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Department of Physics Newsletter: Spring 2007

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PHYSICS NEWSLETTER

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INSIDE

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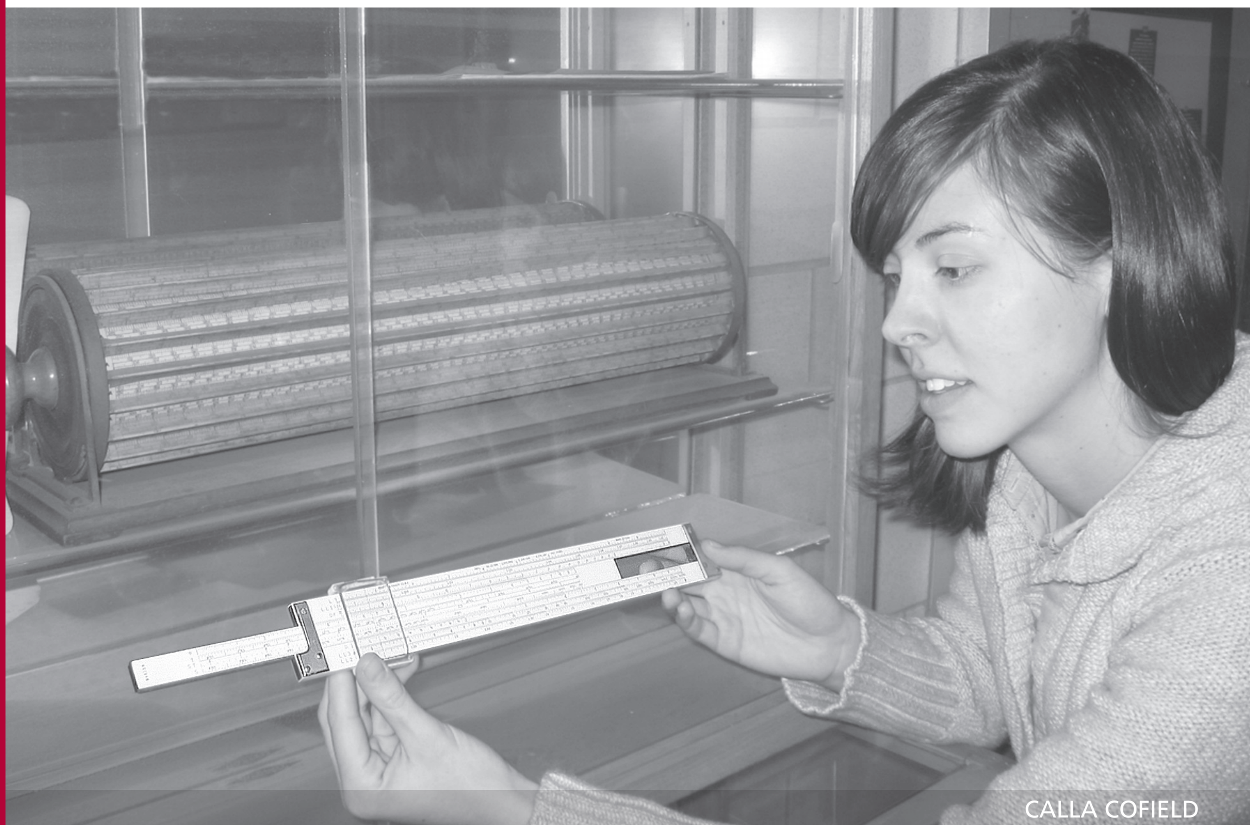

CALLA COFIELD

COMPUTATIONAL PHYSICS

Physics is usually categorized as either being experimental or theoretical. But now computational physics is increasingly recognized as a *third* distinct branch. Some computational physicists are specialists in using computers to carry out simulations of experiments before they are conducted, while others use computers to tackle questions that cannot be answered by using standard theoretical methods. By utilizing the enormous capacity and speed of modern digital computers, problems of great scope, size, and complexity can be pursued. In what follows, we will very briefly touch upon the advances in computer technology that have allowed our Department to move in exciting new directions in both teaching and research.

Professor Emeritus of Computer Science **Conrad (Connie) Wogrin** remembers seeing one of the earliest digital computers that used vacuum tubes when he was a graduate student at Los Alamos in 1950. The amazing advances of the last fifty-seven years, during which time vacuum tube circuitry has been replaced by solid state circuitry, have left Connie with no shortage of material to heighten his fascination with computers. The problems that one couldn't imagine doing on the most powerful computers thirty years ago can now be done on most laptops. A recent APS News article stated that a typical laptop computer today would cost $10 billion if it used vacuum tubes.

Five years before Connie was at Los Alamos, a "computer" was a person who ground out long calculations using slide rules and mechanical calculators. Many of our older readers spent many hours reducing data by using such devices. By 1972, these instruments were being

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Continued/ ***Computational Physics***

replaced by electronic pocket calculators, such as the Hewlett-Packard HP35, capable of evaluating trigonometric and exponential functions. It was priced at $395, which would be more than $1900 in 2007 dollars. Now a more powerful pocket calculator can be purchased for less than $10, and many modern pocket calculators are even programmable.

Connie was in charge of this campus' first computer system. It occupied a single room and could barely handle a few users at a time. Punched cards were used to input programs and store data, and boxes of these 7-3/8 by 3-1/4 inch cards still linger around some UMass Amherst offices today. Initially computer users were mainly from the Physics and Chemistry Departments, but as time went on, a growing number of people found they could utilize computers in their work. Connie was hampered by the high cost of equipment and limitations in accommodating a large number of users. Today the Office of Information Technologies (OIT, headed by former Physics Department Head **John Dubach**) handles the campus-wide computer system that services thousands of users a day. Notwithstanding, to support ever increasing research needs, many departments now maintain computer systems of their own, and some researchers require very large facilities. An extreme example is that of **Stephane Willocq**, who needs a worldwide "Grid" to store and process the enormous amounts of high-energy physics data to be obtained in the next few years. (See his article in the Research Section.)

Professors **Boris Svistunov** and **Nikolay Prokofiev** have utilized the great power of modern computers to create some of the most successful algorithms in computational physics today. Their work deals with highly complex systems that are not easily created in experiment nor fully understood theoretically (See the Research Section). Boris said that computation is involved in about 80% of their work. They contribute to the rapidly growing field of low temperature computational physics by sharing their algorithms through a website, and assisting physicists at other institutions in running simulations.

The growing use of computational methods in physics poses the question of whether or not computers will make other aspects of physics obsolete. Boris and Nikolay agreed that, "Just because you can simulate a system doesn't mean you understand it.

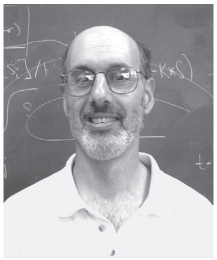
On the Cover: Author **Calla Cofield** examines some museum pieces outside of the Hasbrouck Introductory Physics Laboratories: a slide rule and Thatcher's Calculating Instrument. Like many undergraduates, she had never held a slide rule before. Nevertheless, typical of the younger generation, she is very computer savvy.

Our departmental computer cluster: 72 cpu's are connected in parallel to achieve high speed. These are used in the research programs of Boris Svistunov, Nikolay Prokofiev, and Jon Machta.

And understanding is the goal." Despite the power that computational simulations offer to physicists, shortcomings are also clear: simulations are far less complex than nature, and scientists are never fully certain they've accounted for every detail of the natural system they are simulating. (See **Jon Machta** 's article in the Research Section.) In addition, while some problems are too complex for theoretical calculations, others are too complex to be simulated. It is clear that computational physics will never replace actual experiment.

If you graduated from UMass Amherst less than nine years ago, you'll remember Computational Physics as a required sophomore-level course. Today undergraduates in this course exhibit a wide range of previous experience in writing algorithms, which reflects the increasingly common use of programs like MatLab and Mathematica. (See the Teaching Section). Department Head Jon Machta explained that the course was developed to be implemented early in the curriculum so that students could use computational methods to solve problems throughout their undergraduate careers. Jon says he wants to see even more junior and senior level undergraduate courses embody computational physics.

Research and course work must include computational physics in today's physics world, but real experiments will always be needed. UMass Amherst aims to stay at the forefront of new developments and emerging trends. Thus it has embraced computational physics, and continues to pursue the best resources for its faculty and students.
Calla Cofield (B.S. '07)



Dear Friends and Alumni of the Department of Physics,

The sounds of heavy equipment can be heard all around campus. Not since the 1970s has there been so much construction and renovation on campus. It is inspiring to think about how much better the campus will be in a few years when the projects are completed. The largest of the academic buildings in the current round of construction is the Integrated Sciences Building, which is now a hole in the ground across the street from the Hasbrouck Lab. The 155,500 square foot building will house teaching laboratories, and will be a home for interdisciplinary research in the life sciences.

We are very excited that five young physicists will be joining the Physics Faculty this year. The first to arrive in January was **Benny Davidovitch**, a soft-matter theorist. Benny received his Ph.D. at the Weizmann Institute in Israel and was a postdoc at Exxon Mobil and Harvard. In September, **Jennifer Ross**, **Chris Santangelo**, **Egor Babaev** and **Laura Cadonati** will all come to campus. Chris and Jennifer are husband and wife. Chris works in theoretical condensed matter and polymer physics, and Jennifer is an experimental biological physicist. Both received their Ph.D.'s at UC Santa Barbara and were postdocs at the University of Pennsylvania. Jennifer Ross is our first hire in experimental biological physics and will occupy newly renovated lab space on the third floor of Hasbrouck. Egor Babaev does theoretical condensed matter physics and quantum many-body theory. He received his Ph.D. from the University of Uppsala in Sweden and was a postdoc at Cornell. Laura Cadonati works on the LIGO Gravity wave experiment. She received her Ph.D. at Princeton and was a postdoc at MIT.

