Fall 2009

Cross Sections Fall 2009

Department of Physics and Astronomy

THE NEWSLETTER OF THE UNIVERSITY OF TENNESSEE DEPARTMENT OF PHYSICS AND ASTRONOMY

CROSS SECTIONS

Fall 2009/Winter 2010

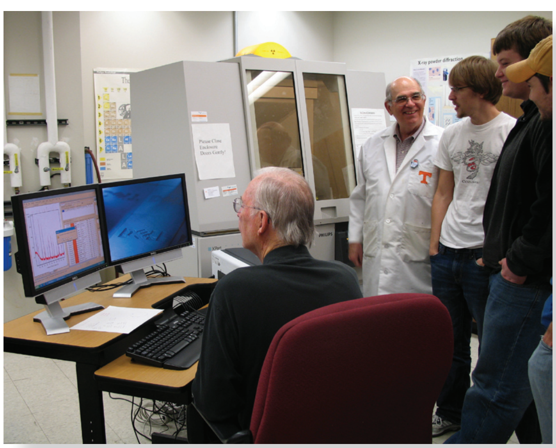
Finding the Physics

The Department's Undergraduate Laboratories

In a few short years they may be doctors, engineers, personal trainers, or physics grad students. But this semester they're undergraduates scattered in laboratories all over the physics building—adjusting oscilloscopes, scrambling for banana plugs, or just using cardboard and straight pins to answer a simple question: "Where's the physics in this?"

Getting to Know You: The Introductory Labs

Dr. Jim Parks can often be found patrolling the fifth floor of the physics building in what has become his uniform, a lab coat with an orange "Power T" embroidered on the pocket. As director of undergraduate physics laboratories, he selects experiments, supervises teaching assistants, and makes sure all the necessary equipment is available and working. This is no small task considering the introductory labs serve about 800 students each semester. Their majors represent a variety of disciplines: biology, geology, physics, chemistry, math, pre-med, exercise science, and all of engineering. Parks, who wrote the students' lab manual, said he tries to match the experiments to course content, but with so many students in so many different course sections, that isn't always possible. So he includes a lot of background and theory with the individual experiment write-ups.



Dr. Jim Parks (in "T"-embellished lab coat) takes his students on a tour of Dr. Joe Spruiell's lab (Materials Science and Engineering), to check out the x-ray diffraction system.

"The labs stand on their own," he said. "The labs are designed to cover the material without prior knowledge. I give minute details on how to do the experiment."

Students work in pairs and complete 12 labs each semester. They learn the finer points of diffraction, standing waves, and centripetal force. Just as importantly, they learn experimental techniques and how to analyze and graph data to verify the principles being studied.

Each lab, Parks said, has one underlying goal: "It has to answer the question, 'where's the physics in this experiment?'"

The cost to answer that query comes to about $250,000 in equipment.

"That's basically 12 sets of apparatus," he said.

The equipment needed to teach the fundamentals of physics, however, don't need constant refreshing.

"It's only outdated if there's something better out there," Parks said. "I mean, a spring is a spring."

He added that sometimes there's a better approach to doing an experiment, but the necessary equipment isn't commercially available. Fortunately, the department has resources that can circumvent that obstacle.

"We have some experiments that you won't find at any other university in the world," he said.

The Ampere's Law experiment, for example, uses a giant magneto-resistance device and precision, state-of-the-art apparatus built by the department's electronic and machine shops. Despite such sophisticated offerings, Parks said the students' favorite lab is the Index of Refraction experiment because it's a very simple set-up using cardboard and straight

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Progress

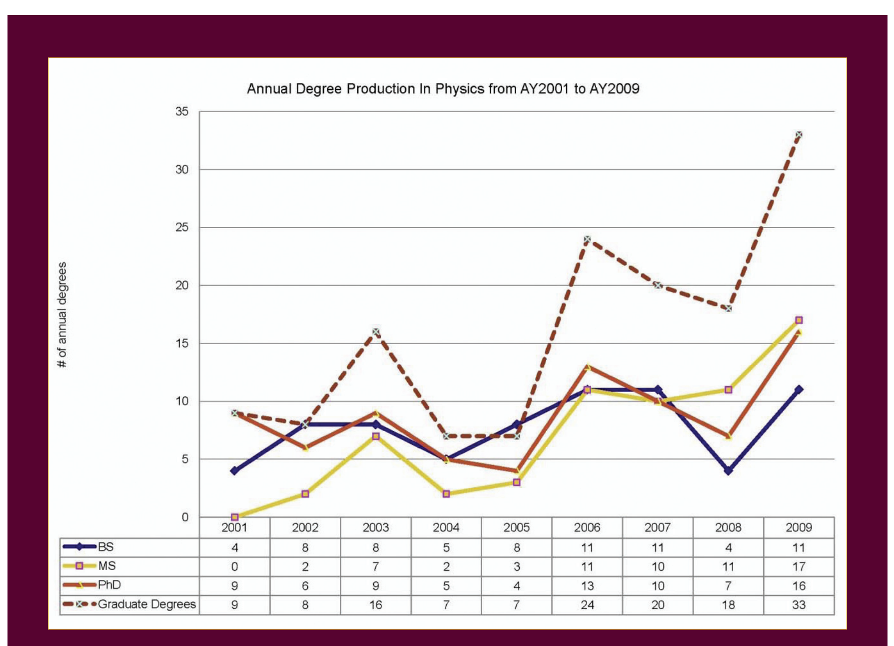
A letter from Department Head Soren Sorensen

In October our department had a mid-cycle academic review. The idea behind the mid-cycle review is to follow up on the recommendations from the main review four years ago in order to ascertain if the department and the university have followed these recommendations. These reviews provide a wonderful opportunity for "taking stock," as I described in this newsletter four years ago; especially because the faculty and staff once more have been able to move our department forward in a substantial manner. In physics we like to measure progress and to give tangible evidence instead of just producing big words. So let's together go through some of the impressive numbers outlined in our mid-cycle review report.

Undergraduate Program

Our undergraduate program has historically been considered by most UT administrators as the department's weakest point since we, like most other physics departments in the U.S., are graduating fewer undergraduate majors than non-physics departments. We have, however, made substantial progress over the last four years in our undergraduate graduation rate. As seen in the figure to the right and the associated table, we graduated annually on the average 6.6 students with a B.S. degree during the period 2001–2005, whereas that number has increased to 9.3 averaged over the last four years. This is, however, not satisfactory for us and we will continue to work for even higher graduation rates. Based on our current enrollment, I am certain we will continue to graduate between 10 and 15 students over the next several years.

