Spring 2005

Cross Sections Spring 2005

Department of Physics and Astronomy

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

CROSSSECTIONS

SPRING/SUMMER 2005

RESEARCH HIGHLIGHT

String Music

Dr. George Siopsis and the Theory of Everything

So here it is, 2005, the World Year of Physics, and everyone is reflecting on Albert Einstein's groundbreaking work from a century ago. But for Associate Professor of Physics George Siopsis the excitement generated by those discoveries isn't history—it's the future.

Dr. George Siopsis

"Einstein is actually still alive," he said. "Even though his major work was over 100 years ago…his ideas are still alive. People are still working on them because we still don't know the answer to these questions."

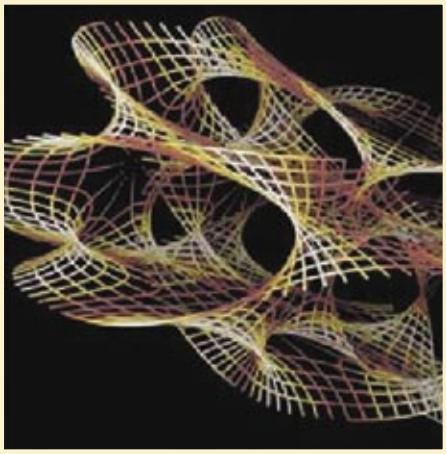
Scientists worldwide are celebrating the anniversary of Einstein's articles on special relativity, quantum theory, and Brownian motion—all published in 1905. A few years later Einstein would put the finishing touches on general relativity. And while these legendary papers forever changed science, they generated as many questions as they answered. Most obvious is the disparity between general relativity and quantum mechanics. General relativity describes how energy and matter can bend space and time; quantum mechanics explains the behavior of subatomic particles and forces. As Dennis Overbye wrote in *The New York Times*, "In the former, nature is continuous and deterministic, cause follows effect; in the latter, nature is more discrete, like sand grains on the beach, and subject to statistical uncertainties."

What's needed to bridge the gap is a unified quantum description of nature, including the gravitational force. String theory provides one such explanation, and Dr. Siopsis is investigating the possibility that it might solve this mystery Einstein left behind. As Department Head Soren Sorensen explained, "George is our superstringer."

SIMPLE ELEGANCE

"String theory," Dr. Siopsis explained, "is very simple."

The model takes its name from the idea that if scientists were to examine subatomic particles like neutrons or quarks with a detailed view far beyond current technological capabilities, they would discover that each particle is a small, oscillating, one-dimensional loop—a string. Both the particle's mass and force are determined by the way the string vibrates. The theory has attracted popular attention by means of Brian Greene's book, *The Elegant Universe*, and the corresponding PBS series.



A decade ago, Harvard scientists "unraveled" a black hole—a mass of strings and D-branes (multidimensional membranes) and calculated its entropy. Their results corresponded to predictions made by Stephen Hawking, who had proposed that the entropy of a black hole was its area divided by four.

"The entropy of a black hole is one of the successes of string theory," Dr. Siopsis said. "The string actually explains the entropy of a black hole."

By taking an in-depth look at the properties of black holes and other extended objects, he and his students are digging deeper into the possibility that string theory might be the approach that reconciles general relativity and quantum

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IN THIS ISSUE

FROM
THE HELM

A Message from Soren Sorensen, Department Head

Listening to our Alumni

Last fall the department did something we have never done before: we asked our alumni to provide us with feedback on the education they received from us. The purpose was to identify both what aspects of our educational programs work well and, in particular, what we need to improve. All physics graduates from the past 20 years (and for whom we have a reliable address) were sent a 10-page survey with questions related to their careers, the relevance of their physics education to their careers, their general satisfaction with their education, and ample space for comments. Currently we have received 65 responses for a response rate slightly above 25 percent, which is better than the usual 15-20 percent rate for surveys like this. We are extremely grateful to the many alumni who spent a considerable amount of time responding to the survey. Helping us in this way is an unselfish gesture, since the resulting improvements will not help our alumni, but only our many new students.