Congratulations to **Nikolay Prokofiev** and **Jennie Traschen**! Both were elected Fellows of the American Physical Society this year. Nikolay was acknowledged for "pioneering contributions to theories of dissipative quantum dynamics and for innovative Monte Carlo approaches to quantum and classical studies of critical phenomena." Jenny was cited for "her ground-breaking contributions to early universe cosmology and black hole physics." I would also like to congratulate **Tony Dinsmore** for his award of tenure and promotion to Associate Professor. Finally, best wishes to **Bob Guyer**, who retired last year and has moved to New Mexico. His presence on the fourth floor of Hasbrouck is sorely missed.

Among the many exciting research activities in the Department I'd like to mention two that you can read about in this newsletter. In the area of high-energy physics, our group is playing an increasingly prominent part in the world's premier particle accelerator, the Large Hadron Collider (LHC). **Stephane Willocq** is Chair of the U.S. ATLAS Analysis Support Group, the umbrella organization for the US role in analyzing the flood of data soon to emerge from the ATLAS detector. Although UMass Amherst has only two senior scientists out of many hundreds in the collaboration, our LHC team of Stephane and **Carlo Dallapiccola** plays a much more central role than the numbers would suggest. The second research area is supersolidity. The discovery of supersolidity in Helium-4 only three years ago has led to intense activity in the low temperature and condensed matter communities. **Nikolay Prokofiev**, **Boris Svistunov**, and their collaborators are the leading theorists in the area, and were the first to propose and explore the idea that supersolidity arises from crystal defects. Their advanced quantum Monte Carlo algorithms allow them to do first principle, realistic simulations of helium to explore these ideas. Experiments in **Bob Hallock's** lab are on the verge of testing some properties of supersolids.

Dean **George Langford** has embarked on an ambitious plan for the College of Natural Science and Mathematics that is built around a set of Initiatives. The Physics Department will be at the center of several of the College Initiatives including computational modeling, nanoscience, and the origin of the universe.

The Department of Physics combined forces last May with the Fine Arts Center to create a multimedia, multidisciplinary set of events called Critical Mass. These events included a public lecture on Einstein's discoveries by **Guy Blaylock**. Guy and **Heath Hatch** also installed fascinating physics demonstrations in the lobby of the Fine Arts Center, and Guy's spectacular set of physics related photographs were shown in the Student Center Gallery. The whole week raised awareness of Physics in the campus community.

I would like to thank everyone who has donated to the Department during the past year. Your gifts are essential to the health of the Department. Donations helped create new experiments for teaching labs including optics experiments in the introductory labs, and a new intermediate lab experiment created by **Rory Miskimen** on quantum entanglement. The Department is especially grateful to **Dandamudi Rao** (Ph.D. '72). His very generous gift endows the Dandamudi Rao Scholarship in Biological Physics that will help support the thesis research of promising graduate students in biological physics.

Sincerely,

Jon Machta, Department Head
machta@physics.umass.edu

Editors' Note: Jon very recently decided to relinquish his Headship as of August 31, 2007, in order to give more attention to his research, largely in computational condensed matter physics. We deeply appreciate Jon's devotion to the Department and thank him for a job well done. A search for his replacement is underway.

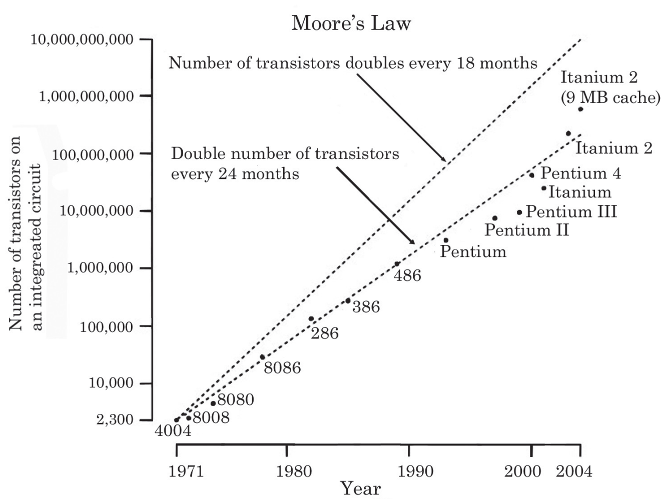
Research

COMPUTATIONAL STATISTICAL PHYSICS

Jon Machta

Statistical physics is concerned with the emergent properties of systems composed of many interacting components. An emergent property is a property that is not defined for the individual components of the system but appears only in the collective behavior of the whole. The viscosity of a fluid is a simple example of an emergent property. It is not a meaningful concept for a single molecule, but appears in the hydrodynamic behavior of many molecules interacting to form a fluid. Frequently these emergent properties cannot be understood analytically and are only accessible via large-scale computer simulations.

Computational studies in statistical physics date back to the dawn of the computer era. One of the first, and still most important computer algorithms, was introduced by Metropolis et al. in 1953 to simulate systems in statistical mechanics. However, in those early days, theory and experiment were much more important than computation, while today it can be argued that the three have equal status.



Moore's Law. Over the last thirty years, in a typical integrated circuit, the number of transistors doubled every 24 months; that number is now about 1 billion (10^9) times greater than it was in 1970. Can it go on forever?

In 2003, I participated in a conference marking the 50th anniversary of the Metropolis Algorithm, one of the core ideas in computational statistical physics. It is a general procedure for simulating the equilibrium states of a system by making a sequence of small changes that are chosen according to Boltzmann's famous factor $e^{-E/kT}$, where E is the energy of the system, T the temperature, and k Boltzmann's constant. After many of these small changes are made, the model system is guaranteed to be in equilibrium, and data about the equilibrium state is collected. Although one could, in principle, use the Metropolis algorithm with pencil and paper, in practice millions of elementary steps are needed to get accurate results, and using the algorithm is only feasible on a fast digital computer. The conference provided an opportunity to reflect on the explosive growth of computing power and the profound changes it has wrought in science. The growth in computing power is summarized by Moore's Law, one form of which states that computing power is doubling roughly every two years.

The consequences for science and society of the exponential increase in computing power have been profound. The laptop I used to write this article has far greater computational power than the mainframe my meteorologist father proudly took me to see 45 years ago. That machine was among the most powerful in the world. It filled a large room and was used by the United States Weather Bureau to prepare the national forecast.

While the explosion of computing power is evident to all of us, a subtler feature of the computer revolution is the discovery of ever more powerful and efficient algorithms for simulating complex physical systems. Indeed, improvements in hardware have been matched by improvements in software. One of my research interests is the development of algorithms for simulating systems undergoing phase transitions. The venerable Metropolis algorithm remains the general-purpose workhorse of computational statistical physics (and many other fields), but it is very inefficient when applied to systems that are undergoing phase transitions. This problem is called critical slowing down and is the same problem that faces experimentalists studying critical systems--near the critical points it take a very long time to reach equilibrium. In the 1980's and 1990's a new class of algorithms was developed that mostly overcomes critical slowing down and has revolutionized the study and understanding of critical phenomena. My research group has developed, analyzed, and deployed these new algorithms. One of the algorithms we developed, the invaded cluster algorithm, not only greatly accelerates the approach to equilibrium, but also automatically finds the critical point.

Although phase transitions in many systems are now well-understood, glassy systems have yet to be cracked by either theoretical or computational techniques. Glassy systems range from window glass, to magnetic systems with impurities, to gridlocked traffic in Manhattan. The unifying theme is "frustration," here meaning not the mental state of the drivers in a traffic jam, but the inability to simultaneously satisfy all the constraints in the system. Glassy and frustrated systems typically have slow dynamics and require extremely long times to reach equilibrium. Neither the Metropolis algorithm, nor the newer accelerated algorithms that work so well at critical points are able to perform realistic simulations of glassy systems. My group has had some success using some new algorithms to study a particular model glassy system, the random field Ising model.

The study of algorithms for simulating physical systems has led me to investigate some deeper and more speculative questions. Why are some systems so much harder than others to simulate? Does the difficulty of simulating a system tell us something about it? Similar questions are also raised in the well-developed area of theoretical computer science known as computational complexity theory. I have enjoyed collaborating with computer scientists and applying the ideas developed in computational complexity theory to the question of how difficult it is to simulate various physical systems. One of the conclusions of these studies is that systems that are difficult to simulate are often systems that we intuitively consider to be physically complex. The relationship between physical complexity and computational complexity is one of my longstanding interests.

Computational science is taking its place along side theory and experiment as an equal partner in the effort to understand the natural world. A simulation of a complex system may yield quite unexpected results that were not anticipated by either theory or experiment. It is a great field for student involvement: It's easy to find model systems that undergraduates can simulate, and yet are on the forefront of research and defy theoretical understanding. It is also an exciting field because of the promise that problems that seem too difficult today will soon be brought within reach by the ever-increasing power of computers and the algorithms running on them.

*Editor's note: our Department Head, **Jon Machta**, not only manages the Department, but he continues to actively pursue and direct research in statistical physics. In recent years his research focus has shifted mainly to computational statistical physics.*

CONDENSED MATTER THEORY

Nikolay Prokofiev and Boris Svistunov

The hallmark of modern quantum statistics is emergent phenomena (see the previous article by Jon Machta), such as superfluidity. At ordinary temperatures and pressures, helium is a gas that can be used to fill balloons, or at very low temperatures, to cool the MRI scanning machines in hospitals. At low enough temperatures, helium atoms "get together" into a new "superfluid" state in which all the atoms flow together without friction. Both helium atoms and photons have integer spin and are bosons: there can be many in one state. The superfluid state is analogous to the classical electromagnetic field of a laser where there is phase coherence. On the other hand, neutrons are fermions with half-integer spin, and there can be only one per state. However, in a neutron star, neutrons also coalesce into a "super" state because they can form composite bosons. (Electrons, which are half-integer spin fermions, can "get together" to form "Cooper pairs" in metals, giving rise to the phenomenon called superconductivity. This has many applications, such as for maglev trains, high-field magnets, and accelerator waveguides.)

