THE NATIONAL ACADEMIES

RESEARCH ASSOCIATESHIP PROGRAMS

The Postdoc

Spring 2013

Table of Contents

Saharan & Asian dust end global journey in California

NOAA's Hydrometeorology Testbed Project at Sugar Pine Dam *continued on page 7*

Turbulence, Ocean Optics & Future UNOLS Chief Scientist

Figure 2: Dr. Silvia Matt, NRC Associate, looks on as instruments are deployed o♂ the UNOLS research vessel R/V New Horizon.

Optical properties of coastal and open ocean water and their impact on underwater optical signal transmission are important for a wide range of practical and scientific applications. Underwater optics are known to be affected by particles in the water, i.e. the turbidity, but less is known about the effect of so-called "optical turbulence". Local changes in the index of refraction caused by small-scale temperature and salinity microstructure in the water can impact underwater electro-optical (EO) signal transmission. The phenomenon is similar to the "Schlieren" effect seen in air wavering over a hot candle or asphalt road.

continued on page 19

"The Postdoc" highlights research and activities of NRC Associates and Advisers in participating federal government agency laboratory programs with the NRC. Our newsletters are available in print and on our website: http://sites.nationalacademies.org/PGA/RAP/PGA_047804.
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NATIONAL RESEARCH COUNCIL
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Boulder *NRCs* Volunteer at Super Science Saturday

Local children and their parents learned about magnetism from NRC Postdoctoral Research Associates working at the Boulder campus of the National Institute of Standards and Technology (NIST) at this year's Super Science Saturday. Super Science Saturday is an annual science outreach event sponsored by the National Center for Atmospheric Research (NCAR), taking place on October 27, 2012. It combines hands-on learning, demonstrations and static exhibits from research laboratories located around Boulder and Denver. Organizers at NCAR estimate that approximately one thousand visitors showed up to learn about the diverse fields of scientific inquiry ranging from atmospheric science to basic physics.

The Boulder NRC Postdoc Social Committee sponsored a booth at Super Science Saturday this year. Dr. Lauren Rast from the newly formed Applied Chemicals and Materials Division wowed young visitors with ferrofluidic visualization of magnetic field lines in real time. In her work at NIST, Dr. Rast develops multiscale and predictive models for optimal design of nanomaterial systems. These systems include graphene-based devices for energy applications, and magnetic nanoparticle systems with applications including hyperthermic treatment of cancer.

Magnetic nanoparticles are being investigated at NIST for many important applications including drug delivery, water treatment, treating diseases of the brain, as well as validating measurement and characterization tools. Dr. Katie Rice, also from the Applied Chemicals and Materials Division, is a part of the effort to synthesize iron and iron oxide nanoparticles to look at some of their fundamental oxidation mechanisms, and investigate how crystal structure affects their behavior. Iron particles are great candidates for these applications because of their low toxicity and relatively low cost. The research in this area has fostered some great collaborative efforts between divisions at NIST.

Atomic force microscopy (AFM) is capable of resolving very weak mechanical forces, but calibration of the measurements has always vexed researchers. NRC Adviser, Dr. Peter Hsieh, aims to apply the Diamagnetic Lateral Force Calibrator method, developed at NIST Gaithersburg, to his research on changes in the lubricity of a complex fluid as a function of its composition. By measuring the twist of an AFM cantilever in contact with a piece of graphite levitating in a magnetic field, the spring constant of the cantilever can be determined accurately and reproducibly. Improving friction and wear measurement methods on the microscopic scale may lead to a better understanding of boundary lubrication, which is vital to the development of longer-lasting and more energy-efficient lubricants in the future.

The Electromagnetics Division at NIST is busy at work developing novel electromagnetic measurement methods, standards, and technology to support a broad range of technical needs. As a part of the hands-on experimentation at Super Science Saturday, Dr. Katy Keenan contrasted the different falling speeds of a rare-earth magnet falling through a copper tube and a plastic tube. *continued on page 16*

NRC Associate, Dr. Lauren Rast, demonstrates magnetic field line visualization with some ferrofluid in a jar.

Photo by NRC Adviser, Dr. Peter Hseih

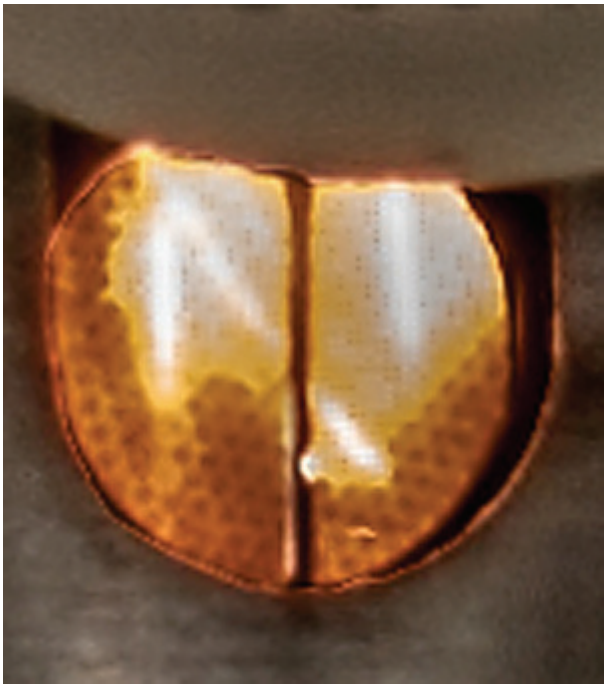
Coming soon: tabletop molecular movies

NIST NRC Associates' and Advisers' Research Project

One of the most urgently sought-after goals in modern science is the ability to observe the detailed dynamics of chemical reactions as they happen – that is, on the spatial scale of molecules, atoms, and electrons, and on the time scale of picoseconds or even shorter.

That is a formidable challenge. But as a successful 2010 proposal for an ambitious NIST project explains, ***"it is critical to the development of next-generation nanomaterials ranging from industrial catalysts to renewable energy devices that harvest sunlight, store electricity, and make hydrogen and other fuels from splitting water or recycling carbon dioxide."***

Now a group of researchers, researchers including NRC Associates Drs. Galen O'Neil and Luis Miaja, devised and demonstrated a highly unusual, compact, and relatively inexpensive x-ray spectroscopy system. The system combines a pulsed-laser based x-ray source with high-efficiency, high-resolution cryogenic x-ray detectors for an imaging system that may soon be employed to produce the kind of "molecular movies" that scientists and engineers need.



Close-up of water-jet target (vertical line, ~ 0.2 mm wide) used to produce picosecond x-ray pulses. Credit: Jens Uhlig

"I believe that we are going to be able to measure interatomic distances to sub-angstrom accuracy [1 angstrom = 10^{-10} m]," says Joel Ullom of the Quantum Devices Group in PML's Quantum Electronics and Photonics Division, Principal Investigator for the collaborative project and head of the team that created the x-ray source. ***"And we will be able to watch atomic-scale activity with picosecond resolution during chemical reactions."***

"Joel's x-ray source is a novel table-top system that creates picosecond pulses of x-rays, a holy grail among scientists who are trying to elucidate the precise, real-time motion of electrons, atoms, and molecules," says Marla Dowell, leader of PML's Sources and Detectors Group. ***"Eventually, this table-top approach will be able to compete head-to-head with far more expensive and elaborate synchrotron techniques."***

The operating principle is extraordinary. It begins with a pulsed infrared (IR) laser beam, which is split into two parts. The first part is used to photoexcite a material under study, starting a chemical reaction. The second part is routed into a vacuum chamber, above which is a water reservoir that has a tiny aperture leading to the chamber. Water is drawn into the chamber in a 0.2 mm wide jet (see figure, above right) and the laser beam is focused onto the streaming water jet target.

"This ignites a plasma on the target," Ullom says, ***"and some of the electrons from the ionization are accelerated – due to the very large electric fields from the laser – back into the water target. There they undergo the same kind of abrupt deceleration that electrons do in a conventional x-ray tube. The IR beam has very little energy per photon. But what comes out of the interaction with the target are x-rays with energies 10,000 times higher. Then we collimate the x-ray beam so that it strikes the sample of interest."*** The x-rays then pass through the sample and into a separate cryogenic chamber where superconducting x-ray detectors record the absorption spectrum. (See figure at bottom of page.)

"So the system contains two strikingly different environments: detectors at millikelvin temperatures, and a plasma source with surface-of-the-sun temperatures," Ullom says. ***"And they are only about 15 cm apart. We address that by placing many layers of IR blocking filters in the detector enclosure. They transmit x-rays but stop visible and IR radiation."***

The source's x-ray output is broadband, with photon energies ranging from a few hundred electron volts (eV) to roughly 15 or 20 keV. That range is important, Ullom says, because different x-ray energies are absorbed by different elements and different combinations of orbital configurations and interatomic spacings: ***"The ability of a material to absorb x-rays depends very sensitively on the chemical state of the atom, and the signal is markedly affected at 'edges' between different sets of orbital transitions. In addition, ripples in the absorption spectrum, caused by interference patterns in the wave function of electrons, reveal an atom's distance to its nearest neighbor."***

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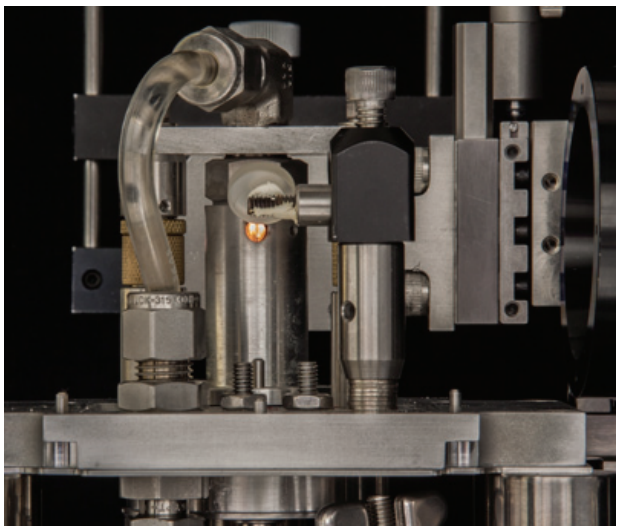


The jet-target area shown in partially disassembled apparatus. The tube at left feeds the water reservoir above the vacuum chamber. Credit: Jens Uhlig

In September, the team demonstrated that the x-ray source was stable over substantial time intervals. The next step is to begin doing science with it. ***"We're very interested in photoactive materials, components for next-generation solar cells and catalysts,"*** Ullom says. "We'll start with model systems and go from there.

"There are some materials which, when integrated into a sensitized solar cell, are known to produce better performance by the kinds of bulk metrics that matter most in practical terms, such as the efficiency of energy creation. But it's not always clear why one particular material is better than another. So if we can see an electron moving from, say, one part of a molecule to another, then that can help explain a particular material's advantage."