The quality of our undergraduate students has also increased substantially. Nearly all of our incoming students have ACT scores at or above the UT average of 26.5, and the last two years the average Math ACT score in the Physics 137-138 class—taken by more than half of our physics majors—was above 31. We have been engaged in substantial efforts to improve our teaching. All probationary faculty members are attending the AAPT workshop focusing on teaching methods in physics, and over the last four years we have established a solid internal teaching review system, where a departmental committee not only evaluates the classroom teaching of our young professors, but also works with them on improving their teaching. Many teachers are now using "clickers," peer-instruction, and other more modern teaching techniques, and next semester we will have a new classroom (Nielsen 206) dedicated to Studio Physics teaching, where labs and lectures are combined.



	2001	2002	2003	2004	2005	2006	2007	2008	2009
BS	4	8	8	5	8	11	11	4	11
MS	0	2	7	2	3	11	10	11	17
PhD	9	6	9	5	4	13	10	7	16
Graduate Degrees	9	8	16	7	7	24	20	18	33

Graduate Program

The graduate program continues to be our pride and joy, and over the last four years we have seen a dramatic increase in our graduation rates. We are now, on average, graduating 12 Ph.D.s and 12 M.S. students annually, which is more than a doubling of the numbers for 2001-2005. There are several reasons for this increase. We are now seeing the results of the improvements to the graduate program we implemented in 2001. We are monitoring the students better, so they have shorter graduation times, and due to our increased research funding we have been able to accept more students into our graduate program. We now typically have 110-115 graduate students, which is very high considering we only have 26.0 FTE (Full Time Equivalent) faculty. An important reason for this high graduate student-to-faculty ratio of 4+ is our ORNL collaboration. We actually have 33 "real" people on our faculty, since 13 of them are joint faculty and we have ~40 adjunct faculty members, primarily from ORNL, who also are engaged on a day-to-day basis with the supervision and mentoring of our graduate students.

Research

If we look at the typical research productivity metrics, like number of refereed publications and citations, the last four years show a dramatic improvement compared to the previous five years. Averaged over 2005–2008 (we do not have the final numbers for 2009 yet) we have published 280 refereed papers annually versus 193 annually in the period 2000–2004. A similar remarkable increase in our citations has occurred, where in 2008 our department was cited more than 8900 times!

Similarly, we have seen a strong increase in research expenditures from an annual average of $6,157k in FY2002-2005 to $8,743k in FY 2006-2009. We reached a temporary maximum in FY 2006 and FY2007 of more than $9.2M due to a $1M+ grant to a research professor.

Faculty and Staff

If we now turn to the number of people who have made these substantial improvements possible, then we find a different picture dominated by reductions. In 2005 we had 34 faculty members corresponding to 27.5 FTE, two professors on post-retirement (0.5 FTE) and one open line, for a total of 29.0 FTE and 36 professors. On August 1, 2009, we had 33 faculty members for a total of 26.0 FTE, no professors on post-retirement, and no open lines. So over the last four years we have had a net loss of four professors and 3.0 FTEs. For our staff we have had a reduction from 16 to 14 staff members.

Financial Situation

Over the last four years our base budget has increased by 8.6% to approximately $4M. But in the same period inflation has been 14.0%, so effectively we are receiving 5.4% less in state funding than four years ago, which of course is reflected in the reduced faculty and staff numbers discussed above.

"The quality of our undergraduate students has increased substantially. Nearly all of our incoming students have ACT scores at or above the UT average of 26.5, and the last two years the average Math ACT score in the Physics 137-138 class–taken by more than half of our physics majors–was above 31."

So over the last four years we have been able to substantially improve our undergraduate and graduate enrolment and graduation rates, to produce more highly cited physics research, and to attract more external funding despite having fewer people in our faculty and staff.

Review Committee Findings

So how did the review committee evaluate our department? Very well! Let me give a few quotes from the report:

"Overall we find the Department very committed to advancing the University. We note with pleasure that nearly all the findings and recommendations of the 2005 report have been addressed or are being addressed, some with a significant allocation of personnel resources."

"We enjoyed lively discussion with all the groups, particularly the students who, as in our earlier visit in 2005, were most positive about their educational experiences and eager to help the Department achieve its goals and objectives."

Naturally the committee also had several concerns. In particular two items were highlighted: the demographics of the faculty and our facilities. The age distribution of our faculty has not changed since the last review, and we now have 25 full professors, but only four associate professors and four assistant professors. The problem is not too many full professors, but too few junior professors to carry our research and teaching in new and fruitful directions.

Hopefully we will be able to address the concerns about the few junior professors and our inadequate facilities before the next review six years from now. In the meantime, let us rejoice in the progress we have made in the core missions of our department, teaching and research, and together find ways to continue the progress.

Undergraduate Physics Labs, continued from page 1

pins. As a scientist and teacher, however, it also happens to be Parks' least favorite lab.

"I don't think it's challenging enough," he said laughing.

Circuits for Survival: The Electronics Lab

Upstairs in the sixth-floor electronics lab, there are, in fact, some challenges afoot. Undergraduates Joe Overman and Rachael Ainsworth are working short-handed, as the third member of their team is absent. The day's assignment is testing input and output voltages of a computer-controlled circuit to make sure everything is correct, but a few glitches have popped up.

In the electronics lab course, "we have a series of lab assignments and experiments that we go through to learn the procedures," Overman said. He gave a wry smile before adding, "Some are more successful than others."

Professor Stuart Elston is lending a hand to work out some problems on the Overman/Ainsworth experiment. He is a veteran of teaching the electronics laboratory and said the goal is "to lead students to a software environment called LabVIEW," which he called "the industry standard in data acquisition."

He explained that in years past data acquisition was much simpler; the biggest challenge was that students didn't understand computers. Now they may be more proficient in computer use, but the machines themselves are still somewhat of a "black box," to them, so he puts more emphasis on the basics of electronics as he guides the students to more advanced tools.

Once, it was enough for students to know how to use an oscilloscope, he said, but "now they need to know how to use an oscilloscope *and* data acquisition."

Electronic applications have become ubiquitous: just driving a car or buying music has changed substantially because of their evolution. Electronics control power, and Elston said that in a lab, that means controlling instrumentation. With that in mind, he uses three threads of development to design the electronics lab curriculum. First is that circuits are good examples of physical systems; second and third are, respectively, an emphasis on instrumentation and design.

