

Three for Three

Haidong Zhou Wins Department's Third NSF CAREER Grant in Three Years

Haidong Zhou is not a scientist easily daunted by frustration. In fact, his latest research deals with materials that have frustration built right in. The project, titled "Emergent Quantum Spin-Liquid in Yb-Pyrochlores and Yb-Spinels," begins August 1 and lasts five years. The work is funded by the physics department's third National Science Foundation CAREER grant in three years.

The research falls in line with Zhou's interest in new materials with novel properties. Quantum spin liquids, or QSLs, are an interesting state of matter because of their magnetic "frustration." Magnetically-frustrated materials have a crystal lattice structure with strong spin correlations (spin is an intrinsic property, like charge or mass) but no static magnetic order, as the electrons' magnetic orientations are constantly changing. To understand QSLs, Zhou will work with the rare element ytterbium in some interesting arrangements.

As he explained, "(the) arrangement of the magnetic spin is kind of strange. Three magnetic spins arrange themselves as a triangular lattice: kind of a very unique structure."

The lattice is two-dimensional and frustrated, whereas "for pyrochlores and spinels, you have a three-dimensional frustrated lattice, like a pyramid. Instead of three corners, I now have four. It is still a frustrated lattice, just from 2-D to 3-D," he said.

"In the quantum spin liquid, the idea is that my spin can select several directions . . . (yet), it cannot select which one to settle on," he explained. "One

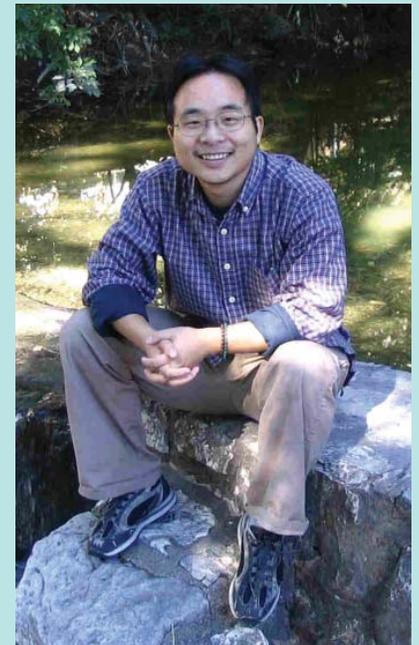
second it's like that and one second it's like that," he said, pointing his fingers in opposite directions to emphasize the point. "The time scale is (actually) much, much smaller than a second; they jump very quickly."

Frustrated materials give scientists like Zhou an opportunity to investigate novel properties related to spin and magnetism. He will also study how the sample's structure—the arrangement of atoms—might affect its magnetic properties. Given the importance of magnetism in everyday applications (computer hard drives or magnetic

resonance imaging, just to name two), getting a clearer picture of how this phenomenon is influenced is fundamental to capitalizing on its potential.

There are some parameters Zhou will have to account for to see what QSLs are all about. For one, they only show their more exotic properties at extremely low temperatures, so he will be working with temperatures down to 20 milli-Kelvin, as well as studying how the materials respond to any perturbations.

A second challenge is that there aren't that many samples available for study. Fortunately, Zhou is a crystal grower and will grow single-crystal samples



Haidong Zhou joined the physics faculty in 2012. He's a condensed matter experimentalist who studies new materials with novel properties.

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Economics of Faculty Turnover



Dr. Hanno Weitering
Professor and Head

This year has been tumultuous with faculty turnover. While condensed matter physics (CMP) Professor Pengcheng Dai had left us one year ago for a faculty position at Rice, this year nuclear physics (NP) Professor Witek Nazarewicz accepted the position of Chief Scientist at the Facility for Rare Isotope Beams (FRIB) and a John A.

Hannah Distinguished Professorship in Physics at Michigan State University. Witek had spent over 20 years of his life building the case for the advanced radioactive ion beam facility in the U.S., and with the FRIB facility becoming a reality, the offer from MSU was the one he couldn't resist. Witek has been an incredible asset to the department, and helped shape the reputation and visibility of the department on the international stage. We wish him the very best with his future endeavors.

Meanwhile, the department has been very successful (and lucky too!) with the arrival of Nadia Fomin (NP), whom we portrayed in our last newsletter, and Steve Johnston (CMP) in AY 2014 (this newsletter). This year, we welcome assistant professors Lucas Platter and Andrew Steiner who will strengthen our theoretical nuclear physics program. You will hear more about Lucas and Andrew in the next newsletters.

With Lucas and Andrew on board, the department now counts eight tenure-track assistant professors, more than any since AY 1975-1976. That's the

year when Solon Georghiou, Linda Painter, David Pegg, Lee Riedinger, C.C. Shih, and Jim Thompson were the rising stars of the department. They all stayed at UT until retirement. Lee, of course, is a notable exception as he still runs the Bredesen center. Looking at the overall demographics of the department, it is clear that we are in the midst of a generational turnover. Indeed, more faculty have announced their upcoming retirement, including distinguished professor Joe Macek, who is retiring this August.

Many departments across the country are facing a similar retirement boom and surely would like to bring in new research talent. However, faculty replacement has become almost prohibitively expensive for many universities as start-up packages have risen sharply during the past 10 years. This partially reflects the increased funding pressure, making it essential for young faculty to hit the ground running when they are hired. It also is what it takes to hire the best and the brightest. This economic reality is exacerbated by demographics.

