2010

Department of Physics Newsletter: Spring 2010

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PHYSICS NEWSLETTER

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UMASS
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Department of Physics
College of Natural Sciences

INSIDE

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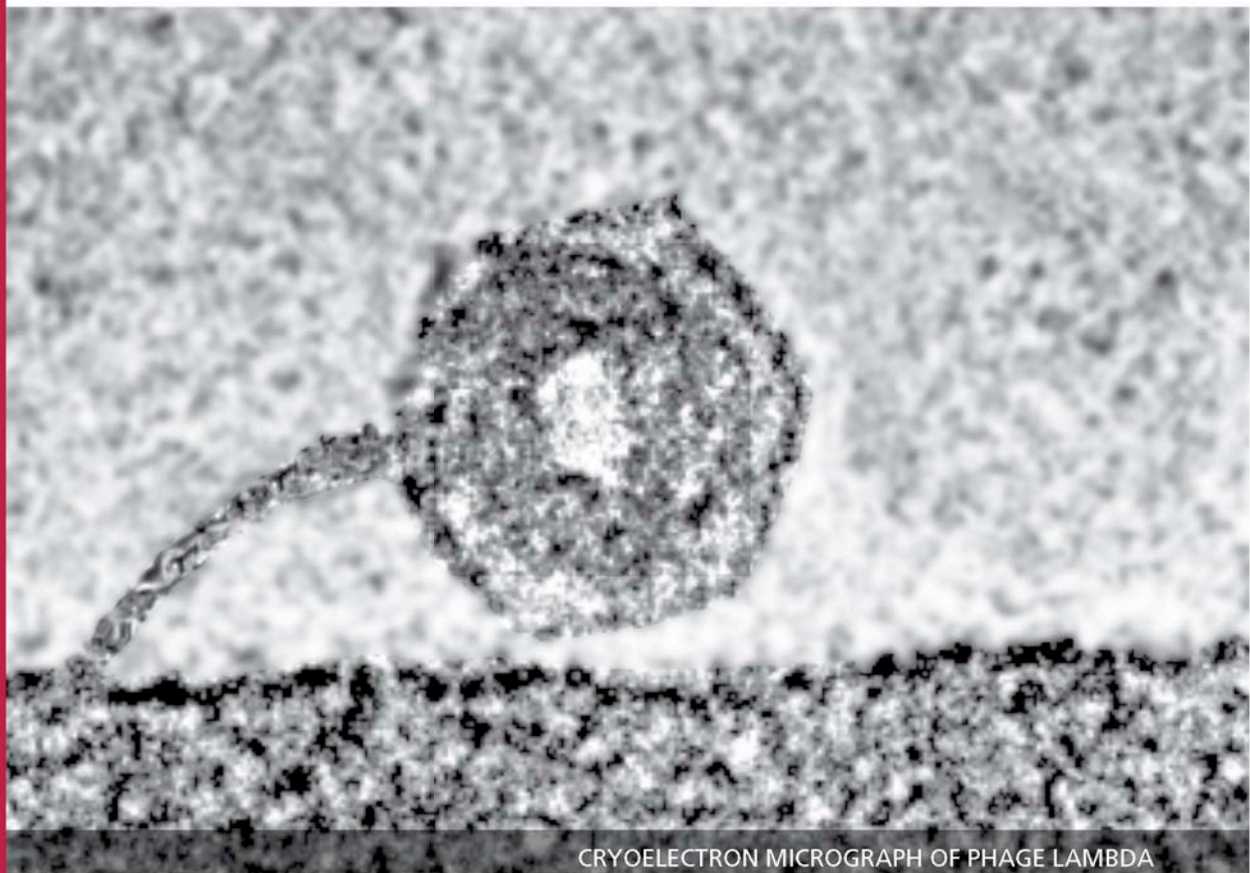


CRYOELECTRON MICROGRAPH OF PHAGE LAMBDA

NEW EMPHASIS ON BIOLOGICAL PHYSICS

Our department has launched a dramatic expansion in the subfield of Biological Physics. Earlier, research on topics related to biology was carried out in the department by Norman Ford, Kenneth Langley, Monroe Rabin, Phil Rosen, and Kandula Sastry. Our present expansion is designed to bring a modern and coherent focus to our efforts in this area. The subject has a long history and has at times been called physical biology, biophysical chemistry, biological physics, or biophysics; but, long before these names were used, Galvani was learning about electricity by observing frog legs twitch, and Helmholtz was intrigued by the act of hearing.

Many scientists think that biological physics unites previously more disjoint subjects, and that physics is learning how to be intellectual friends with many other relevant disciplines. Our university does related science in biology, chemistry, chemical engineering, polymer science, and other fields. We expect to learn from these disciplines, not so much from a common intellectual background, as from a common interest in biological questions that need answers. There are many biological materials, new and old, that need to be understood. The important scientific questions, reflected in large federal support of the "life sciences," provide a unique funding opportunity for biological physics in our department. Physicists can play an important role in answering fundamental questions related to

Continued on page 2

Continued/ ***Cover Story***

the internal dynamics of cells, neural communication, protein folding, and many other processes. In addition, biological physics provides wonderful opportunities for, and is popular with, undergraduate and graduate students.

In support of our new effort in biological physics, several recent faculty additions have been made. Our new colleague Jenny Ross is studying microtubules, but is using new imaging techniques that can be applied to many materials. Lori Goldner is using her physical sophistication with lasers to look at enzymatic reactions in small spaces. Our newest faculty member Adrian Parsegian (see the "New Faculty" page) is learning about physical forces, with origins in, for example, electrostatics, solvation, electrodynamics, and steric hindrance, that organize biomatter and colloids. As an example of such forces at work, shown in the figure is a cryoelectron micrograph of phage (attached to a carbon grid) that has ejected some of its DNA. The DNA that remains inside the phage capsid (~60 nm) has a toroidal structure. The new work Adrian plans to do in the department includes: measuring intermolecular forces among many classes of biological materials such as nucleic acids (e.g., DNA), lipids (e.g., the membranes around cells), proteins, and even polysaccharides, the most abundant materials in the biological world.

The wide scope of our activities in biological physics, both ongoing and planned, should lead to a variety of collaborations on campus and beyond, and hopefully will significantly advance the understanding of our biophysical world.

COLLEGE REORGANIZATION

The Physics Department has a new administrative home. In September 2009 the College of Natural Sciences and Mathematics (NSM) merged with the College of Natural Resources and the Environment (NRE) to form the new College of Natural Sciences (CNS). The Department of Psychology was added to the new college and a few of the former departments in NRE were removed. The merger to create the new college is part of Chancellor Robert Holub's broader strategic framework to elevate "UMass Amherst to the ranks of the very best public research universities in the country." He believes that the powerful new college will be better positioned to compete nationally and internationally and will enable faculty members in the sciences to collaborate more effectively and with fewer administrative constraints.

Steve Goodwin, a microbiologist, and formerly the Dean of NRE, is the Dean of the newly formed CNS, and Jim Kurose, a computer scientist and formerly the Interim Dean of NSM, has joined Dean Goodwin's leadership team as an Associate Dean. Kurose believes that "the integration of the life science and environmental science departments and programs with the physical sciences in a new college is a terrific opportunity to strengthen the campus' current position and promote growth."

The new College of Natural Sciences currently has about 380 tenure-track faculty members, 5500 undergraduates with majors in the college, and 1100 graduate students enrolled in MS or PhD programs. In 2008, the departments that comprise the new college garnered more than $81 million in external research awards from various state and federal agencies.

Professor Emeritus John Brehm resides in Doylestown, Pennsylvania. Here we find him on vacation in Ireland conversing with the poet Patrick Kavanagh, who sat motionless pondering John's remarks.

Dear Alumni and Friends of the Physics Department,

A good theme for this year's newsletter could be: "Making progress and continuing to do what we do best during tough economic times." The UMass Amherst Campus in general, and the Physics Department in particular, are proud to show off new initiatives as well as growth of existing centers of excellence in teaching and research - somewhat like rowing a boat upstream against a current of reduced state support for the University. The analogy is a good one since success depends on strong individual efforts combined with a group spirit to move our department ahead.

Faculty member Stan Hertzbach retired at the end of the 2008-2009 academic year, after a long and distinguished career as a high-energy experimentalist, and more recently, as Undergraduate Advising Dean for the College of Natural Sciences. Offsetting this loss, Dr. Adrian Parsegian has joined the department as our first Robert L. Gluckstern Distinguished Professor of Physics. Adrian adds strength to our growing biological physics group. He was chief of the Laboratory of Physical and Structural Biology at the National Institutes of Health before joining us. You can read a detailed article on Adrian and the biological physics group on the next page.

Due to the budget situation there will be only very limited faculty hiring this year, and a competitive process was set up to determine which departments would be able to fill the small number of new positions available. The focus of the competition was on interdisciplinary areas that span across departmental boundaries, and the biological physics effort meets this requirement very well. I'm happy to report that the Physics Department was one of the successful departments, and as a result, we are searching for a new assistant professor in the area of biological physics to start in September.