Nikolay Prokofiev and Boris Svistunov work in adjoining offices on the fourth floor of Hasbrouck, surrounded by offices of condensed matter experimentalists and graduate students. Nikolay came to us in 1999, and Boris in 2003 (See the spring 2002 and 2005 issues of this Newsletter.) They are well known for their work on "Monte Carlo approaches to quantum systems."

How can both fermions and bosons display similar emergent phenomena? Liquid helium, neutron stars, and superconducting metals are all many-body systems and in general an analytical first-principle description is not possible. In special cases there are theories for how particles "get together" (e.g., "Cooper pairs" in superconductivity), but as yet no general understanding of both the boson and the fermion cases. In principle the thermodynamic functions of any system can be calculated by carrying out a sum over the system's quantum states (the "partition function"), but such a sum can be calculated analytically only in a few special cases. Even direct numerical calculation is impossible or at least formidable.

Boris and Nikolay use a trick in which a sum over quantum eigenstates is replaced by a sum over abstract mathematical diagrams in four-dimensional space, the fourth dimension

Continued/ ***Condensed Matter Theory***

being an imaginary time related to temperature. (This is a generalization of Feynman's interpretation of the quantum wave function as a sum over trajectories in real space.) For bosons, such as those in a ^{4}He superfluid, each such diagram is similar to the set of curves on the blackboard behind Boris and Nikolay in Fig. 1.

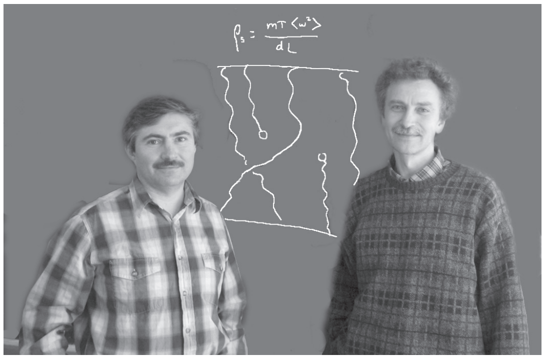


Fig. 1. The drawing on the board behind Boris (on the left) and Nikolay shows "trajectories" of an abstract classical system, which is equivalent to an actual quantum system of bosons, and can be used to calculate thermodynamic properties of the quantum system.

Any particular configuration of curves has no direct physical meaning. Nevertheless, an integral over all possible loops with proper weights is exactly equal to the value of the quantum-mechanical partition function, from which all thermodynamic properties can be calculated.

The quantum-to-classical mapping for neutron matter is even more abstract. To form a "super" state, fermions have to first interact to form composite bosons. The classical equivalent of the equilibrium quantum system is an ensemble of diagrams like the one shown in Fig. 2, for which the trajectories have been integrated out and are not seen. Thus the interactions are represented by the vertices, which are plotted in real space versus the fourth dimension. The arrows are reminders that originally each vertex belonged to two trajectories, analogous to those in Fig. 1. Integrating out the trajectories is the key trick for fermionic systems like neutron stars.

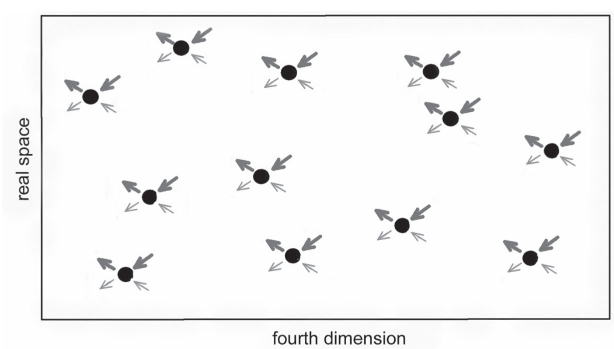


Fig. 2. Diagrams like this one represent the equilibrium statistical properties of neutron matter. Think of fermions which interact only at the vertices; the trajectories connecting vertices have been integrated out, as suggested by the arrows. To get the statistical properties of the actual quantum system, one needs to sum over all arrangements of vertices.

If the classical equivalent of a quantum equilibrium system can be found, then the rest of the job is done by the Monte Carlo technique, which is a method, loosely speaking, of simulating the statistics of classical objects by throwing dice. Basically, one starts with an arbitrary initial configuration of the classical system, generates a set of random numbers that define some way of modifying the configuration, and then either accepts or rejects the modification, depending on the random numbers generated and on the weights of the initial and new configurations. Repeating this procedure many times leads to the statistics of the classical system, and that in turn reproduces the statistics of the original quantum system! Nikolay, Boris, and their collaborators have developed novel Monte Carlo algorithms for simulating ^{4}He and neutron matter, as well as the lattice and continuous-space systems of ultra-cold atoms. Visit their research website for more information (http://montecarlo.csi.cuny.edu/umass/).

COMPUTING IN HIGH ENERGY PHYSICS

Stephane Willocq

Professor Stéphane Willocq is muon reconstruction co-coordinator for the ATLAS detector at CERN's Large Hadron Collider, and chairs the US ATLAS Analysis Support Group. Here he describes this high energy physics research program, and the need for vast computational capacities to process the enormous amounts of data to be produced.

High Energy Physics (HEP) research aims to uncover the most fundamental constituents of matter and their interactions, as well as explore the properties of space and time. HEP experiments typically involve smashing high-energy beams of electrons or protons onto stationary targets, or bringing these beams to head-on collision inside sophisticated particle detectors. The next big particle accelerator to begin operation is the Large Hadron Collider (LHC) currently under construction at CERN, the European Laboratory for Particle Physics in Geneva, Switzerland. The LHC will collide proton beams at unprecedented energies of 7 TeV per beam (1 Tera electron Volt = 10^{12} eV). This new collider will allow the exploration of matter and its interactions at energy scales about one order of magnitude higher than

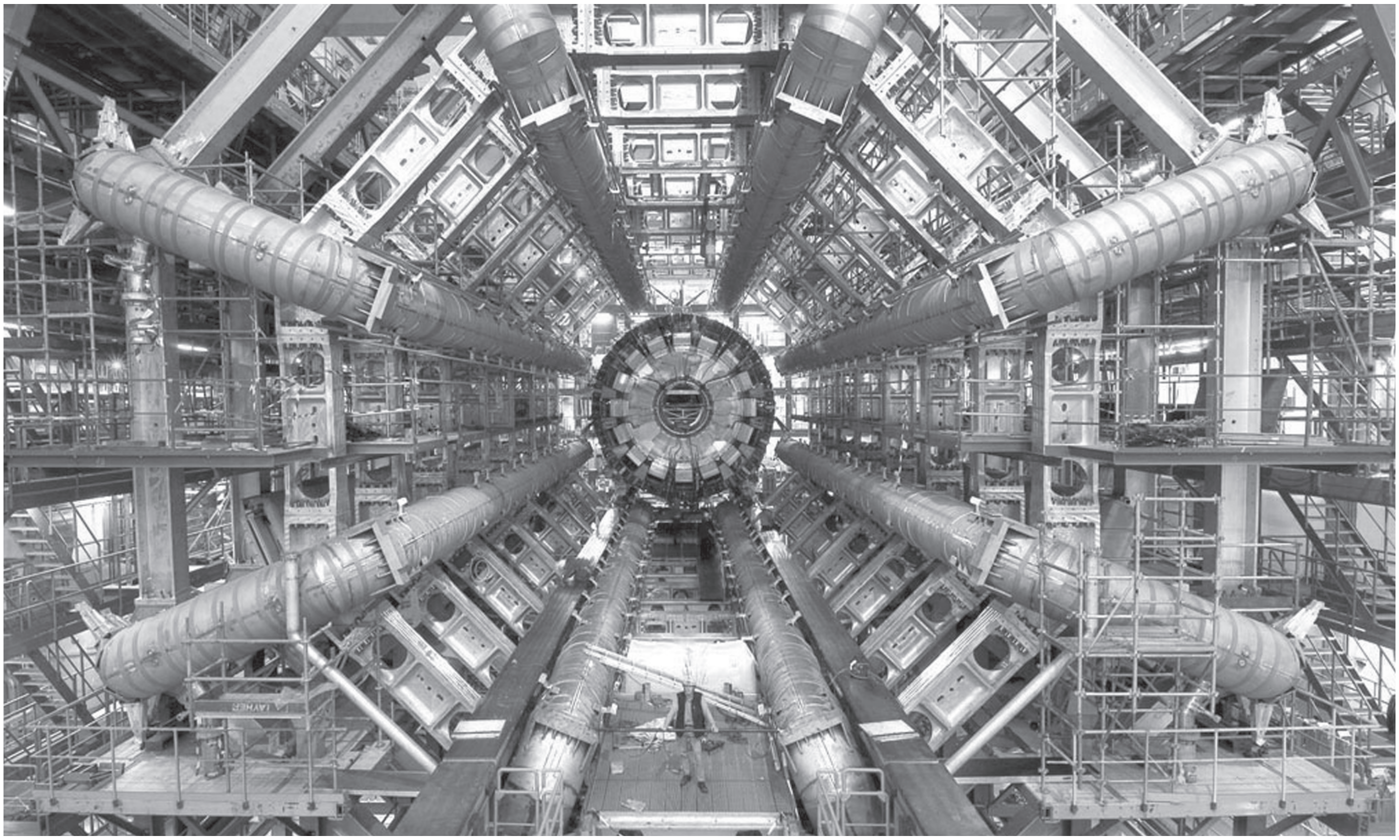


Fig. 1. Superconducting coils providing the toroidal magnetic field for the ATLAS Muon Spectrometer (credit: CERN). For a sense of scale, notice the man in center-bottom of the figure.

previously attainable. LHC operations are expected to begin at the end of 2007, and last for over a decade. It is widely anticipated that some long-standing issues with the Standard Model of particle physics will be resolved.