So why should a major research university, such as UT, invest in expensive physicists? If it does, what would be the return on investment? Unfortunately, not everyone appreciates the fact that while fundamental physics research may not pay off immediately, it has been proven over and over again that it constitutes the foundation of major game changers in the overall economy. Shorter term returns include papers, grants, intellectual property, technology transfer, and ultimately rankings and prestige. But the most important ROI is the education of a highly skilled workforce, not just by

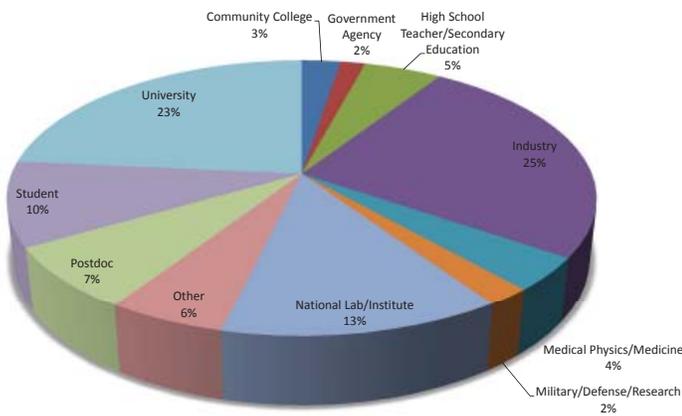
It is imperative to recognize the connection between government investment in long-term, basic scientific research and the private sector's development of innovations that improve people's lives and create jobs.

teachers, but by teachers who are working at the forefront of knowledge, meaning top researchers.

So how do we do? You may find the answer quite surprising. The department was able to track down 70 percent of our alumni who graduated between 1988 and 2013 and found that 1/3 of them actually stayed in Tennessee. Most work in industry, including software & IT, space sciences, detectors, medical devices, energy, semiconductors, etc., or in academic/research environments. Many others (bachelor's and master's grads) are pursuing advanced degrees. This is shown in the pie charts below. Of course, we love to hear from our alumni. We would like to know where you are and how your

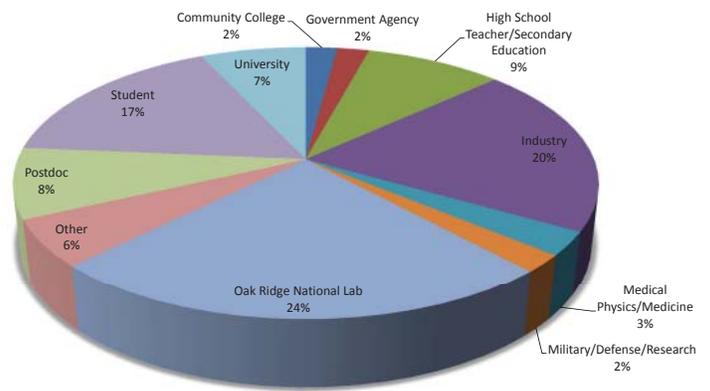
physics education has helped you to advance your careers.

It is imperative to recognize the connection between government investment in long-term, basic scientific research and the private sector's development of innovations that improve people's lives and create jobs. This formula can only work if states recognize the imperative of supporting both fundamental and applied research at their flagship universities. This begins by attracting world-class faculty through competitive start-ups and lasting commitments to grow the faculty size. Let's hope we can continue this path.



Where Do UT Physics Graduates Work?
 Most work in industry (software & IT, space sciences, detectors, medical devices, energy, semiconductors, etc.) or academic/research environments; many others (bachelor's and master's grads) are pursuing advanced degrees.

(Physics Graduates 1988-2013)



Where Do UT Physics Graduates Work in Tennessee?
 Physics alumni work for government agencies and for private sector companies. They teach high school, community college, and university classes. They are not just physicists: they are doctors, engineers, and software developers who have physics degrees.

(Physics Graduates 1988-2013)

Haidong Zhou, Continued from Page 1

in his lab. The CAREER grant supports two graduate students who will benefit from learning that process. He will also make samples and student training available to colleagues interested in the same kind of research.

Zhou earned the Ph.D. in physics at the University of Texas at Austin in 2005. He worked as a postdoc and then assistant scholar/scientist at Florida State University's National High Magnetic Field Laboratory before joining the UT physics faculty in August 2012.

The NSF CAREER grant is a prestigious award for junior faculty like Zhou who are dedicated to integrating outstanding research and education. The honor is the third for UT Physics in three consecutive years: Dr. Jaan Mannik was a CAREER awardee in 2013 and Dr. Norman Mannella won the honor in 2012. [CS](#)

Warren Keller: The Space Man

When Warren Keller graduated from UT, the agency where he would spend a career changing the way we see the universe didn't even exist. Today, the two Voyager spacecraft and the Hubble Space Telescope he helped launch into space are still flying, and Keller is the physics department's 2014 Distinguished Alumni Award winner for his outstanding contributions to NASA.

Born and raised in Knoxville, Keller graduated from Knoxville High School in 1949. At that time he had no plans to even study physics. He just went into the "family business."

