Physics Illinois News

THE DEPARTMENT OF PHYSICS AT THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN • 2004 NUMBER 2

Another Molecular Motor Shown to Move Hand-over-Hand

In the human body, hundreds of different biomolecular "motors" do the work—they contract muscles, reload nerve cells so they can repeatedly fire, and move chromosomes during cell division. Professor of Physics Paul Selvin and his students have developed an extremely sensitive measurement technique to reveal how these little proteins perform. Called FIONA *(Fluorescence Imaging with One Nanometer Accuracy)*, which was identified by the editors of *Science* as one of the top 10 scientific breakthroughs of 2003, the measurement technique can track the position of a single molecule to within 1.5 nm. (In comparison, a human hair is approximately 10,000 nm wide.)

In the cover article of the Sept. 3, 2004 issue of the *Journal of Biological Chemistry*, Selvin's group reported that myosin VI moves materials to various locations within a cell by the same "hand-over-hand" mechanism as two other molecular motors, myosin V and kinesin. Like myosin V, myosin VI has two "arms" connected to a "body." The tiny molecule converts chemical energy into mechanical motion and transports its load by "stepping" along polarized filaments of actin, but in the opposite direction from other myosin variants.

"Studies have suggested two main models for the stepping movement," Selvin said. "One is the hand-over-hand model in which the two arms alternate in the lead. The other model is the inchworm model in which one arm always leads. Now that a third molecular motor has been found to move in the same hand-over-hand fashion, the argument for a rival 'inchworm' motion is getting pretty weak."

To examine the myosin VI stepping mechanism, the researchers applied the same FIONA measurement technique that was used to study both myosin V and kinesin. "First, we attached a small fluorescent dye to one of the arms and took a picture with a digital camera attached to a microscope to find exactly where the dye was," Selvin said. "Then we fed the myosin a little food (adenosine triphosphate), and it took a step. We took another picture, located the dye, and measured how far the dye moved." By examining the step size, the researchers could determine whether the protein used a hand-over-hand mechanism or an inchworm mechanism for movement. "The average step size for the myosin VI arm was approximately 60 nm, while the molecule's center of mass moved only half that distance," Selvin said. "This clearly indicated that a hand-over-hand model was being employed."

Surprisingly, myosin VI has a step size that is highly variable, but on average is nearly as large as that of myosin V, which has a lever arm that is three times longer. "For myosin VI to cover the same distance, the molecule must somehow come apart and then snap together again,"

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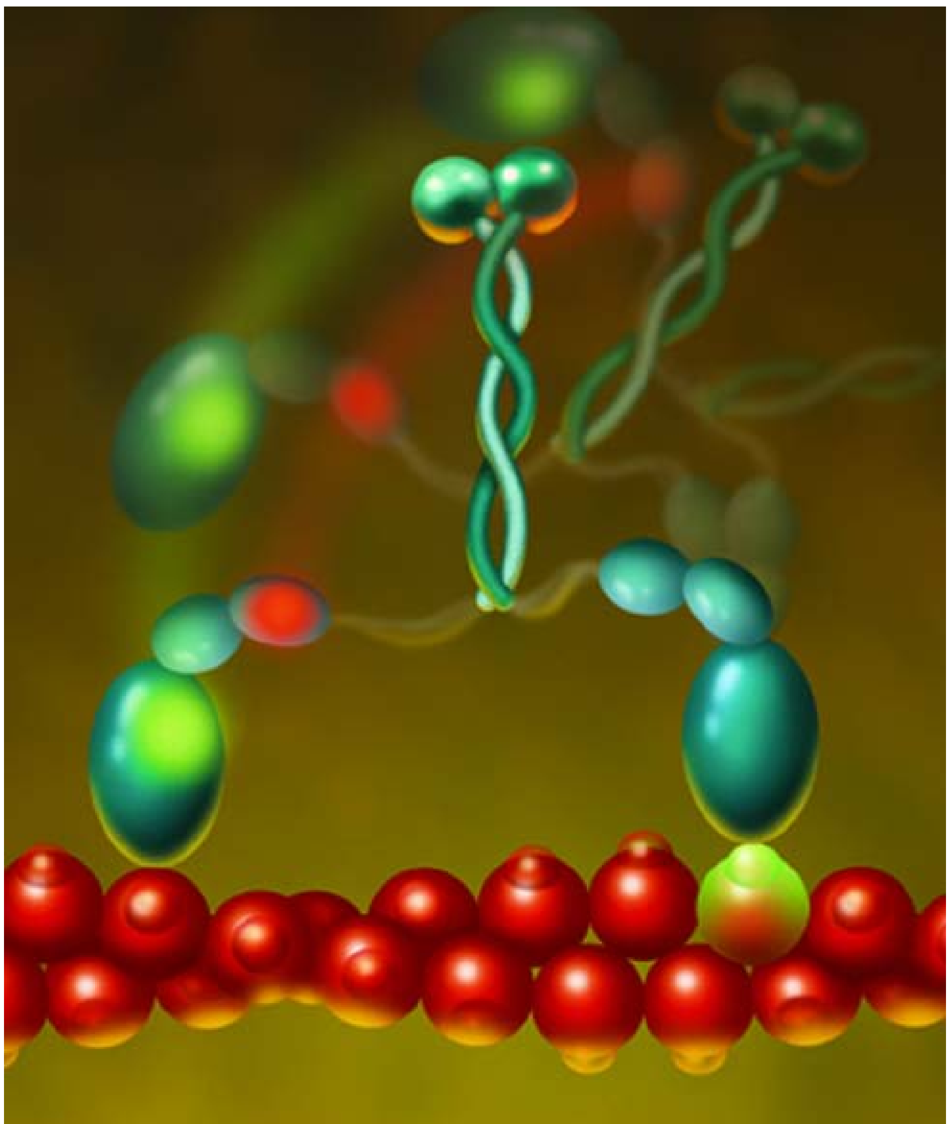


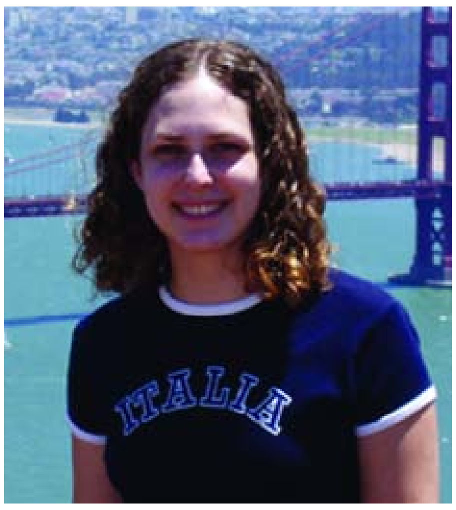
Myosin VI (blue) is a molecular motor that walks "backwards" on actin (red). By labeling a myosin VI molecule on the head or on the neck, and localizing the dye within a few nanometers, the molecule was shown to walk "hand-over-hand", while causing a part of the protein to come undone.

Joannah Metz off to Cambridge

Joannah Metz (BS '04) received a Gates Cambridge Trust Scholar for 2004. She has just begun a one-year master's program in polar studies at the Scott Polar Research Institute at the University of Cambridge (England). Metz's long-term career goal is to join the astronaut corps and do field research on Mars.

Metz is one of 31 U.S. students to receive the merit-based scholarship. Administered by the Gates Cambridge Trust since 2001, the scholarship program is open to students outside the United Kingdom. The Gates Cambridge Trustees award scholarships on the basis of intellectual ability, leadership capacity, and desire to contribute to society.

Metz, who earned bachelor's degrees in three majors—engineering physics, astronomy, and geophysics—focuses her academic attention on the extraterrestrial. At Cambridge, she will study glacial-marine sedimentation—the delivery of



sediments from ice sheets to the ocean and the patterns of sedimentation formed by this process. "I'm interested in studying Earth's polar regions because they provide a particularly good analog environment to Mars. Studying the factors affecting sedimentation in and near Earth's polar regions will be a springboard to my future studies of paleoclimates on Mars," Metz reported.

As an undergraduate at Illinois, Metz gained research experience working with astronomy professor You-Hua Chu, geology professor Bruce Fouke, and physics professor Nigel Goldenfeld, with whom she studied the physical and biological parameters affecting carbonate precipitation, even building an artificial hot spring in the lab. She participated in research projects at NASA, the Harvard-Smithsonian Center for Astrophysics, and the University of Manchester, England, where she studied during the fourth year of her five-year academic program in the Colleges of Engineering and Liberal Arts and Sciences.

At Illinois, Metz's extracurricular activities included working with Volunteer Illini Projects and serving as president of the student organizations Float'n Illini and the Illini Space Development Society. In March of 2000 and 2001, as president of the Float'n Illini's Microgravity Research Team, she took part in NASA's Reduced Gravity Student Flight Opportunities Program at Johnson Space Center. She was one of four team members selected to fly their experiment on rotational fluid dynamics aboard NASA's KC-135. She also served as a mentor and tutor for prospective and current Illinois students and volunteered at St. Jude's Catholic Worker House.

After she completes her studies at Cambridge, Metz will enroll in the Ph.D program in earth, atmospheric and planetary sciences at MIT, where she will continue studies in astrobiology and Mars.

This is the third consecutive year that a UIUC physics student has been named a Gates Scholar. Metz joins Christopher Michael (BS '03) and Harish Argawal (BS '02) in this elite cohort. ■

Letter from the Head

We begin academic year 2004–05 with cautious optimism. After three consecutive years of decreased state funding for the University of Illinois, the total state budget this year is unchanged from the last. Tuition increases together with internal reallocation at the campus, college, and departmental levels enabled modest salary increases for faculty, academic professionals, staff, and graduate assistants for the first time in two years. Sadly but unavoidably, tuition now provides a greater fraction of university operating funds than do state funds, a reversal of the situation that prevailed from the founding of the university until the recent state rescissions. Realistically, the best we can hope for in the near term are modest increases in state funding as the Illinois economy improves, but not a recovery of the withdrawn funds.

Faculty recruiting during the past year was extraordinarily successful. We hired three highly talented young scientists, two of whom are women. All three hires will begin their faculty appointments in August 2005. When added to the current faculty, the new hires result in a total tenured/tenure-track faculty of 64.3 FTE, of which seven are women (11 percent).

