Physics at Brown

News for Alumni and Friends **2001 Issue**

Greetings! Welcome to the Brown University Physics Department newsletter. We are delighted with the opportunity to reach out and to share some news of ourselves with you. Outreach in its many varieties is central to Brown's mission and a prime goal of the Department. On this page you can read about a very successful program organized by Robert Brandenberger, in which six physics graduate students work with local high school teachers and students. Funded by the U.S. Department of Education, this program seeks both to share the excitement of physics and to build the confidence needed to ask questions of nature. A different but also thriving community interaction takes place at Ladd Observatory, the century-old National Landmark and newly restored facility which boasts the beautiful and original Brashear 12" refractor in its dome, as well as numerous piers for portable telescopes on its rooftop observing platform. David Targan, an Associate Dean of the College and a member of the Physics Department, coordinates our weekly Public Open House (see page 7) and with other Physics staff, hosts special visits from local schools, clubs, and other community organizations.

Dave Cutts

Table of Contents

Greetings from the Chair............1
GAANN Outreach Program....... 1
Galkin Foundation Fellowship.. 2
Milestone Discovery.................. 3
Robert W. Morse Memoriam......3
Electrinos!................................. 4
PhD's & Honors Recipients.......5
Extra Dimensions...................... 6
Department Briefs..................... 7
Rich Partridge at Fermilab........8

Brown University

In research Physics has had a momentous year. We have seen an experiment discover vortex phase transitions in superconductors (see page 3), suggestions that bubbles in liquid helium, each containing a single electron, may split (Electrinos! Page 4), and novel searches for evidence that extra dimensions (beyond 3 space and 1 time) exist in nature. Each of these events may foretell a major advance in our fundamental knowledge. At the same time, we celebrate the Galkin Foundation Fellowship held this year by Ann Lee, a graduate student with Leon Cooper; their work uses physics to understand the brain.

While heralding these advances, we are deeply saddened by the passing of Bob Morse, a Physics faculty member who became Chair and Dean of the College. We honor his contributions to Brown.

As the core science, central to the study of the basic laws of nature, physics needs to be at the forefront of improving public understanding of science. We ask the advice and help of you our friends as we seek both to advance the boundaries of knowledge and to share the excitement of the process.

Dave Cutts, Chair, cutts@physics.brown.edu

GAANN Outreach Program

Left to Right: Damien Easson, R. Brandenberger, Warren Galkin`51, Theodore Johnson, Stephon Alexander, Wessyl Kelly, and David Dooling

Over the past two years, several Brown physics graduate students have taken some time off from their engaging PhD research to teach physics and mathematics in Providence area high schools. Their efforts are part of a project supported by the federal Department of Education through their GAANN (Graduate Assistantships in Areas of National Need) program. The program's intent is to encourage more American students to obtain a PhD in the physical sciences and to choose teaching as a profession.

There is an enormous need for improvement in the teaching of physics in the United States. Physics has evolved greatly over the past decades: new branches of physics such as cosmology, string theory and biophysics are increasingly attracting the attention of the public. Brown's GAANN program is predicated on the idea that this evolution will continue and that the teachers best equipped and most interested in keeping up with physics are those with a broad and deep physics background. Those teachers can involve students in simple, but topical, research projects and can convey the excitement of current discoveries.

Our GAANN program intends to encourage physics graduate students to develop the ability to teach well at all levels, while simultaneously involving them in cutting-edge research. They are given the chance to obtain a physics PhD in exciting fields of physics, which as teachers will help them attract more high school and undergraduate students to the field. Note that these fields are not necessarily fields in which a lot of research funding is available.

Continued on page 6

The Galkin Foundation Fellowship

Brain research is becoming the fastest changing, interdisciplinary field drawing on the talents of biologists, psychologists, mathematicians, engineers, physicists and computer scientists. Addressing questions such as, “What is memory?” and “How does the brain acquire the ability to interpret visual images?” demands expertise from this wide range of disciplines. Ann Lee, a graduate student at Brown, researches the latter question. Her work, which is directed by Professors Leon Cooper in Physics and David Mumford in Applied Math and is heavily influenced by work in the Mark Bear neuroscience lab, reflects the advantages of close interactions across different disciplines. It earned her a Galkin Graduate Fellowship.

