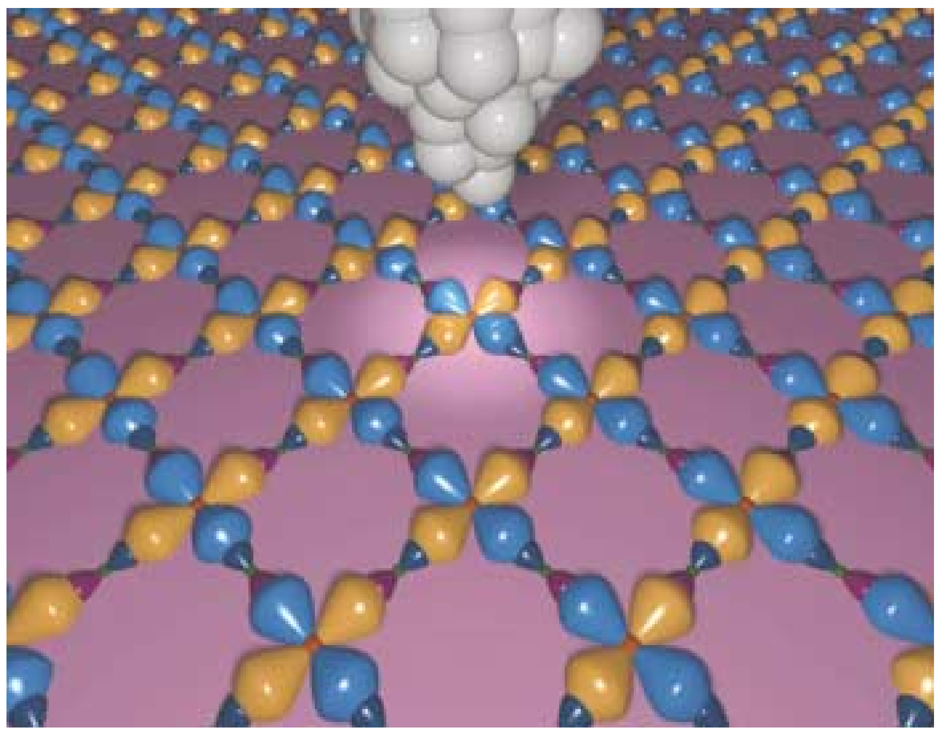
Physics Illinois News

THE DEPARTMENT OF PHYSICS AT THE UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN • 2003 NUMBER 1

First Imaging at Atomic Scale of a CuO_2 Plane in a Superconductor

The peculiar behavior of high-temperature superconductors has baffled scientists for years. Many of the unusual characteristics are believed to arise from the behavior of electrons in the crystallographic planes of these compounds, which consist of copper and oxygen atoms. Physicists at the University of Illinois at Urbana-Champaign have, for the first time, imaged a single copper-oxide plane at the surface of one of the high-T*c* cuprates. This work has not only uncovered some surprises in the nature of electronic states in these planes, but it has also created a new methodology for probing electrons in these unusual materials. The research was reported in a paper authored by S. Misra, S. Oh, D. J. Hornbaker, T. DiLuccio, J. N. Eckstein, and A. Yazdani, "Atomic Scale Imaging and Spectroscopy of a CuO_2 Plane at the Surface of $Bi_2Sr_2CaCu_2O_{8+\delta}$," *Physical Review Letters* **89**, 087002-1 (2002).

The work has been a collaborative effort between the research groups of Professor Ali Yazdani and Professor James Eckstein. Using atomically engineered molecular beam epitaxy (MBE) samples that were grown by Eckstein's group, Yazdani and his graduate student, Shashank Misra, have been able to demonstrate that a single copper-oxide plane can form a stable layer at a superconductor's surface.



Courtesy S. Misra and A. Yazdani

Artist's depiction of how electrons from an STM tip might couple with the atomic orbitals of the CuO_2 plane, whose orbital symmetry, which resembles a cloverleaf, could strongly constrain tunneling.

To image the surface of thin films of a superconducting crystal, Yazdani's group uses a low-temperature scanning tunneling microscope (STM) that they built at Illinois. By exploring large areas of the sample and correlating the STM topographic images with X-ray crystallographic data, the researchers were able to identify individual layers of copper oxide and of bismuth oxide and then measure discrete electronic properties. To their surprise, they found that these two surfaces exhibit very different electronic properties. In particular, they find that the rate of electron tunneling into a CuO_2 plane at the surface is strongly suppressed at low energies—unexpected behavior in a *d*-wave superconductor that demonstrates the dramatic influence of the layered structure on the surface electronic properties.