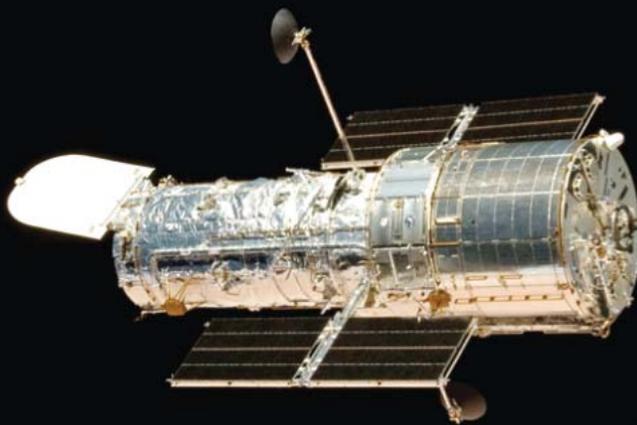
"I had no idea as to what I wanted to major in," he said. "My older brother, Fred, was entering his senior year in engineering physics at UT, and I must admit that I just plain copied him. There was no idea of a career with NASA or in the space program since neither existed at that time. My NASA career was not planned. *It just happened.*"

As an undergraduate he played a trumpet in the Pride of the Southland Marching Band and married Carolyn Burk, a fellow KHS graduate. He finished a bachelor's degree in engineering physics in 1953 before spending two years as an Army lieutenant testing anti-aircraft artillery. He came back to UT, earned a master's in physics in 1957, and moved to Texas to work for Convair in the reactor shielding area.

Timing is Everything

It was at Convair that Keller began thinking about scientific questions that would point him toward NASA and ultimately the historic space race between America and the Soviet Union. When the Russians launched the first Sputnik satellite in October 1957, the U.S. answered with Explorer I in January 1958, eight months before NASA's official birthday.

Keller explained the Explorer satellite found belts of charged particles trapped in the Earth's magnetic field, which could pose a serious obstacle for future space flights. He asked for and received company funds from Convair to study the potential charged particle shielding problem which led to a one-year NASA study contract. In 1960 he accepted a job with NASA, moving to the Marshall Space Flight Center as head of the nuclear physics section, where he continued working on charged particle shielding and nuclear rocket studies. Shortly after assuming this position, he gave a seminar with the famous rocket scientist Wernher



Hubble Space Telescope
(Image Credit: NASA, 2009).

Warren Keller (B.S., 1953; M.S., 1957) shows off new UT band uniforms for a newspaper article in 1951. He played in the Pride of the Southland band all four years as an undergraduate.

von Braun sitting in the front row. They had a bit of a disagreement during the Q&A that followed, but ended the event on a first-name basis.

Keller was aware that a new era of discovery was underway as scientists and engineers sought to defy gravity and explore space. And there he was; a young physicist from Knoxville who had been treasurer of his high school senior class and captain of the band, right in the thick of it.

"It was a great time to be in this field," he explained. "Almost everything you were doing was exciting and new. All the rules that could stand in the way of getting your job done seemed made to be broken. You did whatever it took to get the job done in a timely manner. It was obvious that you were in a race. You could get help from wherever it existed. Everyone seemed to be very dedicated to what they were doing."

In 1962 Keller moved to NASA headquarters in Washington, D.C., where he would become Program Manager for two of the most important space science missions.

When the Planets Align

In 1970, after eight years managing NASA's advanced research on the effect of the space environment on spacecraft design, Keller transferred to the Office of Space Science, the hub for major space flight missions. On the slate was the Grand Tour, a flyby of the outer planets: Jupiter, Saturn, Uranus, Neptune, and Pluto (before its demotion from planet status). Until the mid-1960s, it was thought that using existing propulsion technology missions to the outer planets would take about 30 years. However, trajectory studies at that time showed that in the late 1970s those planets would be so positioned in their orbits that such missions could be accomplished in about 12 years using gravity assist techniques at each encounter to reach the next planet. Keller pointed out that this planetary alignment wouldn't occur again for about 180 years.

The approved Grand Tour mission called for four new-technology spacecraft with a lifetime of 12 years and involved a minimum of two flybys at each planet, but the costs of such an ambitious plan proved too prohibitive and the program was canceled. A fallback mission (eventually named Voyager) that was sold in its place employed only two five-year-lifetime, 1960s Mariner technology spacecraft, each of which would fly by only Jupiter and Saturn using gravity assist at Jupiter to reach Saturn. This reduced program was not without some trials. Fortunately, it was the kind of territory with which Keller, who was



SPATS AND ALL!—Those "Pride of the Southland" musicians were glowing with pride as the U-T bandsmen donned their new uniforms today for fittings. Above, Band 2nd Lt. Warren Keller admires his orange spots as he fits them on. Waist-hugging jackets are orange, trousers and Sam Browne belt, snowy white, metal trimmings, a silvery chrome, and headdress fancy. U-T Band makes its first public appearance in the new rigging at the big Sugar Bowl strut New Year's Day.

Program Manager, and other personnel in the Program Office were familiar.

"One of the toughest challenges," he explained, was that "we would have to fly through a very intense radiation belt around Jupiter to achieve some of our most important objectives. (This) had been anticipated with the understanding that if the radiation turned out to be a problem, we would move the trajectory further from the planet, minimizing the impact. The impact turned out to be larger than we could reasonably accept and the Program Office had to convince the project implementers and NASA top management that the spacecraft could be radiation hardened at a reasonable cost. This hardening was accomplished within the project's budget. Further, it was decided that if Voyager 1 had successful encounters, Voyager 2 would be targeted, at Saturn, to attempt a Jupiter-Saturn-Uranus-Neptune Grand Tour mission, leading to a great success story."

The Voyager "twins" were launched in 1977, and between them have explored the four outer planets, as well as their rings and magnetic fields and 48 of their moons. Keller left the program about a year before the Voyagers left Cape Canaveral. He had been named Program Manager for another important NASA mission: the Space Telescope.

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Warren Keller at his desk as director of the NASA Wallops Flight Facility (1988). Under his leadership, the R&D research budget tripled at the ~1100-person facility.