So what did our alumni tell us? Overall, the satisfaction with their physics education was high. The alumni who graduated at the bachelor's level gave us a grade of 3.9 out of 5 and the Ph.D. alumni gave us 4.3, with similar scores to questions like, "I made the right choice by majoring in physics" and "I am pleased with my career progression to date."

Other questions assessed our educational goals as formulated during the recent SACS accreditation process for UT. Alumni were asked to gauge both the importance of each goal and their preparedness after having finished their education. In general, there was a close correspondence between the two. For example, bachelor-level alumni rated the importance of "develop an understanding of and competence in the theoretical foundations of physics" as 3.3 and their level of preparedness as 3.8. However, there were two areas where all alumni felt there was a discrepancy between the goal's importance and their preparedness: developing skills in oral presentations and in scientific writing. This is definitely a message we will not ignore. This focus on improving our students' oral presentation and writing skills goes well with the university's new emphasis on these skills in the general education curriculum. We need to incorporate more elaborate individual reports in many of our classes and labs and also require students in upper-division and graduate classes to make presentations. We have already taken steps in this direction with our graduate-level seminar classes, where most of the students give several oral presentations on topics related to their research. We also need to improve opportunities for all of our students to attend and give presentations at regional or national APS and AAPT meetings. In short, today it is not enough to know a lot of physics and do good research; you also need to present your work in a way that the rest of the world will understand and appreciate.

Further questions addressed the perceived importance and preparedness in specific areas of physics and related areas. Overall there was good agreement between our graduates' evaluation of an area's importance and their level of preparedness. However, our alumni recommended more emphasis on applied areas of physics like experimental techniques, applied physics and biophysics. Again, we will not ignore this advice and will try to improve these areas. The recent addition of adjunct professors in areas like micro-sensors, accelerator physics, applied laser physics, and medical imaging hopefully will give our students more opportunities to acquire skills in these areas. Our alumni are also asking for better training in numerical techniques, and here we hope that the new course in numerical physics, aimed at graduate students and the best undergraduate seniors, will help. There are also plans for a more elaborate concentration in numerical physics for our M.S. and Ph.D. programs in connection with the new Joint Institute for Computational Science.

One can learn a lot from studying the numerical scores given by the alumni, but somehow it is much more illuminating and interesting to read their many comments. Together they fill 24 typewritten pages, so there is a lot of stuff to digest! Many alumni gave personal comments about faculty members: "Excellent solid state physics instruction from Quinn;" "Professor Blass provided me with the freedom that has paid off by allowing me to have the ability to think out of the box;" "Stu Elston's detailed and critical way of thinking has helped me along my career, and I believe it will influence me through the rest of my life;" "Ted Barnes was an excellent teacher;" and "Watching and working with Dr. Breinig taught me a lot;" to single out a few. Many graduates also commented on the importance of interaction with ORNL: "The vast majority of my development in research, writing scientific papers, giving oral presentations, and my critical analysis came from working with a great group of people at Oak Ridge;" and "High quality and broad experience base through research experience in collaboration with national labs in Oak Ridge and Brookhaven." Finally, many comments focused on the areas of improvement discussed above: "Incorporate

A Little Help from Their Friends

Physics Opens a New Tutoring Center

Dan Parshall is not above swinging on a door to get his point across. And for those struggling with the fundamentals of physics, that just may do the trick.

Recognizing that many students find physics intimidating, Department Head Soren Sorensen decided a center dedicated to one-on-one assistance might alleviate some of their anxiety. To help them wind their way through magnetism, waves, and optics, the department launched the Physics Tutorial Center (PTC) during the spring semester. The center is open five days a week and staffed by physics and engineering physics majors, both graduate and undergraduate. (Undergraduate tutors have passed at least their introductory physics courses.)