Another important growth area for the University and the Physics Department is renewable energy. At the University level, a new, 87% efficient cogeneration (heat and electricity) power plant, and a new science building with many green features (green roof, recycled building materials, rainwater collection) were opened this year. In our department, Professor Mark Tuominen is engaged in projects to enable cheaper and more efficient fuel cells, photovoltaic, and optoelectronic devices. Laboratory space in Hasbrouck is being renovated for a future hire to give us even more strength in these areas.

I am sure that many of our alumni and friends are feeling the pinch of these economic times in their own budgets – but you can be assured that any gifts to the Physics Department you are able to make will have an especially big, positive impact this year. And whether or not you are able to make a monetary contribution, we would be delighted to hear about what you are doing now and the path that led from your time in our department to your present situation.

Sincerely,

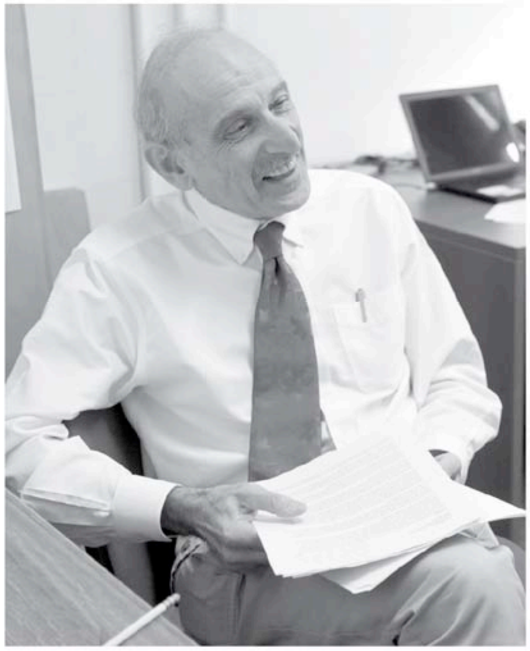
Don Candela, Department Head
head@physics.umass.edu
voice (413)545-1940

Photo by S. Engelsberg

NEW FACULTY

V. ADRIAN PARSEGIAN

Adrian Parsegian, a career researcher at the National Institutes of Health (NIH) was appointed the Robert L. Gluckstern Professor of Physics in the summer of 2009. Here he comments on what drew him to our department and on the research he intends to carry out.



After decades in a federal research institute, I realized that I missed university life. Few places combine the good science and warm friendliness of UMass Amherst. It struck me as the kind or place in which I would be able to continue and expand upon my work. What do I see as that work?

For starters, of course, research. We now have good tools to measure forces between molecules, e.g., to determine the pressure under which DNA is held in a virus, and how tightly cell membranes and proteins pack together. These are biology questions we were able to ask at the NIH, questions of the kind that we can answer here too. But the purview is wider at a university. How about the forces packing polymers? Polymers can be used in the construction of nanoparticles, which are very useful in biological physics.

I got a hint of the possibilities while writing a book on van der Waals forces, which will be part of a series I expect to write here. I was Googling one day and found that Dupont Lab had used our equations and recipes to design a process to make thin film resistors for computers. What a happy moment to see a valuable by-product of something we had done for the love of learning.

The inventor of those resistors is now a friend and collaborator on new projects that we expect to continue for several years. I place great value on friendship in science. It builds naturally into healthy collaboration. Our work measuring forces between and within large molecules can also be expanded into many student projects.

The second component of my work here is teaching. My first teaching assignment was Physics 381 in the fall of 2009, the junior-level writing course. I thoroughly enjoyed it. For spring 2010 I am teaching Physics 850, a graduate course in soft condensed matter physics with an emphasis on intermolecular forces.

My third agenda item is to help to build a program in biological physics. Two excellent colleagues, Jenny Ross and Lori Goldner, preceded me here, and have already built a small biological physics community. We're set to hire two more junior-level biological physicists. Together with soft condensed matter physicists who are already here, we have a thriving community in Hasbrouck. And even better, Hasbrouck is almost surrounded by biologically related sciences in chemistry, polymer science, biochemistry, engineering, and biology. Our ability to reach across boundaries is already clear in research and teaching.

For me there is another outreach resource. I have kept friendships from decades of staying rent-free for weeks or months of collaborative visits. We have already hosted scientists from Australia, Slovenia, Canada, from the UK, and people from my old lab at the NIH. When my wife Val and I downsized to an Amherst condo, she suggested buying a second condo for guests/collaborators. We call it *Casa Fisica*, a place where people can stay for free. This is one more way we plan to build a community of biological physics learning in the Physics Department.

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:

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Our newsletter is sent to more than 1,450 of our alumni and alumnae who received degrees in physics from the 1930s to the present, and to current and former staff and faculty.
For more information about our department, visit our website at www.physics.umass.edu.

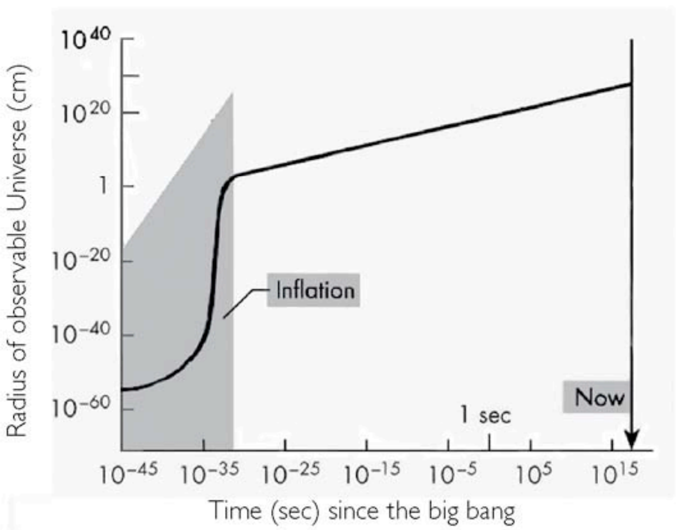
We look forward to hearing from you.

COSMOLOGY, INFLATION, AND THE INFLATON

Professor Lorenzo Sorbo came to our department in 2005 via the International School of Advanced Studies in Trieste. Here he highlights some aspects of the class of problems that he and his theory students are working on.

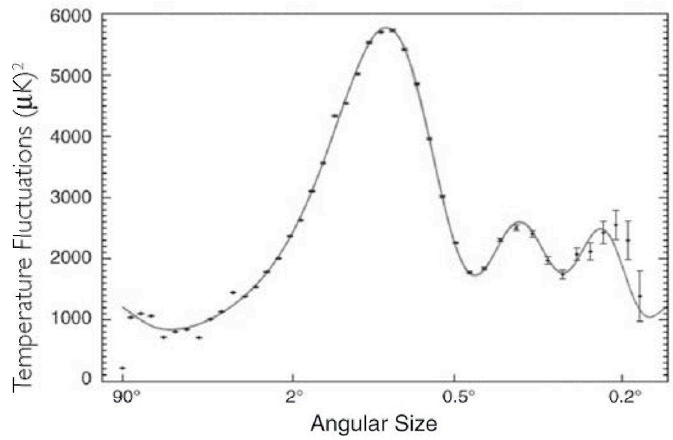
Our ancestors have wondered for millennia about the origin, the properties, and the destiny of the Universe. "Scientific" cosmology, however, is less than a century old: it was born in 1916, when Albert Einstein tried to apply his theory of General Relativity to the whole Universe. Since then, and especially during the last couple of decades, there have been impressive developments in cosmology, both theoretical and experimental. Today we have a consistent account, at the percent level, of the history of the Universe from one second after the Big Bang (when neutrons and protons were synthesized) until today.

How about the first second? We know that something very dramatic must have happened, a phenomenon that made the Universe so big, and at large scales, so smooth. This phenomenon is known as *inflation*, a very short epoch (as short as 10^{-35} seconds) during which a tiny amount of space was almost instantaneously stretched to the size of the currently observable Universe. During inflation quantum fluctuations that permeated the vacuum were stretched, creating larger, classical inhomogeneities. These inhomogeneities, during subsequent eons, evolved under the influence of gravity to form the structures of today (planets, stars, and galaxies).



Radius of the observable universe vs. time showing the dramatic expansion during the period of inflation.

In 2003, the Wilkinson Microwave Anisotropy Probe satellite (WMAP) took a detailed picture of the Cosmic Microwave Background (CMB) - the first light that could travel freely after the Universe became transparent, about 377,000 years after the Big Bang. From this picture one can derive the statistical properties of the primordial inhomogeneities. The perfect agreement of the CMB statistics with the theoretical predictions represents impressive evidence in support of inflation.



The CMB power spectrum, plotted here, encodes the statistical properties of the inhomogeneities of the Universe when it was about 377,000 years old. It can be thought of as an angular Fourier transform applied to the celestial sphere. The data points are superimposed to a best-fit curve obtained assuming that the primordial inhomogeneities were generated by inflation, which ended about 10^{-35} seconds after the Big Bang.