"When you're doing what no one has ever done before, which is common in physics labs, you have to build your own instruments or take something off the shelf and adapt it to your needs," he said. "I use standard, off-the-shelf instruments; the ones they're likely to encounter in a lab."

Although the students, who are primarily physics and engineering physics majors, are typically familiar with circuits on a basic level (e.g., using a battery to light a bulb), Elston said the complete circuit concept can be difficult for them to transfer to other experiments. In the electronics lab, he said the main idea is to provide them with "fundamentals of circuits as needed to survive in a physics lab," and convert their conceptual knowledge into practice.

Through the Looking Glass: The Optics Lab

Putting knowledge into practice is exactly what Professor Marianne Breinig teaches in the optics laboratory. The one-semester course was on hiatus for the fall, but in Spring 2010 she will once again turn students loose to get hands-on experience with laser beam expanders, detectors, and Gaussian beams.

"We always discuss something and then we do it. (The lab) is completely integrated with the lecture," she said.

Breinig chooses the subject matter—reflection and refraction, for example—using standard optics textbooks. Students perform 10 labs and then spend three lab periods working on independent projects. They review articles from physics publications (e.g., *The American Journal of Physics*) and find ideas they can adapt.

"Sometimes they'll do a project someone has done before, and sometimes they do something completely new," she said.

One advantage students enjoy in planning these projects is that the equipment they use is of professional, state-of-the-art quality; only it comes more conveniently packaged.

"It's research-grade equipment boiled down into kits," Breinig explained.

The kits are tailored to topics like optics, fiber optics, holography, and interferometry. There's also supplemental equipment for more sophisticated experiments and special projects. It takes a continuing investment to outfit the lab, because as Breinig said, "new things come out; things break."

That's the case with any working laboratory, and experience in this lab in particular can be beneficial for students looking to get a foothold in the working world.

"I think that optics seems to be a good career path for bachelor's and master's students," Breinig said. There are a lot of jobs."

Optics equipment is available to master's candidates working on their thesis projects, and undergraduates have taken the lab as an independent study to work around scheduling conflicts. While optics is a senior level course, many students take the lab as juniors, especially if they have some laboratory experience already behind them, often in either electronics or modern physics.

The Mod Squad: The Modern Physics Lab

The modern physics lab is tucked away in a far corner on the physics building's third floor. There are nooks and crannies crammed with various gadgets and tools to challenge students' scientific thinking and, at times, creativity. Dr. Parks teaches this lab and said "modern," in this context means "advanced."

"The experiments are sometimes more abstract in the sense that what you're observing isn't always obvious," he said. The spin of a hydrogen atom, for example, shows itself only as signals on an oscilloscope. "You're looking at things on an atomic or nuclear level instead of a macroscopic level."

He begins the course by having students work on the same three or four experiments, after which they can choose their assignments, which range from Pulsed Nuclear Magnetic Resonance to the Compton Scattering Experiment. Depending on the difficulty of the experiments they choose, they'll complete six to 12 experiments in a semester, giving presentations at the end of the term to share their findings.

Typically the students work in teams to learn collaboration and communication skills and also to distribute the workload. As Parks said, "you need more than one pair of hands; these aren't experiments you can do in a two-hour block."

He said the biggest hurdle for students in this advanced lab is usually theory, especially in quantum mechanics, because they haven't really studied the material before. He provides enough background to guide them through the experiments, and in doing so, gives them a foundation for when they encounter these concepts in later courses.

What's Next?

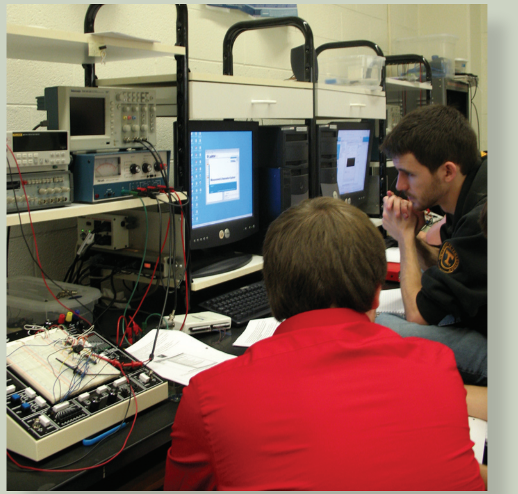
When classes reconvene in Spring 2010, a new room, this one on the second floor, will be ready for a fresh approach to teaching physics. Studio Physics, which Professor Elston has been teaching, will move to a newly-renovated space in Room 207. This method integrates laboratory and discussion sections with peer-teaching to provide an inquiry-driven, interactive learning environment. Studio Physics is another tool the department uses to blend new ideas with solid fundamentals to show students where the physics is.

As Elston summed up the mission of any good lab: "It's all about making things work."

See a feature on the astronomy labs at:
http://www.phys.utk.edu/xsections/xsections_F2006.pdf

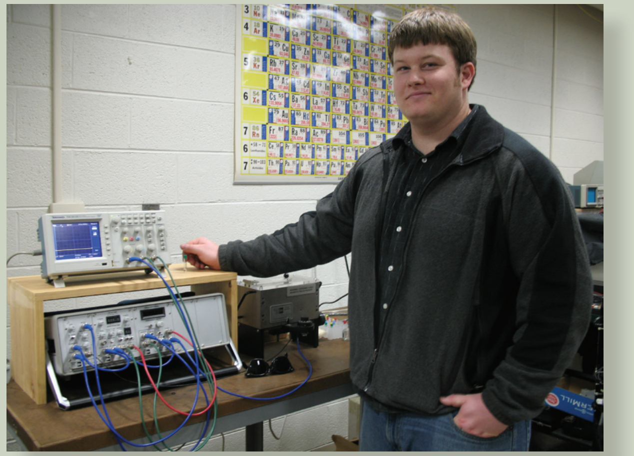
"IT'S ALL ABOUT MAKING THINGS WORK."

Rachael Ainsworth in the electronics lab.



Instrumentation and design are among the fundamentals of the electronics lab.

Andrew Binder, Joe Overman, and Chris Tate with the pulsed nitrogen-pumped dye laser in the modern physics lab.



Jon Willocks shows off the nuclear magnetic resonance experiment in the modern physics lab.

Emeritus Faculty Profile

Dr. Kermit Duckett

SOMETIMES HAVING YOUR PAPERWORK TIED UP TURNS OUT TO BE A VERY GOOD THING FOR YOUR CAREER. At least that was the case for Kermit Duckett, who didn't end up in a space program as planned, but has instead guided hundreds of students through the universe.