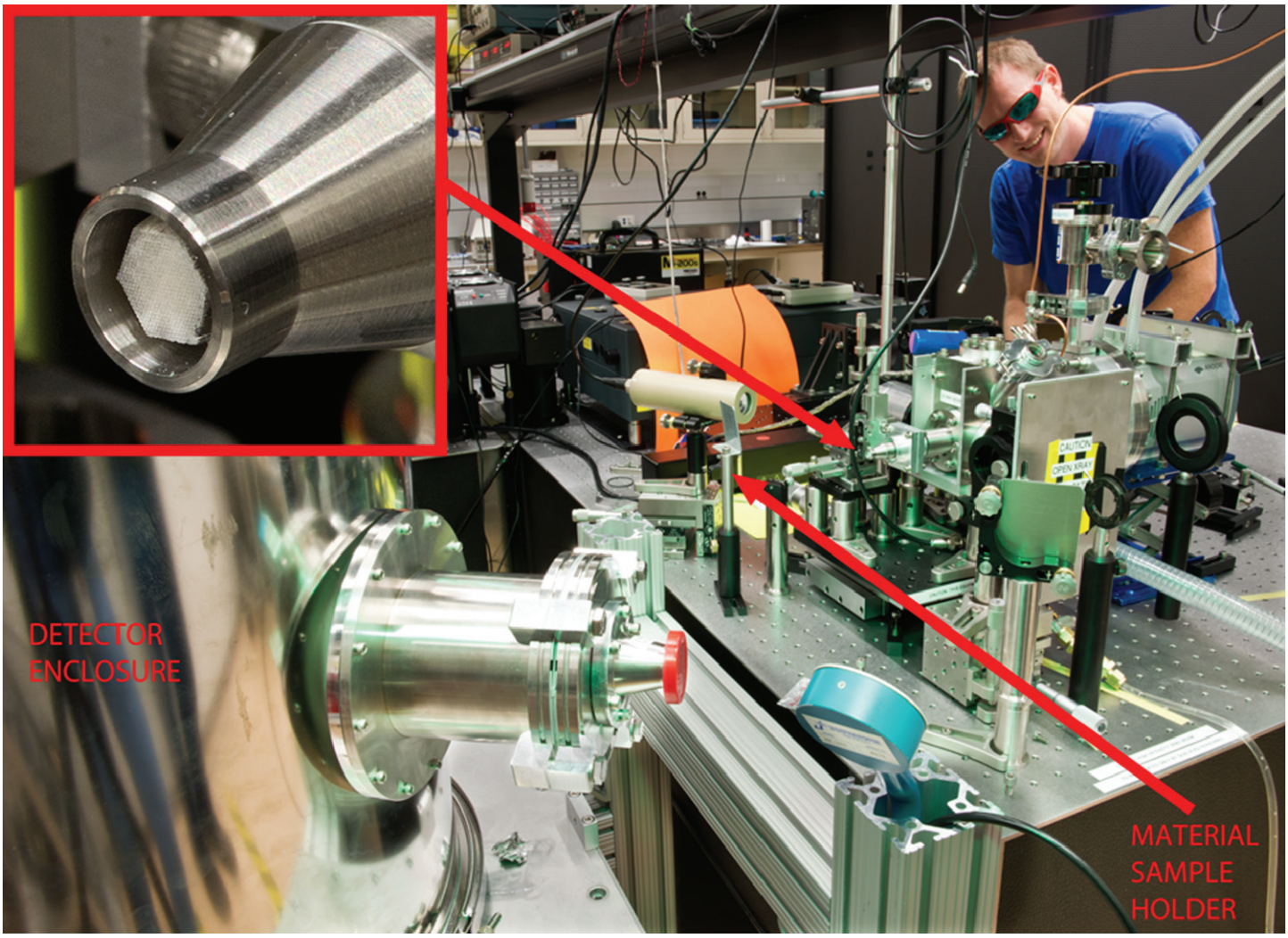
Of course, photovoltaic systems are not designed to respond to respond to x-ray frequencies. So the sample is excited, or "pumped," by the other half of the original IR beam. ***"That beam illuminates the target at wavelengths relevant to its behavior,"*** Ullom says, ***"and then the x-ray beam hits it. The two pulses are very precisely synchronized, so we can control the delay between them. We can start a photoreaction with the first half of the pulse, wait a known delay time, say 50 ps, and then bring in the x-rays to give us a snapshot of the reaction at that point. Then we can change the delay interval to observe other stages of the reaction."***

The chief challenge to date has been making the water jet operation work continuously and dependably, without freezing solid in the vacuum chamber.

"Water is a somewhat counter-intuitive choice for a source," Ullom says. ***"You get more x-rays if you hit something heavier, like copper, and other people working on related designs have typically used metal wires moving from one spool to another so that the ionizing beam never hits the same place twice. We did not want to do that for a variety of reasons. One is that spallation will coat your optics. Water might land on our optics, but it's immediately pumped away, and we don't have to worry about inhaling metal particulates. Also, when electrons hit a dense material, you get both broadband output and sharp emission lines. But for absorption spectroscopy, those lines are actually an inconvenience. Water has no such lines."***

The pulsed x-ray program -- whose team consists of condensed matter physicists, physical chemists, and laser experts, as well as information-processing experts from NIST and academic institutions -- will begin operation with a detector array of 160 elements, with plans to expand to 1000 elements during the remaining three years of the initial project funding.

Expectations are high. The NIST project, Dowell says, ***"has the potential to open the field of time-resolved X-ray imaging to a much broader scientific community, similar to the way Carl Wieman introduced the semiconductor diode laser to the atomic physics community."***



Postdoctoral researcher Galen O'Neil stands behind tabletop apparatus. Inset image at top left is an enlarged view of the polycapillary optic (a collection of very fine glass tubes) used to capture and refocus x-rays from the plasma source onto the sample. NRC Associates Drs. Luis Miaja and Galen O'Neil mentored by NRC Advisers Drs. Kevin Silverman and Joel Ullom respectively.

NRC Associate Delivers Invited Speech at Nigerian Technical Conference

Dr. Charles Kamhoua, is a Postdoctoral Research Associate at the Air Force Research Laboratory's Information Directorate (AFRL/RI) under the auspices of the National Research Council (NRC) of the National Academies. Recently he was an invited speaker at the EIE (Electrical and Information Engineering) 2nd International Conference on Computing, Energy, Networking, Robotics and Telecommunications (eieCon2012) hosted by Covenant University College of Science and Technology, Ota, Ogun State, Nigeria on 21-23 November 2012.

He emigrated to the U.S. from Cameroon in 2005. In 2007, he began his graduate studies at Florida International University (FIU). Subsequently, he got his Master of Science degree in Telecommunication and Networking in August 2008, and then, having become a research assistant at FIU, he began pursuit of his doctorate graduating in August 2011 with his Ph.D. in Electrical Engineering. Dr. Kamhoua then began his tenure as a postdoctoral fellow at AFRL/RI where he was mentored by Dr. Kevin Kwiat who is a Principal Computer Engineer in the Cyber Assurance Branch and is an NRC Adviser, acting as a surrogate of the NRC in monitoring his designated research associates. After Dr. Kamhoua became a US citizen in 2012, he is now employed by AFRL/RI as a full-time Research Electronics Engineer.

At the onset of his doctoral studies he acquired the book *Game Theory Analysis of Conflict* written by the 2007 Nobel Prize Laureate in economics Roger Myerson. In his dissertation Dr. Kamhoua applied game theory to computer network interactions; yet, the result went beyond data communications. According to Myerson, "game theory can be defined as the study of mathematical models of conflict and cooperation between intelligent rational decision-makers". Dr. Kamhoua saw the theory's broad scope reaching to life's numerous human interactions - including the very contemporary concern of the engagement between attackers and defenders in cyberspace.

Dr. Kamhoua is adding to AFRL's contributions to cyber defense – particularly those technologies that target cyberspace survivability. An effective defense-in-depth avoids a large percentage of threats, and defeats those threats that turn into attacks. When an attack evades detection and defeat, and disrupts systems and networks, the defensive priority turns to survival. Dr. Kamhoua's game-theoretic approach to cyberspace survivability has resulted in 2 journal papers and 6 conference papers.

Dr. Kamhoua was included in the proceedings of the eieCon2012 at the invitation of the program committee. The invitation stemmed from the program committee's recognition of his postdoctoral work as exhibited by the papers he published during his fellowship at AFRL. His talk, entitled "Survivability in Cyberspace", delved into how the science of cyber is moving rapidly and the challenges to survivability posed by cyberspace's seemingly endless breadth and evolving technological depth.

In addition, the eieCon2012 Chairman, Dr. Charles Ndujiuba, recognizing that Dr. Kamhoua originated from neighboring Cameroon, remarked that "His participation at eieCon2012 was very fitting for the conference's venue: the African Leadership Development Centre."

Although Dr. Kamhoua has spent the major part of his life in Africa he had never attended a technical conference there, so this was an opportunity for him to engage researchers who are actively fostering the advancement of information technology in the region of his former homeland. A major motivation for him was to understand how their work is shaping cyberspace in developing countries. Any semblance of this formation to surviving in a hostile cyberspace would serve to provide Dr. Kamhoua insight. Such insight is valuable for fine-tuning the trade-off between quality-of-service and information assurance (IA). This tradeoff arises when fighting through a successful cyber attack. Surviving entails the preservation of mission essential functions while controlling and conveying a level of confidence in the system. Can it be affirmed that the system is delivering and continues to deliver its services with respect to IA as expected? Being unable to positively answer implies loss of opportunity, underutilization, undue uncertainty, and unknown risk. These negative outcomes undermine survivability. AFRL is therefore enabling the runtime assessment of the system to provide a sound answer. This assessment is fundamental to cyberspace survivability and it takes contributions from "mathematical models of conflict and cooperation between intelligent rational decision-makers" and insights gained from those that are shaping cyberspace.

Far right: NRC Associate, Dr. Kamhoua, Delivering Invited Speech at the African Leadership Development Centre.
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NRCs at AFRRI – Dr. Cam Ha

NRC Associate, Dr. Cam Ha, presenting her data at the Radiation Research Society's Annual Meeting.

Dr. Cam Ha joined the Research Associateship Programs (RAP) in 2012 as a Senior Research Associate. She was trained as a physician in Vietnam and received her Ph.D. in molecular and cell biology in 2004 from the Uniformed Services University of the Health Sciences (USU).

Subsequently, Dr. Ha worked as a postdoctoral fellow and staff scientist in the USU laboratory of Dr. Gabriela Dveksler (***"a great teacher who provided me with excellent learning opportunities"***). Dr. Ha focused on the biological functions of pregnancy-specific glycoproteins, which play a role in promoting the development of a healthy fetus. During this period she was an author on seven published papers in peer-reviewed journals on reproductive immunology research.

As a NRC Senior Research Associate, Dr. Ha works at the Armed Forces Radiobiology Research Institute (AFRRI), whose mission is **to preserve the health and performance of U.S. military personnel and to protect humankind through research that advances understanding of the effects of ionizing radiation.** AFRRI also provides medical and emergency-response training to manage incidents related to radiation exposure. Dr. Ha works in AFRRI's Radiation Counter-measures Program, whose mission is to develop a better understanding of the biology of radiation injury and, ultimately, pharmacological countermeasures that can be used by military personnel and emergency responders.