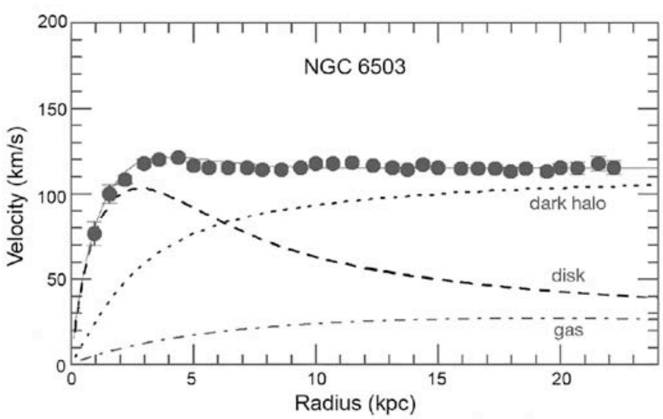
While we now have many reasons to believe that inflation occurred, we don't know anything about the *inflaton*, i.e. the form of matter responsible for inflation. Why was it filling the Universe at some point? How did it decay? How large is its mass? Knowing these details is important because the inflaton stretches tiny lengths to gigantic sizes. Turning the process around, we can use inflation as a most powerful microscope to probe the shortest distances.

Theoretical research on inflation focuses on the construction of models that agree with quantum mechanics and gravity, without being too complicated. After all, inflation was motivated by questions about simplicity: "Why is the Universe so big and uniform on a large scale?" We expect simplicity in the answer. Researchers also study the observational implications of the different models, so that future experiments will allow discrimination among them. And, as usual, we need data. After the successes of the WMAP mission, there are great expectations about *Planck*, a satellite launched in May 2009 that will take a new, more detailed picture of the CMB and the statistics of the primordial inhomogeneities, thus giving information about the strength of the interactions of the inflaton. Moreover, CMB polarization data might give information about the energy scale of inflation. Cosmology is awaiting new, dramatic observational developments, and theorists are looking forward to use the new data in their search for the inflaton.

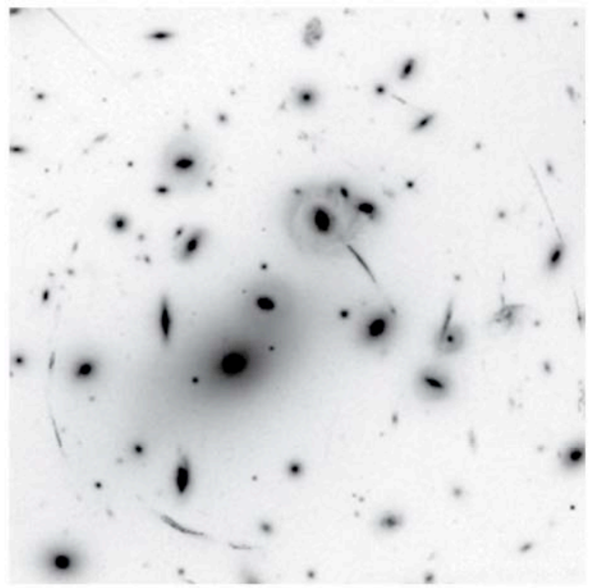
THE DARK SIDE

Searching for Dark Matter

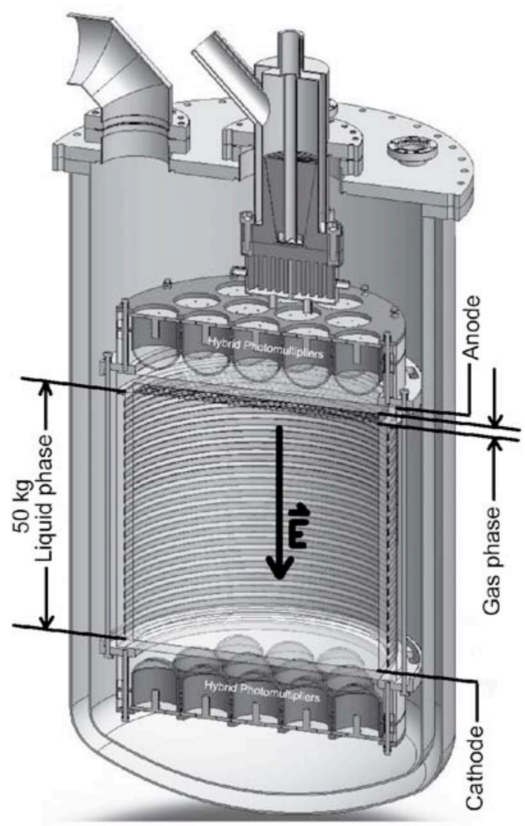
Professors Andrea Pocar and Laura Cadonati are part of a collaboration that is building an extremely sensitive detector to search for dark matter. There is very compelling evidence that visible matter, the kind of matter that stars, galaxies, and humans are made of, accounts for just 4% of the total energy density of the universe. The remaining 96% appears to be in the form of dark energy (74%), which is causing the expansion of the universe to accelerate, and dark matter (22%), which we do not observe in the electromagnetic spectrum, but whose gravity affects visible objects in the sky. The first evidence for dark matter came from the measurement of velocity curves in spiral galaxies by Vera Rubin, whose daughter is UMass Amherst Astronomy Professor Judy Young. In the figure shown below (B. Fuchs, arXiv:astro-ph/9812048v1), some form of dark matter is necessary to account for the large velocities of stars in the outer radii of the galaxy. Another effect requiring dark matter is "gravitational lensing": clouds of dark matter in a galaxy are massive enough to warp the space-time through which light travels, bending the light from more distant galaxies behind the one being observed, so that they appear as curved images, as shown at top right (http://apod.nasa.gov/apod/ap040627.html). Some of the dark matter may be baryonic, i.e., having nuclei of protons and neutrons, such as ordinary atoms in gas clouds, brown dwarfs, and **M**assive **A**strophysical **C**ompact **H**alo **O**bjects (**MACHOs**). But Big Bang nucleosynthesis calculations show that baryonic dark matter can account for only a small fraction of the total amount of dark matter. So what is most of the dark matter made of?



From cosmological and particle physics arguments, it has been suggested that most of the dark matter could consist of **W**eakly **I**nteracting **M**assive **P**articles (**WIMPs**), cold relics of the Big Bang that only interact with visible matter through the nuclear-weak and gravitational interactions. Detectors are being built to search for WIMPs via their interaction with ordinary nuclei as earth moves through the galactic halo at a few hundred meters per second. A WIMP with an energy of 100 GeV/c^2 would result in nuclear recoils in the energy range of tens of keV. Detectors must distinguish such rare low-energy events from natural radioactivity and from neutrons produced in cosmic ray showers; therefore the detectors must be built of materials free of radioactivity and must be located deep underground where cosmic rays are highly suppressed. Pocar and Cadonati's group are



building the **D**epleted **AR**gon **K**ryogenic **S**cintillation and **I**onization **DE**tector (**DARKSIDE**). As shown in the diagram below, it is a one-meter tall two-phase (liquid and gas) argon **T**ime **P**rojection **C**hamber (TPC) that makes use of the fact that argon scintillates in both of its phases. Ionizing particles produce primary scintillation (S1) inside the liquid argon bulk, and ionization electrons drift in the applied electric field into the gaseous phase and produce secondary scintillation (S2). Pulse shape analysis of S1 and the S2/S1



signal ratio are used as powerful tools to discriminate nuclear recoils from background interactions, such as those produced by gamma rays. The DARKSIDE program pivots around combining three technical choices: 1) the use of argon depleted in radioactive ^{39}Ar that allows scaling up the technology to active targets of many tons; 2) the use of novel ultra-low background hybrid photomultipliers, which allows for compact design, and 3) incorporation of a very high-efficiency liquid-scintillator neutron shield. The underground location of the experiment is still being discussed. The DARKSIDE program is already preparing for the deployment of a future, ton-scale depleted argon detector, possibly at the new **D**eep **U**nderground **S**cience and **E**ngineering **L**aboratory (**DUSEL**) in South Dakota.

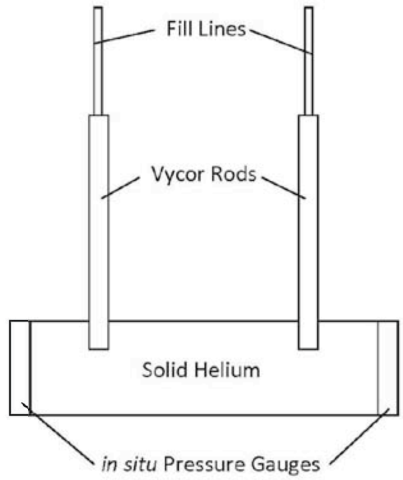
SUPERSOLIDITY

Supersolidity was first predicted to occur in a non-metal solid in 1969: at sufficiently low temperatures a solid might allow friction-free transport of its own atoms, as does superfluid liquid ^4He. Solid ^4He was proposed as a candidate for observing this behavior. Although early experiments failed to support its existence, recent work in several laboratories has reignited interest.