Putting a School Bus into Orbit

As the two Voyager spacecraft began their historic tour of the solar system, Keller was faced with a much more difficult sell. It took three attempts to get the Space Telescope through the budget process. He said the project ultimately succeeded with the help of the many astronomers who lobbied in force for it, prompting Congressional staffers to say they had no idea there were so many astronomers in the whole world.

Getting approval for the project was just the beginning. As Program Manager, Keller faced multiple challenges. There were technical issues, including major responsibilities split between associate contractors on the telescope's critical pointing control system. The telescope, 43 feet long and 15 feet in diameter, weighs 25,500 pounds, and launching it was, as he said, like "putting a school bus in orbit."

There were also political issues. Scientists wanted telescope science operations to lie with an independent institute, but there were differing opinions as to its role and location.

"One of the representatives, who had fought approval of the telescope program the hardest, was making a play for NASA to select the location of the institute and to place it in his district," Keller recalled. "This problem was taken care of by the Program Office convincing NASA management that, contrary to the desires of the scientific community, the selection of location should be a part of the proposals for operation of the institute."

Keller chaired a NASA committee established to determine how NASA should best implement such an institute. The result is the Space Telescope Science Institute, which has been operating since 1981 at Johns

Hopkins. Other technical and financial issues caused delays on the telescope itself, but the effort proved to be worth the headaches.

"We knew that we would be able to see objects about 50 times fainter than we can see with ground-based

telescopes," he said, "equating to 350 times the volume of space seen with the ground-based instruments, taking us back in time close to that of the 'Big Bang.' We knew this would revolutionize astronomy."

The launch was delayed for almost four years by the shuttle Challenger accident, and by the time the telescope (renamed for astronomer Edwin Hubble) was launched in 1990, Keller had been promoted to Deputy Director of NASA's Solar Terrestrial and Astrophysics Division and later served as Director of Suborbital Projects and Operations of the Goddard Space Flight Center, where he was responsible for conduct of NASA's suborbital science programs as Director of Wallops Flight Facility. In 1989, he retired from NASA after a career that mirrored the evolution of the agency itself. Both Voyager spacecraft have been flying for 36 ½ years and are still returning useful data, with Voyager 1 having escaped our solar system into interstellar space. The Hubble Telescope has been operating for 24 years, making more than a million observations.

In 1949, Warren Keller was a UT freshman who chose his path based on the footsteps of his older brother. Some 65 years later, the journey that began in Knoxville has, literally, reached the stars. [CS](#)

The department presented Mr. Keller with the Distinguished Alumni Award at Honors Day. See a write-up of the day's events on page 12.

New Faculty

The department's newest assistant professor spent very little time on the campus that conferred his Ph.D., and it turns out that's a very good thing.

Instead, Steve Johnston left Ontario for SLAC in California, where his combined interests in physics and math became the foundation for the condensed matter theory expertise he brings to the UT faculty.

Johnston's physics path has led him all over the world, but that journey began in Canada. Born in Toronto, he grew up in the small town of North Bay Ontario and went on to attend McMaster University in Hamilton.

"I originally went into my undergrad expecting to do computer engineering," he said. "I was really into programming. I took computer engineering not really being fully aware of what that entailed. In my first year of physics for engineering I started to enjoy physics a lot more because we started using complex mathematical methods."

The links between math and physics drew him to the latter, and so he switched directions.

"I ended up doing a bachelor of engineering in engineering physics and then moving into research," he said.

After finishing his bachelor's degree in 2003, Johnston applied to graduate school and was recruited by Tom Devereaux, then a professor at the University of Waterloo and now the Associate Lab Director for Photon Science at the SLAC National Accelerator Laboratory, to work in condensed matter research as a means to mesh his numerical and physics interests. He moved to California in the first year of his Ph.D. studies.

"My Ph.D. was awarded by the University of Waterloo, yet I spent little time on that campus throughout my studies," he said.

He completed the doctorate in 2010 with a dissertation on "Electron-Phonon Coupling in Quasi-Two-Dimensional Correlated Systems." Next he held

post-doctoral positions with the Leibniz Institute for Solid State and Materials Research in Dresden, Germany, and the University of British Columbia in Vancouver, Canada. Yet while the geography has changed, his interests have been consistent.

"I'm essentially focusing largely on the same groups of problems, which is electron-phonon interactions in various families of correlated systems," he said.

Phonons are the vibrational energy in solids whose atoms are arranged in a crystal lattice pattern. When electrons interact with this energy, the material can present some interesting properties—including the electron pairing that causes conventional superconductivity. In correlated systems, electrons have a significant influence on one another's behavior.

"When you have correlated electrons interacting with phonons, a lot of interesting physics emerges that's not fully understood," he said.

The rich and complex nature of materials like these presents both challenges and opportunities for physicists like Johnston. His prior



Steve Johnston joined the physics faculty January 1. He's a condensed matter theorist whose research interests include electron-phonon interactions in correlated systems.

research interests have included the high-temperature superconducting cuprates and rare-earth element nickelates and are expanding now

to include iron pnictide superconductors and other materials.

While the department's condensed matter theorists typically hang their hats in South College, his office is in a suite in the Nielsen Physics Building, nestled among the experimentalists. That works out well, as he and Assistant Professor Haidong Zhou are working on the lattices of frustrated spin systems, a new area of interest for Johnston brought about largely by the collaborative opportunity. He's also working with Associate Professor Norman Mannella on spectroscopy studies of rhodates and transitional metal oxides. While his research is campus-based at present, he's looking at developing collaborations with scientists at Oak Ridge National Laboratory who have similar research interests.

