2005

Department of Physics Newsletter: Spring 2005

Bob Krotkov

Gerry Peterson

Monroe Rabin

Hajime Sakai

DEPARTMENT OF PHYSICS NEWSLETTER

University of Massachusetts Amherst Issue 5 Spring 2005

The World Year of Physics: A Tribute to Albert Einstein

"The ideals which have lighted my way, and time after time have given me new courage to face life cheerfully, have been Kindness, Beauty, and Truth." A. Einstein

One hundred years ago an unknown clerk in a Swiss patent office wrote five papers in his spare time that shook the foundations of physics and forever changed our world. Before **Albert Einstein's** papers, the concept of atoms was not fully accepted. His thesis on "A New Determination of Molecular Dimensions," and his article on Brownian motion followed by Jean Perrin's experimental work, firmly established the discontinuous atomic structure of matter. Atoms were real. His paper on the quantization of the radiation field, sometimes referred to as the photoelectric effect, showed that light came in discrete packets called photons, and a few years later he showed that radiation fields have particle-like as well as a wave-like aspects. These were the seminal papers on wave/quantum mechanics. His fourth paper on the special theory of relativity did away with Newtonian absolute space and time, and his fifth paper showed the equivalence of mass and energy in what is perhaps the best known equation in all of physics, $E = mc^2$. These five papers in his *annus mirabilis* 1905 were followed in 1916 by his theory of general relativity, which is really a theory of gravity.

This in turn was followed by the theory of stimulated emission of radiation in 1917, by the prediction of Bose-Einstein condensation in 1925, and by a critique of quantum mechanics with Boris Podolsky and Nathan Rosen in 1935. The last 30 years of his life were spent unsuccessfully on trying to develop a unified theory of gravitation and electromagnetism. He received the Nobel Prize in 1921 for the photoelectric effect, which he considered to be his most original idea.

"Imagination is more important than knowledge." A. Einstein

Young Albert Einstein, the 26 year-old patent clerk

Many have benefited by **Einstein's** insights, including Perrin, who got the Nobel Prize in 1926. Others include **Joe Taylor** and **Russell Hulse**, who were at UMass Amherst when they made the first observation of a binary pulsar that led to their sharing the Nobel Prize in 1993. According to **Einstein's** theory of general relativity, oscillating mass distributions, such as two stars in close orbit about each other, can lose energy by radiating gravitational waves. Taylor and Hulse saw that the binary pulsar system slowed down as time went on indicating such an energy loss. (See the "People" section of the 2001 Newsletter.) Still another example is that of Eric Cornell, Carl Wieman and Wolfgang Ketterle who shared the 2001 Nobel Prize for the for the achievement of Bose-Einstein condensation in dilute gases of alkali atoms. (See the "People" section of this newsletter for a discussion of Ketterle's colloquium lecture).

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Inside:

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Locally, **Professor Boris Svistunov** and **Emeritus Professor Bill Mullin** and their students have also been doing research on the theory of Bose-Einstein condensates.

Much of the current research in our department takes its direction from ideas associated with Einstein. For example, one of the big current problems in physics is the unification of general relativity (gravity) and quantum mechanics. **Professors John Donoghue** and **Barry Holstein** are developing new formulations of quantum gravity (see the Research section of this Newsletter). At the same time **Professors Jennie Traschen** and **David Kastor** pursue string theory, which ambitiously tries to unify all of physics, whereas **Einstein** only tried to combine the known interactions of the early 20th century, namely gravity and electromagnetism (See page 3 of the 2003 Newsletter).

> *"A theory is something nobody believes except the person proposing the theory, whereas an experiment is something everybody believes except the person doing the experiment."*
> *A. Einstein*

Whereas **Joe Taylor** and **Russell Hulse** saw indirect evidence of gravitational waves, a large project is now underway to detect gravitational waves directly. The Laser Interferometer Gravitational Wave Observatories (LIGO), located in Hanford, Washington and in Livingston, Louisiana, are undertaking this task. Michelson interferometers, basically the same as you used in undergraduate physics laboratories, but much, much, larger with arms about four kilometers long, and with fantastic precision, are being brought into operation. One of our alumni, **David Wei**, has been instrumental in developing the super-mirrors which are a sine qua non for successful operation of LIGO's Michelson Interferometers (see the Alumni News section of this issue for a discussion of LIGO).

Although much emphasis is being given to **Einstein's** papers of 1905 in this World Year of Physics, **Einstein** produced over 280 other scientific papers during his career. This fact is often not recognized and it is commonly thought that he did little of value after 1916. It has been said that if he had spent the last thirty years of his life at his hobby of sailing, physics would not have greatly suffered. But perhaps this indicates the stylishness of physics. Sometimes certain research areas are thought of as "hot," but looking back, many of these areas have faded into insignificance. **Einstein** didn't go for the stylish things in physics, but instead, he followed his own path. Many of his papers are being rediscovered. It should not be forgotten that **Einstein's** work has led to many practical applications. For example, modern particle accelerators are based upon special relativity. The Global Positioning System requires corrections from special relativity, as clocks onboard the moving satellites run slower than earthbound clocks, but corrections from general relativity for the weaker gravitational field at the satellite makes its clocks run faster than earthbound clocks. Television and many other means of communication are dependent upon the photoelectric effect. The laser is based upon his paper on stimulated emission of radiation, i.e. a photon can induce an atom to emit an identical photon. The list can go on and on.

> *"Whoever undertakes to set himself up as judge in the field of truth and knowledge is shipwrecked by the laughter of the Gods."* *A. Einstein*

In our Newsletters we put the names of people associated with the campus, either now or formerly, in bold font. Since **Einstein's** work has influenced so much of the current research, and since this Newsletter is honoring **Einstein**, we have decided to also put **Einstein's** name in bold font wherever it appears, even though he never set foot on this campus.

The editors wish to especially thank our graphic designer, **Ananda Lennox** of the Dean's Office, for her essential part in producing this Newsletter.

University of Massachusetts Amherst
Department of Physics Newsletter

Editors: Bob Krotkov
Gerry Peterson
Monroe Rabin
Hajime Sakai

This fifth issue of our newsletter is being sent to more than 1,250 of our alumni and alumnae who received degrees in physics from the 1930s to the present, and to present and former staff and faculty. For more information about our department, visit our website at
http://www.physics.umass.edu
Comments about the newsletter, or information about yourself, may be sent to the address on the last page or e-mailed to us at
newsletter@physics.umass.edu.

A Letter from the Department Head

Dear Alumni and Friends,

The 100th anniversary of **Einstein's Miraculous Year** reminds me of the unity and continuity of physics. Although special relativity and the origins of quantum theory are **Einstein's** most famous work from 1905, his work on Brownian motion is dearest to my heart. My own research on non-equilibrium statistical physics can be traced directly back to **Einstein's** work on Brownian motion from that period.

It has been a busy year in the department. The major renovation of Hasbrouck has entered the construction phase with the attendant dust and disruption. By the end of the year, we will have new laboratory space, new offices and a ventilation system with fume hoods suitable for modern work in condensed matter physics, nanoscience, and biophysics.