Faculty hiring in the department and college over the next several years is certain to slow down (but not to zero), but special funding will remain available for qualified “targets of opportunity” at any rank. I will be working with the Physics Appointments and Promotions Committee over the course of the current academic year to review and update the department’s January 2003 hiring plan in light of the hiring we have done, the changed financial climate, college and campus initiatives, and available space.

In summer 2003, all of the advanced undergraduate physics laboratories were moved to remodeled space on floors 5 and 6 of the Engineering Sciences Building, with the additional benefit of a net gain in total space. The space thereby opened in Loomis for new faculty members, graduate students, and postdocs has been invaluable. However, the act of moving the old laboratory furniture and equipment to ESB unmistakably highlighted what we already knew: all of the advanced laboratories are desperately in need of modernization. Efforts by individual faculty members in the past have been helpful, but much more than that is needed.

This year, the department is launching a multi-year initiative to reconceptualize, redesign, and re-equip all of the advanced undergraduate laboratory courses. Selected faculty members will be given release time from classroom teaching for this task, and a special multi-year fundraising effort will be launched to obtain money for new equipment. We hope also that industry will join the cause by contributing equipment as Agilent so generously did this past summer in support of our new spectroscopy laboratory course.

The quality of the graduate application pool last spring was especially strong. An increased number of graduate fellowships obtained in campus competitions and by diligent sleuthing resulted in an impressive incoming class of 58 new graduate students (32 domestic and 26 foreign). The total number of incoming physics majors this year totals 135 (115 freshman and 20 transfer students). We have not seen this number of freshman in well over a decade. Our summer 2004 undergraduate research program enrolled 24 (7 women) students (15 local and 9 from other universities and colleges), another positive sign of the increased interest of today’s undergraduates in careers in physics. We will work diligently to ensure that despite diminishing state support, these young people are well prepared for futures as bright as they are. ■

Jeremiah D. Sullivan

Another Molecular Motor Shown to Move Hand-over-Hand

Paul Selvin

Selvin said. “To understand how it accomplishes this feat will require further study.”

Paul Selvin received his bachelor’s degree in physics, with a minor in chemistry, from the University of Michigan, and earned his doctorate in physics from the University of California, Berkeley. He came to Illinois in 1997 from the Life Science Division, Lawrence Berkeley Laboratory.

The Illinois researchers (Selvin, Hyokeun Park and Ahmet Yildiz) collaborated with Li-Qiong Chen, Dan Safer, H. Lee Sweeney and Zhaohui Yang at the University of Pennsylvania on this work. ■

The Illinois work was supported in part by the National Institutes of Health, the National Science Foundation, the U.S. Department of Energy, and the Roy J. Carver Charitable Trust. Any opinion, findings, conclusions, or recommendations expressed herein are those of the authors and do not necessarily reflect the views of the funding agencies.

Bardeen Quadrangle Dedication

The heart of the Engineering campus—bounded by the Grainger Library on the north, the Mechanical Engineering Laboratory on the east, Engineering Hall on the south, and Talbot Laboratory on the west—has been named the Bardeen Quadrangle in honor of former Professor of Physics John Bardeen. Site improvements include new concrete walks, decorative plaza pavements, bicycle parking, service courtyards, dry-laid stone retaining walls along the Boneyard Creek, and a fountain.

A newly landscaped garden outside the north entrance to Engineering Hall, bounded by the Boneyard Creek to the north, the Burrill Avenue walkway on the west, an observation deck to the east, and Engineering Hall to the south, has also been named in honor of Bardeen.

The area was formally dedicated in a special ceremony on Oct. 14, which was attended by several members of the Bardeen family. This project was made possible by The Grainger Foundation Inc. ■

Faculty News

Mats Selen and Benjamin Wandelt Appointed to Center for Advanced Study

Mats Selen

Photo by Darren Wright

Benjamin Wandelt

Professor of Physics Mats Selen and Assistant Professor of Physics and Astronomy Benjamin Wandelt have received appointments to the University's Center for Advanced Study for the 2004–05 academic year.

Selen is a leader in designing and implementing the ultrafast electronics required to identify and extract, in real time, the events of interest that are produced in high-energy physics experiments at particle accelerators. He is currently the spokesperson for the CLEO experiment at the Cornell Electron Storage Ring (CESR), where he led the design and construction of the new event trigger for the upgraded CLEO detector. This project studies properties of the bottom and charmed quarks and the tau lepton. Its primary goals are (a) understanding the origin of the Cabibbo–Kobayashi–Maskawa mixing matrix, for which no dynamical theory exists, (b) understanding the time reversal symmetry violation, which appears to be a necessary prerequisite to the observed matter-antimatter asymmetry of the universe, and (c) tests of physics beyond the standard model.

Selen is currently exploring the effects of quantum mechanical interference in the decays of mesons containing charmed quarks, using data collected at the CLEO experiment.

Wandelt is a cosmologist whose research focuses on the intersection of cosmological theoretical physics with astronomical observations. His aim is to link astronomically observable phenomena with physics at the highest energy scales, relevant to the processes that occurred during the big bang. These phenomena include views of the early universe afforded by the latest maps of the cosmic microwave background (CMB), as well as the observed properties of dark matter and dark energy. An active member in the Planck satellite mission, he has invented sophisticated statistical and mathematical tools that allow the physical interpretation of CMB data. During his Center appointment, Wandelt will develop novel statistical tests based on mapped fluctuations in the CMB sky and probe for new physics beyond the paradigm of cosmology.

The Center for Advanced Study (CAS) serves as the intellectual nexus of the campus by providing the academic community with opportunities for top-flight interdisciplinary scholarship and interactions. A core group of permanently appointed CAS professors is joined each year by tenured faculty "associates" and untenured faculty "fellows," whose research proposals are selected in an annual competition. Center appointments, which provide teaching release time, allow the faculty member to devote full-time to an individual scholarly or creative project. Selen was one of only thirteen associates selected from the entire campus for the current academic year, and Wandelt was one of only seven fellows. ■

Paul Kwiat Receives J. David Murley Milestone Award

Photo by Bill Weigand

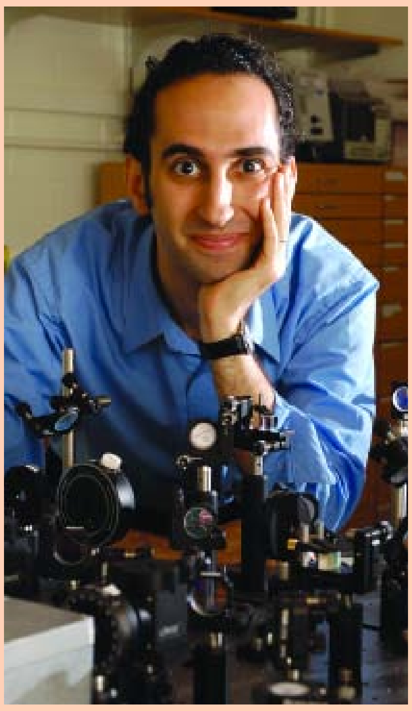
Bardeen Professor of Physics and Electrical and Computer Engineering Paul G. Kwiat has received the J. David Murley Milestone Award for achievements in quantum cryptography. Kwiat is an AMO experimentalist, specializing in quantum information and the foundations of quantum mechanics, especially tests of nonlocality, interaction-free measurements, generation of entangled states, and the principle of complementarity. He and his group made headlines in July when, like virtuosos tuning their violins, they tuned their instruments and harmonized the production of entangled photons, pushing rates to more than 1 million pairs per second.

Ultrabright, ultrapure sources of entangled photons are essential for pursuing quantum computing and quantum networks, as a resource for teleportation in quantum communication and for sending more information faster by means of quantum cryptography. High fidelity quantum states can also provide researchers with a clearer picture of how the universe works on a very fundamental level.

A major production problem, however, is that entangled photons are emitted in many directions and with a wide range of polarization phase relationships, each acting like an individual musician in a large orchestra. "Instead of hearing a soloist hit one note, we were hearing many violinists, some of whom were playing off-key," according to Kwiat. The trick was to come up with a way of tuning the system. "We found that we could pass the photons through another crystal—one that has a different phase profile—to compensate for the different phase relationships," Kwiat said. "The dissonance is corrected and the system becomes harmonized." Just as a corrector lens in a telescope removes chromatic aberration and improves image quality, the researchers' special birefringent crystal removes distortions in the entanglement of the photons. ■

Associate Dean Roscoe Pershing invests Dale J. Van Harlingen with a Donald Biggar Willett Professorship in Engineering at a ceremony on March 31, 2004, at the Beckman Institute. In 1994, the College of Engineering at the University of Illinois established the Willett Research Initiatives Fund. A gift from the late Mrs. Willett has been used to support scholarships, fellowships, research awards, and other activities. The Willett Professorship is for a five-year, renewable term.

DeMarco ONR Young Investigator



Assistant Professor of Physics Brian DeMarco has received a prestigious 2004 *Outstanding Young Investigator Award* from the Office of Naval Research, one of only 26 such awards made in all branches of science and engineering this year. DeMarco will use his award to launch an experimental program in quantum control of trapped ultra-cold atoms.

DeMarco received his B.A. in physics, with a mathematics minor, from the State University of New York at Geneseo in 1996, graduating *summa cum laude*. As an undergraduate researcher, he worked on calibrating and developing neutron detectors for laser-driven inertial confinement fusion experiments. He earned a Ph.D. in physics from the University of Colorado at Boulder (2001), where he extended magnetic trapping and evaporative cooling techniques used to produce atomic Bose–Einstein condensates to create the first quantum degenerate Fermi gas of atoms. This achievement merited *Science* magazine's imprimatur as one of the top ten scientific discoveries of 1999 and earned DeMarco the first JILA Scientific Achievement Award. In 2002, he received the American Physical Society's Division of Atomic, Molecular, and Optical Physics Thesis Award.

From 2001–2003, he was a National Research Council postdoctoral research fellow, working with David Wineland at the National Institute of Standards and Technology (Boulder) on quantum computing experiments with trapped atomic ions. DeMarco's work with the Ion Storage Group focused on developing improved quantum logic elements and "scaling-up" the complexity of quantum information processing tasks with trapped ions.

DeMarco joined the Department of Physics at Illinois in August 2003.