The most important issue is whether the Higgs boson exists. The ATLAS collaboration will try to find this long sought-after particle, referred to by Nobel Laureate Leon Lederman as "The God Particle," because it is hypothesized to give mass to the universe. Just as the photon is the quantum of the electromagnetic field, the Higgs boson is the quantum of the Higgs field reputedly permeating all space. In order to understand how a particle might acquire mass, an analogy may be drawn to an electron moving through a crystal lattice. The electron acquires an apparent larger mass, an effective mass, by interacting with the field of the positively charged ions in the crystal. Similarly it is thought that particles acquire mass by moving through the Higgs field, the larger their interactions, the larger their masses.

The quest to understand Nature at its most fundamental level requires not only high-energy particle beams, but also ever-larger data samples to hunt for the typically rare subset of interactions of interest. For example, the ATLAS detector will record the products of proton-proton collisions occurring every 25 nanoseconds. This yields an expected event rate of one billion events every second. However, most of these interactions are mundane proton-proton elastic scattering events. In contrast, Higgs bosons are expected to be produced at the rate of only about 0.5 events every second. To reject most of the events, while keeping events that may be Higgs boson candidates or other hard-scattering interactions, a three-level trigger system has been designed. This system examines the energy deposition and charged-particle trajectories recorded by the detector to determine whether each beam crossing is of interest. The first-level trigger is performed with programmable electronics mounted on the detector whereas the second- and third-level triggers are carried out by fast dedicated software. The initial 40 MHz detected input event rate is thus reduced to a more manageable 200 Hz output rate to tape. The next processing phase occurs offline to reconstruct physics analysis objects (electrons, muons, taus, neutrinos, quark jets) from the raw data. Part of the analysis involves examining the output of the event reconstruction with so-called "event displays" (see Fig. 2).

Continued/ ***Computing in High Energy Physics***

Following the above example of the ATLAS experiment, it is clear that the trigger software is a critical part of such a project. Dealing with the large anticipated data volume is another critical aspect of the experiment. Given that the size of a typical event is about 2 MBytes, the total amount of data produced in a year is expected to be about 10 PBytes (1 PetaByte = 10^{15} Bytes). Handling such large data samples poses a serious challenge both from the point of view of data storage and access, and from the point of view of data processing. To adequately process and analyze such samples, a total CPU power equivalent to the power of 24,000 Pentium-4 processors will be required.

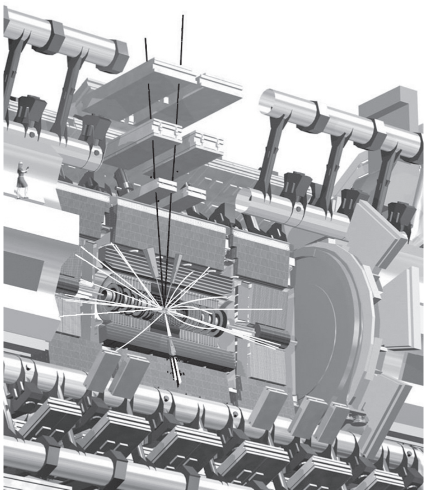


Fig. 2 Display of a simulated pp collision with production of a Higgs boson in the ATLAS detector. The Higgs boson here decays into two muons (dark lines going up through the detector) and two electrons (grey cones near the muons). Other particles produced in the collision are also shown.

The centralized computing model used so far for HEP experiments is unable to cope with the enormous data storage and processing needs of the ATLAS and the other three large experiments that will operate at the LHC. Therefore, a new computing model, referred to as "the Grid," had to be conceived. This new concept calls for both data storage and data processing to be distributed around the globe. In such a model, data is divided into subsets and stored at computing centers around the world. A user needing access to a particular subset of data will then rely on grid tools to export his or her analysis software to the remote site where the data is located. Processing will then take place at the remote site and the output made available to the user for final analysis. In this approach, physicists can submit jobs to the grid from any location.

A new era of computing for High Energy Physics has begun as physicists prepare to meet the challenge of handling and processing the enormous data volume from the LHC later this decade.

Teaching

GRADUATE PROGRAM

New Monte Carlo Methods Course

Professor Nikolay Prokofiev has developed a new course on Monte Carlo methods in quantum statistics that offers a systematic introduction to one of the most powerful and versatile numerical techniques for large complex systems. (See the related article in Research.) Monte Carlo methods can be applied to solve virtually any problem where the system can be in any one of many possible states, and one is interested in finding some appropriately averaged system property. Important applications can be found in the natural sciences, engineering, behavioral studies, and finance.

The course starts with a short introduction to probability theory and algorithms for generating random numbers. This introduction is followed by the theory of Monte Carlo sampling techniques such as the cluster, invaded cluster, histogram, multiple histogram, entropic, tempering, or parallel tempering approaches. The main text for this part of the course is Monte Carlo Methods in Statistical Physics by Newman and Barkema, which offers good coverage of classical methods developed prior to 1999. However, in the course less emphasis is given to the discussion of programming tricks used in writing codes, and more to recent state-of-the-art algorithmic developments such as the Worm Algorithm and the Wang-Landau version of entropic sampling.

The last part of the course deals with quantum Monte Carlo methods. Since there are as yet no textbooks which cover significant recent developments in the field, students study lecture notes and research papers to understand (i) when and how quantum mechanical problems can be mapped to classical ones, (ii) what simulation objects and their states emerge from the mapping, and (iii) which methods are best suited for the efficient sampling of the resulting configuration space. The students start with variational and diffusion Monte Carlo methods for simulations of zero temperature ground state properties, then move to the Feynman path-integral representation of quantum mechanics and diagrammatic expansions, and conclude with a discussion of the most efficient modern methods used to work with path-integrals and diagrams.

UNDERGRADUATE PROGRAM

Computational Physics Course (P281)

When you think back to your undergraduate experience in physics, you realize that most of your courses dealt with theory. The application of the theory was presented as one or more equations used to describe physical phenomena, and analytical methods of calculus were used to solve these equations. The problems were very idealized and simplified versions of "real life" situations. Numbers entered into a problem only after the analytical solutions were achieved. More realistic problems were not encountered until you were past undergraduate work. By then, either the boundary conditions were so complicated that you could not use the usual methods for solving the relevant equations, or the problems were so complicated that they could not be expressed in simple equations.

For the past few years the sophomore–junior level course Computational Physics (P281) has been offered to UMass Amherst physics majors. The course attacks realistic problems using computational and numerical techniques. The students use computer methods to solve problems that cannot easily be solved with pencil and paper, or even good hand calculators. The course was created by **Jon Machta**, who used the Mathematica©[1] software package. More recently, we have been using the MATLAB©[2] package, which is designed around manipulations of matrices.

The course consists of two sections, one taught by a Physics Department faculty member (currently **Monroe Rabin**), and the other by an Astronomy Department faculty member (**Peter Schloerb**). Each section is run as a laboratory course, which meets for two hours twice a week in a room with 22 computers. Students are given a series of in-class problems to get them acquainted with the techniques being studied, and then are responsible for a set of homework problems. Computer codes are handed in and evaluated by the instructor.

The following descriptions of assigned homework problems from the physics section of the course help give a better flavor of the course content.

1. Use a random number generator to solve the Monty Hall problem: There are three doors, behind one of which is a prize. You guess which door contains the prize. Before that door is opened, one of the other doors is opened and shown not to hide the prize. You now have a chance to change your guess. Is it advantageous to stick with your original choice, or to change to other unopened door?

2. Calculate the trajectory of baseballs hit at various velocities and angles when air resistance is included; calculate the trajectories of pitched baseballs, including curveballs.

3. Investigate the Lotka–Volterra description of predator–prey populations.

4. Investigate the chaotic solutions of non-linear differential equations.

5. Determine the equilibrium state of a system of series and parallel springs.

6. Investigate the temporal variation of the carbon dioxide concentration over Hawaii and Alaska for a span of 10 years using fast Fourier transforms.

The material covered changes a bit from year to year, according to the interests of the faculty teaching the course. This keeps the course constantly fresh and interesting for both the instructors and the students. Additional topics that may be covered in the future are: solutions to partial differential equations, relaxation methods, Monte Carlo modeling methods, fitting data sets with non–linear mathematical functions, and image manipulation and analysis methods.

The computers used by Computational Physics have been in the room for a number of years, they frequently break down, and by today's standards are quite slow (300 or 400 MHz). As a result, some of the simulations cannot be carried out in the detail we would like. We are hoping to update the apparatus, and would appreciate any help that Alumni can provide. We are looking into the possibility of obtaining matching funds from the Dean's Office. The entire upgrade could be accomplished for a bit less than $20K.

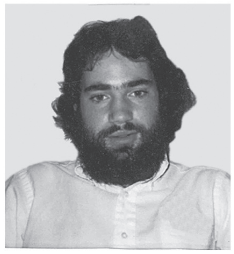
[1] Mathematica is a product of Wolfram Research
[2] MATLAB is a product of The MathWorks, Inc.