This year has also seen a number of transitions. We mourn the passing of **Emeritus Professor Roy Cook** who died this year after a brief illness. Roy was a towering figure in the department and on campus. He guided the department and helped create its institutions during the formative years of the 1970s and early 1980s. He worked hard to create a cohesive sense of community in the department and he was an exemplary teacher for generations of students. He will be deeply missed.

I am pleased to report that **Professor Monroe Rabin** has assumed the role of Associate Head. **Emeritus Professor Art Swift** stepped down from the Associate Headship at the end of 2004. Art has played a central role in the running of the department for many years and his many contributions will be missed. We wish him well as he starts his real retirement. Finally, we welcome **Dr. David Kawall** to the faculty. David joins the Nuclear Physics Group and replaces **Professor Ross Hicks** who retired last year to move to his native Australia. David currently works at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory.

Professor Machta, back row with sunglasses, took some of our new graduate students for a hike in the Holyoke Range last fall. For student identification, see the photo of Entering Graduate Students, Fall 2004, on page 8.

I would like to congratulate **Christopher Serino**, a Junior Physics Major in our Commonwealth College. Chris has been chosen by Oxford University for the exchange program between Oxford and UMass Amherst. He is the recipient of the campus-wide **David and Kathleen Scott Scholarship** that provides for one year of study at Oxford.

It is the responsibility of physicists to understand fundamental trends that affect society and, in that vein, the department is offering a new general education course called Energy and Society, which is being developed and taught by **Professor Mark Tuominen**. In April the Department will sponsor a one-day energy symposium, bringing together a panel of national experts to campus to address the public on the broad issues of energy.

Your contributions to the department continue to be deeply appreciated and, indeed, are necessary for our functioning. Last year donations made a number of initiatives possible including equipping the modern physics lab with a new special relativity experiment, creating an optics lab, as well as an undergraduate lounge for study and for the Society of Physics Students meetings.

Sincerely,

Jon Machta
(machta@physics.umass.edu)

RESEARCH

Relativity Theory

One of **Einstein's** great papers of 1905 introduced the special theory of relativity, in which he united space and time, and all the laws of physics became invariant under a special type of transformation between the spatial and temporal coordinates. In 1916, he extended this to the general theory of relativity, which is a theory of gravity. Another of the 1905 papers was on the photoelectric effect, a landmark insight into quantum mechanics. It is amazing to think of how much of modern physics has flowed from these papers.

One of the challenges over the years has been to unite quantum mechanics with the theory of general relativity--this is called the problem of quantum gravity. Over the past few years, **Professor John Donoghue** has pioneered a way to make quantum calculations in general relativity that allow a certain class of quantities to be reliably calculated. In this way he and his colleagues have provided the first calculation of the quantum correction to the Newtonian gravitational potential, which has been a "Holy Grail" for quantum gravity.

Richard Feynman in the early 1960s combined quantum gravity with general relativity by using the techniques of quantum field theory and Feynman's path integrals. Feynman's methods were subtle and novel for their time, but by now the techniques are standard and the quantization method is straightforward. The trouble comes when you try to calculate with the theory. Quantum calculations involve virtual states of arbitrary energy, and since the gravitational interaction grows with the energy, the contribution of high-energy virtual states grows arbitrarily large as the energy increases, leading to a divergent result for the answer. In other words, for many quantities you get infinity when you attempt to calculate them. After Feynman's success in quantizing general relativity, many people explored these divergences, but could not tame them.

In the meantime, in a completely different framework, the techniques of "effective field theory" were developed. Effective field theory follows from the understanding that physics is an experimental science, and we uncover the true theory only as we explore physics at higher and higher energies. There can be new particles and interactions uncovered as we probe higher energies, and we can never be sure that we know the correct theory at all energies. Effective field theory then develops ways to separate the low energy predictions, which can be reliably known, from the high-energy parts of the calculation, which cannot in general be known. Crudely put, the distinction comes from the uncertainty principle, in which low energy effects correspond to long distances, and high-energy effects to short distances. **Professors Donoghue**, **Eugene Golowich**, and **Barry Holstein** of UMass Amherst Physics were pioneers in the development of effective field theory as applied to particle physics.

It turns out that quantum general relativity exactly fits the pattern of an effective field theory. In the early 1990s Professor Donoghue recognized this parallel and set out to make the theory concrete by demonstrating how to make low energy quantum calculations in quantum gravity. The gravitational potential is a long-range effect falling as one power of the distance r. General relativity predicts a correction to the Newtonian potential, which was first calculated by **Einstein**, and which falls with two powers of the distance. Professor Donoghue recognized that the quantum correction should fall with three powers of the distance, and since it was still a power-law fall off, it only involved the low energy aspects of the theory. There could be no divergences in this and effective field theory could be used to reliably calculate the answer. He then showed in detail how to calculate such effects. For the scattering of two heavy masses, the potential energy has the form:

$$V(r) = -\frac{Gm_1m_2}{r}\left[1 + 3\,\frac{G(m_1+m_2)}{rc^2} + \frac{41}{10\pi}\,\frac{G\hbar}{r^2c^3}\right],$$

where the first term is the classical result, the second is the **Einstein** correction and the third is the quantum correction - note the factor of $1/r^3$. For this definition of the potential, the result was found in collaboration with Professor Holstein and a Danish colleague, N.E.J. Bjerrum-Bohr. The **Einstein** correction is small, but can be measured (it is responsible for the precession of the perihelion of Mercury), but the quantum correction is too small to be measured. However, for a theory that always gave infinity for answers, to produce a reliable finite result is an achievement that has been sought for a long time.

Our understanding of general relativity continues to develop. Professors Donoghue and Holstein are continuing their investigation of the effective field theory, with former student **Tibor Torma**, now on the faculty at the University of Mississippi, and present students **Mike Thorn** and **Andreas Ross.** Effective field theory will not answer all questions about quantum gravity, but it is capable of answering those that only rely on the particles and interactions that have been discovered thus far. Until we uncover evidence for new particles/interactions at higher energies, it appears to be the best that we have for a well-behaved quantum theory.

Condensed Matter Theory

Associate Professor Boris Svistunov came to us in January '03 from the Kurchatov Institute in Moscow. He is interested in quantum-statistical problems related to **Bose-Einstein** condensation and superfluidity. Much of his recent activity has been devoted to developing new Monte Carlo approaches to interacting quantum systems.

A Genial Boris Svistunov

In 1925 **Einstein** predicted that at sufficiently low temperatures weakly-interacting particles obeying Bose-Einstein statistics would condense into an exotic quantum mechanical object, a coherent matter wave, or "Bose-Einstein Condensate" (BEC). Such a condensate was not observed until 1995. (See the People section for a note on a colloquium lecture recently given on campus by Wolfgang Ketterle, who shared the 2001 Nobel Prize for this discovery.) Since 1995 the field of ultra-cold atomic gases has exploded.

With the development of lasers, it has become possible to establish a standing-wave interference pattern to produce a "lattice" of potential wells strong enough to confine atoms. When such a lattice is imposed upon a BEC, the BEC can vaporize into molecules and hot atoms. From the point of view of the Heisenberg Uncertainty Principle, it is as if the potential well constituted a "measurement" of atom position that collapsed the distributed matter wave of the BEC. Under suitable conditions, the BEC can also undergo a "quantum phase transition" between a superfluid and an "insulating" (non-flowing) state. It is expected that experimental progress will ultimately lead to the development of "quantum simulators" – quantum computers for condensed matter.