Boris Svistunov and Nikolay Prokofiev, with their student Gunes Soyler and other colleagues, have proposed a new theory of solid ^4He that is very different from the original theoretical work, with side effects going far beyond mere super transport. The theory and simulations show that a perfect ^4He crystal is not a supersolid; instead they find that certain imperfections, called dislocations, have a superfluid core and thus can demonstrate super transport, a possibility first envisioned about twenty years ago by Sergey Shevchenko.

Svistunov and Prokofiev believe that in recent experiments in Hasbrouck, Robert Hallock and his student Michael Ray have made the first and still unique direct experimental observation of super transport in solid ^4He. In the apparatus shown in the figure, two fill lines feed liquid helium from two reservoirs of liquid helium (not shown) into two rods of helium-filled porous Vycor glass. The Vycor glass in turn is in contact with a sample of solid ^4He kept at a temperature well below 1K and pressurized to 26 atmospheres. (The reservoirs are about 1.5 K warmer.) Tiny pores in the Vycor rods allow helium atoms to remain in the liquid state. The setup prevents atoms from solidifying in the Vycor and allows liquid-solid contact at the boundary between the helium-filled Vycor and the solid helium.

In the experiments ^4He atoms are fed into one reservoir, and if the temperature of the solid helium is below about 0.55 Kelvin, atoms are observed to move from one reservoir to the other through the solid helium, increasing the pressure in the other reservoir. At higher temperatures they do not. The reasons for this are not fully clear. But the experiments so far do not exclude the possibility that something quite remarkable is taking place, as Svistunov and Prokofiev propose. While there are more tests to do, so far their ideas have not been refuted. Even more striking than the supersolidity per se is the so-called effect of giant isochoric, or constant-volume, compressibility that always is present when flow is observed in the experiment: atoms enter the solid and increase the local pressure. Basing their theory on first-principle simulations, Prokofiev, Svistunov and colleagues argue that this bizarre effect is due to a synergy between superfluidity in the cores of the dislocations and the known ability of dislocations to "climb," that is grow under conditions when mass flow is provided to their cores.



When atoms are added to one fill line, changes in pressure in the other and in the in situ pressure gauges in contact with solid ^4He are monitored. Any change, particularly in the second fill line, indicates that atoms must have migrated through the solid.

OUTREACH AND SERVICE

SCIENCE OUTREACH CLUB

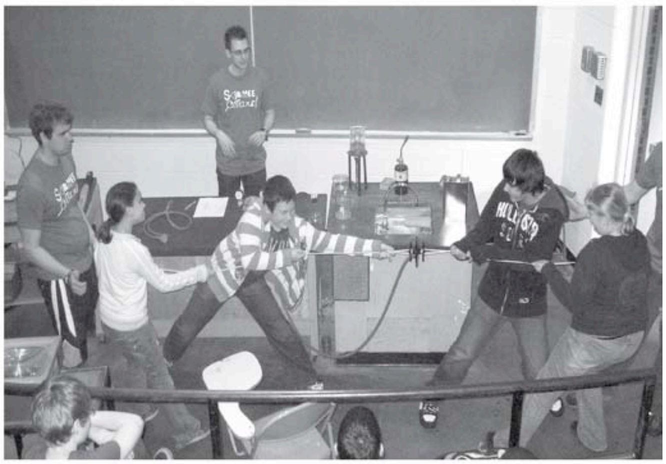
Editor's Note: Marya Semukhina is a Physics and Astronomy Major who is about to graduate, and who has been active in the Science Outreach Club. We asked her to write about what the club has been doing. Here is her response.

The Science Outreach Club puts on physics presentations for children of all ages. Sometimes we host events on campus, and at other times we bring our shows to the schools. Let me tell you why the Outreach Club matters.

Loosely defined, scientists are people with intense interests in understanding the world around them. Some people are born with it, whereas in others this interest can be sparked. This is where Science Outreach comes in. Childhood is the time in one's life when it is easiest to get inspired. For example, imagination runs wild at even the sound of the words "bed of nails." We can do one better: at our presentations, children can actually lie down on this terrifying contraption. Most find it pretty comfortable and are eager to take a shot at explaining why it doesn't hurt. We borrow the bed of nails and other exciting demonstration equipment from the Physics Lecture Preparation Room in Hasbrouck.

Continued/ ***Outreach***

The goal of Science Outreach is to get children interested in physics. All we are trying to do is make them wonder about the world around them. Why doesn't it hurt to lie on this bed of nails? Why does a rubber duck shatter into a thousand pieces after taking a bath in liquid nitrogen and being hit with a hammer? Why does laser light bounce around in a stream of water instead of coming straight out? Why do people's faces look funny in a bent mirror? It's a wonderful feeling to witness the enthusiasm with which the children raise their hands to answer these questions! Our hope is that starting with these simple, yet fascinating concepts, these children will start paying more attention to how the world around them works. Maybe we can even inspire some of them to go on to become scientists.



Magdeburg hemispheres demonstration: In the original demonstration of 1654, two half-meter diameter hemispheres were put together to form a sphere that was evacuated. Two teams of eight horses each could not pull the hemispheres apart. Here students try to pull apart a much smaller device.

Polystyrene balls on the dome of a Van de Graaff generator repel each other dramatically when the dome becomes charged. Like charges repel!

TEACHING

TECHNOLOGY AND ACADEMIA

In the middle 1400s, the new technology of printing had a major impact on academia. Today new computer-based technologies are having their impact. In our department classroom-based student response systems, web-based course materials, and web-submission of homework are all used. In a pilot project supported by the Provost's Office and the Center for Teaching, senior lecturer Heath Hatch is teaching the introductory two-semester sequence Physics for Biology and Life Science Majors using a "blended format": a portion of the content is delivered by way of the web, and a portion in the traditional lecture format. Lectures are recorded using a webcam and a screen video capture program, and are then broken up into smaller pieces and posted to SPARK, the university's class/web management software. In addition, there are email interactions, and Heath and his three teaching assistants have many office hours.

The "blended" approach was taken in order to handle an unexpectedly large demand for enrollment in the course and a shortage of large lecture halls and faculty for extra sections. The class was divided into two sections with one instructor: the students in each section attend only every-other lecture, and watch recorded lectures for those they do not attend. In previous years, class enrollment had been limited by the size of the classroom (Hasbrouck 20) to just over 300 students, but now has increased to more than 500.

Initially students were not pleased with watching lectures online instead of in person. However, before long, they discovered that recorded and archived lectures were very useful because they can be accessed at any convenient time and reviewed in small segments, allowing material to be assimilated before moving on. Students can stop to look up material in a text or compare it with things they have learned before. This allows them to synthesize and organize the information. Many found that a recorded lecture almost feels as if one is in a small room with only a few other students, receiving personal attention from the instructor. One student commented: "I learn much better without having other classmates distracting me in the lecture hall. Also, it is nice to be able to watch the lecture at my own pace when I am not worrying about a test I have in another class later that day."

At the beginning of the semester some students were a little apprehensive about the way the class was to be taught, but by the end, support for the blended model was overwhelmingly positive. To the question "How satisfied are you with the learning experience in this blended course?", 80% of the students replied "extremely satisfied" or "very satisfied." To the question "Did this experience help you become a more independent, self-reliant, learner?" 84 % replied, "Yes".

Note added in proof: Heath just won The Outstanding Teaching Award of the College of Natural Sciences! *See page 10*

