another active field is the inclusion of metabolite concentration data. It has only recently been possible to measure the concentration of metabolites in a high throughput way. Methods of analysis for this kind of data are not established yet as our reconstructions usually are only concerned with rates of reactions. My research is centered on this kind of analysis.

7. Research implementation and results under the program

Title of your research plan:

Systematic Analysis of Metabolomics Data in *E. coli*

Description of the research activities:

At the Keio Institute of Advanced Biosciences, Dr. Baek-Seok Lee has been using a Mass-Spec approach to generate metabolomics data of several adaptive evolution *E. Coli* strains.

This research project was conducted in three parts:

1. Preprocessing of raw data into workable format.
2. Combining of metabolomic data with the metabolic *E. Coli* reconstruction.
3. Performing large scale analysis of integrated data.

Preprocessing

The raw output of the Mass Spec machine cannot be directly interpreted. The output must be compared to the output from a standard of known metabolite concentrations. By taking the ratio of the two, quantification is possible. This process is not trivial and requires peak integration, peak alignment and error checking. A large part of this can be done automatically, however it is always necessary to go back and check for errors and low quality peaks.

Combining data

Because of the different naming conventions used between the UCSD lab and IAB, it is necessary to create a mapping from one to the other. This was done with a combination of scripting and manual curation resulting in 110 metabolites common to both systems.

Large Scale analysis

The final part of this project was only begun and will continue after my return to the US. Of the 110 theoretically detectable metabolites, about 50 were of high quality measurements. These are metabolites found under three conditions (early exponential, mid exponential and late exponential growth) and under triplicate.s Using a student T-test, about 80% of the metabolites showed a change in concentration between at least 2 of the three conditions. About 25% of metabolites showed significant concentration changes between all three conditions.

In order to visualize the data, a program was written which can display attributes of the data (concentration or change in concentration) next to the metabolite on a

metabolic map. Qualitatively this map shows that many of the metabolites which can be measured give good coverage of the central metabolic pathways in *E. coli*. Thermodynamic properties (ΔG_f) were established for each of the compounds. It will be up to future work to establish methods for working with these values.

Recent publications have suggested that this kind of metabolomics data, combined with a detailed network reconstruction can provide useful insight into the structure and function of the network. The purpose of this project was to establish whether the data available by IAB can be used successfully with the metabolic models from the systems biology research group at UCSD and this was accomplished.

8. Please add your comments (if any):

This program has been a great opportunity to see and experience research in another country. The research project that was begun in Japan will be continued and hopefully expanded.

RESEARCH REPORT

1. Name: Akhil R. Shah （ID No.: SP06046）

2. Current affiliation: Department of Physics, University of California, Los Angeles

3. Research fields and specialties: Theoretical Physics – String Theory

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: Yukawa Institute for Theoretical Phyiscs, Kyoto University

5. Host researcher: Hirsohi Kunitomo

6. Description of your current research:

We use string theory to understand properties of black holes, such as entropy, radiation spectrum, etc. More generally, black holes provide an opportunity for String Theory to make contact with the classical theory of General Relativity which has been experimentally tested. Black holes also allow theorists to test the validity of the recently conjectured Holography principle, a profound connection between Gravity and Gauge theories (gauge theories describe particle physics as we know it, i.e. the Standard Model), which may help in eventually constructing a Quantum generalization of Einstein's General Relativity theory of gravity . Specifically this project will employ recent techniques to use number theory in analyzing the sub-leading corrections to the entropy of a certain supersymmetric black hole deduced from Conformal Theory (i.e. a Gauge Theory). Subsequently, using the Holography principle (i.e. the AdS/CFT conjecture), we will attempt to give an interpretation of these corrections in terms of Supergravity (i.e. a supersymmetric theory of gravity).

7. Research implementation and results under the program

Title of your research plan:

Topological String Theory and Black Holes through the Farey Tail formalism

Description of the research activities:

We study a special class of supersymmetric black holes in string theory which are described by compactifiying M-Theory (an 11-dimensional theory conjectured to be the generalization of the four known types of 10-dimensional string theories) on a Calabi-Yau three manifold (a special 6 dimensional space) and a circle, using the recently advocated 'black hole farey tale' expansion. The hope is to shed light on the relationship between the topological string (a simplified version of 10-d string theory) and black hole partition function (a function that describes the statistical properties of a system) that has been conjectured to hold beyond perturbation theory.

Explanatory Note: To make a black hole in the 'ordinary' four dimensions we are familiar with, we start with 11 dimensional M-theory, and then assume 6 of those dimensions are very small, described by a special geometry (a Calabi-Yau space). This gives us a 5 dimensional theory of 'strings', which we then turn into a 4-dimensional (3 space, 1 time) theory by declaring one of the 5 dimensions to be periodic, i.e. a circle, on which we 'wrap' our strings. For an observer living in the 3+1 dimensions, this configuration of wrapped strings (observed from a distance that is large compared to the length of the string or fifth dimension) will look like a black hole. Using the classical theory of General Relativity we can now describe properties of this black hole (i.e. describe the geometry) and compare them to results directly from String Theory, thereby providing a non-trivial theoretical test of String Theory.

8. Please add your comments (if any):

I found my stay at YITP to be very productive, and I feel I have made significant progress towards the research goals cited above. The interactions I had with the faculty, postdoctoral researchers, and graduate students at YITP were very positive. I have especially benefited from my Host Researcher's, Prof. Hiroshi Kunitomo, suggestions about the research problem. Fortunately, I also had the opportunity to visit the Physics Departments of Kyoto University and Tokyo University (Komaba). This summer has been enriching from both an educational and cultural perspective, and I hope the collaboration between JSPS and NSF will continue far in to the future, allowing other students a similar opportunity. I particularly wish this program will reach out to students in Theoretical Physics; a field with a strong tradition in both Japan and the US, ensuring future collaboration and mutually beneficial progress.

RESEARCH REPORT

1. Name: Jason Shoemaker （ID No.: SP06047）

2. Current affiliation: University of California, Santa Barbara

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: Keio University

5. Host researcher: Dr Kotaro Oka (Keio University) and Dr Hiroaki Kitano (The Systems Biology Institute)

6. Description of your current research

Current research has focused on the application of structured singular values (SSV) to elucidate robustness properties in cellular signaling networks and guide network development. A mechanistic understanding of biological systems is key to the future development of effective medical and biology-based technologies, and as such, more and more research is being focused into developing mathematical models capable of describing cellular functions. Specifically for complex diseases such as cancers, effective models will lead to more effective treatments while minimizing unwanted side effects. SSV analysis provides a means to rating model performance over ranges of parametric (and occasionally structural) uncertainties, accounting for model applicability in highly variable biological environments. Successful performance despite uncertainty allows for model confidence, while fragilities highlight network components whose interactions may need further exploration.

While to date, several methods have been used to explore cellular robustness, SSVs offer the advantage of considering multiple, simultaneous perturbations (and/or uncertainties) in the intracellular network. First introduced in 1980 by John Doyle, SSV analysis seeks to find the smallest perturbation required to shift the eigenvalues of a stable system to the imaginary axis. The “structure” of the perturbation is determined by a set of weighting blocks and a block diagonal matrix, Δ, whose diagonal components are designed to be bound [-1 1]. Once the system is properly configured, the smallest perturbation in Δ to shift the left-hand eigenvalues to zero is calculated, and the SSV or μ is defined to be the

inverse of the maximum singular value of Δ.

SSV analysis and standard sensitivity analysis have been applied to the Fas induced apoptosis model and the Staphylococcal enterotoxin B (SEB) induced apoptosis model. Sensitivity analysis revealed portions of the SEB signaling cascade to be highly sensitive to infinitesimal parameter perturbations, specifically the ERK cascade (extracellular, signal-regulated kinases). Application of SSV to the ERK cascade revealed that while the ERK cascade itself was robust to large uncertainties in parameter values, the interactions of the transcription factor downstream of the cascade were very fragile to parametric uncertainty. Specicifically, the Dp1-E2f dimerization mechanism only allowed for 0.012% parametric uncertainty before performance failure.

7. Research implementation and results under the program

Title of your research plan:

Robustness of the Yeast Pheromone Response Model

Description of the research activities:

Collaborators Kofahl and Klipp developed a simple model which accurately captures many intracellular dynamics of the yeast pheromone pathway, including behaviors observed in 15 yeast mutants. This model was first rewritten into CellDesigner. CellDesigner is a SBML based visualization platform designed by the Kitano research group which allows for systematic assembly and simulation of biochemical networks. The SBML code produced by CellDesigner was then implemented in BioSens, a tool which allows for rapid evaluation of the system's sensitivity to infinitesimal perturbations in parameter values. Sensitivity analysis showed a surprising amount of grouping in the sensitivity values, and parameters associated with scaffold formation and the MAPK cascade were seen to be the most sensitive. Using these results as a guide, SSV analysis was performed on parameters associated with these two processes.

Much time was spent developing an efficient procedure for weighting block design when considering large systems. Most examples of parametric uncertainty evaluation using SSV in the literature deal with small dimension systems, and only consider 4 to 5 simultaneously fluctuating parameters. In this work and works to follow, we wish to consider a far greater number of parameters (38 for the pheromone pathway). Only parameters whose consistency has been experimentally validated where not

included in the weighting procedures. Furthermore, the highly linear nature of the pheromone model allowed for a significant reduction in the size of the weighting blocks, allowing for a more accurate calculation of the SSV.

Results indicate that the model is robustly stable when all parameters are allowed to vary within a standard deviation of its nominal value. Skewed SSV procedures were used to determine the amount of variation allowed in the unmeasured/fitted variables, showing that many of the unknown parameters could vary over orders of magnitude and maintain robust stability. In the future, performance criteria will be defined and applied to the SSV analysis allowing for more stringent results.

8. Please add your comments (if any):

Originally, the research plan was to analyze the EGF pathway developed by the Kitano group. But it was agreed that the network was far too large for a short term project and the yeast pheromone pathway was chosen. Working with the Kitano/Oka group has really helped me focus my thoughts on robustness concepts, specifically their potential applications in experimental design.

