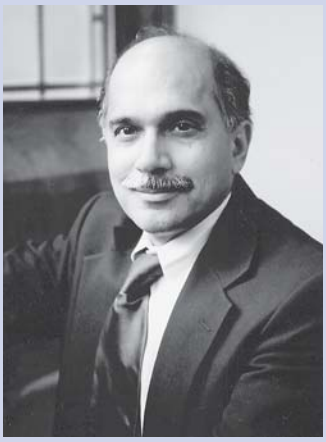
Yale Department of Physics Newsletter

Spring 2003

Greetings from the Chair —



It is my pleasure to continue the tradition of the Physics Departmental Newsletter established by my predecessor, Professor Charles Baltay, in the summer of 2001, which also marked the beginning of my term.

We are pleased to welcome several new faculty to the department. Professor Steven Girvin, a noted condensed matter theorist, joined us in July 2001. Steve was well known to all of us for his breadth and depth of interest in various areas of condensed matter physics, and when we became aware that he was considering relocation from Indiana University, we moved aggressively to bring him here, fighting off competition from some worthy opponents. Steve has already propelled our already strong condensed matter group to new heights. He also works closely with Applied Physics on problems related to quantum information, especially with Michel Devoret, another recent and marvelous addition to the Yale faculty in January 2002. In fact the only thing Steve does not know is the word "no," and an obvious conflict of interest prevents me from rectifying the situation.

Another prized addition to the department will be Professor Pierre Hohenberg, who will switch from Deputy Provost to Adjunct Professor at the end of this academic year. Pierre, who is a member of the National Academy of Sciences, has made seminal contributions to condensed matter physics that have been recognized by a string of honors too long to mention here. So I will limit myself to the latest two: the Planck Medal and the Onsager Prize. Both Pierre and the department look forward to his return to the fold.

Next, in the area of atomic, molecular and optical physics, we have tenured and successfully retained David DeMille. We are very excited by Dave's ambitious experimental program that ranges from searching for the electron's electric dipole moment to quantum computation using molecules. Dave has already become an integral part of our senior faculty, contributing vigorously to its present and future.

Witold Skiba joined our particle theory group as assistant professor, and we are already benefiting from his newly designed course on particle theory and his influence on further recruitments. Andreas Heinz, who joined our nuclear experimental program, will base his operations at the Wright Nuclear Structure Lab and focus on heavy element spectroscopy.

The last year also marked the departure of Mark Kasevich to Stanford and the retirement of Sam MacDowell. Fortunately, Sam will stay on as part of the research staff for a year and continue to teach. Our best wishes to both on their new pastures.

As we readied to go to press, we learned of the passing away of one of the stalwarts in the department, Vernon Hughes. His legendary accomplishments are discussed in an obituary later in this newsletter.

The department has developed and voted on its next Long Range Plan. Once again we hope to address emerging areas of interest without compromising our current strengths.

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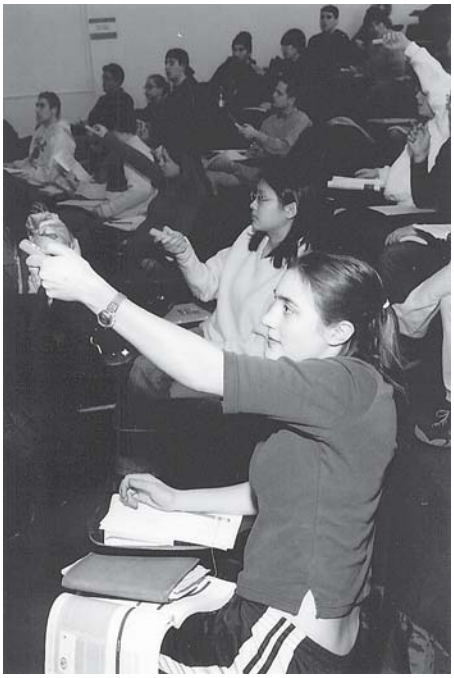

Channel surfing during physics class?

See page 5…

Inside this Issue —

Chair's Message *continued from page 1*

Our graduate program is in the able hands of our registrar, Jo-Ann Bonnett, and our Director of Graduate Studies, Professor Steve Girvin. Steve is working on integrating our admissions with those of sister departments Applied Physics and Astronomy. Open houses for admitted students have become a part of the recruitment cycle. Prospective students get to spend a weekend at Yale mingling with current students, listening to presentations from various groups, and touring the labs. We have seen a visible increase in the number of applications to our graduate programs and hope this will continue. We also plan to maintain our Laptop Program, which awards to each incoming graduate student a network-ready laptop, loaded with useful software, and paves the way for rapid assimilation into research activity.

Professor Sean Barrett continues to be our dynamic Director of Undergraduate Studies, aided by Linda Ford, the registrar. Sean is a key member of COUP, the Committee for the Undergraduate Program, chaired by Professor Thomas Appelquist, and charged with thoroughly exploring our teaching mission. Several changes have already been approved: requirements for graduation that are less constraining, two parallel tracks for those aiming for post-graduate work in physics and those wishing to pursue careers in other areas where a thorough training in physics will serve as a springboard, and finally four new courses open to students after the introductory sequence, related to astro-, geo-, bio-, and nano-physics. All this will take effect in fall 2003. We have also thoroughly revamped the labs—changing both the write-ups to reflect the kind of things that we, the faculty, would have liked to do in their place, and purchasing a lot of new equipment from departmental funds and with bright prospects for additional monies from the university and private sources like the Conde Fund and the Paul Moore Fund. Using electronic feedback in the classroom has become a reality in several introductory courses and is described later in the newsletter.

Our website http://www.yale.edu/physics/ has gone through a major overhaul. Our special thanks to Professor Subir Sachdev for bringing to this task his usual brand of energy and technical wizardry. Sarah Bickman, one of our graduate students, has created a link (described later in this letter) that allows free flow of information between undergraduates, graduates and alumni. Dr. Stephen Irons, our Director of Undergraduate Labs, has a linked site (http://www.yale.edu/physics/facilities/support/physics_demos/ where you can browse the demonstrations from inertial balloons to the Millikan Oil Drop experiment.

Those walking into the corridors in Sloane will see it greatly changed: new carpets and attractive posters and portraits have replaced the aging mailboxes and notice boards. Our tireless business manager Harley Pretty oversaw the transition from "peeling" to "appealing."

We continue to strengthen ties with sister departments. A joint venture with Applied Physics has yielded a 1.2 million dollar grant from the Keck Foundation, detailed later. The free-flow of research activity, graduate students, and pedagogy continues between the two departments. We plan to make appointments in Astrophysics in alliance with Astronomy, leveraging the Yale Center for Astronomy and Astrophysics under the directorship of Professor Meg Urry. Professor John Wettlaufer of Geology and Geophysics will teach an upper level course at the borderline of the two departments.

Our outreach efforts continue with the Yale Olympiad masterminded by Professor Con Beausang and aided by many faculty and students. Professors Beausang and Peter Parker also designed and taught the (sold out) college seminar titled "Introduction to Radiation and Nuclear Physics" for non-science majors and a course for local and federal Emergency First Response personnel. The seminar is teaching non-science majors background information on basic nuclear physics, nuclear weapons, and medical physics for the post-September 11 era; the community course is offering practical information for bomb and hazmat squads in the New Haven area.

It should be evident that this is a department that runs itself, with invaluable and spontaneous contributions from all its faculty and staff, but for which I might have dropped out of Chairmanship 101. Many thanks to them and to you, our alumni, for your continued interest in our affairs. Please stay in touch!

R. Shankar, Chair
Professor of Physics and
Applied Physics

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Your comments, suggestions and news are most welcome!

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Yale Chemistry Alumnus Raymond Davis Wins Nobel Prize in Physics

Raymond Davis, Jr., '42 PhD (physical chemistry), a retired chemist at the US Department of Energy's Brookhaven National Laboratory, won the 2002 Nobel Prize in Physics for detecting solar neutrinos, ghostlike particles produced in the nuclear reactions that power the sun. Davis shares the prize with Masatoshi Koshiba of Japan and Riccardo Giacconi of the US.

"Neutrinos are fascinating particles, so tiny and fast that they can pass straight through everything, even the earth itself, without even slowing down," said Mr. Davis. "When I began my work, I was intrigued by the idea of learning something new. The interesting thing about doing new experiments is that you never know what the answer is going to be!"