To understand their findings, the Illinois researchers consider a model of how electrons from an STM tip could couple with the atomic orbitals of the CuO_2 plane (see illustration). The paper describes how the orbital symmetry of the CuO_2 plane, which resembles a cloverleaf, could strongly constrain the electrons' tunneling from the STM tip. At low energies, electrons from the tip are constrained by the orbital symmetry of the plane's electronic wave function; this directional dependence of the current could explain the suppressed tunneling.

Previous measurements had been performed on surfaces terminated with other layers—bismuth oxide, for example—where the copper-oxide plane was buried under the surface. In those experiments, however, it was not apparent how the STM tip was coupling to the copper-oxide plane. "You could theorize that the other layers had no effect on the measurement, but that flies in the face of our experiment," Yazdani said. "From our results, it is clear that what you put at the surface makes a huge difference in what you measure."

Other collaborators on the project were graduate students Seongshik Oh and Daniel Hornbaker and post-doctoral research associate Tiziana DiLuccio. The work was funded by the National Science Foundation,* Office of Naval Research and the U.S. Department of Energy. ▪

**Disclaimer: This material is based upon work supported in part by the National Science Foundation under Grant No. 9975611. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.*

Charles Gammie Honored at the White House

Charles F. Gammie received a 2002 *Presidential Early Career Award for Scientists and Engineers* (PECASE) in a special White House ceremony on July 12, 2002. The PECASE award, the highest honor bestowed by the United States on young scientists and engineers, recognizes outstanding scholars who, early in their careers, show exceptional potential for leadership at the frontiers of knowledge. Only 60 researchers nationwide were so honored this year. The award also provides a five-year research grant of approximately $100,000 per year.

Gammie, who holds a joint appointment in Physics and in the Department of Astronomy at the University of Illinois, will use his award to carry out a research program in theoretical and computational astrophysics that focuses on building numerical models of plasmas flows around black holes. The release of gravitational binding energy in black hole accretion flows is thought to power quasars and active galactic nuclei and, in our own galaxy, the black hole X-ray binaries. Gammie, together with a postdoctoral researcher and his students, is developing a new code for general relativistic magneto-hydrodynamics. This code will be able to address some of the fundamental unsolved problems in the field related to how jets are launched and under what circumstances energy may be extracted from a rotating black hole.

In a project involving several undergraduate students, Gammie is also developing a web-based "digital demo room" of interactive simulations of stellar evolution, supernovae, star formation, and galactic structure. The user can select introductory, intermediate, or advanced levels and input initial parameters to see how different scenarios evolve in the simulations.

Charles Gammie receiving the "Presidential Early Career Award for Scientists and Engineers" from National Science Foundation Director Rita R. Colwell.

Gammie received his bachelor's degree in mathematics in 1987 from Yale University and his doctorate in astrophysical sciences in 1992 from Princeton University. He joined the Illinois faculty in 1999. ▪

INSIDE

Letter from the Head

Welcome to the inaugural issue of *Physics Illinois News*. This publication brings a new name and new look to the annual *Department of Physics News*, which we have used for more than 60 years to keep in touch with our friends and to keep them informed of the achievements of our faculty, students, and alumni. We've spruced up the format, incorporated our new departmental logo (did you spot the $\hbar$ where the orbit crosses the riser of the "h" in *Physics*?), condensed the topical coverage, and increased the frequency. If you have comments about the new format, suggestions for articles, opinions to share, or special requests, we'd like to hear from you. Please write to *Physics Illinois News*, Department of Physics, 1110 West Green Street, Urbana, IL 61801-3080 or contact *cmelliot@uiuc.edu.*

Funding Squeeze

At the midpoint of my third year as head, there is good news and some bad news to report. Looking ahead to the next two years, I see considerable uncertainty.

It will not surprise you that the bad news and the anxiety derive from a tottering State-of-Illinois economy and the unlikely prospects for a quick recovery. The root of the problem is, of course, the weak national economy. Peer physics departments are also affected—to a greater or lesser degree. Public universities are definitely suffering; the University of California system is facing major cutbacks. The same stories are coming from the East Coast and elsewhere in the Midwest. Private universities are not immune to the state of the national economy, and although they typically have large endowments to provide a greater degree of buffering, their investment income has plummeted in the past few years.

As one of only two public universities in the nation's "Top Ten" physics departments, we are concerned about the future. The core of the department is strong, and we are committed to maintaining the traditions of excellence in physics that is the legacy of a century of wise investment and careful stewardship at the University of Illinois. However dismal the fiscal climate may be over the next two years, I believe that with the help of our friends, we will weather the storm successfully, but *nothing* can be taken for granted. We face major challenges and the certainty that opportunities will be lost and plans scaled back or delayed due to declining State support.

The department began fiscal year 2003 on July 1, 2002, with 4.8 percent ($430,00) less State funding than in the preceding year. Overall, the University of Illinois received a 6.5 percent reduction in State funding for the current fiscal year. One of the consequences was a salary freeze for faculty, academic professionals, graduate student assistants, and staff not represented by collective bargaining contracts.