Brain research is becoming the fastest changing, interdisciplinary field drawing on the talents of biologists, psychologists, engineers, mathematicians, physicists and computer scientists.

A complete description of how the brain learns to interpret visual images must include how the neurons in the optical system become modified by visual stimulation and what features of natural images provide the pertinent stimulation. Ann Lee has worked on both aspects. Her first project started with the knowledge that neurons in the primary visual cortex, the first cortical area to receive input from the eyes, are sensitive to bars of light of various orientations and sizes. This sensitivity implies that the receptive fields of a given neuron consists of different subfields. Some instigate and others inhibit the firing of the neuron as a result of external stimulus.

Ann extended a highly successful theory for how individual synapses become modified by external inputs, the Bienenstock, Cooper, and Munro model, to the analysis of how these subfields develop. In a paper published in the Proceedings of the National Academy of Sciences, Ann, Professor Leon Cooper, Brian Blais, Harel Shouval, and others, reported that this approach yields the subfield segregation described above and observed in “eye opening” experiments. The result is robust to large levels of noise and holds provided that nonlinear effects are small. In addition, the results suggest further simple experimental tests.

More recently, Ann has turned to finding mathematical models for the types of visual signals that the brain processes. Although not clearly understood, there is compelling evidence (from, for example, psychophysical data) that our visual system is well adapted to dealing with naturally occurring images. An important question in vision is whether we can find stochastic models that capture the typical structures of natural images.

In collaboration with Professor D. Mumford in the Pattern Theory Group of the Department of Applied Mathematics, Ann has been developing an image model that attempts to explain key features of natural images — such as the empirical observation that natural images show an amazing scale invariance, and the discovery that “noise” in natural images is often better described as “clutter”, which (contrary to traditional views of noise) has extremely non-Gaussian statistics. The image model is based on the notion that the world consists of discrete structured objects that span many angular scales; and that when viewed, the 3D world creates a cluttered collage of objects that occlude each other. Mathematically, they describe the image formation process by a Poisson process on the positions and the scales of elementary random shapes that are added successively in layers. So far, a comparison to the empirical statistics of large databases of natural images assembled by Huang and Mumford, show that the “random shape model” comes closest to duplicating the simplest, elementary statistics of natural images. Statistics such as the scale invariance property of histograms of filter re-

Ann Lee

sponses, the highly irregular shape of joint histograms of pairs of wavelet coefficients, and the complex behavior of the full two-pixel co-occurrence statistics.

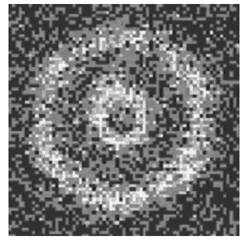
These first results are promising. A complete description of images, however, requires a model that deals both with their intensity values and with the geometry of the shapes in the domains that they define. Current research involves describing the probability distribution of the pixel intensities of small patches of natural images. The ultimate challenging questions are how to put these models together and how to sample and estimate with these models — a problem that has to be solved by the visual system of animals and humans.

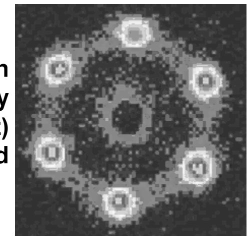
The Galkin Fellowships are funded through a generous donation by Mr. Warren Galkin, Class of 1951. Each year the Fellowship recognizes exceptional promise and achievement in physics by a senior graduate student.

Sean Ling and coworkers make milestone discovery in a superconductor

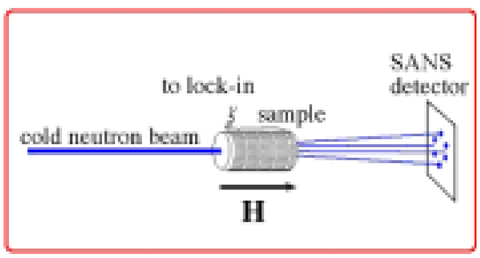
In a recent Physical Review Letter, lauded by an expert as "a milestone contribution", Professor Sean Ling and his coworkers, graduate assistant Sang Ryul Park, undergrad Bridget McClain, and collaborators from NIST, reported the first direct observation of a vortex melting/freezing phase transition in a superconducting Nb crystal. Whether a phase transition of solid-liquid type can occur in the vortex phase of superconductors has been an outstanding issue in condensed matter physics.