Mr. Davis was the first scientist to detect solar neutrinos, the signature of nuclear fusion reactions occurring in the core of the sun. Devising a method to detect solar neutrinos based on the theory that the elusive particles produce radioactive argon when they interact with a chlorine nucleus, Mr. Davis constructed his first solar neutrino detector in 1961, 2,300 feet below ground in a limestone mine in Ohio. Building on this experience, he mounted a full-scale experiment 4,800 feet underground, in the Homestake Gold Mine in South Dakota. In research that spanned from 1967-1985, Mr. Davis consistently found only one-third of the neutrinos that standard theories predicted. His results threw the field of astrophysics into an uproar, and for nearly three decades, physicists tried to resolve the so-called "solar neutrino puzzle."

Experiments in the 1990s using different detectors around the world eventually confirmed the solar neutrino discrepancy. Mr. Davis's lower-than-expected neutrino detection rate is now accepted by the international science community as evidence that neutrinos have the ability to change from one of the three known neutrino forms into another. This characteristic, called neutrino oscillation, implies that the neutrino has mass, a property that is not included in the current standard model of elementary particles (in contrast, particles of light, called photons, have zero mass). Mr. Davis's detector was sensitive to only one form of the neutrino, so he observed less than the expected number of solar neutrinos.

Raymond Davis, Jr., earned a BS and an MS from the University of Maryland in 1937 and 1940, respectively, before he went on to Yale for a PhD. After his 1942-46 service in the US Army Air Force and two years at Monsanto Chemical Company, he joined Brookhaven Lab's Chemistry Department in 1948. He received tenure in 1956 and was named senior chemist in 1964.

Mr. Davis retired from Brookhaven in 1984, but has an appointment in Brookhaven's Chemistry Department as a research collaborator. In 1985, he joined the University of Pennsylvania to continue experiments at the Homestake Gold Mine with Professor Kenneth Lande. He has an affiliation with the university as a research professor.

A member of the National Academy of Sciences and the American Academy of Arts and Sciences, Mr. Davis has won numerous scientific awards, including the 1978 Cyrus B. Comstock Prize from the National Academy of Sciences; the 1988 Tom W. Bonner Prize from the American Physical Society; the 1992 W.K.H. Panofsky Prize, also from APS; the 1999 Bruno Pontecorvo Prize from the Joint Institute for Nuclear Research in Dubna, Russia; the 2000 Wolf Prize in Physics, which he shared with Masatoshi Koshiba, University of Tokyo, Japan; and the 2002 National Medal of Science.

—from Brookhaven National Laboratory Office of Public Affairs

Rosenthal Lecture 2001

The 28th annual Hanan Rosenthal Memorial Lecture was delivered by **Eric Cornell** on November 9, 2001.

Professor Cornell did not let the fact that he had just a month to bone up on his Swedish, try out tail coats, and learn to walk backwards from the King of Sweden keep him from honoring his earlier promise to give the Rosenthal lectures.

He described his Nobel Prize winning work in his talk "Bose-Einstein Condensation: Science within a Millionth of a Degree of Absolute Zero." He explained how new techniques had to be invented and implemented to bring atoms down to a temperature low enough for condensation to take place and once it was achieved, to display that fact unambiguously.

The talk attracted a huge audience, including students and teachers from regional high schools, and a video link to an adjoining lecture hall had to be provided.

Rosenthal Lecture 2002

The 29th annual Hanan Rosenthal Memorial Lecture was delivered by **Mark G. Raizen** on November 8, 2002. Professor Raizen spoke on "New Frontiers in Controlling the Motion of Matter with Light: From Single Atoms to Neurons."

He discussed recent experiments done by his group at the University of Texas at Austin on the interactions and control of matter with light, especially the interface between quantum mechanics and nonlinear dynamics. He described recent experiments on atomic motion in a new system of "optical billiards," and indicated some future directions for quantum dynamics and control in many-body systems. The talk concluded with a discussion of ways in which weak light forces can be used to guide the direction of neuron growth.

Faculty News — Honors and Awards

Yoram Alhassid, professor of physics, received the Alexander von Humboldt Senior Scientist Award in April 2002. The award is given by the von Humboldt Foundation in Germany as "a lifelong tribute to the past academic accomplishments" of "scholars with internationally recognized academic qualifications." Award winners are invited to carry out research projects of their own choice in Germany for periods of between six months and one year. Professor Alhassid was noted for his important contributions to many-body theory, and in particular for his work on the maximum entropy approach, on the quantum Monte Carlo calculations, on chaotic phenomena in nuclei, and on the transport properties of mesoscopic samples.

Pierre C. Hohenberg, deputy provost for science and technology and adjunct professor of physics and applied physics, received the 2003 Lars Onsager Prize from the American Physical Society. Professor Hohenberg received the honor for research that extends over his 40-year career, including work conducted at Bell Laboratories in statistical and condensed matter physics. The society cited him for contributions to the theory of dynamic scaling close to critical points, the theory of pattern formation in nonequilibrium systems, and density functional theory. The $15,000 prize was first presented in 1995 and annually beginning in 1997. It recognizes lifetime achievement and outstanding research in theoretical statistical physics including the quantum fluids.

Francesco Iachello, J. W. Gibbs Professor of Physics, was awarded the 2002 Lise Meitner Prize for Nuclear Science from the European Physical Society for "innovative applications of group theoretical methods to the understanding of atomic nuclei." Professor Iachello, a member of the Yale University faculty since 1978, published a series of papers (with Akito Arima) between 1974 and 1979 that developed the interactive boson model of nuclei. The model has shaped the current understanding of a large class of nuclei. In his later efforts, he discovered a supersymmetric approach generalizing the earlier U(6) work, and introduced a model of molecules, the vibron model, based on the dynamical group U(4). The model has formed the basis for describing many phenomena in small and large molecules. He delivered the Lise Meitner Prize address at the 2002 meeting of the European Physical Society in Budapest, Hungary. Professor Iachello was also honored this March at an international meeting on "Symmetries in Nuclear Structure," in Erice, Sicily. The meeting was organized to celebrate Professor Iachello's career on the occasion of his 60th birthday.

Nicholas Read, professor of physics and applied physics, and colleagues have received the 2002 Oliver E. Buckley Condensed Matter Prize for their outstanding theoretical or experimental contributions to condensed matter physics. The prize was endowed in 1952 by AT&T Bell Laboratories (now Lucent Technologies) as a way of recognizing outstanding scientific work. It is named in memory of Oliver E. Buckley, an influential president of Bell Labs. The other Buckley Prize recipients are Jainendra Jain of Pennsylvania State University, who began his work on this problem when he was a postdoctoral fellow at Yale, and Robert Willett of Lucent Technologies. Professor Read was awarded the prize for his work on the fractional quantum Hall effect, in which electrons, confined to move in two dimensions, exhibit surprising behaviors in their electrical conductivity. His work on this problem spans nearly a decade, starting with a seminal paper in 1993. He is also a co-author with Professors Halpren (Harvard) and Lee (M.I.T.) of one of the most cited papers on this subject.

Subir Sachdev, professor of physics and applied physics, has been awarded a 2003 fellowship by the Guggenheim Foundation for his work on competing orders and criticality in quantum matter. Professor Sachdev's research has focused on the subject of condensed matter theory in general and quantum phase transition in particular. His Guggenheim proposal addresses the problem of newly discovered classes of materials that do not easily fit into any of the standard paradigms of solid state physics, such as cuprate high temperature superconductors and other intermetallic compounds. He argues that such materials can be understood in a framework of competing orderings, using a theory of quantum and thermal fluctuations in the vicinity of quantum phase transitions. He is one of 184 winners—and among them only four physicists—from a pool of 3200 applicants. The purpose of the Guggenheim award is to provide fellows with blocks of time in which they can work with as much creative freedom as possible. Professor Sachdev hopes to spend his fellowship time at the Kavli Institute of Physics in Santa Barbara.