The Monte Carlo technique developed by Boris and his collaborators has also revealed a rich phase diagram for two-component bosons, including states in which the two components flow in opposite directions, while the net flow is zero.

A weakly interacting Bose gas is a textbook system showing strong fluctuations at temperatures very close to the condensation point. Boris and collaborators **Professor Nikolai Prokof'ev** and graduate student **Oliver Ruebenacker** have also used the Monte Carlo method to elucidate the theory in this strongly-fluctuating regime. The formation of the BEC may also be viewed in terms of the decay of superfluid turbulence – a chaotic tangle of quantized vortex lines. With another of his graduate students, **Evgeny Kozik**, Boris studies the theory of such decay.

Exotic quantum properties also arise in Fermi systems - for example, superconductivity in the electrons of a metal. It was recently shown to be possible to manipulate Fermionic atoms, which have half-integer spin, to either attract each other and form a Bose molecule, or repel each other, as electrons do. The Bose molecules can condense into a BEC, while the repulsive interaction leads to superconductivity, as described by the BCS (Bardeen-Cooper-Schrieffer) theory for which the 1972 Nobel Prize was awarded. For diatomic molecules it has become possible to experimentally study the cross over from BCS superconductivity to BEC. With collaborators Nikolai Prokof'ev, Evgeny Burovski, and a computational physics group at ETH Zurich, **Einstein's** old school, Boris is participating in a major computational project to study this crossover using Monte Carlo methods. They are one of only a dozen teams selected to use the Oak Ridge National Laboratory Cray X1 vector supercomputer--one of the world's fastest machines.

"It is a magnificent feeling to recognize the unity of complex phenomena which appear to be things quite apart from the direct visible truth." A. Einstein

Nanotechnology

In our Newsletter's last issue (No. 4, 2004), we reported on the formation of MassNanoTech, a center designed to foster research innovation, education, and infrastructure in nano-technology. MassNanoTech is an "umbrella institute" centered here at UMass Amherst, with a strong emphasis on interactions between the campus and industry with regard to research and development. The campus is now partnering with a number of different companies such as Bell Labs, IBM, Seagate, and others, on projects such as nano-fabrication, characterization, and nano-device prototype development. Negotiations are under way with a number of new industrial partners. More than 50 faculty in seven departments and two colleges are involved here at UMass Amherst. One of the co-directors is our **Associate Professor Mark Tuominen** with co-director **James Watkins** of Chemical Engineering and associate director **Thomas Russell** of Polymer Science.

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Massachusetts is one of the leaders in nano-technology, but to stay that way, it has to foster a fertile atmosphere for growth and innovation. MassNanoTech fits in with the plan. A pre-proposal was submitted to the National Science Foundation for a $20 million Nanoscale Science and Engineering Center. The pre-proposal has been accepted and UMass Amherst is now one of eight institutions competing for the grant. The proposed center is to be a Center for Hierarchical Manufacturing. Three interdisciplinary research groups will provide the scientific foundation for the proposed center: Nanoscale Materials and Processes, Nano-electronics, and Bio-nano-technology. In addition to the development and dissemination of scientific and technological knowledge, the Center will also house a national clearinghouse on nano-technology open to interested parties from all sectors. Graduate students educated within the Center will be immersed in cutting edge interdisciplinary science while being exposed to market assessment and commercialization efforts, preparing them for careers that partner innovation with implementation. The Center will also pursue community college-level nano-manufacturing training curricula, promotion of nano-technology in K-12 science programs, and surveys and workshops concerning the societal aspects of nano-technology.

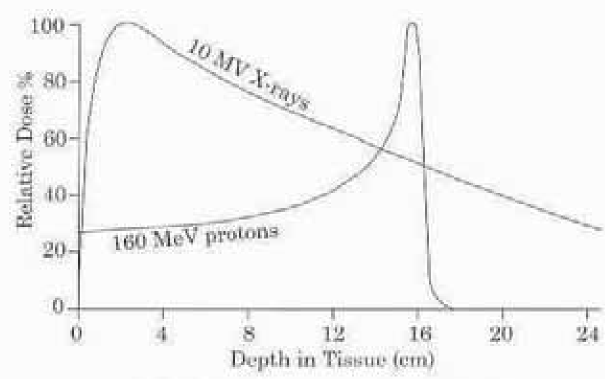
"The pursuit of truth and beauty is a sphere of activity in which we are permitted to remain children all our lives." A. Einstein

Medical Physics

Work on medical physics at UMass Amherst was initiated by **Professor Kandula Sastry** a number of years ago when he began investigating the effects of Auger electrons on the nuclei of cells. His graduate student in those investigations was **Roger Howell**, who is currently a Professor of Radiation Physics at the University of Medicine and Dentistry in New Jersey (New Jersey Medical School), and whose research interests include radiation dosimetry, the biological effects of radionuclides on the bone marrow and radioimmunotherapy.

In 1986, **Professor Monroe Rabin** spent his sabbatical year with a joint appointment as visiting scholar in the Harvard Physics Department and as the first Soriano Scholar in Radiation Oncology at the Massachusetts General Hospital. He worked on projects connected with cancer therapy using accelerated protons and helped develop a new beam delivery system for the protons via a moveable gantry. This system is currently in use at the Loma Linda University Medical Center in California, one of only three proton-therapy treatment centers in the U.S.

The standard method of radiation therapy for cancer uses a beam of X–rays. The radiation is thought to kill the tumor (and other) cells by ionizing cellular material inside the cell nucleus. The ions then disrupt the cellular DNA, preventing the cell from reproducing. One problem with using X–rays is that the ionization of tissue by the beam rises rapidly after the beam traverses the surface of the skin and then decreases exponentially (see graph). Tissue closer to the skin receives a greater dose than the tumor and there can be a significant ionization dose to tissue beyond the tumor. With a beam of protons having energies between 90 and 250 MeV, there is also some ionization between the skin and the tumor. But by controlling the energy of the incident protons, they can be made to come to rest at the far end of the tumor site and not affect any tissue beyond the tumor (see graph). This has great advantage for treating tumors near critical structures, as is the case for brain and eye tumors. The success of proton radiation therapy has stimulated the radiation treatment community to improve the dose distribution for X–ray treatments, and the new method of Intensity Modulated Radiation Therapy (IMRT) using X–rays is the result. This method varies the intensity of the X–rays as a function of beam position in order



Relative Dose vs. Depth in Tissue

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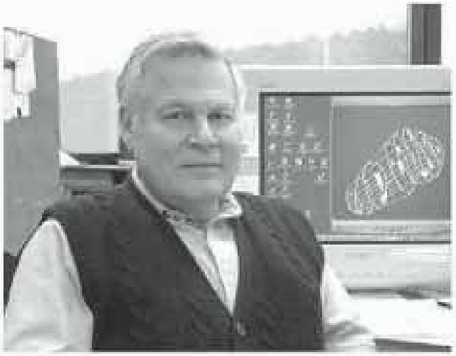
to better conform the radiation dose to the tumor outline both transversely and in depth.