Under the direction of AFRRI Principal Investigator Mang Xiao, MD, Dr. Ha has been designing and conducting experiments to study the effects and mechanisms of radiation countermeasures. She co-authored a paper entitled: Micro-RNA30c Negatively Regulates REDD1 Expression in Human Hematopoietic and Osteoblast Cells after Gamma-irradiation (PLoS ONE, 2012, in press).

The Radiation Research Society (RRS) selected Dr. Ha as a Scholar-in-Training and invited her to take part in a symposium at its 58th Annual Meeting, held in Puerto Rico in September 2012. Dr. Ha presented findings from her study of the mechanism by which genistein, a radiation countermeasure candidate discovered at AFRRI by Dr. Michael Landauer, Ph.D. and colleagues, protects hematopoietic tissues from radiation damage. Hematopoietic tissues are composed of stem cells that are found in adult bone marrow and have the unique ability to give rise to all of the different types of mature blood cell.

Dr. Ha found the atmosphere at the RRS meeting ***"exhilarating," the presentations "informative,"*** and the attendees ***"sharp and focused."***

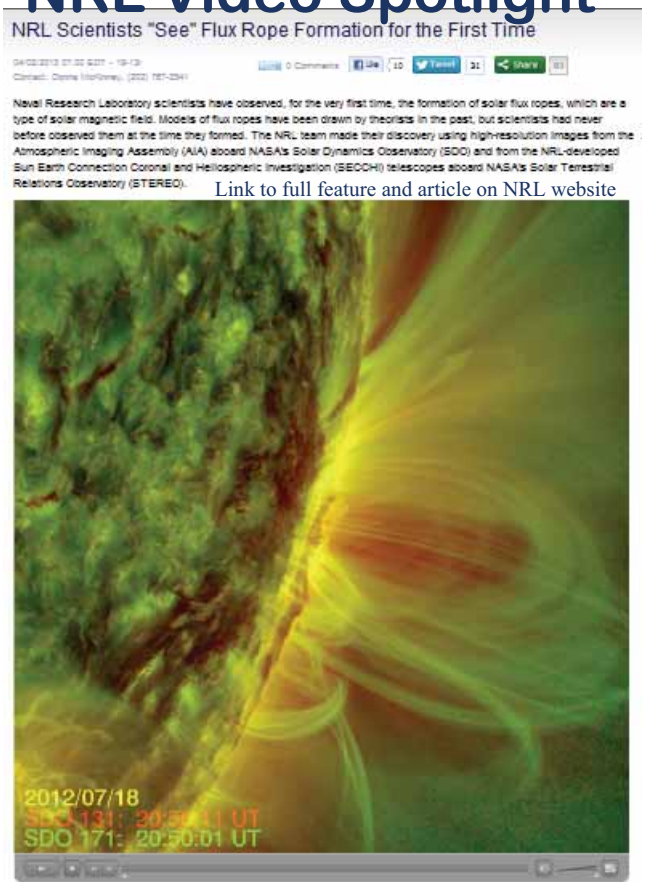
Regarding her career choice, Dr. Ha says, ***"Research in the biological sciences demands keeping abreast of an ever-expanding body of knowledge, meticulous attention to detail, and long hours late into the night and over the weekend. The work is amply rewarded by the joy of discovery—those Aha! moments when what had been your educated guesses become nuggets of new knowledge that you can share with the scientific community at large."***

On working at AFRRI, Dr. Ha says, ***"I have been most fortunate. AFRRI really is one big family where established scientists guide young and upcoming scientists and the scientific administration provides excellent material and moral support for their research endeavors."***

Dr. Cam, Ha speaks at the 2012 annual meeting of the Radiation Research Society.

(The views expressed do not necessarily represent the Armed Forces Radiobiology Research Institute, the Uniformed Services University of the Health Sciences, or the Department of Defense.)

NRL Video Spotlight



Link to full feature and article on NRL website

http://www.nrl.navy.mil/media/news-releases/2013/nrl-scientists-see-flux-rope-formation-for-the-first-time

...continued from front cover

Saharan & Asian dust and global journey in CA

Note: This story was adapted from the press release from the University of California San Diego News Office: http://scrippsnews.ucsd.edu/Releases/?releaseID=1327#.UTAU-P-lXPs.facebook

A field study of aerosol impacts on clouds and precipitation in the Sierra Nevada shows that dust and microorganisms transported from as far away as the Sahara desert help to spur the precipitation that California counts on for its water supply.

The CalWater field campaign, funded by the California Energy Commission and led by UC San Diego and NOAA, could help western states better understand the future of their water supply and hydropower generation as climate change influences how much and how often dust travels around the world and alters precipitation far from its point of origin.

Dr. Jessie Creamean, a National Research Council Postdoctoral Research Associate at NOAA's Earth System Research Laboratory in Boulder, Colo., co-authored the paper appearing in the journal *Science* with Kaitlyn Suski, a graduate student in the laboratory of Prof. Kimberly Prather, who holds appointments at Scripps Institution of Oceanography and the Department of Chemistry and Biochemistry at UCSD.

"We were able to show dust and biological aerosols that made it from as far as the Sahara were incorporated into the clouds to form ice, then influenced the formation of the precipitation in California," said Creamean, who conducted the fieldwork as a UCSD graduate student under Prather, the study leader. ***"To our knowledge, no one has been able to directly determine the origin of the critical aerosols seeding mid-level clouds which ultimately produce periods with extensive precipitation typically in the form of snow at the ground."***

The study, Dust and Biological Aerosols from the Sahara and Asia Influence Precipitation in the Western US, appeared Feb. 28 in online version of *Science and the Mar. 29 issue of Science*.

Researchers have long known that winds can carry aerosols such as dust at altitudes above 5,000 meters (16,400 feet) from continent to continent. An unrelated 2009 study found that in one instance, Asian dust made a complete circuit around the planet in 13 days.

These dust particles can act as ice nuclei within clouds at warmer temperatures than would occur in their absence. They initiate the freezing of water vapor and water droplets, then precipitate as rain, snow, or hail depending on whether meteorological conditions enable them to attain sufficient mass to fall from the sky before evaporating. Without ice nuclei, ice would likely not form in clouds with temperatures above -38 degrees C (-36.4 degreesF).

Besides dust, aerosols can be composed of sea salt, bits of soot and other pollution, or biological material. Bacteria, viruses, pollen, and plants, of both terrestrial and marine origin, also add to the mix of aerosols making the transcontinental voyage. The researchers' analysis of winter storms in 2011 found that dust and biological aerosols tend to enhance precipitation-forming processes in the Sierra Nevada. In previous studies, researchers have found that pollution particles have the opposite effect, suppressing precipitation in the Sierra Nevada.

The bulk of the data collected during CalWater came from instruments known as aerosol time-of-flight mass spectrometers (ATOFMS), co-developed by Prather, and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) satellite, which tracked the transport of aerosols through the atmosphere from continent to continent. Measurements in and around clouds utilized the Department of Energy's G-1 research aircraft, which carried other vital instruments, such as a specialized detector for the presence of dust ice nuclei feeding clouds and their presence in the collected residue of ice crystals. That portion of the study was led by co-author Paul DeMott, a senior research scientist at Colorado State University.

Using these tools, the researchers were able to determine that at least some of the dust and bioparticles detected by an aircraft-mounted ATOFMS unit during February 2011 flights through Sierra Nevada storm clouds were in the skies over Oman 10 days earlier, having likely originated in the Sahara a few days earlier. Along the journey, the Saharan dust and microbes mixed with other aerosols from deserts in China and Mongolia before wafting over the Pacific Ocean.

Upon arrival in California, the aerosols effectively seeded the storm clouds and contributed to the efficiency of clouds in producing precipitation. Two other transportable ATOFMS units housed in trailers at Sugar Pine Dam just south of Interstate 80 in the Tahoe National Forest and other instruments made further measurements. They determined the chemical composition of aerosols at the end of their journey by looking at the particles present in precipitation samples that were collected during storms.

NRC Associate, Dr. Jessie Creamean and Sugar Pine Dam

The researchers said it is a major challenge to sort out the relative impacts of meteorology, atmospheric dynamics, and the original sources of the cloud seeds on precipitation processes. They added that further studies like CalWater are necessary to further identify which aerosols are conducive to precipitation formation and which aerosols stifle its production.

"Due to the ubiquity of dust and co-lofted biological particles such as bacteria in the atmosphere, these findings have global significance," the study concludes. "Furthermore, the implications for future water resources become even more substantial when considering the possible increase in [wind-blown] dust as a result of a warming climate and land use changes."

Besides Creamean, Suski, and Prather, study coauthors include Daniel Rosenfeld of the Hebrew University of Jerusalem, Alberto Cazorla of UCSD, Paul DeMott of Colorado State University, Ryan Sullivan of Carnegie Mellon University, Allen White, F. Martin Ralph of NOAA, Patrick Minnis of NASA's Langley Research Center, and Jennifer Comstock and Jason Tomlinson of the Pacific Northwest National Laboratory in Richland, Washington.

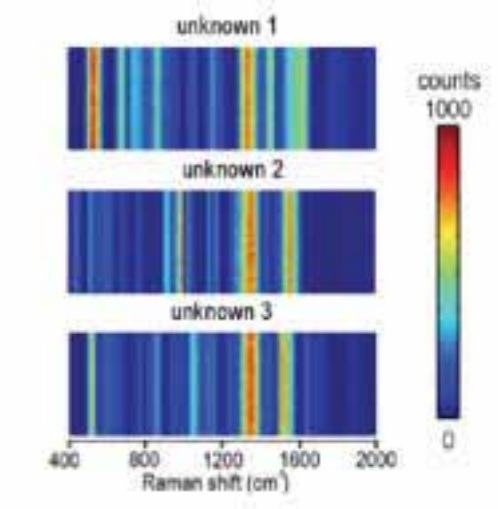
In Situ Strain-Level Detection and Identification of *Vibrio parahaemolyticus* Using Surface-Enhanced Raman Spectroscopy

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

Maintaining shellfish food safety currently requires extensive and expensive monitoring for toxins produced by harmful algae and marine pathogens such as *Vibrio.* Development of improved risk models and predictive tools for marine pathogens would greatly assist public health managers to make timely, responsible, and science-based decisions for shellfish safety. Existing management tools for pathogenic *Vibrio* spp. either require detection of *Vibrio* in shellfish, most often only after someone becomes ill, or are more simply based on non-specific environmental parameters. There is a strong need for sensor development to detect specific harmful algal species and marine pathogens using robust, fast, and accurate methods that are amenable for miniaturization to enable the deployment of sensor networks in coastal waters of concern.

In very recent work, Xu et al. (2013) seek to develop a sensor for marine pathogens by capitalizing on unique chemical and biological components in bacterial outer membranes that carry specific molecular information related to strains, growth stages, and possibly geographic differences. This biochemical information has the potential to be used for rapid detection and identification of marine pathogenic bacteria using surface-enhanced Raman spectroscopy (SERS). This novel method increases detection sensitivity in water up to a trillion times over normal using a plasmon that is generated by lasers striking a nano-textured surface.