Yale Physics Pioneers Electronic Classrooms During Spring 2003 Semester

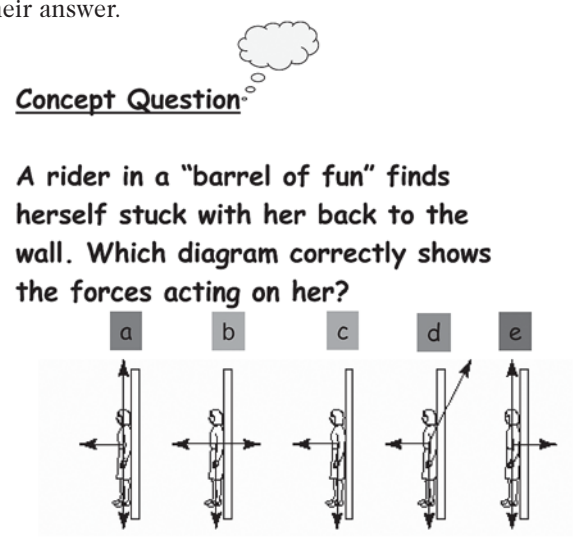
If you have ever seen "Who Wants to Be a Millionaire," then you can picture the new electronic classroom system that has just been installed in Sloane 59 and Davies Auditorium. But instead of guessing the answer to a trivia question, students in two of the department's courses now "vote" on the solution to a physics problem.

With a grant of $12,300 from the university, the Physics Department is the first at Yale to use wireless polling systems as teaching aids. The technology gives both professor and students instantaneous feedback on student comprehension of a lesson. It also allows a professor to keep statistics on attendance and individual and class performance throughout the semester.

The systems are being pioneered during the spring 2003 semester by Professors Cornelius Beausang in Physics 151b (General Physics) and John Harris *(at left)* in Physics 110b (Themes in Modern Physics).

At the beginning of the semester in Professor Harris' course, each student is given a transmitter that looks like a fat orange magic marker with buttons marked A through E. Professor Harris teaches from a laptop that is connected to several receivers installed throughout the classroom.

During one Wednesday afternoon class, Professor Harris reviews the concept of centripetal force by asking a multiple-choice question about the forces acting upon a person in an amusement park ride. Students have one minute to work the problem and press a button on their transmitters corresponding to their answer.



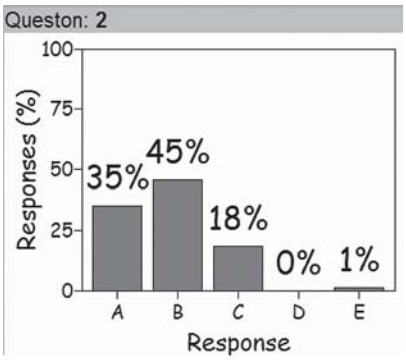
As the minute ticks by, the screen at the front of the classroom registers each vote received by flashing a colored and numbered block. After the allotted time is up, the professor's laptop produces a bar chart showing student answers. Students see how others voted, and they then defend their own answers or reconsider whether their reasoning might have been incorrect.

The hardware and software are manufactured by H-ITT in Fayetteville, Ark. and were procured by Stephen Irons, lecturer and director of instructional labs, who wrote the grant proposal with help from Professor Megan Urry.

Professor Urry, who experimented with a non-electronic version of the polling system, has found that with this interactive method students learn and retain far more. "From the first day I tried it, I could see the promise. Students really sat up straight when confronted with the questions," she said.

The instant feedback also enables Professor Urry to use class time more efficiently: "I pose a question, I see whether they get it or not. Judging from the result, I can go to an easier concept, work the present concept, or move to a harder one. The class gets tailored to the students' understanding."

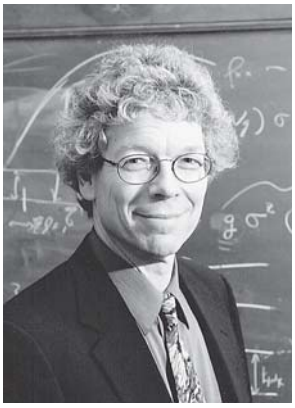
Adds Professor Harris, "The class is a joy to teach."



Graph showing the distribution of student responses to the concept question.

Faculty News — Hires and Promotions

David DeMille was promoted to tenure from within the department in 2002. He came to Yale in 1997 after teaching at Amherst College and earning his PhD from the University of California at Berkeley. His research focuses on atomic molecular and optical physics. Among his projects is a study using atomic physics to measure the electron's electric dipole moment. He is mounting an experiment that will push the level of observation down several levels, and results so far indicate that he can achieve at least a 100-fold improvement in sensitivity to the electron EDM within the next few years. If he sees it and makes the first measurement, it will be an astonishing contribution. He is also working with Steve Girvin, Michel Devoret, Daniel Prober, and others in the development of a quantum computer. *(See related article, page 7.)* Professor DeMille is an active member of the Committee on the Undergraduate Program, which is working to revise, improve, and modernize undergraduate teaching. "He is someone who was broadly regarded as very special and very brilliant from almost the day he came here," said Professor Thomas Appelquist. "The future of the department is going to rely on people like David DeMille." Department Chair R. Shankar agrees: "Dave has already become such an integral part of our present activities and future plans. His decision to remain at Yale is a major boost to our department in general, and the AMO group in particular."



In fall 2001 **Steven Girvin** joined the department as professor and director of graduate studies. Professor Girvin is a theoretical physicist who studies the quantum mechanics of large collections of atoms, molecules, and electrons that are found in superconductors, magnets, and transistors. He is particularly interested in the engineering question of whether it is possible to build a quantum computer. He is collaborating with Michel Devoret and Rob Schoelkopf in the Department of Applied Physics, who are constructing superconducting circuit elements that might someday form the basis for a quantum computer. Such a computer could in principle solve problems that are impossible on ordinary computers. "In order to build a quantum computer it is necessary to create circuit devices which behave quantum mechanically (like individual atoms) despite the fact that they are macroscopic and consist of a very large number of atoms," explains Professor Girvin. "In addition to potential practical applications, this difficult challenge will help us better understand the connections between the microscopic quantum world and the macroscopic classical world of everyday experience." Prior to coming to Yale, Professor Girvin made a number of seminal contributions to the theory of the quantum Hall effect—a phenomenon associated with electrons trapped in certain two-dimensional semiconductors under the influence of an applied magnetic field. He has also made important contributions to the theory of quantum phase transitions, which has broad applications to the properties of electronic materials at very low temperatures. He earned his PhD from Princeton in 1977 and came to Yale from the University of Indiana. "Steve Girvin is one of the premier theorists in the field of condensed matter physics," said Professor Subir Sachdev. "Yale already had a strong group in this area, but with the addition of Girvin, I have been told by many people that this group is ranked in the top one or two in the world." Department Chair Ramamurti Shankar adds, "We all rely so much on Steve for his scholarship, citizenship, and collegial help that we cannot see how we managed before he came."

In January 2003 **Andreas Heinz** joined the department as assistant professor, leading the new field of heavy element spectroscopy. Professor Heinz received his PhD from GSI Darmstadt in 1998, and he has already at this early stage of his career carved out an impressive niche in the study of heavy elements. He has held a highly prestigious Fermi Fellowship at the Argonne National Laboratory. His work at ANL on the spectroscopy of nobelium was cited in the recent US Long Range Plan for Nuclear Physics as one of the worldwide landmark achievements in nuclear structure in the last five years. He helped establish experimentally the unexpected and remarkable stability of nuclei of elements above Z=100 against huge centrifugal forces. At Yale he will use one of the best instruments in the world for such research—the SASSYER. His work will provide an entirely new thrust for WNSL. Professor Heinz is also an enthusiastic teacher who gives clear, well-motivated talks well adjusted to the level of his audience. "We are excited to welcome this very skilled experimentalist to our department, where he can contribute his expertise to teaching and research at WNSL," said Chairman R. Shankar.

Witold Skiba *(photo, next page)* joined the department in 2002 as a new assistant professor after receiving his PhD from the Massachusetts Institute of Technology and completing postdoctoral research at MIT and the University of California at San Diego. His research focuses on theoretical particle physics, particularly phenomena that take place at or above the electroweak scale. He is studying the question of what completes the standard model of weak, electromagnetic, and strong interactions, and is using supersymmetric theories to extend

the standard model of gravity at the quantum level. His recent publications have proposed new models of dynamical supersymmetry breaking and communicating supersymmetry breaking via gauge, anomaly, and gaugino mediations. According to colleague Thomas Appelquist, Professor Skiba was hired because he is "working on exciting problems at the high energy frontier of the field. He has also been examining the possibility that new spatial dimensions might appear at accessible energies." In summer 2003 Professor Skiba will lead a workshop on TeV-scale physics at the Aspen Center for Physics. During his first semester at Yale he designed a graduate special topics course on physics beyond the standard model of electroweak interactions. "Professor Skiba brings much-needed youth, vitality, and know-how to the particle theory group," says R. Shankar, the department's chair.