Duckett grew up in Canton, North Carolina, graduating as valedictorian of his high school class before going on to earn a bachelor's degree in physics at Georgia Tech in the spring of 1958. After graduation he had hoped to work at Redstone Arsenal in Huntsville, Alabama, but by early summer, his security clearance still hadn't come through. So he accepted a job with American Enka Corporation back home in North Carolina, working in textile research and manufacturing. One week later, the paperwork clearing him to work at Redstone Arsenal was complete, but Duckett said he couldn't in good conscience leave a job after only seven days. He elected to stay with American Enka for a year as a textile physicist, which turned out to be a stroke of luck.

"That's actually what got me to where I am today," he said.

Duckett decided to head west for awhile, earning a master's in physics at the University of Colorado in 1961. Although he enjoyed his time in Colorado, the draw of family brought him back to the Southeast to finish his education.

"UT is only 100 miles from home," he said.

At the time, his primary research interest was in solid state physics, and when he wrote to then-Department Head Alvin Nielsen to apply for a spot in the UT graduate program, Nielsen passed that information on to Ken Hertel, who had an assistantship open in his fiber research laboratory. At first Duckett resisted the move to fiber research, but the credentials he had earned at Enka made an impression on Hertel, who said, as Duckett recounted, "You can do your research in any area of physics you want to as long as you use the cotton fiber."

When Duckett finished the Ph.D. in 1964, he spent a year as a post-doc with the U.S. Department of Agriculture in New Orleans, a position Hertel helped arrange.

He said, "Now that you have your Ph.D., you need to learn some fiber physics," Duckett recalled.

The USDA offered Duckett a full-time position, but although he liked the people there, he didn't want to stay in New Orleans.

"It was hot, humid, and the cockroaches were big," he said.

So he came back to UT and took over the fiber research lab upon Hertel's retirement, a move that worked out well for both him and the physics department.

"I've had a great time here," he said.

The fiber research program was actually supported with funding from the University's Institute of Agriculture, so Duckett was part of the faculty in agricultural engineering as well as physics. Later his research was absorbed by the College of Human Ecology, where they were launching a program in textiles and nonwovens, although he always maintained his split faculty appointment with physics.

Duckett has done his share of administrative work over the years; chairing the university's research council and serving as an Associate Dean in the College of Human Ecology, for example. He was also a visiting lecturer at China Textile University in Shanghai and was elected a fellow of the Textile Institute in the United Kingdom. But the basics were always the most important element of his time in academia.

"My heart was in research and teaching," he said. "I love the students. They keep me grounded."

At the beginning of his tenure at UT, he taught an overview science course including physics, chemistry, geology, and astronomy. But with the retirements of physics faculty members Mary Peters and Jack Craven, a different opportunity presented itself.

"I was asked if I would be interested in teaching astronomy," he said.

Duckett took up the challenge, leading many undergraduates through a tour of the solar system over the years. In 1983 he first published an astronomy lab manual still in publication. Although he officially retired from the university in 2001, he remains a teacher; albeit with a slightly different approach. Through the College of Education he has directed a K-12 Teachers' Aerospace Education workshop every summer for the past seven years, recently earning funding for another round in 2010. The workshop is funded by the Tennessee Department of Transportation's Division of Aeronautics and incorporates support from the Civil Air Patrol (CAP), which lists aerospace education among its mandates. (Duckett is a member of the CAP and holds the rank of Major.) He estimates that 300 or more teachers have completed this workshop on the Knoxville campus. He is also the CAP Tennessee Wing internal director for aerospace education across the

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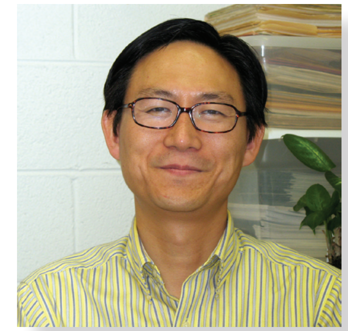
Kermit Duckett

As a student, "you study, work hard, and shine." As you grow in your profession, "study is always there, but then it becomes more sharing than shining."



The newest member of the physics faculty, Biophysicist Jaewook Joo uses a computational, mathematical approach to biology.

Jaewook Joo *Teases Apart* Biological Complex Systems

THERE HAVE BEEN PROFESSORS AND ADVISORS; FRIENDS AND COLLEAGUES: YET IT WAS A CHANCE CONVERSATION WITH A NEXT-DOOR NEIGHBOR THAT PROVED TO BE THE TURNING POINT IN JAEWOOK JOO'S CAREER.

Joo joined the physics faculty in July as an assistant professor through his association with NIMBioS, the National Institute for Mathematical and Biological Synthesis. He is getting settled into life in the department, and spent an autumn afternoon explaining how a physicist in condensed matter theory came to be a biologist who tears apart biological complex systems to chase infectious diseases, diabetes, and cancers.

Joo said scientists and engineers as a whole are becoming increasingly challenged by and thus interested in biology problems that are marked by unprecedented daunting complexity. Understanding and intervening in these intricately-woven, multi-scale biological systems requires the expertise of physical and mathematical science fields, which is part of what NIMBioS seeks to address. The institute is dedicated to using cross-disciplinary approaches to tackle key, yet hard biological questions.

"Biology is a study of a complex system," he said. "It's even more complex than what we used to deal with in physics." The biological complexity arises from a dauntingly large number of heterogeneous types of biological objects (e.g., DNA, RNA, and proteins), complex interactions between objects, and complex interactions across different scales (e.g., molecular, cellular, organismal, and ecological).

Joo went on to explain that traditional biologists appreciate an organism as complex as it is and are utterly repulsed about an idea of "teasing it apart component by component and studying each component," because "once you tease it apart you lose the functionality of the organism altogether. So they treat the organism itself as a black box, i.e., an object which is too complex and mysterious to understand."

Perturbation experiments, like knocking out a single gene, help biologists determine the influence of a certain gene component on how the system functions. What Joo has done, in post-doctoral appointments at Sandia National Laboratories and Penn State University, is to bring a computational, mathematical approach to biology to break open the black box and look more deeply into what happens in a single cell.

"What computational systems biologists do is search the literature to mine individual components and link them together. This latter task can be viewed as solving a jigsaw puzzle," Joo said.