RESEARCH REPORT

1. Name: Rebecca J. Sichel （ID No.: SP06048）

2. Current affiliation: University of Wisconsin-Madison

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: SPring-8

5. Host researcher: Dr. Tetsuya Ishikawa

6. Description of your current research

Bismuth ferrite is a multiferroic material which is both ferroelectric and antiferromagnetic at room temperature. If properly harnessed, this material could be used as in magnetic or electric field sensors, data storage, and transducers. However, the coupling between these two properties is not well understood. To further complicate matters, bismuth ferrite is often grown in thin film form in order to enhance the polarization, which means that any strain in the film will also modify its properties. My current research project is to study the interrelationships of strain, polarization, and magnetic ordering in bismuth ferrite thin films.

One of the primary methods we have used to characterize the strain and ferroelectric dynamics is synchrotron x-ray microdiffraction. This allows the determination of the nanometer scale local structure. When combined with time resolved measurements, it is possible to measure the dynamics of the structural changes due to any electric, magnetic, or strain fields applied to the sample.

7. Research implementation and results under the program

Title of your research plan:

Synchrotron X-Ray Diffraction Techniques at SPring-8

Description of the research activities:

X-ray diffraction is commonly used to determine the atomic-scale structure of materials. The most difficult and precise measurements are done with brilliant x-rays produced at third generation synchrotrons such as SPring-8 in Hyogo, Japan or Argonne National Labs in Illinois, USA. A wide variety of optical elements are used to make the beam sufficiently monochromatic, coherent, or focused, depending on the technique to be used. Dr. Ishikawa's group at SPring-8 studies x-ray optics and the wide variety of experiments that can be done with these simple modifications to the x-rays. My work this summer was to become familiarized with the many characterization techniques available and how they can be applied to my current research. These include (but are not limited to):

Coherent scattering: A small particle (up to a micron or two in diameter) is placed in a highly coherent x-ray beam (SPring-8 beamline BL29XU). The diffracted speckle pattern is recorded with a CCD and using the oversampling method, it is possible to reconstruct the real space structure of the particle. Although the experiment I observed used a yeast cell with tagged proteins, it is equally possible to use this technique on inorganic nanoparticles.

In-situ XMCD and PES: At beamline BL17SU, a laser MBE chamber has been constructed such that it is possible to grow an oxide thin film such as $SrRuO_3$ or $BiFeO_3$ and *without* exposing it to atmosphere, transfer the sample to the XMCD (X-ray Magnetic Circular Dichroism) and PES (Photoemission Spectroscopy) chambers. This setup allows for magnetic domain characterization and electron binding energy to be investigated without the usual surface oxide, which is very important since XMCD and PES are highly surface sensitive. This could be directly applied to my research project at Wisconsin.

Time Resolved Diffraction: This promises to be the most useful of the techniques I studied this summer for my PhD project. Using a Ti:sapphire laser synchronized with the synchrotron's x-ray output, it is possible to obtain diffraction data as little as tens of picoseconds apart (BL19LXU). This will allows the measurement of the very short-term dynamics of the material, such as rapid structural switching.

8. Please add your comments (if any):

This summer has solidified my desire to collaborate with Japanese scientists, particularly at SPring-8. Every single scientist -without exception - that I met or worked with was extremely helpful and willing to explain his or her work to me in great detail. I believe that future collaborations would be not only scientifically fruitful, but also personally enjoyable.

RESEARCH REPORT

1. Name: Daniel Siegwart （ID No.: SP06049）

2. Current affiliation: Carnegie Mellon University (Pittsburgh, PA, USA)

3. Research fields and specialties: Chemistry/Engineering Sciences

4. Host institution: Tokyo University (Tokyo, Japan)

5. Host researcher: Professor Kazunori Kataoka

6. Description of your current research

The overall goal of my research is to create scaffolds for tissue engineering applications with the ability to deliver proteins and growth factors. In general, my research is in the area of polymer synthesis for tissue engineering applications using controlled radical polymerization (CRP) techniques such as atom transfer radical polymerization (ATRP) and reversible addition fragmentation chain transfer (RAFT) polymerization. I am also interested in degradable polymers, polymer bioconjugates, end functional polymers, atom transfer radical coupling (ATRC), and biological *in vitro* cell studies.

7. Research implementation and results under the program

Title of your research plan:
Synthesis and Characterization of
Poly((2-isopropyl-2-oxazoline)-*b*-(2-(dimethylamino)ethyl methacrylate)) For Use in Tissue Engineering and Drug Delivery Applications

Description of the research activities:

The objective of this work was to design a temperature- and pH-sensitive block copolymer that can be used as an intelligent biomaterial. Compelling clinical opportunities for these polymers are as polymer micelles for controlled drug delivery and as the foundation of cross-linkable growth factor-containing injectable scaffolds to enhance fracture repair. Poly(oxazolines) (POx) have emerged recently as materials of importance in biomaterials science, where they may act as protein modifiers, hydrogels, and drug carriers. The end-functionalized thermo-responsive PiPrOx was be used to prepare an ATRP macroinitiator for chain extension with dimethylaminoethyl methacrylate (DMAEMA). PDMAEMA exhibits pH-responsiveness, making this polymer an attractive candidate for combination with PiPrOx. Finally, this work represents a unique example of combining cationic ROP with ATRP to produce a stimuli-sensitive block copolymer with potential application in drug delivery.

Me-PiPrOx-OH was prepared using cationic ROP. Before it was functionalized to make the ATRP macroinititor, we tested whether or not the polymer will complex with copper and reduce or eliminate the activity of the ATRP catalyst. Poly(2-ethyl-2-oxazoline) was purchased and added to an ATRP of DMAEMA. From the GPC traces (Mn=7200; PDI=2.37), it was clear that the presence of P(EtOx) inhibited the polymerization (slowed it down and prevented high conversion from being reached). Nevertheless, the polymerization was able to proceed smoothly to 15% conversion. Therefore, an ATRP of DMAEMA using a P(iPrOx) macroinitiator should be successful.

The Me-PiPrOx ATRP macroinitiator was initially prepared from Me-PiPrOx-OH by reaction with 2-bromo-2-methyl-proprionic acid using the DCC coupling method. After purification, an NMR was taken and it looked clean. An ATRP was conducted and resulted in chain extension from the macroinitiator. However, slightly high polydispersity and a shoulder in the GPC trace (from uninitiated macroinitiator) was observed, indicating that the functionalization reaction was incomplete (Mn=78100; PDI=3.65).

Therefore, a second route was attempted to prepare the pristine macroinitiator. Higher conversion was reached using α-bromoisobutyryl bromide, as catalyzed with triethylamine. This macroinitiator was purified by extraction and dialysis. The structure of the clean product was confirmed using MALDI-TOF and NMR. However, the initial ATRP reactions have failed. A likely reason is that copper is complexing with the PiPrOx-Br initiator and taking it away from the ATRP equilibrium.

To overcome this problem, various modifications were made to the ATRP conditions. The solvent was changed from acetone to isopropanol. An alcohol was chosen for ATRP on the basis of the premise that a hydrogen-bonding solvent could bind to the amide groups of the macroinitiator, and thus reduce their interaction with both catalyst and propagating chain end. A similar approach has been used successfully in the ATRP of other strongly coordinating monomers, dimethylacrylamide and 4-vinyl-pyridine. Also, an excess of catalyst was also employed (10-fold) to overcome complexation with PiPrOx. Finally, the order of addition was changed, such that the copper ligand complex was formed first, and then the macroinitiator was added to the preformed complex.

In addition, a poly(ethylene oxide) (PEO) macronitiator was synthesized using identical conditions as with the PiPrOx-Br reaction. If this macroinitiator can initiate polymerization, then the problem lies with the PiPrOx and not with purification

methods. Ethyl-2-bromoisobutyrate was also purchased and used to initiate the polymerization of DMAEMA. After one day, a gel formed, indicating a successful polymerization. The GPC trace showed high conversion and low polydispersity. Because this compound could initiate polymerization, the problem lies with the PiPrOx. Another reaction to synthesize the PiPrOx-Br macroinitiator was also carried out to enable further attempts to make the block copolymer.

Future Plans. The experiments in progress should help us to understand whether or not copper is complexing with the PiPrOx-Br macroiniator. If it is indeed complexing, then the change in solvent and adjustment of stochiometry should solve the problem. We also want to try changing to a more active ligand and to use a smaller macroinitiator. If these changes do not permit initiation of the polymerization, then the complexation is very strong and ATRP may not be possible. In this case, we will have to change our strategy and use another CRP technique such as RAFT. If we can succeed with ATRP, then the polymers will be analyzed using NMR, HPLC, GPC, and MALDI-TOF mass measurements, cloud point, micelle characterization, cytotoxcity, and drug release profile.

8. Please add your comments (if any):

We plan to continue this research project after the summer program ends. The macroinitiators will be mailed to America, where further polymerizations will be carried out. We are also preparing a shorter PiPrOx-OH sample for future use. After synthesis, various characterization methods will be employed. If successful, we hope to publish a paper together, citing both Carnegie Mellon University and Tokyo University authors.

RESEARCH REPORT

1. Name: Rashad N. Simmons （ID No.: SP06050）

2. Current affiliation: Michigan State 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: National Institute of Advanced Industrial Science and Technology (AIST)

5. Host researcher: Dr. Nobuyoshi Yamashita

6. Description of your current research

My current research consists of modeling transport effects of perfluorinated and hydrocarbon surfactants on environmental pollutants in groundwater by using high-performance liquid chromatography (HPLC). This research is separated into several projects.

The first project uses micellar liquid chromatography (MLC), a variation of HPLC. In MLC, the stationary phase serves as a model for soil particles containing organic matter and the aqueous surfactant mobile phases serves as groundwater containing a surfactant at varying high concentrations, in which surfactant micelles are formed. The surfactant micelles affect the transport of environmental co-pollutants, such as benzene compounds and polycyclic aromatic hydrocarbons, through the groundwater system.