The study tested seven clinical and environmental strains of the marine pathogen *Vibrio parahaemolyticus* isolated from within Washington State, U.S.A. The species-specific SERS spectra were transformed into "barcodes" that successfully identified individual strains in samples and mixtures. Using these unique SERS barcodes as references, they were able to rapidly and accurately identify "blind" (i.e., unknown) preparations of the bacteria strains. Cell wall and outer membrane differences in strains paralleled what is seen using direct genetic methods including multi-locus sequence typng and genomic sequencing, other work also being carried out at NOAA's Northwest Fisheries Science Center (NWFSC). The sensing and detection methods developed in this work could have broad applications in the areas of environmental monitoring, biomedical diagnostics, and homeland security. This work was done, in part, through a collaboration of senior NRC associate, Dr. Mark Wells, NRC associate Dr. Jeff Turner, with University of Washington scientists during their tenure in the labs of Dr. Vera Trainer and Dr. Mark Strom at NWFSC.



SERS barcodes of 3 blind *Vibrio parahaemolyticus* cultures (from Xu et al. 2013)

Xu, J., Turner, J., Isdo, M., Biryukov, S., Rognstad, L., Gong, H., Trainer, V.L., Wells, M. L., Strom, M., Yu, Q. 2013. In-situ Strain-level Detection and Identification of Vibrio parahaemolyticus Using Surface-Enhanced Raman Spectroscopy. Analytical Chemistry. 85, 2630-2637. doi: 10.1021/ac3021888 |

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http://www.chemfeeds.com/comments.php?doi=10.1021/ac3021888

http://www.bioportfolio.com/resources/pmarticle/405460/In-Situ-Strain-Level-Detection-and-Identification-of-Vibrio-parahaemolyticus-Using-Surface.html

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NRL Video Spotlight

Link to full feature and article on NRL website

Grad helps Navy identify better watch schedules

http://news.wsu.edu/Pages/Publications.asp?Action=Detail&PublicationID=35133&PageID.

When **Dr. Lauren Waggoner** started her Ph.D. in criminal justice at Washington State University Spokane, she had no idea that a few years later she would be doing research as a NRC Postdoctoral Research Associate aboard a U.S. Navy guided-missile destroyer in the Arabian Sea.

Waggoner boarded the USS Jason Dunham in December to study the effects of different watch-standing schedules on the sleep and performance of sailors. She is analyzing the data collected.

The project is one of several she has worked on since starting a National Research Council postdoctoral fellowship at the Naval Postgraduate School's operations research department in Monterey, Calif., in July. The goal: find ways to keep sailors healthy and safe in a demanding 24-hour-a-day work environment in which they are required to stand watches in addition to fulfilling their normal work responsibilities.

NRC Associate, Dr. Lauren Waggoner, prepares measurement devices to give out to sailors during the study.

"Often times, on bigger vessels—and even the mid-size destroyer we were on—sailors don't get adequate sleep. They also don't get outside much, so they don't get much exposure to environmental factors that would help them regulate their sleep and wake cycles," said Waggoner. ***"Based on earlier research, we can assume that, in combination with other factors, this can lead to performance deficits."***

She collected data for three weeks on the sleep and performance of 122 sailors working a variety of watch schedules. Some were on traditional 5/10 or 5/15 rotations (five hours on watch followed by 10 or 15 hours off). Others followed the recently introduced 3/9 or 4/8 schedules that Waggoner and her supervisor, Nita Lewis Shattuck, believe to be healthier because they provide a 24-hour daily rhythm.

"The new schedules allow the sailors to structure their work and rest in a way that is consistent each day," Waggoner said. ***"It makes their sleep and wake more predictable, and the same should be true for their performance. Once we've analyzed the data, we'll know whether we can confirm this."***

Waggoner's interest in shift work and sleep was first piqued when she worked as a graduate research assistant in the WSU Sleep and Performance Research Center. She assisted research professors Greg Belenky and Hans Van Dongen with a pair of studies that looked at fatigue in truck drivers working different schedules.

She also helped professor of criminal justice Bryan Vila set up his simulated hazardous occupational tasks lab and run the lab's first study: an experiment in which they used the lab's driving simulators and deadly force judgment and decision making simulators to look at the impact of night shift work on the operational performance of police officers. The results from that study formed the basis for Waggoner's Ph.D. dissertation.

Waggoner says the lab experiences at WSU have made her a better researcher in the field. ***"In my dissertation research, I learned to apply techniques that are normally used in the lab in a controlled manner in the field,"*** she said. ***"My education at WSU really prepared me for going into these messy environments that require you to do a little flying-by-the-seat-of-your pants - but do it in a way that ensures that the outcome measurements are going to be controlled enough to compare and use."***

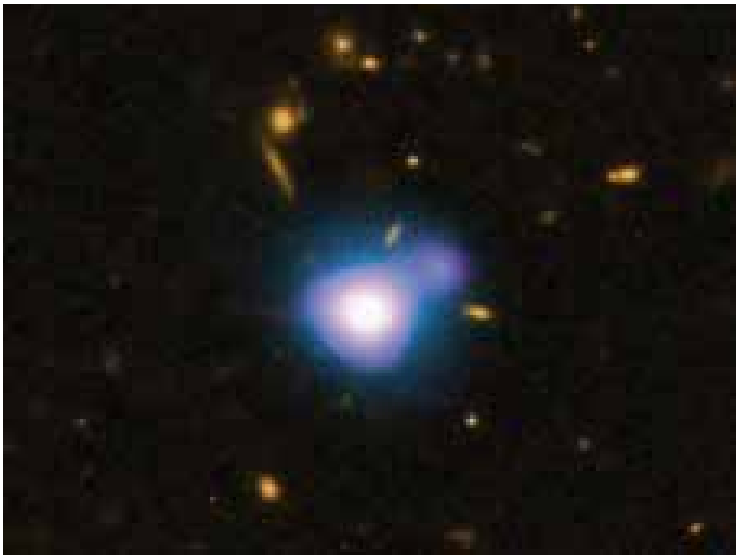
Waggoner wants to continue working with shift workers to help them better schedule their time to balance sleep, work and other daily activities. She is specifically interested in refining existing mathematical models that can predict levels of fatigue and performance, making it possible to prevent fatigue-related errors and accidents.

In addition to the schedule, sleep and performance data, Waggoner came away with a new respect for shift workers in general and Navy sailors specifically. ***"It was very eye-opening,"*** she said. ***"Once the ship leaves port, it's like a microcosm out there—working 24 hours a day with the same people living on top of each other. They are making a lot of sacrifices, and the work out there is very difficult."***

Related Web sites:
WSU Sleep and Performance Research Center: http://www.wsu.edu/sprc
WSU Spokane criminal justice department: http://spokane.wsu.edu/academics/crimj/
Naval Postgraduate School operations research department: http://www.nps.edu/Academics/Schools/GSOIS/Departments/OR/index.html

Contacts:
Lauren Waggoner, Naval Postgraduate School, 831-656-3481, lbwaggon@nps.edu
Judith Van Dongen, WSU Spokane/WSU News, 509-358-7524, jcvd@wsu.edu

Record-setting x-ray jet discovered



X-ray jet from quasar GB 1428, located 12.4 billion light years from Earth. (X-ray: NASA/CXC/NRC/C.Cheung et al; Optical: NASA/STScI; Radio: NSF/NRAO/VLA). View large image A jet of X-rays from a supermassive black hole 12.4 billion light years from Earth has been detected by NASA's Chandra X-ray Observatory. This is the most distant X-ray jet ever observed and gives astronomers a glimpse into the explosive activity associated with the growth of supermassive black holes in the early universe.

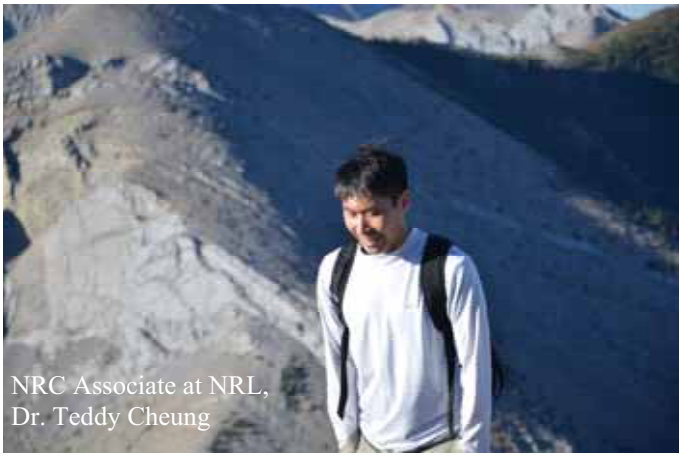
The jet was produced by a quasar named GB 1428+4217, or GB 1428 for short. Giant black holes at the centers of galaxies can pull in matter at a rapid rate producing the quasar phenomenon. The energy released as particles fall toward the black hole generates intense radiation and powerful beams of high-energy particles that blast away from the black hole at nearly the speed of light. These particle beams can interact with magnetic fields or ambient photons to produce jets of radiation.

"We're excited about this result not just because it's a record holder, but because very few X-ray jets are known in the early universe," said lead author **Dr. Teddy Cheung**, of the National Academy of Sciences National Research Council Postdoctoral Research Associateship Program with the Naval Research Laboratory in Washington DC.

As the electrons in the jet fly away from the quasar, they move through a sea of background photons left behind after the Big Bang. When a fast-moving electron collides with one of these so-called cosmic microwave background photons, it can boost the photon's energy into the X-ray band.

"Since the brightness of the jet in X-rays depends, among other things, on how fast the electrons are moving away from the black hole, discoveries like the jet in GB 1428 tell us something about the environment around supermassive black holes and their host galaxies not that long after the Big Bang," said co-author Lukasz Stawarz from the Japan Aerospace Exploration Agency, in Kanagawa, Japan.

Because the quasar is seen when the universe is at an age of about 1.3 billion years, less than 10% of its current value, the cosmic background radiation is a thousand times more intense than it is now. This makes the jet much brighter, and compensates in part for the dimming due to distance.



NRC Associate at NRL, Dr. Teddy Cheung

"We're lucky that the universe gives us this natural amplifier and lets us detect this object with relatively short exposures," said co-author Aneta Siemiginowska, of the Harvard-Smithsonian Center for Astrophysics in Cambridge, MA, ***"Otherwise we might miss important physical processes happening at very large distances from Earth and as far away as GB 1428."***

While there is another possible source of X-rays for the jet -- radiation from electrons spiraling around magnetic field lines in the jet -- the authors favor the idea that the cosmic background radiation is being boosted because the jet is so bright.

Prior to the discovery of the jet in GB 1428, the most distant X-ray jet known was 12.2 billion light years away, and another is located at about 12 billion light years, both discovered by authors of the GB 1428 paper. A very similar shaped jet in GB 1428 was also detected in radio waves with the NSF's Very Large Array (VLA).

