THE NATIONAL ACADEMIES

RESEARCH ASSOCIATESHIP PROGRAMS

The Postdoc

Autumn-Winter 2014

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NRC Adviser awarded 2014 Sustained Research Prize

The Neutron Scattering Society of America (NSSA) established the Sustained Research Prize to recognize a sustained contribution to a scientific subfield, or subfields, using neutron scattering techniques, or a sustained contribution to the development of neutron scattering techniques. The primary consideration is an enduring impact on science. Preference is given to applicants whose work was carried out predominantly in North America.

Nominations are reviewed by a committee of experts in the fields to which neutron scattering contributes, and the NSSA was pleased to announce the **2014 recipient of the Sustained Research Prize —Dr. Jeffrey W. Lynn, NRC Adviser within the National Institute of Standards and Technology.** The prize and $2500 honorarium was awarded at the 2014 ACNS in Knoxville, TN June 1-5, 2014 (http://www.mrs.org/acns-2014/).

Dr. Jeffrey W. Lynn, has established an outstanding record of ground-breaking research on the physics of magnetic materials using neutron scattering. He began his career with insightful studies of ferromagnetic materials, both itinerant systems such as Fe, Ni and their alloys and systems where the electrons are more spatially localized such as transition metal oxides. This work helped to establish our current understanding of these materials, stimulating theoretical efforts and testing their boundaries.

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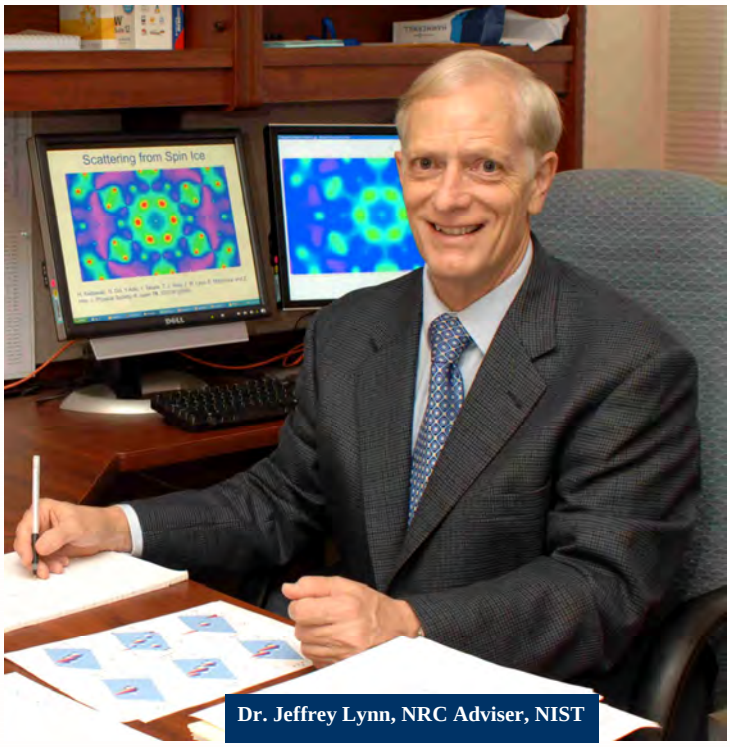

Dr. Jeffrey Lynn, NRC Adviser, NIST

"The Postdoc" newsletter, which highlight research and activities of NRC Associates and Advisers, is available in PDF via our website: http://sites.nationalacademies.org/PGA/RAP/PGA_047804, or in GoogleDoc via our Facebook Page, or in hardcopy (National Academy Press) via the newsletter manager.

Dr. Ray Gamble, Director
NRC Research Associateship Programs
Suzanne White, newsletter manager

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

NRC Representation at 2015 Meetings

Meeting	Dates	City	State
American Institute for Aeronautics and Astronautics SciTech	**01/05/15-01/09/15**	**Kissimmee**	**FL**
NIST Postdoctoral Conference	02/19/15-02/19/15	NIST	MD
APS March Meeting	03/02/15-03/06/15	San Antonio	TX
American Chemical Society-Spring	03/22/15-03/26/15	Denver	CO
National Society of Black Engineers	03/25/15-03/29/15	Anaheim	CA
American Society for Microbiology	05/30/15-06/02/15	New Orleans	LA
Unconventional Resources Technology Conference	07//20/15-07/22/15	San Antonio	TX
National Society of Black Chemists & Chemical Engineers	09/23/15-09/27/15	New Orleans	LA
Hispanic Association of Colleges and Universities	10/10/15-10/12/15	Miami Beach	FL
Latinos in Science and Engineering (MAES)	10/22/15-10/24/15	Las Vegas	NV
Society for the Advancement of Chicanos and Native Americans in Science	10/29/15-10/31/15	National Harbor	MD
American Society for Tropical Medicine and Hygiene	10/25/15-10/29/15	Philadelphia	CA
Florida Education Fund/McKnight Fellows Meeting	October	Tampa	FL
Annual Biomedical Research Conference for Minority Students	11/11/15-11/14/15	Seattle	WA
American Indian Science and Engineering Society	November		
American Geophysical Union	12/14/15-12/18/15	San Francisco	CA

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Dr. Lynn refined and extended this early work to a variety of different systems, investigating how the static and dynamical aspects of magnetism are affected by the onset of different types of magnetic order. These latter systems included manganese oxides, which display unusually large magnetoresistance, as well as multiferroic materials, which simultaneously possess both ferromagnetic and ferroelectric order. His pioneering work on these materials profoundly affected both theoretical and computational studies.

Jeffrey also made career-long contributions towards understanding the interplay between magnetism and superconductivity. He began this effort with his research on the rare earth molybdenum chalcogenides, where he helped to establish the role of magnetism as a driving force for other collective states, namely superconductivity. This led to more recent studies of cuprates and then pnictides, where he and his collaborators made seminal contributions to our knowledge of magnetic ordering in systems where magnetism and superconductivity exist in close proximity.

In addition, Lynn has served as a mentor to a many graduate students, an **NRC Adviser to many NRC Postdoctoral Research Associates**, and collaborator with other organizations, helping to establish a cadre of well-trained neutron scatterers. He also worked to help advance neutron scattering techniques by developing a new thermal triple axis spectrometer at the NIST Center for Neutron Research. This instrument combines many innovative features to provide unprecedented neutron intensity ideal for measurements of small samples, enabling many novel experimental studies.

Jeffrey has been an international leader and vocal advocate of the use of neutron scattering methods to answer fundamental questions in condensed matter physics. He exemplifies the characteristics for which this prize was established – sustained and significant contributions to both techniques and their application to important scientific questions.

Dr. Lynn is a Fellow of the National Institute of Standards and Technology where he leads the Condensed Matter Physics team at the NIST Center for Neutron Research. He received his Ph.D. from Georgia Tech in 1974, performing neutron scattering measurements at Oak Ridge National Laboratory with Dr. Herbert Mook. He then took a post doc under the direction of Dr. Gen Shirane at Brookhaven National Laboratory. In 1976, he became a Professor at the University of Maryland and in 1992 joined NIST full time.

Dr. Lynn has also held important advisory roles within the scientific community, including chair of the Division of Materials Physics of the American Physical Society and Program Co-Chair for the 2004 American Conference on Neutron Scattering. In 2011 President Obama conferred upon him the Presidential Rank Award of Distinguished Senior Professional. He is a fellow of both the American Physical Society and the NSSA.