Graduate Students

OLD AND NEW

Graduated 1986

Bill Barowy



Geoffrey Feldman

Langton Garvin

Stefan Kilmt

Sudha Murthy

Thomas Sotirelis

Hwei Mei Yang

Entered 2006

Back Row: Hunter King, Benjamin Ett, Craig Versek, Marge Abbe', Preema Pais, Jaime Hutchison, Lee Quan Pei, Dong Chen
Front Row: Bo Peng, Hubert Hafner, Katie McNamara, Ebru Yalcin, Annabelle Ke, Dominique Cambou, Jackson Feng

Outreach and Service

CRITICAL MASS

Mass Ensemble (http://www.massensemble.com) is a performance group that blends sculpture, music, dance and the performance arts. Their show, "*Critical Mass,*" was inspired by Einstein's science and had its week premier at UMass Amherst in April 2006. Art and science have much in common. In our Department, **Guy Blaylock** and **Heath Hatch** organized a number of activities during the week, including an image exhibit at the Student Union, demonstrations at the Fine Arts Center, and a lecture given by Guy on "Einstein made (relatively) simple." Einstein made towering contributions to physics, but it may be argued that he was first and foremost an artist.

Trami Li (B.S. '06) plays the "Earth Harp." The strings are not plucked like those of a conventional harp or guitar. Instead, the steel strings are stroked along their lengths by a sticky rosin-coated glove to produce a compression which gives rise to a longitudinal standing wave, just like a "singing rod" you may have seen in a lecture demonstration. The pitch (frequency) is determined by the length of the string and by the speed of sound within the string, not by the tension on the string. The effective length of the string is set by the position of the termination that connects it to the supporting cable, which is anchored to the roof of the Fine Arts Center.The supporting cable plays no role in the physics of the vibrating string.

The images which had been hung in the Student Union Gallery may be seen on the website http://courses.umass.edu/critmass/index.html.

The demonstrations were selected to not only demonstrate physics principles, but also to be vivid. Some were set up for the whole week; others were shown by the Physics Student Outreach Club at specific times. During the week, a huge "Earth Harp" was set up outside the Fine Arts Center, with strings reaching down from the top of the building to a platform at ground level. Passersby were free to play on it; more formal performances were also given.

Another one of the demonstrations was a "Cosmo Walk" from the "sun" at the Fine Arts Center to the Student Union Gallery, with the relative positions of planets marked along the way. The Department plans to put some of these demonstrations on permanent display in the main foyer of Hasbrouck.

Outreach to Local Schools

STEM RAYS

Student interest in science peaks in the third grade at about 90 percent. By the ninth grade it plummets to 20 percent. The National Science Foundation wants to know if "out of schools" programs can help. It has awarded $800,000 to Science, Technology, Engineering, and Mathematics Research Academies for Young Scientists (STEM RAYS) to develop after-school and summer research programs for grade 4-8 students in Franklin County. Among the hands-on activities are studies of air quality, birds, arsenic in the environment, watersheds, and weather prediction. UMass Amherst is the lead partner along with Greenfield Community College, and **Mort Sternheim** is one of the principal investigators. Other partners are Smith College, Franklin County's eight school districts, local businesses, and informal science organizations. More information and pictures can be found at www.umassk12.net/rays.

People

NEW FACULTY

Dr. Benny Davidovitch graduated from the Weizmann Institute in Israel. Before joining our department he was a postdoctoral fellow at Exxon-Mobil Research and Engineering (NJ), and a lecturer in applied math in the Division of Engineering and Applied Science at Harvard University. His research interests are in the behavior of macroscopic systems far from equilibrium. Examples are growing crystal dendrites, evolving bacterial colonies, lightning sparks, the regular patterns of sand dunes or zebra stripes, and the characteristic patterns by which various materials, from solids to complex fluids, yield under applied stress. Equilibrium states, such as the familiar solid, liquid, and gas, or the more exotic states of liquid crystals or plasmas, can be understood in terms of the principle of "maximum entropy." For non-equilibrium systems, there have been many theoretical and experimental studies, but these efforts have left many basic questions unsolved.

Benny Davidovitch

Benny's work has been focused on developing theoretical tools to study the behavior of non-equilibrium patterns. Together with his collaborators (mainly in the Weizmann Inst. and MIT) he applied a mathematical concept, known as "conformal maps," to study models for planar growth phenomena in which the kinetics is limited by slow diffusion processes. Such models typically give rise to fractal shapes, such as those in ice and manganese dendrites, or in bacterial colonies. They showed that the fractal dimension (which characterizes the asymptotic shape) can be predicted from the dynamics of patterns at their early stage of growth, and introduced efficient computational methods to calculate other subtle morphological properties, which had been previously inaccessible. These methods led to a conceptual link between random and deterministic dynamics, both types giving rise to similar fractal patterns. Later, they showed how this formalism could be extended to describe patterns whose growth kinetics is not limited by diffusion rates but rather by other types of transport.

A rock buried underground is a somewhat surprising example of non-equilibrium physics: like a colloidal gel, such a rock is porous and the pores typically coarsen with time, a fact that is important in understanding oil fields. At Exxon-Mobil, Benny and his collaborators studied model equations, analyzing their stability and obtaining estimates of typical coarsening times.

At Harvard Benny became interested in particular patterns, known as shear bands, which emerge in complex fluids, such as colloidal suspensions and liquid crystals. The shear-induced formation of such a band strongly resembles a thermodynamic phase transformation. Yet, proper study of shear banding phenomena requires conceptual tools that are different from the classical ones, such as the Maxwell equal area construction. By studying shear banding under oscillatory shear, Benny and his collaborators showed that it is possible that the emergent shear bands correspond to different thermodynamics phases of the sheared material, although it is unlikely that thermodynamics can predict the volumes of the various bands. In addition, Benny began working on application of pattern formation techniques to gain and improve control of technological processes, in particular nano-structuring of solid surfaces by ion beam sputtering.

Experiments in non-equilibrium physics are being actively carried out in the Department of Physics and elsewhere on campus. These include, for example, experiments on granular systems, on crystallization kinetics in colloidal systems, and various dynamical phenomena in biological systems. Benny intends to continue his theoretical studies in this field, and plans to develop close collaborations with various labs at UMass Amherst.

BOB GUYER RETIRES

UMass Amherst has said farewell to one of its most colorful and productive professors, Robert Guyer. Bob retired at the end of the spring semester of 2006 after many years of studying a wide range of subjects in condensed matter physics, from neutron stars to phonon hydrodynamics. He said he will miss the exchange of ideas in the high-quality interactions with the students and faculty in the condensed matter program. "They are a good group of people to work with, who made a great environment in which to spend the last thirty-seven years."

Bob had a gift for seeing things in a simple, physical way, and was able to communicate ideas clearly to both theorists and experimentalists. He was the man you went to when you had a question.

Bob got his Ph.D. at Cornell and then had sojourns at Duke and Harvard before coming to UMass Amherst in 1969. He will continue to split his time between the Los Alamos National Laboratory, where he works with geophysicists on environmental problems, and the University of Nevada-Reno, where he works with graduate students.

STAFF

Kris Reopell

Kris Reopell is on the 11th floor of the Lederle Graduate Research Tower, where her main responsibility is taking care of undergraduate scheduling. Every time a course is to be scheduled, an exam to be given, a room to be found, it has to go through Kris. If a student needs to take an undergraduate lab, but the lab is officially full, he or she comes to Kris and asks for special dispensation. (Your editor suspects she usually gives it.) She also administers the course evaluations that students fill out near the end of each semester, and records and analyzes the results. Additionally, she is secretary for the nuclear and high-energy programs.

Kris lives in Ware, about a half an hour east of Amherst, with her husband, who also works at UMass Amherst. In addition to being New England Patriot and Boston Red Sox fans, they also watch the basketball games of the Memphis Grizzlies whenever possible – that's because their son Brett is events marketing director of the team. Daughter Trisha is Systems Manager for Housing at UMass Dartmouth.

Kris is an avid gardener. She takes care of over 100 perennials and says iris, clematis, purple coneflowers, and black-eyed Susan's are some of her favorites. When winter doesn't allow gardening, she spends her spare time crocheting and reading.

Jane Knapp

Jane Knapp came to us in the summer of 1999 and has responsibility for and looks after our graduate students (and all administrative aspects of the graduate program). Of the approximately seventy-five graduate students, one third are American, one third Chinese, and one third of other international backgrounds. Jane gets about twenty-five emails a day asking for help and information – such as "How do I get the bus?", "Why did I not get my TA pay last week?", "On the application, what do they mean by…?", or "What do I do next?" By the time new grad students arrive on campus, they already "know" Jane. Besides working with the Graduate Program Director and the Chairs of the graduate committees, she also takes care of assigning office space, finding desks, as well as helping navigate through all the rules and regulations on the road to a graduate degree…a full time job!

Jane has two daughters, one in the Nursing Program at UMass Amherst, and another majoring in Finance at the University of Vermont. She and her husband live just north of Amherst, in Sunderland, where she volunteers with the Sunderland Women's club.

Comments

Comments about the newsletter, or information about yourself for our alumni news section, may be e-mailed to **newsletter@physics.umass.edu**, or sent to:

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

Our newsletter is sent to more than 1,260 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 **www.physics.umass.edu**.

Awards

GLOVER STUDENTSHIP

Calla Cofield (B.S. '07) has been awarded the Glover Studentship by the American Physical Society. She will give a presentation before the Forum on the History of Physics at the April meeting of the APS in Jacksonville, Florida. Her presentation is entitled, "Heisenberg: Paralleling Scientific and Historical Methods."

FELLOW OF THE AMERICAN PHYSICAL SOCIETY

Yury Kolomensky (Ph.D. '97), Associate Professor of Physics at the University of California, Berkeley, was elected a Fellow of the American Physical Society at age 33 for his significant contributions of elucidating the spin structure of the nucleon, the electroweak theory, and B-meson physics.

NEAGEP FELLOWSHIP

Edgardo Ortiz, a candidate for the Ph.D. degree, received a fellowship from the Northeast Alliance for Graduate Education and the Professoriate (NEAGEP) to pay expenses for his first and last year of graduate studies. He and his wife, Suleika Medina, a doctoral student in chemistry, are natives of Puerto Rico. With NEAGEP funding, this spring Ortiz and Medina will tour colleges and universities in Puerto Rico to recruit applicants for graduate programs.