The particle beams that produce these three extremely distant X-ray jets appear to be moving slightly more slowly than jets from galaxies that are not as far away. This may be because the jets were less energetic when launched from the black hole or because they are slowed down more by their environment.

The researchers think the length of the jet in GB 1428 is at least 230,000 light years, or about twice the diameter of the entire Milky Way galaxy. This jet is only seen on one side of the quasar in the Chandra and VLA data. When combined with previously obtained evidence, this suggests the jet is pointed almost directly toward us. This configuration would boost the X-ray and radio signals for the observed jet and diminish those for a jet presumably pointed in the opposite direction.

Observations were also taken of GB 1428 with a set of radio telescopes at different locations around the Earth that allows details to be resolved on exceptionally small scales. They revealed the presence of a much smaller jet, about 1,900 light years long, which points in a similar direction to the X-ray jet.

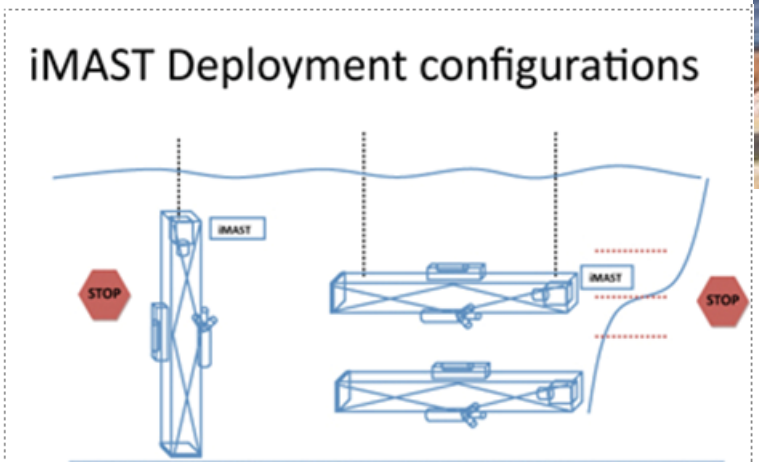
This result appeared in the September 1st, 2012 issue of The Astrophysical Journal Letters. Other co-authors of the paper are Doug Gobeille from University of South Florida in Tampa, FL; John Wardle from Brandeis University in Waltham, MA; and Dan Harris and Dan Schwartz from the Harvard-Smithsonian Center for Astrophysics.

More information, including images and other multimedia, can be found at: http://www.nasa.gov/chandra and http://chandra.si.edu

Experiment explores optics with iPad

As any other dutiful scientist, **Dr. Weilin "Will" Hou**, an oceanographer in the Oceanography Division at NRL Stennis Space Center (NRL-SSC) and NRC Adviser did his research. Earlier last summer, he decided the hottest tablet computer available on the market-the iPad-was the best option for an upcoming experiment. Upon receipt of the No. 1 wished-for item on everyone's Christmas list, he promptly threw it in the water!

iPad in [hot] water?



iMAST is designed to be deployed in horizontal and vertical orientations as shown. The horizontal orientation is designed to capture the maximal impacts from turbulence, while the vertical configuration allows close examination of the "shower curtain" effects of the turbulence and turbidity layer. Photo U.S. Naval Research Laboratory (NRL)

iCan See

Understanding ocean optics is crucial to predicting environmental conditions, which help Navy and Marine Corps forces safely and effectively conduct operations involving signal processing, diver visibility, mine hunting and anti-submarine model performance prediction. While in the office, Hou heads the NRL Ocean Hydro Optics Sensors and Systems Section. As such, he develops and manages new programs to improve understanding of adaptive optics, turbulence quantification, optical flow and signal transmissions over turbulence. Hou's optics research furthers the general understanding of ocean optics through the combined use of in situ observations, remotely sensed data and physical models. How far and how well a diver and a vision system can see, especially under impacts from turbulence, is one of the focus areas Hou is working to explore.

iMAST Keeps It on Target

As part of the Bahamas Optical Turbulence Experiment (BOTEX), Hou and nine other researchers from NRL-SSC and Florida Atlantic University's Harbor Branch Oceanographic Institute (HBOI), set sail in the coastal waters of Florida and Bahamas aboard R/V *F.G. Walton Smith* on June 30, 2011. The team set out to obtain field measurements of optical turbulence structures and quantify their impact on underwater imaging and beam propagation. To measure these phenomena, Hou designed a rigid frame to securely hold a high-speed camera and a target (active or passive), which he called the image Measurement Assembly for Subsurface Turbulence, or iMAST. The name was fitting, as the active target that was mounted to it was the iPad.

Left to right: NRC Adviser, Dr. Weilin "Will" Hou, Capt. Shawn Lake (R/V Walton Smith), NRC Associate, Dr. Sarah Woods, Mr. Steve Sova, Dr. Ewa Jarosz, Mr. Ben Metzger (HBOI), Dr. Gero Nootz (HBOI), Dr. Alan Weidemann, Mr. Brian Ramos (HBOI), Dr. Fraser Dalgleish (HBOI), and Mr. Wesley Goode.

Why the iPad?

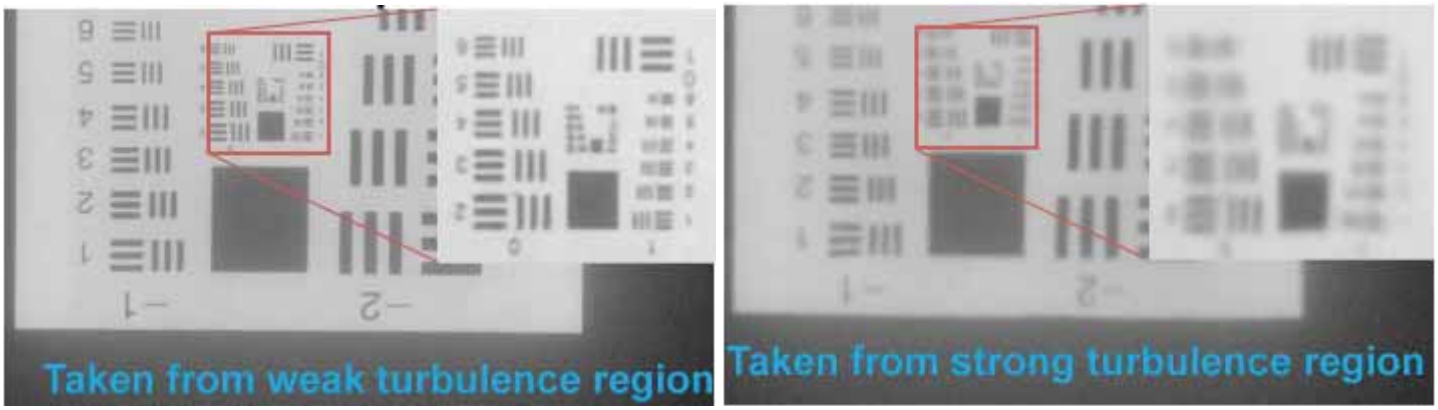
Many factors influence visibility, one of which is the background, or path radiance. An active target (self illuminating) will help to reduce or completely remove such impacts (if carried out at night), which helps to isolate the main factor under examination.

After exploring more than a dozen OEM suppliers to find a solution, Hou found the best solution required a 5-month delivery schedule and cost more than $5,000. Although he had thought of using a tablet computer before, Hou had always dismissed the idea due to the refresh rate limit (60 hz) of most LCD screens, which would not work for his project, since he needed to film at high frame rates (more than 100 frames per second). When all the other options seemed remote, out of frustration, he set up an experiment to determine the performance limit of the LCD screen. To his surprise, there wasn't any! Hou discovered the common conception of refresh rate is defined differently for the LCD. The buzz of the newest gizmo iPad caught his eye as the perfect candidate: small, light, bright, self contained, low power consumption, and low heat emissivity. What's more, it cost an order of magnitude less! He quickly placed the order, and fellow NRL employee Wesley Goode began constructing a waterproof case to attach to iMAST.

Getting it Wet

At night from aboard R/V F.G. Walton Smith, Hou used the iPad, which was safely enclosed in a waterproof casing, to display active targets, such as resolution charts and image patterns. The iPad, securely held in place in the iMAST, was then lowered into the water. The iPad allowed control of the brightness of the patterns and charts, a high-tech Secchi disk of sorts.

"iPad in [hot] water?" continued on next page



High Tech Secchi disk &mdash These iPad images taken in field trial demonstrate how clarity of the target image would be degraded under turbulence conditions. Both are viewed with a range of 5m, with similar turbidity of the water. The top has weak turbulence, while the bottom one is from regions of strong turbulence.

(Incidentally, Hou is also responsible for an improved Secchi disk theory based on an imaging approach, compared to the traditional radiance-based version for the last 100 years.) The team then measured the clarity of the target image in relation to optical turbulence structures in the water, first using a Vertical Microstructure Profiler and 3D velocimeter with a conductivity and temperature (CT) probe in close proximity in the field, and subsequently with a velocimeter and CT probe mounted on the iMAST during moored deployments. Hou and the rest of the NRL-SSC team then calculated turbulence kinetic energy dissipation rate and temperature dissipation rates from both setups to compare to the derived imaging model, which estimates the limiting factors for underwater imaging components.

Collaboration with HBOI

To investigate the impacts of optical turbulence on an active imaging system, such as laser-line scan (LLS), HBOI researchers designed Turbulence Research for Undersea Sensing Structure (TRUSS). TRUSS assisted researchers in determining the resolution limit of LLS systems due to beam wander at the target due to turbulence. Fourier transformed image patterns over turbulence were examined by placing a pinhole mask into the beam path. The same experimental setup was also used in the beam propagation experiment to study the effect of turbulence on the fringe pattern. The team tested the performance of pulsed LLS, where the receiver and the transmitter were mounted on the same side of the pole and the ground glass plate was replaced by a technical target and spectralon panel, to examine the impacts on lidar systems. HBOI collected the data, which are critical in understanding the impacts of optical turbulence on active electro-optical sensing. They collected data from four stations for NRL, covering different types of optical and physical conditions. Because HBOI was funded by ONR, there is no added cost to Hou's core project and this leverage nested Hou's project a complete set of data needed.

BOTEX Results

Initial results confirmed the team's hypothesis that turbulence does play into optical visibility performance prediction, and at times, can greatly reduce the visibility range. However, more research is needed to better quantify and mitigate such effects, especially for Navy's next generation electro-optical systems including active imaging, lidar and optical communications. Hou arrived at NRL-SSC in 2006 after working as a research professor at the University of South Florida. He earned his doctoral degree in oceanography from the University of South Florida. He is the editor of four books, 15 peer-reviewed papers and 40 proceedings papers and is credited as a co-inventor for three patents (two filed, one pending).

They can all be viewed on the iPad!

United States
Naval Research Laboratory

NRC and NRL researchers describe a new infectious mechanism which could be targeted for the prevention of Tularemia.