Dan, a first-year graduate student, was charged with organizing the PTC to get things rolling.

"Part of what I'm doing this semester is defining the role of the PTC coordinator," he said. "Soren knew what he wanted and my job has been to implement it. I've been more responsible for the 'medium scale' vision." (He's also taking a Wednesday afternoon shift as a tutor.)

Dan checked with the math and chemistry departments, as well as other universities' physics departments, to see how they handle tutoring. He also consulted physics students who've worked as tutors in the past. Out of those efforts came the PTC, situated on the second floor of the Nielsen Physics Building.

The center is not a "study lounge." Students are asked to come prepared with specific questions or problems.

"There's an average of six students down there whenever the PTC is open," Dan said. He often finds them waiting outside the door to get in or staying late to complete homework.

As Dan puts it, "either they have problems with the concepts or problems with the math." To make concepts more understandable, his personal approach is to help students "build their intuition," using analogies or visuals (hence swinging on a door). Other students might need help adjusting to the format of online homework problems. If two or three have the same question, Dan gives a kind of "mini-lecture" to all of them at once.

Every week the homework problems change in physics, and just as they do, the students show up at the center. They'll work in groups, or with a tutor, to master their assignments.

The center is open to any UT student taking physics classes. The PTC Web site (*http://www.phys.utk.edu/tutorialcenter/*) offers tips on problem-solving and outlines responsibilities for both tutors and students. The department is also building a "mini-library" of reference books to be used in conjunction with the tutoring center.

"On the big scale, we're done. It's just refinement now," Dan said. "I'd say (the PTC is) operating at 90 percent efficiency. I'll think we'll have the other 10 by the end of the semester."

Graduate students Jonny Dadras and Chad Middleton discuss the finer points of quantum mechanics in the Physics Tutorial Center.

more experimental hands-on courses;" "More emphasis on improving writing skills;" "More emphasis on application of the things we learned in class to real-world problems;" and "More focus on applied physics and numerical analysis."

Now the ball is in our court. We need to take the message from the alumni and use the positive criticism to make our department even better. But overall, the verdict from our graduates was good. We seem to have done well over the past 20 years, and the overwhelming majority of our alumni are very pleased with their experience in our department. Let me finish with one more quote from a recent graduate: "UTK gives great value and a strong student oriented learning environment. Many of the professors gave excellent lectures, on par with much more prestigious research institutions. Enthusiasm for teaching was high among the faculty, especially in the physics department."

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Richard Hatcher at the Andøya Rocket Range in Norway.

Globetrotting

Undergraduate Richard Hatcher Spends a Term in Norway

When pressed for conversation in Norway, take a tip from Richard Hatcher: bring up soccer. That's one of many valuable lessons the UT senior learned during his semester in Oslo.

At first he was a little unsure about spending a term abroad, but after giving it some thought, he decided studying in another part of the world would be a smart move.

"Physics is such an international science," he said. "To do well in the field, you have to understand other cultures."

So he signed on for UT's bi-lateral exchange program, spending the fall 2004 term at the University of Oslo in Norway.

"The city is wonderful," Richard said. The capital of Norway has an excellent transportation system, which made it easy to take in festivals, soccer matches and cultural spots like the Viking Ship Museum and the National Gallery.

And the Norwegians made him feel welcome from day one.

"They warm up to people really quick," he said, and, luckily for him, "everyone knows English." Whenever he stumbled upon an awkward pause in conversation, he found there was at least one topic that would encourage lively discussion.

"You can always get them to talk about soccer if you can't talk about anything else," he said.

That enthusiasm proved contagious.

When Bergen's soccer team beat Oslo's during the Norwegian Cup, their fans took to the streets of Oslo to celebrate.

"That's like Gator fans celebrating on Philip Fulmer Way," Richard said. "So I bought an Oslo scarf and ran through the crowd."