The total departmental budget at the beginning of the current physical year was $28.5M, with 33 percent coming from State funding; 63 percent from external research grants and contracts; 1 percent from private gifts and income from endowed funds, and 3 percent from other local sources (overhead returns to the department, College and campus contributions for faculty start-up packages, graduate fellowships, and small bridge research grants).

The assumptions made by the state government of revenues for the current fiscal year have proven to be wildly optimistic. Actual State revenues are down considerably from projections, and we expect another recission of State funds for the University of Illinois to be announced sometime this semester. There is no way at present to predict what amount of money the Department of Physics will be taxed.

The unlikelihood of a quick turnaround of the current recession and the uncertain effects of international events on the national economy cast a cloud over our expectations for State of Illinois funding for higher education in FY 2004.

Planning for New Faculty

Now the good news. Over the past three years, we have recruited eight new faculty members (five at the junior level and three at the senior level), which, when tempered by three retirements, results in a total faculty count of 60 at the start of the Fall 2002 semester. David Daniel, who became Dean of Engineering in April 2001, following the retirement of Dean William Schowalter, is strongly supportive of expanding the size of the Physics faculty to capitalize on existing strengths and to exploit opportunities in new and emerging areas.

We have four faculty searches open at present: condensed matter experiment, condensed matter theory, atomic, molecular and optical physics, and experimental biological physics. On January 15, 2003, we submitted a faculty-hiring strategic plan to the College of Engineering that calls for eight additional new hires over the next three years. Assuming a total of four retirements and departures during those three years, our faculty size would increase to 68 if our hiring plan is accepted and all searches are successful.

Funding for new faculty positions in the College of Engineering will be decided annually in future years, based on the three-year hiring plans submitted by each department and updated each year. Our submission on January 15 was the first step in that process. The State of the Illinois economy will hang heavily over future plans.

Our Students

In the academic year ending August 20, 2002, we awarded 37 baccalaureates, 22 masters, and 30 doctoral degrees. Physics undergraduate enrollments are increasing, thanks in great part to an effective recruiting program directed by Nicole Drummer with support from Gary Gladding, associate head for undergraduate programs. Our incoming undergraduate class was 66 this fall. We are expecting a slightly larger incoming class in Fall 2003, in accord with the national trends.

In July 2002, Jim Wolfe completed a very successful three-year term as associate head for graduate programs and returned to full-time teaching and research. Alan Nathan took his place and currently is deeply engaged in grad recruiting for next year.

Graduate recruiting has become a highly competitive enterprise. In Fall 2002, our incoming graduate student class numbered 45, down slightly from our target of 50. The associate head for graduate programs is assisted by a faculty graduate recruiting committee that makes initial and follow-up individual contacts to all qualified applicants and hosts prospective graduate students on weekend campus visits. Alan Nathan reports that graduate applications are up nearly 20 percent from last year—both domestic and foreign—and the overall quality of the applicants appears to be stronger. One step that we took last year to improve grad recruiting is to use earnings from our *Excellence in Physics* annual fund to offer $1500 "sign-on bonuses" to new graduate students to assist them with the one-time expenses associated with moving to a new community and starting a new program. The flexible funds that the *EIP* provides is invaluable to the department in meeting these kinds of competitive challenges.

Newly Remodeled Space for Physics

Another big piece of good news is that the space crunch for faculty research laboratories and faculty, postdoc, and graduate student offices, which has become increasingly severe over the past several years, has eased. As an accompanying article in this issue describes, the entire Condensed Matter Theory Group (11 faculty and all of their graduate students, postdocs, and visitors) have now moved to Floors 2, 3, and 4 of the fully remodeled space in the Physics Tower (officially the Engineering Sciences Building, located on the corner of Springfield and Goodwin). Next summer, all 300-level physics instructional laboratories will be relocated to Floors 5 and 6 of the Tower, opening up much-needed space for seminar rooms and faculty research labs and offices in Loomis. The move will result in an additional 1,700 square feet of advanced undergraduate laboratory space, allowing us to revitalize and expand our undergraduate and graduate laboratory instructional programs.

In summary, we face tough challenges in the years ahead, but I am confident that the faculty and staff of the department will rise to meet them, as they have always done in the past. We are committed to keeping our department at the front ranks of international physics research and education, and with the vision and help of our friends, we will. We look forward to using this new forum to keep you informed of our progress. In the meantime, you can always keep track of us at *www.physics.uiuc.edu.* ▪

Tony Leggett Wins Wolf Prize

The Wolf Foundation announced on January 13, 2003, that Anthony J. Leggett and Bertrand I. Halperin will share the 2002/03 Physics Prize for research on condensed forms of matter. Professor Leggett was cited for achievements in "superfluidity of the light helium isotope at very low temperatures, for his exploration of macroscopic quantum coherence, and for his contribution to the study of dissipation processes in quantum systems that cannot be ignored in practical applications."

