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# Quanta

A publication for the faculty, staff, students, alumni & friends of the Virginia Tech Physics Department

2009/2010 Volume 10, Issue 1

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## Message from the Chair:

For 2009, we have much good news to share. Physics faculty, staff, and students have won top university awards for their excellence and commitment to service, teaching, and outreach. With over 200 enrolled physics majors, our undergraduate program is vibrant and competitive with some of the strongest programs in the nation. Thanks to the generosity of our donors who established several new graduate scholarships, we have nearly doubled the size of our graduate program since 2004. Physics faculty are receiving prestigious grants and prizes and are working on some of the most important problems we are facing as a society, such as building a secure energy future.

In these days of tight budgets, the funds that we receive from the state of Virginia continue to dwindle. As a result, your support is becoming ever more critical as we strive towards greater excellence. On the back page, you find more information about how you can help.

Our latest news and updates are always posted at www.phys.vt.edu.

With best wishes for a wonderful holiday season and a Happy New Year,

**Beate Schmittmann**

## Students nab top honors from College of Science

The Department of Physics is proud to announce that two of its students received top honors from the College of Science this year.

**Kevin Finelli** of Yorktown, Virginia was named Outstanding Senior of 2009. Finelli, a recipient of the prestigious Barry M. Goldwater Scholarship in 2008, began graduate studies at Duke University this fall, where he will work toward a Ph.D. in experimental high energy physics.

**Michael Kavic** of Independence Township, Pennsylvania, was named COS Outstanding Doctoral Student of 2009. Under the guidance of Prof. Djordje Minic, he has conducted research into foundational issues of quantum gravity which include the nature of the vacuum energy and the big bang singularity. Mike has also contributed significantly in the area of astrophysics through his proposal to detect hidden dimensions through radio astronomy.

COLLEGE OF SCIENCE

Virginia Tech

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

# Energy Solutions for the Future

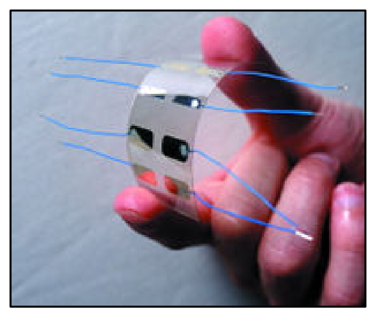
*By: B. Schmittmann, with contributions by R. Heflin, J. Heremans, V. Soghomonian, and R.B. Vogelaar*

According to estimates issued by the U.S. Department of Energy, the world currently uses roughly 13 TW of power, and this number may double by the year 2050 and triple by 2100. Yet, world oil production is expected to peak around 2030, and the production and release of $CO_2$ contribute to climate change. Energy generation, especially from clean and sustainable sources, and energy efficiency are critical issues of global importance. In collaboration with other scientists at Virginia Tech and elsewhere, faculty and students from the Virginia Tech Physics Department are working on solutions to these great challenges. Four of our projects are profiled below. They showcase the enormous range of scientific, technological, and commercial potential of our research efforts.

## Organic solar cells

In the search for alternative and sustainable energy sources, using solar energy more efficiently is an appealing approach. Current photovoltaic technology uses silicon as the primary material for solar energy conversion, with typical power conversion efficiency of ~12% and a cost that is currently 2-3 times more expensive than fossil fuels. Professor Randy Heflin's group, in collaboration with Virginia Tech chemists Profs. Dorn and Gibson, is developing innovative photovoltaic materials, based on organic polymers. If successful, a new generation of inexpensive, lightweight, flexible solar cells will be brought to market.

These plastic solar cells consist of blends of conducting polymers and fullerenes, such as the buckyball $C_{60}$. Light absorbed by the polymer excites an electron to a higher energy level. Without the fullerene, the electron would simply fall back into its ground state, and the energy would be emitted as fluorescent light. However, if there is a fullerene close by (within 10 nm of the excitation site), the electron will be transferred to the fullerene, creating an electron-hole pair which can then be separated further and converted into an electric current.