A new human host mechanism by which a biological agent (in this case the bacteria which causes Tularemia) can enter the human lung epithelial lining. That means that a drug could be used to block that mechanism and therefore prevent the infection. **NRC Associate, Dr. Chris Bradburne, NRC Advisers, Drs. Dzung Thach, Jim Delehanty, Eddie Chang** http://www.jbc.org/content/early/2013/01/15/jbc.M112.362178.abstract

Solving Leatherback Sea Turtle Mysteries (genetically)

Leatherback turtles *Dermochelys coriacea*) are the largest marine turtles in the world and although they are distributed globally, many aspects of their life history still remain a mystery. We recently completed several projects using genetics to tackle some questions such as what is the age to maturity, how many males are in a breeding population, how many breeding stocks exist in the Atlantic and to what nesting beach do turtles foraging in Northwest Atlantic waters off Canada belong?

Using genetic fingerprinting techniques with both mitochondrial DNA (mtDNA; maternally inherited) and nuclear DNA (nDNA; inherited from both parents), we studied a Caribbean population of leatherback turtles nesting at Sandy Point National Wildlife Refuge at St. Croix in the US Virgin Islands. At this beach, each nesting female is identified, genetically fingerprinted and complete nesting histories are known. In 2009, we developed a genetic tagging program for leatherback hatchlings and this work has continued annually since then. Our goals were to a) to sample as many hatchlings as possible as they leave the nesting beach for the purpose of determining age at maturity and juvenile survival rates by following cohorts to maturity b) to assess multiple paternity in multiple clutches from individual female leatherbacks and c) to evaluate the number of males in the breeding population.

Nest numbers vary each year at Sandy Point National Wildlife Refuge and our team of staff and volunteers worked every evening to protect nests from predators, and to collect and sample hatchlings. The first year in 2009 was the busiest for nesting and we sampled nearly 7,000 hatchlings. However, in 2012, we surpassed the milestone of 20,000 hatchlings and now have samples from 20,353 hatchlings. Since each new nesting female that arrives at Sandy Point is genetically sampled, at some time in the future, we expect to get a match between a new nesting turtle and a hatchling that we sampled several years prior, thus directly observing the age to maturity for the first time (current estimates based on growth studies vary from 5 to 30+ years).

Dr. Kelly Stewart, former NRC Associate, with Dr. Peter Dutton NRC Adviser, NOAA captured and sampled on the St. Croix project.

In addition to the hatchling genetic tagging program, we were able to assess the level of multiple paternity in multiple nests for multiple females in 2010. To do this, we fingerprinted (genotyped) the mothers and their hatchlings. By accounting for the maternal fingerprint within the hatchling fingerprints, we were able to deduce the father's genetic fingerprint. In some cases, two males were responsible for the hatchlings and each hatchling could be assigned a specific father. For 12 females, we identified 17 different males (Stewart and Dutton 2011).

Following on the success of our multiple paternity project, we used similar methods to assess the breeding sex ratio for the first time in leatherbacks. Male sea turtles are notoriously difficult to find and sample, and most studies focus only on females since they can be intercepted when they haul out on the beach to nest. However, using genetic techniques on multiple hatchlings from each nest, we are able to determine the genetic fingerprint of the male leatherback(s) that contributed to that nest without having to sample the father. This innovative use of technology has advanced our knowledge of the breeding population of leatherbacks in the US Virgin Islands (one of the 3 primary populations identified in US waters) and contributes to what we know about the number of adults in the breeding population: Previously we could only count females on the nesting beach.

Another major milestone was our publication describing the stock structure of leatherbacks in the Atlantic. This work was based on thousands of hours in the field over more than 10 years, involving several international collaborators. Over 1,400 nesting females were sampled from around the Atlantic basin. We found that there are 9 distinct stocks of leatherbacks; Trinidad, French Guiana, Costa Rica, Florida, St. Croix, Gabon, Ghana, South Africa and Brazil (Dutton et al. 2013). This work met a major objective set forth in the Federal Recovery Plan for leatherbacks in the U.S., Caribbean and Gulf of Mexico (NMFS and USFWS, 1992).

The stock structure work provides an important basis for many other analysis projects that rely on having accurate leatherback stocks identified. We can now look at individual turtles encountered anywhere in the Atlantic, compare them to the genetic.

Lone hatchling has long trek across the beach to sea

continued on next page

Leatherbacks continued

One such project looked at foraging turtles off the coast of Eastern Canada. From 2001 to 2012, leatherback samples were collected at the most important foraging grounds for leatherbacks in the Northwestern Atlantic. Within that set of 288 individual turtles, there were 83 recaptures at nesting beaches throughout the Caribbean and along the coasts of Central and South America. Using microsatellite markers and the latest assignment testing techniques, we assigned natal beaches to each individual captured.

We then used supplemental information gathered on these turtles (re-sightings at nesting beaches, satellite tracking) to corroborate and ground-truth the assignments. We found that most of the turtles were assigned to Trinidad and French Guiana, which are the largest leatherback nesting aggregations in the Western Atlantic. We found no contributions from nesting beaches in the Eastern Atlantic. This important project was possible because of our work with determining the stock structure for leatherbacks within this ocean basin.

Overall, this was a productive NRC tenure, and it provided a professionally-enriching post-doc experience. We produced interesting science that directly addresses NMFS management needs and advances international conservation efforts for marine turtles. Additionally, our work rose to the challenges outlined by the NRC Committee Report (NRC 2010) by developing and applying novel genetic approaches to address gaps in information on life history and population dynamics that are needed for building accurate population models for leatherbacks.

A hatchling leatherback emerging from the nest with its siblings

Dr. Kelly Stewart, NRC Postdoctoral Research 2009 to 2012, working with NRC Adviser, Dr. Peter Dutton, was based at the Southwest Fisheries Science Center (NOAA's National Marine Fisheries Service) in La Jolla, California.

References

Dutton, P.H., S.E. Roden, K.R. Stewart et al. 2013. Population stock structure of leatherback turtles (*Dermochelys coriacea*) in the Atlantic revealed using mtDNA and microsatellite markers. Conservation Genetics. doi: 10.1007/s10592-013-0456-0

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1992. Recovery Plan for Leatherback Turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico. National Marine Fisheries Service. Washington, D.C. 65 pp.

NRC Committee on the Review of Sea-Turtle Population Methods. 2010. Assessment of Sea-Turtle Status and Trends: Integrating Demography and Abundance. The National Academies Press, Washington, D.C. 162pp.

Stewart, K.R. and P.H. Dutton. 2011. Paternal genotype reconstruction reveals multiple paternity and sex ratios in a breeding population of leatherback turtles (*Dermochelys coriacea*). Conservation Genetics 12: 1101–1113. doi: 10.1007/s10592-011-0212-2;

Stewart, K.R., M.C. James, S. Roden and P.H. Dutton. 2013. Assignment tests, telemetry and tag-recapture data converge to identify natal origins of leatherback turtles foraging in Atlantic Canadian waters. Journal of Animal Ecology DOI: 10.1111/1365-2656.12056

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

A LECTURE HOSTED BY THE NATIONAL ACADEMY OF SCIENCES

Vladimir M. Kotlyakov

Professor and Academician, Institute of Geography, Russian Academy of Sciences

April 4th, 2013 12:00 – 1:30 pm
Great Hall
The National Academy of Sciences, 2101 Constitution Avenue, NW
Washington, DC 20001

Vostok is the largest of Antarctica's almost 400 known subglacial lakes. Lake Vostok is located at the southern Pole of Cold, beneath Vostok Station under the surface of the central East Antarctic Ice Sheet, which is at 3,488 m (11,444 ft) above mean sea level. The lake filled into by Russian scientists in 2012. The overlying ice provides a continuous paleoclimatic record of 400,000 years, although the lake water itself may have been isolated for 15 to 25 million years.

NRC Associate gives 1-day workshop at University of Sri Lanka

"Dr. Fernando's research works concerns with two themes- stochastic modeling of uncertainty parameters in turbulence when the fluid flow is subjected to random disturbances and also application of stochastic analysis techniques to search and detection of randomly moving multiple targets. These research problems arise in a variety of naval applications such as efficient design and operation of hydrodynamic configurations, surveillance of adversarial surface vehicles, etc. It was a pleasure to see him giving a lecture series in one of Sri Lanka's best mathematics departments exposing them to cutting edge research in stochastic analysis and fluid dynamics. The lecture series and related discussions he had with University of Colombo Mathematics department will set the stage for future interactions between Naval Postgraduate School and Sri Lankan academic institutions in related subject areas."

Dr. S. S. Sritharan, NRC Adviser

DEPARTMENT OF MATHEMATICS
UNIVERSITY OF COLOMBO

Tele: 94-11-2501731(Head)
94-11-2507010(Coordinator)

P.O. Box 1490, Kumaratunga Munidasa Mawatha, Colombo 03.

January 07, 2013

Dr. B.Pani Wishvamithra Fernando ,
Naval Postgraduate School,
Monterey, California,
USA

Dear Dr.Fernando,

I wish to convey my sincere thanks to you for conducting a one day work shop on "Partial Differential Equations and Stochastic Analysis" for the graduate students of the Center for Research and Developments in Mathematical Modeling (CM^2) at the Department of Mathematics, University of Colombo, Sri Lanka on January 05, 2013. Further would like to extend my heartfelt thanks to your team lead Professor. S.S.Sritharan and looking forward to establish formal joint research collaboration between your post graduate school and CM^2, University of Colombo.

Kind Regards,

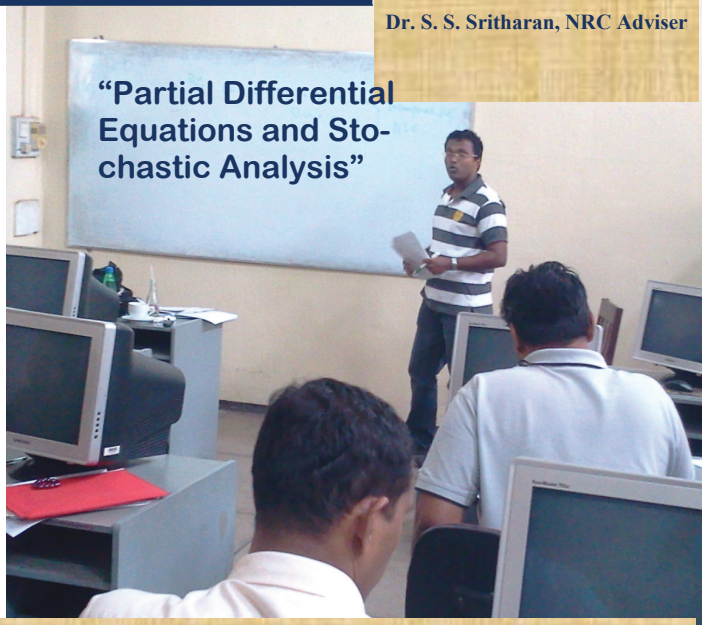
Dr.J.K.Wijerathna,
Head/Mathematics

Dr. Pani Fernando's NRC Adviser is professor S. S. Sritharan—Director, Center for DECISION, RISK, CONTROLS & SIGINT (DRCSI) Naval Postgraduate School

NPS Vita: http://faculty.nps.edu/vitae/cgi-bin/vita.cgi?p=display_vita&id=1216324461

Google Scholar: http://scholar.google.com/citations?user=XYwmvdoAAAAJ&hl=en

Mathscinet: http://www.ams.org/mathscinet/search/publications.html?pg1=IID&s1=226666



Dr. S.S. Sritharan, NRC Adviser, left, with Dr. Pani Fernando, NRC Associate

Naval Postgraduate School

Dr. Pani Fernando, NRC Associate at NPS gives 1-day workshop at University of Sri Lanka, Colombo campus

continued from pg 2

The falling magnet induces eddy currents in the conductive copper but not the nonconductive plastic, slowing its fall in the former. Young visitors were encouraged to perform the test for themselves and verify that the counterintuitive phenomenon is real and repeatable.