All games aside, there was still physics to be studied. Richard visited the Andøya Rocket Range, the northernmost permanent launch facility anywhere in the world. (Unfortunately, it was too cloudy to see the northern lights.) He spent time in an optics lab where the students had cleverly employed Carlsberg beer cans as dustcovers. Oslo's program offers several courses in English, and he availed himself of the opportunity to take classes in computational and atmospheric physics, among other topics. His academic work will show up on his transcript as a foreign studies credit.

Richard is putting together an information sheet for other students interested in studying abroad, specifically in Norway. Some points travelers should know: it takes nearly three months to finish the paperwork for a residency permit and students must have 40,000 Krones (about $6,500) in a Norwegian bank. Yet despite the "hoops to hop through," he added there is no question it was worth the trouble. In fact, he wishes he had gone for two semesters instead of just one.

"I had a great time," he said. "I'd like to go back one of these days."

Continued from page 1

mechanics. They are looking closely at the scattering of black holes and small perturbations of black holes at equilibrium. Other investigations involve "fat branes" (membranes of finite thickness) and gravitons (the hypothetical particle that transmits the force of gravity) to show the extra dimensions predicted by string theory.

"Gravity is very weak and nobody can explain it," Dr. Siopsis said. "String theory can explain it. If we see a modification of Newton's Law because of the extra dimension, that means that we have actually found a signal of string theory, because the particle theory would have everything going in the extra dimension; string theory only has gravity going in the extra dimension."

Dr. Siopsis' research program has attracted some of the department's top students. Scott Ness is working with him to understand the origin of the positive cosmological constant of our Universe, which is driving its expansion. Chad Middleton has been studying the DGP model (named for physicists Dvali, Gabadadze and Porrati), a geometrical setup that assumes infinite extra dimensions. He will finish his Ph.D. this summer and has accepted a faculty position at Rhodes College in Memphis, beginning this fall. Suphot Misuri, who finished his doctorate last year, was involved in the study of black holes and accepted a faculty position in his native Thailand after graduation. He visited UT this spring to continue his research. Already two new Ph.D. students have signed on to join the Siopsis Group in the fall.

Although string theory itself is simple, the calculations and equation-solving it requires are complex.

"The successes of string theory are intellectual," Dr. Siopsis said, smiling.

And while, like all theories, it has its detractors, Dr. Siopsis remains unwaveringly optimistic that this elegant approach may yet prove to be the holy grail in physics: a theory of everything.

"String theory has been very successful in incorporating all the forces, and also as a quantum theory of gravity," he said. "(It) may not have experimental confirmation, but it has provided all kinds of ideas."

Dr. Ed Jones and the Science of Psychiatry

It's March 4, and Dr. Ed Jones and son are leaving the snowy landscape of their home in Mammoth Lakes, California, for a 50-mile backpacking trip in the Grand Canyon. It might seem more like work than a vacation to some, but Dr. Jones is not daunted by a challenge.

The Knoxville native started classes at UT in 1980, graduating with a bachelor's degree in physics in 1985. Growing up with family in medicine and an affinity for their work, he debated a career in physics versus medical school.

"I've always been kind of torn between the two," he said.

The late Dr. Bob Lide, on the physics faculty at the time, offered this advice:

"(He) told me, 'If you want the prestige, get the physics degree. If you want the money, go to medical school,'" Dr. Jones recalled. (Chuckling, he said he discovered there was no fortune in either field.)

He began a round of med school applications, and in some cases was asked to reapply. But by then he had also begun investigating graduate programs in physics, and never got around to those reapplications. Instead he went for a doctorate in physics at UT.

In 1987, high temperature superconductivity came to the forefront, and in 1989 Dr. Jones joined Dr. Jim Thompson's group, finishing his Ph.D. in 1992. The job market had shifted, however, as the cold war came to a close. He joined ORNL as a postdoc in the thermoelectric group. Soon thereafter, an opportunity opened at Y-12 involving the testing of a 60Hz ac-superconducting cable to be used to power Chicago. But, he said, the supercollider lost funding and hiring freezes in superconductivity became the norm.