CAREER AWARD

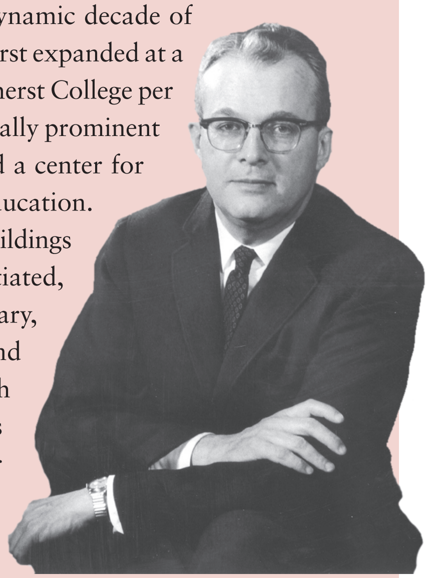
Alexey Petrov (Ph.D. '97), a tenured associate professor of particle physics at Wayne State University, was awarded a National Science Foundation Faculty Early Development (CAREER) Award.

DEAN'S BIOMEDICAL INITIATIVE

Professor **Tony Dinsmore** was selected as a winner of the Dean's Biomedical Initiative for his work on "Measurement of Curvature Induced Forces on Membrane Proteins." The work was done in collaboration with Professor Robert Weis of Chemistry.

Lederle Left Lasting Mark

John W. Lederle, who served as President of the University of Massachusetts from 1960 to 1970, died February 13, 2007, at the age of 94 in Naples, Florida. More than any other person, he played the largest role in shaping the Amherst campus as it looks today. During most of the "dynamic decade of the '60s," UMass Amherst expanded at a rate of roughly one Amherst College per year to become a nationally prominent research university, and a center for excellence in higher education. Forty-five major new buildings were constructed or initiated, such as the DuBois Library, the Campus Center, and the Graduate Research Center named in his honor. The number of faculty grew from 366 to 1157, salaries nearly doubled, and the number of students more than tripled as the academic program expanded, particularly at the graduate level. During his tenure the Research Computing Center was established, as well as the Polymer Research Institute, the Five-College collaborative, the University Press, and the public radio station, WFCR. The budget grew by 700 percent to over $100 million. While Lederle was President of the University System, the medical school opened in Worcester in 1962, and the Boston campus in 1964. He was able to recruit an unusually competent staff headed by Chancellor **Oswald Tippo**.

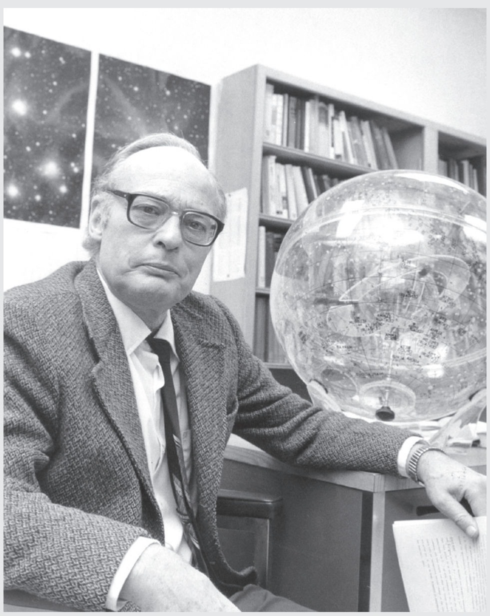


Lederle received his Ph.D. from the University of Michigan. He practiced law, became a professor of political science at Brown University, and then returned to the University of Michigan before coming to UMass Amherst. After his retirement in 1970, Lederle was honored with an appointment to the Joseph B. Ely Chair in Government.

In Memoriam

Dorothy Grannis, 67, of Amherst died at home on July 6. She received a degree from Cornell and was involved in data analysis and computer programming at UC Berkeley in the early 60s, and then at UMass Amherst until 1973 where she worked in the bubble-chamber group on the third floor of Hasbrouck. She later undertook a wide range of activities, including urban planning, small-business ownership, work with the Music Department and the Amherst Ballet Theater, and the Dakin Animal Shelter. She will be remembered for her intelligence and wit by all of the faculty and students who interacted with her, and by the high standards of her work.

Edward R. (Ted) Harrison, Emeritus Distinguished University Professor of Physics and Astronomy, died on January 29, 2007, near his retirement home in Tucson, Arizona. He was one of the founders of the Astronomy program within the (then) Department of Physics and Astronomy in 1966. He also played a major role in achieving international recognition for the Five-College Astronomy Department, which links the University to Amherst, Hampshire, Smith, and Mount Holyoke Colleges.



Ted was born January 8, 1919, in London, England. His education at Sir John Cass College at London University was interrupted by the Second World War, during which he served for six years with the British Army in various campaigns, ultimately acting as Radar Adviser to the Northern Area of the Egyptian Army. It was during the latter service that he met his wife Photeni.

Ted's primary interests were cosmology and astrophysics, but during his career he published over 200 papers that in addition ranged over topics from plasma and high-energy physics to physical chemistry and astrobiology. Probably his most recognized scientific contribution was on the growth of fluctuations in the early expanding universe and his identification of several of the key processes in galaxy formation, work which later became known as the Harrison-Zeldovich spectrum of density fluctuations.

Ted had a very intuitive and physical approach to scientific problems. The latter became the bane of generations of graduate students, who might find themselves asked on their physics qualifying exams to calculate "the length of a wild goose chase" (how far do YOU think a goose can fly on a meal?), or "the inductance of a wedding ring." He was also an erudite popularizer of cosmology through his books, *Masks of the Universe* and *Darkness at Night*, and his monograph *Cosmology: The Science of the Universe*.

Alumni News

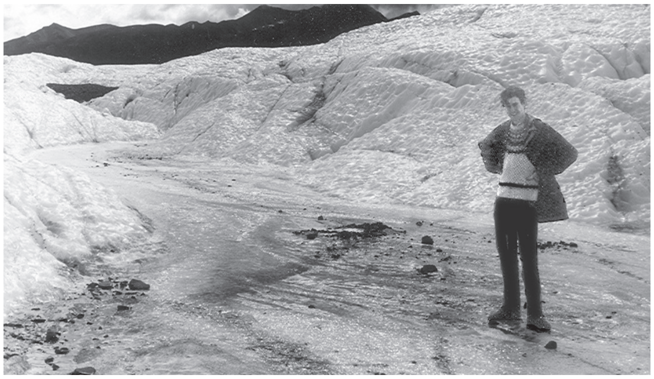
Cara Battersby (B.S.'06) writes: "Upon graduating from UMass Amherst with a double major in physics and astronomy, I did what any student would do if he or she were unsure of what they wanted to do in the real world...I went to graduate school. I am currently a first-year graduate student in the Boston University Astronomy Department. I have been fortunate to be this year's Presidential Fellow in the Astronomy Department, and therefore have no explicit teaching or research responsibilities, but plenty of motivation to reach a decision about my career aspirations.

Since arriving at Boston University, I have kindled an interest in physics and astronomy education research and in public outreach. Busy though I am, with three graduate courses, I have become involved in several Education and Public Outreach projects, including one for a NASA mission, and a couple of small local projects. I am writing several proposals (NSF, NASA GSRP) to engage in astronomy education research with three interested and experienced faculty members, one in each of the Departments of Astronomy, Physics, and Education. I am also working on a more traditional astronomy research project with Professor Jim Jackson using multi-wavelength Spitzer data to investigate new objects in the galactic plane. While I still do not know what the future holds for my career, I have begun down a path that I find interesting, important and challenging. A career, like life, is a journey, not a destination, and I am doing everything I can now to pursue my professional passions." (carabean @bu.edu)

"Gravitation cannot be held responsible for people falling in love. How on earth can you explain in terms of chemistry and physics so important a biological phenomenon as first love? Put your hand on a stove for a minute and it seems like an hour. Sit with that special girl for an hour and it seems like a minute. That's relativity."

Albert Einstein

Justin Armstrong (B.S. Physics, B.A. Math '92) writes: "My first job out of college involved optics. I worked for a time as an optician and lab manager for a large eyeglass chain. There I developed and taught an optics course to optician apprentices throughout the company. After a while the hectic pace and stress of this job led me to look for work in computer programming, a skill that I had honed during various physics and astronomy internships, both at UMass Amherst and other institutions. Currently



On a glacier in the Wrangell Mountains, Alaska, during my summer internship at the Geophysical Institute where Prof. Swift's brother works.

I work for MEDITECH developing software for hospitals in the U.S., Canada, and the U.K. The application I am currently developing assists doctors in writing prescriptions, tracking diagnostics and procedures, and alerts the user to drug interactions and patient allergies."

Armstrong family photo from a few years ago.

"Personal life: I have been married since December 1993, and have one son who is now 10. My son is also very interested in science, math, violin, and computers. We live in the Boston area. I would love to get in touch with fellow physics majors to find out how they are." (jarmstrong@meditech.com)

Joan Centrella (B.S. '75) graduated with a major in Astronomy back in the days when we were a Department of Physics and Astronomy. She was awarded a Marshall Fellowship and went on to get a Ph.D. from Cambridge University. Following postdoctoral appointments at the University of Texas and the University of Illinois, she joined the faculty of Drexel University in the Physics Department. In 2001, she moved to NASA's Goddard Space Flight Center to join their newly-formed gravitational wave astrophysics group, where she leads their source modeling and numerical relativity effort in support of LISA ("Laser Interferometer Space Antenna"). In 2004 she became head of the Gravitational Astrophysics Laboratory, which encompasses the gravitational wave and theoretical astrophysics groups at Goddard. Her research interests include black hole mergers, gravitational waves, numerical relativity, structure formation, and cosmology.