Based on previous literature, they can reconstruct consistent, relevant wiring diagrams, or maps, of how a system responds to a particular stimulation; a method known as network biology. That network, or graph, Joo said, "can tell us how components are interconnected and how signals from one end can propagate to another end. One end can be a receptor which senses a stress signal; another end can be a cellular response."

His particular interest, however, takes the data one step further. He wants to know the dynamics—the biological functionality—of a given network.

"The reconstructed network itself is only a static representation of the biological system of our interest and cannot give us much information about how the biological system dynamically reacts or responds to stimulation," Joo said.

"Biological response is not binary like yes or no," he continued. "Once the cell is exposed to an external stimulus, it makes a decision about how to react. The decision is made by the dynamically regulated expression of genes; some genes are off and then on and others are on and then off. What is most important is that response is dynamically regulated."

One area where these responses are increasingly important is in the area of innate immunity.

"When you get the flu, for example," Joo explained, "your body generates two stages of immunity: innate immunity for the first two weeks of infection and adaptive immunity thereafter. After suffering from coughing and fever for several weeks, you eventually get better. It is because of a large number of activated B-cells and T-cells specifically targeting and eliminating the flu virus. The number of B-cells will decrease over time, but the T-cells will remember what happened to you before. When you get reinfected by the same flu virus, your adaptive immune system can be activated swiftly to remove the unpleasant nuisance."

Joo said that these days much attention is drawn to innate immunity, which is initiated by macrophage cells: white blood cells known as "big eaters" that ingest foreign material and hence play a key role in the body's immune response. But how does this hungry cell know what's a potentially infectious microorganism and what's benign?

New Faculty

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Jaewook Joo, continued from page 7

"It has toll-like receptors," Joo explained.

Toll-like receptors are proteins that act somewhat like sentries. They recognize when foreign microbes have crossed physical barriers like the skin, but there are still mysteries surrounding how this defense system works.

"So here's a black box called a macrophage," Joo said. "The question is, what's going on inside? There are some proteins and some genes, which are interconnected to send information from the toll-like receptors to DNA. Those components are dynamically regulated to turn on or off certain genes. Understanding signal processing within a macrophage was the central focus of my research and the research of the laboratories where I was for the past three years."

Part of that work involved NF-kappa B, shorthand for the nuclear factor kappa-light-chain-enhancer of activated B-cells. NF-Kappa B is a protein complex that controls the transcription of DNA.

Joo said that traditionally, most experimental biology used an average reading because of an inability to measure events within a single cell. Scientists would collect cells, expose them to bacteria, and then measure a given component. With computational and mathematical biology, they can learn more about cellular response dynamics on a much more detailed scale.

"Now, because of advanced imaging and fluorescence techniques, scientists can take a close look at what's happening within the cell, under the microscope," he said.

At Sandia National Laboratories, he and fellow scientists were able to tag NF-Kappa B inside a cell with a green fluorescent color—"so if the protein abundance changes in time as a response to an external signal, we can monitor such a change in real time in a live cell," he said. "When NF-Kappa B abundance increases in the nucleus, you can see much brighter green color in nucleus than in cytoplasm."

They were able to observe NF-Kappa B oscillation in single cells, which provides another window into how this protein regulates gene transcription in helping the body fight off intruding microbes.

Building such collaborative efforts across physics, computer science, math and biology hasn't always been easy. Originally, Joo said, experimentalists didn't trust mathematics, but "that attitude has been dramatically changed."

Evidence of that shift is apparent in initiatives like NIMBioS, where Joo and colleagues are proposing workshops on parasite epidemics as well as cancer biology. That may seem a long way from physics, but in fact, he sees it as a natural progression.

Joo holds bachelor's and master's degrees in physics and earned a Ph.D. in theoretical condensed matter physics at Rutgers in 2004. It was during his graduate school days that he struck up a conversation with a biologist who lived in the apartment next door—one that stretched to four hours and ultimately changed Joo's way of thinking about science and its possibilities.

"He happened to be a biologist," he said of his neighbor. "I didn't know the difference between DNA and a gene at that time and had no high regard for biology. But, on that day, he opened up my eyes and showed me the wonderland of biology. That was kind of an awakening moment for me. That was a great moment."

That moment, however, didn't change Joo's scientific path overnight.

"I didn't make up my mind right away, like 'Oh, I'm going to do biology now,'" he said, with a snap of his fingers. "The change of my career took place slowly and gradually."

After finishing his doctoral degree, he moved into biophysics postdoctoral positions, first in physics and microbiology and then in computational systems biology.

"I'm learning biology on the fly as I'm doing the biophysics research," he said. "I've been exposed to physics for a really long time, but to biology for a very short period of time. So, I love to work with biologists and learn biology from them."

When he's not chasing pathogens, Joo is chasing kids down the soccer field. He and his wife have three sons, ages 8, 10, and 12, and their dad is a referee, as well as a fan.

"I love soccer, but I do not play soccer myself. I ref," he said. "The referee's job is management. It's challenging, but I do really enjoy it."

Joo uses the game he loves as an analogy for his collaborative work across scientific disciplines: the goalie, the fullbacks, and the midfielders all play vital roles, he said, although the forwards do most of the scoring.

"My goal is to grow as an independent biologist," he said, but "I think right now my position is assisting biologists. I recognize that's a very important role."

More information on NIMBioS is available online at: http://www.nimbios.org

Kermit Duckett, continued from page 6

state and contributes to the CAP Aerospace Education Web site (**http://www.capae.info/**).

There are other interests too; astrophotography and clock-building among them. By his own estimate Duckett has built 20 or 25 clocks in his time and is currently building his first movement from scratch. He and his wife, Virginia, celebrated their 44th wedding anniversary on November 25. They have two grown children and two grandchildren, who keep them busy with dance recitals and sporting events.

Duckett mused that there's a natural progression to how a person's career unfolds. As a student, he said, "you study, work hard, and shine." As you grow in your profession, "study is always there, but then it becomes more sharing than shining."

How's the Weather up There?

A UT grad keeps an eye on space conditions and more for the U.S. Department of State

Alumnus Profile

Suzanne Parete-Koon (M.S., 2001; Ph.D., 2008)

SUZANNE PARETE-KOON KNEW EARLY ON THAT SHE WANTED TO BE A SCIENTIST. She knew it the way other kids know that they want to be skateboarders or veterinarians or cowboys. What she didn't know was that realizing her dream of becoming an astrophysicist would involve: 1) riding an African elephant, 2) dodging tennis balls hurled by high school students, and 3) sitting on a panel with an Apollo astronaut while representing the U.S. Department of State.