GRADUATE STUDENTS, OLD AND NEW

Graduated 1989


Hamidah Adam


Jose Alonso


Richard Bonanno


Andres Corrada-Emmanuel

Philip Griboski


V. Harle


Renu Joseph


Daren Lis

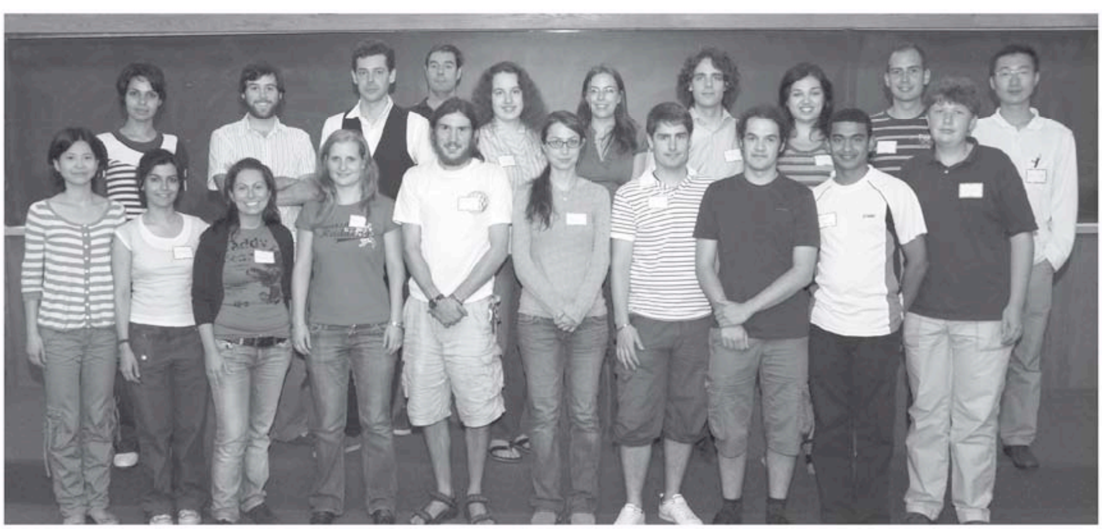

Thomas Reiner


Clark Rowley


Beverly Smith


Shahin Tountounchi

Entered 2009



Back row (L to R) Mina Baghar, Lee Walsh, Dan Hoak, Peter Morgan, Sereres Johnston, Jessica McIver, Stephan Burkhardt, Fulya Cifter, Tim Preukschat, Hua Yang
Front row (L to R) Ning Ouyang, Sheema Rahmaseresht, Simona Maccarrone, Alessandra Baas, Ben Gamari, Jaime Hopkins, Christian Guthier, Alphan Aksoyoglu, Sadeera Bandara, Sven Hein.

AWARDS

APS FELLOWSHIPS

Two physics faculty members were named Fellows of the American Physical Society this past November, an honor conferred on less than one-half of one percent of the membership. Professor Narayanan Menon was cited in the Division of Condensed Matter Physics for "experiments that helped shape the current understanding of granular fluids and supercooled liquids." Professor Rory Miskimen was cited in the Division of Nuclear Physics for his "leadership in the field of experimental electromagnetic nuclear physics, especially in studies of nucleon structure and low energy QCD."

COLLEGE OUTSTANDING RESEARCH AWARD TO COMPUTATIONAL PHYSICS DUO

Nikolay Prokofiev and Boris Svistunov were awarded the Outstanding Research Award of the College of Natural Sciences at the first convocation of the newly constituted college. They were recognized for their path-breaking collaborative work in the field of computational studies of quantum condensed matter systems by new algorithms such as the "worm" algorithm, and diagrammatic Monte Carlo. A recent discovery of theirs was showcased at the American Physical Society's online journal, Physics.

COLLEGE SERVICE AWARD

Stan Hertzbach and Mary Ann Ryan were each awarded the Dean's Service Award at the convocation of the newly-constituted College of Natural Sciences. Stan Hertzbach, after a long and distinguished career in experimental particle physics, took on the duties of Associate Dean of Natural Sciences and Mathematics. Mary Ann, as all of us in our department know, is our tireless business manager who keeps our financial house in order.

ERLANDER PRIZE

Egor Babaev was awarded the Tage Erlander prize "for pioneering theoretical work that predicts new states of matter in the form of superfluids with novel properties". The prize is awarded in the fields of Physics, Chemistry, Technology and Biology once every four years by the Swedish Academy of Sciences.

OUTSTANDING TEACHING AWARD

This year Heath Hatch was one of two winners of the Outstanding Teaching Award in the College of Natural Sciences. Heath carries on a long tradition of teaching awards in physics starting with Professor William Ross who received the very first University-wide award in 1962.

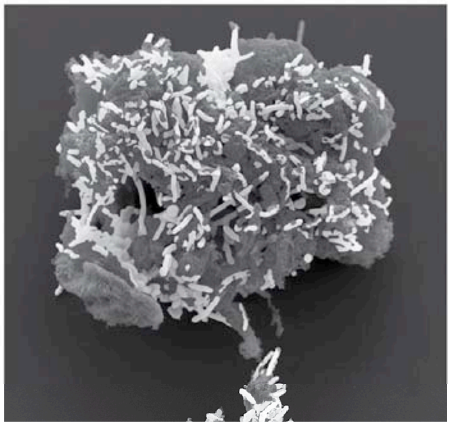
SANTANGELO WINS CAREER AWARD

Chris Santangelo has received a prestigious CAREER award from the National Science Foundation to support his theoretical research on the formation of geometrically complex structures and packing of soft materials. The CAREER award is NSF's primary vehicle in "support of junior faculty who exemplify the role of teacher-scholars through outstanding research and excellence in education". Congratulations Chris!

BUG POWER

In last year's Newsletter there was an article about one of our graduate students, Nikhil Malvankar, whose team had won first prize in the Innovation Challenge of the University's Isenberg School of Management. That was the first step. The second step was to submit a more detailed business plan, and for this the team won second prize and money to continue its planning.

In the Innovation Challenge, UMass Amherst students with an idea can see what is required to have it succeed in the business world. The goal of Nikhil's PhD research, under the direction of Professor Mark Tuominen, is to understand how certain bacteria (geobacter) can produce electric power as they consume their food. Many people have worked on this problem and much is known, but the final answer is not yet at hand. However, under the right conditions bacteria can indeed produce electricity and the idea of "Bug Power" is to build a portable toilet in which bacteria clean up waste and produce electric power. There must be a market for that! It costs money to service a portable toilet (visit it periodically to clean it and remove waste). From a business point of view, the most attractive thing about bacteria may be that they increase the time between services.



Scanning electron micrograph of geobacter bacteria growing on a clump of iron oxide. Each "sausage" shaped bacterium is about 1 micrometer long.

With the money from their first prize, Nikhil's team bought an ordinary portable toilet, took it apart, and installed the bacteria. The toilet is now set up on the east side of campus by the greenhouses near Clark Hall. Field tests continue, and the group is collaborating with a professor in marketing, but Nikhil's main focus is still on his physics research. Last year he received the Dandamudi Rao Scholarship in Biological Physics.

UNDERGRADUATE AWARDS MAY 2009

Chang Freshman Award
Keaton Burns

Chang Transfer Student Award
Paul Hughes

LeRoy F. Cook Jr. Memorial Scholarship
Keith Fratus

Kandula Book Award
Sebastian Fischetti

Hasbrouck Scholarship Award
Robert Deegan
Amanda Lund
Chris Maclellan
Richard Rines

Morton & Helen Sternheim Award
Yitzhak Calm

GRADUATE AWARDS MAY 2009

Quinton Teaching Assistant Award
Luis Cajamarca
Burcu Yucescoy

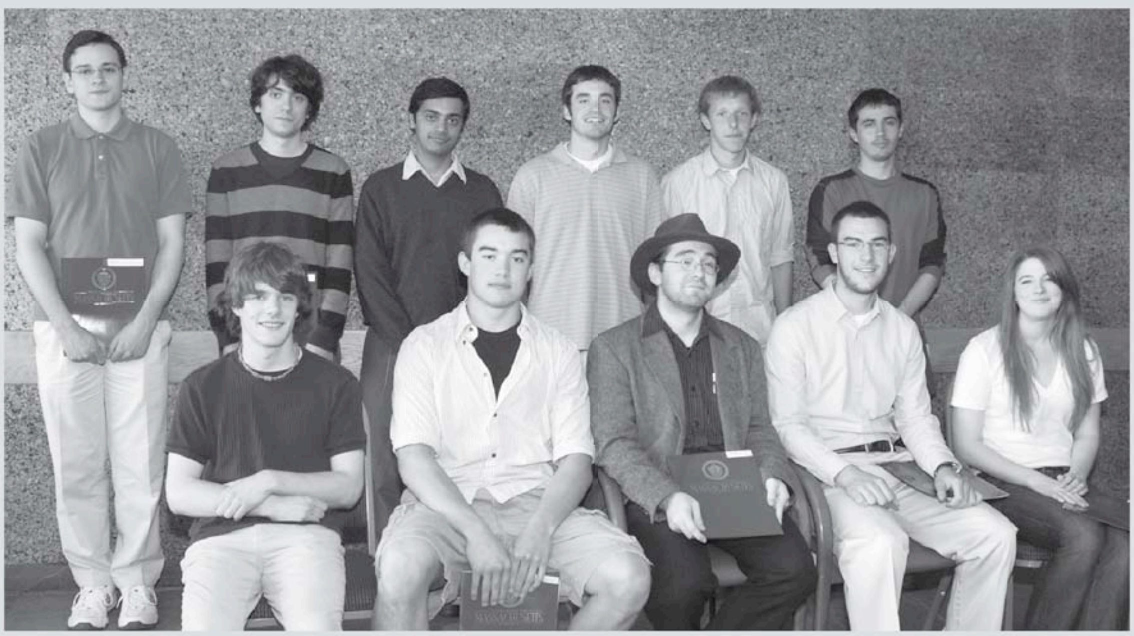
Dandamudi Rao Scholarship in Biological Physics
Nikhil Malvankar

COLLEGE/NATIONAL AWARDS MAY 2009

William F. Field Alumni Scholarship
Keith Fratus

Youngren Award
Sebastian Fischetti

AWARD RECIPIENTS, PHYSICS DEPARTMENT, MAY 2009



Back row (L to R) Keith Fratus, Sebastian Fischetti, Nikhil Malvankar, Christopher Maclellan, Robert Deegan, Luis Cajamarce.
Front row (L to R) Richard Rines, Yitzhak Calm, Paul Hughes, Keaton Burns, Amanda Lund.