The remaining projects use standard HPLC methods. Using HPLC, the transport effects of the surfactants, at varying low concentrations, on co-pollutants are observed. In addition, the transport effects of a perfluorinated surfactant, adsorbed onto the organic matter of soil particles, on co-pollutants are modeled using a perfluorinated stationary phase in HPLC analysis.

When these results are coupled with results from detection and mass balance studies of perfluorinated compounds, a greater understanding of the transport and fate of perfluorinated compounds will be gain. In addition, this information will prove useful in risk assessments.

7. Research implementation and results under the program

Title of your research plan:

Mass Balance Study of Fluorinated Organic Compounds in Environmental Samples

Description of the research activities:

Fluorinated organic compounds (FOCs), particularly perfluorinated compounds (PFCs), are considered to be persistent organic pollutants and are ubiquitous in the environment. Other than those recognized as volatile organic compounds, few of the FOCs are regulated in the U.S, Canada, Europe, or Asia. While reports of the concentrations of the primary PFCs and the main environmental sources of these compounds are appearing, it is unknown whether these are the only compounds in the environment or whether there are others that need to be monitored or considered in risk assessments.

Representative waste water samples were collected from two locations inside of a perfluorooctane sulfonate (PFOS, $C_8F_{17}SO_3^-$) manufacturing plant, as well as one location from waste runoff in a nearby stream. The waste water samples were extracted and analyzed using standard methods. The waste water samples were treated by solid-phase extraction (SPE) using Oasis® WAX cartridges, in order to isolate the extractable FOCs. After SPE, the extracts were diluted and analyzed using liquid chromatography with tandem mass spectrometry (LC-MS/MS). LC-MS/MS analysis was utilized to 1) identify individual known PFCs in the extractable organic fluorine and 2) detect concentrations of PFCs at trace levels. In order to validate this method, procedural blank and recovery samples were extracted and analyzed concurrently with the waste water samples.

Recovery results for the known PFCs ranged from 87 – 117% for perfluoroalkyl sulfonates, 75 – 133% for perfluoroalkyl carboxylic acids, and 64 – 112% for fluorooctane sulfonamides and alcohols. Concentrations of the known individual PFCs in the blank samples were below the limits of quantification (LOQ). Upon analysis of the waste water samples, only PFOS and perfluorooctanoate (PFOA, $C_7F_{15}CO_2^-$) were detected at concentrations above the LOQ. Concentrations of PFOS ranged from 22 – 217 ng/L, while PFOA concentrations ranged from 75 – 106 ng/L.

Results suggest that there are low levels of PFCs in the manufacturer's waste water, waste water runoff, and in the nearby stream. Further analysis is needed to determine what percentage these known PFCs make up of the total extractable organic fluorine and total fluorine content in the environmental samples.

8. Please add your comments (if any):

I feel that the JSPS Summer Program is a highly effective program. Through my involvement in the program I have increased my knowledge base in my area of research, established connections with foreign researchers (both in and out of Japan), and learned a large amount about the Japanese culture.

9. Advisor’s remarks (if any):

Mr. Simmons has got excellent progress in spite of very limited time of research. He has learnt enough about basic knowledge and skill of PFCs analysis in water samples. I think he is ready to use the experience in AIST to start his own research in US. We will continue to support his activity and plan to get several publications in near future.

RESEARCH REPORT

1. Name: Mia Steinberg （ID No.: SP06051）

2. Current affiliation: University of Delaware, College of Marine and Earth Studies

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, Seto Marine Biological Laboratory

5. Host researcher: Yoshihisa SHIRAYAMA

6. Description of your current research

The Asian shore crab, *Hemigrapsus sanguineus*, is a recent invasive species on the east coast of the USA. Since 1989 this crab has spread northward to Maine and southward to North Carolina. *H. sanguineus* also appears to have been introduced to several locations along the coast of France and the Netherlands as well as the Mediterranean Sea. Regardless of its recent success in the North Atlantic Basin, *H. sanguineus* has not established breeding populations in the Eastern Pacific Ocean. This is surprising, given the relative proximity to native Asian populations, the great abundance of rocky coast, and the recent success of the European green crab in California and Oregon. My research tests the hypothesis that *H. sanguineus* has been unable to compete successfully with two native species of *Hemigrapsus* (*H. nudus* and *H. oregonensis*) that also occur in this otherwise favorable habitat. Specifically I am investigating: 1) the effects of chemical cues produced by adults of native species of *Hemigrapsus* on settlement and metamorphosis of the postlarval stage of *H. sanguineus*; 2) space competition between juveniles of *H. sanguineus* and each of the native species of *Hemigrapsus*; and 3) the population genetics of native and invasive *Hemigrapsus* species.

7. Research implementation and results under the program

Title of your research plan:

Biochemical cues affecting settlement and metamorphosis of post-larval *Hemigrapsus sanguineus*, a non-indigenous shore crab in North America

Description of the research activities:

My research at Seto Marine Biological Laboratory completed a set of experiments examining the metamorphosis of *Hemigrapsus sanguineus* into juvenile crabs. The post-larvae (megalopae) were exposed to exudates produced by several crabs from the east and west coasts of North America as well as from Japan. These included four species of the same genus, one species of the same family, and five species found in rocky intertidal habitat. Megalopae accelerated metamorphosis only in response to conspecific exudate, however, and preliminary results suggest the presence of multiple cues, one of which may be a small protein or peptide.

RESEARCH REPORT

1. Name: Adam Z. Stieg （ID No.: SP06052）

2. Current affiliation: University of California – Los Angeles

3. Research fields and specialties:

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

4. Host institution: Kumamoto University

5. Host researcher: Dr. Masashi Kunitake

6. Description of your current research

Along the forefront of fundamental research lies the experimental approach toward understanding how matter behaves at increasingly smaller dimensions. Atomic and molecular scale studies have seen dramatically increased attention over the last twenty years with the invention of scanning probe microscopy (SPM). In order to probe chemical systems at this level through imaging and spectroscopy, scanning tunneling microscopy (STM) is the tool of choice. The field of research I am presently engaged in entails nanoscale studies at the solid-liquid interface, specifically in the field of electrochemistry. This work involves the optimization and application of an electrochemical scanning tunneling microscope (ECSTM) designed and constructed in-house. Once completed, the instrument will carry out *in-situ* studies of both redox active molecular systems and templated electrochemical deposition. The attractive nature of *in-situ* STM and STS lies in its ability to control the electrode-electrolyte interface while imaging the electronic density of states with sub-nanometer resolution. The development of our home-built instrument began with basic design and has progressed through numerous stages resulting in its final configuration. From mechanical stability and noise isolation to control integration, the system has been optimized for flexible low-noise STM imaging in both ambient and electrochemical environments. Current work is focusing on application of this EC-STM toward the study of a variety of molecular adsorbates, including the rotaxane family of supramolecular machines.

7. Research implementation and results under the program

Title of your research plan:

Nanoscale Studies of Molecular Machines by Electrochemical Scanning Tunneling Microscopy

Description of the research activities:

The research carried out at Kumamoto University during the EAPSI program involves two main areas. First, in order to achieve high resolution images by EC-STM, proficiency in a variety of specific techniques and, in some cases, nuances is necessary. Acquisition of these skills involved sample preparation and imaging of molecular systems previously reported in the literature. A variety of surfaces and adsorbates were imaged with molecular and/or atomic scale resolution during this stage. Second, development and execution of a clearly defined experimental approach toward imaging a new system of interest, in this case the rotaxane molecular machines, requires a great deal of consideration. Working with Dr. Kunitake has provided great insight into this process, and multiple concepts have been developed. Specifically, *in-situ* imaging of controlled supramolecular assembly has been defined as a novel first stage. At present, molecular resolution images have been obtained for two components of the rotaxane assembly on the electrode surface. EC-STM images of both the molecular building blocks and their controlled ordering have not previously been reported.

RESEARCH REPORT

1. Name: Asako Stone （ID No.: SP06053）

2. Current affiliation: Washington State 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: Doshisha University

5. Host researcher: Ofer Feldman

6. Description of your current research

As an attempt to better understand China-Japan relations, the present research extended intergroup relations and conflict resolution research from a social-psychological perspective. Using an experimental study based on the subjective group dynamics and sequential resource dilemma game, China-Japan relations at the public level were examined. Even though China-Japan conflict has been escalating, little research has been conducted to investigate a social-psychological aspect of their conflict. The objectives of this study were to address the following two elements of China-Japan conflict: 1) root causes of China-Japan conflict and of the Sino-Japanese War II; 2) why China-Japanese conflict has been difficult to resolve.

7. Research implementation and results under the program

Title of your research plan:

Effects of Subjective Group Dynamics on the China-Japan Conflict

Description of the research activities:

A total of 85 Japanese undergraduate students at Doshisha University participated in this study and played a sequential resource dilemma game. Data from six participants were excluded for either their low identity with their Japanese nationality or failure to complete the experiment.

The initial analyses of the collected data suggested that the nature of subjective group dynamics changed depending on the nationality of the third party. Specifically, stereotypical Chinese were evaluated more negatively when compared to stereotypical Americans than when compared to stereotypical Koreans (ethnic ingroup of stereotypical Chinese) and stereotypical Swiss (ethnic ingroup of stereotypical Americans). The results of the initial analyses suggested that the present study might support the previous study's claim that the presence of the U.S. worsened the China-Japanese conflict.