The principle sounds easy, but challenges remain. At the moment, the best present organic polymer-based cells convert about 5% of the incoming light into electric power, compared to 12% for commercial silicon cells. To achieve optimal conversion efficiency, the detailed structure of the polymer-fullerene composite must be controlled down to the nanoscale, and the energy levels of polymer and fullerene must be matched appropriately. Heflin and his collaborators are pursuing creative solutions to both challenges which will *double the efficiency* of their solar cells. Stay tuned!

## Energy storage in ultracapacitors

Generating energy is one challenge; storing it is another. Energy storage devices are everywhere – in our cell phones, iPods, laptops, and, of course, our cars. While batteries store energy chemically, ultracapacitors store it electrostatically: Just like the simple parallel-plate capacitor with a dielectric, they store energy by separating charges at the interface of an electrode and an electrolyte. Unlike batteries, they can be charged and discharged hundreds of thousands of time without degrading, and they can provide quick, powerful bursts of energy.

The performance of energy storage devices is determined by three measures: their power density, their energy density, and the time it takes to recharge them. For example, in hybrid or electric vehicles, both high power and energy densities are desirable: the former tells us how fast a car can accelerate while the latter translates into how far it can go on a single charge. And of course, you want to be able to run it for as long as possible! The figure below, a Ragone plot, compares the performance of various energy storing devices, in terms of power density, energy density and duration of time they can be used at full power.

*"Energy Solutions" continued on p.10*

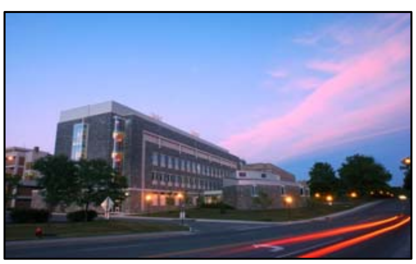
# New Faculty

**Vito Scarola** joined the Department of Physics in August 2009. He received his Ph.D. from Penn State for theoretical work on the fractional quantum Hall effect. His postdoctoral appointments included a position at the Condensed Matter Theory Center at the University of Maryland and a subsequent joint position between the University of California-Berkeley and ETH Zurich.

His research in theoretical quantum condensed matter uses numerical methods to study interesting quantum many-body phases of matter (e.g., quantum liquids and supersolids) found in a variety of different systems including nanostructures, quantum wells and cold atomic gases. He collaborates extensively with experimentalists and is always looking to work with people with a computer science background.

**Kenneth Wong** recently joined the department as a research assistant professor in the Northern Capital Region. He works with Dr. Seong Ki Mun in the area of biomedical physics. Dr. Wong received his Ph.D. from the University of California-Berkeley and the University of California-San Francisco. His research interests include: trauma medicine, particularly relating to spinal cord injury and ultrasound imaging,; imaging biomarkers as a long-term predictor of injury risk,; and neuroscience as applied to studies of human performance and cognitive bandwidth (people's ability to multi-task).

# Chem/Phys building renamed for T. Marshall Hahn, Jr.



In April 2009, the Chemistry/Physics building was renamed Hahn Hall–North Wing, in honor of T. Marshall Hahn, Jr. Hahn served as professor and head of the Department of Physics from 1954-1959, and in 1962, at the age of 35, became Virginia Tech's youngest president. Chemistry's Hahn Hall will now be called Hahn Hall–South Wing.

On October 16, 2009, a dedication ceremony sponsored by the College of Science and University Development was held in Hahn Hall-North Wing. Guest speakers included President Charles W. Steger, former university provost Dave Roselle, former Virginia Tech faculty member and Rhodes Scholar William Lewis, and former Norfolk Southern CEO David Goode.

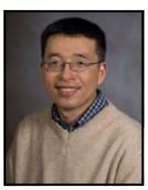
# In short...

**Prof. Randy Heflin** and a team of scientists from the Virginia-Maryland Regional College of Veterinary Medicine and the Carilion Clinic were awarded a seed grant from the Virginia Tech Carilion Research Institute to fund their project titled *Development of nanoscale optical fiber biosensor assays to detect and differentiate Staphylococcus aureus and Methicillin-Resistant S. aureus (MRSA)*. The Virginia Tech Carilion School of Medicine and the Virginia Tech Carilion Research Institute comprise a unique partnership to establish a new generation of health care professionals and leaders in their chosen fields. Originating from the Carilion Clinic, one of Virginia's largest health care providers, and Virginia Tech, the school and institute will occupy the nexus of modern results-driven medical training with applications-oriented research.