He retook the MCATs and reapplied to medical school.

"About two weeks after I was accepted to medical school, Bob Dynes offered me a postdoc position," he said.

Dr. Dynes, then chancellor at UC San Diego, is a physicist and an expert on semi- and superconductors. Once again, Dr. Jones had to make a choice between physics and medicine.

"I talked to the only four doctors that I could locate who had Ph.D.s in physics and M.D.s," Dr. Jones said. "They all said I would regret not going to medical school."

So he enrolled at Meharry Medical College in Nashville and last summer finished his residency in psychiatry and neurology at Vanderbilt University.

Dr. Jones at his medical school commencement.

"There are actually more physics applications in psychiatry than in neurology," he explained. "The brain is so complex that it requires quite a bit of chaos theory."

He also uses Fourier analysis to pick out patterns: to see how the neurotransmitter metabolites behave—how the neurons talk to each other. He studies how the patterns are different for people who are depressed versus those who are not. Physics training, he finds, is especially helpful in medicine.

"You can use it in just about every medical field: from surgery down to psych," he said, ticking off examples such as how respiratory systems involve volume and pressure and how psychiatry uses chaos theory to model mood disorders.

Dr. Jones will share that knowledge with medical students in his new position: he joined the faculty at Loma Linda University beginning April 3. He and his family (wife Gita and their children, 12-year-old Jonathan and 8-year-old Elizabeth) will move to a less snowy climate, and on the side he will do neural networking analysis.

"I still putter around in research," he said.

Dr. Jones got involved in ionospheric studies after taking up ham radio to stay in touch with his inlaws in India. That interest acquainted him with Ray Greenwald at the Johns Hopkins Applied Physics Laboratory.

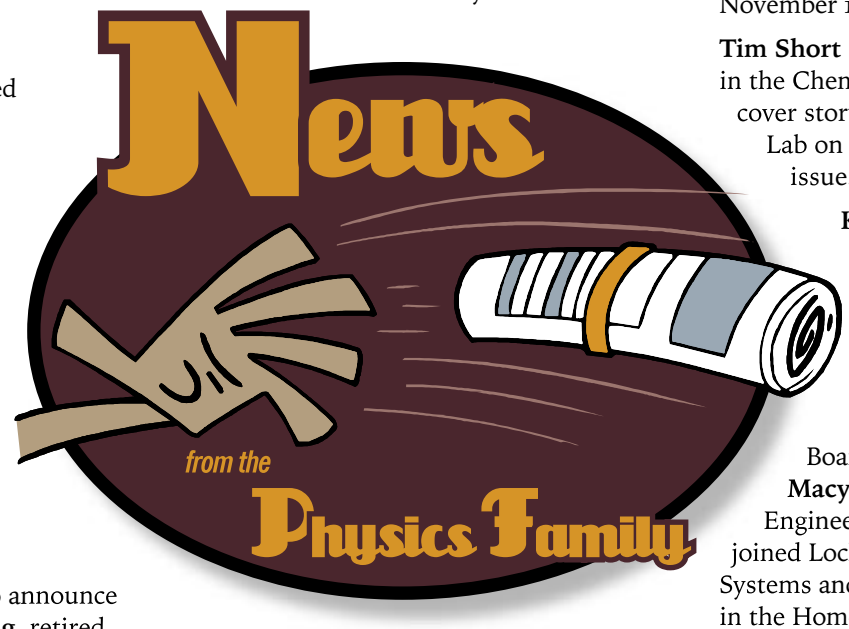
SuperDARN radars in the Northern and Southern Hemispheres.

Dr. Greenwald's group is involved in SuperDARN: the Super Dual Auroral Radar Network—an international collaboration that uses high frequency radar to study the ionosphere. Dr. Jones has taken radar data that augments that of the Johns Hopkins group. Recently, the Department of Defense has become interested in his ionospheric work as a means of improving their global positioning systems.