To understand the physical significance of this discovery, recall that vortex lines are persistent whirlpools of current that exist *within* a superconductor placed in a magnetic field. Ideally, at low enough temperatures, the repulsive interactions between vortex lines drive them to freeze into a crystalline phase, the Abrikosov lattice, that supports supercurrents. Imperfections in the crystalline lattice of atoms in which the vortex lines are embedded, however, make competing distortions and thus, disorder in the vortex lattice energetically favorable. Whether this competition, which is similar to that present in other physical systems, destroys the phase transition from an ordered to a disordered state has been controversial.





Neutron diffraction patterns produced by a vortex liquid (left) and by a vortex solid (right)



Schematic of small angle neutron scattering measurement

Ling and coworkers settled the issue by simultaneously using neutron diffraction to measure the order in the vortex system and magnetic susceptibility measurements to determine the supercurrent carrying capability of the sample. At low temperatures, the sample supports supercurrents and exhibits sharp, hexagonally arranged, peaks in its neutron diffraction pattern (see left panel). These peaks result from the constructive interference of the neutron matter waves scattered by a regular array of magnetic vortices (see schematic). Increasing temperature or magnetic field leads simultaneously to the abrupt disappearance of the peaks (see right panel) and loss of the capacity to carry a supercurrent. Moreover, cycling up and down in temperature reveals these changes to be hysteretic. These observations are hallmarks of a first order melting transition and super heating or cooling effects, respectively. This work was featured in Physical Review Focus on January 18, 2001.

Robert W. Morse 1921-2001

If you were a graduate student between the late forties and the mid-sixties, you will remember Bob Morse, graduate student, professor, chair and Dean of the College. Bob died on January 19, 2001 at his home in Falmouth, Massachusetts.

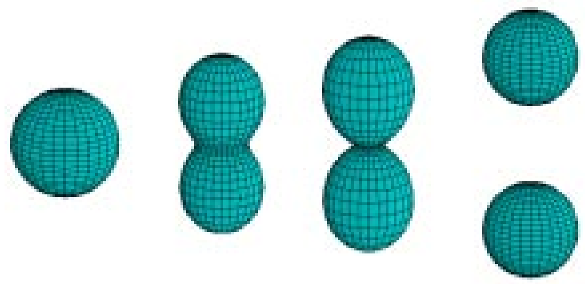
Robert W. Morse

Morse attended Bowdoin College, graduating in 1943, acquiring his degree, marrying his wife Alice, and receiving a commission in the U.S. Navy all at almost the same time. After World War II he came to Brown as a graduate student and took his PhD in theoretical acoustics under Bruce Lindsay (1948). He stayed with the Physics Department, rising to full professorship in 1958. While he did considerable research in underwater sound for Brown and for the Navy, he achieved fame for his research in ultrasonic absorption in superconductors, developing an ultrasonic technique for determining the gap in the density of states of unpaired electrons in a superconductor, a measurement that provided an important verification of the BCS theory of superconductivity. He became department chair in 1960, and Dean of the College in 1961. Two years later, President Lyndon Johnson appointed him Assistant Secretary of the Navy for Research and Development. He left that position in 1964 to become President of Case Institute of Technology in Cleveland, Ohio, and then presided over its merger in 1967 with Western Reserve. This was a difficult time for presidents of universities as they tried to maintain a balance between the raging student protests over the Vietnam War and conservative boards of trustees, and Bob fell victim, leaving CWRU in 1971. He moved to Woods Hole, Massachusetts, where he headed the academic side of the Woods Hole Oceanographic Institution. He assisted in the merger of this program with MIT and played many useful administrative roles in that development.

Bob was a first class student, an excellent researcher and an administrator of great skill and courage. In these roles, he was greatly assisted and supported by his wife Alice, who charmed his associates at every level, and who predeceased him by a year.

Electrinos!