Even though further analysis is necessary to draw any inferences, a primary analysis suggests that the participants perceive stereotypical Chinese differently depending on the ethnicity of the third party. If that is indeed the case, the results of the present study would confirm the previous studies in this field and extend the claims of subjective group dynamics. The results of this study would provide a foundation to further understand linkages between one's social identity and his or her attitudes and choice behaviors, as well as to further investigate how to improve the China-Japan relation. As the most powerful nations in Asia, the China-Japan relation affects not only themselves but the rest of the world. With the growing threat from North Korea, it is crucial that countries like China and Japan cooperate fully to maintain peace and security in Asia and the rest of the world. Thus, alleviation of China-Japan conflicts should be initiated immediately. Even though this research focuses on the first of a series in studies necessary to reveal ways to successfully alleviate their conflict, suggestions from this study should be valuable.

RESEARCH REPORT

1. Name: Keith Sullivan （ID No.: SP06054）

2. Current affiliation: Department of Computer Science, George Mason University, 4400 University Drive MSN 4A5, Fairfax, VA 22030, 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: Osaka University

5. Host researcher: Professor Minoru Asada

6. Description of your current research

I am currently studying evolutionary computation, multi-agent systems and robotics. In particular, I am interested in the relationship between human development and robotics, and how robots can learn in a manner similar to humans.

7. Research implementation and results under the program

Title of your research plan: Learning to Move

Description of the research activities:

Developmental neuroscience studies the relationship between the physical brain and the mental processes it supports. In addition, it studies the origin of biological structures, such as the human brain. In particular, developmental neuroscience seeks to understand how neurological structures form, how they develop, and how these structures support cognitive processes. Similarly, the field of developmental robotics studies the intersection of brain, mind and body as related to robot cognition. Still in its infancy, this fast growing field is exploring ways for robots to develop various mechanisms and (neural) structures to interact with the world, much in the manner human infants learn to interact with the world.

This project aims to study the development of locomotion in the absence of external programming. The robot will have access to a vector of unknown objects (e.g., motors and sensors). The robot must learn what the objects are and how to use the information provided by them, through self-exploration and self-experimentation.

Like infants, the robots must learn their capabilities, and how to use the information from these capabilities to accomplish locomotion.

The motor cortex can be modeled as a sparsely connected network of inhibitory and excitatory neurons. The network contains leaky integrate-and-fire neurons, split into inhibitory and excitatory populations. The populations are randomly connected according to a Poisson distribution. Brunel's model takes the frequency of external stimuli as input, and outputs the inhibitory and excitatory firing rates.

The experimental testbed linked together three software packages: the robot simulator Player/Stage, the evolutionary computation package ECJ, and the Neural Estimation Toolkit NEST. Experiments consisted of training the robot in one environment, and running the result in other environments to test generalizability. These experiments also test the relationship between neural structures and the environment.

For all experiments, the robot learned to successfully navigate all environments. To test generalizability, the best individual from the 30 independent runs was tested in the remaining five environments. Each individual was executed three times, and the average performance computed. While it is expected that training in the simple environment results in poor performance in more complex environments, it is surprising that performance in the most complex environment did not result in good performance in simpler environments.

Training in the most simple environment biased the robot control towards small speeds and turnrates. This is surprising since the lack of obstacles should have allowed to robot to bias the frequency partition to large values. The bias results in poor performance in more complex environments since the robot is forced into movements that are not appropriate for the environment. In contrast, training in the most complex environment resulted in almost no bias in the robot control, which makes sense due to the complexity of the environment. Given the high occurrence of obstacles at a variety of distances, the robot needs a control pattern that allows a variety of different speeds and turnrates. Finally, the two control patterns are almost statistically identical at the 95% confidence level. This suggests a minimal correlation between the environment and the simulated neural structures; however, additional experiments are needed to verify this hypothesis.

8. Please add your comments (if any):

This program was outstanding. The summer started with high expectations, and every one was exceeded! Besides the rich cultural experience, the research lessons (and a potential PhD thesis topic) were invaluable, and will greatly assist me in the coming years.

RESEARCH REPORT

1. Name: Kari A. Terzino （ID No.: SP06055）

2. Current affiliation: Iowa State University, Ames, IA, USA

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: Tohoku University, Sendai, Japan

5. Host researcher: Dr. Ken-ichi Ohbuchi

6. Description of your current research

My research centers on cross-cultural differences in forgiveness. In the academic forgiveness literature, there are various definitions of forgiveness. The focus of definitions range from avoidance and revenge motivations (McCullough et al., 1998), to emotion (Worthington & Wade, 1999) and cognition (Thompson & Snyder, 2003), to an interplay of cognition, emotion, and behavior (Enright & Fitzgibbons, 2000). Despite noticeable discrepancies among researchers, little research has been conducted to define forgiveness. Studies that have attempted to empirically define forgiveness have surveyed clinicians, academics, and religious figures. However, as Kearns and Fincham (2004) point out, this is a critical limitation because lay conceptions of forgiveness can help refine theories of forgiveness, as well as contribute to the development of forgiveness interventions and therapies.

To date, little research has focused on examining cultural and contextual variables and how they relate to forgiveness. For example, is forgiveness valued and practiced in similar ways across cultures? How do particular cultural factors influence individual and group processes of forgiveness? In some cultures, forgiveness is an individual decision. In Western cultures such as the United States, forgiveness is a perceived to be a personal choice. Forgiving an individual for an offense is beneficial for victims because it allows them to “save face.” In contrast, forgiveness is less of a personal choice in collectivistic cultures such as Japan. Forgiveness may be perceived as a duty in certain social situations. In collectivistic societies, it is common for a family or group to offer forgiveness to the offender. Consequently, forgiveness serves to restore closeness and group harmony rather than personal benefits (Sandage & Williamson, 2005). For example, Fu, Watkins, and Hui (2004) reported that the way Chinese individuals think about and define forgiveness is

potentially influenced by their collectivistic cultural traditions, particularly the importance of social harmony. The authors remarked that “although interviews [of Chinese participants] yielded similar dimensions of forgiveness, the processes the Chinese described were much different than in Western research” (p. 313). Chinese participants reported that they tended to forgive in their daily lives because they cared about maintaining in-group stability and relationship harmony.

Surprisingly little research has been conducted in this area despite the emphasis on the immense need for cross-cultural forgiveness research by several prominent researchers. Sandage and Williamson (2005) suggest that qualitative research focusing on obtaining detailed descriptions of forgiveness, as well as cultural conflicts and practices, would be extremely beneficial in extending the forgiveness literature. Furthermore, they point out the lack of measure development, commenting that there have been virtually no cross-cultural validations of forgiveness measures. Because nearly all of the currently utilized forgiveness scales have been tested and validated using Western samples, it is possible that these measures are biased by defining forgiveness in primarily Western

I plan to begin to bridge the cross-cultural gap in forgiveness research. I am particularly interested in how individuals from collectivistic societies, such as Japan, view and define forgiveness compared to traditional Western societies. In order to examine the lay perspective of forgiveness, Kearns and Fincham (2004) conducted a prototype analysis of forgiveness in a predominantly Western sample. A prototype analysis involves identifying central features of a concept, whereas classical paradigms require certain characteristics to be necessary and sufficient for definition. For example, not holding a grudge may be a *central* feature of forgiveness, but it is neither *necessary* nor *sufficient* to define forgiveness. However, some concepts cannot be defined in such rigid terms. Instead, concepts can be organized around the best examples, called prototypes (Fehr, 2005). Importantly, conducting a prototype analysis of forgiveness is crucial because, in addition to other uses, results from such analyses can be used extensively in additional cross-cultural studies. For example, this data will provide the necessary information to refine current measures, create additional scales, or clarify forgiveness processes in non-Western societies.

7. Research implementation and results under the program

Title of your research plan:

Culture and Forgiveness: A Prototype Approach

Description of the research activities:

I conducted the first stages of the prototype analysis approach of defining forgiveness in Japan.

Study 1: Participants were asked to think about the concept of forgiveness and what it meant to them. They were asked to identify features of forgiveness they would use to explain to someone who did not know what forgiveness was. I collected data from 85 participants at Hokkaido University in Sapporo, and 35 participants from Tohoku University in Sendai. The features were compiled from all participants and were coded by two Japanese individuals and myself. The list was narrowed to attributes that multiple participants mentioned (approximately 65 attributes). This narrowed list will be used for items in future studies.

Study 2: We are currently developing the questionnaire for this study. Data will be collected at the beginning of the semester at Tohoku University. A different sample of participants will be asked to rate each attribute from the narrowed list on its centrality to the experience of forgiveness. It is hypothesized that some attributes will be rated as more central (and thus, more prototypical) of forgiveness than others. In their predominantly Western sample, Kearns and Fincham (2004) found that the most central features of forgiveness were sincerity and truthfulness. These features demonstrate the Western focus on personality traits and individual characteristics. However, because individuals in collectivistic cultures place relatively greater value on group harmony, I hypothesize that features related to group harmony and relationship repair will be rated as more central.

Study 3: To further demonstrate fundamental cultural differences in forgiveness, participants from the United States will rate the centrality of forgiveness features generated by Japanese participants. Likewise, Japanese participants will rate the centrality of forgiveness features generated by American participants from the Kearns and Fincham (2005) study. I will conduct exploratory and confirmatory factor analyses to examine the differences in structure of forgiveness attributes between the cultures. Data collection will occur in Japan and the US this fall.

8. Please add your comments (if any):

This was a wonderful and very helpful experience. For individuals who conduct cross-cultural research, being immersed in the culture is much more informative than any book you can buy.

RESEARCH REPORT

1. Name: Kari Beth Thompson （ID No.: SP06056）

2. Current affiliation: West Virginia University Division of Plant and Soil Sciences

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 (NIBB)

5. Host researcher: Dr. Mitsuyasu Hasebe

6. Description of your current research

Cold shock domain proteins, or CSDs, are among the most ancient and conserved nucleic acid binding proteins. They have been well characterized in prokaryotic systems but little is known about their function in plants. The overall objective of my current research is to understand the evolution and function of the cold shock domain in plants. My first approach is to characterize and describe the domains found within plant CSDs. The domains are being identified using alignments of the cold shock domain sequences identified *in silico* from EST (expressed sequence tag) databases and will allow us to pinpoint conserved areas. In order to characterize the CSDs on a functional level, their expression in three independent cold responsive signal transduction networks will be analyzed. This analysis will be performed by using quantitative Real-Time PCR to assess the level of CSD gene expression in transgenic Arabidopsis backgrounds that are independently overexpressing the cold regulated transcription factors ZAT12, Ice1, and CBFs 1, 2 and 3. Microarray data have provided evidence that the Arabidopsis CSDs may be involved in plant growth and development. In order to gain a better understanding of their putative association to plant development, expression levels of all four Arabidopsis CSD genes will be quantitatively assessed in well-known floral developmental mutant backgrounds. We hope that this foundation of knowledge gained from these studies on the cold shock domain will lead to a better understanding of its importance in higher plants of agronomic importance.