After Rabin's sabbatical ended, he continued his association with the proton radiation treatment team at Mass General Hospital, along with graduate students **Friedel von Goeler** and **James Case**. A third student, **Piotr Zygmanski**, received his Ph.D. for studying proton tomography at the Harvard Cyclotron Laboratory, a topic that could be important to the future of proton radiation therapy.

Another project started several years ago by Professor Rabin, in collaboration with the Pathology Department at Baystate Medical Center in Springfield, is a study of a common form of breast cancer, ductal carcinoma in situ. This project



Monroe Rabin

has involved undergraduates **Oliver Döhm** and **Ryan Duvally** as well as graduate students **Joseph Regensburger** and **Franklin Periera**. After a surgeon has done a lumpectomy of tissue from the breast, tissue slices on slides, which have been examined by a pathologist, are scanned into a computer that automatically aligns the tissue slices on all of the slides. The computer software detects the tissue boundaries, and with the aid of the pathologist, locates the positions of malignant cells. Then the computer program builds a three-dimensional picture of the excised tissue and the tumor locations that can then be rotated on the computer screen by the physicians. This will aid the physicians in determining the extent of the tumor and whether it is getting larger as it approaches the margin of the excised tissue. Hopefully, it will also aid in determining whether any tumor was not excised and determine the probability of the tumor recurring. It will also serve in designing further treatment with radiation if necessary.

Professor Rabin has continued his contacts with the people at Mass General Hospital and currently has a graduate student, **Tarek Halabi**, who is working with the radiation oncology group there to improve the treatment algorithms used with the new technology of IMRT described above.

"God is subtle but he is not malicious." A. Einstein

Undergraduate Research

Research projects are an important part of our undergraduate students' education. They are usually supervised by a faculty member and undertaken in the junior or senior years. Recent theses have been written by **Kazem Edmond**, **Yutaka Maki**, and **Ryan McGorty** under the supervision of **Professor Dinsmore**, by **Robert Lychev** and **Megan Juszkiewicz** under **Professor Menon**, by **Pjerin Luli** under **Professor Miskimen**, by **Jennifer Misuraca** under **Professor Tuominen**, by **Kyle Thompson** under **Professor Hallock**, and by **Can Kayatekin** under **Professor Rabin**. (Megan Juszkiewicz also did research during a summer internship in high-energy physics at Fermilab.) Results of student research were presented at the annual Five-College Student Symposium held at Smith College in the fall of 2004 that gave our majors a chance to meet and interact with their peers at the other colleges.

Spring '05 Undergraduate Awards

Chang Freshman Award: **Julia Kumpf**

Chang Transfer Award: **Pjerin Luli**

Hasbrouck Scholarship Award: **Edward J. Slavich**

Kandula Book Awards: **Thomas C. Hall, David W. Bearse, Daniel J. Pomeroy, Benjamin R. Farley**

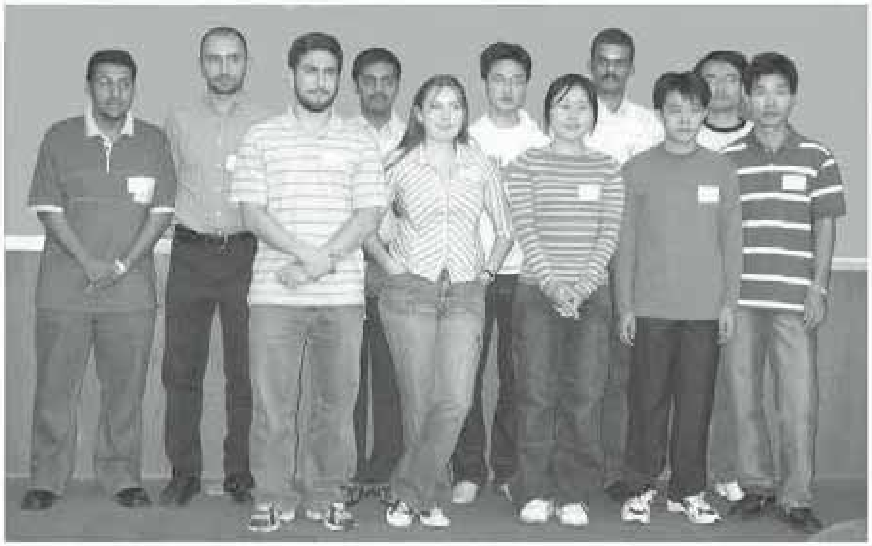
Outstanding Undergraduate: **Ryan J. McGorty**

David and Kathleen Scott Scholarship for study at Oxford: **Christopher Serino**

Students who received awards in 2004

Front row (left to right) **Christopher Jones, Ashley Dasilva, Teresa Liberatore, Jennifer Misuraca, Megan Juskiewicz, Yutaka Maki, Jake Ferguson.** Back row (left to right) **Matthew Maiberger, James Border, Nickolai Botchau, Ryan McGorty, David Bloore, Katherine Whitaker, Robert Lychev, Karl Hendricksen**

New Graduate Students Fall 2004



From left to right: **Mohamed Anber, Emmanuele Salvati, Peter Grima, Nikhil Malvankar, Emily Thompson, Xuan Ding, Tianyu Yang, Satya Mohapatra, Chuan Zeng, Kan Du, Jianshui Huang**

Outreach and Service

STEM Adventures

Last fall, aided by a grant from the Vice-Chancellor for Outreach, the STEM (Science, Technology, Engineering and Mathematics) program started STEM Adventures, Saturday morning programs for scout groups. A total of about 400 girls and adults attended one of the four programs. Topics such as Amazing Physics, Chemistry Fun, and Food and the Environment were all offered one or more Saturdays. The highlight of Chemistry Fun was making delicious ice cream with liquid nitrogen. The girls had an exciting morning and enjoyed the hands-on activities led by faculty and undergrads. Here is a picture of a girl scout on a bed of nails! (A lecture demonstration that most of you have probably seen.)

PEOPLE

Distinguished Visitors

Wolfgang Ketterle

On December 3, 2004, MIT **Professor Wolfgang Ketterle** gave a colloquium lecture on Bose-Einstein Condensates (BEC) of atoms, molecules, and fermionic pairs, work for which he shared the Nobel Prize in 2001. Ultracold BEC gases are "quantum degenerate," i.e., the condensed particles become one new, exotic quantum object. In his experiments Ketterle achieved the record lowest-temperature to date, 500 picokelvin. He told us of many new results; for example, the magnetic field of miniaturized wires on a chip can be used to trap and manipulate ultracold atoms close to the surface. Many of his early experiments focused on the condensate as a whole, for example, by studying its reflection from surfaces. As a result of his work, a new frontier is opening up in which the condensed particles are studied as a new form of matter. Our own **Professors Bill Mullin, Nikolai Prokof'ev,** and **Boris Svistunov** have been developing theories of BEC of interacting particles. Here we see Professor Ketterle projecting the Nobel Prize gold medal.