When an electron enters liquid helium, interesting things happen! Instead of wandering in between the helium atoms, the electron prefers to force open a spherical cavity inside the liquid that is completely free of helium atoms. The radius of this cavity in which the electron is confined is approximately 19 Å. The size of the cavity is determined by a balance between the surface tension of the liquid which tries to make the cavity collapse, and the zero-point energy of the electron that increases as the cavity shrinks. These "electron bubbles" in helium have been studied since the 1960's and their properties are well-established as a result of many experiments performed in different labs around the world.



A bubble starting in a 1S state is excited into a higher angular momentum state that causes the bubble to fission

During the past few years, Professor Humphrey Maris has been thinking about ways to use these electron bubbles to test the basic concepts of quantum mechanics. The idea is as follows: The normal electron bubble is spherical and the electron inside is in the 1S state. Suppose now that it is possible to find a way to divide the bubble into two "daughter bubbles", while at the same time keeping some part of the wave function of the electron inside each of the new bubbles. It is easy to show that if this is done the radius of the daughter bubbles that minimizes the bubble energy is equal to the radius of the original bubble multiplied by a factor $f^{1/4}$, where f is the integral of $|\psi|^2$ within the bubble. Thus, for example, if the wave function is equally divided between the two bubbles, the radius becomes $19 / 2^{1/4} \approx 16$ Å.

In a paper published in the August issue of the Journal of Low Temperature Physics, Maris described a way in which it might be possible to carry out this process of bubble fission. In the paper he decided to call bubbles that contain a fraction of the electron wave function "electrino bubbles". While writing the paper, he discovered that there were a number of old experiments on electron bubbles in helium that had given strange results that no one had succeeded in explaining. Maris pointed out that these results might possibly result from the formation of electrino bubbles in the experiments.

So why are these ideas a challenge to quantum theory? In the first place, quantum mechanics is considered to be a linear theory, i.e., Schrodinger's equation that governs the time development of the wave function is a linear differential equation. For the bubbles in helium, however, the size of the bubble and other properties such as the optical absorption and the mobility, depend on the magnitude of ψ. Secondly, it is not clear what predictions quantum theory makes for the results of measurements on the bubbles. Suppose, for example, that an experiment is performed to look for the electron in one of the bubbles. If it is found in that bubble, then, according to the Copenhagen view of quantum measurements, the wave function immediately becomes zero inside the other bubble, no matter how far away that bubble is. This would cause it to collapse because it is only the presence of the wave function that prevents the surface tension forces from shrinking the bubble down to zero size. Can the energy released in the collapse be detected experimentally? Or should we consider that the bubble never existed in the first place? And, of course, what does existence mean in this context?

The paper has attracted a great deal of attention in the popular press and in science magazines, and the interactions with the media have been interesting. "Some of the articles have been very well written and accurate (see for example, the article by Eric Lerner in the Industrial Physicist). Others have been sloppy and have talked about bubbles having fractional charge, which I certainly do not expect to be seen", says Maris. The San Francisco Examiner interviewed P.W. Anderson about the paper and his comment was "It's fascinating. My immediate response was it's not possible, but I've been wracking my brains for why it's not possible and I'm not sure. I just don't know one way or the other." At this point, that neatly sums up Maris' view of the situation. The answers will come from further experiments. Graduate students Denis Konstantinov and Ambarish Ghosh are currently testing these ideas.

Continued from page 6

Extra Dimensions

understanding of how the universe works!

As the Fermilab Tevatron is the highest energy particle accelerator in the world, it is the perfect place to look for extra dimensions, since the higher the colliding particle energy, the stronger should be the extra dimensional enhancement of the gravitational interaction. Physicists in the DØ experiment, led by Professor Greg Landsberg, looked for the effects of gravitational interactions by observing pairs of electrons or photons produced in high-energy collisions. Careful analysis of data collected from 1992-1996 produced no evidence for extra dimensions and set the strictest limits on their size so far. These new limits place significant constraints on Arkani-Hamed, Dimopoulos, and Dvali's theory.

The DØ collaboration's search for extra dimensions is not over yet. In fact, it has only just started. They are also looking for the effects of extra dimensions in collisions that produce different types of particles, such as quarks and for events where gravitons are produced in collisions and then leave our three-dimensional world, traveling off into one of the other dimensions. The latter would cause an apparent non-conservation of energy from the point of view of our three dimensional world. As the next data-taking run has just started (March 1, 2001), and is likely to deliver twenty times the data presently accumulated, they will have a significantly extended sensitivity to large extra dimensions, and very well might see them!