Dr. Keenan works with powerful magnetic fields on a daily basis in her work to develop standards for Magnetic Resonance Imaging (MRI). Quantitative MRI techniques, including biomarkers and morphological measures, are used in clinical research and trials. Measurement variability in clinical trials arises from image data collection at multiple sites, in different imaging platforms and coils, and at multiple time points. Standards for image quality control and image data collection have been identified as an important area of research for NIST, and this work could reduce the cost and risk associated with clinical trials.

Following initial imaging at MD Anderson Cancer Center, Massachusetts General Hospital and the University of Colorado, systematic differences in some quantitative MRI measurements were identified as a function of protocol and type of MRI scanner. The BioImaging project is also developing phantoms for diffusion imaging, thermal mapping and temperature measurement using MRI, as well as nano-iron imaging.

Taking a break from his work as a theorist, Dr. Kyle Beloy from the Time and Frequency Division instructed young participants on several hands-on demonstrations, ranging from electrical generators and motors to magnetic levitators and primitive compass-making. At NIST, Dr. Beloy investigates the physical phenomena of ytterbium optical-lattice clocks. The ytterbium optical-lattice clock is an improvement on existing atomic clocks, which serve as primary time standards today. Accurate timekeeping is vital to the telecommunication and transportation industries, affecting nearly every aspect of modern life.

For more information on the NIST/ISMRM phantom, please visit: http://collaborate.nist.gov/mriphantoms/bin/view/MriPhantoms/MRISystemPhantom.

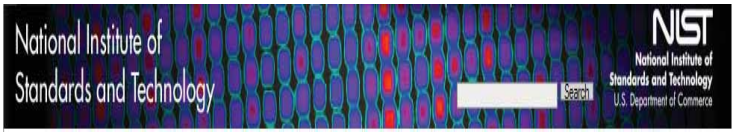


Figure 2 Visualizing the magnetic field of a neodymium rare-earth magnet with a ferrofluid. Photo by Peter Hseih.

Figure 3 NIST Boulder volunteers at Super Science Saturday (from left to right): NRC Associates Dr. Katie Rice, Dr. Kyle Beloy, Dr. Lauren Rast, and Dr. Katy Keenan. and NRC Adviser, Dr. Peter Hsieh. Photo by Rajul Pandya

NANOALUMINONSILICATES: A NEW ADDITIVE OF CEMENTITIOUS MATERIALS

Dr. Jose Munoz, NRC Associate; Dr. Jack Youtcheff, NRC Advisor, FHWA
Turner-Fairbank Highway Research Center
Dr. Eric Li, Wake Forest University

Amorphous nanoaluminosilicates are potentially being seen as a new generation of nanoparticle additives because of their potential to replace traditional calcium silicate hydrated (C-S-H) gel formation by a calcium aluminate silicate hydrate (C-A-S-H) gels in cementitious materials. It is expected that the microstructure of cementitious materials rich in C-A-S-H over C-S-H will show improved overall mechanical properties. Based on atomistic simulations, the presence of aluminum in C-S-H like structure results in several changes in the chemo-mechanical properties of the hydrated gel. The aluminum can replace silicon in the original C-S-H structure resulting in higher capacity of the gel to bind alkalis[1,2]. The aluminum can also replace calcium in the interlayer spacing of the C-S-H and then bind itself to silica chains creating a variety of dimensional linkages ultimately resulting in enhanced integrity and stability of the overall gel structures[2]. The consequences of this linkage are an increase in the strength and elastic response of the C-A-S-H[2].

These specific properties of the C-A-S-H gel have a great potential to engineer the interface between the aggregates and cement paste (ITZ) in concrete. This ITZ is one of the most vulnerable areas in concrete. It is a preferential area for the nucleation of cracks[3-5]. The surface of the aggregates can act as vectors for the ingress of deleterious microfines (particles < 75 μm) as aggregate coatings during the mixing process, mostly certain types of clay minerals, or as starting point of degradation mechanisms such as alkali-silica reaction or freezing and thawing deterioration.

Additionally, it is of interest to study the capacity of these nanoaluminosilicates to promote the massive hydration of glassy alumina phases, especially in high volume of fly ash (HVFA) mixtures. In this system portland cement is a minority component. Therefore, it is hypothesized that the nucleation of significant amounts of C-A-S-H gel from high alumina glassy particles would help to offset current mechanical performance problems experienced in HVFA mixes, such as long setting times and low early strength developments.

The nanoaluminosilicates being investigated at Turner-Fairbank Highway Research Center are created through a sol-gel method by mixing silicon and aluminum alkoxides. This synthesis process allows for the diffusion of aluminum into the silica framework by promoting the formation of aluminum-oxygen-silicon bond (Al-O-Si). This method posse an additional advantage since it is possible to synthesize nanoaluminosilicate particles with a vast range of silicon to aluminum ratio. Fourier transform infrared spectroscopy (FTIR) was used to confirm the formation of Al-O-Si bond. The presence of this bond induced changes in the typical silica FTIR spectra, such as shifting of the band assigned to Si-O-Si asymmetric stretching at 1070 cm^{-1} towards lower wavelengths[6-8] (Figure 1a), and the appearance of bands in the region of 680-500 cm^{-1} associated to Al-O stretching vibrations[7,8] (Figure 1b).

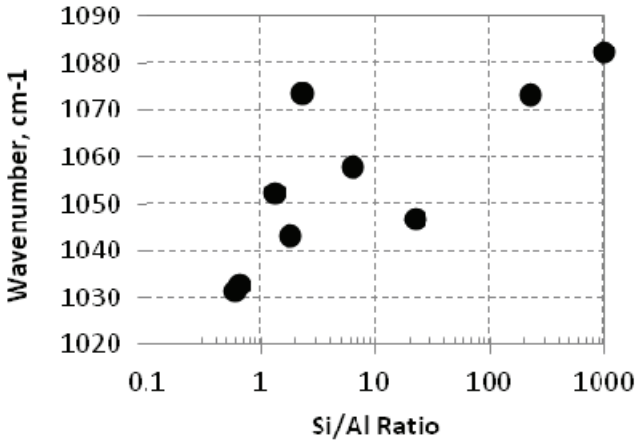
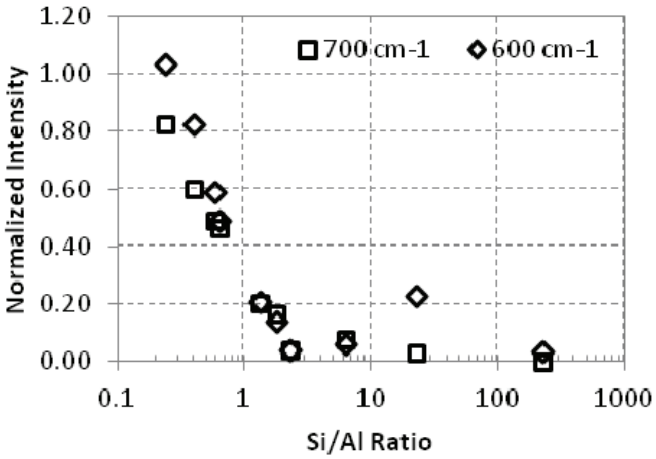


Figure 1. Shift in Si-O asymmetric stretching band (a) and normalized intensity of the Al-O-Si bending bands (b) as a function of the Si/Al ratio in the nanoaluminosilicates.



The effect of these nanoaluminosilicates with various silicon to aluminum ratio on the early hydration reaction of the portland cement was studied using isothermal calorimetry measurements as is shown in Figure 2. The results demonstrate that these nanoparticles are very effective in promoting the hydration reaction of alumina-bearing phases in portland cement paste samples. In particular, 0.75% by total mass of nanoaluminisolicates with a Si/Al ratio of 0.65 can accelerate the alumina-bearing phase hydration reaction up to 15 hours with respect to the control.

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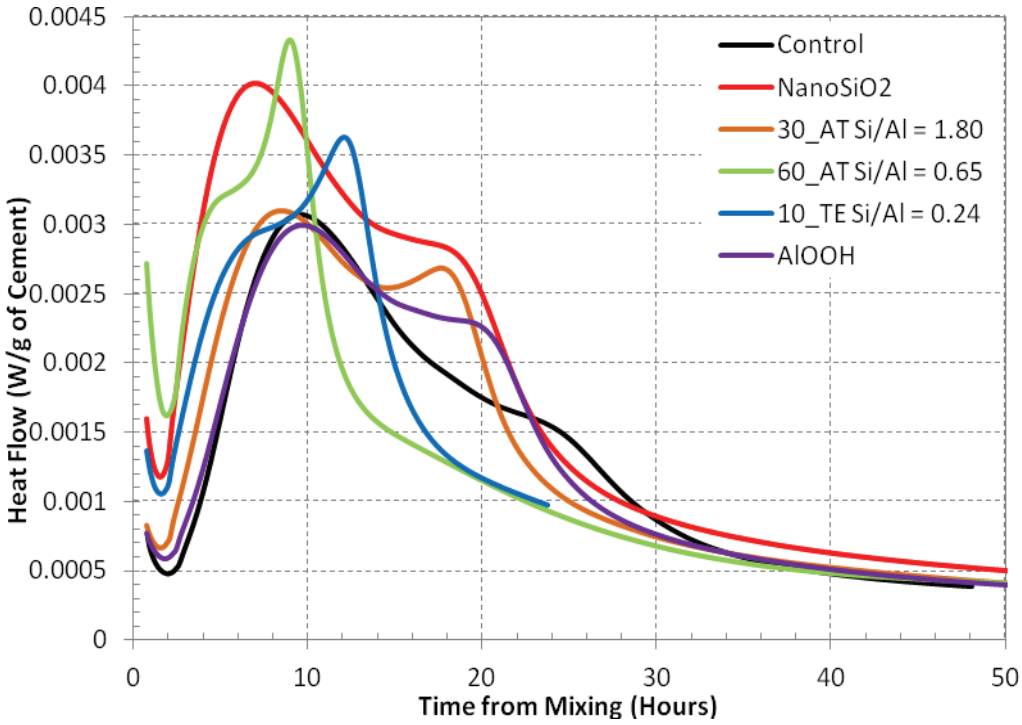

Figure 2. Effect of nanosilica, nanoboehmite, and different nanoaluminosilicates on the early hydration reaction of portland cement.