related Lynn article on next page

NCNR neutrons highlight possible battery candidate

From NIST *Tech Beat*: May 20, 2014

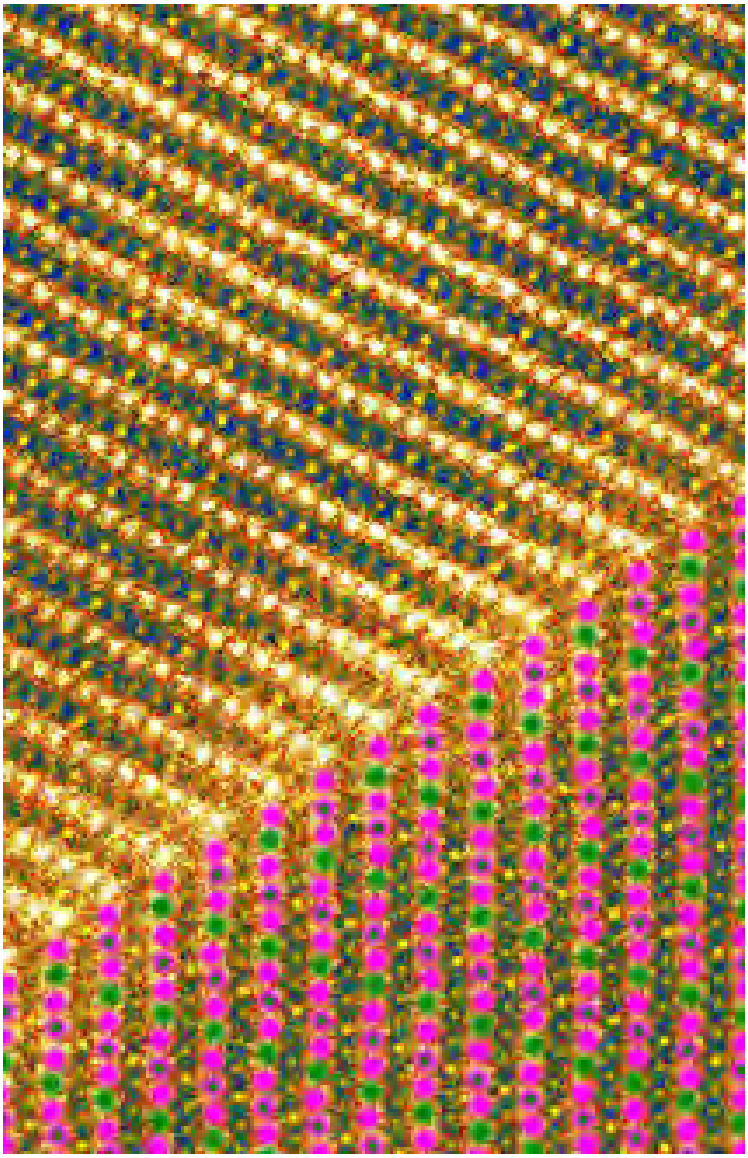
Analysis of a manganese-based crystal by scientists at the National Institute of Standards and Technology (NIST) and the Massachusetts Institute of Technology (MIT) has produced the first clear picture of its molecular structure. The findings could help explain the magnetic and electronic behavior of the whole family of crystals, many of which have potential for use in batteries.

The family of crystals it belongs to has no formal name, but it has three branches, each of which is built around manganese, cobalt or iron—transition metals that can have different magnetic and charge properties. But regardless of family branch, its members share a common characteristic: They all store chemical energy in the form of sodium, atoms of which can easily flow into and out of the layers of the crystal when electric current is applied, a talent potentially useful in rechargeable batteries.

Other members of this family can do a lot of things in addition to energy storage that interest manufacturers: Some are low-temperature superconductors, while others can convert heat into electricity. The trouble is that all of them are, on the molecular level, messy. Their structures are so convoluted that scientists can't easily figure out why they do what they do, making it hard for a manufacturer to improve their performance.

Fortunately, this particular manganese crystal is an exception. ***"It's the one stable compound we know of in the manganese branch that has a perfect crystal lattice structure",*** says **Dr. Jeff Lynn, NRC Adviser at the NIST** Center for Neutron Research (NCNR). "***That perfection means we can isolate all its internal electronic and magnetic interactions and see them clearly. So now, we can start exploring how to make those sodium atoms more movable."***

Team members from MIT made the material and performed analysis using state-of-the-art lab techniques such as electron microscopy, but they needed help from the NCNR's neutron beams to tease out the interactions between its individual atoms. The effort showed that the crystal was unusual for reasons beyond its structural perfection. Its layers absorb sodium in a fashion rarely seen in nature: In each layer, one 'stripe' of atoms fills up completely with sodium, then the next three stripes fill up only halfway before another full stripe appears. Lynn says the pattern is caused by different charges and magnetic moments that manganese atoms possess in different parts of the crystal, a feature revealed by analysis of the NCNR data.



At the top of this image, a sodium fills in layers of the crystal, represented by one bright yellow dot followed by three darker ones; at bottom, the layers' magnetic ordering is shown as green and purple dots representing magnesium at two different charge states, with the green-in-purple dots representing a mixture of the two charge states. Artwork generated from a scanning tunneling microscope image.

***X. Li, X. Ma, D. Su, L. Liu, R. Chisnell, S.P. Ong, H. Chen, A. Toumar, J-C. Idrobo, Y. Lei, J. Bai, F. Wang, J.W. Lynn, Y.S. Lee and G. Ceder. Direct Visualization of the Jahn-Teller Effect Coupled to Na Ordering in $Na_{5/8}MnO_2$. *Nature Materials*, DOI:10.1038/nmat3964, May 18, 2014.**

Dr. Jeffrey Lynn, NRC Adviser, NIST

"This particular crystal is probably not the one you'd use in a battery or some other application, it just permits us to understand what's happening with its internal structure and magnetism for the first time", Lynn says. ***"Now we have a basis for tailoring the properties of these materials by changing up the transition metals and changing the sodium content. We no longer have to hunt around in the dark and hope."***

Spotlight on ARL

Dr. Hongmei Li-Byarlay, NRC Associate with Army Research Lab, has new publication:

***Hongmei Li-Byarlay et al., Socially responsive effects of brain oxidative metabolism on aggression. PNAS 2014 ; published ahead of print August 4, 2014, doi:10.1073/pnas.1412306111 ,* August 26, 2014 vol. 111 no. 34 12533-12537**

SIGNIFICANCE

Despite high energetic demands in the brain, glucose is not always metabolized to produce maximum energy. Aerobic glycolysis, that is, high levels of glucose consumption relative to oxygen use, is connected to cognition and disease, but metabolic plasticity remains challenging to study in vivo owing to the brain's complexity. We show that decreased oxidative phosphorylation activity, a pattern that resembles aerobic glycolysis, causes increased aggression in honey bees and fruit flies. This effect is specific to neurons and not glia, and the social environment modulates the relationship between metabolism and aggression. The fly–bee system, linking variation in brain metabolism to a natural behavior, could be used to further study the function of brain metabolic plasticity.

RESULTS

Metabolic dynamics are critical to brain function in both vertebrate and invertebrate species (1–3). In mammals, cognitive and behavioral tasks result in increased glucose metabolism and minor increases in oxygen consumption (relative to availability), and similar processes have been shown to occur in insects (3,4). These metabolic changes underlie widely used technologies that measure brain activity (e.g., functional MRI and PET) (5–7). Because the brain is an energetically demanding organ with high ATP requirements (8), temporal and spatial variation in glucose metabolism is generally assumed to fulfill the energetic demands of signaling and recovery (5). Paradoxically, in humans, less than 10% of the glucose that is taken up as a result of brain activity is fully oxidized through oxidative phosphorylation (OX) to produce ATP, despite adequate oxygen availability, a phenomenon known as aerobic glycolysis (6, 9–11). Furthermore total glucose uptake by the adult human brain exceeds oxygen use by 10–12% (12). Thus, increased demand for high levels of ATP is inadequate to explain the function of variation in glucose metabolism in the brain. Understanding the functional significance of metabolic plasticity, which is essential for cognition but also linked to disease, is a critical issue in neuroscience (6, 9, 13). To study the relationship between metabolic plasticity and brain function, it is necessary to develop in vivo experimental systems that are amenable to precise metabolic manipulations and that link brain metabolic states to specific behavioral states (14). In this study we present a two-species experimental system that meets these requirements.

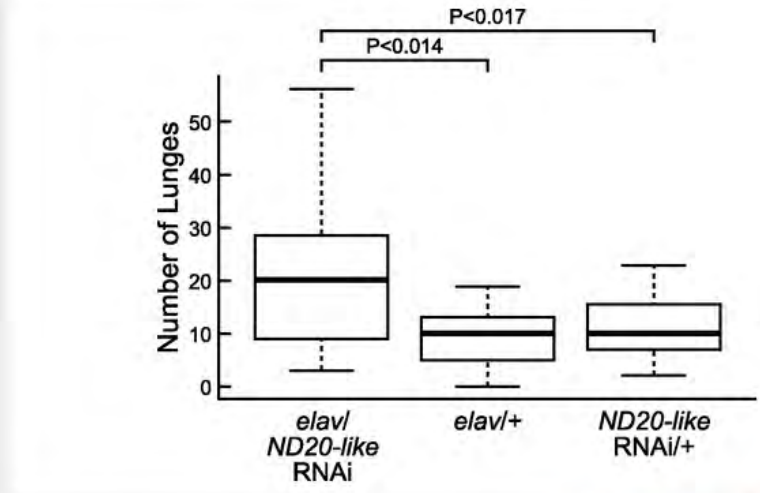


Fig. 2.

Effect of neuronal RNAi knockdown of metabolic genes on aggression in *Drosophila*. *ND20-like* neuronal knockdown flies (*elav/ND20-like* RNAi, $n = 23$ pairs) showed significantly more lunges compared with two heterozygous parent controls (*ND20-like* RNAi/+, $n = 20$ pairs, *elav/+*, $n = 10$ pairs; Kruskal-Wallis test: $H_2 = 7.08$, $P < 0.029$; post hoc Mann-Whitney U tests: *elav/ND20-like* RNAi vs. *ND20-like* RNAi/+, $Z = 2.13$, $P < 0.017$, *elav/ND20-like* RNAi vs. *elav/+*, $Z = 2.21$, $P < 0.014$).