Both scientists were recognized for their "seminal contributions to the broad range of structures and processes in condensed forms of matter. They have provided a better understanding of the macroscopic properties of materials, which rely on non-intuitive quantum effects and interactions that determine the properties of different states of matter and transitions between them. The theoretical work of both recipients has always been accompanied by experimentation and has had a significant impact on understanding numerous physical phenomena," the Wolf Jury announced.

Professor Halperin was recognized for his work on two-dimensional melting, disordered systems, and strongly interacting electrons.

Winner of the 2002/03 Wolf Prize in Physics

The Israel-based Wolf Foundation was established by the late German-born inventor, diplomat, and philanthropist Dr. Ricardo Wolf. Beginning in 1978, five annual Wolf Prizes have been awarded to outstanding scientists and artists "for achievements in the interest of mankind and friendly relations among peoples, irrespective of nationality, race, color, religion, sex, or political view." The prizes are given every year in four out of five scientific fields in rotation—agriculture, chemistry, mathematics, medicine, and physics. In the arts, the Prize rotates among architecture, music, painting, and sculpture. To date, a total of 204 scientists and artists from 20 countries have been honored.

The 2002/03 Wolf Prizes will be conferred by the President of the State of Israel, Mr. Moshe Katsav, in a special ceremony at the Knesset in Jerusalem on Sunday, May 11, 2003. ▪

Remodel of 2002

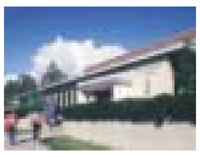
First it was Physics 106, 107, and 108—those mainstays of introductory physics—that we overhauled. Now it's the orange chairs in 141 and 151. . .

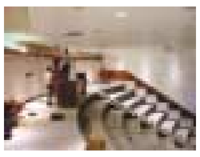
The two large lecture halls in Loomis underwent a rebirth this summer—the first major changes since 1963. Room 141 (~325 seats) and Room 151 (~225 seats) were gutted and completely remodeled to incorporate better lighting, a new floor, state-of-the-art multimedia instructional hardware, and improved accessibility. The orange chairs are gone—shipped to California in late May for a complete face lift (including *blue* upholstery).

Why refurbish 40-year old chairs? Surprisingly, restoring them resulted in a more substantial chair than could be bought new for the same dollars. Secondly, Physics wired Room 151 several years ago so that students can plug their calculators into chair jacks to communicate in real time with the lecturer, and the configuration of new (smaller) chairs would have meant rewiring.

We celebrated our new lecture rooms with a rededication on August 30, 2002. (It was a good excuse for a party.)

. . . and that's only half the story . . .





In the Engineering Sciences Building (aka Physics Tower), construction is nearly complete on Phase I of a two-part project. Phase I includes Floors 2, 3, and 4. The second floor is the new home of the condensed matter theory faculty, providing remodeled offices (new ceilings, floors, doors, and a LOT more light) and a central "commons." The commons, which includes a small kitchenette, provides comfortable seating and informal conversation areas to draw the theorists and their students out of their offices for the collaborative interactions so essential to their work. Offices for condensed matter theory graduate students and postdocs and a traditional conference room occupy the third floor. The fourth floor will house the department's computer team, other faculty members, and graduate students.

Phase II has begun and will convert Floors 5 and 6 from traditional office space into teaching laboratories. At its completion (June 2003), the 300-level teaching labs will move from Loomis to the Tower, resulting in consolidated and more spacious labs for these courses. The faculty is hard at work, evaluating existing labs and equipment and planning upgrades that will better prepare students for their future careers. Moving the upper-level instructional labs will also provide new laboratory space in Loomis for new faculty members.

The creation of research laboratory space in the heart of Loomis will allow us to attract and retain faculty members in emerging areas, such as atomic, molecular, and optical physics, the physics of information, and nanoscale science and engineering, ensuring that Illinois remains in the top echelons of world-class physics.

A final benefit of this move to the Tower will be the relocation of our teaching assistants to the Loomis-Seitz Interpass. This move will put them in a more convenient location for the undergraduate students they serve and allow them to be proximate to the teaching support facilities for which our department is so well regarded.

Other, less jazzy improvements around Loomis this year and next include new air conditioning equipment and a new roof. The air conditioning project was recently completed, and the roof project will be completed in Spring 2003.

That's the good news. The bad news is that State of Illinois budget shortfalls have left us with empty pockets for furniture for the Tower or upgraded experiments for the new 300-level labs. If you'd like to help, go to *http://www.physics.uiuc.edu/Giving/gift.html* or contact Celia Elliott (217-244-7725—phone; *cmelliot@uiuc.edu*). ▪

A Physics Illinois Timeline—Traditions of Excellence

The 1870s

1870

As a cornerstone of engineering education, Dean and Professor Stillman Robinson introduces and teaches a course in physics, believing that a knowledge of physics is fundamental to the education of every engineer.