2000 PhD Recipients

STEPHON ALEXANDER, "Topological Defects in Alternative Theories of Cosmic Inflation and String Cosmology"
Advisor: Robert Brandenberger

CHRISTOPHER BOWLEY, "Physical Studies of Holographically-formed Polymer Dispersed Liquid Crystals"
Advisor: Greg Crawford

MARTIN GOTZ, "Studies in the Origin of Large-Scale Structure"
Advisor: Robert Brandenberger

BRIAN KEATING, "A Search for the Large Angular Scale Polarization of the Cosmic Microwave Background"
Advisor: Peter Timbie

XINWEI LI, "Spin Dependent Transport in Half-Metallic Magnetic Microstructures"
Advisor: Gang Xiao

MIHAIL MIHAILESCU, "Investigation of Gravity and Large *N* Conformal Field Theory"
Advisor: Antal Jevicki

ANDREI SMUK, "Direct Laser Writing of Topographic Features in Semiconductor-Doped Glass"
Advisor: Nabil Lawandy

CHEN-KUANG SU, "Electrons, Vortices, and Cavitation in Liquid Helium"
Advisor: Humphrey Maris

2000 Senior Honors Recipients

Erin Quinn, Aditi Chandra, Sarah Wasserman, Miriam Friedel, and Erin Weeks
Class of '00

MIKHIL BOPAIAH, "Evaluation of Patient Exposure from X-ray Machines Using Radiation Backscatter"
Advisor: Douglas Shearer

MATTHEW BOWEN, "Selection of Top Quark Events via Project PHASER"
Advisor: Richard Partridge

ADITI CHANDRA, "Nondestructive Evaluation: An Application of SQUID Microscopy"
Advisor: Charles Elbaum

PHILIP DAVIS, "On-line Handwriting Recognition with Hidden Markov Models and the Neskovic / Cooper Objective Function"
Advisor: Leon Cooper

OWEN FINK, "Design, Construction, and Calibration of a Low Temperature, Low Pressure Thermocouple Pressure Gauge"
Advisor: George Seidel

MIRIAM FRIEDEL, "An Investigation of SU(2n) Quantum Antiferromagnetic Ground States in One and Two Dimensions"
Advisor: Brad Marston

Peter Shephard '00 fields a question at his honors thesis defense

RAJU GOYAL, "Liquid Beams"
Advisor: Peter Weber

MARK HENLE, "The Melting of Vortex Matter in Type II Superconductors"
Advisor: Sean Ling

LAWRENCE LIN, "Minkowski Functionals and Cold Dark Matter Models"
Advisor: Robert Brandenberger

MATT PILLSBURY, "Supersymmetry and the Calogero Model"
Advisor: Antal Jevicki

ERIN QUINN, "Using Capacitance to Measure the Active Area of Ultra-thin Silver Films"
Advisor: Jim Valles

PETER SHEPARD,"Numerical Simulations of Gauged U(1) Cosmic String Networks"
Advisor: Robert Brandenberger

SARAH WASSERMAN, "Magnetic Manipulations: Understanding Cleavage Plane Determination in the South African, Clawed Frog, Xenopus laevis"
Advisor: Jim Valles

Physics at Brown

Editor
James M. Valles, Jr.
Layout Editor
Jane Martin
Physics Dept. Chair
Dave Cutts
Executive Officer
James M. Valles, Jr.
Address:
Physics at Brown
Box 1843
Brown University
Providence, RI 02912

Contributors
Robert Beyer
Robert Brandenberger
Leon Cooper
Dave Cutts
Greg Landsberg
Ann Lee
Sean Ling
Humphrey Maris
George Seidel
Jim Valles
Photography
James M. Valles, Jr.