John Wettlaufer joined the Yale geology department in January 2002 with a joint appointment in physics. He is associated with the condensed matter theory group in the department. He previously was with the University of Washington, Seattle, where he received his Ph.D. in 1991. Professor Wettlaufer studies the dynamics and thermodynamics of ice. He has shown how microscopic films of unfrozen water that exist at ice surfaces to temperatures well below 0° C play a central role in phenomena as diverse as ozone-destroying chemistry in polar stratospheric clouds, frost heave in soils, thunderstorm electrification, and the redistribution of paleoclimate signals in the earth's great ice sheets. During his research career he has spent a total of over a year on drifting sea ice in the Arctic Ocean. Professor Wettlaufer brings to the classroom an energetic and articulate lecture style. He is teaching courses in geophysical fluid dynamics, mathematical methods in geophysics, and dynamical climatology. "Professor Wettlaufer's affiliation with the physics department is a source of great satisfaction to all of us, since he takes such an active interest and part in the well being of the department," says Chairman R. Shankar. "His willingness to teach a course on the physics of geology is a striking example." Professor Wettlaufer hopes that his research and teaching will help forge links between geophysics, geochemistry, engineering, astronomy, mathematics and physics that do not presently exist in a traditional departmental structure but that Yale is embracing with his arrival.

Quantum Computing Comes to Yale

A four-year, $1.2 million award from the W.M. Keck Foundation of Los Angeles will establish the grant-funded W.M. Keck Foundation Center for Quantum Information Physics at Yale. Exploring the science and technology necessary to build a quantum computer is an important goal of the new center to be established at Yale's Faculty of Engineering and Department of Physics.

The project involves six Yale principal investigators, including Michel Devoret, Daniel Prober and Robert Schoelkopf in condensed matter experiment, Steven Girvin and A. Douglas Stone in condensed matter theory, and David DeMille in atomic and molecular physics. Professor Devoret came to Yale this year to spearhead the University's efforts in this area from the condensed matter physics section of the French CEA (Atomic Energy Research Center), Saclay, where he was director of research.

A major goal of the project is to determine if a quantum computer can be built using "atom-like" circuits. A quantum computer differs from a classical computer in that its components behave according to the laws of quantum mechanics rather than those of classical physics. The center will develop both the theoretical and the practical aspects of quantum computing. The quest to build a quantum computer is based on the theory that such a computer would be far superior to conventional computers in terms of memory and security. The results of past studies have shown that a quantum computer would be a calculating device more powerful in principle than any conventional computer that could ever be built.

"Although we still do not yet understand the range of problems for which a quantum computer is specially suited, there is every reason to believe that such a machine would have a revolutionary impact on information technology," said Professor Devoret.

The team will consider whether quantum information can be stored and processed in solid-state and molecular systems. The team will also experimentally and theoretically address questions relating to noise in quantum systems and the effect of the measurement process. Another project involves developing a new molecular system for storing and processing quantum information, which would involve the first demonstration of ultracold arrays of polar molecules. The total project budget, including the W.M. Keck Foundation grant, is more than $4.8 million.

In addition to these specific goals, the researchers anticipate other significant contributions to condensed matter physics and atomic and molecular physics, which are areas that are particularly strong at Yale.

IN MEMORIAM: FACULTY

Charles Bockelman, professor emeritus of physics and Yale's first deputy provost for the sciences, died on June 6, 2002, at age 79. Professor Bockelman's research focused on nuclear structure physics. In the late 1950s he developed an important correlation between neutron transfer and neutron capture reactions, which served as a cornerstone of the then-emerging utilization of these reactions for the measurement of nuclear structure. He also played a key role during the 1960s in the installation and management of both the upgraded electron linear accelerator and the Wright Nuclear Structure Laboratory's MP tandem Van de Graff accelerator at Yale. Over the course of his career he published more than 50 scientific papers and articles.

Professor Bockelman taught both elementary and advanced courses in Yale College and occasional courses in the Graduate School. Describing him as an instructor who was "always coherent and clear," Robert Adair, Sterling Professor of Physics, notes that Professor Bockelman's "work with his graduate students introducing them to the techniques and ethos of research was especially important to him." Indeed, one grateful graduate student, Karl Wetzel, wrote in the acknowledgements to his dissertation, " In sharing his insights into the nucleus and its interactions, Professor Charles Bockelman has also conveyed his sense of importance in understanding the interactions among people."

His wisdom and intelligence in human affairs led him to positions of leadership in the Yale administration. During 20 years in the provost's office beginning in 1969, Professor Bockelman facilitated the construction of new buildings, the implementation of computer systems, getting new faculty settled, and maintaining the programs of senior faculty. He returned to teaching in the Physics Department in 1987 and served as director of undergraduate studies in physics from 1990 until his retirement in 1992. During this time he focused on converting the spectrograph he had installed in the 1960s to a large-scale scattering chamber for heavy ion studies.

Born in 1922 in San Francisco, Professor Bockelman grew up in Milwaukee, Wisconsin. He served for four years in the Army Air Corps in the Pacific during World War II and went on to earn PhB and PhD degrees from the University of Wisconsin. He joined the Yale faculty in 1955 as an assistant professor.

Vernon W. Hughes, Sterling Professor Emeritus and Senior Research Associate, died March 25, 2003, in New Haven at the age of 81. He was Chairman of the Physics Department from 1961-1967, crucial years when Yale was transformed into a modern research university.

Professor Hughes began research in physics in 1942 when he worked on radar at the MIT Radiation Laboratory, and he remained active even during his terminal stay in the hospital, when he wrote recommendation letters for a post-doc working with him. Thus he was a working physicist for 61 years.

He was born in Kankakee, Illinois, on May 28, 1921, and following the death of his father was raised in New York by his mother, a librarian at Teachers College of Columbia University. Entering Columbia as a pre-law student, he quickly gravitated to mathematics and physics. After winning the Van Buren Math Prize, he graduated as a physics major in three years and enrolled as a graduate student in Cal Tech in 1941. There is a picture of Professor Hughes atop Mt. San Gorgonio in California along with Pief Panofsky and two other Cal Tech grad students.

After receiving his MSc, he worked at MIT in a group directed by Burton Chance, with whom he would later coauthor a book on waveforms. After the war he began research at Columbia under I. I. Rabi on nuclear electric quadrupole moments using a molecular beam apparatus that he constructed. He received his Ph.D. in 1950 and after two years as a post-doc at Columbia and two years at the University of Pennsylvania, came to Yale in 1954.

While much of Professor Hughes' work was on the properties of atoms, he regarded atoms primarily as laboratories for the study of the fundamentals of electromagnetism. Thus he concentrated on studies of the helium atom, of positronium, and then—arguably his most unique contribution to physics—of muonium, the muon-electron atom that he was the first to identify in 1960. His following 40 years of experimentation on that atom verified to high precision that the muon is indeed a "heavy electron," gave us new avenues into the experimental study of quantum electrodynamics, and created a tool to probe the highest energy scales of elementary particle physics.

Professor Hughes was also an originator of the use of polarized electrons in high energy accelerators beginning in 1963, when he developed the first polarized source for the Stanford two-mile accelerator. That vision led to the observation of parity non-conservation in deep inelastic electron scattering and in electron-positron scattering and to measurements of the spin dependent structure of the proton. These observations demonstrated inadequacies in the understanding of the relationship between the nature of the constituents of the proton and its spin.

Most recently Professor Hughes conceived of and led an experiment to improve the measurement of magnetic moment of the muon by a large factor. The deviation of the magnetic moment, g, from the elementary Dirac value of 2, in natural units, thus g-2, serves as a benchmark for the testing of new ideas in particle physics.