A faculty position, however, brings teaching as well as research responsibilities, and Johnston,

[Continued on Page 8](#)

who joined the faculty January 1, jumped right in, teaching Advanced Solid State Physics to graduate students during the spring semester.

“It was fun,” he said; “definitely a new dimension to the job from when I was doing postdoc research.”

In the fall he’ll be teaching Electricity and Magnetism to engineering majors, or, as he described them with a smile, “My people. It should be interesting.”

When he takes a break from physics, he counts among his avocations electronic music (“I’ve been into writing and DJing for quite some time”) and snowboarding, which can be a bit of a challenge in East Tennessee, so some return trips to Vancouver might be in order.

Right now, however, he’s working to set up a program for quantum Monte Carlo simulations on multi-orbital systems. Named for the famous casino locale, Monte Carlo calculations use random, computer-generated numbers to simulate physical systems.

“The focus is really looking at strong interactions and one of the necessities of this is to look at non-linearity,” he explained. “When interactions become very strong—especially the electron-phonon interaction—non-linear terms become important; they can actually have a very profound effects on physics, and this has been largely unexplored,” he said.

He plans to recruit graduate students in that area eventually, and is gradually growing his group with the addition of a postdoc this fall (Yan Wang from the University of Florida) and a summer graduate student, Umesh Kumar. Graduate Student Shaozhi Li has also joined his group.

Johnston brings a sort of bridge-building component to the department with a program that focuses on the close ties between theory and experiment in condensed matter, something he is happy to encourage in younger scientists.

“If students are interested in that kind of work,” he said, “they should get ahold of me.” [CS](#)

Keeping Safe through Games and Google

Physics Professor Michael Guidry likes technology, but not in a techie snob, cooler-than-you kind of way. He’s more interested in putting it to work for science and education, and in fact was an early developer of online astronomy courses and a site to help teachers use the Web more effectively. Lately, however, he’s been adapting the world of mobile games (and Google Glass) for national security.

In 2012 the Y-12 National Security Complex in Oak Ridge, which deals with the security of radioactive material, approached the university about developing game-based training for the Global Threat Reduction Initiative (GTRI). The original cast comprised Dr. Evan Meaney of the Department of Art (now at the University of South Carolina and a game-design specialist) and Dr. David Banks from the Department of Electrical Engineering and Computer Science, who is expert in interactive simulation.

“I was brought in shortly after initial discussions had started, I think primarily because I had a past history of leading collaborations to develop interactive technology for educational and training applications that might be relevant to the project,” Guidry said.

Overcoming Delays and Outsmarting Bad Guys

A highlight of the program was hiring undergraduate students to work on campus for prototype development. Unfortunately, things didn’t go according to plan. Within three weeks, the project was shut down when funding fell victim to a federal sequester. The team lost students to graduation, including what Guidry called “a dream-team” of undergraduates with complementary talents. Some had quit or turned down other jobs to work on the project. They were just getting ready to re-start with new funding last fall when the federal shutdown hit, further delaying the project. This spring, however, they began recovering.

Guidry credits Drew Burden and Matthew Weeks with keeping the programming side of the enterprise above water. Burden graduated with a degree in computer science but still works with the group as a consultant.

“He’s the one who at this point has saved the project,” Guidry said. “He did almost all the initial programming of the current version. It’s very good. He’s made a lot of progress.”

He gives similar praise to UT nuclear engineering student Weeks, and to Meaney and his design team at South Carolina (and to the team led by Banks, who are working in parallel to develop 3D emulation strategies for the complete implementation of the game). And though these valiant efforts have kept the game project afloat, there’s still work to be done.

“It’s very much in development,” Guidry explained of the prototype. “But the idea that we have is that it will be a typical multi-player game situation, except that the game in this case has pretty serious implications, which is to keep radioactive material from being taken by bad guys.

“There are a lot of hospitals that have irradiation sources that if they got in the wrong hands could be used



Dr. Mike Guidry demonstrates Google Glass to an audience from Y-12 National Security Complex. Glass will have a role in a new game-based training initiative he's working on with students and university colleagues. (Image credit: Y-12)

to make a dirty bomb, for example," he continued. "The worry in the context of the game is that they could of course steal the material, take it away, and then manufacture a device somewhere. But probably the more dangerous scenario is that they come on-site with explosives and they manufacture on-site, get to the roof, and set the device off."

The way to win the game is to contain the radioactive material within the building.

The audience will be GTRI training classes, a diverse group that may include radiation safety officers, Red Cross first responders, or hospital security personnel. They come from across the U.S. and even a few NATO countries.

"They get a fairly diverse mix. It's not just people from facilities like Y-12," Guidry explained.

During the classes they develop professional bonds, and a multi-player game like the one in development could give them recurrent training once they go back home.

"If you had a mobile strategy game that a set of people (who) might be geographically dispersed could be involved in, that could serve to re-up their training," he said.

While that's the primary motivation, Guidry believes if the game is done well it could be directly incorporated into the training itself. While current simulations might, for example, have all participants in one room watching a surveillance camera and then discussing what they see, the game could allow participants to set preferences as to role: local policeman, radiation safety officer, dispatcher, etc.

"Depending on what your character is, we would set the programming so you would only get the information in your display in the way that you realistically would," he said.

This offers a more accurate communication scenario between, say, a dispatcher who sees something suspicious on a camera and then notifies a security officer who didn't see the video firsthand and relies on information he or she is given.

Along those lines, the team plans to incorporate a newer piece of technology, Google Glass, into the game.