1875

Laboratory practice is introduced into the physics curriculum at Illinois. (At this time, only two other U.S. universities offer laboratory work in physics—Stevens Institute of Technology [1871] and Massachusetts Institute of Technology [1873].)

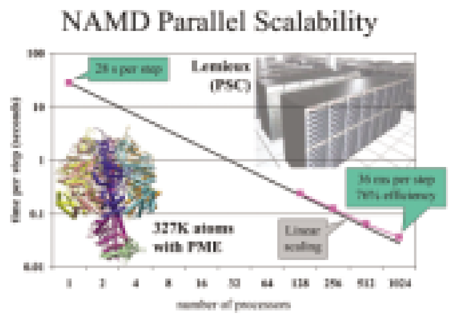
1878

Professor Selim Hobart Peabody comes to the University as Professor of Mechanical Engineering and Physics. (He will continue to teach physics even after he becomes Regent in 1880.) The *University Catalog* boasts that the "Physical Laboratory" has "a collection of apparatus from the most celebrated European and American makers, costing over $5000 and illustrating the subjects of mechanics, pneumatics, optics, heat, and electricity."

Theoretical Biophysics Group Wins 2002 Gordon Bell Award

Years of work by the Theoretical Biophysics Group, directed by Professor Klaus Schulten, were recognized at the SC2002 High Performance Networking and Computing Conference in Baltimore with the presentation of a *2002 Gordon Bell Award* for unprecedented parallel performance on a challenging computational problem. The Theoretical Biophysics Group, a unique interdisciplinary collaboration of physicists, chemists, biologists, and computer scientists, develops software for the nation's fastest supercomputers to study the tiny components of living cells.

The Gordon Bell Award, the nation's most prestigious prize in high performance computing, recognized the work of former Physics graduate student (and recent Ph.D.) Jim Phillips and his colleagues in the Theoretical Biophysics Group for achieving unprecedented scaling of NAMD, a code that renders an atom-by-atom blueprint of large biomolecules and biomolecular systems. A paper detailing their research was presented at SC2002.



The program NAMD allows researchers to calculate each femtosecond step in the molecular dynamics simulation of a 327,000 atom biomolecular model using the particle mesh Ewald algorithm, a task requiring 28 seconds on a single processor, in only 36 milliseconds by using 1024 processors of the Lemieux supercomputer at the Pittsburgh Supercomputing Center.

The parallel molecular dynamics program NAMD, and its sister visualization program VMD, have helped researchers at Illinois discern how muscles stretch, how nerves sense pressure, and how kidneys filter water. The kidney filtering project, for example, used simulations of 106,000 atoms to discover how aquaporins, which are ubiquitous in mammals, plants, and bacteria, allow water to pass while preventing the conduction of protons or ions. NAMD and VMD are distributed, free of charge, to thousands of scientists in industry and academia around the world, quickening the pace of drug discovery and other vital research to unravel biological processes. More information about this exciting work is available at *http://www.ks.uiuc.edu*. ▪

Douglas H. Beck Named 2002 University Scholar

Douglas H. Beck was named one of six 2002 University Scholars at the Urbana-Champaign campus of the University of Illinois. The program recognizes excellence and helps to identify and retain the university's most talented teachers, scholars, and researchers.
"The University Scholars Program is the premier recognition accorded to faculty at the UI by their colleagues," said Nancy Cantor, the Urbana chancellor. "In honoring these outstanding members of the faculty, selected by their peers, we recognize at the same time the highest values of the university." The Scholars were honored at a dinner hosted by Chancellor Cantor on November 26, 2001.

Beck's primary research contribution has been his creative work on the measurement of the parity-violating asymmetry in the scattering of longitudinally polarized electrons from the proton to elucidate the role strange quarks play in the structure of the nucleon. His seminal paper, "Strange-quark vector currents and parity-violating electron scattering from the nucleon and from nuclei," (*Phys. Rev. D* **39**, 3248-3256 [1989]) established the connection between strange quarks and parity-violating electron scattering and proposed using this experimental technique to study the internal structure of the proton. Previous parity-violating electron scattering experiments had concentrated on the weak interaction; it was Beck who first recognized that such experiments could also provide a novel tool for studying the quark flavor structure of the proton. Based on this innovative idea, he (with R. McKeown) proposed the SAMPLE experiment at the MIT-Bates linear accelerator facility.