At his death, Professor Hughes (at 81!) was a spokesman for two large international groups, one working on a large muon g-2 experiment at Brookhaven National Laboratory and another engaged in a massive effort at CERN studying the problem of the nucleon spin constituents that he had uncovered. Professor Hughes was elected to the National Academy of Sciences in 1967. In 1978 he was awarded the American Physical Society Davisson-Germer Prize in Atomic Physics and in 1990 the Tom R. Bonner Prize in Nuclear Physics.

Contributions toward a fellowship for graduate students in Hughes' name may be sent to Ramamurti Shankar, Chair of Physics Department. P.O. Box 208120, New Haven, CT 06520-8120.

—by Robert Adair

"He was never satisfied until he fully understood whatever phenomenon he studied. Hughes educated a generation of students who have become leaders in the international scientific community. He will be much missed worldwide by all his friends and collaborators, most especially by his colleagues at Yale, who admired his endless supply of energy, drive and unyielding persistence."

— D. Allan Bromley, Sterling Professor of the Sciences

Faculty News

Yoram Alhassid recently organized a two-week workshop at the Max Planck Institute on "Electrons in Zero-Dimensional Conductors: Beyond the Single-Particle Picture" and a 10-week interdisciplinary program at the Institute of Nuclear Theory at the University of Washington, Seattle, on "Chaos and Interactions: From Nuclei to Quantum Dots." His research achievements in 2002 included the development of methods to derive statistical properties of nuclei at higher temperatures and on elucidation of the role of the exchange interaction in the statistical theory of quantum dots. He was honored as a fellow of the American Physical Society at the APS annual meeting in April.

Thomas Appelquist began a new research project exploring whether a natural explanation of neutrino masses and mixing angles can be found within the framework of dynamical electroweak symmetry breaking. He continues to serve as Chairman of the Board of the Aspen Center for Physics and as a member of the NSF's Mathematical and Physical Sciences Advisory Committee. He also continues to chair the department's committee to improve undergraduate physics education.

Charles Baltay coordinated and taught a college course "Perspectives in Science," a lecture and discussion course that highlights the interdependence of the scientific disciplines and is designed for freshmen who have unusually strong backgrounds in science and mathematics. He initiated and is leading the QUEST project, which utilizes a very large area detector built for the Schmidt Telescope at the Palomar Observatory. The goals of the QUEST project are to study gravitational lensing of quasars and type Ia Supernovae to determine cosmological parameters and the nature of Dark Energy in the universe.

Sean Barrett has begun a second term as the department's director of undergraduate studies. His group has made a new discovery in the NMR of silicon. The result appears to be useful for research in quantum computation and also to require some modification to the standard model of NMR in solids.

Cornelius Beausang has developed a new course on basic radiation physics for emergency workers, police, and firefighters in New Haven. He has also developed a new college seminar course on radiation physics intended to educate non-science majors about basic nuclear physics for the post-September 11 world. He serves on the steering committee for the Gamma Ray Energy Tracking Array, which will be the next major US gamma-ray spectrometer. The Stewardship Science Academic Alliances Program has awarded him a grant of $500,000 to investigate the structure of actinide nuclei and various aspects of the fission process and yields.

Allan Bromley delivered 14 lectures during 2002, including the commencement address at Texas Tech. He served on the Presidential Commission on Science and Security, on the NAS Committee on Presidential Appointments, and as a consultant to the Southern Governors' Association. He has just completed an autobiography, *A Life in Physics, Engineering, and Public Policy*.

Richard Casten is the director of the Wright Nuclear Structure Laboratory (WNSL). His research currently focuses on studying the first new paradigms of nuclear structure in decades, involving empirical manifestations of the critical point symmetries E(5) and X(5). He also has derived a new first order phase transition separating prolate and oblate nuclei in the context of Landau Theory. His work is primarily experimental but with a strong theoretical component as well. In 2002, a conference on "Mapping the Triangle" was held in his honor in Jackson, Wyoming.

David DeMille published a paper classified as "highly cited" by the ISI outlining how ultracold polar molecules can be used as bits in a feasible-to-build, large-scale quantum computer. His group has completed a proof of principle for its measurement of the electron's electric dipole moment, based on spectroscopy of PbO molecules. He has published another article describing the first serious calculation of the intrinsic sensitivity of PbO to the electron EDM.

Colin Gay served as organizer of the New England Particle Physics Summer Retreat and co-organizer of the Yale Physics Olympics. He taught the graduate introduction to particle physics and supervised graduate students and postdocs on CDF research.

Steven Girvin, in addition to serving as the new director of graduate studies, has collaborated with Subir Sachdev to start researching optical lattices, a new research area in atomic physics. His work on a general theory of quantum noise in mesoscopic detectors and amplifiers was published in 2002. He has also developed a new idea for a quantum bit readout using cavity QED effects and has been awarded grants for the study of quantum computation and the physics of quantum information.

John Harris continues to develop interactive teaching methods in the Physics 110 course for non-science majors. *(See article about electronic classrooms, page 5.)* He also continues his research on the STAR experiment, which has reported new results in eleven journal articles in 2002.

Andreas Heinz joined the department in time for the Spring 2003 semester. His research focuses on the physics of atomic nuclei, especially in nuclear structure, nuclear fission, nuclear fusion,

continued on page 10

Scenes from the Fall 2002 Departmental Picnic

Faculty News *continued from page 9*

and the production of rare isotopes. He is especially interested in heavy nuclei and the question of how heavy a nucleus can ultimately become and in the physics that determines that limit.

Francesco Iachello has completed his study of the symmetries of differential equations with discontinuous potential functions for applications to problems in physics and chemistry. He has also introduced a model of high-temperature superconductors with s and d bosons, based on the analogy with atomic nuclei.

Samuel MacDowell taught three sections of advanced general physics during 2002. He continued his research on solar and atmospheric neutrinos and on massive neutrino mixing. All this in addition to preparing for retirement!

Simon Mochrie has implemented a new fast CCD-based x-ray area detector for carrying out x-ray photon correlation spectroscopy experiments. With the new camera he has characterized the dynamics of a polymeric "sponge phase" as well as the dynamics of an asymmetric diblock copolymer melt. He has also continued supervising two PhD students and teaching theory of solids. In fall 2003 he will teach a newly developed biophysics course.

Vincent Moncrief has continued to serve as director of undergraduate studies for the math/physics major. In his research he is developing light cone and energy estimates for Einstein's equations, and in his teaching he is preparing a special research level course on Einstein's equations and geometrization. He participated in a number of summer workshops, including the Stanford AIM workshop, the Cargese summer school, and the Caltech and Santa Barbara workshops on numerical relativity.

Homer Neal continues research on three experiments, including BaBar, the Future Linear Collider, and the OPAL experiment at CERN. With Mike Zeller he has formed a new group for carrying out research on the Compact Muon Solenoid detector at the Large Hadron Collider at the CERN laboratory.

Peter Parker continues his study of nucleosynthesis in exploding stars using stable beam spectroscopy experiments at the accelerator facilities here at Yale. He also continues to study direct radioactive-beam measurements at facilities such as Oak Ridge and TRIUMF (in Vancouver). He is working with Con Beausang to develop a program to teach first responders in the New Haven area how to deal with nuclear radiation in an emergency.

Nicholas Read was awarded the Oliver E. Buckley Prize of the American Physical Society in March 2002. At the prize symposium and on three other occasions he delivered a talk on "Bosons, Fermions, and Half-Filled Landau Levels." His research continues to focus on supersymmetric nonlinear sigma models and fractional quantum Hall states with applications to cold trapped atoms. He enjoys teaching intensive introductory physics to some of Yale's best undergraduates and serving on the Marshall/Rhodes selection committee.

Subir Sachdev continues his research on competing orders and quantum phase transitions in the cuprate superconductors. Several leading experimental groups have tested key aspects of his group's predictions, and his research was highlighted in the Search and Discovery section of Physics Today. During 2002 he delivered 10 invited talks, including the F. A. Matsen Endowed Regents lecture on the Structure of Matter at the University of Texas at Austin.

Jack Sandweiss has been pursuing research in two directions. One is the study of high energy heavy ion physics using the STAR detector at the Brookhaven National Lab Relativistic Heavy Ion Collider. The other is a search for strange quark matter in the cosmic radiation. This search will be carried out with the Alpha Magnetic Spectrometer, which is scheduled to be mounted on the International Space Station in 2006. In addition, he serves as the principal investigator for Yale's high energy physics contracts with the US Department of Energy.