In Memoriam

LeRoy F. Cook Jr., 73, high-energy theorist and former Department Head, died of rapidly progressing melanoma cancer on January 6. Just ten days earlier at a luncheon to honor him in the Bernie Dallas Room of the old Goodell Library, **Chancellor John Lombardi** had awarded him the University Outstanding Service Award. In 1965 Roy left a faculty position at Princeton to come to our Department with six other new faculty at the beginning of the "Gluckstern Era," when our Ph.D. program in physics was launched. After **Bob Gluckstern** became Provost in 1969, Roy became Head from '69 to '75 and again from '78 to '84, during which time he played a major role in determining directions in both teaching and research. Former heads **Fred Byron** and **John Dubach** spoke of Roy's talent for bringing together people with disparate views and coming up with a plan that all could agree upon. From '76 to '82 Roy chaired the Chancellor's Lecture Series that brought visiting lecturers to the campus. He also chaired the committee that established core requirements for undergraduates in the influential "Cook Report." In his later years, before he retired in 2001,

he was active in starting and directing a number of large outreach programs that brought high school science teachers to the campus so as to keep them up to date in their science knowledge. Roy was born in Ashland, Kentucky and grew up in Long Beach, California. He received his Ph.D. from the University of California at Berkeley. Memorial gifts may be made to the **LeRoy F. Cook Jr. Memorial Scholarship in Physics**. For details about donating to this scholarship fund, please see the "Gifts" section of this newsletter on page 15.

James A. Krumhansl, 84, died May 6, 2004, in Lebanon, NH after a stroke. Jim was an adjunct professor in our Department after he retired in 1990 from Cornell, some 50 years after he enrolled as a graduate student there. He had served on the board of the American Institute of Physics and was editor in chief of Physical Review Letters as well as the Journal of Applied Physics, and was President of the American Physical Society in 1989.

Jim's research focused on theoretical condensed matter physics and materials science, but it also included microwave communication and information systems, applied mathematics, nonlinear science, and molecular biological physics. He was particularly known for his work on phonons (quantized sound), solitons (particle-like waves), defects in materials, and the engineering properties of carbon and graphite. He opposed the funding of the superconducting supercollider in 1987, and ten years later questioned the air of wartime urgency that seemed to drive the fusion reactor program. During his long scientific career he received many honors both nationally and abroad.

Mary Pelis

The department does a lot of teaching, and a lot of research – but none of it would happen without "the business office" – the administrative staff that keep things running. For example, **Mary Pelis** came to us 20 years ago, in 1984, when **Roy Cook** was the Department Head, and **Bob Gray** was the business manager. She remembers "Science Days" when high school students would come to hear about physics and she would sneak into **Bob Hallock's** lecture to see him shatter flowers frozen in liquid nitrogen. Another high point was breakfast every Wednesday with **Bob Gray**, **Jim Walker**, and **Dick Kofler**, who was famous for his donuts. Mary takes care of purchasing, both for grants and for the department, and many other financial matters. At home, she likes to do the Times crossword and acrostics puzzles (in one hour) and to cook gourmet foods. She has won Cyber Awards (virtual ones) for her contributions to the soap-opera newsgroup "Rec.Arts.Tv.Soaps.Abc" and tells us she is a "RATSAfarian." Her Siamese cat, "Mookie Wilson" lives a life full of love, and keeps her busy.

Word from Down Under

What becomes of our retired faculty? In **Ross Hicks'** case, he has returned to Australia where he is building a straw house. Although Ross is not afraid of the big, bad wolf, he is afraid of what will become of our world if we are not more concerned about our use of energy and its effect on our environment. Straw bale houses are very environmentally friendly: they provide excellent insulation in all seasons, they can be easily crafted, and they can be made relatively fire proof. A check of "straw houses" in Google will bear this out.

Ann Cairl

Ann Cairl

Our Department Secretary, **Ann Cairl**, came in 1987. The Department Head at the time was **Bob Hallock** and he offered her the job from a telephone booth in Vermont! (He was on the way to a meeting. These busy executives...) When Ann first came, her daughter was one year old, her son three. Now the son works in Florida, the daughter goes to college...we have all noticed how time runs on! When Ann first came, she used a typewriter (albeit an electric one). As a child, she lived for a while in Ware, next door to **Mary Pelis**. Ann is an enthusiastic golfer (handicap 25 – "bogey" golf). In a conversation she remarked on how stable the office staff has been since she came... few people have left for other jobs, though there have been offers. There must be something they like here!

Australian Gothic (Our apologies to Grant Wood) Left to right: A crimson rosella, Ross Hicks, Anna Hicks, a king parrot, and in front, a kookaburra.

Another Bill Ross Story

Following up from last year's Newsletter, here's another one. One of our editors met an elderly lady who said that she had a physics course from **Bill Ross** during WWII. The final exam was coming in a few days, and Bill admonished the class, "Don't stay up all night trying to cram in what you should have been learning all semester! You should relax so that you will do your best. And one way to do that is to go to a good movie that's playing downtown. (In those days there was a movie theater in downtown Amherst.) I expect to see you there. And I'm going to take attendance." So she went to the movie. And yes, Bill was there, and he did take attendance. However, he paid for all of the tickets.

Birthday Celebration last summer for two of our former **professors**, **Arthur Quinton**, left, his 80th, and **Ed Soltysik**, right, his 75th, while **Bernice Soltysik**, who once set up lecture demonstrations, looks on.

ALUMNI NEWS

Elizabeth Brackett (B.S. '80) writes: I recently had the pleasure of returning to campus to give a lecture about my career and profession to freshman physics majors. I also caught up with **Professor Kofler** who served as advisor to our freshman class (he still remembers everyone from the class!), and **Professor Hallock**, whose lab I worked in as a work-study student (to my surprise, the shelves I put up are still hanging!).

After graduating, I received an M.S. degree in Radiological Sciences and Protection, a program within the Physics Department of the University of Lowell, now UMass Lowell. The field of radiation protection is called health physics, a term coined during the Manhattan Project, in part because the earliest practitioners were physicists, and in part to avoid the use of the word "radiation." UMass Amherst prepared me well for grad school – I seemed to be a step ahead of many of the other students.

My first job was in an environmental laboratory, where we monitored nuclear power plant workers for exposure to radioactive material in addition to analyzing samples collected from the vicinity of the plants. It was there that I met my husband. A couple of years later we both got jobs at the Oak Ridge National Laboratory, so we packed up and moved south.

After living in Tennessee for six years and various parts of Ohio for another six years, we made it back to New England four years ago, where I'm hoping to stay (I was constantly reminded what a "Yankee" I was while living in Tennessee!). My husband is a research engineer at United Technologies Research Center in East Hartford, CT. I work for a consulting firm based in Buffalo, NY, but telecommute from my home in Connecticut. I also have an office in Cincinnati, where our biggest client, the National Institutes for Occupational Safety and Health (NIOSH), is located.