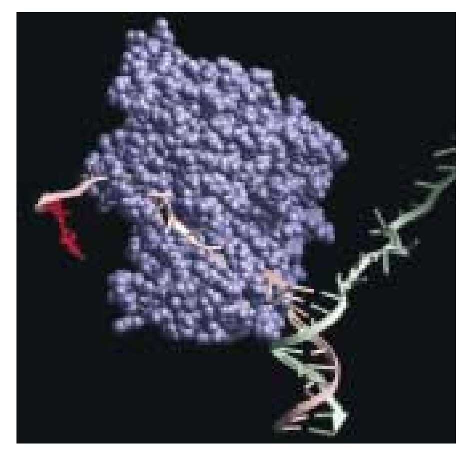
The SAMPLE results have been spectacular. In December 2000, the collaboration announced experimental results that address the role of strange quarks in generating nuclear magnetism ("Strange Magnetism and the Anapole Structure of the Proton," *Science* **290**, 2117-19 [2000]).
The measurement reported provides an unambiguous constraint on strange quark contributions to the proton's magnetic moment through the electron-proton weak interaction. Evidence was also shown for the existence of a parity-violating electromagnetic effect known as the "anapole moment" of the proton. In addition to his on-going work on the SAMPLE experiment, about 10 years ago Beck conceived a more far-reaching experiment ("G0") to be carried out at the then soon-to-be-commissioned Thomas Jefferson National Accelerator Facility (JLab). The collaboration of nearly 100 physicists from twelve U.S. universities, France, Canada, and Armenia will measure the parity-violating asymmetry in elastic electron scattering from the proton at both forward and backward angles and over a range of momentum transfers from about 0.1–1.0 GeV^2.

Other Physics faculty members recently named University Scholars include David W. Hertzog (2000), Tony M. Liss (1999), and Dale J. Van Harlingen (1998). ▪

Caught in the Act!

DNA helicases are molecular motor proteins that separate (or unzip) two strands of DNA and run along the DNA by converting chemical energy to mechanical work. Some human helicases, if defective, cause serious diseases whose symptoms include premature aging and higher risk of cancer. Despite extensive study, there are still many open questions about the helicase mechanisms—partly because of the lack of good experimental techniques. Crystal structures provide only a static view of the molecule, and conventional ensemble tools provide mean values averaged over millions or billions of molecules, missing rare and transient events. Professor Taekjip Ha and postdoctoral research associate Ivan Rasnik developed and used single molecule fluorescence resonance energy transfer (FRET) to study the unzipping mechanisms of helicases (T. Ha, et al., "Initiation and re-initiation of DNA unwinding by the *Escherichia coli* Rep helicase," *Nature* **419**, 638 [2002]).

In single molecule FRET, two fluorescent dye molecules are attached to a biological molecule. The interaction between the two dyes reveal about how far apart they are. This distance information is used to measure the shape changes of a single molecule during its function. In the DNA unzipping experiment, two dyes are attached to the part of the DNA where the unzipping begins. Then, as the unzipping is initiated by the helicase, the distance between the two dyes increases and the FRET decreases. Using this technique, pauses and re-initiation of unzipping were detected, the first time for any helicase, and their mechanisms were deduced. Such information can be obtained only by using single-molecule measurements, and this technique is generally applicable to many other DNA-protein interactions.



Courtesy Taekjip Ha

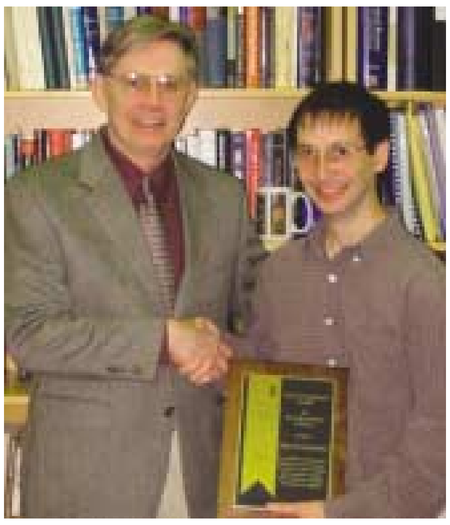
Illustration of the "unzipping" action of Escherichia coli Rep helicase. The pauses and re-initiation of unzipping by any helicase were detected for the first time by Illinois researchers.

Perhaps one of the most controversial and important questions in the field is how many molecules of the enzyme are required to unzip the DNA. The Ha study shows that a monomer can move along single-stranded DNA (akin to movement along a one-way street), but once it encounters a junction with double-stranded DNA (a two-way street), it cannot go any farther and displays futile fluctuations and falls off the DNA. Only if another protein binds to the monomer at the junction, forming an active helicase complex, can the complex continue to run along the double-stranded DNA and unzip it. If the complex partially breaks off, the remaining monomer cannot move farther along and gets stalled.
The binding by another monomer can then restart the unzipping.