Dr. Hongmei Li-Byarlay, NRC Associate, ARL

Linkedin.com/in/hongmli

In our previous study, brain transcriptional profiling in the honey bee (*Apis mellifera*) revealed a negative correlation between whole-brain OX activity and aggression. This was seen in three different comparisons: in highly aggressive Africanized vs. less aggressive European honey bees; in older, more easily aroused honey bees compared with younger individuals; and in response to alarm pheromone (15). Transcriptomic data and enzyme activity assays showed that effects were most prominent for genes associated with complexes I, IV, and V of the OX pathway (15). We used these results as the basis for experiments that determined the functional implications of plasticity in brain glucose metabolism on aggression.

We manipulated OX in behaviorally relevant ways in honey bees and the fruit fly (*Drosophila melanogaster*) and tested for a causal relationship between a change in brain OX and aggression. With *Drosophila* we studied whether the relationship between brain OX and aggression originally discovered in honey bees is evolutionary conserved and also determined whether it is localized to neurons or glia. With honey bees we also assessed how variation in social experience modulates the link between brain OX and aggression.

Ft. Detrick scientists visit west African countries hit by Ebola outbreak

Dr. Aileen O'Hearn, NRC Associate at USAMRIID with Dr. Randall Schoepp, NRC Adviser, recently participated in the Ebola virus outbreak response.

Several Fort Detrick Scientists have recently visited west Africa, which is suffering from a deadly outbreak of the Ebola virus. One of them is Dr. Aileen O'Hearn, with the US Army Medical Research Institute for Infectious Diseases, who spent some time this year in Sierra Leone, one of three nations hit hard by the Ebola outbreak. The other countries are Guinea and Liberia.

Dr. Aileen O'Hearn, NRC Associate, USAMRIID, works in a biological safety cabinet in the lab at Kenema Government Hospital in Sierra Leone.

Dr. O'Hearn went to Sierra Leone to do research on Lassa fever. She was doing a lot of her work in a laboratory at Kenema Government Hospital, which is about 150 to 200 miles east of Freetown, Sierra Leone's capital. But she also visited the hospital wards as well. The Ebola virus is spread through direct contact with bodily fluids. It can take as long as 21 days before an infected person starts showing symptoms, according to the World Health Organization.

"It's a challenge, especially as a foreigner, to convince the local population to seek medical treatment when they or a friend or family member contracts Ebola", says Dr. O'Hearn. ***"There's a good portion of people that don't think the disease is real",*** she says. ***"There are some people that believe that the disease was brought there by foreign nationals on purpose. That makes things very difficult. General fear of the disease within the community causes people to hide infected family members or friends, which will allow it to spread even further",*** she says.

But many of the staff at Kenema Government Hospital have been able to convince their fellow citizens to seek medical help if they contract Ebola. ***"The group that works at the hospital is really fantastic. They try and get people out in the villages, and explain to everyone that it is really is for their own good. That they need to come into the hospital, to take care of their personal hygiene. And they really do a good job of communicating"***, says Dr. O'Hearn.

The Ebola outbreak in this part of Africa is considered the largest in history since it first emerged on that continent 40 years ago. Patients have overcrowded hospitals in Sierra Leone, Guinea and Liberia. According to the Sept. 23 NYTimes, CDC estimates that Ebola cases could reach 1.million within four months,

The Centers for Disease Control and Prevention has warned Americans against any non-essential travel to these three nations. The CDC also says it will send 50 additional personnel over the next 30 days to Sierra Leone, Guinea and Liberia to help the 12 staff members already in those countries. The Peace Corps has also pulled out its volunteers from these three countries.

There is no cure for Ebola, but patients can recover. ***"It is a hemorrhagic disease and you lose a lot of fluids during the course of infections. The primary point of care is replacing those fluids, putting you on an IV line, and having you drink as much as possible throughout the day so you don't become dehydrated",*** says O'Hearn.

With the ease of modern travel, there is always a concern that the US could face an Ebola outbreak. But Dr. O'Hearn says that's unlikely. ***"With the point of care and the precautions that we take over here, it would be flushed out in no time"***, she says. While handling the Ebola virus, Dr. O'Hearn said she and her fellow scientists took the necessary precautions at the Kenema Government Hospital Lab as they would at Fort Detrick. That includes wearing lab coats, scrubs, face shields and gloves.

Despite the dangers of working in a country with the Ebola virus and the suspicions of the population, Dr. O'Hearn says she would go back to Sierra Leone again. ***"As many concerns as there are, it's always something I've enjoyed doing and I'd go back in a second"***, she says.

In a news release, USAMRIID cites a study in the publication Emerging Infectious Diseases that says the Ebola virus has been circulating in that area of Africa since 2006, eight years before the recent outbreak.

One-on-one radio interview: **http://www.fredericknewspost.com/news/disasters_and_accidents/usamriid-scientists-ebola-outbreak-larger-than-official-numbers/article_ee993ae7-4f7b-5650-b7bb-86769f130a3d.html**

Group interview: **http://www.wfmd.com/articles/wfmd-local-news-119935/ft-detrick-scientists-visit-west-african-12629641/**

Dr. Aileen O'Hearn, NRC Associate, USAMRIID

Army science protects healthcare workers from Ebola

The spread of Ebola to the U.S. in recent weeks has heightened public fears of this deadly virus. Researchers at the U.S. Army – Natick Soldier RD&E Center (NSRDEC) are helping personnel on the front lines meet challenges in this global public health issue.

Natick scientists invented, licensed, and commercialized a novel disinfectant technology that is being used to sterilize Ebola -contaminated medical equipment in remote clinical sites in West Africa.

This invention consists of packaged dry chemicals that mix in water to generate chlorine dioxide gas in a closable container. Chlorine dioxide is more effective on microbes and less corrosive to materials than conventional bleach treatments.

This power-free, portable technology is ideal for sterilization in austere environments. The invention is now being used by Doctors without Borders, World Health Organization (WHO), Public Health Canada, and National Institute of Health (NIH - with support from US government), thereby protecting healthcare personnel and alleviating fears of transmitting Ebola while caring for patients in a vulnerable population.

According to lead inventor Dr. Christopher Doona, NRC Adviser and Senior Research Chemist at Natick, ***"The chemistry of this system makes it very unique. We're proud to be contributing in the fight against the spread of Ebola."***

Doona's team includes Microbiologist Florence Feeherry and Professor Kenneth Kustin (Brandeis University, *Emeritus*). The team recently published a video demonstration of this technology in the Journal of Visualized Experiments (www.jove.com).

With extensive experience in microbial modeling, textile decontamination, graywater disinfection, sanitizing fresh produce, Dr. Doona (past-Chair of the Institute of Food Technologists – Nonthermal Processing Division) is Natick's leading research expert in High Pressure Processing and the mechanisms of bacterial spore germination and inactivation for more than the past decade.

Florence Feeherry, who began working in bacterial spores as a High School intern at Natick, has co-authored 3 books, numerous manuscripts and chapters, and 15 patent applications with Doona since the 1990s. ***"We're especially thrilled to be supporting the men and women caring for the ill on the front lines of this crisis."***

"We've certainly contributed valued publications to the scientific literature," added Kustin, formerly a Post-doctoral Fellow for Nobel Prize winner Manfred Eigen, ***"but working with Chris to move exciting laboratory findings into the commercial marketplace, and now to help in this global public health crisis is truly an unbelievable experience."***

http://www.necn.com/news/new-england/Mass-Researchers-Create-Disinfectant-to-Fight-Ebola-280284792.html

http://www.jove.com/video/4354/the-portable-chemical-sterilizer-pcs-d-fens-d-fend-all-novel-chlorine

http://www.metrowestdailynews.com/article/20141029/NEWS/141025763/0/SEARCH

http://on.wcvb.com/1wz0Q6z

http://www.nbcnews.com/watch/nbc-news-channel/researchers-develop-ebola-disinfectant-348828227663

Dr. Christopher Doona, NRC Adviser, serves as Senior Research Chemist for the US Army Natick Soldier Research, Development, and Engineering Center (NSRDEC) and conducts basic research investigations into the relationships in chemical reaction mechanisms, novel decontamination technologies, and nonthermal technologies for food preservation. Dr. Doona holds a Ph.D. in Chemistry from Brandeis University and was a National Science Foundation (NSF)-Hungarian Academy of Sciences visiting scientist at Loránd University in Budapest, Hungary, and an NSF Visiting Scientist in Physical Chemistry at Würzburg University, Germany.

Oct 21, 2014, By NSRDEC Public Affairs

Natick — key role in fighting Ebola

http://www.army.mil/article/136641/Natick_plays_key_role_in_helping_to_fight_spread_of_Ebola/

Researchers at the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) invented a next-generation disinfectant system that kills the Ebola virus on surfaces. The scientists developed and patented a novel chemical system, which is being used to sterilize medical equipment and electronic items used in the treatment of patients on the front lines of the war on Ebola in West Africa.