Parete-Koon came to the University of Tennessee after finishing a bachelor's degree in physics and chemistry at Bluffton University in Ohio. She finished the master's program in physics, taught high school science for awhile, and then re-joined the department in the astrophysics group, earning a Ph.D. in 2008. Next she embarked on a whirlwind, worldwide tour via a State Department fellowship through the American Institute of Physics. Her primary responsibilities revolved around the policies and diplomacy related to space weather and ITER, an international energy collaboration.

Satellites, Elephants, and Tin-Foil Hats

At first blush, the weather in outer space might seem an odd concern for an agency that sends diplomats to nearly 200 nations. But Parete-Koon explained that what's going on well beyond the stratosphere has serious implications for those of us who are earthbound.

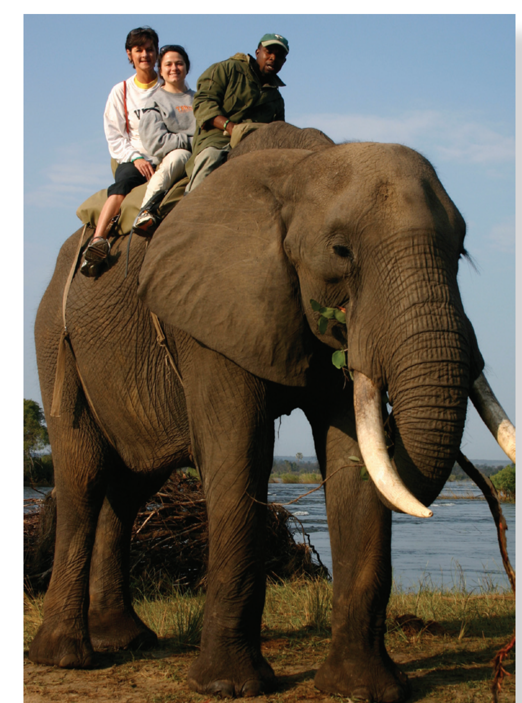
"We have an active sun that spits a lot of particles at us that could damage our satellites and take out our power grid," she said. "We've only just become really, really dependent on satellites for everything—communication, navigation, even banking. A lot of our farmers use tractors that are GPS-guided so they'll precision fertilize; they save a lot of money that way. All these things are vulnerable to damage by solar storms."

The Space Weather Prediction Center in Boulder, Colorado, is one means by which the country monitors solar and geophysical events, working with both national and international partners with whom they share data, tools, and services.

"That's where the State Department comes in," Parete-Koon said. "They try to make sure that there are agreements in place so that they can do science with other countries and monitor the whole globe."

Part of this effort was working with the International Heliophysical Year (IHY), an initiative promoting a greater understanding of both space science and heliophysics (how objects interact with the immense magnetic bubble containing our solar system). One aspect of the program involved delivering instruments that use GPS and radar to figure out what's going on with the ionosphere—the uppermost part of the atmosphere—at the equator. (Given the magnetic field around the earth and the sun's relative position, "space weather at the equator is very hard to predict," Parete-Koon said.)

"That's how I ended up in Africa," she said, where she managed to sneak in a ride on an elephant in the midst of long hours of work, including a meeting at the United Nations to discuss a new program in the IHY vein aimed at continuing astronomy education and instrument distribution.



Suzanne Parete-Koon (center) takes a ride with Bop the elephant during a trip to Africa.

Having her photo made at the iconic UN Council table and crossing oceans to check on the equator were not exactly items Parete-Koon thought her appointment would include, but they made the job that much more exciting.

"When I took the State Department fellowship, I didn't think that I was going to be traveling or speaking in the capacity of a diplomat," she said. "I thought diplomats were going to send papers across my desk and I (would) read them and say, 'yep, that's science; no, that's a guy with a tin foil hat on.'"

While the tin foil-hat-wearing guy never showed up, she did get to spend a little time with the Sphinx.

Parete-Koon was just two days into her fellowship when Egypt came calling. Her predecessor, an AAAS (American Association for the Advancement of Science) Fellow, had made some contacts involved with an international symposium on space weather. An invitation to the meeting, in Cairo, wound up on her desk, so the State Department sent her as their representative. She gave a talk explaining how her office develops frameworks between the U.S. and other countries to ease cooperation, and also explained the rules and provided people with contacts. She worked with a representative from

Continued on page 10

Suzanne Parete-Koon, continued from Page 9

> *"I would recommend these science policy fellowships to any scientist. I would never have expected that physics would lead to Cairo."*

Egypt's space agency on a potential workshop for countries with smaller satellite programs to work together for maximum benefit.

"I ended up continuing to work with Egypt to see if this workshop was possible and if there were an organization in the inter-agency that would be interested," she said. "That was my other function—to find science cooperation opportunities that would be mutually advantageous for the U.S. and the country I was in."

Along with space science policy, Parete-Koon's second major responsibility was ITER, now known by its acronym, but originally christened the International Thermonuclear Experimental Reactor. Currently under construction in the south of France, ITER is an international collaboration that seeks to use fusion as a next-generation commercial energy source. Each partner has four representatives on the project's governing body, the ITER Council, and Parete-Koon was selected to visit France as a council delegate for the United States.

"That was absolutely phenomenal," she said.

Land of Lincoln

It might be easy to conclude that some exotic city outside North America was the travel highlight of Parete-Koon's year-long fellowship, but that is not the case.

"I went to Zambia and all these really amazing places," she said, "but Lincoln, Nebraska, is what sticks out in my head."

Her supervisor was slated to sit on a panel at the April 2009 Space and Telecom Law conference at the University of Nebraska in Lincoln, but a shift in scheduling meant he sent Parete-Koon instead. She had been working with a number of groups that were studying how world governments might react to the possibility of an asteroid or near-earth object impact, and as that was the topic of the meeting, she was a good fit to represent the State Department. So she met with NASA and the Office of Science and Technology Policy, got the inter-agency opinion, and polished her talking points. She headed off to Lincoln thinking her fellow panelists would be her peers. She arrived in Nebraska to find they were Apollo Nine Astronaut Russell "Rusty" Schweickart; Sergio Marchisio, who chairs a UN subcommittee on the peaceful uses of outer space; and other high-ranking diplomats from Japan and Nigeria.

"So they give their perspective from decades of managing world peace in space and I give my perspective from six months following near-earth objects and talking to the Office of Science and Technology Policy last week about it," she said, laughing.