Hands-Free Recipes

Google Glass looks like a funky pair of glasses with a tiny built-in computer that takes photos with a blink or calls up an instruction manual with the tap of a finger. Guidry is among the technology's early developers and beta testers.

"It's a mobile device that shares all the characteristics of a phone or tablet, but what sets it apart is that it can give you a hands-free display and actions; you have your full field of vision and your hands are free," he explained.

This spring Guidry demonstrated Glass to a Y-12 audience where he called up a recipe (in this case, the Elvis Presley Fried Peanut Butter and Banana Sandwich) and showed how easy it was to go through the steps, moving backward and forward on demand—all the while keeping eyes on the task at hand.

"Now generalize that to a much more complex task," he said, such as teaching new employees detailed step-by-step assembly with instructions right in front of them and their hands free to follow the steps. People tend to retain what they do, so Glass could be a very valuable training tool.

"We intend to build at least a small role into the game for Glass," Guidry said. "What we have in mind initially is that there will be the capability to send one of the local security guys equipped with Glass to do local surveillance."

The security guard could then transmit back pictures and video undetected because the device can be programmed to transmit whatever he's seeing. Thus in the training game, Glass becomes an additional surveillance tool that's mobile, rather than a fixed camera or alarm.

"In addition to the game simulation of Glass use, we are working on actual programming of Glass for potential applications in the Y-12 mission, both for GTRI training and for other areas. Although it remains to be seen how successful Glass will be as consumer electronics once Google releases it to the public, it is clear that it could have a large impact on technical and training applications in industry," Guidry said.

Finding ways to tailor technologies like this across multiple disciplines (and multiple universities) is pretty commonplace for Guidry.

"In my 'day job,' most of my research collaborations in theoretical and computational physics and astrophysics involve a broad range of projects with far-flung international participants," he said.

Projects like this are also a great resume-building experience for students, and a bonus for the university as well as the economy.

"This fits well into the overall mission of the university to prepare its students for a diverse range of possibilities in the real world, and seeds creative new ideas among those students," Guidry said. "It is quite possible," he said, "that the ideas, approach, and expertise being nurtured in the current project could seed some future high-tech startups in a range of different subject areas." [CS](#)



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.

#3

Title: Measurement of Neutrino Oscillation with KamLAND: Evidence of Spectral Distortion

Authors: T. Araki et al.

Journal: *Physical Review Letters* **94**, 81801 (2005)

Times Cited: 653 (as of 7/22/2014)

Summary

**Courtesy of Dr. Bill Bugg
Professor Emeritus, UT Physics**

By 1975 three separate types or flavor neutrinos, designated ν_e , ν_μ and ν_τ , were known; each associated with its own charged lepton. It was believed that a ν_μ could only create muons, ν_e electrons, etc. Measurements of electron neutrinos from the sun indicated that the number of electron neutrinos observed at the Earth was less than half the expected number. The discrepancy was labeled the solar neutrino problem.

One of many theories proposed to explain the deficit was that neutrinos had mass and could therefore change their flavor. The quantum description of this oscillation process predicted that the transition probability from one flavor to another depended on the square of the neutrino mass difference Δm^2 and a mixing parameter $\tan^2\theta$. However, alternative explanations of the solar neutrino deficit existed that could explain the data and even in the framework of the oscillation hypothesis the solar data was insufficient to determine a unique solution for the neutrino parameters.

To remove these uncertainties a precision experiment was required to measure the flux from a well understood source other than the sun. KamLAND is an underground neutrino detector designed to measure the antineutrino flux and energy spectrum from 53 Japanese nuclear reactors located at an average distance of 175 km from the detector. It consists of 1000 tons of ultrapure liquid scintillator enclosed in a thin, transparent, 13m diameter balloon floating in 1800 tons of non-scintillating buffer oil enclosed in an 18m stainless steel tank. Scintillation light generated by antineutrino interactions is measured by

photomultiplier tubes (PMT) mounted on the tank wall. Location of neutrino interactions within the detector was determined by PMT hit timing.

UT contributed to KamLAND construction, installation, commissioning, operation and data analysis in a major way. Over 600 giant 20" PMTs were extensively modified to function in buffer oil. A special lab equipped and manned by UT was set up in Sendai to modify, test, and certify the PMTs and prepare them for shipment to the detector. UT installed and commissioned the modern, computer-controlled power supply system for the photomultipliers and prepared over 3 miles of used signal and HV cables for use in the detector. In addition to these offsite tasks the group contributed heavily to KamLAND installation, which was extremely labor intensive. To meet commitments to these tasks, a dedicated effort was made by the EP group, including Professors William Bugg, Yuri Efremenko and Yuri Kamyshev, as well as Engineer Steve Berridge, postdocs, graduate and undergraduate students, and Bugg's temporarily unemployed son Tom. Also recruited were retired physicists Hans Cohn from ORNL, Roger Gearhart from SLAC, and, surprisingly, Brad Dallas, an internationally-known architect. They were motivated by interest in the experiment and the unique opportunity to work in the Japanese environment. These individuals worked without compensation other than food and lodging and made a powerful contribution to the experiment.