This came about through the transfer of the technology from the Army lab to a privately held company, ClorDiSys Solutions, which is manufacturing the portable "no power required" chemical compound, and supplying it worldwide. One of the key research thrusts at the U.S. Army Natick Soldier Research, Development and Engineering Center is the discovery and development of decontamination technologies to keep the warfighter healthy and safe from bioterror attack.

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Natick's invention is a portable "no power required" method of generating chlorine dioxide, known as ClO2, gas, one of the best biocides available for combating contaminants, which range from benign microbes and food pathogens to Category A Bioterror agents. The starting ingredients used to generate ClO2 are now produced and marketed by Lebanon, New Jersey-based ClorDiSys Solutions, and they can be quickly mobilized and applied as a gas to decontaminate or sterilize equipment and surfaces.

Dr. Christopher Doona, NRC Adviser and the lead inventor of this field-portable method for generating ClO2, is a senior research chemist at the center, known locally as Natick Labs, with extensive experience in ClO2 reaction chemistry. Doona and his team are credited with inventing and perfecting this process of converting dry powder chemicals into ClO2. Doona says an important exponent of ClO2 is its versatility as a disinfectant suitable for any industry, ranging from textiles, medicine, wastewater treatment and public health, to food safety, personal hygiene, and household uses. ClO2 can be activated in small or large quantities and in varying strength levels from potent enough to sterilize medical instruments to mild enough to use in toothpaste to fight off germs in the mouth.

This technology could have ended up like many military technologies, in a warfighter-only product. However, the Army patented it and the technology transfer specialists at TechLink in Bozeman, Montana, collaborated with Natick's Technology Transfer Office, to transfer the technology to ClorDiSys, so it could be commercialized and made widely available. Technology transfer such as this, from a government lab to private enterprise, is mandated by Congress and ensures that useful technologies don't just gather dust on a shelf, but find application in U.S. industry.

Jeff DiTullio, business development lead at Natick, is always searching for opportunities where military innovation can be licensed for commercial application. Natick is one of dozens of DOD laboratories actively involved in research and technology aimed at benefiting the U.S. warfighter, and giving the military unrivaled operational capability. Working as a conduit between the DOD and the private sector, TechLink assisted ClorDiSys in navigating the Army's licensing process. ***" It was a perfect scenario. We needed something and the Army had it. TechLink helped us get to the finish line"***, said Paul Lorcheim, ClorDiSys Solutions' director of operations. ***"This transfer would not have happened without TechLink"***, added DiTullio.

ClorDiSys Solutions is a spinout of Johnson & Johnson. The company focuses on generating and using ClO2, providing both powered and unpowered solutions for a variety of applications, and in particular for decontamination and sterilization of pharmaceutical, medical, veterinary, and food facilities. When the opportunity came along to provide ClO2 on the Ebola front, ClorDiSys was willing and ready. ***"ClorDiSys is proud to be helping to fight the spread of Ebola in Africa",*** said Mark Czarneski, ClorDiSys Solutions' director of technology. ***"Various world health organizations, including the U.S. government, are using ClorDiSys's gaseous chlorine dioxide to sterilize medical equipment contaminated with Ebola. It has been tested and is being utilized by these organizations for a number of applications".***

The company's ultraviolet light disinfection system, called TORCH, was also utilized by the University of Nebraska Medical Center to perform the terminal disinfection after the release of their first Ebola patient. Chlorine dioxide is a yellow-green gas with a faint odor similar to chlorine bleach, but otherwise it is very different. It has been recognized as a disinfectant since the early 1900s, and has been approved by the U.S. EPA for many applications.

In the modern age, the effectiveness of ClO2 was confirmed at the dawn of the new millennium. In the weeks after the 9/11 attacks when terrorists sent anthrax in letters to public officials, hazardous materials teams used ClO2 to decontaminate the Hart Senate Office Building, and the Brentwood Postal Facility. Unlike other methods of preparing chlorine dioxide, no electricity or caustic acids are needed to activate the powdered ClO2, nor is clean water required, making it ideal for use in remote field locations.

Packets of ClorDiSys's ClO2 product, which until recently did not exist, are portable enough to be carried in backpacks. Chlorine dioxide is a broad-based biocide that kills spores, bacteria, viruses, and fungi. To date no organism tested against ClO2 has proved resistant. It has effectively been used to kill bacterial spores, which are much more difficult to kill than viruses, such as Ebola, according to Doona. ***"Americans hear in the news about outbreaks of E. coli, Listeria, and Salmonella from fresh fruits and vegetables. ClO2 holds promise for the food industry but also, on a smaller scale as a home sanitizer for rinsing fresh produce or appliances",*** Doona said.

The success of ClO2 in combating Ebola and other pathogens follows collaboration between the DoD and a biotech company that yielded a potential treatment for victims sickened by Ebola. The Ebola antibody that is a key component of the experimental drug called ZMapp was developed in the Army Medical Research Institute of Infectious Diseases, and transferred with assistance from TechLink to Mapp Biopharmaceutical of San Diego. ZMapp is credited with having saved the lives of two American medical missionaries who contracted Ebola last July, and is regarded as one of the most promising treatments for Ebola currently under development.

Researchers Dr. Christopher Doona (right) and Florence Feeherry of the U.S. Army Natick Soldier Research, Development, and Engineering Center developed next-generation decontamination technologies that safely, conveniently, and controllably generate chlorine dioxide without acids or power. ClO2 kills bacterial spores, viruses, and vegetative cells, while minimizing hazards to the user and the environment.

Dr. Joseph N. Tan
NRC Adviser
NIST

Dr. Shannon Fogwell Hoogerheide
NRC Associate
NIST

Precision Experiments with Multiply-ionized Atoms using Compact Ion Traps

Shannon Fogwell Hoogerheide and Joseph N. Tan
National Institute of Standards and Technology (NIST)
Gaithersburg, MD 20899, USA

Abstract

In the past few decades, multiply-ionized atoms have become available in the laboratory for studies that enable information extraction from observations of our sun and astrophysical objects (such as found by the Chandra X-ray Observatory), as well as for development of technological light sources (such as required for the next generation EUV lithography). At NIST, a room-size facility operates a device called an electron beam ion trap (EBIT) that can remove all the electrons from an atom if its nucleus has no more protons than cadmium (Z=48), and can also remove most of the electrons from heavier elements. The intense electron beam at the heart of the EBIT creates conditions resembling those found in the solar corona or in research devices for controlled-fusion energy sources.

Interestingly, theoretical studies have shown that some highly-ionized atoms have special features that are well-suited for very high precision measurements—such as in studying possible time-variation of fundamental constants, or in developing next-generation atomic clocks that can rival the best frequency standards [1]. Moreover, if fully-ionized atoms can be reconstituted with a single electron in a high-flying orbit called a Rydberg state, then precise values of fundamental constants could be measured using an optical frequency comb [2].

Recently at NIST, highly-ionized atoms have been isolated at low energy in a compact unitary Penning trap, which is made extremely compact using embedded rare-earth permanent magnets [3], as illustrated in Figure 1. This system has been used to observe the spontaneous spin-flipping decay of a Rydberg-like metastable level in Kr^{17+} ions, improving the lifetime measurement [4]. It can also facilitate a variety of spectroscopic studies of interest in atomic physics and metrology—such as the possibility of new atomic frequency standards [1]. One application of interest in understanding comet x-ray emission is the study of charge-exchange (electron capture) processes using fully-stripped ions. Another application involves the production and formation of low-Z, one-electron ions in high-flying Rydberg states that are favorable for measuring fundamental constants [2]. We have tested a miniature EBIT that is suited for low-Z ions [5]. We plan to use the mini-EBIT with an attached rubidium beam oven to allow charge exchange between laser-excited Rydberg rubidium atoms and isolated bare nuclei to form one-electron ions in Rydberg states. Optical comb-based spectroscopy of such ions could provide an independent determination of the Rydberg constant [2] to help resolve the discrepancy in the proton charge radius measurements [6].

Motivation: to study or measure atomic properties and processes.