- **Prof. Giti Khodaparast** has received a five-year CAREER grant from the National Science Foundation (NSF) to support research and education to better understand quantum states and interactions in semiconductor materials. NSF's CAREER awards are highly competitive and given only to the most outstanding junior researchers. Other Virginia Tech Physics faculty who received CAREER awards in the past include Prof. Jean Heremans and Prof. Mark Pitt.

**Prof. John Simonetti** won the University Wine Award for Excellence in Teaching as well as a College of Science Certificate for Teaching Excellence. The Wine Award is Virginia Tech's top teaching award. We thank all the Physics Alumni who wrote enthusiastic letters on John's behalf. John and his achievements are profiled at http://www.vtnews.vt.edu/story.php?relyear=2009&itemno=272. In addition, Simonetti received a College of Science Award for Outreach Excellence, recognizing his passion for sharing science with the general public.

- **Prof. Michel Pleimling** co-organized an international seminar, on *Many-body systems far from equilibrium: Fluctuations, slow dynamics and long-range interactions*, in Dresden, Germany.



**Physics Instructor Dr. Roger Chang** won the 2009 College of Engineering Sporn Award for Excellence in Teaching and received the annual Students' Choice Award for Faculty Member of the Year. Roger teaches our introductory physics course, which is taken by all engineering majors. He is a passionate teacher and dedicated mentor who lives and breathes for his students.

- **Business Manager Lisa Stables** completed an Administrative Excellence Certificate in Human Resources Practices. Her newly gained knowledge will be put to good use in the department.

**Graduate Coordinator Chris Thomas** received the 2009 President's Award for Excellence, for outstanding service and dedication to Virginia Tech. Chris is one of only five staff members around the university who received this award for 2009. It is the most prestigious staff award at Virginia Tech.

- The **Kimballton Underground Research Facility** was recently featured in the *New River Valley Magazine*, as well as *The Roanoke Times*. Located in an active limestone mine 30 minutes from Blacksburg and directed by **Prof. Bruce Vogelaar**, the facility houses four experiments from six different universities and laboratories at a depth of 1700 feet, with three additional experiments to move there shortly.

- **Prof. Nahum Arav's** infectious enthusiasm for astronomy teaching and research was profiled by *The Roanoke Times* on January, 20, 2009.

- A paper by graduate student **Michael Kavic**, **Profs. Djordje Minic** and **Chia Tze**, and Dr. Vishnu Jejjala receives honorable mention in the 2009 Gravity Research Foundation Essay Competition.

**Prof. Royce Zia** was named the winner of a Humboldt Research Prize, awarded by Germany's Alexander-von-Humboldt Foundation. This is his second award, following an earlier one in 2001. The prize is designed to attract internationally leading scientists to work with their colleagues in Germany. Royce plans to spend three months at the University of Duisburg-Essen in the spring of 2010.

# Professors organize condensed matter summer school

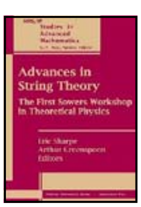
*by Michel Pleimling*

The *2009 Boulder School for Condensed Matter and Materials Physics - Nonequilibrium Statistical Mechanics: Fundamental Problems and Applications* took place in Boulder, CO, July 6 - July 24, 2009.

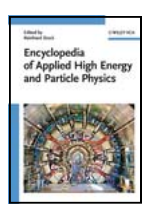
Organized by Virginia Tech physics professors **Michel Pleimling**, **Beate Schmittmann**, and **Uwe C. Täuber**, with Prof. Chiang-Hwa Kiang (Rice University), the school was devoted to the behavior of nonequilibrium systems and processes. Funded by the National Science Foundation, the Boulder School series is among the most prestigious in condensed matter physics. Each year, a different team of scientific organizers is asked to invite lecturers, arrange the program, and select the 65 participants, mostly graduate students and postdoctoral researchers. The goals of the 2009 school were twofold: First, to provide a pedagogical introduction and overview of the fundamentals and recent progress in nonequilibrium statistical physics for young researchers working in both theory and experiment, and second, to point out opportunities for fruitful future developments.