PEOPLE

STAN HERTZBACH RETIRES

Reflections on 44 years at UMass Amherst

Stan Hertzbach was a chemical engineering undergraduate at the Johns Hopkins University, but in his senior year he switched to physics. He continued graduate work at Hopkins, and in June 1965 received the PhD under the supervision of Richard Zdanis and Leon Madansky, for a determination of the branching ratios of vector meson decay into lepton pairs. That September, together with Roy Cook, Norman Ford, Claude Penchina, and Mort Sternheim, he joined the 14-member UMass Amherst Physics Department headed by Bob Gluckstern. Dick Kofler, Steve Yamamoto, and Stan made up The Experimental High Energy Physics Group that was joined the next year by Janice Button-Shafer.

The group studied strong and weak interactions by using the bubble chamber at the Brookhaven National Laboratory. Raw data consisted of rolls of photographic film containing stereoscopic images of particle tracks in the chamber. Our department shop built most of the apparatus for scanning the images and digitizing the particle tracks. The digitized track data were recorded on IBM punch cards, and were processed at our campus computer center into a momentum vector for each track. This information was then further processed to determine the nature of the interactions in the bubble chamber.

After Steve Yamomoto left to start a research effort at the University of Tokyo, Monroe Rabin joined the group in September 1972. This led to a 1975 measurement of large angle proton Compton scattering and pion photoproduction at the Cornell electron synchrotron.

In 1986 Stan and Dick Kofler joined the Stanford Linear Detector (SLD) collaboration at the Stanford Linear Accelerator Center (SLAC), studying electron-positron collisions at the energy of the Z^0 boson. An addition to the linear accelerator had allowed head-on collisions of electron and positron beams. However, focusing the beams to sub-micron size created photons that interacted in the high-resolution tracking detector close to the collision point, obscuring the signals of particles created during the collision. The UMass Amherst group solved this conflict between accelerator and experimental design by becoming involved with accelerator operations and monitoring detector backgrounds. They were able to understand the compromises required in running the accelerator and modified the detector design. Logistically, this work was made possible by semesters of research leave at SLAC, alternating with double teaching loads in Amherst.

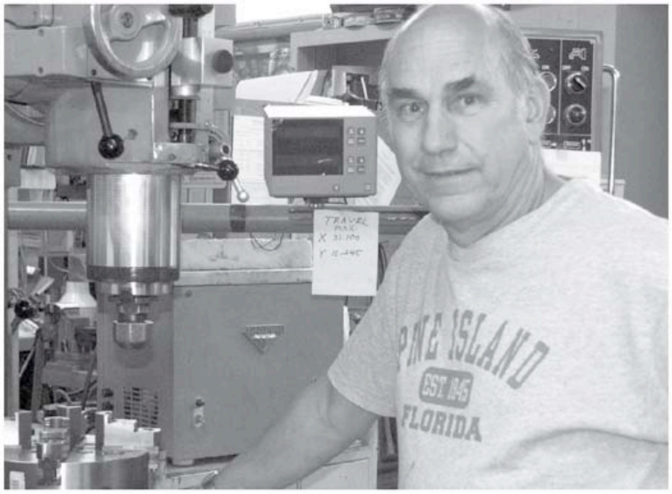
Later, in addition to work on the BaBar experiment at SLAC studying CP-violation in the B meson system, Stan continued work on the interplay of accelerator and experiment design, and joined an international collaboration designing the next generation linear collider. While at SLAC, Stan was elected to the SLD Advisory Board, the SLAC Users' Organization (SLUO) Executive Board, and served as SLUO chair in 1997-98. Our current Experimental High-Energy Physics Group is a direct result of contacts made at SLAC since 1986.

From January 2006 through July 2009 Stan divided his time here between teaching and an appointment as Associate Dean for Undergraduate Advising in the College of Natural Sciences and Mathematics (NSM). His feeling about the experience is: "It has been one of the most educational, demanding, and rewarding experiences of my 44 years at UMass Amherst. The impact on students' lives was direct and immediate, in a manner different from the classroom and research lab. I believe the students benefited from my advice and decisions." His major impact on student life in NSM resulted in his receiving the Dean's Service Award in the spring of 2009.

Stan officially retired from UMass after the 2009 summer semester. He and his wife Bobbye are moving to the Washington, DC area, where their daughter currently resides.

ASHLEY WEBB RETIRES

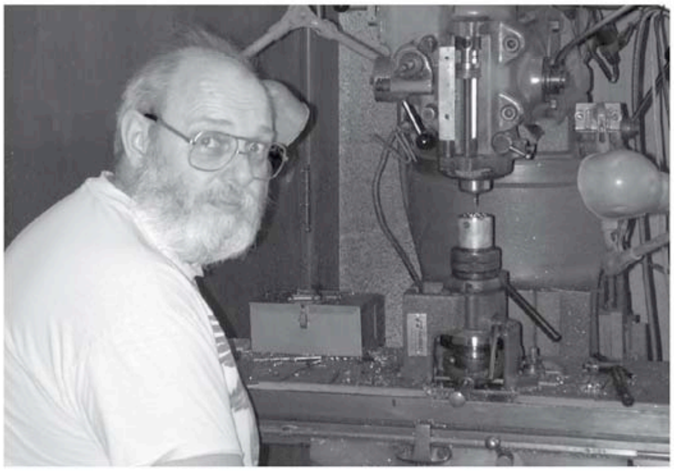
We have a strong tradition of excellent machining in our department that was especially exemplified by Ashley Webb who recently retired. Ashley started working for the department in the 4th floor Graduate Research Center Tower Shop in 1985, but transferred to the main Hasbrouck shop in 1996 as foreman. Ashley was known for his precision machining, expertise with welding, ability to schedule priorities for the flow of work, and his kindness and patience in dealing with faculty and graduate students. He frequently had excellent suggestions that improved upon designs as well as finding easier ways to accomplish the tasks at hand. He always had the attitude that "An experiment's and a student's success is our success!" We deeply appreciate all he did for the department.



Ashley lives on a farm in Leyden near the Vermont border where he has a sawmill, a machine shop, tractors, other farm equipment, and vehicles that he keeps in tip-top condition. In February he is typically found collecting maple sap and boiling it down in the large evaporator in his sugarhouse. He also gathers many cords of firewood for himself and his friends. It is fair to say that Ashley has not retired, but just changed jobs.

RICK WILKEY RETIRES

Richard Wilkey has retired after working for the department for 42 years. Many of our alums will remember Rick for his student shop course, typically taken by experimentalists. Some technical drafting was also taught. The course wasn't meant to turn out skilled machinists, but rather to acquaint the students with what can be done in a shop, and to



appreciate sound design. Furthermore, students acquired a respect for high quality machining and an awareness that for many experiments, a team effort of students, professors, machinists, and others is required. Of course Rick did much more than just teach his course, as he is a very capable machinist himself and especially liked the challenge of unusual designs. He also did a number of other things for the department, most recently crafting a design for the woodworking shop to accommodate its move from old to new Hasbrouck.

In his life off-campus, Rick is an avid conservationist who served 18 years on the Orange Conservation Commission. He has a great appreciation of nature, and often observes wildlife near his home. He also has made and continues to be involved with the sale and distribution of wood burning stoves. We wish him well in his retirement.

LAUREN SCHEIPER: A VERY SPECIAL WORK-STUDY STUDENT

It was with sadness and a lot of pride that we, the office staff (Ann Cairl, Barbara Keyworth, Jane Knapp, Mary Pelis, Kris Reopell, and Mary Ann Ryan), had to say goodbye to our wonderful student worker, Lauren Scheiper. Lauren graduated in May 2009, and is now a graduate student at Massachusetts General Hospital in Boston, majoring in Communication Disorders.

In the 3½ years that Lauren worked with us, she became an integral part of our office staff. We came to depend on her for many things, from sorting and delivering mail, to conference organization, and compiling data for reports and surveys. Anything we asked her to do, she would do with a smile. Over the years, she learned many departmental procedures and nuances, and was able to make her own decisions about prioritizing her work and answering questions from students, staff, and faculty. It is very rare to have a student worker who is as motivated, dedicated, cheerful, meticulous, honest, dependable....you get the picture!

Before Lauren graduated, she was presented with a University "Student of the Year Award," given to students who have demonstrated leadership, initiative, and a unique work ethic. Ten students from across campus received a cash award at a luncheon attended by the students' families and many University dignitaries. The Physics Department was very proud to have Lauren as part of that elite group.