Still, she saw the experience as a tremendous opportunity and walked into it undaunted. Interestingly, it was Parete-Koon's tenure teaching physics students at the high school and college levels that forged her considerable mettle.

"I just didn't fear anything, even when I was on that panel with all those leaders and an astronaut," she said. "After being heckled for years doing recitations, I don't really have a lot of fear of public speaking; especially after the high school kids and their antics."

(During a high school teaching stint in Florida, Parete-Koon faced a classroom of students who would pull the tennis balls from the feet of their desks, put there to protect the floors, and throw them at her while her back was turned.)

"Some diplomat may come at me and say 'I can't believe the U.S. is doing that,' but he's not armed with tennis balls," she said.

Possibilities

Parete-Koon's fellowship ended earlier this year, and she and her husband Tim, an audio engineer with WBIR-TV, are settling back in to life in Knoxville. She is currently working as a postdoc in Oak Ridge National Laboratory's Astrophysics Program, studying supernovae and nucleosynthesis. She enjoys the technical aspects of modeling supernovae, "or anything you could describe with math," and said her collective experiences have widened her interests to encompass teaching and writing. The AIP fellowship reinforced the appeal of those opportunities; particularly in communicating about science within the profession she chose a kid and with the general public as well.

"I would recommend these science policy fellowships to any scientist," she said. "You do feel a sense that the clock is ticking and you're not publishing, if you're in the early phase of your career, but you're meeting everybody from every agency."

For Parete-Koon, science is about both people and possibilities, and she's happy to see where those possibilities might take her.

"I would never have expected," she said, "that physics would lead to Cairo."

4,850 Feet under the Earth

By George Duffy

When I first came to the University of Tennessee, I was excited about getting into research. Of course, as a freshman undergraduate, I never really knew what "research" was, but I had some ready stereotypes—me in a lab coat, taking laser measurements or playing with test tubes. However, I never dreamed I would find myself 4,850 feet underground in an abandoned gold mine, leading a team of five researchers in a magnetic survey of the deepest shaft of what would eventually be the world's largest underground laboratory.

But there I was, and what's more my job was already done and successful. This was the target of my research over the summer; I was working with Dr. Yuri Kamyshkov for his proposed N-Nbar experiment, and it was my job to measure the magnetic field of the shaft so that we would know what kind of effects to compensate for in designing a magnetic shield. The work up to this point had been grueling; in between a job, summer school, and research, I was in the physics building until 3 a.m. almost every night and I had to neglect pretty much all social life for the month of June. But it was all worth it as I now stood more than a kilometer under the surface of the Earth.

For more reasons than one, I was lucky to even be there. Only two months back, this whole level had been deep underwater, and while the shaft I was taking would eventually be the main elevator of the Deep Underground Science and Engineering Laboratory (DUSEL), the world's largest underground lab, for the time being it was an abandoned gold mine in the middle of serious repair. In fact, the second shaft I surveyed didn't even have walls in the elevator. I had to be physically latched on to posts. This all only increased the sense of adventure though, and by the end of the day I had two ideal magnetic maps of over a kilometer of deep rock. What's more, the results were a great success. Even with the magnetic anomalies of the scaffolds and the ore, the magnetic field was fairly constant the whole trip down in both shafts. My work proved that our proposed experiment was feasible and gave us a model of what to look for in designing a magnetic shield.

Undergraduate Research

Undergraduate Physics Major George Duffy under the Davis Tank during his summer adventure in South Dakota.

My subterranean experience wasn't over though, for it turns out that this wasn't just any hole in the ground. Unbeknownst to me before my arrival, I was actually standing in a bit of scientific history. Over 40 years ago, Ray Davis performed his Nobel Prize-winning solar neutrino experiment in this chamber, stubbornly trusting his results to eventually provide the first proof that neutrinos could change their flavor in transit from the sun. When I learned that I was so close to this tank, I decided that I couldn't leave without seeing it. So once we surfaced and I overheard another group discussing that they were going to take Radon measurements of the chamber, I quickly chimed in that it might be interesting to see the magnetic field of the neutrino tank (my battery was actually dead at this point; no one needed to know). The professors agreed and after traveling about a mile through caves I ended up in the Ray Davis Room. I even had enough time to snap some pictures next to the tank before I was quickly rushed to the surface and flown back home to Tennessee.

The experience was the highlight of my summer. Not only did I have an unforgettable experience in an historic gold mine, but my research companions ensured that my whole stay was enjoyable. When I wasn't traveling under the Black Hills I was exploring them. I was lead on a tour through the Spearfish Canyon, got to see first-hand the famous Mount Rushmore, and had one of the greatest cheeseburgers I've ever found, complete with a side of "freedom fries" and some "pop" to drink. I'd never have guessed it, but South Dakota is actually a lot more exciting than I ever could have imagined.

George Duffy is an undergraduate physics major, recipient of a General Physics Scholarship, and president of the University of Tennessee Chapter of the Society of Physics Students.

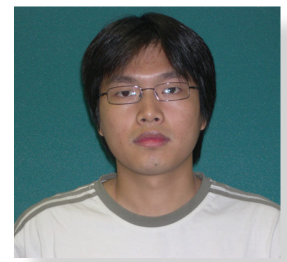
> *". . . it turns out that this wasn't just any hole in the ground. Unbeknownst to me before my arrival, I was actually standing in a bit of scientific history."*

Physics Family News

Students

Oleg Ovchinnikov

Undergraduate physics major **Oleg Ovchinnikov** has been selected for Honorable Mention in the Computing Research Association's (CRA) Outstanding Undergraduate Research Award competition for 2010. His submission was titled "Deciphering Energy Transforms on the Nanoscale: Artificial Neural Networks and Scanning Probe Microscopy." The CRA is an association of more than 200 North American academic departments of computer science and engineering and related fields; as well as industry, government, and academic centers engaging in basic computing research. The undergraduate research award program recognizes undergraduate students in North American universities who show outstanding research potential in an area of computing research.



Jun Zhao

Jun Zhao, a member of Pengcheng Dai's research group, has won the GMAG (Topical Group on Magnetism and its Applications) Student Dissertation Award from APS. This is the second award to a graduate student from the Dai group. (Former graduate student Stephen Wilson won this award in 2006-2007, and will join the faculty of Boston College in January 2010.) Zhao will give an invited talk at the APS March meeting in Portland 2010. He receives a $500 prize and up to an additional $250 in travel expenses to attend the meeting.

