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Department of Physics Newsletter: Spring 2011

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PHYSICS Newsletter

DEPARTMENT OF PHYSICS AT THE UNIVERSITY OF MASSACHUSETTS AMHERST
SPRING 2011 Issue No. 11

Black Holes

Most of us are familiar in one way or another with the concept of a black hole, a mysterious region of space and time that we can't see, that is cut off from the rest of the universe, and that consumes matter near it. Such objects likely exist throughout the Universe. They come in all sizes, over a range of many orders of magnitude.

Supermassive Black Holes

At the high end of the mass scale are the most massive objects in the Universe, the supermassive black holes, with masses equal to millions and even billions of solar masses at the center of all galaxies. In our own Milky Way Galaxy, the black hole at its center, Sagittarius A*, has a mass of about 4 million suns. To put that in perspective, the sun could hold a million earths. The black hole mass was determined by observing the elliptical orbits of a few stars closest to it. Some of those stars and their planets have been observed to whip around the black hole with periods of only 15 to 20 years, whereas our solar system takes about 200 million years to go around the Milky Way.



Microscopic Black Holes

At the low end of the mass scale, our own Professor **Carlo Dallapiccola** is searching for microscopic black holes at the Large Hadron Collider (LHC) in Geneva, Switzerland. He asks, "Have you ever wondered if we could *make* a black hole here on Earth?" To answer that question, one first must understand under what conditions a black hole may be created, and then we can decide whether or not it's possible to create such conditions in a laboratory.

Continued page 4

DEPARTMENT OF PHYSICS CENTENNIAL, 1911-2011

This year, 2011, marks the 100-year anniversary of the founding of the Department of Physics at Massachusetts Agricultural College, that in 1947 became the University of Massachusetts Amherst, now the largest public university in New England. The founder and first professor of physics was Philip Bevier Hasbrouck Jr., after whom the Hasbrouck Laboratory is named. Full story page 12.



UMASS
AMHERST

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Thank you

design &
production
Brigette McKenna

Simulated jets from colliding black holes.

Dear Alumni and Friends of the Department of Physics,

This has been a year of challenges and of hopeful new initiatives for the Department of Physics and for the University. Although economists tell us the recession is over and better economic times are in sight, it will take a while longer for this to show up in state revenues and funding. In the meantime UMass Amherst is responding with its own initiatives to provide funding and research facilities, and to increase student enrollment. These initiatives are taking visible form in a massive new laboratory science building now going up across the street from Hasbrouck, in a new 1,500-bed learning and living facility to be built for Commonwealth Honors College, and in a large New Academic Classroom Building (NACB) to be built right next to Hasbrouck.

Correspondingly, in the department several large renovations projects are nearing completion. These projects are creating attractive, modern laboratory and student office spaces in both New and Old Hasbrouck, including an all-new student machine shop next to the main shop. Speaking of Old Hasbrouck, this 1950-era building, once considered a good candidate for demolition, has now seen some major infrastructure improvements and is providing room for our condensed-matter and biological physics groups to expand their research operations.

The department is taking initiatives to benefit from some of the large new campus projects, which generally are not geared to the use of any one department. For example, the NACB next to Hasbrouck will have several "Team-Based Learning" (TBL) classrooms in a format developed by other physics departments, including those at Rensselaer and MIT. In the TBL concept students work in collaborative groups around large round tables in rooms equipped with laptop computers, multiple projectors, networking, and other technology. Instructors, rather than lecturing, circulate among the groups and use the technology to both pose questions and gather and present student contributions to the whole class. In our department we will use the TBL classrooms as an opportunity to modernize the introductory labs for our majors.

Of course it is not buildings, but people that create a strong department. While a major expansion of the physics faculty will need to await the continued swing of the economic pendulum, we are at least holding our own with the hiring this year of Assistant Professor [Maria Kilfoil](#) and Instructor [Nicholas Darnton](#), and a search now underway for a condensed-matter experimentalist. The number of physics majors has hit a new high of more than 140, and our SPS chapter is in one of its periods of high activity and student involvement.

Among the most important people for the department are you, our friends and former students.

Your gifts directed to the department are highly appreciated, and show that the teaching and research carried out by the department are important to the alumni community. We hope that you continue sending us news of your activities and that you enjoy this newsletter.

Sincerely,



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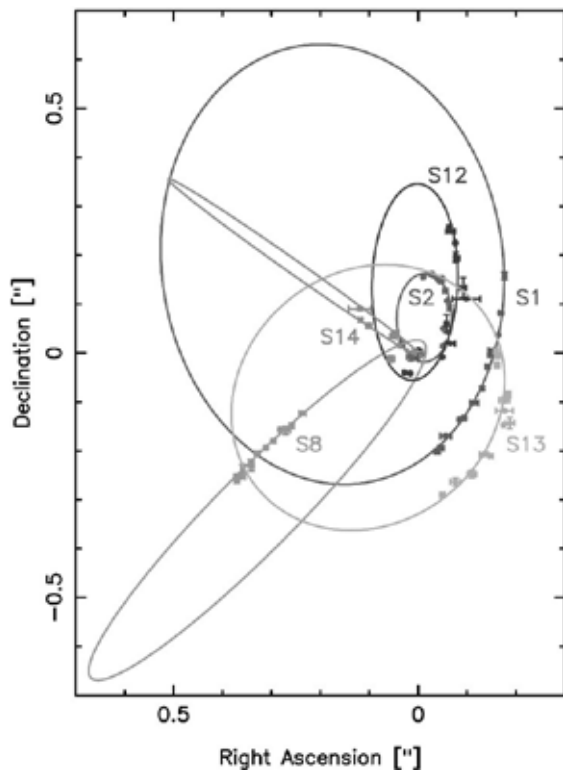
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research