The Young Investigator Program is intended to confer honor on outstanding new faculty members at U.S. universities, to support their research, and to encourage their teaching and research careers. Awardees are selected on the basis of past performance and the quality and creativity of their research proposals. ■

IClicker "Connects" Students and Lecturers

Ever since the first teacher gave the first lecture to more than one pupil, we have wondered if the message gets through. How can we make sure that students understand the material? How do we encourage shy students to ask questions when they don't understand?

Well, perhaps technology being developed at Physics Illinois has an answer. Across the campus, instructors are experimenting with a new tool called the IClicker, a device the size of a television remote control that provides instant interaction between students and their instructors, even in large lecture halls.

"The Department of Physics has tried a variety of classroom polling tactics since the introduction of the undergraduate curriculum revisions about eight years ago," explained Tim Stelzer, assistant research professor of physics, one of the IClicker's inventors. "These ranged from simply asking students to raise their hands or hold up cards with letters printed on them, to a 'hard-wired' system that interfaced their Texas Instrument calculators to an infrared data acquisition system. All of these strategies had significant technical barriers that prevented their effective use in large classrooms (those seating more than 100 students)." These shortcomings led Stelzer, Professors of Physics Gary Gladding and Mats Selen, and Physics graduate student Benny Brown to develop the IClicker.

"We're doing beta tests in Physics 101 right now," Stelzer explained. "We have had only five lectures so far this semester, but I am extremely pleased with the IClicker's performance. They

Photo credit Darren Wright

Tim Stelzer with the first shipment of IClickers, which are being used to monitor student comprehension in Physics 101 this semester.

have allowed me to double the number of ACTs—or interactive segments—during the lectures, and I have noticed a significant increase in student participation," he remarked. "I was somewhat surprised to see that the use of the IClicker has also increased students' willingness to ask questions. I'm not sure if this is due to a difference in the lecture atmosphere, or if it is because the increased number of ACTs helps the students identify their misconceptions and formulate questions."

Stelzer, Gladding, Selen, and Brown formed Interactive Learning Technologies, the company that developed the IClicker. Stelzer said that although other student polling systems are available, they offer only one-way communication. The team thus adopted rf technology to get a two-way device for true lecturer–student interactivity and to avoid the line-of-sight constraints that make infrared systems hard to use in large lectures.

"The advantage of using rf technology is that I can send a response to a student's IClicker," Stelzer said. "Another advantage is its simplicity. Competing systems have very complex controls. With this one you can just click, and you are done."

While some instructors use the IClickers just to take attendance, others have been more creative. "The first day of class, I used this to get students to answer questions such as what college they're from, what year they were in," said Cleo D'Arcy, professor of plant pathology in the College of Agriculture, Consumer, and Environmental Sciences. "I could show them the diversity in the class." D'Arcy, also used it in "game-show style," asking multiple-choice questions to poll the class.

"One idea I thought was particularly innovative was to use the system to continuously monitor student comprehension," Stelzer said. "At any point during a lecture, students can click the 'E' button to indicate that they don't understand what is being presented. Because student responses are transmitted and displayed in real time, when an instructor notices a large number of 'E' entries he can slow down, reiterate the point in different words, or ask a question. Students can thus ask for help without the embarrassment of raising their hands in front of their peers and admitting that they are lost."

After attending a demonstration of the IClickers last spring, Associate Provost Ruth Watkins thought the idea had a lot of potential. As a trial, the Office of the Provost purchased about 1400 of the devices, distributing them through the Teaching Advancement Board and EdTech and Educational Services. As a result, she said, IClickers are being tested in eight classes across campus, providing a cross section of environments, class sizes, and disciplines.

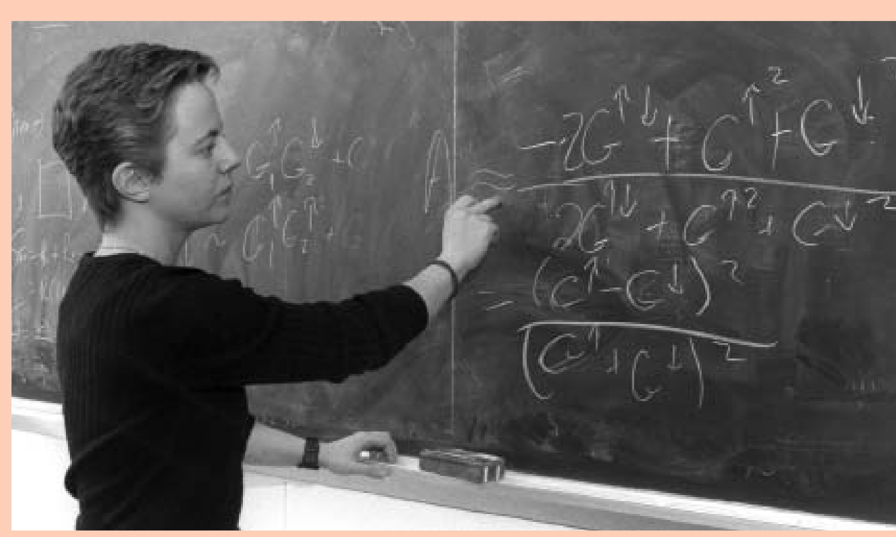
"It's a pilot test," Watkins said. "We will see how students react to the technology and whether it is particularly relevant in certain classes. There's an evaluation component. We're testing how effective this is. And the results of that will affect what happens next."

According to Stelzer, the biggest problems encountered so far were manufacturing problems, including bases having broken antennae and a few units (<3%) having poor range. However, once these quality assurance problems were resolved, the system has performed well.

"Currently we are revising the design to improve the performance of the system based on our experiences this fall," he said. "We are also enhancing the software to accommodate the innovative ideas our faculty colleagues have provided."

Stelzer said that the Spring 2005 version of the IClicker would have an auto power-off function to preserve battery life and a button on/off switch and would also draw less power. Interactive Learning Technologies is working to reduce per-unit costs so that the IClickers can be priced competitively with existing one-way infrared models currently on the market. ■

2004 Arnold Nordsieck Physics Award for Teaching Excellence



The 2004 Arnold Nordsieck Physics Award for Teaching Excellence was presented to Associate Professor Naomi C.R. Makins for her outstanding classroom instruction in both upper-level and introductory physics classes. Makins has earned a place on the *Daily Illini's* "Incomplete List of Teachers Ranked as Excellent by Their Students" every semester she has taught at Illinois. (All instructors are required to offer students in their classes the opportunity to fill out confidential teaching evaluation forms at the end of each semester. These comprehensive surveys are collected by the Office of Instructional Resources, which analyzes the data. Differing weights are assigned to required vs. elective classes, instructor effectiveness vs. utility of the textbook, students' perceived difficulty of the subject material, class management, and other variables. The instructor is then assigned a numerical "grade" based on a 5.0 scale, and a list is prepared of the campus's best teachers.)

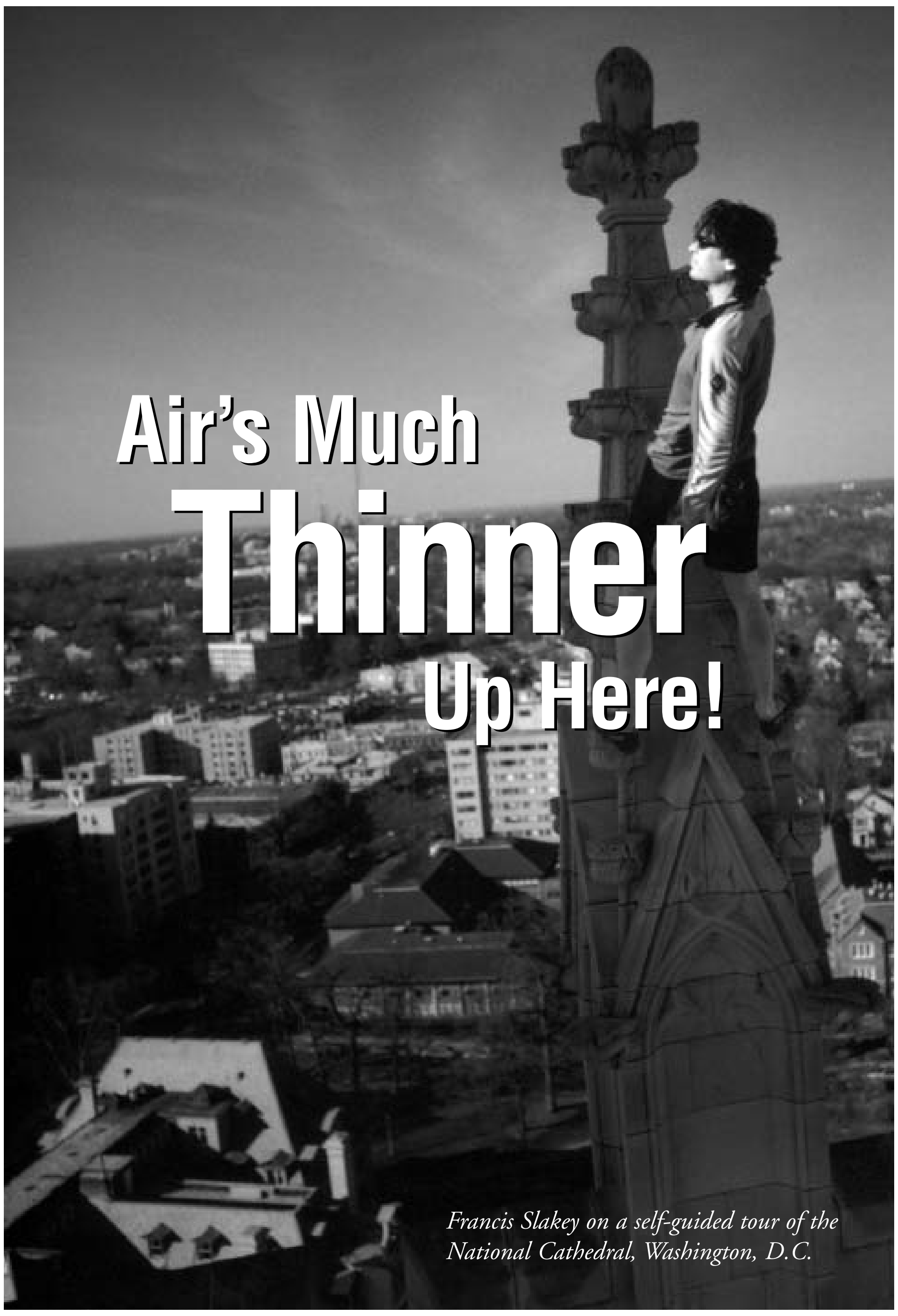
Makins' teaching philosophy and infectious zest for physics makes it clear why she is such an outstanding instructor: "Teaching undergraduate physics courses is a real privilege; no other experience comes close to giving the depth of understanding of a subject that undergraduate teaching does. Every semester, the students' ideas and questions cast a new light on apparently familiar material, and enable me to see things I never quite noticed before. Plus I get to relive my undergraduate days vicariously." (infectious grin) "What a thrill it was seeing Maxwell's equations for the first time!"