Potential applications: (1) Fundamental constants, (2) Proton Radius Puzzle calls for independent Rydberg constant, (3) Enhanced sensitivity to time-variation of the fine-structure constant α, (4) Atomic

Experiments with Highly Charged Ions Isolated in a Unitary Penning Trap

Joseph N. Tan
Atomic Spectroscopy Group
National Institute of Standards & Technology

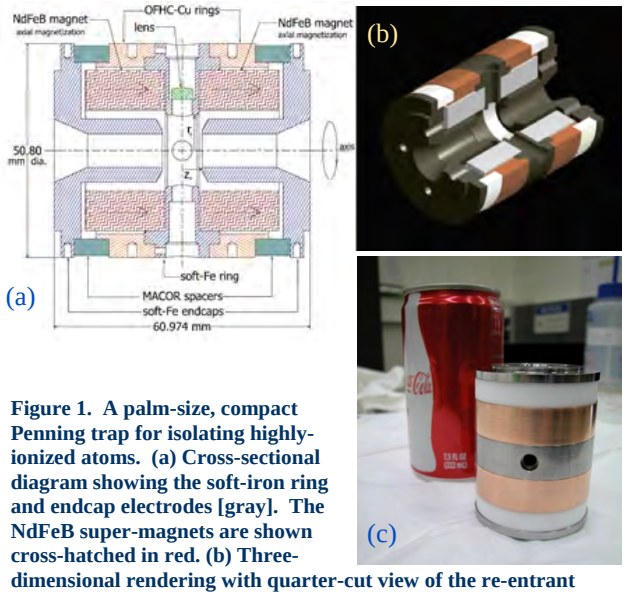
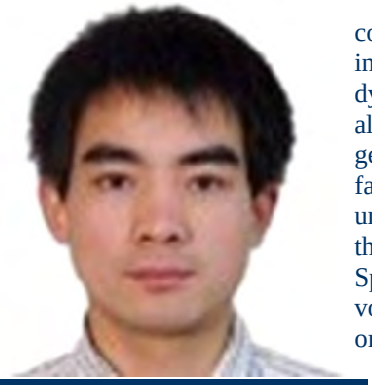


Figure 1. A palm-size, compact Penning trap for isolating highly-ionized atoms. (a) Cross-sectional diagram showing the soft-iron ring and endcap electrodes [gray]. The NdFeB super-magnets are shown cross-hatched in red. (b) Three-dimensional rendering with quarter-cut view of the re-entrant endcaps and the two embedded permanent magnets [gray]. (c) Photograph of the two-magnet, unitary Penning trap in front of a 222 mL soda can. An aspheric lens is mounted in one of the four mid-plane holes to collect light emitted by captured ions.

References:

[1] A. Derevianko, V. A. Dzuba, and V. V. Flambaum, Phys. Rev. Lett. 109, 180801 (2012).
[2] U. D. Jentschura, P. J. Mohr, J. N. Tan and B. J. Wundt, Phys. Rev. Lett. 100, 160404 (2008).
[3] S.M. Brewer, N.D. Guise, and J.N. Tan, Phys. Rev. A 88, 063403 (2013).
[4] N.D. Guise, *et al.*, Phys. Rev. A 89, 040502(R) (2014)
[5] S. Fogwell Hoogerheide & J.N. Tan, Journal of Physics (accepted).
[6] R. Pohl, *et al.* (CREMA collaboration), Nature 466, 213-218 (2010).

Traffic Performance Analysis of Dynamic Merge Control using Micro-Simulation



Dr. Ximiao Jiang, NRC Associate, FHWA
U.S. Dept. of Transportation
Federal Highway Administration

Dynamic merge control (DMC) can be used in freeway merge areas to dynamically change lane allocation at interchanges. It generally prioritizes the facility having higher volume, and closes a lane on the lesser-volume roadway. Specifically, When ramp volumes are relatively light, or when mainline volumes are heavy, it may be most effective to have an entrance ramp merge into the rightmost lane. However, there may be times that the volume on the ramp is extremely high while the mainline volumes are low. In this case, traffic merging from the on-ramp will have to find gaps in the mainline traffic, despite the mainline traffic being relatively light. The delay caused by hesitation and time required to find a gap may be disruptive to ramp capacities and flows, thus creating a situation with higher rear-end collision potential on the ramp.

The DMC strategy is currently implemented in Germany and the Netherlands, where lane control signs are installed over both approaches upstream of the merge, and priority is given to the facility with higher volume. This strategy produces a more uniform traffic flow, with fewer conflicts and safer maneuvers (Helleman, 2010). The abovementioned DMC is used to "close" the right lane of the mainline upstream of the on-ramp to give ramp traffic free-flow conditions onto the mainline. This strategy can be generalized to prioritize high-volume roadways by dropping a lane on the lower-volume roadway, especially in merge areas involving a downstream lane drop. Lane drops in the merge area can easily cause a bottleneck, leading to upstream congestion on both roads. In this situation, closing a lane on the lower-volume road would reduce or eliminate the friction caused by "weaving" (gap acceptance) movements in the merge area. As such, the DMC strategy is hypothesized to reduce traffic congestion at the merge of two freeways.

Dr. Joe Bared, NRC Advisor, FHWA

This research employed microsimulation studies using VISSIM, to investigate efficiency of the DMC strategy. The objective of this research is to investigate DMC efficiency where 3-lane and 2-lane freeways merge into 4 lanes, and explore optimum thresholds for activating and deactivating DMC. Figure 1 shows a sketch of the hypothetical road geometry and lane closure strategy.

To explore optimum DMC operation thresholds, traffic demands on Route A were varied from 2500 to 4600 vehicles per hour (vph), in increments of 300 vph. Simultaneously, demands on Route B were varied from 3000 to 4600 vph in increments of 200 vph. Thus with 8 demand levels on Route A and 9 levels on Route B, a total of 8*9=72 demand scenarios were analyzed. When closing a mainline lane, drivers were assumed notified of that lane closure 2500 ft upstream of the closing point. In the merge area, vehicles originating from the mainline were not allowed to make lane changes from lane 4 to lane 3, ensuring that ramp vehicles could freely merge onto the mainline. The simulation period for each scenario was 8400 seconds, including 1200 seconds of initialization "warm-up" time. In each scenario, traffic demands on both roads were assumed fixed over the entire simulation period.

Results show that the network travel speed was greatly increased (Figure 2) and the traffic delay was significantly reduced (Figure 3). Due to the reduction of lane changes, traffic density in the merge area decreased thus the Level Of Services (LOS) was improved (Figure 4). To better understand

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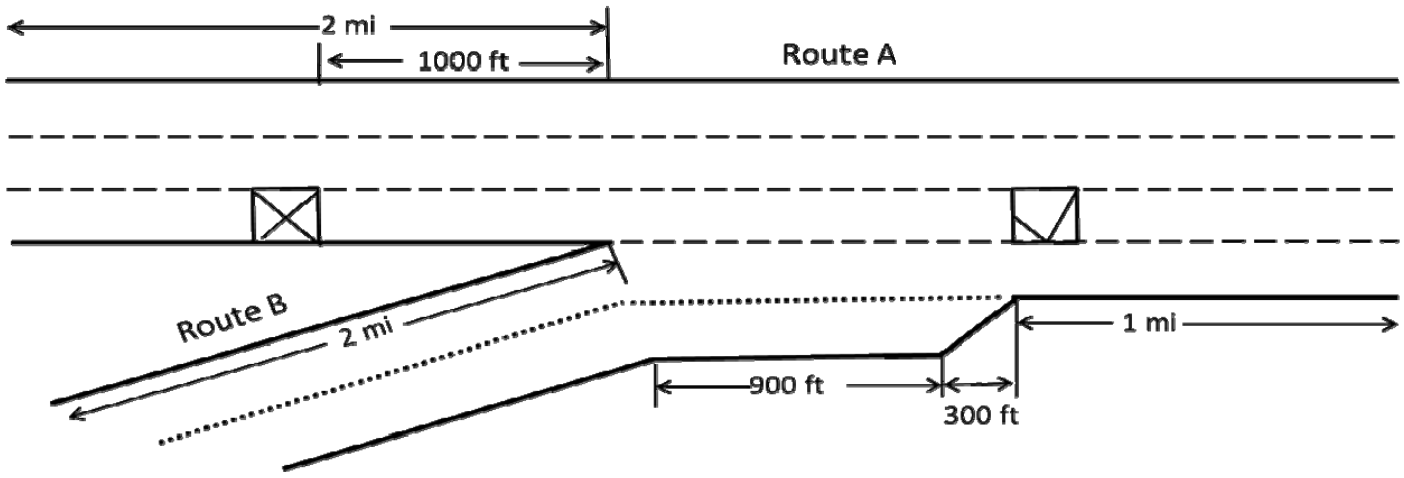
Figure 1: Sketch of the hypothetical road geometry and the lane closure strategy.



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the impact of lane changes on capacity, flow rates within 300 ft after the lane drop were investigated. Flow rates under free-flow conditions were calculated by dividing combined demand from Routes A and B by the total number of lanes (4 in the measured section). Figure 4a presents lane-drop-area flow rates for 4600 vehicles per hour (vph) on Route A, and various demands on Route B. Figure 4a indicates that Route B flow rates were very similar under DMC and free-flow conditions, for all considered traffic demands. However under baseline conditions, when demands on Route B exceed 3600 vph, flow rates remain capped at around 2000 vphpl. This implies that without DMC control, merge-area capacity is constrained by lane changing disturbances. Figure 4b presents lane-drop-area flow rates for 4600 vph in Route B, and various demands on Route A. Figure 4b shows nearly identical Route A flow rates between DMC and free-flow conditions, with baseline flow rates consistently 150-200 vphpl lower.