Joan Centrella and some of her co-workers at the Goddard Space Flight Center.

Light has been our window on the universe; gravitational waves are expected to open a new window, and LISA (together with other observatories) will look out. The big question is: "What do we expect to see?" One of the many possibilities is the merger of black holes, which should lead to an intense flash of radiation, including a burst of gravitational waves. The details are too much for analytic solution; this is a problem that at the present time can only be addressed by computer simulations ("numerical relativity"). Joan, a leader in this field, says, "These mergers are by far the most powerful events occurring in the universe, with each one generating more energy than all of the stars in the universe combined."

An idea that has been confirmed by the numerical simulations is that when unequal black holes merge, they can get a kick that can eject them from the halo in which they formed, with interesting consequences for cosmology. Her work has been widely recognized. On May 2, 2006, she was featured in the *Science Times* cover story in the *New York Times*. There have also been articles in *Aviation Week* and *Science* magazines. Here are some URL's:

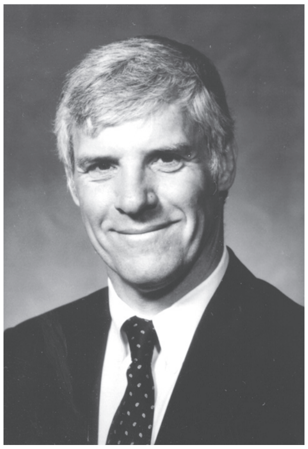
http://www.nasa.gov/vision/universe/starsgalaxies/gwave.html

http://sciencenow.sciencemag.org/cgi/content/full/2006/418/2

http://gsfctechnology.gsfc.nasa.gov/newsletter/Spr_06_TechTrends_FINAL.pdf

Joan.Centrella@nasa.gov

Willard Jule (Ph.D. '73) has had an interesting and successful career in the world of physics and business. His Ph.D. on the electromagnetic fields of wave guides led to his work at Los Alamos on a project whose goal was to upgrade their proton linear accelerator to achieve an average current of 1 mA. He enjoyed the stimulating work environment, but after four years, during a sunny day on a dock in a bay in Ontario, where he was attending a conference, he met an engineer from New England Nuclear, a company that produced radioisotopes using cyclotrons that did not have high reliability. They were interested in building a more reliable proton linear accelerator.



Willard Jule

The end result was that Willard went to New England Nuclear where he headed a project to design and build a 40 MeV proton linac having a record breaking current of 5 mA. They were successful, but before going into production, the company was bought by DuPont, and the project mothballed.

Willard stayed at DuPont, becoming production manager for all radiopharmaceuticals. Then, in another transition, he went to DuPont's Savannah River Lab, which did all the physics and engineering to support the operation of the production nuclear reactors. SRL also did the research to change the reactor core configurations and the hydraulics to increase the production capacity of the reactors.

In the late 80s DuPont decided to cease operation of the Savannah River plant, so Willard started a very successful consulting business, Success Resources of Atlanta, which concentrates on the healthcare industry. March 31 is the 13th anniversary of the founding of this business.

Willard says, "All of my success stems directly from my education in physics at UMass Amherst. The most important thing I learned was how to learn. Having the ability to go into any situation and acquire the necessary knowledge and skills has enabled me to be successful in my various pursuits. I have noticed that one of the characteristics of successful people is that they have this ability to learn and create value with that learning."

"I am now in my second marriage. We are very happy with five children (all college grads), three granddaughters, and a Cavalier King Charles spaniel. We live in the suburbs of Atlanta where we are currently enjoying the spring profusion of azaleas, oriental magnolias, dogwoods, and myriad other flowers and flowering trees and shrubs."

Willard Jule (center) at National Masters Judo Championship

"Finally, while I was at UMass Amherst I began practicing judo. After I left, I was away from this sport for 20 years. However, when I moved to Atlanta and began our business, I also took up judo practice again. In 2001, I was rewarded for years of practice by winning a National Masters Judo Championship. This is just one more example of how a learning strategy pays off." (sratlanta@bigplanet.com)

"I think physicists are the Peter Pans of the human race. They never grow up and they keep their curiosity."

Isidor Isaac Rabi

"Even for the physicist the description in plain language will be a criterion of the degree of understanding that has been reached."

Werner Heisenberg

A CLASS REUNION

by Richard Kofler, Professor Emeritus

After retirement in 2001, following a 35-year research and teaching career in our Department, I have often reminisced about the highlights of that career. The class that always came to mind as the most memorable was the physics major introductory course (Physics 171 and 172 at the time) that I taught in the 1976-77 academic year. It was my first time teaching that course and I was determined to teach a course that was demanding but still stimulating and enjoyable for the students. I kept the lectures rather interactive and utilized as many demonstrations as could be assembled with the equipment available. My part of the Department had just moved into the Lederle Graduate Research Tower (LGRT) and exams, discussion sessions, and occasional class parties were held in the tenth floor classroom/lounge. The exams were open book with no time limit other than student exhaustion. On the first exam, thinking students would take 2 to 2 ½ hours, I was surprised to find students still looking for inspiration more than 4 to 5 hours later! On succeeding exams I felt compelled to supply coffee, soda and cookies. One of the students came to an exam with a pillow and dressed in pajamas!

Front Row: Robby Siegel, Prof. Kofler, Elizabeth Brackett, Paul Makinen
Back Row: John Ferreira, Diane Tessaglia-Hymes, Doug Alden, Walter Buchwald

Fondly remembering many of the students from that class, I often longed to see them again and catch up on developments in their lives. So I was more than pleased to receive an email from several of those students suggesting that we attempt to reassemble the class for a reunion. We were able to find addresses for only half of the class and discovered that those class members were spread out all over the country. Nevertheless, seven of the students (and significant others) came back to Amherst for a mini-reunion on the weekend of September 29, one of them from as far as Houston, Texas. A dinner on Friday night allowed all of us to get reacquainted. On Saturday night we had a pizza party in the tenth floor lounge (LGRT 1033) and reminisced. For old times sake, I gave a mini-exam and was surprised that all conversation stopped as the (former) students took it seriously. We enjoyed watching a short 1976 film comedy that parodied the activities of the Department. One of the students, Robby Siegel, a part time and very talented singer/songwriter, brought his guitar and entertained us with a number of his compositions (www.robsiegel.com). It was a delightful evening, and like the exams of old, lasted almost to midnight. The reunion ended with a brunch at the Lord Jeffrey Inn on Sunday morning.

One of the finest rewards from an academic career is the knowledge that you played a positive role in the professional development or personal lives of your former students. I was very much touched by the enthusiasm these students still had for a course they took 30 years ago.

Editor's note: Here are some comments from Dick's former students that may be found at www.robsiegel.com/physics_reunion.htm. "Remember the Six Hour Long Exams? Remember Kofler on the bed of nails? Remember the best class you had at UMass Amherst? For many of us, 30 years later, Honors General Physics with Dick Kofler stands out as the "I never worked so hard, I never had so much fun, I never had a professor so dedicated" class. Did it spoil us for the remaining three years? Probably. Was it the stuff of legend? Absolutely!" For his outstanding teaching, Dick was the second *member of the Department to receive the University Distinguished Teaching Award.*

The very first University Distinguished Teaching Award was made to Professor Bill Ross in 1962, which brings to mind still another Bill Ross story (see the '04 and '05 Newsletters for others). Bill had a way of focusing his students' attention that was a bit unusual to say the least. If he perceived a lack of attention to his lecture, he would do a backwards-standing high jump onto the stone table at the front of the lecture hall while continuing to face the class. The loud crash of his shoes on the table, plus his then domineering stature above the class, assured student concentration.

Note added in proof: this year Professor Guy Blaylock won the Distinguished Teacher Award.

Clay Holdsworth (B.S. '96) writes: After getting mathematics and physics degrees from UMass Amherst, I went to UCLA for an M.S. and a Ph.D. in biomedical physics. Graduate school was very difficult and not nearly as social or enjoyable as UMass Amherst (Go UMass!). While at UCLA, I developed a Monte Carlo simulation of Positron Emission Tomography (PET) scanners. The final product was a user-friendly computer program that in four minutes could simulate PET scans more accurately than the original program, which took 24 hours. With this high-speed simulation, the field now has a tool that can look at PET results very rapidly.

Clay Holdsworth

After six arduous years at UCLA, I began a postdoc at Brigham and Women's Hospital in Boston. Within a year I was hired as a faculty medical physicist at the Dana Farber Cancer Institute. I also continued research on clinical applications of the Monte Carlo simulation that I developed in graduate school, and developed criteria, based on statistical analyses, for determining which patients would react positively to a new form of chemotherapy and which should be put on a different drug. I was the first to discover that as long as tumors did not grow in the first month, patients should remain on the drug and expect successful treatment for years to come.

I left the medical physicist position to become a professor at the Massachusetts College of Pharmacy and Health Sciences. Directly helping people and interacting with students was much more fun than working in a lab. The office hours were especially rewarding, but the lecture format, particularly for large groups of students who wanted to be pharmacologists, not physicists or mathematicians, was less than ideal. Something had to change, and I left this position last spring.

I have used my statistical knowledge to develop an algorithm for playing poker. After a brief, lucrative, but somehow unrewarding stint as a professional poker player, I left the tables to find something a little more fulfilling. Currently I consult, primarily for research involving programming and statistical analysis with applications in physics, medicine, and finance (anyone at UMass Amherst interested?) and am in the process of starting a business in real estate. (clayholdsworth@yahoo.com)

Xiayou Yang (Ph.D. '04) was a graduate student in Prof. Don Candela's group. For his thesis he studied granular media using a sophisticated Magnetic Resonance Imaging (MRI) apparatus that he had built together with other students. [Editor's note: In MRI a strong but non-uniform magnetic field is applied to a sample, e.g. a biological or granular one. Appropriate electromagnetic pulses induce precession of nuclear spins (typically protons) about the field, with the frequency of precession depending on position in the sample. Analysis of the signals picked up by detection coils leads to maps, or images, showing the spatial distribution of the precessing nuclei.] Design and construction of the pick-up coils is crucial to success, and this has become Dr. Yang's expertise.