The participants of the 2009 school came from institutes in the U.S., Germany, Great Britain, Hong Kong, India, Ireland, Israel, The Netherlands, Switzerland, and Uruguay. The lectures were given by sixteen world-leading experts in nonequilibrium physics and included presentations by Virginia Tech physics professors Michel Pleimling (on aging phenomena in magnetic systems) and **Royce Zia** (on driven diffusive systems). In addition, Prof. Zia gave a well attended public lecture on "What is Physics? - A Personal Perspective." Virginia Tech graduate students **Nasrin Afzal**, **George Daquila**, **Sven Dorosz**, and **Alireza Karimi**, postdoctoral associate **Thierry Platini**, and alumnae **Jiajia Dong** (Hamline University) and **Leah Shaw** (College of William and Mary) also took part in this summer school.

# Books by Faculty




*Advances in String Theory: The First Sowers Workshop in Theoretical Physics*
Edited by: **Eric Sharpe**




*Encyclopedia of Applied High Energy and Particle Physics*
Contribution by: **Tatsu Takeuchi** (Chapter 2)

# *In Their Own Words:* Lt. Josh Hattery, USN (Class of 2004)

It was the summer before senior year. The Junior Wall was behind us, but for many the pain was not yet over. With the GRE on the horizon preparations could not begin soon enough. For me, however, senioritis set in a little early. It was then that I made a decision that would shape the next five, ten, perhaps twenty years of my life.

As my friends huddled with their study guides, relentlessly practicing for the exams in the fall, I had already decided that graduate school could wait for now. After four years of rigorous academics in both physics and math I was ready to do something different and exciting. Six months went by and I still hadn't figured out what. As winter break approached a friend of mine suggested I go with him to meet the local Navy recruiter. He had already been accepted into the Navy's nuclear officer program, which didn't appeal to me, but the gruff old Master Chief had many other options. One in particular had been a dream of mine since I was a small boy: flying jets.

**An EA-6B Prowler from VAQ-139 cruises the skies near Hawaii during the Western Pacific 2008 deployment.**

Fast-forward nearly six years. My quest for something different and exciting has certainly yielded results. In the past 15 months I've been to nine countries around the world during two combat deployments. I've watched the sunrise over the Himalayas. I saw the peak of the Perseid meteor shower through night vision goggles (NVGs) at 26,000 feet. Through those same goggles I saw the incredible power of an early morning thunderstorm over the mountains of Pakistan. Surrounded by all of this natural wonder and majesty, I needed only to shift my gaze downward to wrench my mind out of its starry dream and back to the stark reality in which we live. Below us the ground forces convoy was a tiny chain of faint headlights making their way home after completing their mission. In an instant one of the military vehicles turned into a bright green bloom through the NVGs. "Explosion, 10 o' clock, in the convoy," I said over the inter-cockpit communications system. The convoy had hit an improvised explosive device (IED).

I am assigned to a carrier based squadron aboard USS RONALD REAGAN (CVN 76). My unit is Electronic Attack Squadron ONE THREE NINE (VAQ-139). We fly the EA-6B Prowler, and we're currently steaming home after our second combat deployment in support of Operation ENDURING FREEDOM in less than two years. Due to classification issues I can only sum up our work in Afghanistan as "supporting the troops on the ground," but I can talk about how having a degree in physics has helped me along the way.

As the most fundamental of technical degrees, physics provides the foundation of knowledge that gives one an innate understanding into both natural and man-made systems. During flight school I benefited in courses such as aerodynamics and aircraft propulsion system, which were exceedingly more difficult for the political science majors in the program. In the electronic warfare community our methods and effects are largely intangible. We don't drop kinetic ordnance that can be observed hitting a target. Having in-depth knowledge of the basic principles behind what we do, and being able to explain them to others, helps lend credence to our methods that are otherwise unobservable. It also provides a unique and more detailed perspective on tactics and techniques, whereas others with non-technical backgrounds may only glean a cursory understanding.

**USS RONALD REAGAN (CVN 76) at sunset during aircraft recovery operations.**

In a broader scope, four years of intense physics coursework provides unparalleled training in logical problem solving that simply cannot be attained anywhere else. It teaches us methods to break seemingly insurmountable problems into smaller, more manageable pieces. It teaches us that although a problem looks impossible, a little bit of time and mental acumen can go a long way. These talents are applicable in all areas of life, regardless of the profession one might choose. It is for these very reasons that physics majors are marketable to a plethora of different industries.

Personally, I could not have chosen a better major. Physics not only helps quench the thirst for knowledge that many of us have, but it also provides a lifetime supply of useful skills. For those of you who are physics alumni, I hope you will agree. If you are a physics student when you read this, your future may not have you solving Laplacians, Hamiltonians, or grand canonical partition functions, but rest assured that what you learn today in physics will echo throughout your lifetime.

## What's your story?

Gotten married? Added a new member to the family? Landed your dream job? If so, we'd love to share your good news in future issues. Visit *www.phys.vt.edu* for contact information, or use the form below. Mail your completed form to: **Department of Physics at Virginia Tech, 123 Robeson Hall, Blacksburg, VA 24061**.

NAME: ______________________________________________

CLASS: ________________

E-MAIL ADDRESS OR PHONE NUMBER: ______________________________

YOUR GOOD NEWS:

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# Justin Bangerter (class of '09) wins first Bowden Essay Prize

**Dr. Bowden with Bangerter**

**The Department of Physics** expresses its sincere thanks to **Dr. Robert Bowden**, Emeritus Professor in Residence, and his family, for establishing the Robert Lee Bowden, Jr. Essay Prize. Bob Bowden retired in 1996 after 33 years on the physics faculty but remains active and engaged in the life of the department.

In today's world, writing and communication skills for science students are becoming ever more critical. Almost all career paths require effective communication with colleagues from many different backgrounds and the general public. The Bowden Prize has been established in order to encourage and reward excellent science writing. In 2009, its inaugural year, the prize was awarded to graduating senior **Justin Bangerter** of Forest, Va. Below is an excerpt from Justin's winning essay.

***Deus Ex Calculus: The Principle of Least Action***

Light from the morning sun greets your cheeks warmly. Good morning. It is 7:25am, and you have the day off. Something is different about the air today; breathing deeply, the crisp awakens your lungs. It is the perfect day for a hike. You quickly make a few snacks and fill your water jug, throwing them into your backpack. The extra weight will be worth it.

You toss your supplies into the car as you make up your mind about where to go. It is a beautiful morning, for sure, but you've been missing out on a lot of hiking, lately. You don't know how you'll feel after a few hours of walking, so you decide to hike the Old Oak Way. Three miles into it are the Sandy Springs: a nice view next to a small stream: a great spot for picnicking. If you're still ready for more adventure by then, you can hike another three miles to Charlie's Peak, an excellent lookout at the top of the ridge. Traveling twice the distance means using about twice the effort, but the spectacular view is tempting, especially now in the spring.

You finally reach Old Oak Way and park on the side of the road (it was a 40 minute drive). You grab your backpack and make your way to the path. You know it takes you 6 hours to reach the peak and get back to your car (at a leisurely pace), but you're feeling adventurous today. You decide to make up for those lost trips and hike the trail in 4 hours. You'll have to use some extra effort to pick up the pace, you've been meaning to get the exercise.

Of course, it's common sense that it would take more effort to carry more weight, walk further, or walk faster. Why did I even bother to mention it? The point is that this effort represents an important idea that has been used in physics for about 300 years. Scientifically, it is referred to as the "action." The action involved with an object's motion is directly proportional to that object's mass, the distance it travels, and the speed with which it travels. Said again, mathematically:

*Action = Distance * Mass * Speed*

**Work and Energy**

You may know from physics that energy is a measure of the ability to do work. Work is the conversion of one form of energy into another, but it is more simply defined as the application of a force through a distance. For example, we say that work is done as you fight friction to pull a sled through the snow. To keep the sled moving at a constant speed, you must pull with just enough force to counteract the frictional drag. The amount of work you do depends on how far you pull the sled and how hard you pull it. The chemical energy in your muscles is converted into motional energy in the sled (doing work). This motional (based on motion) or "kinetic" energy is converted to heat (thermal energy) by friction (doing work against you).

Kinetic energy is represented mathematically by $T=\frac{1}{2}mv^2$, where T is the kinetic energy, v is the velocity, and m is the mass of an object. Objects can have a positional (based on position) or "potential" energy. For example, a marble that is about to drop off of a skyscraper has more gravitational potential energy than one on the ground because of its *potential* to build a high kinetic energy. The work that changes this potential energy into kinetic energy is done by gravity (in this example). If we are only considering objects near the earth's surface, we can pretend that gravity is uniform... that is to say... it is the same everywhere. The potential energy may then be written as $U = mgh$, where U is the potential energy, m is the mass of the object, g is the acceleration of free-falling objects in gravity, and h represents the object's height from the ground. This expression implies that there is no potential energy at h = 0. Actually, it doesn't matter *where* we say that there is no potential energy, because an object's total energy can never be completely defined. *Changes* in energy are the real business. The potential energy is just called zero wherever will make the problem easier. Here, we'll say it is zero at the ground. The change in energy from one point to another won't be affected.

**The Relationship between Energy and Action**

Anyway, you are probably wondering what the big deal is, but bear with me a minute, for there is still more that I must show you. You see, the action I mentioned before has a funny relationship with work and energy. Remember that the units of action go something like "mass * speed * distance?" What if I divide that *distance* by time? Well, we would end up with mass * speed * speed. "By Jove!" you might say... ok, maybe you're not *that* big of an egghead, but you might get excited. After all, these are the same units as kinetic energy! What if, instead of the distance, we divide the *speed* by time? We would end up with mass * acceleration * distance. These are the same units found in gravitational potential energy! We've stumbled upon something great here.

*Action / Time = Energy (by units alone, mind you)*
*Action = Energy * Time (if you prefer)*

I might tell you something like, "the action is actually work done through a period of time." Nobody really believes that. If I told you that, some angry physicist would try to shoot me, probably with a high energy beam of protons. It's funny, though: these are, in fact, the units of Planck's constant (Joules * seconds to be specific). This makes me want to tell you that this important constant represents the quantization (partition) of action, but the physics gods would probably rain down on me with a mighty wind of ionizing radiation or something...

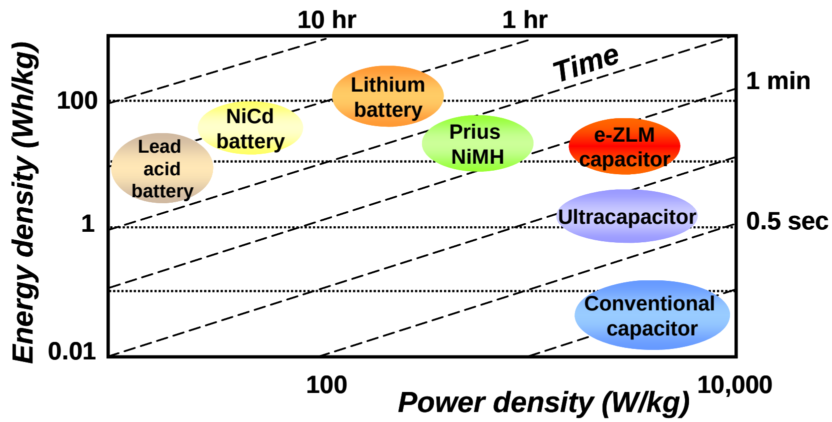
*If you want to find out how Justin relates the concept of physical action to Dido, the wise queen of Carthage and her land grab in Africa, and to German philosopher and mathematician Leibniz and his notion that our world is perfect, go to http://www.phys.vt.edu/awards/essays/bowden2009.pdf where you can read "Deus ex Calculus" in its entirety.*

# Awards Day 2009

On Friday, April 10, 2009, the department held its annual awards day assembly. The luncheon, awards ceremony, and keynote address were held at the Graduate Life Center. **Justin Krometis**, recipient of the 2004 H.Y. Loh Award, gave a talk titled *How My VT Physics Degree Keeps Me One Step Ahead of Disaster*.

Awards were given to nine graduate students and twenty-eight undergraduate students. The department awarded two new awards this year: the Clayton D. Williams Graduate Fellowship in Theoretical Physics and the Robert Lee Bowden, Jr. Essay Prize (see pg. 8 for winning essay). Additionally, thanks to the generosity of Mr. Armand Mancini, the department awarded the Award for Excellence in Academics and Research in Astrophysics.

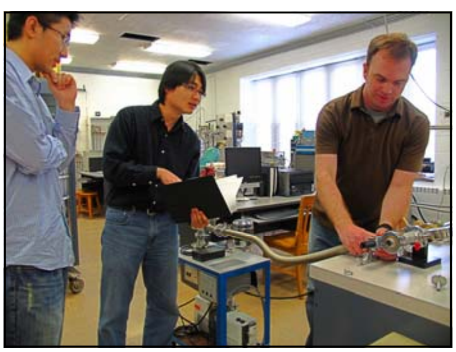
*"Energy Solutions" continued from p. 2*




Good ultracapacitor electrode material should be highly porous for high internal surface area and should be electrically conducting. Zeolites seem perfect candidates: they are microporous aluminosilicate materials, also known as "molecular sieves", due to their ability to selectively sort molecules based on size. However, existing zeolite materials are all electrical insulators, and so they fall short of the second property. Here is where Prof. Victoria Soghomonian's expertise at the interface of physics and chemistry comes into play: Her group has synthesized and characterized *electrically conducting zeolite-like materials*, e-ZLMs, which offer new avenues in energy storage and conversion. Preliminary studies for an ultracapacitor based on this new material are very encouraging: They show roughly the same energy density as the current state-of-the art Ni-hydride batteries, but greater power density than the best ultracapacitors available today!

## Energy harvesting

Low-level but steady sources of energy are everywhere, in the form of vibrations, thermal gradients, and stray electric or magnetic fields arising from vibrating structures, power stations, and radio or television towers. If these forms of energy can be "harvested" and converted into electrical energy, new power sources can be created to replace batteries, plug-in converters, or wiring. Such energy harvesting would reduce or eliminate the need to replace batteries in implanted medical devices, and allow autonomous robotic systems and sensor networks to function far more independently. Physics Professor Jean Heremans is working on developing innovative materials and devices for energy harvesting applications, in collaboration with Virginia Tech engineers.



**Graduate students Yao Zhang, Yong-Jae Kim, and postdoctoral associate Dr. Ray Kallaher, from the Heremans group.**

To extract energy from, e.g., stray magnetic fields, and convert it into electric power, materials or devices are needed which couple magnetic and electric degrees of freedom. Multiferroic materials are the candidates of choice since they combine several so-called ferroic orders. For example, they show ferromagnetic (or antiferromagnetic) and ferroelectric (or antiferroelectric) behavior in a single material. Moreover, their electrical properties can be magnetically controlled, and their magnetic properties electrically controlled. Chemically, many multiferroics are complex oxides, such as $BiMnO_3$ and $BiFeO_3$. Yet, the physics of these materials still poses many puzzles. We do not know, for instance, how to predict the magnitude of the coupling between magnetic and ferroelectric properties. Even more fundamentally, we do not know whether, based on general quantum mechanical principles, such a coupling should be expected quite generally, or whether it can only be realized in exceptional cases. Clearly, these are critical questions if we want to optimize the energy harvesting potential of these materials. Very soon, Jean Heremans and his collaborators will know the answers.

**GEM*STAR: A new nuclear reactor technology**

According to federal renewable energy standards, 10% of US electricity should be generated from renewable sources by 2012 and 25% by 2025. To keep carbon emissions limited, much of the difference will have to come from nuclear energy – provided we can address the problems posed by nuclear proliferation and nuclear waste. Physics Professor Bruce Vogelaar and Virginia Tech Physics Alumnus Charles Bowman are proposing a solution to both issues. Bowman is the president and founder of ADNA, a nuclear engineering start-up company based in Los Alamos and Roanoke. Together with Vogelaar and Virginia Tech nuclear engineer Mark Pierson, the trio is spear-heading a university-wide effort to develop a new reactor technology, based on a *subcritical* molten-salt reactor. To achieve criticality, an external accelerator provides the missing neutrons, making the system inherently very safe. Preliminary studies show that this reactor will be able to burn natural, unenriched uranium which would eliminate the need for uranium enrichment and thus address proliferation concerns. The system would also be able to operate on spent fuel from today's light water reactors, greatly increasing the amount of energy which can be extracted and reducing the amount of remnant waste. As an additional advantage, the reactor operates at high temperatures and low pressures, providing higher thermal to electric conversion efficiency and eliminating the need for a high-pressure containment vessel.

The team is working on sophisticated simulations of the reactor design and pushing towards constructing a pilot plant at a suitable location. With the strong support of the Dean of the College of Science, Lay Nam Chang, and other university administrators, connections with Oak Ridge National Laboratory, the Department of Energy, and the Nuclear Regulatory Commission are being established, to support the project in the scientific as well as the regulatory and political arena. GEM*STAR stands for *Green Energy-Multiplier Subcritical Technology for Alternative Reactors*.

## Applause, Applause!

- Ph.D. student **Zachary Lewis** won the Commendation Award in the 2009 Graduate Teaching Assistant Excellence Award competition.
- **Eric Christensen**, B.S. '09 and current graduate student, co-authored an article published in *Journal of Physics.*
- Congratulations to our Society of Physics Students chapter and advisor Vicki Soghomonian for being named Outstanding SPS Chapter for 2007-08!

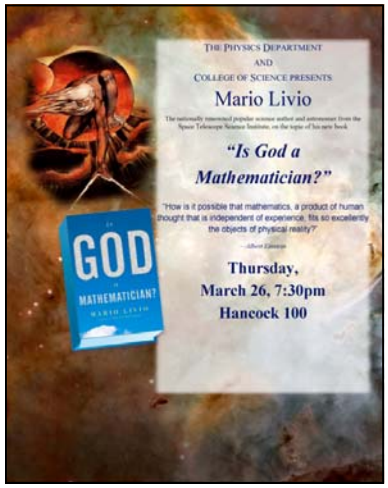
*Quanta 2009*

**Editor**: Betty J. Wilkins

**Additional editing, content, and design**: Beate Schmittmann

**Contributors**: Josh Hattery, Randy Heflin, Jean Heremans, Michel Pleimling, Victoria Soghomonian, Vito Scarola, Bruce Vogelaar, Kenneth Wong

# The Physics Department Annual Fund


The Department of Physics impacts the state and the nation in many ways: We offer strong educational programs in a supportive environment, perform research at the very frontier of fundamental knowledge and emerging technologies, and share our excitement for physics and science with the broader community, through our K-12 outreach, public lectures, and media appearances.

For the coming years, the department has identified three key priorities: Support for our students, support for our faculty, and support for our outreach efforts. You can support our students, in these days of tuition increases, by establishing a scholarship or prize or by contributing to existing ones. You can support our faculty by establishing endowed chairs or fellowships or by contributing to our research fund. And you can raise the profile of our outreach efforts by supporting our goal to establish a **Distinguished Lecture Series**.

These lectures will introduce the Virginia Tech campus and the Blacksburg regional community to some of the most distinguished physicists of our time. The photos above show our most recent guests (from left to right): MacArthur genius grant winner Prof. Eva Silverstein from Stanford University; the announcement of a lecture by astrophysicist and science writer Dr. Mario Livio from the Space Telescope Science Institute; and world-renowned string theorist Prof. Joe Polchinski from the Kavli Institute for Theoretical Physics and the University of California at Santa Barbara. Students and faculty alike are inspired by meeting these top scientists. With your support, such lectures will become regular events in the life of the department.

**Please help us advance towards these goals!** When you receive your College of Science Annual Fund letter or phone call, please earmark your support for the Physics Department. Simply make a donation on the gift card or let the caller know that you want to direct your donation to the Department of Physics. You can also visit our Website, www.phys.vt.edu, or give us a call at (540) 231-7472. You are welcome to direct your support to a specific student scholarship, to our lecture series, or to the department general fund. Thank you!

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## *Physics in Your Neighborhood!*

- **Alumni Reunion** – March 16, 2010 – Portland, Oregon. (restaurant TBD)
- **Fun with Physics** – March 21, 2010 – Northern Virginia Center

For more information, go to http://www.phys.vt.edu/events.html