2009 SURF Summer Seminars and Tours

May 26 First official work day and orientation for SURF Session I students

June 4 Kristen Markham, Esmaeel Paryavi, and Phil Sandborn
University of Maryland College Park Students

Engineers Without Borders – Building a Better World – One Community at a Time

Speakers were officers within the University of Maryland, College Park's Engineers Without Borders chapter. Speakers met with and answered questions from the NIST SURF fellows and NIST staff following the symposium.

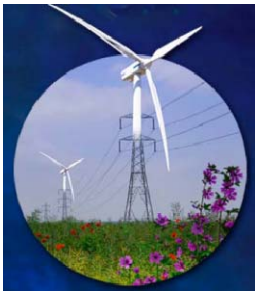
June 11 Bob Shull
NIST Materials Science and Engineering Laboratory, Metalurgy Division

Nanomagnetism – What is it? Why should we care?

As has been found for many other properties, the magnetic character of materials possessing some material dimension in the nanometer regime can be quite different from that commonly associated with convetional macro-scaled materials. New magnetic penomena, unusual property combinations, and both enhanced and diminished magnetic property values are just some of the changes observed. As a consequence, these materials are being investigated for their potential as the next generation soft ferromagnets in addition to their future as pioneered hard ferromagnets with vastly improved energy products. Why that is the case andwy you should care was presented. In addition, the unique domain kinetics, the "Giant Magnetoresistance (GMR)" effects, and the "Enhanced Magnetocaloric Effects" of this class of material were also described. These nanostructured materials were one of the reasons for the excitement surrounding the "Nanotechnology Revolution" that has presently captured the imagination of the world.

June 18 Dave Wollman
NIST Electronics and Electrical Engineering Laboratory, Quantum Electrical Metrology Division

What's So Smart about the Smart Grid?



By upgrading our existing electric power grid with two-way communications and advanced sensors, monitoring and control, the resulting Smart Grid will support increased use of renewable energy sources, allow more efficient and effective use of electricity, and reduce the potential for blackouts and power disturbances. In the Energy Independence and Security Act of 2007, NIST is charged with "primary responsibility to coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems...". This talk helped to explain what makes the Smart Grid unique, and why this topic is of great interest in the U.S. and around the world. NIST's Smart Grid efforts were presented within the context of numerous challenges, including significant national visibility, bringing together multiple stakeholders with varying goals and objectives, and developing a standards roadmap to organize and accelerate standards development in the private sector to support and enable new Smart Grid technologies.

June 25 Tom Juliano
Academic Programs Manager, American Society for Engineering Education

Creating a Competitive Application for the NSF Graduate Research Fellowship Program

Using the National Science Foundation Graduate Research Fellowship Program (NSF-GRFP) as the working example, this presentation introduced attendees to the program and ways they can be more competitive when applying.The strategy can be applied to other various award programs, graduate school applications, and employment positions.

The National Science Foundation Graduate Research Fellowship Program offers

up to 3 years of graduate school support worth over $120,000 to each awardee – this year 1,236 awards were offered. Benefits include a $30,000 stipend, a $10,500 annual cost of education allowance, a one time $1,000 international travel allowance, and access to TeraGrid supercomputing facilities. U.S. citizens, nationals, and permanent residents at or near the beginning of their graduate study seeking research-based Master's and/or PhD degrees in NSF-supported science (including

social science and psychology) and engineering disciplines are eligible to apply. The NSF welcomes applications from all qualified students and strongly encourages women in engineering and computer science, under-represented minorities, and persons with disabilities to apply for this fellowship. For more information, please visit www.nsfgrfp.org or www.nsf.gov/grfp.

July 2

Brian Paegel
Scripps Research Institute Florida

Oceans and Archipelagos: Landscapes for Extracellular Darwinian Evolution

Natural selection and the evolutionary adaptation of organisms to their environments are direct reflections of the Darwinian process of selection and imperfect reproduction at work on the molecular level. RNA and DNA, the informational molecules of modern biology, can be evolved directly using the tools of biochemistry to achieve selection, amplification, and mutation. These extracellular Darwinian systems enable systematic control over the entire evolutionary process, from population size, to selection pressure and mutagenesis. Over the past decades the molecular and physical sophistication of these experiments has blossomed. Reactions of simple replicating RNAs have expanded into muti-species experiments with RNAs competing to catalyze the key reaction of biological information transfer. And, the test tubes of conventional chemistry are yielding to computer controlled microchip reactors and microfluidic droplet generators that precisely create billions of microscopic islands, each populated with a single progenitor molecule. On the 200th anniversary of Charles Darwin's birth, we can now recreate in the laboratory the quintessential evolutionary experiment of the Galapagos finches entirely from molecules!*

* Beaks and feathers not included.