Faculty

Elbio Dagotto

Two physics faculty members, **Dr. Elbio Dagotto** and **Dr. Witek Nazarewicz,** have been elected to fellowship in the American Association for the Advancement of Science (AAAS). Election as a Fellow of AAAS is an honor bestowed upon members by their peers. Fellows are recognized for meritorious efforts to advance science or its applications. A Distinguished Professor of Physics at UT and a Distinguished Scientist at the Materials Science and Technology Division of Oak Ridge National Laboratory, Dr. Dagotto is also a fellow of the American Physical Society and a member of the Solid State Sciences Committee of the National Academy of Sciences.

Earlier this year Dr. Nazarewicz received more than $300,000 in funding from the National Nuclear Security Administration (NNSA) for a project titled "Microscopic Description of the Fission Process." The grant was among $20 million worth of awards the agency is investing in studies associated with the safety, security, and reliability of the nuclear weapons stockpile. In July 2009 he was presented with the honorary degree of Doctor of the University of the West of Scotland.

Witek Nazarewicz (center) received an honorary degree of Doctor of the University of the West of Scotland in July. From left: the Principal and Vice-Chancellor of the University of the West of Scotland Professor Seamus McDaid, Witek Nazarewicz, and Roddy Williamson; Dean, Faculty of Science and Technology.

Dr. Jim Thompson and Research Assistant Professor Yuri L. Zuev and their colleagues have fabricated and tested a new kind of superconducting wire that avoids the "frictional" losses that have plagued earlier versions. Their efforts on "Superconducting Wires by Expitaxial Growth on SSIFFS (Structural, Single-Crystal, Faceted, Fibers)" culminated in an R&D 100 Award in the Electrical Equipment category. Since 1963, the R&D 100 Awards, sponsored by R&D Magazine, have identified revolutionary technologies including the ATM, the fax machine, and HDTV.

Dr. Hanno Weitering has been elected a fellow of the American Physical Society in recognition of his contributions to electronic instabilities and magnetic phenomena at surfaces, interfaces, and in thin film materials. The recommendation came from the APS Division of Condensed Matter Physics. In 2006 Weitering was named a Chair of Excellence for the UT-Oak Ridge National Laboratory Joint Institute for Advanced Materials for his original and creative contributions to understanding novel physical phenomena in low-dimensional materials. In 2007, along with ORNL researchers and fellow faculty members Zhenyu Zhang and Ward Plummer, he was awarded a $1.2 million grant from the Department of Energy to work on controlling hydrogen chemistry for energy applications. This fall he and Zhang, working with colleagues from Oak Ridge and Argonne National Labs, have published research that shows the possibility of improving titanium oxide's ability to absorb visible light—another potential energy source.

Hanno Weitering

Outreach

Students made spectroscopes and discussed the importance of spectroscopy in astronomy and planetary science in Paul Lewis' class on "Understanding Our Solar System," just one of the events at UT's Earth Science Fair. Middle and high school students from across East Tennessee are invited to this annual October event to celebrate the earth sciences.

Alumni

Roy T. Hull, Jr. (B.S., Engineering Physics, 1973) is a retired electronics engineer from Civilian DOD (Robins Air Force Base) and resides in Bonaire, Georgia.

Sonali Shukla (B.S., Physics, 2003) successfully defended her doctoral dissertation at Vanderbilt University in July and is now a post-doc in the Pennsylvania State University Department of Astronomy and Astrophysics.

Glenn Young (B.S., Physics, 1973) retired from his post as Director of the Oak Ridge National Laboratory Physics Division on August 28 after more than 30 years of service to ORNL. He is moving to Thomas Jefferson National Accelerator Facility, where he will be associate project manager for physics for the 12GeV upgrade.

In Memoriam

The department lost a former faculty stalwart with the passing of **Dr. Mack Breazeale** on September 14. He was 79 years old. Dr. Breazeale was a member of the physics faculty from 1962 until 1995, where he helped develop the astronomy program and contributed to fiber research with Dr. Ken Hertel. He went on to become a Distinguished Research Professor and Senior Scientist at the National Center for Physical Acoustics at the University of Mississippi. Dr. Breazeale was a longtime editor of the *Journal of the Acoustical Society of America* and a fellow of the Acoustical Society, receiving its Silver Medal in 1989. He was also a fellow of the Institute of Electrical and Electronics Engineers and of Great Britain's Institute of Acoustics.

The department was saddened by the loss of **Delle Craven**, who passed away on October 3 at the age of 88. The widow of Physics Professor Jack Craven, she was one of the first two women to receive a Ph.D. in English from the University of Tennessee. She was native of Talladega, Alabama, and graduated from Alabama College (now University of Montevallo). She taught English at UT until her retirement in 1979. Mrs. Craven was an active member of St. John's Episcopal Cathedral, where she was an early organizer of the FISH ministry. She studied organ, loved music, and was a beloved member of the physics family.

Physics Family Photos

On December 8, the physics department got together to honor Dr. Bill Blass' more than 42 years of service to the university. During his tenure he has overseen the Molecular Systems Laboratory, taught a broad spectrum of undergraduate and graduate courses, helped restore the iconic flag the Star Spangled Banner, served multiple terms on the faculty senate (including a term as president), and helped develop a computer facilities plan for the university system. As he becomes professor emeritus, the department will still enjoy his company as we wish him the best of luck on his future endeavors.

Dr. Blass and his lovely wife, Betty.

Current Faculty Senate President Toby Boulet offered his congratulations.

Dr. Jim Parks, Associate Department Head, presents Dr. Blass with a gift from the department.

Current Department Head Soren Sorensen and former Head Bill Bugg.

Professors Emeritus Kermit Duckett and Tom Callcott.

Thanks to our Donors

The department is pleased to acknowledge the generosity of the following donors for their support:

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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
The G. Samuel and Betty P. Hurst Scholarship Fund
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 General Scholarship Fund
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CROSS SECTIONS
is published twice each year by the UT Knoxville Department of Physics & Astronomy.

Department Head: Dr. Soren Sorensen

Associate Department Heads: Dr. Marianne Breinig and Dr. James E. Parks

Publications Coordinator: Catherine Longmire

(865) 974-3342 phone (865) 974-7843 fax

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Original photograph by Chad Middleton (Ph.D., 2005)

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A project of the UTK Department of Physics & Astronomy, (865) 974-3342, with assistance from the UT Creative Services Division. 6872