That may seem an odd avocation for a physician, but as Dr. Jones said, "There aren't too many psychiatrists who can do Fourier analysis."

STUDENTS

Graduate Student Donald Hornback is one of 600 graduate students worldwide selected to attend the 55th Meeting of Nobel Prize winners from June 26 through July 1 in Lindau, Germany. The meeting will include representatives from medicine, physics, and chemistry, with 53 Nobel laureates scheduled to attend. Donald spent six years in the United States Air Force before completing a bachelor's degree in physics at UT. He is now working toward a doctorate with Drs. Soren Sorensen and Ken Read in the Relativistic Heavy Ion Physics research group.



STAFF

The department is sad to announce the death of **Charlie King**, retired physics staff member, who passed away March 16. He was 72 years old. For years Mr. King was responsible for maintaining inventory and laboratory equipment—doing everything from setting up lecture demonstrations to making sure the undergraduate labs had the equipment they needed. He will be sadly missed.

FACULTY

Physics Professor **Witek Nazarewicz** is co-author of a paper published in *Nature* proposing that super-heavy nuclei may have a chameleon-like quality that helps them survive.

In "Shape coexistence and triaxiality in the superheavy nuclei," published in the February 17 issue, Dr. Nazarewicz and his colleagues predict that "long-lived superheavy elements can exist in a variety of shapes—spherical, axial and triaxial configurations." They also put forth the idea that these shapes can make identical elements decay in very different ways, which can complicate the journey as researchers seek to fill out the periodic table.

See the paper online at: *http://www.phys.utk.edu/witek/Nature/natureSHE.pdf*

Dr. Nazarewicz has also been invited as one of three members of the International Advisory Board for EURISOL, a project aimed at the design—and eventual construction--of the next-generation European Isotope Separation On-Line Radioactive Ion Beam Facility.

Four scientists with ties to the UT Department of Physics have been elected fellows of the American Physical Society. **David Dean, Anthony Mezzacappa, Serge Ovchinnikov,** and **Lal Pinnaduwage** will join the ranks of APS members recognized for making significant contributions to the world of physics through research, applications, or teaching. Every year, their peers elect less than one-half of one percent of the current APS membership as fellows.

Dr. Dean is an adjunct associate professor in the department. He is a senior scientist in the physics division at Oak Ridge National Laboratory where he is also the nuclear theory group leader. **Dr. Mezzacappa** is adjunct professor of physics and an astrophysics theorist at ORNL. **Dr. Ovchinnikov** is a research professor in the physics department. **Dr. Pinnaduwage** is a research professor in the department and a senior scientist at ORNL.

ALUMNI

Alan Ewing (M.S., 1993) is a senior engineering manager with Nokia Mobile Phones in Irving, Texas.

The department was saddened by the passing of **Dr. John Wilson Thomas Dabbs** (Ph.D., 1955), who passed away November 17, 2004.

Tim Short (Ph.D., 1987) was featured in the Chemical & Engineering News cover story, "Taking the Analytical Lab on the Road" in the March 28 issue.

Korey Sorge (Ph.D., 2002) has accepted a position as an assistant professor in the department of physics at Florida Atlantic University.

Board of Visitors Member **Macy Summers** (B.S., Engineering Physics, 1981) has joined Lockheed Martin's Integrated Systems and Solutions and is working in the Homeland Security Systems based in Valley Forge, Pa.

Alexander Thesen (Ph.D., 2003) is a product manager with Carl Zeiss Nano Technology Systems in Oberkochen, Germany.

Glenn Young (B.S, 1973) has been elected a Fellow of the Institute of Physics. He directs the ORNL Physics Division and is a member of the department's board of visitors.