7. Research implementation and results under the program

Title of your research plan:

Determining the Evolution and Function of Cold Shock Domain Proteins in Plants

Description of the research activities:

Orthologues of the prokaryotic CSD proteins have been identified in many eukaryotes. In order to determine the evolutionary history of the cold shock domain, I collected sequences of CSD genes of different species from online public databases. I brought these sequences to the Hasebe Laboratory and learned how to construct various phylogenetic trees using the PHYLIP program. The conserved region of the CSD proteins is composed of only 65 amino acid residues. This is unfortunate because it does not allow for a high degree of confidence in the tree branching patterns, therefore few evolutionary conclusions can be made from these trees.

For the rest of my research here in Japan I am working with the organism *Physcomitrella patens*. *P.patens* is a bryophyte that is quickly gaining popularity as a model plant for molecular biology. One of its greatest advantages is that during a large part of its life cycle it is a haploid organism, and therefore can undergo homologous recombination. This is highly useful for molecular work because it allows for gene targeting for any locus of interest. Gene targeting allows for the replacement of a native gene with a gene that has been designed to accommodate straightforward scientific analysis.

Previously, we found that the genome of *Physcomitrella* encodes three CSD proteins. Through genomic Southern blot analysis here in Japan we were able to find a fourth homologue. So far expression constructs for two of them, which we named PpCSD1 and PpCSD2, have been made. Two reporter genes, GUS (beta- glucuronidase) and YFP (yellow fluorescent protein), have been fused to the C-terminal region of the coding regions for PpCSD1 and PpCSD2. A gene encoding antibiotic resistance is also present which will facilitate the selection of positive transformants. Utilization of these constructs will allow for the visualization of temporal and spatial expression patterns of the PpCSD genes under different treatments. This will give us a better idea of their *in vivo* function in the moss system. I have taken these constructs and transformed them into moss protonema tissue and the transformed moss is currently undergoing its second round of selection on G418 media. We have confirmed that many transformants are growing well which indicates that they have picked up at least one copy of the construct, and are therefore positive for transformation. One more pass on the selection media will be necessary to find stable transformants with one copy of the desired construct.

I have also designed constructs that will knockout (KO) the expression of PpCSD1 and PpCSD2. These constructs are currently under construction and will be ready in the near future for transformation as well. Comparative phenotypic observations between wild-type and KO lines will allow us to determine a precise in vivo functional role since the mutants will have a disrupted native gene locus.

The Hasebe Laboratory is one of the leading laboratories in the world for work with *Physcomitrella patens*. During my stay I have been learning about the growing conditions, basic protocols, and techniques for growing and working with moss. They have taught me how to effectively isolate high quality DNA and RNA. I have also learned how to perform Green PCR for checking positive transformants.

Reverse transcriptase PCR was utilized for semi-quantitative analysis of the level of expression of PpCSD1 and 2 under cold treatment at four degrees Celsius. Preliminary results show that the expression level of PpCSD1 was unaffected by cold whereas the expression of PpCSD2 was up-regulated in protonema tissue. I have also begun to perform RT-PCR analysis to check the expression of the PpCSD genes at the different growth stages of moss, but this experiment is still in its preliminary stages and will be continued in West Virginia.

8. Please add your comments (if any):

Researching in Japan has been one of the most amazing and rewarding experiences of my life. Everyone in Japan has made me feel so welcome, inside and outside of the laboratory. Thank you so much for this opportunity.

RESEARCH REPORT

1. Name: Douglas Turnbull （ID No.: SP06057）

2. Current affiliation: PhD Student, Department of Computer Science and Engineering, University of California, San Diego

3. Research fields and specialties:

Engineering Sciences

Interdisciplinary and Frontier Sciences

4. Host institution: National Institute of Advanced Industrial Science and Technology.

5. Host researcher: Masataka Goto

6. Description of your current research

My work focuses on computer audition: the design of artificial systems that can extract meaningful high-level information from sound. The work involves machine learning, computer vision, and audio signal processing. My pervious work on this topic has mainly involved creating system that can automatically retrieve music from large databases using text-based queries (e.g., Google for song).

This summer I worked on building an automatic music segmentation system. Our goal is to automatically segment musical pieces into homogeneous segments such as choruses, verses and solos. This system can be used for music information retrieval, musical knowledge discovery, and musical summarization (e.g., creating short thumbnails that describe a song.)

Our work this summer will result in a paper that will be submitted to a top level conference on signal process and acoustics (ICASSP 2007). We plan to have follow-up papers related to this topic.

7. Research implementation and results under the program

Title of your research plan:

“Detecting interest points for music segmentation”

Description of the research activities:

“Detecting interest points for music segmentation”

Much of the previous work on music segmentation has focused on finding homogeneous segments of audio content based on the self-similarity of perception-based features. These segments often correspond to high-level structures in the music such as choruses or verses. Our work focuses on finding boundaries, or 'musical interest points, at the point in a song where a listener experiences perceptual changes in the music. These changes often correspond to musical boundary events such as the beginning of a chorus, or the ending of a guitar solo. The concept of `interest points' has been developed within the computer vision literature to represent salient locations or times in images or videos. In both audition and vision domains, interest points are useful for summarization, information retrieval, and knowledge discovery.

While the segment-based and boundary-based formulations for music segmentation are largely complementary, a boundary-based formulation allows us to apply a supervised learning framework in a straight forward manner. That is, we extract features that are designed to reflect timbral differences in the music and used these features to learn a classifier that is able to detect musical interest points. The labels for our supervised framework come from the "soon-to-be" released AIST Annotation data set. This data set includes 100 popular music songs with aligned, hand-labeled structure information related to beginnings and endings of introductions, chorus, verses, bridges/solos, and outros.

8. Please add your comments (if any):

My summer was very productive due to great interaction with my host Masataka Goto, his post-doctoral research Elias Pampalk, and a number of Japanese graduate students. Both professionally and personally, this summer was a great experience. I only wish that I could stay longer.

RESEARCH REPORT

1. Name: Megan Turnbull （ID No.: SP06058）

2. Current affiliation: San Diego State University

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: University of Tsukuba, Department of Epidemiology

5. Host researcher: Dr. Yukiko Wagatsuma

6. Description of your current research:

Schistosomiasis, a parasitic disease, is endemic in 74 countries and infects 200-300 million people worldwide. Even though many countries have made major investments in control projects, the number of those infected has not changed due in part to population growth in endemic areas. In Subtropical and Tropical countries, schistosomiasis is second only to Malaria in terms of public health importance, and is also considered the most important helminth infection to humans. The parasite can penetrate human skin when submerged in water and eventually damages vital organs. Schistosomiasis increases morbidity and mortality, financial burdens on families, communities, and governments, and inevitably decreases their ability for advancement.

With schistosomiasis continuing to be a major problem in parts of the world, it is imparative that health professionals understand the indicators of schisotsomiasis to help improve the treatment for those with severe morbidity. One goal is to link epidemiological factors to disease progression, distribution of the infection, and individual predisposition to the infection. These factors include, knowledge, attitudes, pain, fatigue, nutritional status, genetic variability, gender, and types of water activities.

The global control strategy has recently changed from reduced transmission and eradication of schistosomiasis to morbidity control. With cost-effective drugs and continual commitments from governments, morbidity control should succeed. Our current research is being undertaken to determine if this is an effective model.

7. Research implementation and results under the program

Title of your research plan:

Schistosomiasis: Positive Predictors of Morbidity

Description of the research activities:

Analysis is ongoing to determine positive predictors of Schistosomiasis morbidity using the 1999-2002 School Screening, Treatment and Education (SSTE) Program data from the UMP district, a high priority zone in Zimbabwe. Urine dipsticks were used to detect microhaematuria in students in Grade 1 and 5. Grade 1 was chosen to prevent severe morbidity during the ages of 10-14, and Grade 5, the peak years of infection, was chosen to keep the prevalence of schistosomiasis at a low level (<10-20%). Around age 15, students usually acquire immunity to schistosomiasis. Those infected were treated with one oral dose of praziquantel. The four data sets used contained data from 47 schools in the UMP district, and over 22,000 student entries in total.

Much of the work involved cleaning the data sets. Missing data was the biggest concern in the analysis, with over 75% of some variables absent. Names of students, schools, and districts were also imputed as string variables, often with numerous different spellings depending on who entered the data. Student Ids were also classified in a different way in the data sets depending on the year.

Three new variables were created for analysis, distance from schools to nearest clinic, altitude of school, and nutritional status. The distance and altitude variables values were established using Zimbabwe government maps. Currently the nutritional status (weight for age) for each student is being calculated using Epi Info. Using the SPSS program, prevalence of microhaematuria, a morbidity indicator, has been shown to decrease from 1999 to 2002. Formal analysis using regression models will follow to determine actual risk factors for the individual schools. Ultrasound data will also be added as soon as it becomes available. Once completed, results will be presented to the Department of Health in Zimbabwe.

8. Please add your comments (if any):

Using data that one has not initially been involved in, as well as data sets from a third world country can be very challenging. You are limited to the data that has been provided, which in many cases have many flaws. But, in the end it can be even more rewarding to find results that may lead to improved public health initiatives.