The KamLAND experiment conclusively confirmed electron neutrino oscillation as the source of the solar neutrino deficit. The antineutrino energy spectrum and flux expected at KamLAND in absence of oscillation were known from detailed reactor operation data provided by Japanese power companies. The results of a 766 ton year run confirmed antineutrino disappearance at the 99.998 percent confidence level. Moreover, oscillation theory predicts that disappearance probability of neutrinos with energy E observed a distance L from the source should depend in a known way on the ratio L/E , and the intrinsic neutrino parameters. KamLAND confirmed this prediction in detail, ruling out other theories such as neutrino decay. Finally the KamLAND data determined the intrinsic neutrino parameters Δm^2 and $\tan^2\theta$ with sufficient accuracy to remove the ambiguity in the interpretation of the solar neutrino data experiments, selecting the so-called Large Mixing Angle solution and providing the most precise values for the neutrino mixing parameter and mass difference. [CS](#)

Gifts in Action: The Dorothy and Rufus Ritchie Scholarship

Reflections From **Hanneke Weitering** Class of 2014

While many people my age are unsure about what exactly they would like to do with the rest of their lives, I can gladly say that I have successfully determined my niche during my time here at UT.

I just graduated this spring with a B.S. in Physics and a minor in Journalism & Electronic Media. This may seem like an odd combination of subjects, but it makes perfect sense for me. I have always loved physics, but I get far more excited when I'm talking about physics than when I'm actually doing it myself. I've always been better with words than with numbers, and I'd much rather share my excitement about science with the world than be cooped up in a lab working on one specific project. Therefore, I decided to go into science writing. Rather than narrowing down my interest in physics to one particular field of study, as a science journalist I can use my background in physics to write about any and all physics-related topics that interest me. Rather than being an expert in one thing, I have the opportunity to learn a little bit of everything.

I did not always know that I wanted to become a science writer. For a while, I had absolutely no idea what I was going to do after finishing my physics degree. That changed when UT hosted the Southeastern Conference for Undergraduate Women in Physics in 2012. I attended in hopes of gaining some insight and possibly coming closer to figuring out what to do with my life. While listening to one speaker in particular, Katie Yurkewicz, I suddenly had an epiphany. She spoke about her job at Fermi National Accelerator Laboratory, where she was the communication director, and then it hit me. Why not just write about science? Why had I not thought of this before? Immediately I knew exactly what needed to be done. I decided to begin a minor in Journalism & Electronic Media that same semester, and it was one of the best decisions I ever made.

One of the first classes I took in the Journalism department was titled "Writing about Science, Technology and Medicine" by Dr. Mark Littmann. If I wasn't convinced before, taking this class really helped me see that science journalism was the right career choice for me. Dr. Littmann later agreed to work with me in a customized independent study course we titled "Physical Science Writing as



Hanneke Weitering at the KRAKEN supercomputer at ORNL. She has written features for the Joint Institute for Computational Sciences (JICS) and will take her physics and journalism experience to NYU this fall when she begins work on a master's degree in Science, Health, and Environmental Reporting.

Literature." I can't thank Dr. Littmann enough for all his guidance and support during my time with him here at UT.

Also during my first semester as a journalism student, I began writing news stories for the Sci/Tech column at *Tennessee Journalist*. One year later, I joined the Joint Institute for Computational Sciences (JICS) at Oak Ridge National Laboratory (ORNL), where I write feature stories about all kinds of cool research that is being performed on some of the supercomputers housed at ORNL. During my time with JICS I have had the opportunity to learn about so much fascinating science. The best part about my career choice is that I get to learn more and more each day for the rest of my life.

I know that I would have never come this far without the solid education, support and resources that UT's Physics Department has provided me. The Dorothy & Rufus Ritchie Scholarship, the UT Volunteer Scholarship, and the HOPE Scholarship have been tremendously helpful in ensuring that my time at UT was spent solely on furthering my education and not worrying so much about the financial hardships of being a college student. This fall, I will be attending New York University to earn my M.A. in Science, Health, and Environmental Reporting. [CS](#)

Honors Day 2014

The annual Physics Honors Day celebration on April 28 gave the department the chance to honor a distinguished alumnus, recognize outstanding students, applaud the teaching of a selected faculty member, and hear about launching a school bus into orbit.

2014 Distinguished Alumni Award

The department honored **Warren Keller** (B.S., 1953; M.S., 1957) with the 2014 Distinguished Alumni Award (read more in the Alumnus Profile on page 4). He gave the Honors Day talk, describing his illustrious career with NASA. He was Program Manager for the agency's most important unmanned space science missions: the Outer Planets Grand Tour and Voyager Programs, and the Hubble Space Telescope Program. Of the Hubble, he said, "it was like putting a school bus in orbit."

The department cited Keller "for his leadership and personal contributions to space science at NASA through his service as Program Manager for the Voyager and Hubble Space Telescope Programs and for three decades of dedicated service to the total NASA program."

Next up were student honors and the Society of Physics Students' presentation of the Outstanding Teacher Award:

Undergraduate Awards

Outstanding First Year Physics Student:

Louis Varriano

Robert Talley Award for Outstanding

Undergraduate Research: Mark Alexander Kaltenborn

Robert Talley Award for Outstanding

Undergraduate Leadership: Richard Prince

James W. McConnell Award for

Academic Excellence: Cody Wiggins

Douglas V. Roseberry Award: Gregory Lyon

Students inducted into Sigma Pi Sigma, the National Physics Honor Society:

Andrew Belt, John Burnum, Kennon Carlisle, and Gregory Lyon

Laboratory/Service Awards

Robert W. Lide Citations: Bo Daugherty and Jacob Wessels

Outstanding Graduate Teaching Assistant Award: Kayla Craycraft and Santiago Munoz

Outstanding Physics Tutor Award: Kaleb McClure

Graduate Awards

Colloquium Award: Robert Van Wesep

Paul Stelson Fellowship for Beginning Research: Zhiling Dun

Paul Stelson Fellowship for Professional Promise: Phil Griffin

Fowler-Marion Outstanding Graduate Student Award: Kubra Yeter

Wayne Kincaid Award

Bo Daugherty

SPS Teacher of the Year Award

Tony Mezzacappa

Honors Day Photos (from top): Department Head Hanno Weitering (left) presents Warren Keller with the Distinguished Alumni Award; Dr. Marianne Breinig congratulates Kubra Yeter (right) on winning the Fowler Marion Outstanding Graduate Student Award; SPS President Richard Prince (left) with Dr. Tony Mezzacappa, the SPS Teacher of the Year for 2014.