e-mail: newsletter@physics.brown.edu

Continued from page 1

GAANN Outreach Program

The most significant component of our present program is the successful outreach by GAANN fellows into inner city Providence high schools. The goals of this outreach are to address the national needs of improving scientific literacy among students, and to encourage more U.S. students to choose a field of science as their career. Our fellows have spent on the average one full day per week teaching in various Providence high schools, working directly with mathematics and science teachers, or on a one-to-one basis with individual students. With the Federal funds (and with private matching funds generously provided by Warren Galkin) we have been able to support six graduate students as GAANN fellows. The three senior students have or are now completing their PhD theses; the other three are well under way in their research. Stephon Alexander, an African-American student, graduated last May with a thesis in theoretical cosmology. He is currently a postdoctoral fellow at Imperial College in London, and is also affiliated with a new program in string theory and cosmology at Columbia University. Stephon grew up in the Bronx, and attended De Witt Clinton High School, where an excellent teacher became his role model and encouraged him to go to college in spite of all the odds. Now, his thesis on string cosmology has gained him wide recognition in the field and several excellent postdoc offers. In his work with our present GAANN program he has in turn become a role model for many Providence inner city minority high school students. He is continuing his high school outreach through his present affiliation with Columbia University. David Dooling and Damien Easson are currently writing their theses in theoretical high energy physics and theoretical cosmology, respectively, and have already received offers of good postdoctoral positions.

Our GAANN fellows have worked at Central, Mt. Pleasant, Hope and Classical High Schools, among others. One year, Stephon Alexander spent one day a week co-teaching Eric White's mathematics classes at Central High School, and becoming a role model for many of Eric's students. After the first month of co-teaching, the students were performing so much better that Eric was able to substantially upgrade the yearly projected achievements of his students. The following year, Stephon worked with Theodore Johnson, a science teacher at Mt. Pleasant High School. Once again, the regular presence of a Brown graduate student in the classes increased the motivation of the high school students to work hard. David Dooling and Wessyl Kelly spent a year coaching the Classical High School Physics Olympiad team which went on to win the State competition and represent Rhode Island at the National event. Damien Easson has been tutoring at Hope High School, and Lance Ritchie established contacts with the MET High School and took on a MET student as his advisee, enabling him to make use of our facilities to complete his major research project.

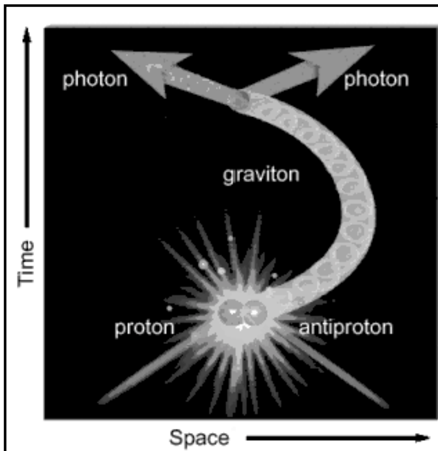
We are currently applying for continuation grants which would enable us to build on the strong links which we have established with high schools in Rhode Island and to construct a lasting program to improve the quality of physics education in Rhode Island.

Extra Dimensions

All of our current observations are consistent with a 3+1 dimensional universe. (The fourth dimension is time, which Lorentz and Einstein showed to be intrinsically related to space.) In the quest to produce a self-consistent quantum theory of gravity, however, string theorists have advanced the idea that there are 10 (or even 11) dimensions, 6 or 7 of which we have not yet observed!

The reason we do not "feel" these additional spatial dimensions (if they exist) is because they differ from those with which we are familiar. It could be that our world is 'pinned' to a 3-dimensional sheet (a so-called 'brane') that is located in a higher dimensional space. The extra spatial dimensions are thought to be curled-up, or "compactified". To illustrate this, imagine an ant constrained to walk on the surface of a sheet of paper that has been rolled up to form an infinitely long cylinder. If the ant starts crawling in the direction of curvature, it eventually returns to its starting point. This is an example of a compactified dimension. If the ant crawls in a direction parallel to the length of the cylinder, it would never come back to the same point. This is an example of a "flat" dimension. According to string theory then, we live in a universe where our three familiar dimensions of space are "flat", but there are additional dimensions which are curled-up very tightly so that they have an extremely small radius: 10^{-30} cm or less.