ALUMNI NEWS

Steve Churchwell (PhD '98) has been working as the lead research scientist for Veritide Ltd., a small start-up company in Christchurch, New Zealand. He has helped design an anthrax screening device for first responders at white powder spill incidents. The device uses the fluorescence signature of spores, and more importantly, how this signature changes following UV exposure, to separate hoax substances from real threats. Veritide now has a working product that has been externally tested and won several awards.

This year Steve expects to be working on an imaging version of the screener that should be capable of resolving and identifying individual spores in a matter of minutes. The conventional way to truly identify spores, which takes about a day, is to culture them, during which time people who have been exposed need to be treated as if they've been in contact with anthrax and the building in question must be shut down, often at great expense and inconvenience. The new screening device should eliminate such problems. *s.churchwell@veritide.com*

Paul Finley (PhD '99) writes: I was awarded the NASA Exceptional Public Service Medal for my work on the Spitzer Space Telescope. This medal is an individual award granted by NASA to non-government employees who provide exceptional contributions to NASA's mission. I was responsible for managing the cryogenic system on the telescope, and we were able to extend the cryogenic science mission to more than six months beyond the original design goal of five years.

My career in the aerospace industry has been a winding path, but much of the groundwork took place as a doctoral student of low temperature physics with Bob Hallock. Although I haven't measured helium coupling to hydrogen substrates (which was part of my dissertation work) in quite some time, experimental physics teaches a versatility that can lead to success in a variety of environments. I was attracted to Hallock's low temperature lab because of the independence of performing scientific experiments with a small team. I had the opportunity to work the whole process: literature review, experiment design, fabrication, equipment repair, measurements, data analysis and finally, publications. I'm now involved in scientific and engineering endeavors that involve subcontractors all over the country and my experiences at UMass Amherst prepared me well. *pfinley@ball.com*

Xiaodong Jiang (PhD '97) writes from the Los Alamos National Laboratory: The other day I was sorting my old physics files stored in UHaul boxes that provided clear evidence of having moved around too many times. I came across a photo of myself from UMass Amherst days, standing next to the cryogenic ^{3}He target system we had built. The next photo I found was of my wife standing next to the system. She was pregnant with our first child. Wow! I thought, that's a long way back. My son is now in high school!

I also came across a set of transparencies: old fashioned, hand-written ones used in a talk I gave at a seminar in 1992 after coming back from a nuclear physics summer school. My advisor, Gerry Peterson, had asked me to give a summary of what I learned at the summer school. I made a report on deep inelastic lepton scattering, and showed a cartoon of a lepton probe hitting a quark inside a nucleon. To my surprise, I found that I had drawn a pion coming out of the nucleon along the same direction as the scattered lepton. I remember that I pointed out that by looking at the leading pion in the quark "jet," one could effectively tag which quark got hit. When you see a fast π^+ coming out (made of an up-quark and an anti-down quark), most likely it is an up-quark that got the initial hit.

That was in 1992, before the fashionable phrase "semi-inclusive deep inelastic scattering" had been invented, and there wasn't any theory paper on that topic. Now, almost 20 years later, semi-inclusive deep inelastic lepton scattering has become a very busy subfield in nuclear physics for studying the nucleon's quark structure. Recently several major experiments were carried out, such as HERMES at DESY in Germany, COMPASS at CERN, and I just finished one at Jefferson Lab, using high-energy electrons (6 GeV) to hit quarks inside a polarized neutron in ^{3}He. By detecting the scattered electron at a particular kinematics, I know that a quark must have gotten hit, since the electron lost a huge amount of energy. At the same time, while it is certain that a quark must have been hit, I will look for a high-energy charged pion (+ or -) that carried about half of the energy transferred from the probe electron. Chances are that the high-energy pion would contain the valence quark that received the initial hit, otherwise it wouldn't travel so fast.

The question we were asking in the recent Jefferson Lab experiment is, "Does the production rate of the fast pion have anything to do with the neutron's spin orientation?" In other words, "Do quarks inside a polarized nucleon rearrange their distribution density, or do quarks behave in a special way, such as in a collective angular motion, considering that they have to provide an overall spin-1/2 to the nucleon?" It's a very exciting time for nuclear physics, and I am glad that my education at UMass Amherst, although I didn't realize it at the time, helped to steer my scientific career towards such an exciting and productive direction. Thank you Gerry! *xjiang@lanl.gov*

Charles Mayo (PhD '91) writes: A few years ago, as I was flying to a meeting to give a presentation, the moment came when the attendant announced that the passengers could use their electronic devices. Around me spreadsheets and word documents were popping up as people began to work.

On my laptop was something different. I was working with a radiation treatment planning system for developing a better technique for delivering radiation therapy for breast cancer using a new technology called intensity-modulated radiation therapy. It struck me how fortunate I was to have a career that lets me use my technical skills to help patients in a very direct and tangible way. That career is in medical physics, and I owe my entrance into this field to one of my professors at UMass Amherst, Monroe Rabin.

Monroe had been my instructor for Electricity and Magnetism. He'd forged contacts at Massachusetts General Hospital and Harvard University in the then little known world of proton radiation therapy though a sabbatical at the Harvard Cyclotron Laboratory. My interest in using physics in medicine had been piqued during my thesis work in Robert Hallock's laboratory where we'd developed an optical technique to use surface plasmon resonance to monitor the binding kinetics of antibodies to antigens adsorbed on a thin layer of metal film. So when Monroe Rabin, said "Maybe you want to think about this area," I jumped.

Modern medicine is a team effort, and in radiation oncology, physicists play an important role on that team because of the advanced, computer intensive technologies used to develop customized radiation treatment approaches for each patient. The past decade has been remarkable for this field as the pace of development and introduction into clinical practice of new technologies far outstrips the more gradual pace of previous years. In addition to using experimentalist's skills learned in graduate school to put new technologies into practice, the field also leverages modeling and computational skills to improve understanding of the biological response of healthy and cancerous cells to radiation to further improve our approach to treatment.

Now my experience at UMass Amherst has begun to come full circle. Monroe and his graduate and undergraduate students have begun several fruitful collaborations on the work that I do here at the University of Massachusetts Medical School. I'm looking forward to the opportunity to follow in his footsteps in introducing a new generation of physicists to the field. *Charles.Mayo@umassmemorial.org*

IN MEMORIAM

Raymond Wyman (BS'37)
December 12, 1915 – February 8, 2010

When Ray Wyman was in our department in the 1930s, it had only three faculty members and was located in an old wooden building up the hill across from Hasbrouck. In that time transistors were unheard of, so when Ray made the first oscilloscope in western Massachusetts as well as audiovisual equipment, he had no choice but to use vacuum tubes. Ray became internationally known for his expertise in audiovisual and other technology used in academia. (See the Spring 2004 Newsletter, page 10.) Ray retired as a professor of education over 31 years ago, but continued to be active in civic affairs. He passed away on February 8th and he will long be remembered.

Huai-Ti Lin (BS '06) writes: I came to the United States from Taiwan after high school in 2003, with an interest in aeronautics shared by many teenage boys. That interest waned and I switched my major to physics at UMass Amherst. Seven years later, I still find my training in physics supporting my biomechanics graduate research in the Department of Biology at Tufts University.

Huai-Ti Lin in his lab at Tufts University

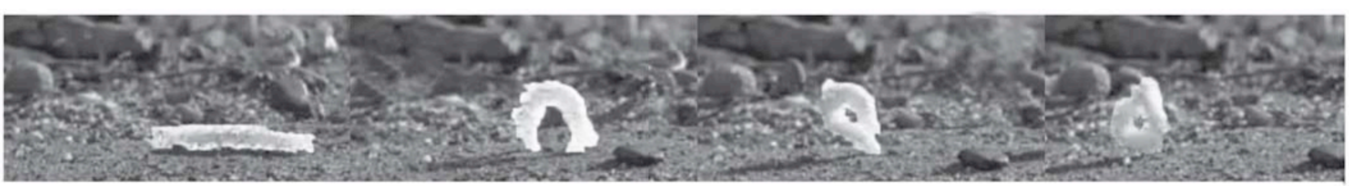
Why biomechanics? I spent quite a portion of my childhood in the mountain ranges and tropical forest in Taiwan. The workings of biological systems have always been awe inspiring to me. At UMass Amherst, I graduated early with a minor in biology. Biomechanics is one natural pathway by which physicists enter biological research and I have not been the first to walk down this path.

Currently, I am a fourth year PhD candidate at Tufts. My research focuses on force transmission and body control in caterpillar locomotion. Soft-bodied animals are extremely good at complying with the environment. How do they do this? My first project was to design a sensor array to measure the tiny reaction forces applied by a substrate to the legs of a crawling caterpillar. The force analysis revealed how caterpillars use the substrate to support their bodies, and also how that substrate applies forces that mold the caterpillar body much like the forces applied by an internal skeleton molds ours. To take this finding further, we are investigating the "hydrostatic skeleton" in different caterpillars, using a combination of finite element modeling and field surveys.