Dr. Yang writes us that before completing his thesis he worked for a start-up company ("USA Instruments, or USAI") that supplied MRI coils worldwide. He said: "This company was acquired by GEMedical System (GEMS) in Dec. 2002. I became a project leader soon after the acquisition. My major role at USAI had been to lead MRI coil development in the engineering department until the coils became marketable products. During the first two years of working I really struggled a lot between a demanding job and finishing my dissertation. Fortunately I finished the dissertation, with much help from Prof. Candela, in Dec. 2003, and received my Ph.D. in Feb. 2004.

In September 2005 I resigned from USAI, and was recruited as senior research associate by Prof. Robert Brown in the Case Western Reserve University Physics Department. Since then I have joined a startup MRI coil-company as VP and engineering manager.

Besides industrial R&D development, I have also been active in the International Society of Magnetic Resonance in Medicine (ISMRM). I have regularly submitted abstracts to the annual meeting of ISMRM during the past five years. I also gave an invited lecture on reviewing several major devices of MRI coils in the annual meeting this year. Right now I have several patents pending in the area of MRI coil design.

All of the training and knowledge I received from Dr. Candela have been very important in my career development. I benefit from them everyday. Life goes so fast. I will always be grateful for my five years at UMass Amherst." (Xiaoyu_Yang2003@yahoo.com)

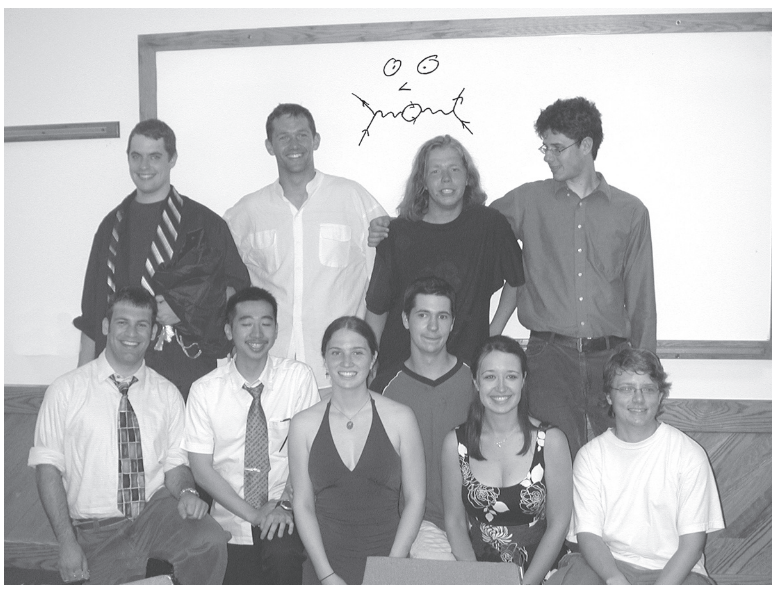
New Alumni

Degrees awarded since Spring 2006 Newsletter

B.S. Degrees			
Cara D. Battersby	Jared B. Howenstine	Victor J. Quinn	Albert F. Smith
Jason F. Cahoon	David B. Lawrence	Christopher M. Roberts	Andrea S. Tinney
James Crosby	Haui-Ti Lin	Kevin T. Sheridan	Kyle J. Thompson
Patrick B. Dragon	Robert D. Lychev	Edward J. Slavich	David J. Valcourt

M.S. Degrees			
Peter Grima	Xiangdong Gu	Christopher Jones	Neil Naik
Robin Plachy			

Ph.D. Degrees	Thesis Title	Advisor
Evgeni Burovski	Simulations of Strongly-Interacting Fermion Systems	Prokofiev/ Svistunov
Lisa J. Kaufman	Precision Measurement of the Proton Neutral Weak Form Factors at $Q^2 \sim 0.1\ GeV^2$	Kumar
Dwight Luhman	Studies of Helium Films on Disordered and Patterned Substrates	Hallock
Kevin McCarthy	Charge Transport at the Nanoscale: Experimental and Numerical Methods	Tuominen
Deepak Kumar Singh	The Physics of Nanoscopic Metal Rings and Honeycombs	Tuominen



At a reception for the newly graduated seniors in May, 2006, several posed before a fanciful Feynman diagram. Pictured from left to right are:

Kneeling: Christopher Serino, Huai-Ti Lin, Cara Battersby, Kyle Thompson, Andrea Tinney, Rob Jasperson
Standing: David Lawrence, James Crosby, Christopher Roberts, Edward Slavich

New Biophysics Fellowship

Dandamudi V. Rao (Ph.D.'72) has made a very generous donation to endow a graduate fellowship in biophysics. Dr. Rao has had a distinguished career as a Professor of Radiology and Director of Radiation Research at the University of Medicine and Dentistry of New Jersey, where he authored four books on nuclear medicine, written many chapters and reports on nuclear medicine, and has given numerous invited talks on medical biophysics, as well as receiving many awards both in the U.S. and abroad. He writes: "During the years '68 to '72, I worked very closely with Profs. Kandula Sastry and Bill Gerace. Both were highly professional and very understanding and supportive as were all of the professors in the Department. I have fond memories of my education at UMass Amherst. I was the first student to leave the Department in 1972 to pursue a career in the field of biological physics, so it is fitting that this gift support a graduate student in that area. It is a small way to show my gratitude for the wonderful time I had at UMass Amherst." The Department would like to extend its deepest gratitude for this generous gift.

Gifts

Thank you!!

Your generous contributions to the Department are greatly appreciated and are vital to our success. The days are long past when we could carry out our mission by relying only on state and federal funding. Private giving by our friends and alumni is essential for us to maintain and improve the quality of our teaching and research. Since our last Newsletter, your support has helped to set up physics demonstrations and to display physics related artwork at the Fine Arts Center. It has also helped to build a new experiment on "gamma ray quantum entanglement" in the Intermediate Lab; it has sent an undergraduate student to the University of New Hampshire to interview Professor Heisenberg about his father Werner Heisenberg; and it has financed a field trip to the Boston Museum of Science for students in the PSCITAP program. (PSCITAP is a program that encourages physics majors to live on the same floor of a dormitory and to interact with each other.)

To Make a Donation

Visit our Physics donation page at www.physics.umass.edu/donate/ for information and a link to the online donations site of the University of Massachusetts Amherst. Please follow the instructions carefully to ensure that your gift is directed to teaching and research in the Department of Physics.

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The Development Office
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Please contact the NSM Development Office with questions.
Voice: 413.545.0974
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web: www.umass.edu/development.

Donation questions specific to our Department may be directed to the Head's Office at 413.545.2545.

Honor Roll

This Honor Roll lists those who contributed to the Department of Physics from January 1, 2006, to December 31, 2006. We apologize for any omissions and request that you bring them to our attention.

Michael Azure
Elizabeth Brackett
Siu-Kau Chan
Edward Chang
Scott Chase
Dansong Chen
Christopher Davis
Edward Demski
George DeVere
John Donoghue
Laurence Dutton
Christopher & Carol Emery
Frederic Fahey
Klebert Feitosa
Robert & Rebecca Galkiewicz
Robert Gamache
Douglas & Carol Gregor
Robert & Nancy Hallock
Leroy Harding
Marion Haupert
Evan Heller
Rudolf Hergenrother
Pamela Houmere
Julie Johnson
Grace Kepler
Kurt Ketola
Per & Linda Kirstein
Christopher Koh
Yury Kolomensky
Nancy & William Kuchinsky
Richard & Denise Lammi
Brian Lamore
Margaret Latimer
James Leas
Roger Legere
Mark Leuschner
Haddon Libby
Gregory Loring
Margaret Loring
Theodore Lundquist
Jonathan Maps
Cynthia Matley
Charles Mayo
Donald McAllaster
Eugene & Alice Megna
Leonard Mellberg
Barbara Merrill
Mark Messier
Caleb Mills
John & Joyce Mistark
Thomas & Jean Munro
Steven Newton
John O'Donnell
Elizabeth Ouellette
Karen Parker
Marti Peltola
Gerry & Doris Peterson
John Pribram
Keith Quinton
John Rahn
Dandamudi Rao
Shari Richardson
Francesc & Kathleen Roig
Thomas & Mary Ann Ryan
Hajime & Sachiko Sakai
Edwin Sapp
George Schmiedeshoff
James W. Sharrard
Ker-Li Shu
Mary Anne Siegel
Arthur Signorella
Thomas Silvia
Scott Simenas
Mary Skinner
Thomas Slavkofsky
Peter Smart
Peter & Kathryn Smith
Morton & Helen Sternheim
Michael Takemori
George Theofilos
Shahin Toutounchi
Jorge Uribe
Jonathan Wainer
Edward Weinberg
Xiaoyu Yang
Eric Ziese

Matching Gifts

3M Foundation
BTM Capital Corporation
Exelon Corporation
Fidelity Investments
Lockheed Martin Corporation
Raytheon Company

For the past few years, Department Head Jon Machta has taken the new students and other interested people on a hike up Mt. Norwottock. Pictured on the September 2006 hike are (from left to right):

Dong Chen (in front), Don Blair, Ozgur Yavuzcetin, Boris Svistunov, Katie McNamara, Jon Machta, Annabelle Ke, Natalie Imbiar, Ed Chang, Marge Abe', Bo Peng, Nikhil Malvankar, Lei Quan Pei and Stefan Dickert

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