Michael Schmidt has recently completed a three-year term as Director of Graduate Studies, as well as teaching classical mechanics and supervising the work of one doctoral and two postdoctoral researchers. He has published papers on b quarks, B mesons, and upsilons, based on his DOE-supported research. Recently submitted work on the D_s-D+ mass difference demonstrates the new abilities of the upgraded CDF detector.

Ramamurti Shankar along with collaborator G. Murthy has found an exact solution to the problem of chaotic quantum dots with interacting electrons. He delivered several lectures during 2002, including multiple presentations of "FQHE for Dummies" in this country and in India. In October 2002 he gave a talk for a general audience entitled "When You Come to a Fork in the Road, Take It: Yogi Berra's Guide to the Quantum World" for the Yale Graduate School Dean's Lecture Series, "In the Company of Scholars."

Witold Skiba has prepared a new graduate course about physics beyond the standard model of electroweak interactions. His current research focuses on constructing a new "little Higgs" theory without electroweak triplets. In summer 2003 he will lead a workshop on TeV-scale physics at the Aspen Center for Physics.

Jeffrey Snyder has published an article on "A Large Area CCD Camera for the Schmide Telescope at the Venezuelan National Astronomical Observatory" and his current research involves a large area survey for nearby supernovae. He taught two courses, including electromagnetism and optics.

Charles Sommerfield is working on solving a difficult but important problem in M theory. Over the past year he helped organize the particle theory seminar and served as vice chair of the Danny Heineman prize committee of the American Physical Society. He taught four courses, including statistical physics and relativistic field theory.

Meg Urry has started two key projects as part of the Yale-Chile collaboration: one, a study of galaxy formation and evolution, the accretion history of black holes, and the galaxy-black hole connection; and the other, a study of the host galaxies of supermassive black holes. She is helping to organize a conference on women in science on the occasion of the centennial of Marie Curie's first Nobel Prize. At the 2003 annual summer meeting of the American Astronomical Society, she will be giving an invited talk on "Grand Unification of Active Galaxies."

John Wettlaufer, who has a joint appointment with geology and geophysics, will be teaching a geophysics course in the department as part of the sequence of new courses open to all who have taken the introductory sequence. Professor Wettlaufer just joined Yale from the University of Washington. He has always had close ties to Physics and works on problems of common interest such as ice.

Tilo Wettig taught a course on mathematical methods in physics for first-year graduate students and advanced undergraduates. His research over the past year focused on the application of the color-flavor transformation to lattice QCD. He has also continued to work on the QCDOC project, the design of a new generation massively parallel computer dedicated to lattice QCD applications, and he has started a project aimed at a better understanding of the properties of the complex eigenvalues of the Dirac operator in the presence of a chemical potential. He is also organizing YALELAT03: 13th Workshop on Lattice Field Theory for the spring of 2003.

Michael Zeller has published articles on the decay of K+ - >mu+ nu e+ e- and K+ ->e+ nu e+ e- and Rare K. His work in progress measures the Ke3 decay branching ratio, and the properties of Ke4 decays. In his 2004 budget message, President Bush recommended construction of a project in 2006 for which Mr. Zeller is a co-spokesman. The experiment would measure a fundamental time reversal violating parameter that could hold the secret to why the Universe has such an excess of matter over antimatter.

Web Site Updates

Check out the improved and reorganized Physics Department web site at http://www.yale.edu/physics/. The web site received a makeover in summer 2001.

And if you are interested in seeing the resources for teaching at Yale, visit the new lecture demonstration web site at http://www.yale.edu/physics/facilities/support/physics_demos/physdemo.html. Developed by Steve Irons, Lecturer and Director of Instructional Labs, this site allows faculty to browse the demonstrations available for topics from inertial balloons to the Millikan oil drop, and then reserve a demonstration for their own class.

Graduate Student News —

First-Year Graduate Student Laptop Pilot Program

In 2001 the Physics Department began providing all entering graduate students with laptop computers and wireless network access. The program was launched with seed funding through voluntary contributions from interested faculty, the department, and the Provost's Office.

A substantial motivation for the program was to provide first- and second-year students with computational resources that could augment their coursework, such as easy access to Maple/Mathematica, Matlab, and other numerical tools. We were able to provide the laptops again this year to entering graduate students with funding from the department, the Provost's Office, and faculty contributions. We hope that the level of support will continue each year from these and other sources so that we can continue this beneficial program.

A Popular Daily Ritual Continues

Entering graduate students:

Fall 2002

Amir Aazami (University of California at Berkeley); Marco Ascoli (University of Pisa); Yang Bai (University of Science and Technology of China); Andrew Cahoon (University of Maryland); Catherine Deibel (Amherst College); Yanqun Dong (University of Science and Technology of China); David Glenn (University of Toronto); Ke Han (Peking University); Jonathan Jerke (University of Washington); Angel Manzur (National Autonomous University of Mexico); Michael Metcalfe (Trinity College, Dublin); Christopher Morling (Michigan State University); Dennis Murphree (Stanford University); Stephen Powell (Oxford University); Jing Qian (Peking University); David Rahmlow (California Institute of Technology); and Wade Rellergert (University of Missouri/Columbia).

Prizes

The 2002 Leigh Page Prizes for three incoming first-year graduate students were awarded to Yang Bai, Stephen Powell, and Jing Qian.

Fall 2001

Ho-Chiang John Ai (Rutgers University); Anne Bauer (Amherst College); Grant Biedermann (University of Oklahoma); Lev Bishop (Oxford University); Samuel Flores (MIT); Zachary Harris (California Polytechnic State University); Kevin Koch (Truman State University); Deseree Meyer (Yale University); George Mias (Yale University); Anuj Parikh (Simon Fraser University); Jessie Petricka (Carleton College); Elizabeth Ricard-McCutchan (Wellesley College); Jeffrey Satinover (Yale University); David Schuster (Brown University); Ken Takase (MIT); Jun Wang (Wuhan University); Julie Wyatt (MIT); and Fan Xiao (Wuhan University).

Correction: Our apologies to Yong Jiang, Wei Li, Mingchang Liu, Qian Wan, Zhenyu Han, Ruoxin Li, Fei Du, Yi Wei, and Haibin Zhang, whose undergraduate university was listed incorrectly in the last newsletter. Their alma mater is the University of Science and Technology of China.

Students and faculty alike enjoy the department's daily tea at 3:30 in the physics lounge.

Graduate Student Dissertations, Advisors, and Job Placements –

2001-2002

Sotiria Batsouli, "Study of Light Hypernuclei Production in 11.5 A GeV/c Au-Pb Heavy Ion Collisions"; Jack Sandweiss; postdoctoral research associate, Columbia University.

Chiranjeeb Buragohain, "Quantum Antiferromagnets in One and Two Dimensions"; Subir Sachdev; graduate student, Department of Computer Science, University of California at Santa Barbara.

Manuel Calderon De La Barca Sanchez, "Charged Hadron Spectra in Gold-on-Gold Collisions at a Centre-of-Mass Energy per Nucleon Pair of 130 GeV"; John Harris; postdoctoral fellow, Physics Department, Brookhaven National Laboratory.

Hansen Chen, "In Search of Illumination Invariants"; Peter Belheumer; Deutsche Bank, Singapore.

Jeffrey Russell Cooper, "Measurement of V(M1) Values in the Crossing Region of Shears Band 1 in ^{197}Pb and Interpretation in the Semi-classical Model"; Reiner Kruecken; postdoctoral fellow, Lawrence Livermore National Laboratory.

Zhiyong Duan, "Studies on Phases of Gauge Theories"; Thomas Appelquist; Research Analyst, JP Morgan Chase, New York.

Dmitry Green, "Strongly Correlated States in Low Dimensions"; Nicholas Read; McKinsey Management Consultants, Stamford, Connecticut.

Raj Kumar Jain, "Multiwavelength Observations of Black Hole and Neutron Star X-ray Binaries"; Charles Bailyn; Morgan Stanley, Tokyo.

Alexay A. Kozhevnikov, "Electron Dynamics and Coherence Effects in Mesoscopic Hybrid Normal Metal-Superconductor Devices"; Daniel Prober; Lucent Bell Laboratories, Murray Hill, New Jersey.