The effect of the cement paste pore solution on the nanoaluminosilicates was initially explored by exposing the 0.65 Si/Al nanoparticle to this solution for 3 days. After this time, xerogel samples of the nanoparticles were analyzed under scanning electron microscope and energy dispersive X-ray spectroscopy (SEM/EDX), as is illustrated in Figure 3. The top images in Figure 3 show the original nanoparticles, as xerogel, prior to their exposure to pore solution. The EDX analysis indicates only the presence of aluminum and silicon, and the SEM image shows typical sharp edges of xerogels. The two images at the bottom of Figure 3 show the morphological and chemical changes experienced by the nanoparticles after 3 days of exposure to cement paste pore solution. The EDX analysis indicates presence of calcium in the nanoparticles and SEM image portrays a gel-looking compound. Further analyses are required to determine if the gel is C-A-S-H.

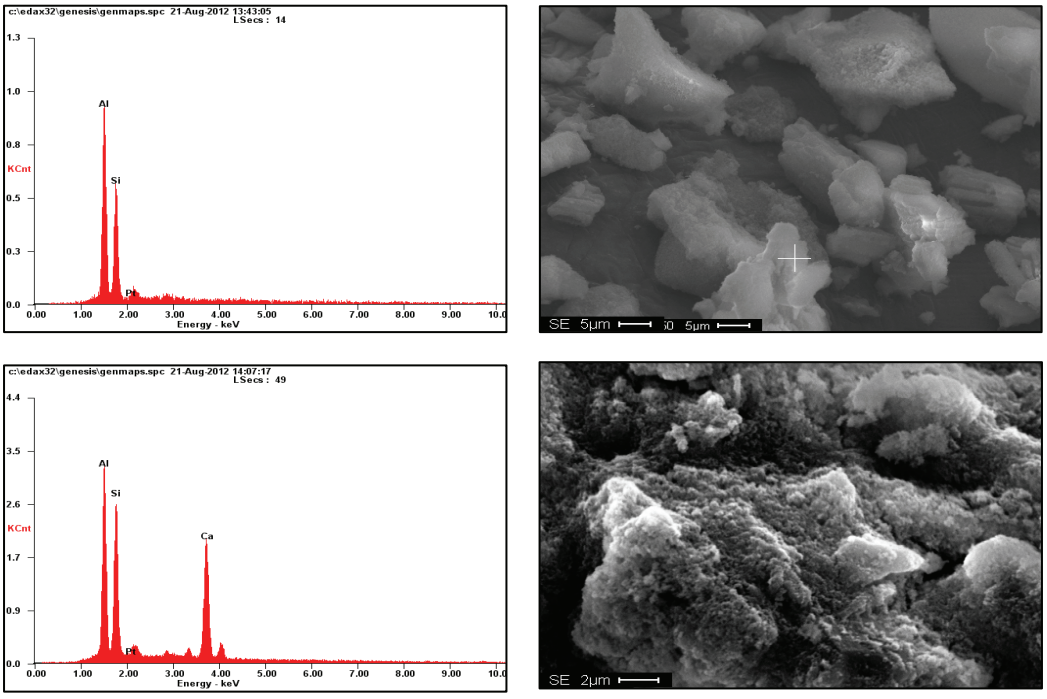

Figure 3. SEM/EDX analysis of original 0.65 Al/Si nanoaluminosilicate (top) and after 3 days in cement paste pore solution (bottom)

18 *continued from pg. 17*

These results indicate that the nanoaluminosilicates have a strong capacity to modify the hydration reaction of portland cement, mostly the dissolution and reaction of aluminum bearing phases. Future steps of the research at Turner-Fairbank Highway Research Center with nanoaluminosilicates include: an investigation on the effect of aluminosilicates on the composition of cement pore solution at early hydration stages and a detail study of the structural changes experienced by these aluminosilicates under cement pore solution.

References:

Hong S and Glasser FP. Alkali Sorption by C-S-H and C-A-S-H gels. Part II: Role of Alumina. Cement and Concrete Research 2002; 32 (7): 1101-1111.

Qomi MJA, Ulm FJ, and Pellenq RJM. Evidence on the Dual Nature of Aluminum in the Calcium-Silicate-Hydrates Based on Atomistic Simulations. Journal of American Ceramic Society 2012; 95 (3): 1128-1137.

Akcaoglu T, Tokyay M, and Celik T. Effect of Coarse Aggregate Size on Interfacial Cracking Under Uniaxial Compression. Materials Letters 2002; 57 (4): 828–833.

Caliskan S, Karihaloo B.L, and Barr BIG. Study of Rock-Mortar Interfaces. Part 1: Surface Roughness of Rock Aggregates and Micro- structural Characteristics of Interface. Magazine of Concrete Research 2002; 54 (6): 449–461.

Domone PLJ, Illstn JM. Construction Materials. London: Taylor & Francis, 2001.

Jones SD, Pritchard TN, and Lander DF. Physical Properties of Sol-gel Aluminosilicates. Microporous Materials 1994; 3 (4-5): 419-431.

Sinko K, Mezei R, Rohonczy J, and Fratzl P. Gel Structures Containing Al (III). Langmuir 1999; 15 (20): 6631-6636.

Hernandez C and Pierre AC. Evolution of the Texture and Structure of SiO2-Al2O3 Xerogels and Aerogels as a Function of the Si to Al Molar Ratio. Journal of Sol-Gel Science and Tech-

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Dr. Silvia Matt, a NRC Postdoctoral Research Associate at the Naval Re-search Laboratory Stennis Space Center (NRLSSC), is a physical oceanogra-pher in the Hydro Optics Sensors and Systems Section, headed by Dr. Weilin "Will" Hou. The group studies the impact of turbulence on underwater optical signal transmission through laboratory experiments, high-resolution numerical simulations, and field studies.

In 2012, Silvia Matt was selected to participate in the UNOLS Chief Scientist Trainig cruise, a workshop sponsored by UNOLS, the University-National Oceanographic Laboratory System, to train the future generation of sea-going oceanographers on how to be a chief scientist aboard a UN-OLS vessel. The workshop took place November 7-17, 2012, and consisted of two days of shored-based training and mobilization as well as a 7-day cruise on the UNOLS research vessel R/V New Horizon out of Scripps Insti-tute of Oceanography in San Diego, California. The research cruise brought together biologists, chemists, geologists and physicists from different US in-stitutions and all with different sampling strategies and needs, for the com-mon goal of studying the ocean off California and learning what it means to be a UNOLS chief scientist. The scientists' objectives ranged from the study of oceanic bacteria and viruses, over studying marine invertebrates, to atmospheric chemistry and ocean physics. During the seven days at sea, the scientists maintained a blog describing their experiences aboard the ship (http://csw.unols.org).

Dr. Matt's goal during this training cruise was to explore the use of the Nortek Vector Acoustic Doppler Velocimeter (ADV) combined with a PME Fast Conductivity and Temperature (CT) sensor for high-resolution velocity and turbulence measurements from a ship, in particular for collecting vertical proles of 3D velocity and inferring dissipation rates. Data were collected in the upper ocean across the seasonal thermocline in coastal and open waters off San Diego, in the La Jolla Canyon, and in the Santa Barbara Basin (Figures 1, 2). The ADV/CT package was deployed slowly pro_ling as well as pausing at preset depths, allowing for a comparison between these two approaches for the calculation of turbulent kinetic energy and temperature dissipation rates (Figure 3). CTD pro_les with the ship's CTD were collected at each ADV station to gather information about the stratification and stability of the water column, as well as to infer dissipation from Thorpe scales. Optical data was collected with a 9-channel scattering transmissometer (ac9) and concurrent satellite images of ocean color and other properties were acquired for the area and duration of the cruise.

Figure 1: Deployment of the ADV package o♂ the UNOLS research vessel R/V New Horizon in the California Borderlands on November 15 under ideal, calm conditions.

Results from the analysis of the data collected during the UNOLS workshop are expected to help address the sampling challenges involved in the use of ADVs to probe oceanic turbulence and its effect on underwater optical signal transmission.

The data collection during the UNOLS cruise and the discussions with senior nior PIs Clare Reimers and Dave Checkley directly benefitted the analysis of ADV/CT data previously collected during the Bahamas Optical Turbulence Experiment (BOTEX) for the study of optical turbulence. The BOTEX study was the first comprehensive effort comparing traditional proling approaches of turbulence measurements to estimates of dissipation rates from an ADV/CT package on a moving platform, with the aim to quantify oceanic microstructure in the context of studying EO signal transmission. This work has been presented and published as part of the 2013 SPIE DSS conference (http://www.spie.org) and proceedings [Matt et al., 2013]

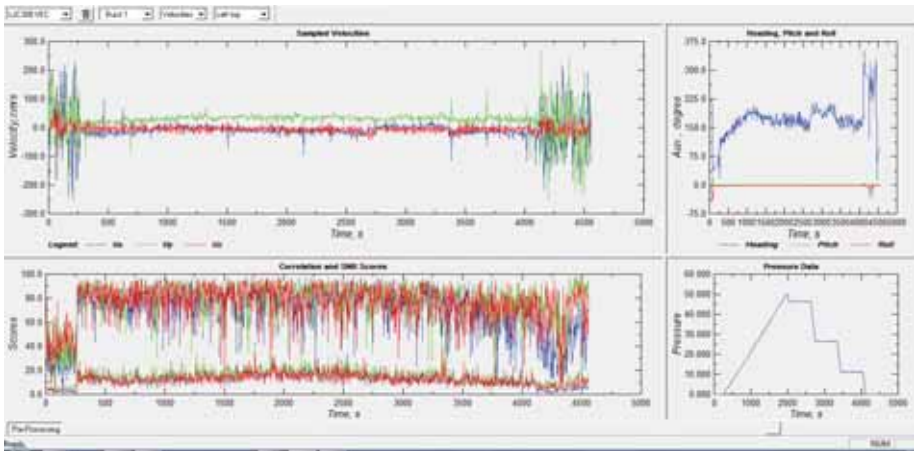

Figure 3: Data from the Nortek Vector ADV for a station in the La Jolla Canyon. The data are visualized using the Nortek software ExploreV, which provides graphics of the velocity components, heading, pitch and roll information, signal strength (beam correlation and signal to noise ratio, SNR) and pressure data for a given sample. The pressure panel on the lower right-hand side illustrates how the data collection consisted of the initial profiling and then the additional 10 minute long pauses at several depths.

2013 SCHEDULE

February Review

February 1	Application deadline
February 15	Deadline for supporting documents (transcripts/letter of recommendation)
March 12	Review results finalized
March 20	Review results available to applicants

August Review

August 1	Application deadline
August 15	Deadline for supporting documents (transcripts/letter of recommendation)
Sept 23	Review results finalized
Sept 28	Review results available to applicants

May Review

May 1	Application deadline
May 15	Deadline for supporting documents (transcripts/letter of recommendation)
June 21	Review results finalized
June 29	Review results available to applicants

November Review

Nov 1	Application deadline
Nov 15	Deadline for supporting documents (transcripts/letter of recommendation)
TBD	Review results finalized
TBD	Review results available to applicants

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