Makins adds seriously, "Teaching the next generation of physicists is also a daunting challenge. Human scientific knowledge today is so vast, and growing at such a tremendous rate, that preparing our students for work at the research frontier in a mere handful of years is already nearly impossible. As educators, we have to keep generating new ideas for how to distill our fundamental topics to their essence and teach them ever more efficiently."

Makins received her bachelor's degree in physics from the University of Alberta in 1989 and her Ph.D in physics from Massachusetts Institute of Technology in 1994. She joined the department as an assistant professor in 1997 and was promoted to associate professor in 2002.

Since coming to Illinois, Makins' principal research activities have involved the HERMES experiment at the Deutsches Elektronen-Synchrotron (DESY) in Hamburg, Germany. The HERMES experiment, an internal polarized target experiment in the electron beam of the HERA storage ring, is an extensive program of inclusive and semi-inclusive spin-dependent deep inelastic electron/positron scattering to determine the contribution of the different quark flavors to the spin of the nucleon.

The Nordsieck Award was endowed by the family of former faculty member Arnold T. Nordsieck to recognize his commitment to superlative teaching. Former winners include Dennis J. Kane (PIN, 2004, No. 1), Nigel D. Goldenfeld (PIN, 2003, No. 1), and George D. Gollin (PIN, 2003, No. 2). ■



Francis Slakey on a self-guided tour of the National Cathedral, Washington, D.C.

BY RICK KUBETZ

If there is such a thing as a non-traditional career in physics, Francis Slakey (MS, '87; Ph.D, '92) is living it. As associate director of public affairs for the American Physical Society (APS), Slakey advises Congress on the impact of physics on society. He is also the Cooper–Upjohn Lecturer in Biology and Physics at Georgetown University, where he teaches a course in hardball politics, which includes lobbying in the Capitol.

"I didn't expect to do the things I am doing now when I was in college," Slakey explained. "I knew I wanted to get a degree in physics, but I didn't know what I could do. I loved research. I worked with Miles Klein. I don't think there was a better guy to work with.

"I think every grad student wants to be part of a great scientific moment. I joined the group right when high temperature super-conductors were hitting. Don Ginsburg was making the best samples in the world—these great crystals. I had a fantastic laboratory and a great adviser."

According to Slakey, "The key to career preparation is for students and faculty to get acquainted with what lies outside the (academic) circle. Get your Ph.D, not because of what you want to do after that, but because you enjoy doing research. That way, whatever career you decide to pursue, you will have enjoyed your time as a grad student.

"When I was winding down, I decided I had other interests as well. I also studied applied ethics under a UI philosophy professor who has forever shaped my thinking—Jeff McMahon. I concentrated on nuclear weapons and arms control issues. My last year at Illinois, I got a MacArthur Scholarship from U of I's program in Arms Control, Disarmament and International Security.

"I decided to spend one year in Washington, and I knew I could get back into research. I went to D.C. and worked as a lobbyist for the APS, which was brand new to them and me. I was able to learn on the job, and I've been here ever since."

At APS, Slakey lobbies on defense and environmental issues. In one recent campaign he drafted and collected signatures for an international scientific statement opposing nuclear weapons testing. It was complemented with a more dramatic letter sponsored by an advocacy group, the Creative Coalition, which included endorsements by Beverly Sills, Billy Joel, Desmond Tutu, and Francis Slakey. "No one recognized my name," Slakey said.

By the way, Slakey is also the first Illinois physics alumnus ever to climb Mount Everest, and he is one of fewer than 80 mountain climbers in history to complete the world's "Seven Summits."

"My climbing started in earnest after leaving Illinois," Slakey related. "It is an incredibly intense drama. Every climb has its unforgettable moments."

In May 2000, Slakey reached the summit of Mount Everest (elevation 29,035 feet) as part of the Everest Environmental Expedition, a not-for-profit climbing team whose mission—apart from the climb itself—was to make a significant cleanup of discarded oxygen bottles and other debris that has accumulated at the high base camps over the years since Sir Edmund Hillary and Tenzing Norgay first attained the summit in 1953.

"Because of the harsh conditions, climbers scramble to get off the mountain, and this often means they leave equipment behind," Slakey said. An onsite documentary crew filmed more than 100 hours of footage during the course of the expedition. The resulting documentary, *Beyond the Summit*—narrated by Sharon Stone—has aired on the National Geographic Channel and several East Coast PBS stations.

In addition to the immense personal satisfaction of having accomplished a feat that few people on the planet have achieved—or will even have the opportunity to attempt—Slakey returned with a more concrete memento: one of the oxygen bottles used by Sir Edmund Hillary on his historic first ascent in 1953, identifiable by its serial number.

As if climbing were not challenge enough, traversing hostile environments—primarily man-made—is often more dangerous than the mountain itself. As an often independent international traveler, he has begun to take an interest in U.S. policies supporting other governments and militaries.

"It would be nice if these rocks were in safer places," Slakey noted wryly. Last year, he chronicled a recent near-death experience in the story, "I Went to Indonesia, and Ran into a Mountain of Trouble" (*Washington Post*, December 7, 2003).

"I wasn't worried about Indonesia's political troubles," he wrote, "even though I'd heard the islands were training grounds for terrorists. In all my years of traveling, I'd always managed to steer clear of local conflicts. I figured I'd go, climb, leave—end of story.

"Instead, I found myself staring down the barrel of a rifle, my life in danger—and surrounded not by terrorists, but by Indonesian soldiers." After giving the soldiers all of the money they had, Slakey and his climbing partner were allowed to pass—shaken, but thankful. Two days later, ten people traveling along the same road were ambushed. Two American teachers and an Indonesian were shot to death; eight other Americans were wounded.

"I got out in one piece, relieved that I'd never have to give the country or that moment another thought," Slakey related. "But when I recently heard President Bush recommend that we increase military ties with Indonesia to help in our war on terrorism, the moment came back to me. I couldn't help thinking that the President's suggestion—even though the White House later retracted it—was a bad idea."

Back at sea level, Slakey has also written and lectured on another subject he is passionate about: physics education. In his 1995 article for the APS News On-line (www.aps.org/apsnews/articles/11234.cfm), he critiqued the state of undergraduate physics education and emphasized the need for preparing students for non-academic careers. He noted that fewer than half of the nation's physics graduates with bachelor's degrees went on to further study at that time, while the rest searched for jobs in an extraordinarily competitive marketplace.

Slakey's work at APS provided an entrée to Georgetown University, where he started teaching in 1995. "I received an offer from the physics and biology departments, who had decided that their students could benefit from a science policy class," he explained. "It is a once-a-year seminar. Students break into groups. They identify some science-based social problem of their own choosing. They develop a political solution to the problem. Then, they go to Capitol Hill and lobby. Their grade is based on what they accomplish on the Hill.

"The amazing thing is that Washington D.C. is the only place you could teach such a course," Slakey remarked. "One reason I like to teach scientists is that they approach it with a good frame of mind. They are problem-solvers. The students learn how to develop and craft their ideas so they are compelling, and learn how to sell those ideas." In 2000, Slakey was named a Cooper-Upjohn Lecturer in Biology and Physics at Georgetown.

Non-traditional or not, Slakey knows that he has a good deal going. "APS has been really accommodating. Congress is out-of-town in August and from November through January. Since I only teach in the spring semester at Georgetown, I can get decent chunks of time off. I've also had good fortune with my climbing partners—some are full-time climbers so they have a lot of flexibility."

So what's left? "There's always stuff that I want to do. I'm trying to be an all-around climber—both alpine and rock. I have three climbs on my list: Cerro Torre, a rock wall in Argentina, Trango Tower in Pakistan—a premier wall climb of 4000 vertical feet—and K2, also in Pakistan.

"Climbing a mountain isn't about gaining a great view," he reflects. "That's an added bonus. It's about the challenge that the elements thrust upon you. It's about surviving. It's about discovering who you are." ■

Science Fiction Fueled by Science Fact

Cover artwork for MOONSTRUCK by Doug Chaffee

BY RICK KUBETZ

Capping four years that saw a dozen sales to top science fiction magazines and an entry in a *Year's Best Science Fiction* anthology, Edward M. Lerner (BS '71 Physics, MSE '73 Computer Science) will see his second novel, *Moonstruck*, published in February 2005. Lerner's fiction draws on his academic background—physics and computer science—and 30 years' experience at some of the country's premiere high-tech firms.

"Both books feature physicist heroes," Lerner explained. "It goes back to that whole notion of writing what you know. I think it is especially important in science fiction, where settings and characters ground the story in reality, particularly when the plot is 'out there'."

According to Lerner, the idea of writing science fiction surfaced "somewhere in the vicinity of 1982." "I finished my MBA, which meant I had my evenings and weekends back, and was reading again for fun. I was criticizing some of the things I read. My wife suggested, 'If you can do better, why don't you?'

"At that time, I had a long commute to work, so I started toying with plot ideas. I did a lot of 'what if?' game-playing with myself while I drove, then scribbled down my thoughts the moment I arrived. It took a couple months of driving to refine the plot." His first novel, the techno-thriller *Probe*, was reviewed in the November/December 1991 issue of the university's alumni magazine (then called the *Illinois Quarterly*).

"The hero of *Probe* is a physicist named Bob Hanson from UIUC, and chief technologist at the imaginary Illinois-based Asgard Aerospace Corporation. His life's work is Asgard's privately funded space probe, *Prospector*, which is seeking mineral wealth in the Asteroid Belt. When Prospector stumbles upon a wrecked alien spacecraft, the Pentagon, NASA, his employers, and a cabal of mysterious plotters all have plans—disclosed and otherwise—for *Prospector* and what it's found.