July 9

Bill Phillips, Nobel Laureate
NIST Physics Laboratory, Atomic Physics Division

Time, Einstein, and the Coldest Stuff in the Universe

At the beginning of the 20th century Einstein changed the way we think about nature. At the beginning of the 21st century Einstein's thinking is shaping one of the key scientific and technological wonders of contemporary life: atomic clocks, the best timekeepers ever made. Such super-accurate clocks are essential to industry, commerce, and science; they are the heart of

the Global Positioning System (GPS), which guides cars, airplanes, and hikers to their destinations. Today, atomic clocks are still being improved, using atoms cooled to incredibly low temperatures. Atomic gases reach temperatures less than a billionth of a degree above Absolute Zero, without freezing. Such atoms are at the heart of Primary Clocks accurate to better than a second in 80 million years as well as both using and testing some of Einstein's strangest predictions. This was a lively, multimedia presentation, including experimental demonstrations and down-to-earth explanations about some of today's most exciting science.

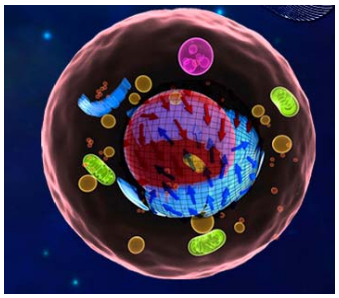
July 16

Rob Ivkov
School of Medicine, Johns Hopkins University

Cindi Dennis
NIST Materials Science and Engineering Laboratory, Metallurgy Division

Treating Cancer with Magnets: Fact or Fiction?

Magnetic nanoparticles are being developed for a wide range of biomedical applications. These range from diagnostic tests like DNA assays and clinical Magnetic Resonance Imaging (MRI) contrast agents to a variety of disease treatments through drug delivery and hyperthermia (artificial fever). MRI is a well-established technology with FDA approved commercial contrast agents to enhance the visibility of abnormal tissue. However, both drug delivery and hyperthermia are still in the early stages of development. Here we will focus on hyperthermia, as aspects of it also play a critical role in drug delivery applications.



Biologically, it is well-established that heat has a profound effect on cells and tissues. It has also been known, for about two thousand years, that heat can be an effective treatment for cancer. However, the question has long been how to deliver heat locally to cancer without overheating the normal tissue. This is where magnetic nanoparticles may provide an answer. Hyperthermia involves heating magnetic nanoparticles through exposure to an alternating magnetic field. This promises to be a successful method if there are enough particles in the tumor possessing a sufficiently high specific absorption rate (SAR) to deposit heat quickly while minimizing thermal damage to surrounding tissue.

However, there is a complex relationship between heat production, physiological methods for dispersing that heat, targeting of the nanoparticles, and RF radiation interactions with tissue, resulting in a not well understood system, either physically, chemically, and biologically. The various factors were discussed that play a role, both on the biology/physiology side as well as in the physics/chemistry. In addition, methods for characterization and quantification

both *in vivo* (in live animals) and *in vitro* (in glass dishes) of these parameters were described. Finally, to illustrate the interplay between physiology and physics, recent studies were discussed about new magnetic nanoparticles, including their effectiveness.

July 23 Antonio Possolo
NIST Information Technology Laboratory, Statistical Engineering Division

Statistics – A Contact Sport

The subject of "statistics" more often than not stirs memories of boring lectures, irrelevant textbooks, and impossible homework – just ask any student of nursing or anthropology (who, in most schools, must take at least one statistics course), about their encounters with statistics.

The funny thing about statistics is that it has made (and undergone) its most consequential advances in the hands of geneticists, chemists, geophysicists, and agronomists.

Then there is the probability part, which we all are familiar with because we know abut odds in gambling, and chances of rain. Statistics courses usually dedicate a good deal of attention to probability. But do we ever get to figure out what relation there may be between familiarity with games of chance and the evaluation of risks in real life (of an earthquake or a hurricane, or of an accident at a nuclear power plant)?

This talk told several statistical tales that attempted to suggest that there is a lot more to statistics than has met the eye of many the suffering nurse or pained anthropologist; that probability is the language of statistics; that statistics is the art of dealing with vagueness and with interpersonal differences in decision situations; and that statistics is best practiced, and then makes a difference, when it involves collaborations between professional statisticians and scientists (geneticists, chemists, geophysicists, agronomists, etc.), jointly to advance knowledge – that is, when it is "played" as a "contact sport."

August 4 Final presentations by SURF students moderated by invited guests.

August 4 Lunch: SURF Directors and special invited guests.

August 5 Final presentations by SURF students moderated by invited guests.

August 6 Final presentations by SURF students moderated by invited guests.

August 7 Last day for SURF students and farewell pizza party.