Figure 2: Delay reduction upon the DMC control

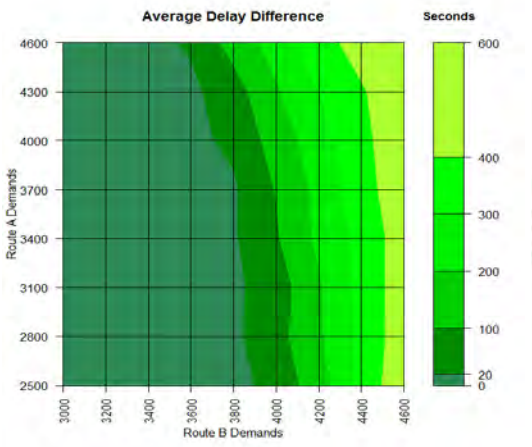


Figure 3: Speed increase upon the DMC control

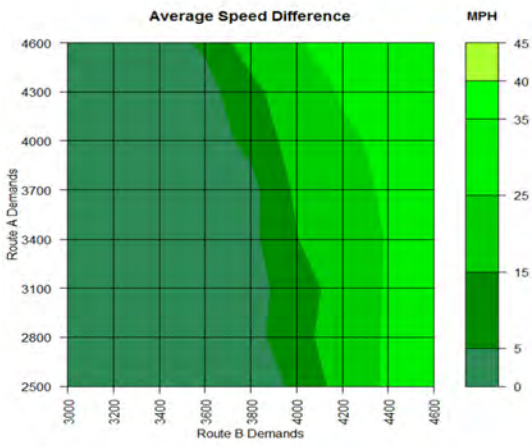


Figure 4: Traffic density in the merge area before and after the DMC control

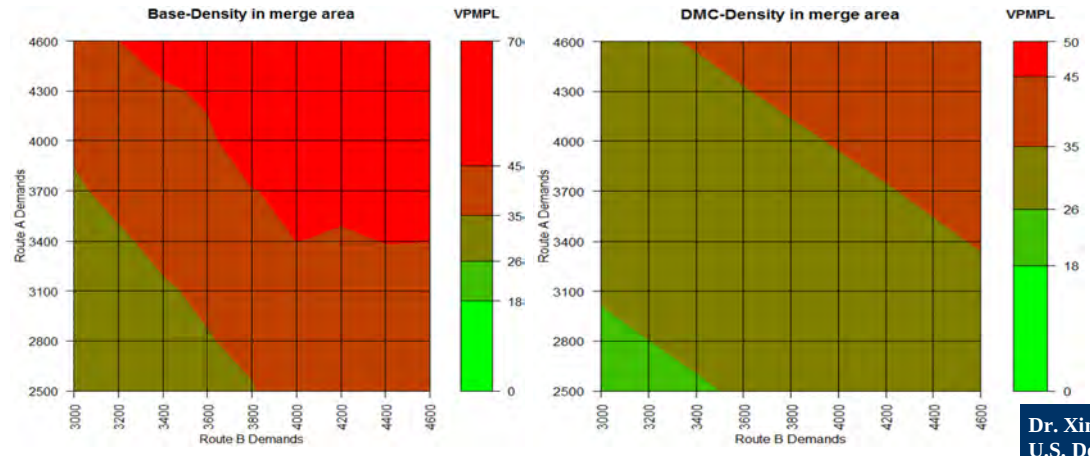
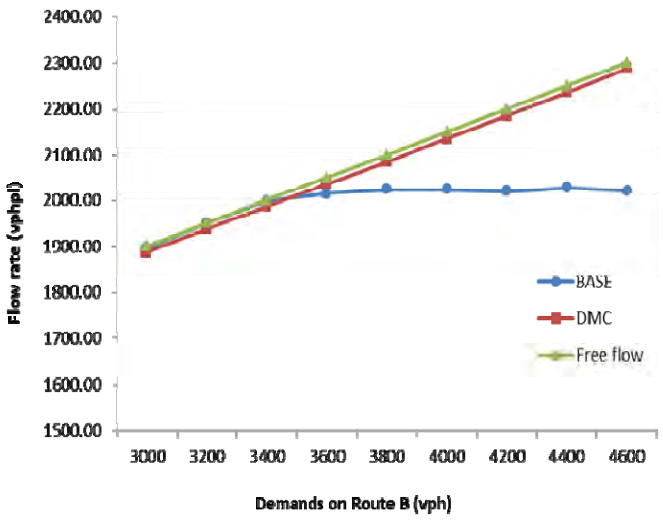
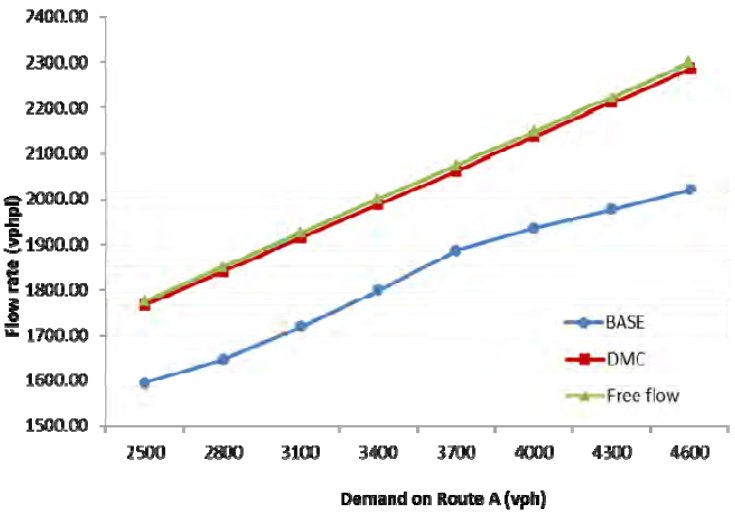


Figure 2: Flow rate analysis in the merge area.

(a) Fixed demand on Route A at 4600 vph



(b) Fixed demand on Route B at 4600 vph



Remarks:

- ◊ The DMC strategy is beneficial for almost all traffic demand combinations considered in this research
- ◊ After implementing DMC, average delay per vehicle was reduced by up to 540 seconds (around 98%).
- ◊ DMC can increase average speed by 26 mph (more than 80%)
- ◊ When traffic demand on the minor road exceeds 1900 vehicles per hour per lane (vphpl), benefits become statistically and practically significant;
- ◊ DMC can greatly alleviate the capacity reductions caused by lane changing in the merge area.

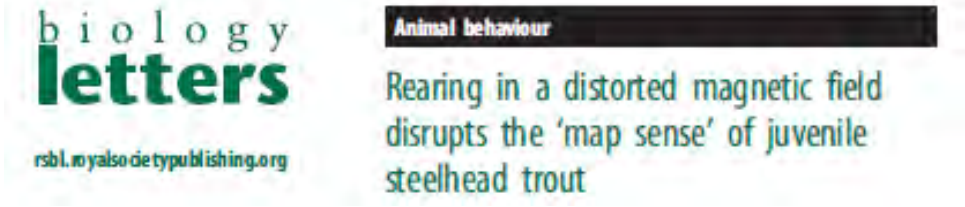
Dr. Ximiao Jiang, NRC Associate, FHWA
U.S. Dept. of Transportation
Federal Highway Administration

Spotlight on NOAA/NRC — Dr. Nathan F. Putman

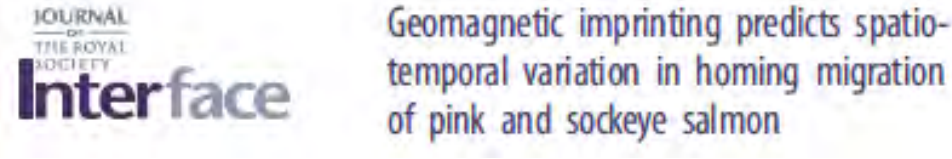
Dr. Nathan F. Putman, NRC Research Associate, NOAA Southeast Fisheries Science Center, Affiliate Faculty Dept. of Fisheries & Wildlife, Oregon State University

Earlier this year Dr. Nathan F. Putman led a team of scientists in demonstrating that Pacific salmon use Earth's magnetic field as a sophisticated navigation system. The work, published in *Current Biology*, experimentally showed that juvenile Chinook salmon measure the strength of the magnetic field and the angle of field lines to estimate where along their migratory route they are and thus which direction to swim. The findings came by using simulated magnetic displacements, in which salmon were exposed to magnetic fields that exist at the latitudinal extremes of their oceanic range. In each case the perceived magnetic displacement elicited oriented swimming that would return the fish toward the center of their range, as if to correct their abrupt change in location (i.e., exposure to the northern magnetic field elicited southward orientation and exposure to the southern magnetic field elicited northward orientation). Given that the fish never left the testing site, they had no opportunity to learn the large-scale gradients in the Earth's magnetic field; thus implying that the remarkable behavior is inherited.