Susan Kurien, "Aniostropy and the Universal Properties of Turbulence"; Katepalli Sreenivasan; Los Alamos National Laboratory, New Mexico.

Hui Li, "Dynamic Symmetry and Band Structure"; Dimitri Kusnezov; Bear Stearns, Manhattan.

John Rock Novak, "Nuclear Structure of the Odd-Neutron Radon Isotopes $^{203, 205, 207}$Rn"; Cornelius Beausang; Financial Consultant, New York City.

Andrew Wing On Poon, "Optical Resonances of Two-Dimensional Microcavities with Circular and Non-Circular Shapes"; Richard Chang; Assistant Professor, Electrical Engineering Department, Hong Kong University of Science and Technology.

Nathan Benjamin Rex, "Regular and Chaotic Orbit Gallium Nitride Microcavity Lasers"; Richard Chang; Consultant, Mars Management, Stamford, Connecticut.

Andrew Michael Schaffer, "Quantitative Characterization of Species, Temperature, and Particles in Steady and Time-Varying Laminar Flames by Optical Methods"; Marshall Long; Farley Capital, L.P., New York.

Alumni Career Counseling Network on the Web

What happens to Yale physics majors after graduation? To find out, see the new physics alumni network at http://research.yale.edu/cgi-bin/physics/physics_db.pl

Under the sponsorship of the Physics Department, graduate student Sarah Bickman *(right)* has spent the last nine months surveying all undergraduate physics alumni, asking what jobs they have held since college and soliciting their participation as mentors. The result is a database of alumni in a variety of fields who are willing to advise students and alumni about their careers.

"I had no idea how many careers are open to those of us with a physics background," said Ms. Bickman. "This database shows the range of options available to me when I complete my degree."

The project was begun in response to complaints from undergraduates that they received little guidance on how to use their physics major outside of graduate study. The network can connect students to alumni in such careers as science journalism, medicine, and patent law.

The network will initially be advertised to current students through posters in the physics building, but it is available to anyone. In the future, Ms. Bickman would like to expand the network to help graduate students get in touch with physics alumni from the graduate school who are doing postdoctoral research, consulting, or software development.

Graduate alumni have yet to be surveyed; if you are interested in offering your services as a mentor, please send an email to sarah.bickman@yale.edu

Accelerator School Held at Yale

The US Particle Accelerator School was held for the first time at Yale June 10-21, 2002.

About 65 students attended from across the US and the world, including Europe, South America, and the Far East. The courses were taught in Sloan and Gibbs Laboratories and were intended for students who had already completed an undergraduate degree.

Two-week courses were offered on Accelerator Fundamentals, Accelerator Physics, Classical Mechanics and Electromagnetism in Accelerators and Beams, and Computational Methods in Electromagnetism.

One-week courses included Magnetic Systems: Insertion Devices; Accelerator Vacuum System Devices; Particle Beam Optics Using Lie Algebra Methods; Applications of Synchrotron Radiation in Materials Science; Medical Applications of Accelerators and Beams; and Applications of MATLAB in Accelerator Physics and Engineering.

"The school was a stimulating success," said Professor Michael Schmidt, organizer of this year's school. "This was in no small part due to the support from Dean Sleight of the Graduate School, Jo-Ann Bonnett, Stephen Irons, and Harley Pretty of the Physics Department and the indefatigable efforts of Marilyn Paul, who clearly has considerable experience running the USPAS schools which are held at different sites from year to year."

The US Particle Accelerator School conducts graduate and undergraduate level courses at leading universities across the United States twice per year, in January and June. The school is governed by a consortium of 11 national laboratories, 10 of which are part of the Energy Research Office of the Department of Energy and one of which is an NSF laboratory.

Undergraduate Prizes for 2002

The DeForest Pioneers Prize for distinguished creative achievement in physics by a senior physics major was awarded to Laura Judith Feiveson. The Howard L. Schultz Prize for an outstanding senior in the Physics Department was awarded to Kenneth MacLean.

Perlmutter and Robertson Give Leigh Page Lectures

The 2001-2002 Leigh Page Prize Lecture series featured Saul Perlmutter of the Lawrence Berkeley Laboratory speaking on dark energy. Professor Perlmutter addressed the topic of "Supernovae, Dark Energy, and an Accelerating Universe," suggesting that the universe will last forever and that its expansion will speed up indefinitely, and then "Dark Energy Challenges the Physicists," arguing that some new, unidentified dark energy pervades all space and is accelerating the expansion of the universe. He concluded with "Studying Dark Energy with Supernovae (the part of the story that always gets left out of departmental colloquia)."

The 2002-2003 lecture series featured R. G. Hamish Robertson of the University of Washington speaking on neutrinos. His first lecture, "A place in the Sun for the Neutrino", reviewed the solar neutrino problem, its resolution, and the resulting implications for neutrino oscillation and mass, which dovetail neatly with experiments on atmospheric neutrinos and reactor antinutrinos. "If they have mass, why can't you tell me what it is?" was followed by "Neutrinos: the Road Ahead" in which Professor Robertson described the remaining unknowns about the neutrino and its role in the universe, and expressed optimism about the potential for new discoveries.

Scenes from the Fall 2002 Departmental Reception

Michael Scott Armel '94 MS is currently an adjunct professor of physics at Occidental College in the Los Angeles area. He received his PhD from the University of California at Berkeley, with a specialty in particle astrophysics. He has recently finished serving as host for the science and health sections of the Reader's Opinion Forums for the New York Times on the web.

Aimé Fournier '98 PhD is research associate at the University of Maryland Department of Meteorology, and a visitor to the National Center for Atmospheric Research in Boulder. In 2000-01 he was awarded grants for research on multiresolution adaptive spectral element solvers for atmospheric fluid dynamics and for multi-resolution climate modeling. He fondly remembers the late Yale professor of geology and geophysics Barry Saltzman (1931-2001), who "perfectly exemplified how a physicist should investigate climate change."

Michael S. Lubell '69 PhD is currently chairman of the Department of Physics at City College of New York and director of public affairs for the American Physical Society. His research focuses on photon-atom and photon-molecule interactions.

Elizabeth F. McCormack '89 PhD is associate professor of physics at Bryn Mawr College. Her research focuses on photoionization, autoionization, predissociation, photodissociation, ion spectroscopy, the dynamics of transient excited states, the coupling between electronic and nuclear motion, and highly excited molecular Rydberg states. In 2001 she served as a physics curriculum consultant to a new science college for women in Jeddah, Saudi Arabia.

Arthur P. Ramirez '84 PhD, '78 BS was identified by the Institute for Scientific Information in 2001 as a Highly Cited Researcher. He serves as leader of the condensed matter and thermal physics group at the Los Alamos National Laboratory, with recent research on superconductivity in alkali-doped C60, colossal magnetoresistance, negative thermal expansion materials, high-dielectric constant materials, and collective effects in magnets.

Naoki Saito '94 PhD received the Presidential Early Career Award for Scientists and Engineers in a ceremony at the White House in October 2000. She serves as associate professor in the Department of Mathematics at the University of California at Davis. She was cited "for pioneering work on harmonic analysis and wavelet theory, with application to signal and image processing."

Richard B. Setlow '47 PhD is senior biophysicist at the Brookhaven National Lab. His research examines the biological effects of high energy cosmic ray nuclei and the wavelengths in sunlight responsible for malignant melanoma. In 2001 the Environmental Mutagen Society honored Setlow by publishing "A Richard B. Setlow Festschrift," a collection of essays dedicated to "the father of DNA repair" on the occasion of his 80th birthday. Setlow discovered that damage to DNA can be reversed by cutting out and replacing the defective section of a DNA strand.

Thomas E. Van Zandt '55 PhD, '51 BS retired from the National Oceanic and Atmospheric Administration in 1999. He lives in Boulder, Colorado, where he continues to do research and co-author papers on radar methods for measuring atmospheric turbulence.