RESEARCH REPORT

1. Name: Chia-Jean Wang （ID No.: SP06059）

2. Current affiliation: University of Washington

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: Prof. Motoichi Ohtsu

6. Description of your current research

The trend towards ultra-high density photonic circuits is driving innovation in fabrication for nanoscale components. To capitalize on the inherent advantages of their increased bandwidth and modulation speed, the search for a viable process to create devices which may propagate energy and compute at a sub-diffraction level is underway. However, there is yet to be a dominant and widely applicable method for large scale, finely-tuned manipulation of objects under 100 nm.

My current research involves creating waveguides for nanophotonics using self-assembly techniques with quantum dots on a substrate. Successful fabrication has been accomplished by an amino-carboxyl bonding as well as with methods using DNA as a programmable element. The goal for EAPSI 2006 was to examine nanoscale fabrication in terms of enhancing size, position and separation controlled alignment by using optical near-field to position nanoparticles through DNA linkers.

Experiments with utilizing optical near field to assemble gold nanoparticles along a silicon wedge structure and DNA assembly techniques were verified prior to the project. The integration of the two would be useful in providing a means for precise, programmable, large-scale assembly of nanoparticles, which may lead us a step further to fabricating nanophotonic integrated circuits.

7. Research implementation and results under the program

Title of your research plan:

Programmable Nanoscale Positioning with Optical Near Field

Description of the research activities:

The platform for experimentation is described in prior work by Yatsui et al where gold nanoparticles (NPs) conjugated to carboxyl groups are self-assembled along a silicon wedge using solution evaporation for coarse deposition and energy transfer by optical near field at 690 nm for alignment. Accordingly, I started learning the fabrication process and understanding the testing methods immediately and soon began to make the wedge structures to perform the optical near field experiments independently.

For the DNA assembly, we selected four 12 base sequences in two complementary pairs, each with a fluorophore or quencher modification:

- 5'Oregon Green 488-spacer-ATCCTGAATGCG'3

  + 5'Black Hole Quencher1-spacer-CGCATTCAGGAT-biotin
- 5'Bodipy 630–spacer-AATATCCTGGCG

  + 5'Black Hole Quencher2-spacer-CGCCAGGATATT-biotin

Progression of the experiments was designed in three stages. The first test was demonstration of DNA near-field manipulation through the fluorophore absorber via tuned laser, which would be verified by fluorescence at designated wedge peak location. Next, we would demonstrate hybridization with complementary DNA chain and observe subsequent quenching of the base layer fluorophore. Thirdly, DNA selectivity would be exploited through hybridization experiments in multiple regions on same wedge. The cDNA linked to biotin would be chemically bonded to streptavidin coated polystyrene spheres, 1 um diameter or streptavidin coated Au, 10 nm diameter for the latter experiments.

Without access to a fluorescence microscope, we tried imaging with a CCD camera and relevant filters as well as with a near-field scanning optical microscope (NSOM). While the former did not provide enough resolution nor could detect much light after the filter stage, the latter was able to pick up fluorescence using an apertured Al coated fiber probe. Unfortunately, much time was spent debugging the imaging process as well as reproducing the gold particle near-field alignment process in order to better understand the dynamics and restrictions of the method. Consequently, the current state of research is at detecting the DNA and cDNA fluorescence on the device with the NSOM. Initial images show a bright line at the wedge tip and are to be confirmed with further control tests.

8. Please add your comments (if any):

I am grateful to Prof. Motoichi Ohtsu, Dr. Takashi Yatsui and Wataru Nomura for their valuable support and suggestions. The Ohtsu lab was more helpful and gracious than I could have expected. I would like to thank NSF and JSPS for enabling and funding this unique and educational experience and my advisor, Prof. Lih Lin for encouraging me to take this opportunity.

9. Advisor's remarks (if any):

Ms. Wang's proposal is very promising for future development of nanophotonic devices, and is interesting as an interdisciplinary field of research between photonics and biology. Within a very short period of stay, she studied intensively and got several important experimental results. I expect her future progress and look forward to have collaboration with Prof. Lin's group. I gratefully acknowledge NSF and JSPS for supporting this program.

RESEARCH REPORT

1. Name: Tracey-Ann Wellington （ID No.: SP06060）

2. Current affiliation: Texas A&M 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: Institute of Solid State Physics (ISSP)

5. Host researcher: Professor Hidehiko Ishimoto

6. Description of your current research

Mn_{12}-acetate $[Mn_{12}O_{12}(CH_3COO)_{16}(H_2O)_{14}].{}_2CH_3COOH.{}_4H_2O$, behaves like a single S=10 system with very high anisotropy. It exhibits macroscopic quantum tunnelling of the magnetization (QTM). At temperatures below 3K, there is an observable magnetic bistability with hysteresis, as well as splitting of zero field and field cooled magnetization. Due to the characteristics of Mn_{12}-acetate, it shows a strong antiferromagnetic ordering only at temperatures below 3K. I am measuring the magnetic properties of thin films of Mn_{12}-acetate using a range of temperatures and magnetic field. The thin films of Mn_{12}-acetate were deposited on silicon wafers and plastic straws with measurements of approximately 5mmx5mm. Two processes were used for deposition, Laser Ablation and Dip and Dry (DAD) technique.

7. Research implementation and results under the program

Title of your research plan:

MAGNETIZATION MEASUREMENTS on MN_{12}-acetate THIN FILMS

Description of the research activities:

During the laser ablation process a pellet of Mn_{12}-acetate is mounted in an ablation target and the films are fabricated using a pulse frequency of about 1Hz. The DAD technique is done by dipping the substrates in a solution of Mn_{12}-acetate and isopropanol to deposit the Mn_{12}-acetate on the substrate. A Magnetic Property Measurement System (MPMS) was used to measure the magnetic properties of the thin films. Three magnetization measurements were taken for each sample in order to obtain the magnetization of the Mn_{12} thin films. These magnetization measurements were of 1) the sample holder and grease (used to support the sample on the holder), 2) the sample holder, grease and sample, and 3) the straw holder with the substrate (silicon or plastic straw). The measurements were first done using a glass holder to mount the sample. The approximately 12 hour measurements were done on each of the samples prepared by both methods of various depositions. After analyzing the results obtained from these runs it was found that the background from the glass holder was too high and was adversely affecting the results. The glass holder was substituted for a straw holder ad the measurements were redone. The results were mixed and some inconsistencies in the results prevent any definite conclusions. The 150nm thin film deposition garnered the best results as hysteresis loops were observed for both the silicon and straw sample where the thin film was deposited using laser ablation. The samples prepared by the DAD technique did not produce a hysteresis loop, which might be due to the 2nm deposition of the Mn_{12}-acetate.

8. Please add your comments (if any):

The experimental results obtained for the magnetization of the Mn_{12}-acetate thin films prepared with laser ablation method are larger by a factor of about 5 than the theoretical calculation obtained for the magnetization of the bulk Mn_{12}-acetate crystals. The reasons for the inconsistencies in the results are not very clear, as these types of measurements on thin films are fairly new. Regardless, the data obtained is useful for further understanding the magnetic properties of these thin films.

9. Advisor’s remarks (if any):

The magnetization measurement of Mn_{12}-acetate film seems to be difficult because of a large background signal from silicone or straw substrate. We tried to measure the background signal carefully, but the data still include some ambiguities. Particularly in the dip and dry samples, Mn_{12}-acetate films are so thin that the obtained data are not so reliable. On the other hand, the magnetization data for laser ablation samples show a qualitatively reasonable behavior. Nevertheless quantitatively they are not so consistent with those estimated from crystallized sample. We wonder if the film samples have a different kind of Mn complexes or structures. Further investigations are eagerly desired.

RESEARCH REPORT

1. Name: Jeffrey D. Witzel （ID No.: SP06061）

2. Current affiliation: University of Arizona, Department of Linguistics

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: University of Tokyo

5. Host researcher: Dr. Yuki Hirose

6. Description of your current research

My research focuses on the mental processes that underlie the production and comprehension of language. Specifically, my research targets lexical (or word) level and sentential level processing in English and Japanese by first and second language speakers of those languages. As far as lexical level processing is concerned, I am interested in the organization of the mental lexicon (or the “mental dictionary”) and how this lexicon is accessed during the production and comprehension of English and Japanese. As far as sentential level processing is concerned, I am interested in how speakers of Japanese and English form meaningful representations from strings of words in real time. This involves identifying preferences for the interpretation of sentences in these languages and explaining these preferences with reference to statistical regularities, working memory resources, and the components of the mental grammar. Japanese and English differ in many interesting ways, so careful examination and comparison of the production/comprehension processes in these two languages can potentially contribute to the development of cross-linguistically-valid language processing models.

7. Research implementation and results under the program

Title of your research plan:

The Online Processing of Japanese Control Sentences

Description of the research activities:

In Japanese, the information necessary to posit/analyze empty categories (or unpronounced elements) is often not available until the end of the sentence, at the main (or matrix) clause verb. For example, consider the following Japanese control sentences:

(1) Japanese Subject Control (SC) Sentence (Sakamoto's (1996: 54) (32b))

Kooiti$_i$-ga kaisya-de Tamae$_j$-ni [$e_{i/*j}$ Tookyoo ryokoo]-o wazato kakusiteita.

Kooiti$_i$-NOM company-LOC Tamae$_j$-DAT [$e_{i/*j}$ Tokyo travel]-ACC purposely concealed.

At the company, Kooiti purposely concealed from Tamae his travel to Tokyo.

(2) Japanese Object Control (OC) Sentence (Sakamoto's (1996: 54) (33a))

Jiroo$_i$-ga sensyuu Kazumi$_j$-ni [$e_{*i/j}$ Tookyoo iki]-o denpoo-de tanonda.

Jiroo$_i$ -NOM last week Kazumi$_j$ -DAT [$e_{*i/j}$ Tokyo going]-ACC telegram-INSTR requested.

Last week, Jiroo requested of Kazumi by telegram that she go to Tokyo.