"I'm partial to stubborn physicists who refuse to take some phenomenon at face value (even if that face belongs to a supposedly much-smarter-than-human alien sapient)," he remarked. "And the unwrapping of physical riddles is plot-crucial. My other U of I degree is in computer science, so that affects my writing as well."

The hero of *Moonstruck* is a physicist and government researcher named Kyle Gustafson. "Having finally achieved the eminent post of Presidential science advisor, Gustafson thinks that, just maybe, he'll have the opportunity to make a difference," Lerner stated. "Then, even before the prologue ends, the shuttle *Atlantis* self-destructs during launch. By the end of Chapter One, the aliens arrive. And the physics of it all is just so puzzling…and interesting."

As a side note, Lerner mentions that he sold *Moonstruck* in serial form just days before the *Columbia* self-destructed during its descent, which was an eerie near-coincidence. "With some minor edits—to be sensitive to the *Columbia* tragedy—we went forward," he explained. "Then the Iraq war happened, and (without 'spilling the beans' plot-wise), suddenly, more plot tweaks were in order. Writing near-future fiction is a dangerous business."

But it's from his "business" that Lerner has gotten his best ideas. "My stories are seeded by technologies that currently interest me. Those seeds can take time to germinate, though. *Moonstruck* draws heavily upon my NASA contractor days, which ended in 1997."

Over the course of his career, Lerner's employers have included some of the country's technology heavyweights: Bell Labs ("What a talent pool that is!"), Honeywell—first as a consultant, then as an employee—PAR (Pattern Analysis & Recognition) Technologies, AT&T, Northrop Grumman, and Hughes Aircraft.

"At Hughes, I worked on a proposal for NASA's Earth Observing System, monitoring the world from low-earth orbit to see how its parts—atmosphere, oceans, land, ice caps—interact. The observation program is planned for at least 15 years (two full solar cycles). Hughes was bidding to be systems integrator for the multi-petabyte distributed data repository."

After Hughes was awarded the contract, Lerner became a manager, with more than 300 engineers and scientists reporting to him. "I contributed to the first three releases, and several of the satellites have since been launched. Along the way, I procured lots of good story input to *Moonstruck*. As the plot developed, I needed an alien weapon that was something different. I ended up caucusing with an atmospheric physicist on the concept.

"Concurrently, I was developing ideas for computer-science fiction, which eventually became a virtual-reality–neural-interfaces novella published in *Analog* in February 2002. That was followed by a short-novel sequel in the November and December issues, adding artificial life to the mix. This story arc deals with evolved-inside-the-computer monsters. I call it, 'Cyber without the punk'."

Lerner has fond memories of his days at the University. "I've been back several times on recruiting trips. When I was there in '94 to do some recruiting, I swung by NCSA to check out the newfangled World Wide Web."

Upon turning 50, Lerner decided that he had been managing projects long enough and gave himself a sabbatical, writing stories for magazines such as *Artemis* and *Analog*. He recently decided to pursue writing full-time from the home that he shares with his wife, Ruth Mayland Lerner (BA '71 FAA, MS '72 LIS) in Herndon, Virginia. "She is my first reader," Lerner added. "She doesn't like it when I kill people. That's how I can tell if I have a likeable character; she objects when I kill them off."

Moonstruck will be published by Baen Books (an imprint of Simon & Schuster) in February 2005; it will be available for advanced ordering starting November–December 2004. Lerner's website is *www.sfwa.org/members/lerner* (SFWA = Science-fiction and Fantasy Writers of America). ■

M. George Craford

National Medal of Technology

At a White House ceremony, President George W. Bush presented the National Medal of Technology to M. George Craford (MS '63, Ph.D '67) and Russell Dupuis (BS '70, MS '71, Ph.D '73, Electrical Engineering). Both were graduate students of Nick Holonyak Jr., John Bardeen Professor of Electrical and Computer Engineering and of Physics, who also shared in the prize. The award recognized the team's "contributions to the development and commercialization of light-emitting diode (LED) technology, with applications to digital displays, consumer electronics, automotive lighting, traffic signals, and general illumination."

Craford is currently the chief technology officer of Lumileds Lighting, a joint venture of Agilent Technologies and Philips Lighting, located in San Jose, California. He began his professional career as a research physicist at Monsanto Chemical Company before joining the Hewlett Packard Company in 1979.

Craford's research has focused on the development of visible LEDs using a variety of compound-semiconductor materials. At Monsanto, his group developed nitrogen-doped GaAsP technology and, at Hewlett Packard, he pioneered AlInGaP LEDs and also developed AlGaAs and InGaN products.

Dupuis is a professor of electrical and computer engineering at the Georgia Institute of Technology. Holonyak (BS '50, MS '51, Ph.D '54, Electrical Engineering) was the first graduate student of two-time Nobel laureate John Bardeen. An early researcher in semiconductor electronics, Holonyak gained eminence through his numerous inventions and contributions to advances in semiconductor materials and devices.

Established by Congress in 1980, the National Medal of Technology recognizes men and women who embody the spirit of American innovation and who have advanced the nation's global competitiveness, the White House said in its news release. To date, 146 recipients have been honored with the medal. ■

U of I Hosts Symposium on the Development of Condensed Matter Physics

On October 22–23, 2004, the Department of Physics at the University of Illinois at Urbana-Champaign hosted a special symposium on the "Early Years of Condensed Matter Physics at Illinois." The symposium, which was held at Loomis Laboratory of Physics, celebrated the discoveries in condensed matter physics that grew from the pioneering work done at Illinois during 1949–1959. "Our aim was to gather here in Urbana the people who took part in those early days, as students, faculty, postdocs and visitors, to document their memories and to recreate some of the excitement of that remarkable time in physics," explained Jeremiah Sullivan, head of the Department of Physics. "Illinois' #1 ranking in condensed matter physics today has its roots in that remarkably fertile decade." Nearly 130 guests, most of them alumni, joined the department's faculty and students in a festive, memory-filled reunion.

Leo P. Kandanoff of the University of Chicago, member of the National Academy of Sciences and winner of the 1999 National Medal of Science, opened the symposium with the first annual Charles P. Slichter Colloquium. A theoretical physicist, Kandanoff was a member of the University of Illinois physics faculty from 1962 to 1969. According to Kandanoff, "The 1950s—and perhaps also the 1960s—were very special times for the development of solid-state/condensed-matter physics, and Illinois was at the center of these activities. In areas such as nuclear magnetic resonance and superconductivity, methods were developed that would form the basis for the next half century of science and technology."

In an address on Friday evening, Acting Chancellor Richard Herman remarked, "In 1948–49, Wheeler Loomis, aided and abetted by his friend and collaborator Louis N. Ridenour, Dean of the Graduate College, put into play a breathtakingly bold gamble in the Physics Department at Illinois. Recognizing that the department should not concentrate all its research activities in one field, i.e., nuclear physics, and intrigued by the promise of silicon—he had become acquainted with Ridenour's work on silicon rectifiers at MIT's Rad Lab during World War II—Loomis decided to start a solid state physics program at Illinois in an era when few serious physicists deigned to study, in Murray Gell-Mann's words, 'squalid-state physics.' We are here to celebrate Wheeler's gamble and those who made his vision a reality in Urbana.

"In Loomis' characteristic audacious style, in 1949 he added five faculty positions (to an existing faculty of 18!) raiding the Carnegie Institute of Technology for Fred Seitz, his collaborator Bob Maurer, and a newly minted Ph.D, Dillon Mapother, and took a chance on two more promising youngsters, David Lazarus from the University of Chicago and Charlie Slichter from Harvard. The next ten years brought Jim Koehler (also from Carnegie Tech), John Bardeen, John Wheatley, Fred Brown, Robb Thomson, Andy Granato, Don Ginsberg, and Pete Flynn to Urbana, along with a host of young students and postdocs—Al Overhauser, David Pines, Erwin Hahn, Dick Norberg, Hans Frauenfelder, Ralph Simmons, to name only a few—who were also willing to bet their careers that there was a future in the physics of solids. These nuclear, atomic, and solid state physicists would, in the next years, build something new—condensed matter physics—with profound effects for the digital revolution and the dawn of the Information Age."

Charlie Slichter reminisces with former students Chuck Henry, Dave Lang, Ted Castner, and Chuck Hebel just before the first annual Charles P. Slichter Colloquium, which was held in conjunction with the "Early Years" symposium on the development of condensed matter physics at Illinois.

Nick Holonyak Jr., the John Bardeen Endowed Chair in Electrical and Computer Engineering and Physics and Bardeen's first graduate student, noted recently "There was a revolution in the science of electronics in the 1950s, when the transistor replaced the vacuum tube." Fred Seitz's theory of solid state physics, which up until that time had just been a book on the shelf, transformed electronics and enabled the digital age.

Over the weekend, a host of distinguished speakers discussed several related topics, including the development of nuclear magnetic resonance as a technique to study the structure of matter, the impact of Illinois' work on radiation-induced defects in solids, and optical studies of solids. For further information on the pioneers that transformed physics at the University of Illinois at Urbana-Champaign, visit www.physics.uiuc.edu/General_Info/history.html. ■

Alumni Benefit from Expanded Services

Engineering Career Services recently expanded its services for all University of Illinois College of Engineering alumni and now offers free access to job postings and other resources on its new online job board at www.uiucengineeringjobs.com. Through this new job board, alumni can directly access and apply to job postings from employers seeking experienced professionals or recent grads. Additionally, alumni can post full-time and internship employment opportunities for their company or organization and manage the process by which all applicants apply. There is no cost for any of these services.

One other new feature included with the online job board is an Alumni Mentor and Networking Program. All alumni have the option of participating in a new College-wide mentor network for both students and alumni. Participants in this program register online and indicate their willingness to provide industry information and share career expertise. The system also enables volunteers to manage the frequency of requests for information by students and other alumni. In addition to enabling students to gain more direct insight and knowledge about engineering careers, alumni mentors can participate and expand their own professional network.

To access the online job board or to participate in the student mentor and alumni network program, log onto http://ecs.cen.uiuc.edu or contact Engineering Career Services at (217) 333-1960. ■

Keep in touch with other alumni and build relationships for life through the University of Illinois Alumni Association. A portion of you UIAA dues goes directly to support Physics alumni activities, such as the Physics-on-the-Campus Luncheon (Student Awards section) and the "Early Years" symposium.