I've also been involved in several professional societies. Positions have included Secretary and Director of the American Academy of Health Physics; chair of the American Board of Health Physics (the certifying organization for health physics professionals); and a member of several American National Standards Institute committees, developing guidance on the measurement of internally deposited radioactive material. I'm currently the Program Committee chair for the Health Physics Society that organizes the technical program of the Society's annual conference. Serving on these committees has been a lot of fun and a great way to network with others in my field. (brackett@alumni.umass.edu)

Neal Kalechofsky (Ph.D. '95) writes: "My Ph.D. work was in low temperature quantum fluids under **Professor Don Candela** in which we studied ^{3}He-^{4}He mixtures confined in a porous matrix of aerogel. After leaving UMass Amherst I went to the University of Notre Dame where I was a post-doctoral researcher under Dr. Peter Schiffer. The work there centered on setting up a dilution refrigerator/magnet system to study frustrated magnetic systems such as gadolinium garnet. It was during my postdoc that I became familiar with Oxford Instruments [OI] as an equipment supplier. I was always more interested in applied physics than in basic research and the decision to leave academia was an easy one for me, especially when I learned that OI North America was based in Concord, MA, very near to where I grew up. Currently I work in the Physical Sciences Division overseeing sales and marketing of OIPS products into the North America marketplace. OI is the world's leading supplier of cryogenic and high magnetic field equipment and my work in the Physical Sciences Division takes me into virtually every laboratory in North America.

I have carved out a particular niche at OI, which is the development of applications for low temperature technology. Low temperature technology connects in a natural way to many seemingly unrelated fields including medical imaging, nanotechnology, next generation sensor development, biotechnology, and others. I have several patents in these areas and currently run an internally funded project looking at employing superfluid helium to address some unique needs of nano-manufacturing.

I'm particularly pleased that some of my work has resulted in an ongoing relationship with UMass Amherst Physics. For example, in 2000 I developed and patented a technique to employ ultra-low temperatures and high magnetic fields to produce hyperpolarized contrast agents for emerging MRI applications. That work led to OI funding a project in Professor Candela's laboratory for two years at UMass Amherst, work which sought to establish proof of concept for the technique. Professor Candela has since obtained NSF funding to continue the work and I look forward to continued collaboration with him on some exciting applications for ultra low temperature technology.

On a personal level, I live in Stow, MA, with my wife Janice (whom I met waiting for the elevator in Hasbrouck) and my three children Adrienne, Adam, and Alexa. It's a busy life, but very fulfilling, and I will always be grateful for my years at UMass Amherst which did so much to shape the person I am today." (kalechofsky@ma.oxinst.com)

Philip Kan (Ph.D. '75) writes: "As a graduate student I studied the nucleus ^{3}He by means of electron scattering at the National Bureau of Standards (NBS, now NIST) in Gaithersburg, Maryland. The picture shows some of our Nuclear Physics Group in the wee hours of the morning at the NBS linear accelerator. After getting my Ph.D., I received a fellowship at the University of California San Francisco to work on X-ray Computed Axial Tomography. In 1977 I accepted an Assistant Professor position at the University of Richmond in Virginia, and since 1980 I have been in southern California working for General Dynamics and later for Rockwell/Boeing where I made a transition to microwave physics, from MeV/GeV to MHz/GHz and Mbytes/Gbytes. My courses in E&M that included wave-guides especially eased this transition. I still use concepts such as TE/TM modes and boundary conditions nearly every day. The traveling wave tube amplifiers that I work with are the opposite of a linear accelerator: They extract electron beam energy to the microwaves instead of the other way around. In 1982 I married Kathy Hung. We have two children, Nathan who is studying biological sciences at UC Irvine, and Mary Beth, who is a freshman at Santa Monica College. In one of my trips back east in the coming year, I would very much like to make a side trip to Amherst." [Editor's note: Your visit would be most welcome, as would those from other alumni.]

Moment of Discovery: A peak in the on-line data at NBS showed that the breakup of ^{3}He had a monopole component [Phys. Rev. Lett. 34, 899 (1975)]. From left to right: Larry Robinson, B.S. '73; Gerry Peterson, Professor; Don Fleming, Ph.D. '73; Phil Kan, Ph.D. '75; and Marty Graham, Ph.D. '74.

Rich Piazza (Ph.D. '69): African Journey

In our last newsletter there was a picture of Rich, our first Ph.D. graduate, with his wife Yu-ling and infant daughter, Millie. Last June he visited Amherst with Millie, who is now a Ph.D. candidate in environmental science at the University of Michigan. It was a most pleasant visit, and we welcome such visits from other alumni.

During the visit we learned that before his graduate studies, Rich had been in Africa as one of the first Peace Corp volunteers. In 1963, after the Peace Corp, he made a solo 10,000-mile trip on the Triumph 350 cc motorcycle shown here, from Nigeria, east to Zaire, Uganda, and Kenya, then north through Ethiopia, Sudan, and Egypt, then west through Libya, and Tunisia, and finally north through Europe to London. Features of this fantastic journey may be found in the John F. Kennedy Library in Boston, and at the web site http://members.aol.com/richpiazza/index.html. Rich is still a motorcycle enthusiast, but he hasn't taken such a long trip in a while. (rich@piazza.name)

Rich Piazza on his Triumph motorcycle near the start of his 10,000 mile solo adventure through Africa.

Jack Stone (Ph.D. '82) writes: "For the last 15 years I have been working at the National Institute of Standards and Technology (NIST), in the Manufacturing-Engineering Laboratory. Our group bears primary responsibility for practical dissemination of the unit of length in the U.S. In my time here I have been involved with the development of several systems related to dimensional measurement, ranging from coordinate measuring machines to laser interferometry, and soon to optical frequency combs. My wife, Wilma, works for the District of Columbia court system in an office involved with family law. We live in Silver Spring, MD, about 1 mile from the DC border and barely "inside the Beltway". We enjoy the urban life of the DC area, but when the traffic backs up on the Beltway we miss Amherst. Our son, Michael, lives in Durham NC. He is a movie buff and works in the IT department of an educational testing firm. Our daughter, Rachel, is an art major at Skidmore College. For her fall semester Rachel was in Japan; Wilma and I took this as a fine opportunity to visit Japan last November, and we made good use of Rachel's language skills whenever we got into trouble (such as being lost on the train or filing reports at the police station!). With the children out of the house we have plenty of room for out-of-town guests, and would welcome any visitors from the 1970s physics program. At the least, be sure to stop by to say hello if you are in town." (jack.stone@nist.gov.)

Russell Turner (B.S. '84) writes: "My career has followed a somewhat meandering path since my undergraduate years, which were among the most interesting and enjoyable of my career. I worked under **Ross Hicks** in the Medium Energy Nuclear Physics (MENP) lab headed by **Gerry Peterson**. I had the opportunity to design and build targets for experiments at the Bates Linear Accelerator, and most importantly, developed data display software using some of the early Tektronics graphics terminals. This experience convinced me that the best way I could contribute to physics, or science in general, was by developing better scientific software.

Dear to my heart as physics was, and still is, I came to the conclusion that my talents were better suited to computer science. So I started graduate studies in Computer Science (COINS), although I continued to work part-time in MENP. Curiously, I didn't physically move between departments, instead the departments moved around me. MENP was originally in the Graduate Research Center Low-Rise, but they relocated to the High-Rise, COINS moved into the vacated space, and I kept the same office.