In the SC sentence (1), the antecedent of the empty subject (*e*) in the embedded clause is the subject of the matrix clause, *Kooiti*; in the OC sentence (2), the antecedent of *e* is the object (or dative-marked NP) of the matrix clause, *Kazumi*. Crucially, information about the antecedent of *e* is not available until the matrix verb – in (1), *kakusiteita* ('concealed'); in (2), *tanonda* ('requested'). The questions examined in the present study are as follows: (a) Does the sentence parser (or structural computation mechanism) assign an antecedent to *e* before information about this antecedent becomes available from the matrix verb? (b) If so, which NP – the matrix subject or object – is tentatively assigned as this antecedent?

The experiment consisted of a region-by-region, moving window, self-paced reading task. This task allowed reading times to be recorded for each region of the test sentences. Four sentence types were tested: Subject Control with empty embedded clause subjects (SCE), Subject Control with overt embedded clause subjects (SCO), Object Control with empty embedded clause subjects (OCE), and Object Control with overt embedded clause subjects (OCO). It was predicted that if there is an SC bias for positing the antecedent of *e*, reading times for control verbs that are inconsistent with this bias (namely, object control verbs in OCE sentences) should be inflated. On the other hand, if there is an OC bias for positing the antecedent of *e*, reading times for control verbs that are inconsistent with this bias

(namely, subject control verbs in SCE sentences) should be inflated.

Forty-eight sets of the 4 test sentences were created. From these sets, counterbalanced lists were compiled – each with 48 test items and 80 distractor items. The test and distractor items were presented to subjects in pseudo-random order. Forty-eight native Japanese speakers participated in the experiment.

Preliminary analyses indicate an OC preference for the tentative assignment of antecedents to the empty embedded clause subject in Japanese control sentences.

8. Please add your comments (if any):

I very much enjoyed my experience working with Dr. Yuki Hirose at the University of Tokyo. Without Dr. Hirose's help with the design and implementation of this experiment (including the recruitment of subjects), this study would not have been possible. I also had the chance to present my work at a sentence processing conference at the University of Tokyo and at a meeting of a linguistics reading group on campus. These opportunities allowed me to meet and discuss my research with students and colleagues who share my interests in language processing in general and in Japanese sentence processing in particular.

9. Advisor's remarks (if any):

Mr. Witzel conducted an experiment on Japanese control structure. The results look very promising. I really enjoyed working with him and grateful for this opportunity to collaborate with him this summer.

RESEARCH REPORT

1. Name: Jamie Yang （ID No.: SP06062）

2. Current affiliation: Massachusetts 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: Keio University

5. Host researcher: Prof. Yoshinori Matsumoto / Prof. Kohei Itoh

6. Description of your current research

The processing and storage of information depend on its implementation: Information cannot be separated from its physical representation. Manipulating information on a quantum system allows one to exploit the uniquely quantum phenomena of superposition and entanglement, and to consequently solve certain problems much more efficiently than on a classical system. Nuclear and electron spins are attractive candidates for quantum bits because of their isolation from environment: Nuclear spins feature long coherence times but suffer from weak interactions and very weak polarization. The larger magnetic moments of electrons allow for higher polarization and more efficient state manipulation, but shorten the coherence time. By combining electron and nuclear spins and controlling the hyperfine interaction, it will be possible to exploit the advantages of both systems. For example, nuclear spins can be used to store information, while electron spins can be used to initialize bits, transfer information, and for readout. Nuclear magnetic resonance (NMR) and electron spin resonance (ESR) techniques are used to achieve control over these systems. Also, a variety of methods that could be useful for quantum computing have been implemented to manipulate the state of electrons in solids. My research in the US and Japan is directed towards using magnetic resonance on appropriate spin systems to study aspects of fulfilling the requirements for building a quantum computer. A particularly interesting spin system involves a localized electron in a silicon lattice interacting with the nuclear spins of the phosphorus donor impurity and the spin-1/2 silicon-29 isotopes within the electron's Bohr radius. The concentrations of the silicon isotopes can be controlled to achieve desired effects. Also, due to several decades of experience in integrated circuits, silicon fabrication technology is very well-developed.

7. Research implementation and results under the program

Title of your research plan:

Quantum Information Processing using Coupled Electron and Nuclear Spins in Silicon

Description of the research activities:

At low field, the strength of the hyperfine interaction (between the electron spin and nuclear spin) is comparable to that of the electron spin Zeeman interaction (between the spin and the external magnetic field), and allows significant mixing between the usual eigenstates. Thus in a coupled single electron—single nuclear spin system, in addition to the four single-spin-flip transitions available at high field, the two transitions involving simultaneous spin flips are also accessible. We would like to first characterize the low-field energy levels of donor electron spins in silicon and of radiation defects in silicon, and to possibly use this information to generate desired quantum states at low field. This summer I worked with a graduate student, Hiroki Morishita, on redesigning a low-field photoconduction detected ESR probe. This ESR method—capable of detecting a much smaller number of spins, especially at low field–measures the change in the conductivity of optically excited electrons due to spin-dependent recombination. Hiroki had already implemented such a system, but the measurement suffered due to hysteresis of the magnetic field and mechanical instability of the sample. For the new probe, we are using a different magnet, and have modified a liquid helium temperature cryostat to our specifications. The new probe has better mechanical support for the sample to counteract the turbulence caused by the boiling helium. After dealing with several design problems, we were finally able to test the system in the magnet in early August. We saw that the light scattering off of the bubbles of boiling liquid nitrogen in the outer jacket of the cryostat seemed to be causing instability in the signal, and that some source of heat was causing the liquid helium to boil off so quickly that we were unable to run the experiment. We have made modifications to address these problems, but as of the date of this report (August 20, 2006), we have yet to retest the system.

RESEARCH REPORT

1. Name: Mark Zielke （ID No.: SP06063）

2. Current affiliation: UC Santa Barbara

3. Research fields and specialties
Engineering Sciences

4. Host institution: Tohoku University

5. Host researcher: Prof. Ono

6. Description of your current research

Selective Growth of Carbon Nanotubes using Nafion as a Precursor

Carbon Nanotubes (CNT) have a potential use as electron field emitters. Electric field lines are concentrated around a sharp object. Due to their high aspect ratio, their electrical conductivity and a sharp tip radius, nanotubes produce a very high electric field at their tip. A reliable method is still to be found to produce large arrays of single, widely spaced, vertical carbon nanotubes. Prof. Ono's group in the Esashi lab, Tohoku University, has been working on different approaches to achieve this. Since carbon nanotubes will not grow on a plain silicon surface, a catalyst is needed to initiate the growth. The objective of this research is to create a catalyst pattern for the CNT growth. Therefor a method is developed to create small iron catalyst particles on a silicon chip. Eventually single CNTs should be grown vertically on the selected spots in order to use the CNTs for electron field emission. The catalyst size should be preferably in the range of 10nm – 50nm.

Nafion is a synthetic polymer with ionic properties. These polymers are called ionomers. Being able to transport metal ions, the nafion can act as a storage medium for iron ions on top of a silicon chip. Soaking the nafion in iron sulfate solution lets the iron ions migrate into the nafion. After ashing the nafion in oxygen plasma, the iron will remain and it can act as a catalyst for CNT growth.

Dots of nafion are to be deposited on top of a silicon chip Shrinking of the nafion dot during the ashing process might act as an additional advantage for decreasing the catalyst size.

7. Research implementation and results under the program

Title of your research plan:

Selective Growth of Carbon Nanotubes using Nafion as a Precursor

Description of the research activities:

Experiments have been made to prove the selectivity of carbon nanotube growth with this method. A sharp tip was dipped into an alcohol nafion solution and then swiped over the surface of a silicon chip. Afterwards the sample was soaked in iron sulfate solution and then the nafion was ashed in a oxygen plasma. CNT growth in the CVD chamber proved the desired selectivity of growth. Although the complete silicon chip was dipped in iron sulfate solution, only the areas which have originally been covered with nafion formed CNT growth. Samples which have not been soaked in iron sulfate solution, do not form any CNT growth. The working principle of using nafion to deposit iron as a catalyst has been shown. Forming dots of nafion in order to produce single standing CNTs still remains a challenge.

The first approach for forming the nafion dots was the Dip Pen Lithography method. This method uses the tip of an atomic force microscope as a "fountain-pen " to write onto the silicon sample. Therefore the AFM tip is dipped into the alcohol based solution of nafion before it is brought into contact with the sample surface. Touching the silicon sample with the AFM tip was supposed to leave marks of nafion on the surface. However, the solution seemed to dry rather quick and no nafion marks were visible on the silicon surface. Even scratching over the silicon surface with a nafion covered AFM tip did not prove sufficient to deposit any particles which could be used to form CNT growth.

The research now focuses on using the direct write E-Beam lithography to generate a pattern on the nafion. The JEOL EB 5000LSS system is supposed to be able to produce patterns with dimensions as low as 30nm. A large array of dots with varying sizes has been exposed. For these experiments, silicon samples have been spin coated with a 130nm thick layer of nafion. Two approaches for patterning the nafion have been pursued.

First, the nafion layer is directly written on with the electron beam writing system. The exposure with the electron beam proves to be sufficient to make the exposed areas insoluble to ethanol, whereas the unexposed parts completely dissolve in ethanol. It has been possible to produce larger patches of CNTs with this method. However, the resolution of this technique has been unsatisfactory in terms of growing single standing CNTs. Maybe varying the electron beam doses can calibrate this method in order to improve the resolution, but time will be too short to do these experiments.

The alternative method is to evaporate a thin layer of chromium on top of the nafion and then spin coat it with a photo resist. The chromium can be patterned with the photo resist and then it acts as an etch mask during the oxygen plasma etch of the nafion. Process controllability determines the achievable dot size of the nafion. Since the oxygen plasma etch also undercuts the chromium mask, the nafion dot sizes end up being much smaller than then they were defined by the lithography. After the plasma etching, the chromium can be removed with a chromium etchant in order to expose the nafion dots for the iron treatment. This last step is being performed right now and hopefully results will produce iron dots small enough to enable the growth of individual carbon nanotubes.