Education and Outreach

What does an electron do when it comes to a fork in the road?

BY ROBERT COLBY

To paraphrase the famous quote by Hall of Fame baseball player Yogi Berra—*it takes it*. For half a century physicists have known that the electron really does take both paths, acting as a wave as much as a particle. This well-known quantum-mechanical duality has recently reemerged in a rather unexpected place—superconducting nanowires. The experiment is part of an ongoing project being pursued by Professor Alexey Bezryadin's research group (www.physics.uiuc.edu/People/Faculty/profiles/Bezryadin/)

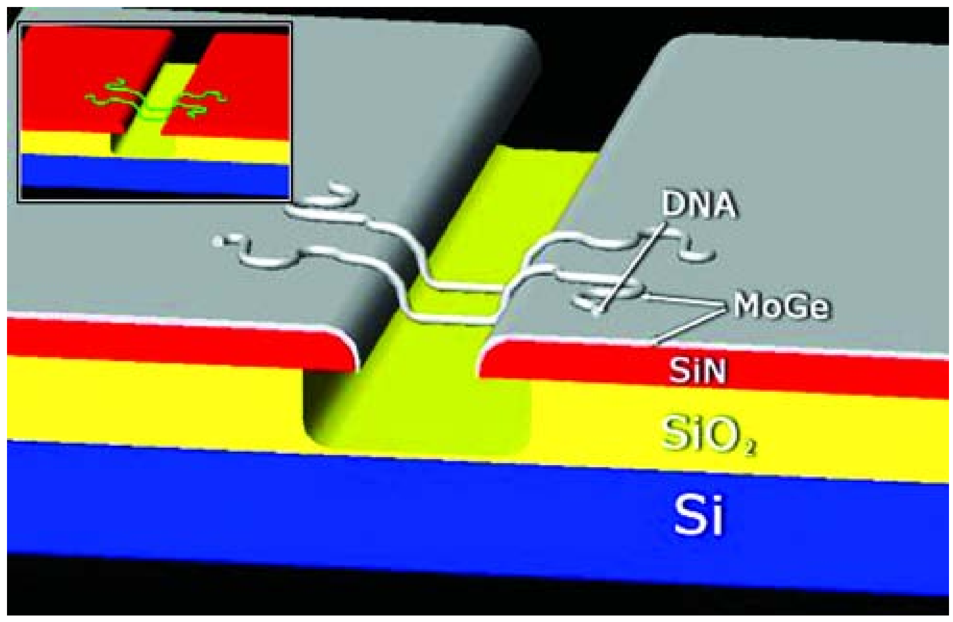


Figure 1. Diagram of a sample wafer with suspended DNA "bridges." The inset shows the strands of DNA suspended over an undercut trench in the substrate before sputtering. The sample is coated with MoGe, a superconducting metal, to make two nanowires.

Building with the building blocks of life

Bezryadin's group has most recently been focused on novel approaches to creating nanoscale superconducting devices. One such technique uses DNA as an exceptionally tiny piece of scaffolding on which to build a superconducting wire.

The process is remarkably simple. A small wafer of three silicon layers is prepared with a trench only 100-nm wide cut into the topmost layers. Then a solution containing DNA is dropped onto the sample. With any luck, some of the DNA strands land across the trench, and as the liquid evaporates, a perfect nanoscale "bridge" remains. The entire sample is then sprayed with a thin, even layer of superconducting metal, covering the exposed surfaces and any DNA strands that might span the gap. The final touch is isolating such a bridge under a scanning electron microscope and removing unwanted metal around it, leaving a single superconducting wire and leads on both sides of the wire, which can be used to explore some of the most basic questions of electron transport in superconductivity.

The next step

But what happens when there are no good wires? The chances of finding a strand of DNA across the gap are pretty good; there are usually many candidates on a single sample. However, some wires are often too close together to be individually isolated. Bezryadin's group exploited this "flaw" to examine what would happen when two wires lay in close proximity across a trench.

When the current is turned on, the electrons now have two paths to choose from to cross the trench. Quantum mechanics dictates that the electron goes through both wires simultaneously. However the waves going through each wire join back together on the far side of the trench, and the result isn't much different from what would occur with a single wire. So how can we show that the electrons are taking both paths?

Imagine a pair of stairs connecting two floors. Going up one set is the same as going up the other, just like the electrons do in the DNA wires. Now imagine a pair of escalators, one going up and the other down. It's possible to walk up both escalators to get to the second floor; walking up the "up" escalator would shorten the journey, while walking up the "down" escalator would take more time but still get to the second floor. Two people starting the trip to the second floor together would end up arriving separately.

Analogously, a stream of electrons that joined back together after crossing the separate nanowires would not look the same as it did going into wires. In the case of an electron, the output has to be considered as a mixing of the two waves emerging from their respective wires. When the waves happen to line up, they add constructively, but when they don't line up, they partially interfere with each other. When they line up asymmetrically, they cancel each other out entirely. This shifting between constructive and destructive adding creates oscillations in the output signal. Seeing these signals would show that the electron is crossing both wires, as expected.

The trick, of course, is figuring out how to make the DNA wires act like the opposing escalators. The solution that Bezryadin's group uses is a strong magnetic field. When a changing magnetic field (B) passes through a loop, a current (I) is induced about the perimeter of the loop. The two DNA wires and the borders of the trench form such a loop, so an induced current is expected. As the current loops around, it hits one wire going one way, and the other wire coming back. As the input current breaks up to go along both paths, one has a current pulling it along with it, and the other has a current pushing it back. If input current is taking both paths, the output should oscillate.

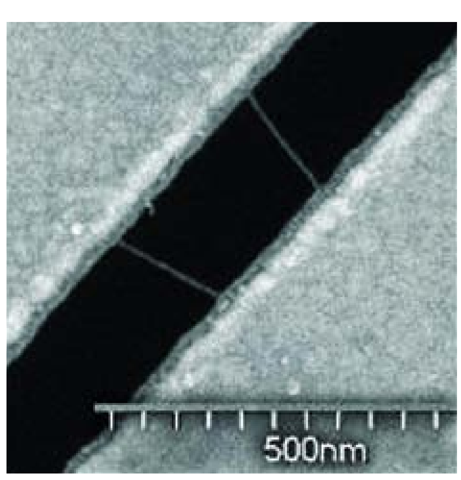


Figure 2. Scanning electron microscope (SEM) image of a pair of DNA wires. (Courtesy A. Bezryadin)

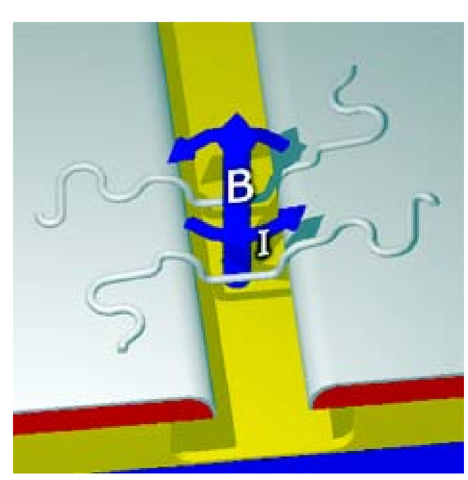


Figure 3. A strong magnetic field perpendicular to the wafer induces a current that flows in opposite directions across the pair of nanowires.

"It ain't over 'til it's over"

Yogi Berra must have been hiding a secret passion for physics. Measurements on two wires, carried out by graduate student Dave Hopkins, have shown oscillations that suggest the electron is crossing both wires (Fig. 4). While this result is very encouraging, more work is needed before any grand conclusions can be made. Bezryadin's group has continued to vary the geometry of the loop and is examining samples having more than two wires. They are also looking to recreate the effect with carbon nanotube wires in the near future. ■

Robert Colby is a senior in Engineering Physics. He wrote this article and prepared figures 1 and 3 as an assignment for Physics 398, "Introduction to Physics Research." He worked with Bezryadin's group this summer as part of his senior thesis.

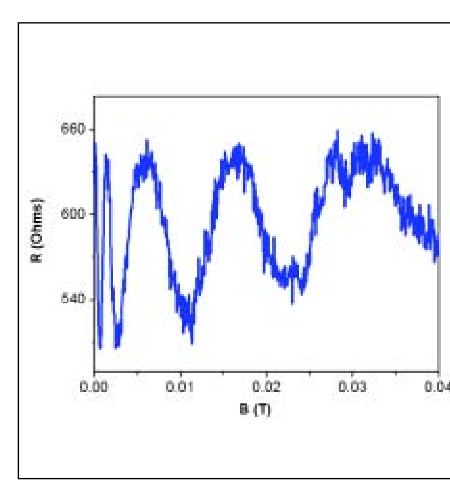


Figure 4. Resistance vs. applied magnetic field data of two MoGe wires in parallel showing oscillations. The period of oscillation is inversely proportional to the effective area enclosed by the two paths the electron can take, which decreases with increasing magnetic field. (Courtesy D.S. Hopkins)

Joint U.S.–Russian Team Pushing the Frontiers of Nuclear Physics

An international team of physicists, led by Research Associate Professor Peter Kammel, is resolving a hotly debated issue in intermediate-energy physics in an experiment being carried out at the Paul Scherrer Institut (PSI) in Villigen, Switzerland. A precision measurement of the muon capture rate on the proton directly determines a fundamental microscopic property of the proton. While this quantity can be calculated to high precision based on the symmetries of the underlying basic theory, recent experiments show a discrepancy with these predictions. In addition to scientists and students from Illinois and PSI, the team includes researchers from the Petersburg Nuclear Physics Institute (PNPI) in Gatchina, Russia, the University of California, Berkeley, the Université Catholique de Louvain, (Belgium), the Technische Universität München (Garching, Germany), Boston University, and the University of Kentucky.

Although such international collaboration is the norm in today's modern accelerator experiments, Kammel is particularly gratified that the Illinois team has been able to secure funding from the U.S. Civilian Research and Development Foundation (CRDF) to support critical work by the Russian members of the collaboration.

"This talented group, including several former weapons scientists, has developed a state-of-the-art hydrogen purification and handling system," Kammel explained. "The sophistication of their system is critical for realizing a new experimental technique to eliminate the main uncertainties of earlier efforts."