More Family News on the Physics Web site: A roundtable discussion with graduating seniors.

www.phys.utk.edu/news.html

At the Top of Their Game

Outstanding Students and Teachers Get Their Due at Honors Day

Each year on Honors Day the department rewards students who sacrifice hours of their young lives to excel in scholarship, leadership, and service. On April 25, members and friends of the department gathered to celebrate these accomplishments.

Dr. Lee Martin, managing member of Clarity Resources, delivered the Honors Day address, which was followed by the much-anticipated awards. The ceremony began with the induction of students into Sigma Pi Sigma, the national physics honor society. The department honors students at all levels, from the most promising first year to top graduate researchers. The students in turn, recognize faculty members with a Teacher of the Year Award, this year adding an additional award for a graduate teacher.

Stephen Wilson receives one of two Stelson Fellowships

Sigma Pi Sigma Inductees

Mehdi Bolorizadeh
Songxue Chi
Dragoslav Grbovic
Nasrin Mirsaleh Kohan
Eun Ju Moon
Ke Zhao

2005 Honors Day Recipients

Undergraduate Awards

Outstanding First Year Physics Student Award
Jeff Hankins

Robert Talley Award for Outstanding Undergraduate Research
James Alsup

Robert Talley Award for Outstanding Undergraduate Leadership
Olga Ovchinnikov and Chad Overcast

Douglas V. Roseberry Award
Gail Zasowski

Dr. Sorensen presents the Feynman Lectures to Jeff Hankins, who was honored as the Outstanding First Year Physics Student

Graduate Awards

Outstanding Graduate Teaching Assistant Award
Yi-Jung (Frankie) Yang and Ryan L. Holloman

Paul H. Stelson Fellowship in Physics (For Professional Promise)
Xiaoguang Li

Paul H. Stelson Fellowship in Physics (For Outstanding Beginning Research)
Stephen Wilson

Fowler-Marion Outstanding Graduate Student Award
Martin Djongolov

Other Honors

Robert W. Lide Citation for Outstanding Physics Laboratory Service and Development
Jason Therrien

Colloquium Award

Nasrin Mirsaleh Kohan

Honorable Mentions:
Valentina Kuznetsova, Suzanne Parete-Koon, James Wicker

Outstanding Graduate Teacher Award

Dr. Ted Barnes

SPS Outstanding Teacher Award

Dr. Marianne Breinig and Dr. Kermit Duckett

And Still More Accolades for Physics…

The physics department claimed eight citations at the university's Chancellor's Award Banquet on April 13. Among the decorated physicists were

Dr. Hanno Weitering
Research and Creative Achievement Award

Dr. Stuart Elston
Academic Outreach Award

William Overcast and Gail Zasowski
College of Arts and Sciences Citations for Academic Achievement

Olga Ovchinnikov and James Wicker
College of Arts and Sciences Citations for Professional Promise

James Alsup
College of Engineering Citation for Professional Promise

Gail Zasowski
College of Arts and Sciences Top Collegiate Scholar

SPS co-presidents Gail Zasowski (left) and Olga Ovchinnikov (right) present a Teacher of the Year Award to Dr. Marianne Breinig

More Honors Day 2005 information is available on the Web at:

www.phys.utk.edu/news.html

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GIVING OPPORTUNITIES

Undergraduate Scholarships
- The William Bugg General Scholarship Fund
- The G. Samuel & Betty P. Hurst Scholarship Fund
- The Dorothy & Rufus Ritchie Scholarship Fund

Undergraduate Student Awards
- The Douglas V. Roseberry Memorial Fund
- The Robert Talley Awards and Scholarships

Graduate Awards
- Paul Stelson Fellowship Fund
- Fowler-Marion Physics Fund

Other Departmental Funds
- Physics General Scholarship Fund
- Physics Equipment Fund
- Physics Enrichment Fund
- Robert W. Lide Citations

Giving to the Department
If you would like more information on how to make a donation or a pledge to our scholarship funds, please contact

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