BLACK HOLES

Einstein's theory, unlike the Newtonian theory it supplanted, predicts that if enough mass is concentrated into a sufficiently small volume, the gravitational field it generates becomes so strong that nothing can prevent the subsequent implosion of all the mass into a dimensionless point, a singularity of infinite density. Surrounding the *singularity* is the *horizon* – the boundary that marks the “point of no return,” from which nothing, not even light, can escape. *This is a black hole.*

For a given mass M , into how small a sphere must the mass be compressed to create a black hole? The answer is a sphere with the Schwarzschild radius $R_s = 2GM/c^2$, where G is the gravitational constant and c the speed of light. For instance, a 1 kg clump of matter would need to be compressed into a sphere of radius 7×10^{-28} m, or 10^{18} times smaller than an atom for it to constitute a black hole! This would appear to be well beyond our



Measured time-dependent positions and best-fit orbits of six stars near Sagittarius A*. (Courtesy of Fulvio Melia, *The Galactic Supermassive Black Hole*, Princeton University Press, 2007, p. 110. Professor Melia is a visitor at Amherst College for the academic year.)

capabilities. Could we instead create a tiny black hole by colliding two very small subatomic particles together? At the LHC protons are accelerated to speeds very close to the speed of light and then collided with each other at the highest energies ever produced in a physics laboratory. For the first data run in 2010, the protons had energies

of 3.5 TeV (Tera electron Volt = 10^{12} electron volts). At such energies, the distance at which colliding protons approach each other is effectively 10^{-17} m, or one-hundredth the radius of the proton itself, a very small distance, indeed. The condition for creating a black hole, however, requires that they pass within the astoundingly smaller distance of $R_s = 10^{-50}$ m! We may now ask why the popular press sent out attention-grabbing stories about the earth being consumed if a black hole were created at the LHC. In fact, the possibility of black hole production at the LHC is much discussed within the particle physics community, but only within the framework of theoretical models that speculate the existence of *extra spatial dimensions*. Such models, inspired in part by string theory, try to explain one of the great mysteries of physics: Why is the gravitational force so much weaker than the other fundamental forces? One hallmark of such models is that at very small length scales the gravitational attraction between particles becomes enormously stronger than what is predicted by Einstein's theory of gravity with only three spatial dimensions – strong enough, in fact, to make the production of black holes at the LHC a realistic possibility. So-called “microscopic” black holes would be exceedingly ephemeral, harmlessly evaporating away very quickly (in roughly 10^{-85} s) via Hawking radiation (see page 6).

Over the past couple of years, Professor Dallapiccola has been a member of a relatively small group of physicists dedicated to the search for black holes at the LHC using data collected by the ATLAS detector. What they look for is the Hawking radiation emitted by the black holes as they evaporate. The signature is very striking: a large number of highly energetic particles emitted isotropically from the proton-proton collision. First data were collected in the period March-December 2010, and are still being analyzed. Preliminary results show no hints of black holes, but in March 2011 a new run will commence with the promise of higher intensity proton beams and new opportunities to discover evidence of extra spatial dimensions via black hole production. At the very least, stringent limits on the models will be made so that they may be ruled out as ever more unlikely.

Black Hole Collisions and Ripples in the Fabric of Space Time

Einstein's theory of general relativity predicts that when massive objects accelerate they produce ripples in the fabric of space-time that propagate at the speed of light. These ripples, called gravitational waves, are tiny changes in lengths and times. Their measurement could tell us about catastrophic events in the distant universe: the death of a star, the collision of black holes, and if we listen very carefully, even

murmurs from the Big Bang. Our understanding of the Universe is deepened because we are not restricted to observation of electromagnetic waves as in astrophysics.

This is an extremely challenging measurement: gravitational waves are tiny and elusive. The effect we need to measure is equivalent to a change of the size of an atom in the distance between earth and the sun. Amazingly we are very close to reaching that goal. UMass Amherst has played and continues to play a central role in this quest. Our own [Joe Taylor](#) and [Russell Hulse](#) received the 1993 Nobel Prize for proving the existence of gravitational waves from their 1975 observation of the binary pulsar PSR B1913+16, a system of two neutron stars orbiting around one another. As the neutron stars orbit, they lose energy in gravitational waves and inspiral, just as predicted by general relativity. In about 300 million years they will collide and produce a black hole.

The discovery of Taylor and Hulse jump-started experimental gravitational wave physics. The largest operating detector is LIGO, the Laser Interferometer Gravitational wave Observatory, supported by the National Science Foundation. LIGO aims to measure changes of the order of 1/1000 the size of a proton in the distance between mirrors that are located 4 km away from each other, at the ends of two perpendicular arms, in an apparatus similar to a Michelson interferometer. This requires a unique combination of innovations in vacuum technology, precision lasers, and advanced optical and mechanical systems. LIGO has two such detectors, one near Baton Rouge, Louisiana, and the other in eastern Washington State. There is a similar detector in Italy, called Virgo, a French-Italian venture.

Our department is once again at the forefront of this research, as a member of the LIGO Scientific Collaboration. