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Department of Physics & Astronomy
COLLEGE OF ARTS & SCIENCES

# CrossSections

*The Newsletter for UT Physics Alumni & Friends*

# Leadership Transition

## A last letter as department head from Professor Soren Sorensen

On August 1, 2012, Professor Hanno Weitering will officially assume the position as Head of the Department of Physics and Astronomy. This transition of power has not happened very often in physics. Since 1908 we have only had 6 department heads: James Porter (1908-31), Kenneth Hertel (1935-56), Alvin Nielsen (1956-69), Bill Bugg (1969-1995), Lee Riedinger (1996-2000), and Soren Sorensen (2000-2012). So this is only the 6th leadership change in more than a century.

The selection by the new dean, Theresa Lee, of Hanno as our new head followed a very encouraging search. Five of our professors had thrown their hat in the ring and the selection committee, headed very effectively by Professor Larry McKay from the Department of Earth and Planetary Sciences, decided to select three of them for the final grueling interview process: Geoff Greene, Mike Guidry, and Hanno Weitering. All three candidates did an outstanding job and at the final faculty meeting it was unanimously decided that all three of them were highly qualified to be head. Many other departments are having problems finding willing candidates within their own ranks, so we were very fortunate to have such a strong set of volunteers.

Hanno is coming into the headship with impeccable credentials. He is one of our leading researchers focusing on experimental condensed matter physics, and he has already shown considerable administrative skills in his work as co-Director for the Joint Institute for Advanced Materials (JIAM). In addition, he is an experienced teacher, both in the classroom and as a mentor for graduate students and postdocs. Through his two decades in our department he has become familiar with all the many aspects of life in a large and complicated academic department like physics. And last, but not least, Hanno is a really nice guy, who has the personality needed to interact with all the many constituents of our department.

Personally I am facing this transition with mixed emotions. On the positive side I am really looking forward to dedicating much more time to my research on the properties of hot and dense nuclear matter. The last decade has been extremely exciting within this field of nuclear physics with the discovery of the Quark-Gluon Plasma, which has turned out to have properties very different from what was originally expected. We have now realized that it is a superfluid gluon liquid with a few quarks floating around. So over the next decade I hope to again be part of this fascinating research at Brookhaven National Laboratory and at CERN in Geneva, Switzerland. It is also going to be invigorating to work more closely with our graduate students and postdocs. I think I can still teach them a few tricks, but I also know that they will have to be the ones to teach me many of the important details on how the detectors and the software work. But after all, this learning and research process was the reason I always wanted to be a physicist.

But ... I will also miss the job as head. In particular, I will miss the regular interactions with all the wonderful people in the department and the university. Before I became head

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I only knew a few of them, but now I have been so fortunate to have developed close and interesting relationship with so many people, and have had opportunities to interact with even more. I have met with countless prospective undergraduate students and their parents and tried to convince them that UT Physics was the right place for them, counseled numerous undergraduate students on physics problems and graduate school choices, and interacted with many, many graduate students about all professional aspects of their life ranging from sharing their happiness after passing the qualifying exam to helping female students combine graduate studies with motherhood. I have enjoyed so much working with both the current and all the previous members of our incredible staff in order to "get the wheel to turn" in our department, and have learned so much from all the varied interactions I have had with our teachers and faculty members, who are every day doing an outstanding job in the classroom and in their research. It has been an eye-opener to meet all the wonderful people from all walks-of-life at UT outside of the department of physics and through them come to appreciate all the great things that are happening here. In particular, I will miss my "support group," consisting of all the other science heads, who have met for lunch every three weeks for many years. And last, but not least, I have gotten to know many of our alumni, who have visited campus or have e-mailed us with news about their lives. Never had I thought that being a head would involve so many encounters with such fascinating and interesting people.

**"It has been 12 wonderful years for me as head. I have enjoyed every moment of it and will always treasure the many memories of the people, the successes, and even the setbacks."**

A headship transition is also a good reason for looking back to the last transition of leadership to identify the changes that have occurred in the department over the last 12 years. In a nutshell: *we are doing more with less.*

Let's first look at the "more" part. Around the year 2000 we would graduate 4-6 undergraduates and 10-14 graduate students annually. Now we are typically graduating twice as many, if not more. This is an extremely encouraging development, since educating young people is after all one of the most important tasks of any academic department. We also have many more students in our general education and service courses. A quick look at the enrolment numbers shows that we might be having more than 50% more students in these classes today. Our classrooms are also much better after we got them renovated, so they now contain all the latest technological equipment, which is being used very effectively by so many of our teachers. In short, we are delivering a much better teaching product to many more students.

Our research productivity has also increased. Twelve years ago we published between 150-200 refereed papers annually, and now the number is 250-300. This increase is both due to an increase in publication productivity of each of our regular professors and to the increase in the number of adjunct faculty, who have enabled our doctoral students to produce more scientific papers. Our external funding has also increased from around $5M to $10M annually in research expenditures. Even if we correct for inflation, this corresponds to at least a 50% increase. I could go on quoting research and visibility measures like citation indices, invited talks, AAAS memberships, etc., etc. They have all increased, showing that our faculty and students have been able to substantially increase their research productivity.

So what about the "less" part? There are simply fewer people employed in the department now than twelve years ago. In AY2000 we had 40 professors and lecturers while in AY2012 we had only 32. Since some of our faculty are only part-time at UT we can also look at the number of FTEs (Full Time Equivalents). In 2000 we had 32.3 FTEs and in AY2012 this number had decreased to 25.6 FTEs, corresponding to a reduction of over 20%. So we have unfortunately lost a lot of positions primarily to retirements, that, due to the tight financial situation, have not been replaced. This same pattern can also be seen with our professional staff. We have fewer people in our electronics and machine shops and in the front office, who have all been able to increase their productivity due to extensive training and the introduction of new equipment and software. I am extremely proud of our faculty and staff, who have been able to respond so effectively and professionally to the challenges over the last decade.

It has been 12 wonderful years for me as head. I have enjoyed every moment of it and will always treasure the many memories of the people, the successes, and even the setbacks. But now it is time for somebody else to "step up to the plate" with a fresh perspective and new approaches to the many challenges facing the department. I know Hanno is up to the task and he will be able to provide inspiring leadership for years to come. Good luck Hanno!

# All Together Now

## Norman Mannella's NSF CAREER Research Imposes Coherence on Complex Systems

Watch a herd of horses galloping at full speed and try to calculate when each individual hoof hits the ground. That's the kind of challenge Assistant Professor Norman Mannella is up against, in a scientific sense, when he studies complex electron systems. With a $600,000 Faculty Early Career Development (CAREER) grant from the National Science Foundation, he has additional support to meet that challenge for the next five years.

The CAREER program sponsors the foundation's most prestigious awards for junior faculty who exemplify outstanding research and teaching and work to integrate the two within their respective institutions. When Mannella joined the physics faculty in August 2007, he began building a research program dedicated to studying novel materials—new and improved materials that can be altered by design to meet needs in medicine, industry, etc. A key to developing such technologies lies in understanding the fundamental properties of complex electron systems, which are at the heart of this research.

### The Chicken and the Egg

On its own, an electron is a fairly straightforward elementary particle, whizzing around the nucleus of an atom in its assigned orbit. But when electrons abandon their solitude and interact with each other to form complex systems, some interesting and unconventional phenomena can result. One example is superconductivity, where electrons—which by nature repel one another—group themselves in pairs, allowing current to flow without resistance. Electrons interact by means of their charge, spin (a mechanical property at the heart of magnetism), or lattice (the atomic arrangement, or "cage," of the material in which they're located. Electrons moving through the lattice can cause this cage to deform.)

Mannella wants to unravel these interactions to illuminate the fundamental physical principles behind them. Yet a major hurdle in this type of research has been establishing a cause-effect pattern among the interactions. Does magnetism, for example, render a material metallic, or does a metallic material induce magnetism? This is what Mannella calls a classic "chicken-and-egg" problem, but one he has a plan to help solve using sophisticated experimental tools, including Angle-Resolved Photoemission Spectroscopy (ARPES)—a technique that observes the distribution of electrons. By taking advantage of ultraviolet laser pulses that last less than a thousand of a billionth of a second, he can excite electrons so rapidly that the interactions between them are destroyed instantaneously. He then monitors the electrons as their interactions begin to re-form, taking note of the timeframe and looking for their respective signatures. The key idea is that, since every interaction has its own characteristic time, one can separate several interactions based on observing how the system goes back to equilibrium after an impulsive excitation.

Dr. Norman Mannella

"Different phenomena have different recovery times," he said. "So if I establish a hierarchy in time of what's going on, I can disentangle the response of the different phenomena."

Mannella explained that his experimental setup uses two laser beams in succession: beam one hits the sample material, followed by a time-delayed beam two—a pump and probe approach. By delaying the second beam, he said, it's as if you're taking a rapid series of photographs, with each photo corresponding to electronic spectra, or distribution; thus disentangling the electronic interactions.

"So every picture will contain a particular signature which suggests one behavior with respect to another," he said.

He explained that what happens as a function of time delay is very important.

"Suppose that the electrons have a complicated behavior because there are interactions both among the electrons and the electrons interact with the lattice," he said. "Sometimes it is really difficult to disentangle the contributions of the two."

Take, for example, the typical case of vanadium dioxide, a well-known material used in applications such as infrared sensors.

"The experiment would be that one unbinds the electrons from this interaction by basically giving them a 'kick,' and then takes a look at the response of the system," Mannella said.

"With optical pump-probe measurements it was observed that (the) signature appeared only after a certain time lag," he explained. "It was an indication that those interactions have to do with the lattice because the lattice is massive and slow to move . . . so you had those signatures but you had to wait a certain time before seeing them, and that was the proof that the lattice is involved."

The new twist on these experiments pursued by Mannella's group will be to probe the response of the system following an impulsive excitation by monitoring electrons

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with Angle Resolved Photoemission, a technique known for its power to observe directly how electrons move in a solid.

## Orchestrating Wild Horses

These time-resolved experiments have another key advantage in that they impose coherence on the system. To explain, Mannella pulled up a stop-motion image on his computer showing a bullet flying through four brightly-colored crayons lined up in a row.

"Imagine that these are pictures taken instantaneously of a bullet coming out of a rifle," he said. "You can ask, 'Why can't you take these fast pictures (in an experiment)? And the answer is that there is no available means to do it because even if you buy the best oscilloscope on the market, a quick estimate tells you that you cannot measure anything that is faster 50 picoseconds, and we are a thousand times faster than that."

This, he explained, is why he uses a pump and probe experimental setup.

"This is a scheme that is used anytime your detector is not fast enough," he said. "Imagine that you have a horse that is running as fast as an electron: you cannot see it. There is no instrument able to see it. So you keep your detector open and imagine that you measure the dark, because this horse is so fast that it's like you see nothing, and then all of a sudden" . . . whoosh—the horse appears. "So you illuminate your field of view with a flash so you can basically retrieve the motion of the horse as a sequence of pictures that capture its movement, because you can make the flash as fast as you want.

"Now, here's the complication," he continued. "You do not have one horse; you have $10^{23}$. If I had only one horse I can use this scheme and determine when the first gallops on the four legs are elevated from the ground. But imagine you have a herd of horses. Your horses are incoherent: what one horse does has no correlation whatsoever with what another one does. So in your picture you see four times $10^{23}$ because there are four legs. You have to ask, 'What do I want to do to these horses in order to understand something about them?' That's the idea of the pump that imposes the coherence."

The pump, he said, can be thought of as an explosion that startles the horses, causing them to rear; the probe then takes a rapid succession of photographs to see, collectively, when their hooves return to the ground.

Using this kind of research to teach physical principles is a critical aspect of the CAREER grant, and Mannella has worked closely with Physics Professor Marianne Breinig to develop a concrete plan to do just that.

## Bridging Gaps & Tweaking Knobs

An expectation of this NSF program is that the scientists involved will become lifetime leaders in integrating research and education. Mannella's proposal incorporates three defined elements to bridge the gap between the lab and classroom: integrating his research into Breinig's sophomore-level Modern Physics course; creating research opportunities for undergraduate students through the department's Summer Fellowship Program; and working with the teaching staff and students of Hardin Valley Academy, a local high school, to develop confidence and competencies in advanced physics principles.

"This is not just about science," Mannella said, adding that outreach and educational components help define an individual as a professor. He and Breinig defined a strategy to overcome a significant hurdle in physics education: helping students make sense of concepts when they have no everyday experience to which they can make comparisons.

He explained that in mechanics, for example, there are a number of examples a professor can use, but with quantum mechanics, "it's difficult for a novice student to refer back to his experience because he doesn't have any. I can refer back to my experience in the lab, but the student cannot."

His laboratory, however, can help bridge that gap.

"This is feasible because the kind of lab that we have hosts state-of-the-art instrumentation," Mannella explained. "We have many of the elements that are at the technological front," including powerful lasers and vacuum systems. His research techniques, such as ARPES and low-energy electron diffraction, also blend nicely into the undergraduate physics curriculum.

"These are based on experiments like the photoelectric effect and the Davisson-Germer effect, which the students encounter during their first exposure to modern physics," he said. "So if a student studies that an electron is a wave and there is a diffraction pattern, the student can come in my lab and tweak the knob and see that."

While Breinig will explain concepts to students, Mannella will identify activities based on his research that will offer clear, real-life illustrations.

"Imagine a homework problem that would not just be academic—where you invent a hypothetical situation that you never encounter—but a problem that can really stem from practical issues that we encounter in the lab," he said.

For example, he has a laser and he needs to find the proper lens to get the appropriate focus—a routine necessity in the lab.

"You can show the student that this is important because this is my (laser) light, and I have to go from here to here; I have to focus and I need to buy the proper lens," he explained. "I have a catalog—what lens do I buy?"

Teaching students the practicalities of research is hardly unchartered territory for him, as his lab has already been a training ground for both college and high school students.

Among those are undergraduate physics majors Emily Finan and Eric Martin. In March 2010, Finan was looking for an opportunity to work in a departmental research lab, and Mannella was among the faculty members who offered her a spot.

She has worked with Dr. Christine Cheney, a research assistant professor in the group, and has gained experi-

# The Physics Top 10 List

In the Fall Of 2010, *CrossSections* began highlighting the Top 10 Most-Cited Papers from our department, with insight from the authors, beginning with Number 10. These papers show the breadth and influence of the physics department's research program.

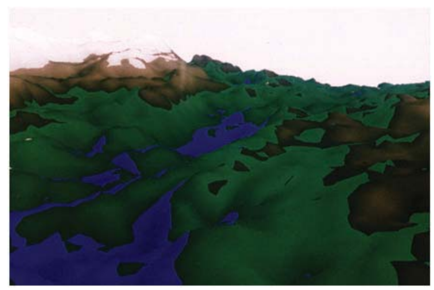
## #7

| | |
|---|---|
| Title: | New Form of Scanning Optical Microscopy |
| Authors: | R.C. Reddick, R.J. Warmack, and T.L. Ferrell |
| Journal: | Physical Review B 39, 767 (1989) |
| Times Cited: | 407 (as of 6/12/2012) |

### Summary

**Courtesy of Dr. Thomas L. Ferrell**
**Research Professor, UT Physics**

In 1986 my Submicron Physics Group at Oak Ridge National Laboratory constructed an electron scanning tunneling microscope (STM) and imaged atoms of silicon just prior to the announcement of the Nobel Prize for G. Binnig and H. Rohrer for their invention and use of the STM. In 1987, I encouraged my UT physics graduate student Robin Reddick to build the photon analog of the STM and he did so with extensive help from Bruce Warmack of my group (a UT physics graduate). Bruce improved upon my concept with a clever method of sharpening an optical fiber and using it as the scanned probe and we were able to then build and use the resulting photon scanning tunneling microscope (PSTM) to image beyond the Rayleigh diffraction limit and simultaneously collect optical spectra from samples. While the resolution of the PSTM is roughly 1000 times worse than that of the STM, the spectral resolution is about 1,000,000 times better. The PSTM is distinguished from near-field optical scanning probe microscopes by the fact that it detects virtual photons rather than simply real photons passing through a nearby aperture. This means the PSTM signal is basically exponential in nature, just as with the STM. Today the PSTM is used more for plasmonics as a probe of surface plasmons propagating in nanostructures and less for topographical chemical mapping, but promising nonlinear effects are in their infancy in terms of future uses of the PSTM.



**Quartz Valley National Park—A PSTM image of a commercial quartz microscope slide specified to be flat to better than one wavelength. The colors mark contours of differing height.**

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ence with the lab's high-powered laser system and electron-beam evaporator, with plans to work on a new spectrometer system. Finan said the hands-on aspect has definitely added a new dimension to her physics education.

"There's a really big difference between what you learn in class and what you do day-to-day in the lab," she said. "It's reinforced the idea that I want to go into research — in physics in particular."

Martin, who graduated in May, began working with Mannella more than two years ago, first doing programming, then moving on to physics research. He has analyzed data from synchrotrons and, with Mannella's support, has travelled to the Advanced Light Source at Berkeley to take ARPES data. Last fall he worked on X-ray photoelectron spectroscopy experiments using titanium oxide.

"I've learned a tremendous amount about condensed matter, and a lot of additional physics," he explained. "It was really a very full education."

Martin starts graduate studies at the University of Colorado this fall and counts his work with Mannella as an advantage in his graduate school applications. He said his research background is comparable to, if not better than, those of students coming from some of the top technical schools in the country.

"That's just from working with Norman," he said. "Without it I would have had no way of standing out. He's a really good physicist and a really good writer. He pushes, but he's relaxed. That really enforces learning."

His gift for teaching physics principles with research experience is a cornerstone of Mannella's CAREER grant, as is a philosophy that Finan said he emphasizes both in the classroom and the lab: scientific curiosity is more important than purely academic success. He's taught her, she said, that "it's not about making straight A's; it's about looking at things in a new way."

# Seven Questions for

## UT Physics Graduate **Izabela Szlufarska**

**(Ph.D., 2002)**

Associate Professor, Materials Science and Engineering
The University of Wisconsin, Madison

1. What brought you to the University of Tennessee for graduate work in physics?

The main reason I came to UT was my Ph.D. advisor Professor John Quinn. I know a number of scientists from Poland who had worked with Professor Quinn sometime in the past (either at Brown or at UT). I was introduced to Professor Quinn, who then invited me for a short scientific visit at UT while I was still working on my M.S. degree in Poland. I enjoyed immensely working with him and I fell in love with Knoxville and the Smokey Mountains. At that time of my visit I didn't know much about the Department of Physics, but I found it to be very welcoming. Professor Quinn invited me to apply to the physics Ph.D. program and I was excited to come back later the same year as a UT graduate student.

2. Do you have any standout memories or experiences from your time at UT?

I have many great memories. One thing that really stood out in my mind is how dedicated the UT faculty members are to the students. The professors are not only excellent teachers, but it is also clear that they really like the students. For example, Professor Quinn had a habit of inviting students enrolled in his solid-state physics course to his house for a cookout, which was a lot of fun. I will also always remember the time when Professor Witold Nazarewicz invited me and my parents to his house for dinner during the summer when my parents visited me from Poland. I find these kinds of interactions between professors and students to be quite unique to UT.

The welcoming attitude is also shared by the administration of the UT Physics Department. It is one thing that all the staff members were very friendly and helpful while I was still a graduate student. It is quite another thing that many people remembered me when I stopped by the department nine years after my graduation while attending a workshop at Oak Ridge National Laboratory. I was astounded that people remembered not only my name, but also a number of details about my life, as they knew it from my time in Knoxville.

I also have a few vivid memories related to my transition to the American education system. During my first semester at UT I was a teaching assistant for a general physics course. I taught both a lab and a recitation, which is a problem-solving section. The beginnings were quite challenging because I had a hard time understanding my students. In Poland I was taught British English and I was not familiar with the southern American accent. There was also vocabulary that I needed to learn. Every week before the lab I would study the lab manual and a dictionary to learn the English words for valves, pulleys, integrands, etc. I also spent some time with a speech therapist at UT working on accent reduction. In retrospect, it was probably a little obsessive but I think it helped me become a better TA. Interestingly, now I use the same obsessiveness and passion to fuel my growth as a scientist.

Another memory is related to my first steps as a scientist and in particular to struggling to write my first paper. I remember Professor Quinn inviting me to his house for Christmas and telling me that it was absolutely the deadline to turn in the manuscript. I worked hard and finished it before Christmas. The manuscript was long and unwieldy and it got rejected from the journal. The reviewers liked the science but hated the manuscript. I dreaded showing the reviews to Professor Quinn, but of course he was very nice about it. He asked a postdoc from his group to help me rewrite the manuscript and it got accepted to the same journal. I try to remember this experience when I now teach my students how to write a scientific paper. In fact I dedicate a significant amount of my time to writing manuscripts with each student and giving him/her a detailed feedback on his/her technical writing.

3. How did you transition from physics to materials science and engineering?

The transition was fairly smooth since nowadays the boundaries between scientific disciplines can be somewhat diffuse. There is a considerable fraction of faculty in materials science departments around the country who earned Ph.D.s in physics, chemistry, or biology. For me the transition took place during my postdoctoral studies at the University of Southern California (USC), although at that time it wasn't entirely clear to me that I was becoming a materials scientist. Looking back, I can identify three factors that drove this transition. The first one is that I became interested in applied science. While I loved working on many-body theory during my Ph.D., around the time of my graduation I was not sure whether I would like to work in industry or in academia. My thinking was that focusing on problems that have more immediate applications and that are to some extent driven by industry would keep my options open and give me more time to decide which of the two paths to take in the future. In addition, I wanted to make an impact on society through my research and working in an applied field seemed like a faster way to accomplish that. Secondly, I was always fascinated by how powerful numerical methods are in physics and I wanted to learn new skills in this area. I joined the USC group because I was intrigued by their capabilities to carry out virtual experiments and gain information that was inaccessible to real experiments and theory. Last but not least, my transition to materials modeling and materials science was enabled by Professor John Quinn. He patiently discussed with me different career options and was supportive when I decided to move away from more traditional many-body theory. Professor Quinn knows my postdoctoral advisors and it was his recommendation that opened the doors to a position for which I did not have prior experience.

### 4. You've won an Air Force Office of Scientific Research (AFOSR) Young Investigator Program Award and a National Science Foundation Career Award. What research are you pursuing in connection with these?

The objective of my AFOSR project is to develop fundamental understanding of friction of wear and to guide design of novel wear-resistant coatings. These coatings are made of nanometer-sized particles, which means that each particle is smaller than one millionth of an inch. Such nanostructured materials can exhibit incredibly small wear because if nanoparticles break off from the coating due to mechanical impact, they can roll between two surfaces and lubricate them. Materials with superior wear resistance are needed for a large number of applications, including many parts of engines, windmills, and rail guns. It has been estimated that one third of energy produced in industrialized countries is lost to friction and therefore there is a strong drive from the industry to understand and control this phenomenon. While the problems of friction and wear are industrially relevant, they are also enticing for somebody who has been trained as a physicist because of how little we understand about fundamentals of friction. It is known that friction is related to energy being lost during sliding, but because there are many possible mechanisms that can lead to such energy losses, it is currently not possible to predict a coefficient of friction even if we know everything about the properties of a given material.

In my NSF CAREER project we are simulating biosensors and developing theories that would allow highly accurate measurements of biomolecules (such as a strand of DNA). These particular biosensors are based on micro- and nanometer-sized resonators. The main idea is that each resonator vibrates with a characteristic frequency and this frequency changes when something (e.g., a molecule) is attached to the surface. The advantage of using nanometer-sized resonators is that they can detect a very small molecule. The challenge is to develop a theory that will allow one to recognize what molecule is attached based on the measurements of the change in frequency. Such theories exist for larger resonators and attachments, but break down when applied to small resonators with floppy molecules in aqueous environments.

### 5. How long was your visiting professorship at the Massachusetts Institute of Technology? How did that come about?

I spent my sabbatical as a visiting associate professor in the Department of Materials Science & Engineering at MIT from January to December of 2011. I have many colleagues at MIT, whom I know either from conferences or from my earlier visits to MIT when I was invited to give seminars. Spending a year at MIT provided great opportunities to strengthen my existing collaborations and to form new ones. An additional advantage of being in Boston was that it is a home to a number of very good schools and start-up companies and therefore both my husband and I were able to find desirable places for our sabbaticals in the same area. My husband is also a faculty member at the University of Wisconsin and our department was very helpful in allowing us to go on a sabbatical during the same year. We had a fantastic time living and working in Boston.

### 6. At UT you won the Physics Outstanding GTA Award for your teaching. What courses do you teach now, and how has your teaching evolved with your experience?

I teach one core undergraduate course on deformation of materials and I developed and teach one graduate course on materials simulations. Although the specific course content is not related to my teaching at UT, I definitely benefitted from the experience that I gained as a TA during my graduate studies. Interestingly, I won the GTA Award the same semester when I was struggling to understand my students' southern accents and when I had to catch up on my technical vocabulary in English. The lesson I learned then was that one of the most important things in teaching is to care and be engaged in the teaching process. These requirements can be more challenging than it seems since

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Dr. Gene Ray (Ph.D., 1965) received the department's 2012 Distinguished Alumni Award

# Dr. Gene Ray Named 2012 Distinguished Physics Alumnus

On March 5, the department was pleased to host Dr. Gene Ray for a visit to honor him with the 2012 Distinguished Alumni Award "for his innovative contributions to advanced technology in national security and his outstanding entrepreneurial vision and leadership."

Ray grew up in Murray, Kentucky, and earned his bachelor's degree in physics and chemistry at Murray State University in 1960. He came to UT for his master's and doctoral work, finishing the Ph.D. in 1965 before moving into the aerospace industry, eventually going to work for the Science Applications International Corporation (SAIC). In 1981, he co-founded the Titan Corporation, a company that provided information and communication solutions and services for national security and intelligence needs until its sale in 2005. Currently he is managing director of GMT Ventures, LLC, in La Jolla, California, where he provides guidance to early stage companies.

In a short awards presentation, Ray addressed physics faculty and students. In a bit of a surprise, the man who had a successful career in industry confessed, "What I really wanted to do was get a post-doc and be a teacher." While family circumstances and other demands veered him toward the business sector, he learned years later that his instincts were right on the mark. He had the opportunity to see his personnel file from the Aerospace Corporation (his first employer after graduate school) and found a glowing recommendation letter from UT Physics Professor Ed Deeds, who had written that he could not actually recommend Ray for a position in industry "because he should be teaching."

That detour did not detract from Ray's professional success, however. He went on to work in the defense and aerospace industries, holding—among other posts—a senior appointee position on the staff of the U.S. Air Force Chief of Staff. At SAIC he was executive vice president, general manager, and director; at Titan he was CEO and president. Ray has served on several boards and won numerous honors, including induction into the CONNECT Entrepreneur Hall of Fame in 2011. He reflected fondly on his time at UT, telling students "you are getting not only an excellent education, but a special one."

# UT Physics Hosts SCUWP 2012

More than 100 young women converged on the UT campus January 12-15 for the Third Annual Southeast Conference for Undergraduate Women in Physics (SCUWP). Representing 51 institutions, these future scientists had an opportunity to learn more about professional life in physics and get firsthand advice from successful women working in universities, government agencies, and the private sector. They also toured Oak Ridge National Laboratory, presented talks and posters, and got the chance to network with both professionals and fellow students. Christine Nattrass, who will join the department as an assistant professor in August, organized the conference with help from colleagues and students at UT, ORNL, East Tennessee State University, and Tennessee Tech.

SCUWP Attendees in front of Ayres Hall

# Motivation to *Move Forward*

## Alumnus Perspective

My name is Anton Naumov and I am an alumnus of the UT Department of Physics and Astronomy. I graduated with a bachelor's degree in physics with minors in math and chemistry. My decision to study physics came from high school in Russia, where I realized how interesting the science could be. This interest grew a lot at UT, thanks to my undergraduate professors in the physics department who instilled in me their curiosity, relentless drive for new discoveries, and the main thing: the ability to ask the right questions. Even though in the course of my life I will probably forget a lot of what I learned in my classes, this interest and desire to learn will always stay with me.

Anton Naumov
B.S. in Physics, 2005

In my sophomore year, thanks to incisive guidance and advice from Professor Yuri Kamyshkov, I started doing undergraduate research with Professor Robert Compton in physical chemistry. This field in between two areas of science had interested me for a long time since it was relatively new and still had great room for discoveries. The research under the experienced and careful guidance of Dr. Compton helped me to learn a number of valuable laboratory techniques and motivated me greatly to continue experimental studies throughout. Later on, still in Dr. Compton's research group, I started working with carbon nanotubes. This new and intriguing topic introduced me to the field of nanotechnology that has given me a lot of interest and motivation to continue my studies in graduate school with a focus on the experimental research of nanomaterials.

After graduating from UT I started my Ph.D. work at Rice University in Houston, working with Professor R. Bruce Weisman on the optical and electronic properties of carbon nanotubes. That research in a novel field of nanotechnology gave me an opportunity to discover and learn a lot of new things. In the course of my Ph.D. work I also had two internships (one at the Honda Research Institute and another with the IBM T.J. Watson Research Center) that taught me a lot about carbon nanotube production and nanoscale device fabrication, and, most importantly, gave me a valuable experience of working in the professional industrial environment. I continued at Rice with research on carbon nanotube characterization, optical properties of graphene oxide, and biomedical applications of carbon nanomaterials. I received my Ph.D. in May 2011 in Applied Physics, after which I started working at a biotechnical company, Ensysce Biosciences, Inc., located in the Houston Medical Center.

Currently I work as a research scientist at Ensysce Biosciences in the area of cancer research, using carbon nanotubes as drug delivery vehicles that transport active anticancer agents directly into the cancer cells. In addition to providing efficient drug delivery into the tumor together with near-infrared fluorescence imaging of the delivery pathways, carbon nanotubes protect their payload from degradation in blood and also protect the regular tissue from the active agents they are carrying. I find this new field of nanomedicine very interesting and rewarding. As a completely new direction, it has great potential for further development and, most importantly, it can directly affect human lives.

In the end, I am grateful to the Department of Physics and Astronomy at UT for providing me with an excellent education, interest in science, and motivation to move forward.

"… professors in the physics department who instilled in me their curiosity, relentless drive for new discoveries, and the main thing: **the ability to ask the right questions.**"

Alumnus Profile, from page 7

in addition to teaching, university faculty need to raise funding, write reports, oversee a research group (which means scientific oversight, equipment purchasing and balancing budgets), provide service both to the university and to a broader scientific community, and travel to professional meetings.

Another thing I adapted from my TA experience was the use of recitation, which is a problem-solving session. I found such sessions to be very effective in teaching. When I now teach a class that does not include a problem-solving session in the timetable, I schedule such a session myself. Even though it is optional, most of the students typically show up and find it helpful.

How did my teaching evolve? It continues to evolve in terms of specific teaching techniques and exercises that I try to incorporate into the classroom. One particularly valuable skill that came with experience is how to set clear expectations and how to communicate them with the students. It is true for both the students in the classroom and the graduate students and postdocs that I supervise. Having the opportunity to observe and interact with many students over the years gave me more confidence in teaching, advising, and evaluating students. In my opinion people rise to the expectations that are set for them. Therefore I try to set the expectations high and I give my time and energy to help them meet these expectations. When teaching for the first time, it is difficult to know what expectations are reasonable.

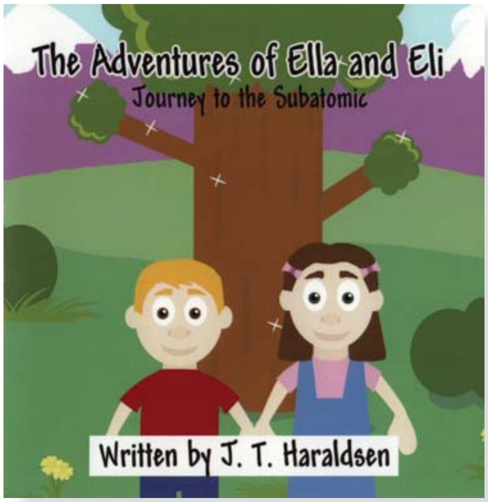
7. What do you like to do when you're not working on physics?

In the last few years I developed an interest that stems from me being a scientist and a Christian. Specifically I became interested in a dialogue between science and faith. I believe that one can be simultaneously an excellent scientist and a person of faith, and unfortunately these two ways of thinking have been unnecessarily polarized. During my sabbatical in Boston I was involved in The Cambridge Round Tables on Science, Art and Religion. The roundtables bring together religious and non-religious faculty from MIT, Harvard, and other Boston colleges to have a seminar/dinner/discussion about issues at the intersection of science and religion. These dinners were quite stimulating and I enjoyed exchanging ideas with thoughtful people of different backgrounds. We have similar dinners at the University of Wisconsin. One of the things that I do in my free time is read books related to this subject.

# A Subatomic Adventure

Physics Alumnus Jason Haraldsen (Ph.D., 2008) spends his days at Los Alamos National Laboratory working with nanomagnetic and complex oxide materials, a concept he has found can be difficult to convey to the children in his life. For years he tried to explain neutrons and other subatomic particles to his nephews, but when his daughter was born, he was inspired to go a step farther and write a book with a young audience in mind.

"I realized that there were not many children's books out there that would expose kids to these ideas before high school," he explained. "After having my daughter, I started thinking about how I could explain things to her. I came up with a basic story and wrote it down. My goal was to have a story that was both fictional but also taught real concepts. I wanted the main characters to be a girl and a boy to hopefully encourage my daughter and other girls that science and exploration is for everyone. I tried to make the story open to everyone. Therefore, while a child may only understand the basic concepts, the parent reading the story may see more subtle points."




**Physics alum Jason Haraldsen wrote *The Adventures of Ella and Eli: Journey to the Subatomic*, to explain his work to a young audience.**

The biggest hurdle for Haraldsen was not actually in writing the story, but in finding a publishing company that would consider a manuscript that came with no illustrations, written by someone with no literary background. A tip from a friend led him to PublishAmerica, which not only published the book but helped out with the illustrations. The result was *The Adventures of Ella and Eli: Journey to the Subatomic*, where the young protagonists get a tour of an entirely new world from an electron named Flash and learn about neutrons, protons, and quarks.

Haraldsen said that in publishing the book he's accomplished his main goal: "That being that I now have a book on my shelf that I can pull down and show my kids when trying to explain what I work on and what makes up the world we see."

The book is available at: http://www.publishamerica.net/product45778.html

# Taking Care of Business

Watching the physics business office at work is sort of like watching a tennis match. Or maybe a dodge ball game. Mike Roach and Debra Johnson have worked together for two years now and have established a routine involving the daily exchange of good-natured volleying—and challenges—across their shared real estate in Nielsen 404.

Roach joined the department as Business Manager in 2007; Johnson arrived in March 2010 as Administrative Coordinator I.


Mike Roach and Debra Johnson make sure the department's finances are in good order.

"We're charged with making sure all expenditures through the whole department—all of our college money as well as all of our research money—are spent in accordance with plan and to ensure the department is compliant with fiscal policy," Roach said. "Our job is to give (department head) Soren Sorensen and (associate head) Jim Parks financial information to run the department. And I think they're getting that. We know where we are at any given time."

To realize that goal, the duo has a wide range of responsibilities.

"(Debra) does her stuff; I do mine," Roach said. "We both have some production work, which is unusual for business managers. I process payments, for example. I could say, 'Debra, you ought to do that.' But then I'd have to do something really hard that she's doing," he laughed. "So we've got a really nice mix of production work and the razzle dazzle."

Johnson explained that while there's a lot on their plates, "because of the skills and knowledge on both our ends, we make it look effortless. I like being a part of the professors' team when it's time for grants and proposals. I love crunching numbers and putting that together. They're very appreciative, and they let you know it."

The skills and knowledge she referred to come from the collective education and experience they bring to the department. Roach has a bachelor's degree in accounting and is a certified public accountant; Johnson's undergraduate education includes degrees in accounting and human resources. Both are UT graduates. With typical self-effacement, however, they are the first to say that their respective academic journeys were not without a few detours.

"The first grade on my transcript is a D, in biology," Roach said. "But it ends up better than it started."

Johnson enrolled as an accounting major, circumventing some negative feedback before finishing her degree.

"After the first test in cost accounting, (the professor) was handing the test back and told me I needed to change my major because I'd never be an accountant," she said. "And I did; I changed to HR. But then I worked for an accountant and realized that what he said wasn't true."

She completed degrees in both majors, and is now 50 percent of the department's accounting staff. Although physics is among the larger departments in the college, Johnson and Roach are the entire full-time staff assigned to making sure physics is in good financial health.

"It's a different approach than a lot of departments," Roach explained. "We have less people, but I would argue with a higher skill set, because Debra could very well be a business manager in most departments at this university. We're highly automated; we're able to work on vacation or at home or whatever we need to do. But the fact that we both are highly qualified allows us to kind of function independently."

## "Challenge!"

As for a typical day in their office, that's a point the pair debate in what has become classic Johnson-Roach style—always underscored with a sense of humor.

"A lot of (the work) is typical," Roach said. "But then you're liable to get an e-mail at any minute that changes all your priorities. Still, a lot of accounting is typical and boring. It's not as glamorous as you might suspect."

Johnson, however, has a different take:

"With Mike Roach there is not a typical day," she said, grinning. "I can come in and be cheery and upbeat and he'll come in intent on putting me in a totally different frame of mind. He calls it 'challenging.' That's his word. I don't know how many times I heard that word when I first got here. No matter what I said, 'Challenge,'" was his response.

Roach insisted his challenges force Johnson to back up her points with evidence.

Continued on page 13

# Honors Day 2012

The physics department recognized top students (and one top teacher!) on April 23 with the annual Honors Day celebration. Dr. Jim Beene, an Oak Ridge National Laboratory Corporate Fellow and Director of the Holifield Radioactive Ion Beam Facility, gave the opening remarks, reflecting on the HRIBF's history and its possible future.

The ceremony continued with the presentation of the department's student honors and the induction of new members into Sigma Pi Sigma, the physics honor society. Those recognized were:

- Outstanding First Year Student: **John Burnum**
- Robert Talley Award for Outstanding Undergraduate Research: **Tucker Netherton**
- Robert Talley Award for Outstanding Undergraduate Leadership: **Richard Prince**
- James W. McConnell Award for Academic Excellence: **Caleb Redding** and **Geoffrey Laughon**
- Douglas V. Roseberry Award: **Eric Martin**
- Robert W. Lide Citation: **Eric Plemons**
- Outstanding GTA Award: **Joel Mazer**
- Outstanding Tutor Award: **David Morse**
- Colloquium Award: **Nick Sirica**
- Stelson Fellowship for Professional Promise: **Leland Harriger**
- Stelson Fellowship for Beginning Research: **Robert van Wesep**
- Fowler-Marion Award: **Jordan McDonnell**
- Wayne Kincaid Award: **Sarah Wood**
- Sigma Pi Sigma Inductees: **Emily Finan**, **Tucker Netherton**, **Caleb Redding**, **Ryan Sinclair**, and **Kubra Yeter**

The students weren't the only ones honored at the ceremonies. The Society of Physics Students awarded their annual Teacher of the Year prize to **Dr. Norman Mannella**. You can see the complete photo album and learn more about our awards at: www.phys.utk.edu/news/2012/news_honorsday_04232012.html.

**Photos top to bottom: SPS President Lisa Agle presents Dr. Norman Mannella with the Teacher of the Year Award; Dr. Kate Jones presents Eric Martin with the Douglas V. Roseberry Award; and Dr. Mike Guidry with Kincaid Award Recipient Sarah Wood.**

# And Still More Honors …

In other award-related news, the physics department was well-represented at the **2012 Chancellor's Honors Banquet on April 9**. Assistant Professor **Kate Jones** was recognized for Professional Promise in Research and Creative Achievement. Honored for Extraordinary Professional Promise were undergraduates **Eric Martin** and **Tucker Netherton**, as well as graduate students **Andrew Nicholson** and **Miaoyin Wang**. Undergraduate **Geoffrey Laughon** was also recognized with a Chancellor's Honor for Extraordinary Academic Achievement.

"Taking Care of Business," from page 11

"It's a way of learning," he said jokingly. "It encourages her to learn, knowing she'll have to prove it."

Johnson countered: "That's what he said until he started losing. He's like my grandson—when I finally found a game I could beat him in, he stopped playing."

Tracking departmental finances—including roughly $10 million in research funding each year—is no game, however, and to be successful Johnson and Roach draw on their combined experience. Roach has worked in state and federal governments, private industry, non-profit settings, and university environments. Johnson's resume includes stops in the private sector, non-profit organizations, federal contractors, and the university — although Roach couldn't resist questioning her work for the United States Department of Energy.

You worked *with* them, but not *for* them," he said. "Did your paycheck come from DOE?"

"Sure did," she replied.

"Challenge! Challenge! Bring in your W-whatever it is and show me," Roach said.

"See? This is what I have to deal with day in and day out," Johnson answered, laughing.

All kidding aside, Roach said his greatest accomplishment as a supervisor always lies in "recognizing the potential in people and trying to challenge them to reach beyond;" something Johnson clearly appreciates.

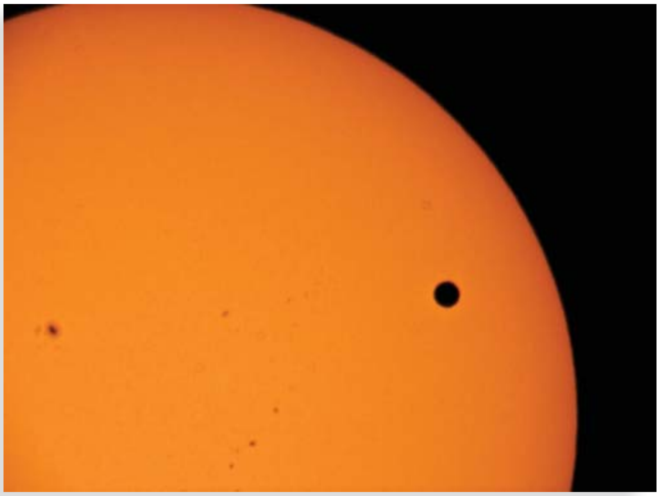
"I've always encouraged growth in other people, and it's good to have a supervisor who does that," she said. "I like the fact that he encourages me to learn everything I can, which helps make me be a better team player, as well as a person."

When they aren't keeping the department's accounts in order, both Roach and Johnson have plenty of other activities that interest them. Roach has been a fly-fisherman for more than 30 years, and also enjoys kayaking and spending time with his family, for whom he is the unofficial vacation organizer. Johnson enjoys teaching hip-hop line-dancing, taking Zumba classes, and playing with her grandkids, with plans to add more travel to her hobbies.

Although they get a kick out of giving each other a tough time, they also enjoy being part of the wider physics family.

"We're part of the management team, not just the scorekeepers," Roach said. "I like the camaraderie of working with very talented people who are good at what they do," including faculty and other staff members.

"We're all good at what we do," he said, "but we have a good time at work."



## Venus Transit

The roof of the Nielsen Physics Building was packed on June 5, with an audience clamoring to see Venus pass between the Earth and Sun for the last time until 2117. Paul Lewis, Director of Space Science Outreach, opened the roof at 4:00 p.m. for solar observations until the Venus transit began at 6:09 p.m. Visitors used the department's telescopes and filters to watch the transit, which lasted until sunset. Physics Graduate Student Austin Chertkow (below left) was among the hundreds of people who took advantage of the rooftop viewing session.


# News from the Physics Family

## Faculty

**Christine Nattrass**, who joins the faculty as an assistant professor in August, was recognized as the American Physical Society's Woman Physicist of the Month for May 2012.

## Students

**Congratuations to our Spring 2012 Graduates!**

**Bachelor's Degrees: George Duffy**, **Eric Martin** (Engineering Physics), **Tucker Netherton**, **Kyle Preece** (Engineering Physics), **Caleb Redding**, and **Travis Tune**

**Master's Degrees: Zachary Barnett**, **James Austin Harris**, and **Matthew Hollingsworth**

**Doctoral Degrees: Lucia Cartegni**, **Giordano Cerizza**, **Hua Chen**, **and Mostafa Jon Dadras**

**Joel Smith**, a physics major enrolled in the university's VolsTeach program, was one of only four U.S. students selected to take part in an international professional development program for in-service and pre-service teachers. The program was sponsored by Shodor, an organization that blends computational science and interactive computing with STEM (science, technology, engineering, and math) education.

Congratulations to the UT chapter of the **Society of Physics Students** on being named an outstanding chapter for 2011 by the national SPS organization.

## Alumni News

Since retiring as a professor of physics at Old Dominion University, **R. Lee Kernell (Ph.D., 1967)** and wife Judy have traveled the world, visiting the seven continents and all 50 U.S. states. During his 30 years at ODU, Kernell received the Tonelson Award, the highest honor given to a faculty member there. In 1989, Kernell was selected by CASE [COUNCIL for Advancement and Support of Education] as the Virginia Professor of the Year; additionally, he was a bronze medalist at the national level. Kernell's research in Space Radiation Effects was funded by the NASA Hubble Space Telescope and used accelerator facilities at Brookhaven and Los Alamos National Laboratories.

## In Memoriam

The department is saddened by the loss of **Dr. Robert D. Birkhoff**, who passed away on Friday, February 17, 2012. A Chicago native, he was born January 29, 1925, and did his undergraduate work in physics at the Massachusetts Institute of Technology, interrupting his studies to serve in the United States Navy. He then went to Northwestern University, where he completed the Ph.D. in 1949. That same year, he joined the physics faculty at UT and became a consultant to Oak Ridge National Laboratory. His early research program was in beta ray spectroscopy and later he would carry out studies on the electronic properties of liquids. In the mid-1950s, Birkhoff left the university to join the Health Physics Section at Oak Ridge National Laboratory, holding an adjunct professorship with the university, where he was named a Ford Foundation Professor in 1967. He retired in 1981. Birkhoff was a champion of the department and in 1983 established a charitable trust to provide undergraduate and graduate fellowships for physics majors at UT. He will be greatly missed.

The physics department lost a friend and colleague with the passing of **Dr. David King** on March 17, 2012. King was born in Wellington, New Zealand, on January 16, 1923, and joined the Royal New Zealand Army at age 18. He was involved in pioneering development of radar defenses and received a master's degree in 1946 from Wellington University. After World War II, King traveled from New Zealand to Bristol University in England to complete his doctoral thesis in high energy particle physics. He performed research for Dr. Cecil F. Powell, who won the 1950 Nobel Prize in Physics. King provided early and substantial work in the field of sub-nuclear particles, especially the pi-meson, and was awarded the Ph.D. by Winston Churchill in 1950. He and his wife Joyce moved to Washington, D.C., in 1952, where he was employed by the U.S. Navy in nuclear submarine research at the U.S. Naval Research Laboratory. In 1955, King accepted a UT faculty position in physics. Following his retirement from the university, he consulted at Oak Ridge National Laboratory and at NASA in Huntsville, Alabama. The department mourns the loss of a wonderful scientist and professor.

We're social! The physics department now has a Facebook page to connect with our friends and alumni. Like us by visiting the page at: https://www.facebook.com/UTKPhysicsAndAstronomy

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# Giving Opportunities

The physics department has several award and scholarship funds to support our vision of excellence in science education at both the undergraduate and graduate levels:

### Undergraduate Scholarships

The William Bugg General Scholarship Fund

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The Dorothy and Rufus Ritchie Scholarship Fund

The Robert and Sue Talley Scholarship Fund

### Undergraduate Awards

The Douglas V. Roseberry Memorial Fund

The Robert Talley Undergraduate Awards

### Graduate Awards & Fellowships

Paul Stelson Fellowship Fund

Fowler-Marion Physics Fund

### Other Departmental Funds

Physics Enrichment Fund

Physics Equipment Fund

Physics General Scholarship Fund

Robert W. Lide Citations

Wayne Kincaid Award

If you would like more information on how to make a gift or a pledge to any of these funds, please contact either the physics department or the College of Arts and Sciences Office of Development at (865) 974-2365.

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