Sukeyasu (Steve) Yamamoto '55 BS, '59 PhD is now director of the International House at the Institute of Physical and Chemical Research (RIKEN) in Tokyo, an apartment complex for foreign scientists which makes use of his bi-cultural and bi-lingual background. He writes, "After I got my PhD in 1959 under Fred Steigert in nuclear physics using the old Pollard cyclotron, I changed my field, and joined Ralph Shutt's bubble chamber group at Brookhaven. It was a great time for high energy physics with the AGS near completion, and the 80-inch bubble chamber which I helped to build under construction. In 1965 I moved to the University of Massachusetts in Amherst to start a bubble chamber group funded by the Atomic Energy Commission, and in 1970 joined the physics department at the University of Tokyo, building up a high energy physics group there. My group did a number of bubble chamber and counter experiments at the KEK Proton Synchrotron. From 1992 to 2000, I taught at Sophia University, a Jesuit University in Tokyo."

The Sloane hallway with its new carpet.

IN MEMORIAM: ALUMNI

Jack Wayne Ballou, who left the PhD program in 1940, died June 27, 2001, in Wilmington, Delaware. He received his doctorate in physics, summa cum laude, from Johns Hopkins University and worked in the pioneering research laboratory of the textile fibers department at DuPont Company.

William Cronk Elmore '35 PhD died January 23, 2003, at the age of 93. From 1938 to 1974 he taught on the physics faculty at Swarthmore College. During World War II, he was recruited to work on the Manhattan Project, where he played a major role in the development of electronic circuits to handle the fast-pulse signals needed in the atomic bomb work and developed close associations with Robert Oppenheimer and Enrico Fermi. He was an accomplished musician who played the saxophone, accordion, piano, organ, and recorder, as well as an enthusiastic farmer, craftsman, and inventor.

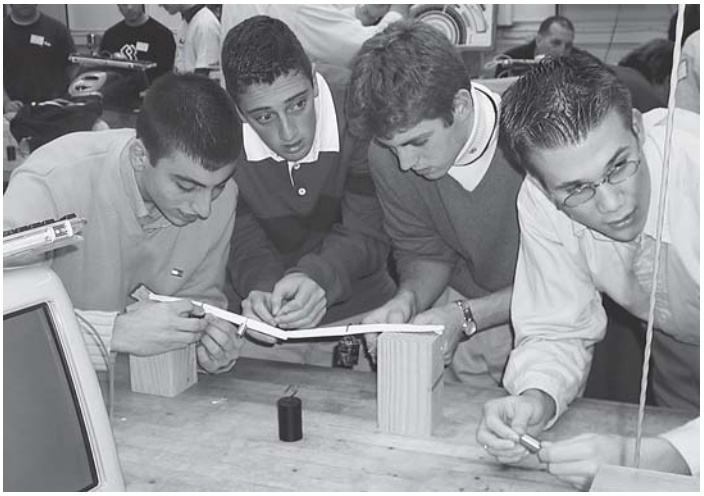
Charles A. Fenstermacher '57 PhD died July 28, 2002, in Los Alamos, New Mexico. After his graduate studies, he joined the Los Alamos Scientific Laboratory, where his career included research in nuclear physics, laser science, and fusion.

Joel Henkel '61 MS died July 29, 2002, in Hanover, New Hampshire, at the age of 71. He earned a BA in physics from Princeton in 1952, an MS in physics from Yale, and a doctorate in physics from the University of New Hampshire. His career included research at the Brookhaven National Laboratory in New York and work in electronic countermeasures at Wright-Patterson Air Force Base in Ohio during the Korean War. He was also interested in quantum physics and philosophy and published a book, *Mind from Matter*.

Benjamin Lepson '44 BS, '44 MS died January 14, 2002, in Takoma Park, Maryland, at the age of 77. He earned a master's degree in physics from Yale at age 19 and a doctorate in mathematics from Columbia University. After a postgraduate fellowship at the Institute for Advanced Study in Princeton, he worked as a civilian mathematician with the Navy from 1952 to 1990. At the Naval Research Lab in Washington, he headed up the team that in 1958 sent up the Vanguard satellites. Among his final assignments was to consult with NATO about which technologies to share with communist countries.

David W. Madsen '69 PhD died December 28, 2002, in Worcester, Massachusetts, at the age of 59. Following his graduate studies in nuclear physics, he worked for Scientific Atlanta Corp., for Q.C. Optics Corp., and as director of marketing for Exergen Corp.

Physics Olympics Grows



The Yale Physics Olympics went from strength to strength in 2001 and 2002. Now in its fifth year, the Olympics annually attracts 150-200 high school students, plus their teachers, to the Physics Department for a day of physics and frolics.

The competition consists of five events or activities for teams of students, four students per team. Recent events have included "That Sinking Feeling," which asked students to determine the density of an unknown object using only two liquids of different densities, a 500 ml beaker, two 100 ml graduated cylinders, and a pencil, and "Bridging the Gap," in which students competed to construct a bridge that would span the longest gap and at the same time carry the heaviest mass, using only two pieces of paper, scissors, five centimeters of scotch tape, one index card, five paper clips, and a variety of masses.

The activities use low technology apparatus and are based on fundamental physics principles, such as forces, waves, magnets, and electricity. The goal is not to intimidate the students with complicated experiments but instead to give them tasks that they can complete in 30 minutes with a limited knowledge of physics, a modicum of common sense, and a bit of teamwork.

Each activity takes place in a different location around the Physics Department, showing the students as much as possible of the department and the university. Typically three activities take place outdoors near the Sloane Physics Laboratory and on the grass quadrangle outside the Gibbs Laboratory. The other two are held in the freshman teaching laboratories in the Sloane Laboratory.

Last year's event, the largest Olympics so far, was attended by over 40 teams from 35 high schools from Connecticut, New York, Rhode Island, and Massachusetts. Prizes were awarded to the best-placed team in each event as well as the best three teams overall.

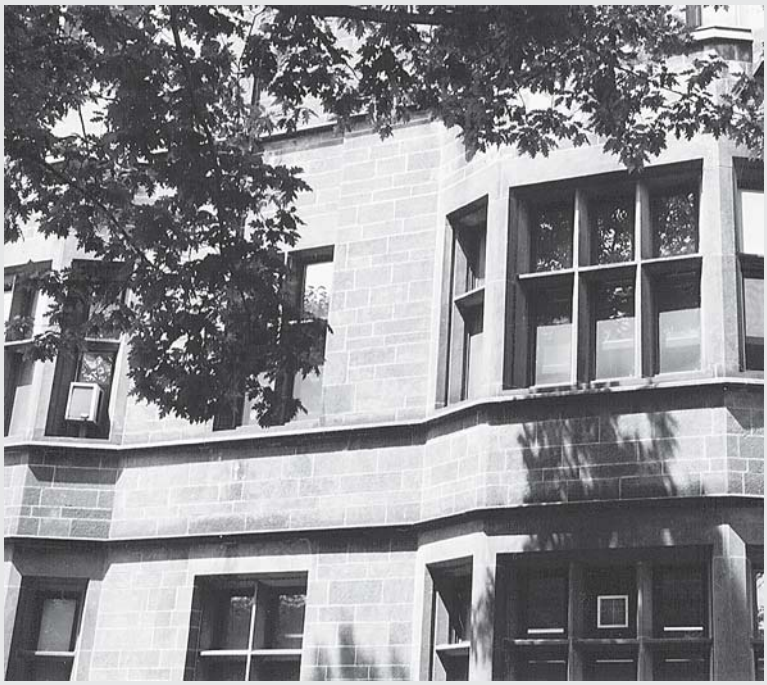
Organizers are contemplating ways to expand the competition to a national level. This would involve major changes in logistics because the event would have to cover several days rather than just one.

Why put so much work into a high school science competition? "Educating young people is what professors are meant to do. It is important to educate young people in physics, and it's important to start in high school," says Professor Cornelius Beausang, who organizes the competition each year.

"We need more people doing physics; it's a nationally vital subject," he adds. "The civilization we live in is controlled by devices—from your coffeemaker to the space shuttle—which are run by the principles of physics, and we need people who understand how these devices work. The number of young people going into physics is declining, and we need to change that.

"And it's fun— I get a cool t-shirt each year."

Physics Department — Recent Statistics



Graduate Students Entering Program:	**2002-2003: 17** **2001-2002: 18**
Actively Enrolled Graduate Students:	**2002-2003: 82**
PhD Degrees Granted:	**2001-2002: 15**
MPhil Degrees Granted:	**2001-2002: 8**
MS Degrees Granted:	**2001-2002: 10**
BS and BA Degrees Granted:	**2001-2002: 7** **2002-2003: 13**

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