In 1987 I got an M.S. and took a position at DataViews Corp. developing dynamic data display software toolkits-very interesting work in the brand-new field of scientific visualization. But after two years I realized that I wanted to be more than a software engineer, so in 1989 I jumped at an opportunity to study for a Ph.D. in the Computer Animation Laboratory of the Swiss Federal Institute of Technology in Lausanne. This is the French-speaking campus of the same university, ETH, where **Einstein** did his doctoral work. This was a fabulous experience not only to work with state-of-the art Silicon Graphics high-performance 3D workstations, but also to live in Europe and learn to speak French. My research thesis, relying in part on my background in physics, involved computer animation using the technique of physics-based modeling. An animated cartoon character was modeled as a mechanical system with a differential equation solver that drove the animation in real-time.

After four years abroad, I returned to the States with a Ph.D. in Computer Animation and in 1994 took a tenure track position in the Computer Science Department of the University of Maryland Baltimore County. There I taught computer graphics courses and did research in computer animation and virtual reality. In 1997 I decided to jump off the tenure track, and joined a very small Amherst-based startup company, Wigitek Corporation, to develop a prototype dynamic-drawing editor. Two years later, in 1999, I joined Celera Genomics, the company that raced with the publicly funded project to be the first to sequence the human genome. At Celera, I headed a team of developers who built the genome visualization and annotation tool that was used to annotate the location of all the genes on the human genome.

Last year, I moved to the Johns Hopkins Applied Physics Laboratory in Maryland where I do research in visualization and human-computer interactions. In some ways I feel that my career has come full circle, since I'm again involved with an organization that does physics research.

Although I've had quite a few jobs, I've lived in Maryland for over 10 years now. My wife, Ling Wang, and I feel pretty settled here along with our two teenage daughters, Anna and Karen. My parents still live in Amherst, so we frequently make family trips back to western Massachusetts and have managed to stay in touch with many of our UMass Amherst friends, especially Ross Hicks and his wife Anna. Although it's been just over 20 years since I left

Peter Utz

UMass Amherst, it seems like only yesterday that I was studying for my final exams and building boron targets for MENP. The knowledge and experiences gained from those days continues to influence my work and my life." (Russell.Turner@jhuapl.edu)

Peter Utz (B.S. '67) writes: "Entering UMass Amherst following the aftershocks of Sputnik, I chose the hardest science I could find, physics, as did many others. At that time my courses were very math oriented, an approach that didn't appeal to me very much. However, laboratory work was fun, as there was less math. In my senior year I switched my minor from math to education, and met **Dr. Ray Wyman**, eloquent teacher of audiovisual, who focused on its applications to learning (UMass Amherst Physics B.S. '37, see Spring '04 Newsletter). After graduating, I had a brief stint at General Electric before coming back for an Ed.D. degree with Dr. Wyman. Since then I have had the opportunity to blend high tech video with the latest learning techniques to devise complete study programs in nursing, biology, and of all things—math. I moved to an administrative position running instructional media programs and building several TV studios. Although 95% of the physics that was math-oriented was wasted on me, the physics principles stuck with me as I grasped new technology with ease. I've published 16 books and nearly 300 articles on TV and audio equipment operation, selection, setup, and production. I am now a semi-retired writer doing daily battle with a computer that is as inscrutable as Lagrange equations were many years ago."

"Do not worry about your difficulties in mathematics. I can assure you mine are still greater." A. Einstein

David Wei (Ph.D. '69) was one of the first three Ph.D.'s from our Department. His research field was broadly called electro-optics. After leaving UMass Amherst, he worked for several companies in Southern California. After retirement, he has worked with the nanotechnology group of Professor Axel Scherer at Caltech. Among his proudest accomplishments are the special high-quality mirrors developed for the Laser Interferometer Gravitational-wave Observatory, LIGO.

Indirect evidence for the gravitational waves predicted by **Einstein's** general relativity theory was first found by **Joe Taylor** and **Russell Hulse**, who observed the slowdown of pulses coming from two massive neutron stars orbiting one another, a so-called binary pulsar. Their measurement indicated energy loss by gravitational radiation and won them the Nobel Prize in 1993. *Direct* evidence for gravitational waves, however, has proved wanting. All efforts to detect gravitational waves with earth-bound devices have failed because of inadequate detection sensitivity. LIGO, on the other hand, is a very large, ultra-sensitive, earth-bound Michelson interferometer that should be able to *directly* detect gravitational waves. In LIGO the beam from a powerful laser source is divided by a beam-splitter into two beams and sent into perpendicular optical arms of approximately 4 km physical length. The beams are reflected back to the beam-splitter to combine, forming optical interference between them. These arms are designed to produce an extremely long optical path by use of multiple reflections within a Fabry-Perot cavity with two mirrors placed at its ends. The very tiny space-time disturbance propagating with the gravitational wave would produce a corresponding tiny optical path difference between these two interfering beams. LIGO is designed to pick up this tiny optical path difference. The sensitivity of the device is solely dependent upon how long the optical path can be made by multiple reflections in the Fabry-Perot cavity, which in turn is dependent upon the high quality mirrors placed at the both ends of cavity. **David Wei** made an essential contribution to the development of these high quality super-mirrors by improving their reflectivity to about 0.9999 ("4-9's mirrors") using an ion-beam sputtering technique, which in turn led to further development. The final mirrors used in LIGO have a reflectivity of the order of 0.99999 ("5-9's mirrors"). With the 5-9's mirrors the optical path in the interferometer arm increases by two orders of magnitude from the physical length. Two such LIGO observatories have been constructed: one in Hanford, Washington, and one in Livingston, Louisiana. Detection of near-simultaneous signals at the two distant observatories will give assurance that gravitational waves have been detected.

David wrote: "I am the son of a Chinese-American immigrant. I was not a bona fide foreign student though often mistaken for one. (We should be sensitive to this difference. Confusing one with the other is disrespectful to the people involved.) My wife Anna was a UMass librarian. My son, born in Amherst, received a Ph.D. in chemistry. My life at UMass Amherst was memorable, and I still long for the serene small-town Amherst life. None of my physics education was a waste, including my summer experiences at the Indiana University cyclotron, my time at the cryogenics Magnet Lab at MIT, in addition to the intensive Ph.D. work on optics at UMass Amherst. What was learned from these experiences all came together later in my productive years, and I am happy to have made a substantial contribution to LIGO." (david.wei@lycos.com)

NEW ALUMNI

B.S. Graduates (9/04 and 2/05)

Jonathon R. Dick
John N. Durkee
Russ L. Juskalian
Randal B. Leiter
Matthew J. Maiberger
Adam J. Marquis
Stephen W. Mirigian

M.S. Graduates

Moritz Fragner
Tarek Halabi
Hae Kwong Jeong
Surachate Kalasin
Wenfeng Kang
Christopher Knutson
Mini Puthayathu Kurian
Izabela Santos
Michael Thorn
Wolfgang Unger
Robert Wagner
Josef-Stephan Wenzler

Ph.D. Graduates and Thesis Titles

Balakrishnan Ashok, "Dynamics of Polyelectrolyte Solutions and Diblock Copolymer in an Electric Field"

Ventzi Koptchev, "Study of the rare decay $B \rightarrow X_s \ell^+ \ell^-$ at BaBar"

Moataz Emam, "Calibrated Brane Solutions of M-theory"

Klebert Feitosa, "Inelastic Gas: an experimental study of virbro-fulidized dilute granular media"

Yung Ho Kahng, "Adsorption to Carbon Nanotubes"

GIFTS

WE THANK YOU!