Upon joining the NRC as a Research Associate in March, Dr. Putman has published two new papers applying their work on magnetic navigation in salmon to fisheries management issues. In a paper published May 2014 in *Biology Letters*, he used simulated magnetic displacement experiments to show that juvenile steelhead trout (the anadromous form of rainbow trout) also use the Earth's magnetic field to find marine feeding grounds. However, this ability is obliterated for fish reared in a distorted magnetic environment typical of many hatcheries (due to iron pipes, steel-reinforced concrete, etc.). The reduced navigational abilities that were observed might explain lower marine survival and poorer homing precision in hatchery fish relative to wild fish. Given that billions of hatchery-reared fish are released annually, determining the extent that rearing fish in distorted magnetic fields diminishes hatchery efficiency and increases negative interactions with wild fish is critically important. Moreover, these findings suggest that the there is a strong environmental component to the development of magnetic navigation in salmonids.



This July, Dr. Putman published a paper in *Journal of the Royal Society Interface* demonstrating the importance of geomagnetic navigation in the wild. Dr. Putman and colleagues from the Pacific Salmon Commission analyzed a unique dataset in which movement patterns in the homing migration of sockeye and pink salmon were recorded over a period spanning six decades. The data are collected to manage the shared fishery between the U.S. and Canada. Dr. Putman showed that spatiotemporal variation in the homing migratory routes of sockeye and pink salmon were predicted by the geomagnetic imprinting hypothesis of natal homing. Geomagnetic imprinting hypothesizes that marine animals remember the magnetic field values (e.g. field strength and angle) at the onset of their oceanic migration and, upon reaching maturity, follow the large-scale magnetic gradients to relocate this same magnetic value. Drift of the magnetic field relative to the likely imprinting site predicted up to ~45% of the annual variation in migration route for both species. Other factors traditionally assumed to influence variation in migratory routes (such as ocean temperatures and currents) provided limited predictive ability for sockeye movements and were unrelated to pink salmon movements. More generally, Dr. Putman points out that, given the diversity of animals that use the Earth's magnetic field for navigation, geomagnetic drift may provide a unifying explanation for spatiotemporal variation in the movement patterns of many species.



As global climate continues to change and as humans further modify habitats the need to predict long-term trends in animal movements and distribution is growing. The recent findings by Dr. Putman suggests that a renewed focus on navigation mechanisms is an elegant approach to generate insight into the ecological, evolutionary and economic implications of animal movement.

Links to more of Dr. Putman's publications can be found on his Google Scholar profile:
http://scholar.google.com/citations?sortby=pubdate&hl=en&user=gYH6e70AAAAJ&view_op=list_works

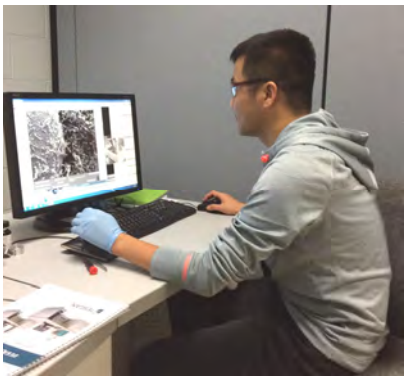
Bridging Human Health & Ecosystem Integrity,

by Dr. Shibin Li

"A blue sky/A green lake/Vast is the grassland/ This is my homeland/Horses running wild /Sheep as white as snow/And you my girl/Where my heart is at home/I love you, my homeland/My homeland my heaven/I miss you my homeland/ My homeland my heaven" .
Tengger, Heaven
https://www.youtube.com/watch?v=rBquB6L_Zk8

I was born in a remote area in Inner Mongolia, China, materially poor but blessed with a beautiful natural environment, as in the poem by Tengger. Our ancestors valued the concept of "Nature and Human in One", which can be interpreted as the concept of co-existence and harmony of heaven, earth, humans, and all living things, an inspiration of Confucius. Respect for people and nature was embedded in the soul of every Inner Mongolia child, and the spirit of "Nature and human in one" was part of our daily lives. Over three decades of economic growth of China, my Mongolian home has been tremendously modernized. However, such rapid economic growth cannot overshadow the associated environmental problems. Environmental protection along with human well-being are concerns for every country and every individual.

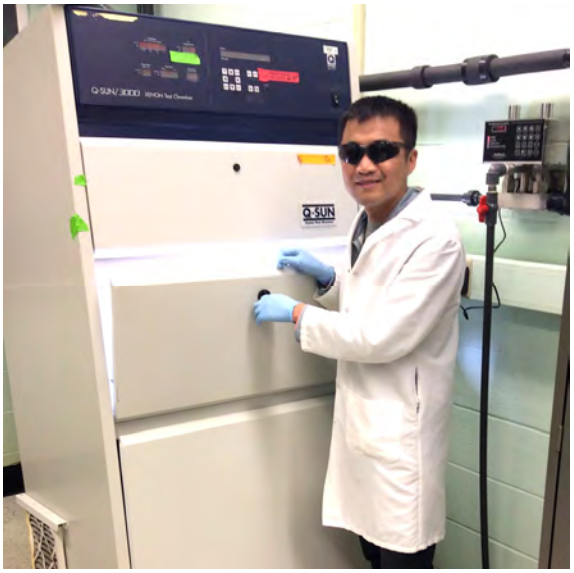
Inspired by my homeland and people, I chose environmental chemistry for my career. I have greatly benefited from my personal and professional experiences in the United States, especially in the area of environmental toxicology. Providing foundational and practical research results, that contribute to world-wide environmental protection, continues to be the motivation for a meaningful and exciting career choice for me. As the most developed country in the world, the United States has decades of experience and efforts in environmental protection. In 2008, I joined Texas Tech University and received my Ph.D. in Environmental Toxicology at the Institute of Environmental & Human Health in 2012. Currently, I am a National Research Council (NRC) Research Associate at the US Environmental Protection Agency's (USEPA) Mid-continent Ecology Division in Minnesota.



Dr. Shibin Li, NRC Associate, EPA

The Properties and Behavior of Nanomaterials

My research at the USEPA concerns the properties of nanomaterials in freshwater and their behavior and effects on aquatic animals. Riding the wave of advances in material sciences in the 20th century, nanotechnology has been a field marked with tremendous progress, as evidenced by the discovery, manufacture, and application of various nanomaterials. As well, understanding the potential human and environmental health impacts of nanomaterials has become a top priority within many national and international entities.



Dr. Shibin Li, NRC Associate , EPA

My work has mainly involved nano-sized titanium dioxide, one of a variety of materials produced as photocatalysts in surface coatings, solar voltaics, and water purification products. Nano-sized titanium dioxide (TiO_2) appears to be one of the most promising nanomaterials, due to its abundance, stability, low cost, and the remarkably labile photoreactivity of TiO_2, achieved by manipulation of the crystal structure and a variety of coatings. Upon interaction between nano-TiO_2 and photons in the ultraviolet radiation (UV) wavelength range (less than 380 nm), electron-hole pairs emerge during the shift of electrons from the valent band into the conduction band by photon energy. This pair is able to strongly react with oxygen in water to form reactive oxygen species (ROS) such as $OH^{\bullet}$, and $O2^{-\bullet}$, known for their aging properties and disease in humans, and toxic effects in aquatic organisms.

Understanding the aquatic ecotoxicology of photoactive nanomaterials attracted my interests, and I am privileged to be affiliated with the USEPA facility in Duluth, MN for my postdoctoral training and research on aquatic toxicology. The USEPA Mid-Continent Ecology Division and its sister, the Atlantic Ecology Division in Rhode Island, support world-class research programs responsible for many of national and international standard guidelines and assessment methods. In collaboration with USEPA scientists and talented students, I am investigating the impacts of nanomaterials on biological aspects of water quality and implications for environmental and human health, research that will advance risk assessment of nanomaterials. Our research has led to several publications illustrating the nature of phototoxicity of nanomaterials in various aquatic species.

My interests and motivation in environmental research originated in the beautiful yet fragile grassland of my homeland. After years of research and education in the United States, I appreciate the complicated environmental challenges in various habitats in the world associated with development and use of new types of chemicals, many of which serve the health and well-being of human society. As a researcher focusing on chemical toxicology, I aspire to provide scientific support for the safe use of chemicals, to provide strategies for risk management appropriate for particular chemicals, to educate future scientists in chemistry and toxicology, to serve as a communicating bridge between developed and undeveloped regions, and to maintain the ancient spirit of "Nature and Human in One".

NRL, Aerospace Industry Host 10th Annual CanSat Student Challenge

Created in 2004 by the American Astronautical Society (AAS) and American Institute of Aeronautics and Astronautics (AIAA), the Texas CanSat Competition is an undergraduate and graduate level design-build-launch event simulating the end-to-end life cycle of a complex engineering project.

Since its start in 2004, the CanSat competition has become an annual event providing a unique opportunity for university and college student teams to design, build and launch a soda can-size satellite (CanSat) to meet specific mission objectives. The goal of CanSat is to foster student growth in multiple disciplines of science, technology, engineering and mathematics (STEM).

Spanning a decade long commitment by the U.S Naval Research Laboratory (NRL) and other federal and commercial sponsors, the goal of CanSat is to foster student growth in multiple disciplines of science, technology, engineering and mathematics (STEM).