The CRDF is a nonprofit organization authorized by the U.S. Congress and established in 1995 by the National Science Foundation. Its mission is to advance the transition of foreign weapons scientists to civilian work by funding collaborative non-weapons research and development projects and to strengthen research and education in universities abroad. ■

Boris Bezymiannyh, Marat Vznuzdaev, Victor Trofimov, and Alexander Vassiliev from PNPI are shown holding the bodies of the adsorber-compressors of their novel hydrogen purification and handling system.

Physics Alumni Association "March Meeting" Reception

Catch up on new Physics Illinois developments and meet old friends at the traditional Physics Illinois reunion at the 2005 APS March meeting.

Tuesday evening, March 22, 2005, 6-8 p.m.
Check your meeting program for room location.

Hot, Cold, Large, and Small are Explored at SPH

From steaming geysers to absolute zero, from the infinite to the infinitely small. Together, they meandered down molecular highways and examined crystals that nature cannot make.

Now in its 12th year, the Saturday Physics Honors Program is a series of lectures on modern aspects of the physical sciences by renowned scientists, which is offered by the Department of Physics each fall. Although designed primarily for high-school students, the free program is open to the public and regularly attracts college students, teachers, and community residents who take advantage of this unique opportunity to meet world-class researchers in a relaxed, interactive setting.

"This is a great chance to interact with renowned scientific leaders in the research community," explained Dr. Inga Karliner, one of the program's administrators. "The lecturers who volunteer for the program include new faculty—together with equally enthusiastic members of the National Academy of Sciences—and distinguished visitors. They share their interests and explain how things work—from MRI, transistors, liquid crystals, and GPS, to neutron stars, quarks, gluons, black holes, and more."

"Participants learn about recent advances in the physical sciences, see how physics inspires modern technology, and how it affects our everyday lives," explained Toni Pitts, program coordinator. A question-and-answer session is held at the end of each program. The sessions are held in 141 Loomis Lab.

Topics for the Fall 2004 Series included:

"Steaming Geysers and Puffing Volcanoes,"
Susan Kieffer, Geology
Kieffer, a member of the National Academy of Sciences, has been studying the Old Faithful geyser in Yellowstone National Park for nearly 30 years to learn how it works and to compare its eruption dynamics with that of explosive volcanoes. These studies culminated with the lowering of a small video camera into the conduit to film the insides of Old Faithful.

"What is Absolute Zero? Ultra-cold Quantum Weirdness,"
Brian DeMarco, Physics
Demonstrating the cutting-edge techniques researchers use to cool gases to temperatures as low as one half of one-billionth of a degree above absolute zero, DeMarco explained how atoms and molecules behave in strange and amazing ways.

"Could a Defense Against Intercontinental Missiles Work? History and Technology,"
Frederick K. Lamb, Physics
An internationally recognized expert on the issue, Lamb's presentation summarized the history of missile defense and related technologies and discussed whether the approaches now being pursued are likely to be more effective than those of the past.

"From the Infinite to the Infinitely Small: Probing the Cosmos at an Accelerator"
Tony Liss, Physics
In his presentation, Professor Liss explained how experiments at particle accelerators may answer some of the current mysteries of cosmology.

"Little Engines that Could: How Tiny Motor Proteins Move on a Molecular Highway,"
Taekjip Ha, Physics
Ha explained how physicists use ultra-sensitive single-molecule imaging techniques to unravel the mystery of how nature's motor proteins can move along congested cellular highways with remarkably high precision by converting chemical energy from "fuel" molecules into mechanical energy with a much higher efficiency than man-made engines.

"The Crystals that Nature Cannot Make,"
James Eckstein, Physics
Through his lecture and images, Professor Eckstein showed how scientists make artificial crystalline materials by controlling the composition of thin films. These novel materials are grown one atomic layer at a time, forcing them to assemble in ways that are not observed in nature.

For additional information, see the Saturday Honors Physics Program website: www.physics.uiuc.edu/outreach/Honors. ■

The Library Can Use Your Help

Gifts to the UIUC Library Friends Fund and through the Departments of Physics and Astronomy are greatly appreciated. These supplemental funds help purchase big-ticket items (such as electronic journal backfiles) and meet user requests for specific items outside the normal book acquisition practices. The spiraling costs of journals has put enormous strains on the library's budget, and book acquisitions have been particularly hard hit. Several publications are on the PAL "wish list":

Volumes to complete the Series on **Directions in Condensed Matter Physics** ($435)

- *Volume 2: Ionic Solids at High Temperatures*
- *Volume 5: Defect Processes Induced by Electronic Excitation in Insulators*
- *Volume 6: Spin Glasses and Biology*
- *Volume 15: Thin Films: Heteroepitaxial Systems*
- *Volume 17: Insulating and Semiconducting Glasses*

Black Holes, Gravitational Waves, and Cosmology, Martin Rees, Cambridge (2004). New edition of Rees's 1974 classic, including 26 new articles that describe the enormous progress and increased complexity of these areas and a lengthy new introduction linking them to the ideas of the original edition. ($51)

Hamiltonian Systems and Fourier Analysis: New Prospects for Gravitational Dynamics, D. Benest, C. Froeschlé, E. Lega, Cambridge (2004). Introduces mathematical methods for the theory of Hamiltonian systems and Fourier analysis, including up-to-date research and applications. ($110)

Inspec Search Aids, Inspec, Inc. (2004). A thesaurus of controlled terms, a list of the full titles of the 4000 journals indexed in INSPEC, and a classification scheme providing the period of use of each classification entry in the INSPEC database, the premier database for journal articles and conference proceedings in physics, electronics, computing, control engineering, and information technology. ($240)

If you would like to donate one of these volumes, or contribute to the Library Friends Fund, contact Celia Elliott (cmelliot@uiuc.edu). ■

PHYSICS ILLINOIS NEWS
Physics Illinois News is published twice a year by the University of Illinois Department of Physics for its students, faculty, alumni, and friends.

MISSION
The mission of the Department of Physics of the University of Illinois at Urbana-Champaign is to serve the people of the State of Illinois, the nation, and the world through leadership in physics education and research, public outreach, and professional service.

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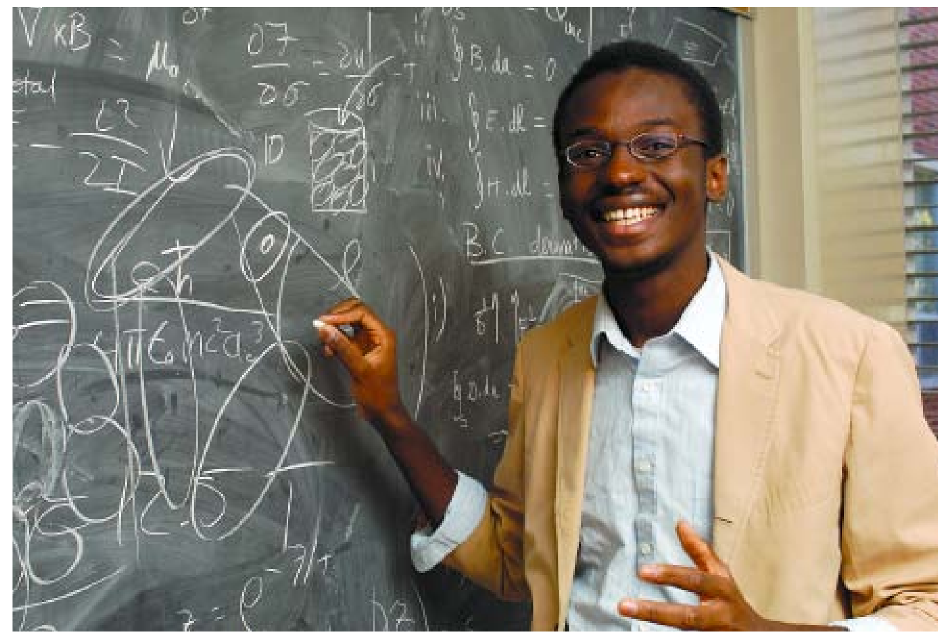
If you have suggestions for stories or features that you would like to see, comments about this edition, or requests for an electronic version of the newsletter, please write to us. We're listening!

The University of Illinois at Urbana-Champaign is an equal opportunity and affirmative action institution.

Student News

Ibrahim Cisse Named Finalist for APS LeRoy Apker Prize



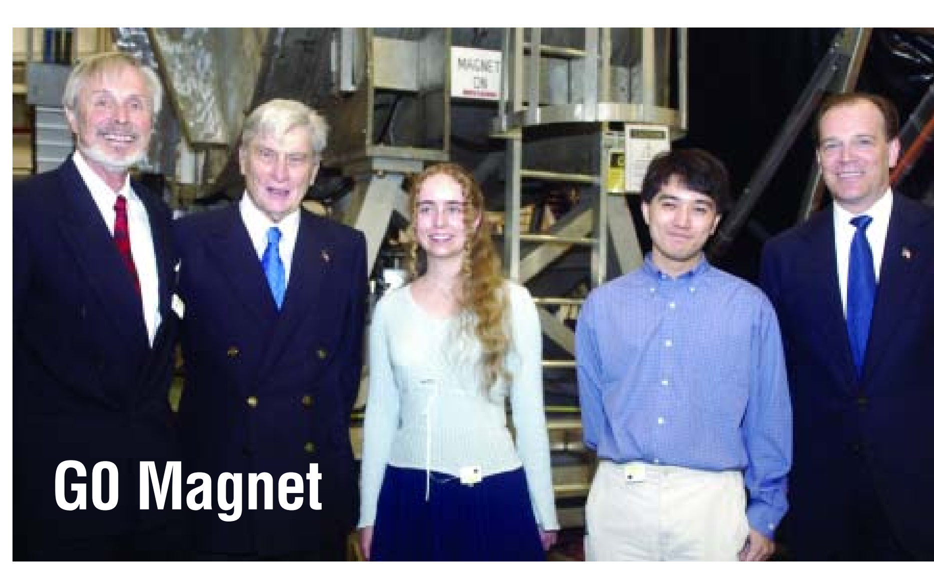
Entering graduate student Ibrahim Cisse has been named a finalist for the 2004 LeRoy Apker Prize of the American Physical Society in recognition of his research achievements as an undergraduate. Cisse did his prize-winning work as an REU student with Professors Paul Chaikin (Physics) and Salvatore Torquato (Chemistry) at Princeton University, where he explored fundamental principles governing the random packing of particles using M&M™ candies (*Science* **303,** 990 [2004]). This work has profound implications for a broad range of scientific problems, including the properties of granular media and high-density ceramics, glass formation, and discrete geometry.