Well, in fact we could "feel" these extra dimensions through their effect on gravity. While the forces that hold our world together (electromagnetic, weak, and strong interactions) are constrained to the three "flat" dimensions, the gravitational interaction permeates the entire space. Unfortunately, since gravity is a very weak force and since the radius of extra dimensions is tiny, it could be very hard to see any effects, unless there is some kind of mechanism that amplifies the gravitational interaction. Such a mechanism was recently proposed by Arkani-Hamed, Dimopoulos, and Dvali, who realized that the extra dimensions can be as large as one millimeter, and still we could have missed them in our quest for an



An example of the extra-dimensional effects observable at colliders. A graviton leaves our world for a short moment of time, just to come back and decay into a pair of photons (the DØ physicists looked for this particular effect).

Continued on page 4

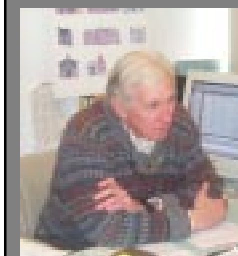
Bob Dean Retires


Bob Dean

With 45 years of service to Brown University under his belt, Bob Dean retired this past fall. While according to one, "Bob gained more titles at Brown than the Prince of Wales!", he has been best known to us in physics as the machine shop manager. We are indebted to him for the many jobs he saw to completion for our research and teaching efforts and his example of unflagging loyalty to Brown.

Humboldt Foundation Recognizes Seidel

George Seidel is the recipient of a Senior Research Award from the Alexander von Humboldt Foundation in support of collaborative research with Professor S. Hunklinger and Dr. C. Enss of the University of Heidelberg. The research involves the development of energy dispersive x-ray detectors with high resolving power based upon the use of low temperature microcalorimeters. Seidel spent several months in Germany while on sabbatical during the past academic year and will return this year for another three-month period.


George Seidel

New Sloan Fellow

Professor Greg Landsberg is one of the year 2001 recipients of a prestigious A. P. Sloan Foundation Research Fellowship Award. These awards are intended to enhance the careers of the very best young faculty members in physics and other sciences. Congratulations Greg!

Brown Department of Physics
Arthur O. Williams Lecture

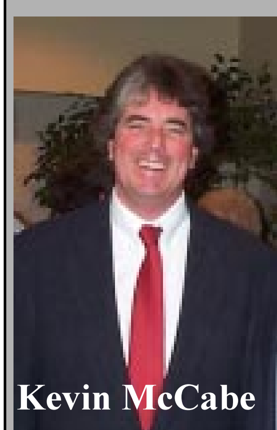
"The World's Numerical Recipe"

Professor Frank Wilczek

MIT

April 16, 2001
4:30 p.m.
Barus & Holley - Room 168

Best Wishes Kevin!


Kevin McCabe

After 11 years in Physics at Brown, Mr. Kevin McCabe has moved on to a new position in private industry. Our alumni will remember him most vividly in his capacity as the Senior Lab Technician where he was surrounded by inclined planes, Millikan oil drops, strings and other parts of student designed experiments. Over the past several years he became quite popular with the students in these labs, always knowing when to offer assistance and when to let them figure things out on their own. His bright, friendly personality and helpful nature left a lasting impression on the graduate student teaching assistants and faculty who worked at his side.

Ladd Observatory
210 Doyle Avenue
Providence, Rhode Island
(401) 521-5680

Open Tuesday evenings after dark if the sky is clear.

Physics at Brown

Physics at Brown Newsletter
Department of Physics
Box 1843
Brown University
Providence, RI 02912

ALUMNI, WE'D LIKE TO HEAR FROM YOU!
News? Comments?
Please write to the above address or e-mail us at newsletter@physics.brown.edu

Professor Richard Partridge is shown working on the installation of the Luminosity Monitor for the D-Zero detector at the Fermilab Tevatron. Professors Cutts, Landsberg, and Partridge, their students and postdocs, are in the process of completing several major parts of the D-Zero upgrade in preparation for Run II at the giant proton-anti-proton collider. Over the next year, the multi-institution, international D-Zero collaboration hopes to build on the successes in Run I, highlighted by the discovery of the top quark, and probe more deeply into the structure of matter than ever before. They will search for the Higgs Boson, evidence of supersymmetry and more. Stay tuned . . .