This year's 10-year anniversary CanSat competition, co-sponsored by NRL in cooperation with NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory (JPL), AIAA, AAS, Ball Aerospace Technologies, Praxis Inc., and Kratos Integral Systems International, required teams to develop a CanSat capable of harvesting energy from the environment, and once deployed, transmit telemetry in real time to the team ground stations.

Beginning in October and culminating in a final competition mid-summer, teams from around the nation as well as South America, Europe and Asia, entered to design and build a space-type system and then compete against each team at the end of two semesters to determine winners.

The CanSat had to use aero-braking to slow its descent and protect a raw egg during the launch, deployment, descent and landing. Parachutes or similar devices were not allowed. Preliminary design reviews were held in February and critical design reviews in April. Those teams able to compete attended the three-day launch event in June in Burkett, Texas. The first day was committed to safety checks and preflight briefings, the second day launch competitions were held, and day three, posting of flight reviews and announcement of final awards.

Of the 54 original teams, 39 attended the launch competition:

1st place: Team Arisat, Istanbul Technical University;

2nd place: Team Wilkensat, Sri Ramaswamy Memorial (SRM) University, India;

3rd place: Team Wind Chargers, University of Alabama Huntsville;

4th place: Team Tomahawk, Ryerson University, Canada;

5th place: Tarleton Aerospace Club, Tarleton State University, Stephenville, Texas.

Atoms and Bonds in Molecules and Matter

Dr. Jerry A. Boatz, NRC Adviser, AFRL

The familiar atomistic picture of matter was first offered approximately three millennia ago by the Greek philosopher Democritus but was made quantitive only upon the introduction of quantum theory in the early part of the last century. In spite of this important more recent development, the degree to which constituent atoms retain their structural identities in matter, and the notion of chemical bonds between them, is widely perceived as quantitatively illusive.

Dr. Peter W. Langhoff, NRC Associate, AFRL

The ability to express the generally complicated electronic energies of polyatomic molecules as their geometries vary in the form of a simple sum of atomic and bonding energies opens an entirely new approach to quantitative studies of their structures and properties, an opportunity the group hopes to pursue with applications in materials and bio-molecular science for publication in the open literature.

This fundamental shortcoming has now been overcome. **Senior NRC Research Associate Peter W. Langhoff of the University of California San Diego, working in collaboration with Drs. Jerry Boatz and Jeffrey Mills of AFRL, Edwards AFB**, reported the first quantitative quantum-mechanical definition of the energies of individual atoms and of their bonds in molecules and matter at the 54th Sanibel Symposium on Quantum Chemistry held at St. Simon Island, GA, on 16 -21 February 2014, at the 45th Annual American Physical Society DAMOP Meeting held at Madison, WI, on 2-6 June 2014, at the 50th Symposium on Theoretical Chemistry held at the University of Vienna, AT, on 14-18 September 2014, and at a special Celebration Symposium held on 1 October 2014 in San Francisco honoring this year's Nobel Laureate in Chemistry, Professor Martin Karplus, Dr. Langhoff's early mentor at Harvard University.

The first illustration of the new theory addressed the classical case of the potential energy surfaces of the tri-atomic hydrogen molecule, reporting for the first time the energies of the three constituent atoms and of the three bonds holding the atoms in place for the ground and a number electronically excited states, work appearing in a special AFRL Technical Report.

Dr. Jeffrey D. Mills, AFRL

Distributed Sensing Research Facility Now at AFRL-WPAFB

Dr. Jia Li,
NRC Associate,
AFRL WPAFB

Supported by NRC Research Associateship Program, Dr. Jia Li of Oakland University is working with Dr. Robert Ewing, NRC Adviser, to develop algorithms of radar imaging and RF tomography for a distributed sensing research facility recently built in Wright Patterson Air Force Base. It consists of 12 sensor nodes distributed on a ring of 200-meter diameter and is located in a near urban environment. This facility is developed to create complex EM environments for different testing purpose, and to facilitate experiments in RF tomography, radar imaging and distributed sensing.

As the facility is still under development, a simulation of the distributed sensing system has been performed in a chamber. The sensor nodes are distributed in a smaller ring within the chamber. Experiments with single and multiple stationary targets are performed. Wideband pulses are used to illuminate targets. RF tomography is then generated by using the echoes received at distributed sensors. Reconstructions based on matched filtering and inverse models are then compared. Targets can be clearly identified in the reconstructed tomography. Experiments of target tracking, holographic tomography, and compressive sensing are being planned and will be performed when the facility is fully functioning. It is expected that the outcome of these experiments will have applications not only in defense and homeland security but also in the automotive industry.

Dr. Robert Ewing, NRC Adviser,
AFRL WPAFB

Distributed Sensing Research Range (DiSeRR)

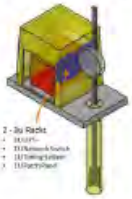
What Is It?

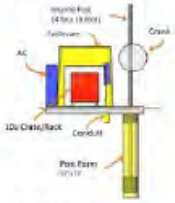
Located at the corner of Airway Road and Harshman Avenue, the Distributed Sensing Research Range (DiSeRR) allows AFRL S&Es to develop and explore advanced distributed sensing concepts in a realistic electromagnetic environment.

- 200m ring with twelve: 20m tower + concrete pad + one Tx/Rx node
  - Non-uniform tower distribution
  - Wideband directional + omnidirectional antenna per tower
  - Computer + 1 Tx channel + 2 Rx channels per Transmit/Receive node
- 12 strand fiber connection from each node to building 910

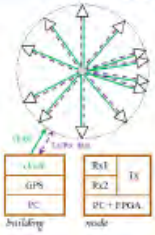
Each Pad

- 12 strand fiber optic cable to control building
- 50' Mast, 4' x 6' concrete pad
- AH-570 horn antenna + AH-545 biconical antenna
- One 20A, 120V power outlet
- 6U 19" fixed rack + 10U Pelican Case
- 10 MHz reference, 1 PPS & trigger from building
- Lockable ventilated equipment shelter with AC





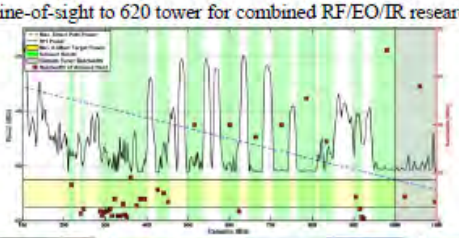
Node



- Arbitrary Waveforms
- Simultaneous Tx/Rx
- Distributed clock
- Distributed triggering
- Open modular design
  - Well defined interfaces
  - Open standards
  - COTS hardware

DiSeRR Environment

- Total of 554 MHz of usable bandwidth
  - 39 bands of varying widths from 210 – 1100 MHz
  - Bandwidths range from 1 – 71 MHz
- Noisy RF Environment + Clutter
  - Foliage, high-speed movers, and urban structures
- Line-of-sight to 620 tower for combined RF/EO/IR research



Site Capabilities

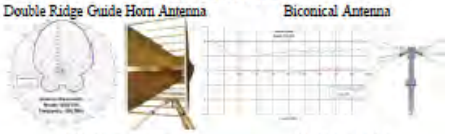
- Waveform design
- Tomography
- FOPEN/BPEN tests
- Multi-static ISAR
- Distributed sensing
- Collaborative UAV sensing
- Imaging
- Passive radar
- Cognitive radio testing
- Embedded communications
- Distributed/MIMO comms
- Compressive RF Sensing
- EA/EP/RF sensing interactions
- Drop-in customer hardware

Node Performance

- 1 Transmit + 2 Receive channels
- Frequency range: 200-1000MHz
- Channel bandwidth: 40MHz
- Tx DAC max sample rate: 800MS/s, 14 bit
- Rx ADC max sample rate: 250MS/s, 16 bit
- Noise Figure < 10 dB
- Largest RFI at -20dBm
- IP and spurs >70dB down
- Single sample SNR >40dB
- FPGA - Kintek 7/325 (28% used)
- 1 Terabyte solid state RAM per node

Antennae

Double Ridge Guide Horn Antenna — Biconical Antenna



170 MHz – 3 GHz — 30 MHz – 1 GHz

DISTRIBUTION STATEMENT A. Approved for Public Release – Distribution Unlimited (88ABW-2014-

2015 SCHEDULE

February Review

Dec 1, 2014	Online application open
Feb 1, 2015	Application deadline
February 15	Support documents deadline
March 17	Review notification date

August Review

June 1	Online application open
August 1	Application deadline
August 15	Support documents deadline
Sept 25	Review notification date

May Review

March 1	Online application open
May 1	Application deadline
May 15	Support documents deadline
June 26	Review notification date

November Review

Sept 1	Online application open
Nov 1	Application deadline
Nov 15	Support documents deadline
Jan 11, 2016	Review notification date

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NRL video:

https://www.youtube.com/watch?v=EK_YUhc_css

Robotics Secrets Revealed, Episode 3: The Furlough Gambit