Collaborators on the project were Wei Cheng, George Gauss, and Timothy Lohman at Washington University School of Medicine and Hazen Babcock and Steven Chu at Stanford University. The work was funded by the National Institutes of Health, National Science Foundation*, Searle Scholars program, the Research Corporation, and the University of Illinois Research Board. ▪

**Disclaimer: This material is based upon work supported in part by the National Science Foundation under Grant No. 0134916. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.*

Nordsieck Award Presented to Nigel Goldenfeld



Department Head Jeremiah D. Sullivan presenting the 2002 Arnold Nordsieck Award for Teaching Excellence in Physics to Professor of Physics Nigel D. Goldenfeld.

Professor of Physics Nigel D. Goldenfeld received the second annual *Arnold Nordsieck Award for Teaching Excellence in Physics* for exemplary graduate teaching. The Nordsieck Award, named in honor of former Professor of Physics Arnold T. Nordsieck and endowed by a gift from his family, was established to recognize outstanding teaching in the Department of Physics.

Goldenfeld is an outstanding teacher who has a singular ability to convey his excitement and interest in physics to his students. He has described his approach to teaching in this way: "I try to make the problems interesting, sometimes even unusual. My attitude . . . is summed up in an aphorism attributed to Confucius: 'I hear and I forget. I see and I remember. I do and I understand.'" His book, *Lectures on Phase Transitions and the Renormalization Group* (Addison-Wesley, 1992), has been adopted by many graduate schools as the text of choice for this subject.

Arnold T. Nordsieck, a professor of physics at the University of Illinois from 1947 to 1961, was a brilliant theorist with an uncommon affinity for experiment. A specialist in the mathematics of computation, he (with Hicks and Yen) successfully solved the full nonlinear Boltzmann equations for several nonequilibrium flow problems—a pioneering computational effort and a breakthrough in computational fluid dynamics and rarefied gas dynamics. He also proposed the first electrostatically supported gyroscope and built the first computer to be used at Lawrence Livermore National Laboratory, the Nordsieck Analog Computer. In 1953, he proposed the "Cornfield System," a naval air-defense system that was one of the first applications of digital computer technology to complex decision-making. ▪

The "Whys" Guy

Champaign's CBS affiliate, WCIA Channel 3, has a new celebrity—the "Whys" Guy, Physics' own Mats Selen. The popular high-energy experimentalist, who founded *Physics Van*, the traveling science outreach program that has intrigued, inspired, and invigorated more than 40,000 K–5 students and their teachers in the last nine years, has now taken his infectious enthusiasm for physics to central Illinois television. In a regular weekly Wednesday-morning program, Mats presents basic scientific concepts in exciting visual demonstrations. He has explained why curveballs curve, why things float or sink, and what to do with a Van der Graaf generator. He has crushed, smashed, or blown up countless objects—his trademark. In addition to the television program, Mats has launched a website that offers more detailed explanations and answers viewers' questions (see *www.hep.uiuc.edu/home/mats/whysguy.html*). You can also watch video clips from the program there, too, thanks to WCIA. If you'd like to support Physics' many outreach programs, go to *www.physics.uiuc.edu/Giving/gift.html* or contact Celia Elliott (217-244-7725 or cmelliot@uiuc.edu). ▪

Alexey Bezryadin Named 2002 Alfred P. Sloan Research Fellow

Alexey Bezryadin has been awarded a prestigious Alfred P. Sloan Research Fellowship, one of 100 fellows selected this year in the combined fields of chemistry, computer science, economics, mathematics, neuroscience, and physics. The Sloan Fellowships were established in 1955 to support the very best of the nation's scientists early in their careers.

Bezryadin is a condensed experimentalist who explores physics at the nanoscale. He is developing innovative nanofabrication techniques to enable novel investigations of the properties of superconducting systems with dimensions approaching 5 nanometers—a virtually unexplored size scale at which macroscopic quantum effects become dominant. He has fabricated some of the world's tiniest nanowires, loops, and SQUIDs by using carbon nanotubes as substrates for deposited metallic films. New approaches utilizing DNA templates (instead of carbon nanotubes) and a focused electron beam "sculpting" technique are being refined. The Sloan Fellowship will allow Bezryadin to extend his work on biological templates for nanostructured materials. For more information about Bezryadin and his work, see *www.physics.uiuc.edu/People/Faculty/profiles/Bezryadin/*. ▪

Gordon Baym Receives 2002 Bethe Prize

Gordon Baym received the 2002 Hans A. Bethe Prize of the American Physical Society for "*his superb synthesis of fundamental concepts that have provided an understanding of matter at extreme conditions, ranging from crusts and interiors of neutron stars to matter at ultrahigh temperature*." The prize was established in 1998 and recognizes outstanding work in theory, experiment, or observation in the areas of astrophysics, nuclear physics, nuclear astrophysics, or closely related fields.