RESEARCH REPORT

1. Name: Jessica A. Zimberlin （ID No.: SP06064）

2. Current affiliation: Department of Polymer Science and Engineering
University of Massachusetts, Amherst

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 Women's Medical University

5. Host researcher: Teruo Okano

6. Description of your current research

Cell sheet harvesting has been developed as a novel technique that is currently being employed to further advance the field of tissue engineering. Although significant research has been done over the past five years, many challenges in fully understanding the release process of the cell sheets remain. Further understanding will not only contribute to the extension of the promising strategy, but will provide fundamental insight into biomaterial interfaces. In order to contribute to this promising field, we have proposed a novel method by which to characterize specific cell sheets and their separation from the thermoresponsive polymer, poly(n-isopropyl acrylamide) [PIPAAm].

This method involves attaching a thin film of polystyrene [PS] to a cell sheet and characterizing the response of the system upon a temperature reduction that promotes the subsequent release of the cell sheet from the PIPAAm. The response of the system will include either a wrinkling or a bending depending on the thickness of the confining PS layer. The wavelength of the wrinkling and the effective radius of the curvature of the system will allow us to determine both the modulus and residual stress respectively. To achieve the set goals, my research at Tokyo Women's Medical University with Professor Okano's research group has been split into three phases 1) to learn the process of culturing cell sheets, 2) to establish a procedure to attach a polystyrene thin film onto a cell sheet, and 3) to characterize the mechanical properties of different cell sheets.

7. Research implementation and results under the program

Title of your research plan:

Structure-Property Relationships Related to the Control of Cell Sheet Harvesting

Description of the research activities:

After completing phase one, we have worked on phase two to develop a reproducible, robust technique for attaching polystyrene thin films of defined thickness onto a cell sheet. The original plan had been to use PS films that had been pre-made at the University of Massachusetts by the flow coating technique, but those samples were not viable as they had been pre-treated with UV-Ozone and could not be removed from the silicon wafers. The new procedure, which eliminates this treatment, has been proven through experiment. The procedure for phase two is described in Figure 1. As indicated in step five, the basal side of the cell sheets was used because they display a greater adhesion than the top side of the sheets. This phenomenon arises because the cell sheets deposit a layer of extracellular matrix on the side to which they are actively adhering or in other words to the basal side that is attached to the PIPAAm. This extracellular matrix contains adhesive proteins that allow for local junction points to be made between the cell sheet and a substrate.

This experiment was then performed on bovine aortic endothelial cells. After the cell sheets are released from a PVDF membrane, the internal stress of the cells is no longer balanced by the stiffer substrate. Due to the presence of this internal stress, the cell sheets want to contract. The confining, flexible PS layer that is attached to the cell sheet prevents this and instead, the samples bend as seen in Figure 2. With time, the contractile force increases and a decreased radius of curvature of the sample is seen, as in the second image in Figure 2. Using the radius of curvature, R, of the cell sheet/PS sample, a simple beam bending analysis can be employed to determine the residual stress, σ, of the cell sheet:

$$\sigma = \frac{Eh}{R}$$

where E is the elastic modulus of the confining layer and h is its thickness. The thickness of the PS layer is the only remaining unknown in this equation.

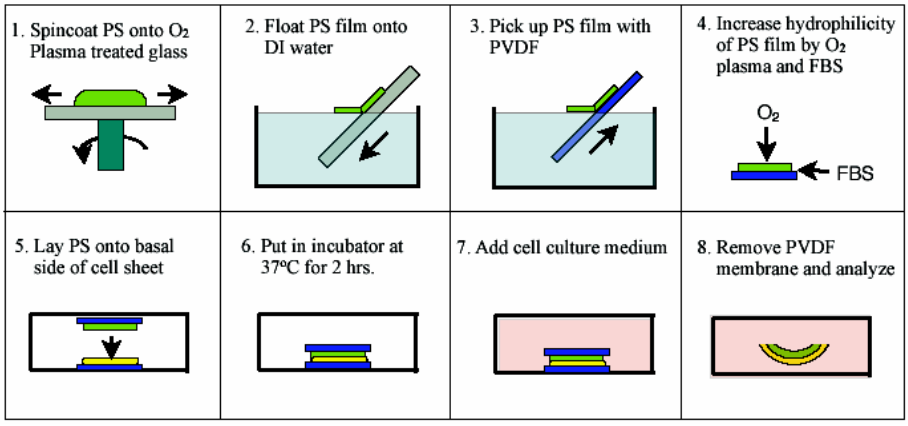


Figure 1: Description of Procedure

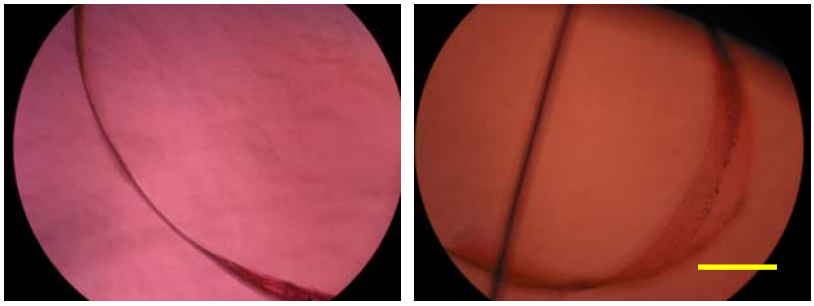


Figure 2: Cell sheet/PS pair. The first image was taken five minutes after removal from the PVDF layer and the second was taken 22 hours after removal. The scale bar is 1mm.

The thickness of this layer will be measured at the University of Massachusetts this fall and further experiments using different cells lines will be performed.

The knowledge of the residual stress will allow us to further probe other mechanical properties such as the critical energy release rate. Through this characterization, we will be able to extend the current understanding of the surface and near-surface contributions to the cell sheet release process, the effect of PIPAAm processing conditions on the cell sheet release process, and the impact of geometry on the cell sheet harvesting procedures.

8. Please add your comments (if any):

In addition to the valuable experience I have gained from being in another laboratory, this experience has allowed me to immerse myself into a different culture and has shown me new ways of doing research. This program has been invaluable for my personal growth and will have a strong impact on my future career as a scientist. More immediately, it has already had an impact in establishing ties between the Crosby and Okano research groups that will hopefully lead to a fruitful collaboration.

9. Advisor's remarks (if any):

"I think this program has been a great experience for Jessica and for our research group. Jessica has taken full advantage of this opportunity, not only to grow scientifically and professionally, but also to gather scientifically significant results. I am confident that Jessica will use her new knowledge, experience, and results to build the next phase of her Ph.D. research." A. Crosby

"I feel that this program is an excellent way to bridge the gap between research in the United States and in Japan. I believe that this program has provided a platform from which to form a collaboration that would otherwise have not been established." T. Okano

RESEARCH REPORT

1. Name: Brian Zimmer （ID No.: SP06065）

2. Current affiliation: Northern Arizona 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: Shinshu University, Matsumoto, Japan

5. Host researcher:Yasuyuki Miyake

6. Description of your current research

Yakedake volcano, located in the North Japan Alps, Western Honshu, Japan has produced numerous lava flows and a lava dome. The Shimohorizawa lava flows ($1.5km^3$) cover a wide expanse of the southern flank of the volcano. Yakedake dome ($0.5km^3$) was emplaced about the same time as the Shimohorizawa lava flows, but the two lavas differed significantly in eruptive character. While the Shinohorizawa lava flows were emplaced in a quiet, effusive manner, Yakedake dome produced numerous pyroclastic flows generated by collapse of the frontal lobe. These pyroclastic flows are voluminous (<40m thick) and widespread. Because both the dome lava and the Shimohorizawa lava were emplaced onto similar slopes, the differences in lobe stability suggest critical differences in the internal structures and chemistry of the lavas. In an effort to quantify these differences, extensive field work was completed, in which the Shimohorizawa lava flows and Yakedake dome were surveyed, the stratigraphies of the different flows were assembled and representative samples were collected. Previous mapping of the lava flows was also updated and corrected. The goal remains to correlate significant differences in the vesicularity, chemistry, crystallinity, and volatile concentrations within the lavas with increased pyroclastic flow production.

7. Research implementation and results under the program

Title of your research plan:

Lava composition; correlations with the production of pyroclastic flows.

Description of the research activities:

Field surveys and sample collection were completed on both Yakedake dome and the Shimohorizawa lava flows. Basic petrologic analyses of these samples separated the Shimohorizawa lava flows into three compositional variations; 1) an end member dacite composed of large plagioclase and hornblend phenocrysts and small, but abundant pyroxenes in a glassy to microlitic groundmass, 2) an end member dacite composed of smaller plagioclase and hornblend phenocrysts and small accessory mafic minerals, and 3) the heterogeneous product of magma mingling between the two end members. Petrologic analyses included thin section observation and point counting for quantitative results. Internal heterogeneities within the uppermost lava flow were greater than expected suggesting complex magma interactions in the upper crust. The Yakedake dome lava is composed of eight individual lavas, mostly dacite in composition. Inclimate weather restricted field excursions to Yakedake dome to only the last two weeks of the study. Consequently, analyses of these samples are significantly delayed.

Electron-dispersal spectrometry was conducted on various samples from the Shimohorizawa lava flows to confirm petrographic correlations. Electron-dispersa l spectrometry analizes phenocryst and volcanic glass chemical compositions and can be used to help determine pressure/tempreature/H_2O regimes at the time of crystallization. Results from these analyses were not yet compiled at the time of this publication.

The scope of the project was very large, but significant progress has been made and this work will be continued by Shin'ya Hashimoto as part of his thesis research. Further analyses include ICP-MS for chemical composition and Micro-FTIR for determining volatile concentrations within volcanic glass. Hashimoto-san and I will remain in close contact throughout the remainder of this work with the goal of publishing the results.