In addition to modeling, there are robotic projects directly relevant to basic science. "Soft-bodied robotics" is a new concept, emphasizing the use of soft material mechanics to produce organic, intelligent behaviors. Without any joints or rigid structures, posture mapping becomes exceedingly difficult. In fact, when the terrain is uneven and undetermined, "establishing an exact posture" becomes ambiguous. Soft-bodied animals never use vision to coordinate movements. Instead, the body has to maintain a certain compliance that facilitates adaptive substrate conformation.

My first generation of soft robots, "InchBots", was made from simple strips of rubber foam that moved in a way that was similar to inchworm caterpillars. For greater speed, I considered faster modes of caterpillar locomotion. The fastest self-powered "wheeler" in nature is a caterpillar named *Pleurotya ruralis*. My second generation of soft robots, "GoQBots," emerged from this behavioral imitation. It has a top speed of 20 cm/s in short bursts. With a self-righting behavior, the robot can perform consecutive ballistic rolls with great efficiency. This design revolutionizes the current rolling robots based on motors and fixed wheels. You can follow this work at my research blog: http://morphingmorphology.blogspot.com

Despite my graduate biological training, I consider physics to be the foundation of all sciences. The problem solving skills I learned in physics have been extremely helpful in shaping biological questions and in tackling engineering issues. They have given me the confidence to step into any science-related career, even outside the sciences. However, in order to feel comfortable mingling in what people deem to be different disciplines, one must dare to make connections. Natural phenomena share certain characteristics, whether in biological systems, in machines, or in distant galaxies. "Make connections" was my answer when Monroe Rabin inquired, at the end of my undergraduate thesis defense, "what would I say to succeeding physics students"? I don't think I would ever change that answer. *Huai-ti.Lin@tufts.edu*



Resting State (0ms) *Ballistic curl (660ms)* *Body kissing (775ms)* *Lock position (800ms)*

Time sequence of Pleurotya ruralis as it transforms itself from its resting state, to the shape of a wheel for rapid locomotion.

John Medeiros (PhD '72) now lives in Alabama and works for the COLSA Corporation, where he uses supercomputers to investigate fluid dynamics problems connected with hypersonic flight. That's a far cry from the things he did when he was a graduate student here working in experimental atomic physics with his advisor Robert Krotkov. (John's thesis was on collision processes involving metastable hydrogen atoms.) After graduation from UMass Amherst, he went to the University of Western Ontario in Canada, and as a post-doc there, worked on the anatomical structure of the retina, color vision, and on laser damage mechanisms in the eye. After Western Ontario he went to the York campus of Pennsylvania State University as an assistant professor where he continued his research on vision – including fractal patterns of arterial branching in the retina and on the separation of rod and cone perception.

Shortly after getting tenure, he was offered a position with a defense company for more than twice the salary he was getting as an assistant professor at Penn State. Given that he had a young family at the time (two boys), and was having a hard time making ends meet, it was an offer he couldn't refuse. So he relocated to the deserts of New Mexico. There, he worked on various optical effects on imaging systems of military interest (still classified). After five years there, he was offered a position at COLSA Corporation in Huntsville, AL, and twenty years later he is still there. COLSA is a defense services company and John has worked on projects ranging from radar tracking of missiles to target identification using various kinds of computer simulations. His wife, Nancy, is an ophthalmologist (retina specialist) and he tells us that they both enjoy living in the Huntsville area.

He is still interested in vision, and since his days at the University of Western Ontario has been working on a Cone Spectrometer Model of color vision. The retina is made up of rods and cones and it is the cones that provide our sensation of color. In the conventional trichromatic theory of color vision, different cones are sensitive to different colors because they have different photo-absorptive pigments and the fact that they have a conical shape is not particularly relevant.

In his book *Cone Shape and Color Vision: Unification of Structure and Perception*, he explains his idea that the cone shape (and size) is actually very important. It is well known that the details of how light propagates through an optical fiber depend on the wavelength and on the optical properties of the fiber such as size, shape, and index of refraction. For a conical fiber having properties such as those of a cone in the retina, standard electromagnetic calculations show that white light normally incident on the wide end of the cone will be separated into its spectral colors along the length of the cone (essentially due to waveguide mode cutoff). Long-wavelength, red light is excluded from the cone interior first, starting at the wide part, and shorter-wavelength, blue light remains in the cone interior until it is excluded only at the narrowest part of the cone. It is as if red light cannot squeeze through an ever-narrowing cone. Pigments are indeed present, and they play an important role, but so does the separation of light into its component colors through the optical properties of cones. A further, key part of his model is the conversion of the spectral ordering along the cone length into a time code, due to the propagation delays along the cone of the detected signal.

While this dynamic model of color vision explains a lot about color vision that is otherwise rather mysterious in the standard three-cone model, most of those supporting the standard view have been very resistant to this new approach to the understanding of color vision. Despite this, John continues to explore various aspects of the cone spectrometer model of color vision (see his web site, conesandcolor.net) while pursuing his day job as a defense analyst. He still fondly remembers the time he spent in the Physics Department and the people he worked with there over forty years ago. *john.medeiros@mac.com*

Paul Silva (BS '00) is managing partner of "Angel Catalyst," a company that helps build and run professional investor groups and fosters connections between yesterday's successful entrepreneurs and today's would-be entrepreneurs. Paul is one of the founders of the Entrepreneurship Initiative at UMass Amherst, an organization that helps students become innovators and entrepreneurs by offering courses and sponsoring twice-yearly competitions. Paul runs the competitions and gives talks at the events. One of the group's initiatives was the "Grease Car" that uses vegetable oil as fuel in diesel cars and trucks. Paul continues with "AllinPlay" (formerly "ZForm"), an online community that provides computer games to help the blind and visually impaired interact with each other. Making money may be one reason for becoming an entrepreneur, but what is more important, Paul says, is that he loves what he does every day, has the flexibility to work from home, and can see his family as much as he likes. *paul.silva@angelcatalyst.com*

Send your alumni news to
newsletter@physics.umass.edu

NEW ALUMNI

Degrees awarded since Spring 2009 Newsletter

BS Degrees

Vitaliy Belyshev
Samuel C. Boone
Morgan-Elise Cervo
R. Yemima Citron
Stephen John Dickenson
Matthew C. Drake
Brian P. Francis
Collin P. Laily
Michael F Linnehan
Andrew J. Loschuavo
Peter A. Mistark
Timothy Glenn Mortsolf
Andrew N. O'Donnell
David J. Ouellette
David Mark Parker Jr.
Daniel Ryan Rogers
Shaina M. Rogstad
Brandon K. Schmoll
James E. Schneeloch

MS Degrees

Benjamin Ett
Huajie Ke
Preema Pais
Craig Versek
Sibel Ebru Yalcin

PhD Degrees

PhD Degrees	Thesis Title	Advisor
John Cummings	Bilayer Bolometers to Kosterlitz-Thouless: A Study of Helium Films	Hallock
Wenfeng Kang	Numerical Studies of Granular Gases	Machta
Emmanuele Salvati	Rare decays in BaBar: search for decays of the neutral B meson into two leptons and measurement of CP asymmetry in inclusive radiative decays of the B meson into a strange-quark system.	Dallapiccola
Sebnem Gunes Soyler	Novel Superfluid States in Bosonic Systems	Prokofiev
Yikuan Wang	Exciton-Plasmon Interactions in Hybrid Metal-Semiconductor Nanostructures	Achermann
Qijun Xiao	Hierarchical multiple bit clusters and patterned media enabled by novel nanofabrication techniques – High resolution EBL and block polymer self assembly	Tuominen
Ozgur Yavuzcetin	Nanofabrication Techniques For Nanophotonics	Tuominen

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Please contact the CNS Development Office with questions.
Voice: 413.545.0974, Fax: 413.577.1108

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

DONORS

This lists represents those who contributed to the Department of Physics from January 1, 2009, to December 31, 2009. We apologize for any omissions and kindly ask that you bring them to our attention.

Douglas Alden
Dean & Barbara Alfange
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Lucy Benson
David Lawrence
Jason Blind
David Bloore
Elizabeth & Thomas Radcliff Brackett
John Brehm
Christopher Brockmeyer
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Julie Johnson
Phillips & Ereda Jones
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Philip Kan
Lisa Kaufman
Shaun Kelly
Paul Kendra
Joseph Kinard
John Knapton
Yury Kolomensky
John Kudukey
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James Leas
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Michael Swift
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MATCHING GIFTS

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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.

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University of Massachusetts Amherst
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Change Service Requested

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Permit No. 2

Our Campus Pond is fed by Tan Brook, which drains into the Mill River, and which in turn feeds into the Connecticut River. The pond has long been a campus icon, but has suffered from poor circulation, and from the buildup of silt and algae. Three fountains have recently been installed to provide circulation, and to speed up the decay of organic material. It is too early to judge how effective they will be from those points of view, but from an aesthetic point of view, they were immediately an overwhelming success! (The ducks and geese on the pond seem to be taking the fountains in stride.)