Learn about the names and inspiration behind the awards:
<http://www.phys.utk.edu/honors.html>



See the 2014 Honors Day Photo Album:
<http://www.phys.utk.edu/events/2014-honors-day/index.html>



See the 2014 Honors Day Ceremony Video:
<https://tiny.utk.edu/physicshonors2014>

News from the Physics Family



Faculty Distinguished Professor Joe Macek

has retired from the physics faculty as of this August. He joined UT in 1988 and has led the theoretical atomic physics program, focusing specifically on ion atom collisions. In recent years he has expanded his scientific interests, venturing into condensed matter physics with graduate student Rachel Wooten and colleague John Quinn. Before joining the UT faculty, he held a chaired professorship at the University of Nebraska. He is a fellow of the American Physical Society, and in 2008 was elected a member of the Scientific Council of the Ioffe-Physical-Technical Institute in St. Petersburg, Russia. Be sure to read the next issue of our newsletter for a more in-depth feature on Professor Macek.

Distinguished Professor Joe Macek is retiring this August after 26 years on the physics faculty.

Students

UT's Society of Physics Students hosted the SPS zone meeting April 11-13. Students from the University of Illinois, the University

of Louisville, Morehead State, and UT Chattanooga attended. Faculty members Kate Jones and Soren Sorensen gave talks, and Assistant Professor Nadia Fomin gave a presentation and tour of the Spallation Neutron Source following visits to the High Flux Isotope Reactor and the supercomputing facilities at Oak Ridge National Laboratory.

[More Family News on Page 14](#)



UT's Society of Physics Students hosted the April SPS Zone meeting, which included a tour of facilities at Oak Ridge National Laboratory.

Physics students claimed eight awards at the **Chancellor's Honors** banquet on April 23. The honorees were:

For Extraordinary Professional Promise:

- **Wei Chen**
- **Erik Olsen**
- **Allison Sachs**
- **Zachary Sims**
- **David Surmick**
- **Alex Woods**

For Extraordinary Academic Achievement:

- **Nickolas Luttrell**

For Extraordinary Campus Leadership and Service:

- **Jacob Clark**

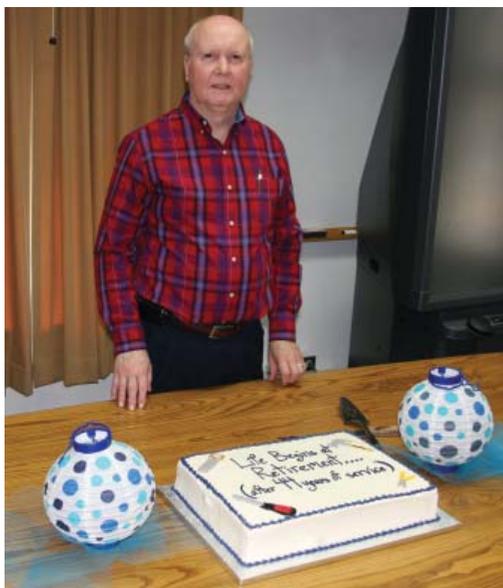
In the past 10 years, physics students and faculty have won 52 Chancellor's Honors!

Alumni

Nasrin Mirsaleh-Kohan (Ph.D., Chemical Physics, 2013) has joined the faculty of the Department of Chemistry and Biochemistry at Texas Woman's University in Denton, Texas.



Cornstarch + Water + Speaker = Cornstarch Monster (also known as a non-Newtonian fluid)! Physics undergrads show off their experimental skills at the physics picnic on April 11.



The department honored Gene McGuire for more than 44 years of service with a luncheon on June 30.

Stanley Paulauskas (Ph.D., December 2013) was featured as a student profile in the National Nuclear Security Administration's 2014 Stewardship Science Academic Program Annual. He was part of the Stewardship Science Academic Alliances (SSAA) Program from 2009 to 2103 and, among other responsibilities, developed high resolution timing algorithms for digital electronics for the Versatile Array of Neutron Detectors at Low Energy (VANDLE) at Oak Ridge National Laboratory. He is currently a research associate at Michigan State University.

Congratulations to **John Tilson** (B.A., Physics, 1990), who teaches at Hardin Valley Academy in Knoxville and was named the **2014 Outstanding High School Physics Teacher in the state by the Tennessee Section of the American Association of Physics Teachers.**

Staff

After more than 44 years in the Physics Electronics Shop, Supervisor **Gene McGuire** has retired. The department bid him adieu with a luncheon on June 30, 2014. Faculty and staff had several kind words to share about his dedication to his work and his generous and easy-going nature. Best of luck to Gene in retirement!

Thanks to our Donors

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

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(Gift records forwarded to the department dated November 1, 2013, through June 30, 2014)

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 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 **Mr. Don Eisenberg** in the College of Arts and Sciences Office of Development at (865) 974-2504 or don@utfi.org. You can also donate online by going to: <http://artsci.utk.edu/> and clicking on "Give to the College of Arts and Sciences."

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