Baym has been a major intellectual force in the study of matter under extreme conditions in astrophysics and nuclear physics and has been a frequent collaborator of Hans Bethe for more than 30 years. He has made original, seminal contributions to our understanding of condensed matter and statistical physics, including Bose-Einstein condensation in atomic vapors. He was a pioneer in the study of neutron stars and more generally in the nature of the matter under extreme conditions of density and pressure. He was a leader in the conception of the Brookhaven Relativistic Heavy Ion Collider (RHIC). ▪

Ha Named 2001 Searle Scholar

Taekjip Ha was named a 2001 Searle Scholar. The prestigious award was established at The Chicago Community Trust in 1980, funded from the estates of Mr. and Mrs. John G. Searle. (Mr. Searle was the grandson of the founder of the international pharmaceutical company, G. D. Searle & Company.) The program supports outstanding young researchers in medicine, chemistry, and the biological sciences. Approximately a dozen awards are made nationally each year. Only 50 U.S. universities are allowed to submit nominations, and candidates face rigorous local screening before being entered in the national competition.

Despite his relative youth, Ha has achieved many "firsts" in experimental biological physics: the first detection of dipole-dipole interaction (fluorescence resonance energy transfer, or FRET) between two single molecules; the first observation of "quantum jumps" of single molecules at room temperature; the first detection of the rotation of single molecules; and the first detection of enzyme conformational changes via single-molecule FRET. His most recent work—using single-molecule measurements to unravel protein-DNA interactions and enzyme dynamics—has led to novel optical techniques, fluid-handling systems, and surface preparations.

Ha received his Ph.D. in Physics in 1996 from the University of California, Berkeley. Before joining the Physics faculty at the University of Illinois in August 2000, he was a postdoctoral fellow at Lawrence Berkeley National Laboratory (1997) and a postdoctoral research associate in the laboratory of Nobel laureate Steven Chu in the Department of Physics at Stanford University (1998–2000). ▪

PHYSICS ILLINOIS NEWS

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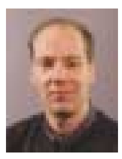
If you have suggestions for stories or features that you would like to see, comments about the new format, or requests for an electronic version of the newsletter, please write to us. We're listening!

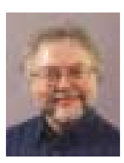
"Our" New 2002 APS Fellows

Three faculty members and eight alumni were elevated to Fellow status in the American Physical Society in December 2002. The APS Fellowship Program was created to recognize members who have made advances in knowledge through original research and publication or have made significant and innovative contributions in the application of physics to science and technology. Fellowship may also be granted for significant contributions to the teaching of physics or to service and participation in the activities of the society. Each year, no more than one-half of one percent of the then-current membership of the society are recognized by their peers for election to the status of Fellow. Congratulations to all.

Faculty



Douglas H. Beck, *for pioneering work in the use of parity-violating electron scattering to elucidate the quark structure of the nucleon*



Paul T. Debevec, *for novel development of instrumentation and deep intellectual contributions to a broad range of photonuclear experiments, hadron spectroscopy, and precision muon physics*

Philip W. Phillips, *for creative theoretical contributions to the studies of strongly correlated electronic systems, including the random dimer model and superconductor-insulator transitions*

Alumni

Alan T. Dorsey, University of Florida, *for seminal contributions to the theory of magnetic flux dynamics and non-equilibrium pattern formation in superconductors*

Christopher J. Hardy, GE Corporate Research and Development, New York, *for contributions to the science and technology of magnetic resonance imaging, particularly methods for the noninvasive visualization of cardiac anatomy, function, and metabolism, and for the MRI selective pulse design*

Efstratios Manousakis, Florida State University, *for innovative and original computational studies in the many-body problem including development of novel algorithms to tackle the many-fermion problem with very important applications to condensed matter physics*

Franco Nori, University of Michigan, *for innovative theoretical contributions to the study of vortex dynamics in superconductors, dynamical instabilities, Josephson junction arrays, and quantum interference*

Rocco Schiavilla, Thomas Jefferson National Accelerator Laboratory, *for advancing the theory of nuclei as systems of nucleons bound together by two- and three-body forces, and particularly for studies of their electroweak interactions*

Pierre Sokolsky, University of Utah, *for his discovery of the highest energy cosmic ray events that have challenged current understanding of cosmic ray sources and for his leadership of the Utah Fly's Eye and HiRes experiments*

Carol E. Tanner, University of Notre Dame, *for her contributions to the understanding of atomic structure through precision measurements of atomic lifetimes and transition amplitudes*

Gerald L. Witt, Air Force Office of Scientific Research, *for exemplary leadership of national interdisciplinary research efforts in the fields of quantum-effect devices, low-temperature GaAs, optoelectronic measurement techniques, radiation effects, and defects in wide bandgap semiconductors*

not a place, a habit of mind . . .

Physics Illinois

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