Our dynamic **Chancellor, Dr. John V. Lombardi**, in his usual succinct way of expressing himself, gives his three trademark points as requirements for the University of Massachusetts Amherst to excel: (1) performance counts; (2) money matters; and (3) time is the enemy.

With regard to the first point, we hope that this newsletter gives a sampling of the many activities in our Department, and of one of the ultimate tests of performance, the outstanding success of our graduates. There is a tremendous potential for our Department and this campus. The talent is here, as well as a positive "can do" attitude. But the second point, money does matter, and your past support has helped tremendously. For that **we sincerely thank you.**

We welcome your continued investment in the Department's mission of teaching, research, and public service across the Commonwealth and beyond through tax-deductible donations. If you wish, you may contribute directly to the Department of Physics by making your check out to the University of Massachusetts Amherst, and mailing it to:

Department of Physics
University of Massachusetts Amherst
710 North Pleasant St., Office C
Amherst, MA 01003-9337

Please state that your gift is for the Department of Physics. If its use is not specified, allocations may be made where they are most needed to support the wide variety of research and educational activities such as are reported in this newsletter. On the other hand, if you wish to specify how your gift is to be used, we will honor your request. Furthermore, if you give to the Annual Fund, you can indicate that your support is for the Department of Physics. For your convenience, you can also make your gift online by visiting **www.umass.edu/development**, choosing "Make a Gift Now," and selecting Physics Department from the gift allocation menu. Every gift, no matter the size, will be greatly appreciated.

You also may wish to make a tax deductible *memorial gift*, such as to the LeRoy F. Cook Jr. Memorial Scholarship in Physics. If your donation arrives before June 30, 2005, it will be increased by 50% from state matching funds. Your donation should be mailed to the University of Massachusetts Amherst, Records and Gift Processing, Memorial Hall, 134 Hicks Way, Amherst, MA 01003-9270.

For more information please contact:

Susan Alston, Director of Development
College of Natural Sciences & Mathematics
at **413-577-4712** or
salston@nsm.umass.edu

HONOR ROLL

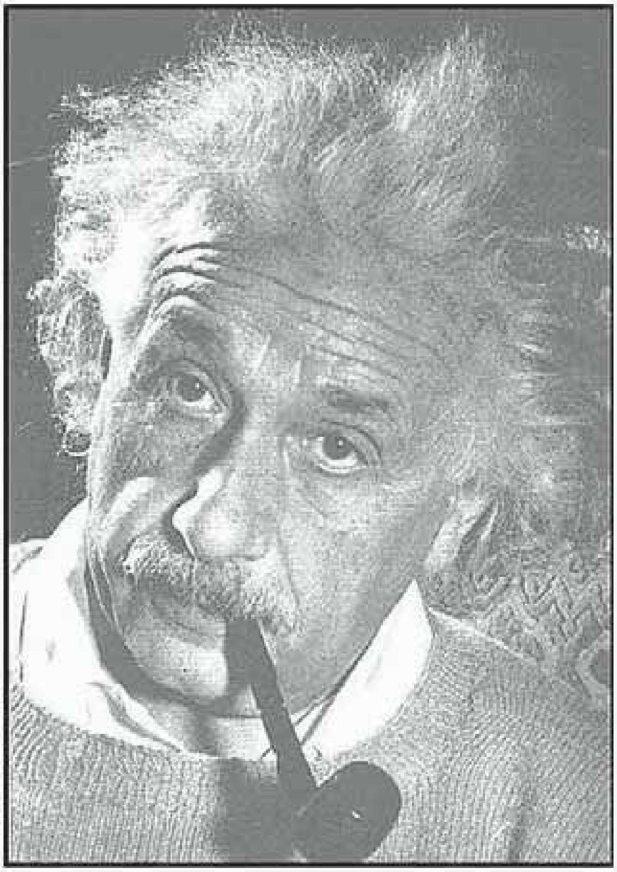
The following "Honor Roll" lists those who contributed to the Department of Physics during the year 2004. We apologize for any omission and request that you bring them to our attention.

Anonymous
Anonymous
Richard C. Anderson, Jr.
Matthew A. Bonn
Elizabeth Brackett
Herbert Brody
Shirley M. Bruno
Phillip C. Catagnus
Scott B. Chase
Benjamin C. Crooker
Thomas S. Daly
Edward F. Demski
Glenn C. Driscoll
Laurence R. Dutton
David T. Ekholm
Christopher B. Emery
George B. Estrella
Robert R Gamache
Paul C. Gardner
Thomas W. Gorczyca
Leroy W. Harding
Evan K. Heller
Richard F. Hollman
Russell A. Hulse
Andrew T. Hyman
Philip T. Kan
Grace M. Kepler
Per & Linda Kirstein
Joseph R Kinard., Jr.
Gary A. Kleiman
Christopher T. Koh
Kleanthes Koniaris
Richard & Denise Lammi
Margaret W. Latimer
James M. Leas
Roger J. Legare
Mark B. Leuschner
Haddon & Lynn Libby
Theodore R. Lundquist
William Anthony Mann
Charles S. Mayo
John & Anne McGovern
Barbara Merrill
Mark N. Messier
Jan Y. Miller
Rebecca C. Mitchell
Steven M. Moore
Alexey A. Petrov
Stanley A. Pulchtopek
Arthur R. Quinton
John R. Rahn
William N. Reynolds
Mary Ann and Tom Ryan
Edwin R. Sapp
George M. Schmiedeshoff
Karen E. Shramko
Thomas J. Slavkovsky
Luther W. Smith
Peter L Smith.
Michael T. Takemori
Jonathan J. Wainer
Edward D. Weinberg

We want to particularly thank:

Philip T. Kan for his especially generous gift. There is a note from Phil in the preceding Alumni News Section.

An anonymous scientific instrument company for a substantial contribution.



The Elderly Einstein

The Legacy of Albert Einstein

The central theme of this newsletter has been the "World Year of Physics" and the impact of **Einstein's** scientific contributions that have changed the world forever. But there are other sides to **Einstein** beside the scientific. He was a pacifist, and having experienced the aftermath of WWI and the rise of Nazism, he fled Germany and protested against militarism. Although he opposed the making of weapons, he knew of the fission of uranium and that it might be possible to use it in new weapons that were many orders of magnitude more powerful than those based on chemical reactions. In August of 1939 he wrote a famous letter to President Franklin Roosevelt that pointed out this possibility, and that the Nazis may have been developing such weapons. This led to the Manhattan project and the development and use of nuclear weapons. He was purported to have said: "The release of nuclear power has changed everything except our way of thinking....the solution to this problem lies in the heart of mankind. If only I had known, I should have become a watchmaker." Into his final days, he continued to be a man of conscience who spoke out against injustice and was an advocate for a peaceful world. If **Einstein** were alive today, no doubt he would speak out against the many injustices that are so evident in our modern world.

Department of Physics
University of Massachusetts Amherst
710 North Pleasant St.
Amherst, MA 01003-9337

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