In a surprising result, the researchers showed that oblate spheroids pack more densely than spheres when poured randomly and shaken. In further experiments and sophisticated computer simulations, they found that a related shape—the ellipsoid—packs even more densely at random than spheres in even the tightest possible, perfectly ordered arrangement.

Although problems of particle packing have been studied since Johannes Kepler investigated the ordered arrangements of spheres in the 16th century, it was not until 1998 that the densest possible arrangement of spheres was shown to fill 74.04 percent of the total space, as Kepler had predicted. The packing of randomly assembled particles is considerably less well understood.

A citizen of Niger, Cisse graduated in May 2004 from North Carolina Central University before enrolling at the University of Illinois. He worked this summer in Professor Taekjip Ha's research group.

The Apker Prize is presented annually to recognize outstanding achievements in physics by undergraduate students and thereby provide encouragement to young physicists who have demonstrated great potential for future scientific accomplishment. ■



Graduate students Kaz Nakahara (UIUC) and Sarah Phillips (William & Mary) explained the G0 (G zero) experiment currently underway at Thomas Jefferson National Laboratory to Senator John Warner (R, Virginia) and Kyle McSlarrow, Deputy Secretary, DOE, on April 16, 2004, at JLab. Part of the 40-ton superconducting magnet that was designed and tested at Illinois is shown in the background. (L to r) Christoph Leemann, Director, JLab, Warner, Phillips, Nakahara, and McSlarrow.

Physics Illinois Represented at 54th Lindau Meeting

Graduate student David Pekker represented the United States at the 54th Lindau meeting of Nobel Laureates and young researchers.

Since 1951, Nobel Laureates in chemistry, physics, and physiology-medicine convene annually in Lindau, Germany, for open and informal meetings with students and young researchers. The meetings rotate by discipline each year, and the 2004 event focused on physics. David Pekker, a graduate student in the Department of Physics and member of Professor Paul Goldbart's research group, represented the University of Illinois.

The U.S. Department of Energy (DOE) and the National Science Foundation, as well as Oak Ridge Associated Universities (ORAU), were invited to bring groups of top young researchers to the 2004 meeting, which was held June 27–July 2, 2004. The DOE/NSF delegation consisted of 57 doctoral students from the United States, whose current research at their universities is funded by DOE or NSF.

"On the way to Lindau, we made a short stop in Münich for sightseeing, to check out the beer gardens, and to catch up on sleep," Pekker reported. "We finally arrived at Lindau just in time to check in at our hotels and go to the opening ceremony. At the Inselhalle Auditorium, Countess Sonja Bernadotte welcomed the more than 500 students from all over the world and the 16 Laureates in attendance.

"Monday through Thursday, the Nobel Laureates gave lectures in the mornings and participated in question-and-answer sessions in the afternoons," he added. "The lectures covered all sorts of topics, from high-temperature superconductivity to the Space Shuttle Columbia accident. Besides answering questions about physics, the Laureates expressed their opinions about football (err, I mean 'soccer'), science education policy (this was especially relevant to the German students, as Germany is moving to reform its university system), quantum mechanics, and all sorts of other topics.

"On Monday evening, there was a dinner to give the students a chance to personally meet the Laureates. At the dinner I got to talk with Dr. t'Hooft, who is currently looking for a new 'theory of everything'(beyond the standard model). He has a very interesting view on the nature of quantum mechanics as a low-energy limit of a classical theory. Thursday lunch was shared with Professor Osheroff from Stanford. He talked about his recent work on the Space Shuttle Columbia investigation board and about low temperature physics."

In addition to the unique interaction, the participants enjoyed the picturesque island city of Lindau, which is located at the eastern end of Lake Constance, just north of the Swiss Alps. Located at the common border of Austria, Germany, and Switzerland, the medieval city is rich in central European culture.

David Pekker was born in Volkhov, Russia, (100 km from St. Petersburg). His family lived in Akademgorodok ("Academic City," which hosts more than 20 scientific institutes of the Russian Academies of Science, Medicine, and Agriculture) in Siberia. "My father worked at the institute for nuclear physics and my mother at the hydro-meteorological center," he explained. "In the United States, my parents found work at the University of Texas at Austin, and in 1997, we gained our citizenship.

"I have always been interested in physics and mathematics, so after completing high school in Round Rock, Texas, I went to Rice University where I studied physics and math. In 2002, I entered the University of Illinois as a graduate student in the Department of Physics.

Reflecting on his Lindau experience, Pekker said, "Attending the Laureates' lectures, and meeting them in person to ask questions was an invaluable opportunity to learn about both the great discoveries of the past and leading-edge physics of today from the men who put it together. In addition, I very much enjoyed meeting my peers from the United States, Germany, Israel, India, Russia, and other countries. It was my honor to represent the university in this way." ■

Two Staff Members Are Chancellor's Award Finalists

Penny Sigler and Julie Wright, two of the department's long-time employees, were finalists for the 2004 Chancellor's Distinguished Staff Award. This extremely competitive award is presented annually to up to eight civil service staff selected from the entire campus for their exceptional accomplishments and service to the University.

Penny Sigler is a staff secretary for the nuclear physics (NPL) research group. In this capacity she serves eight professors, two research physicists, four postdoctoral research associates, and more than twenty Ph.D. students, plus several members of the technical staff and a host of part-time undergraduate helpers and visitors. In her job, she does "everything, except the physics itself," according to her nominator. In addition to traditional administrative duties, Sigler helped coordinate a four-day meeting of the Division of Nuclear Physics for the American Physical Society (APS), hosting physicists from around the world. Several years ago, she also organized the Seventh International Symposium on Polarized Target and Beams, and she was instrumental in the launching of the highly successful Saturday Physics Honors Program (see article in this issue).

Those who work with Penny are quick to recognize her accomplishments. "Penny is the single most impressive secretary I have every encountered," remarked Professor Naomi Makins. "I have never experienced a moment's concern about any administrative matters since I know that Penny is completely on top of everything...She goes well beyond the call of duty."

Since 1986, **Julie Wright** has served as the secretary for the Laboratory for Fluorescence Dynamics (LFD), an international research laboratory collocated within the Department of Physics. In that capacity, she handles numerous tasks, including administrative and secretarial support of the senior LFD staff and affiliated professors of physics and biophysics. She also manages all aspects of the international conferences and meetings sponsored by the lab,

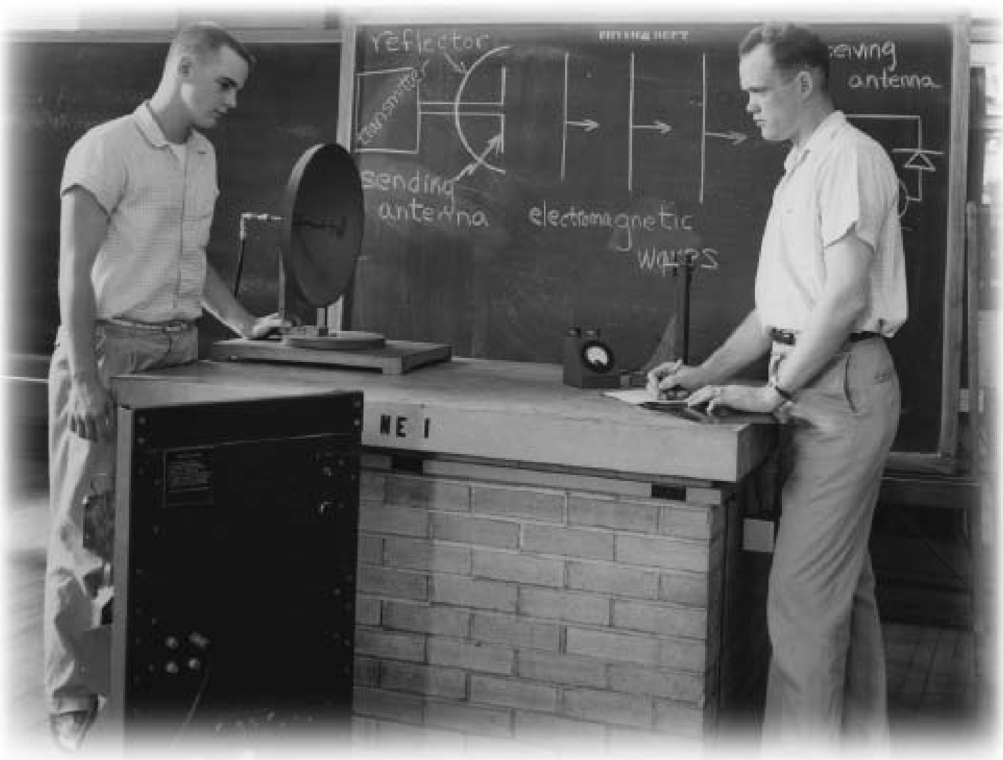
Julie Wright

as well as seeing to the needs of the many foreign visitors who come to do experiments in the LFD facilities.

As a National Institutes of Health national resource laboratory, the LFD is required to maintain extensive user records—on more than 25,000 hours of user-time annually—and Wright handles most of that documentation. In fact, she designed the original database for recording the equipment usage information, which, in 1986, required learning and writing code in dBase III and later converting it to the current database. Entirely self-taught, Julie is a primary resource for questions about LFD software. She also serves as webmaster for the LFD and has developed web-based "everything-you-ever-needed-to-know-about" information pages that are used by everyone in the department.

According to Jan Kane, director of budget and resource planning for the department, "Penny and Julie's combination of history within the department, along with their commitment and willingness to go above and beyond job descriptions, is what makes them invaluable. They represent a culture that fosters excellence among all the employees. We're very proud of Penny and Julie." ■

Penny Sigler, photo not available



Backward Glance

Do you recognize the physics students in these ca. 1952 photos of the E&M laboratory in the old Physics Building? We'd like to record your memories as we document our department's past. If you have photos to share, please contact the editor at (217) 244-7725, cmelliot@uiuc.edu.

Physics Illinois

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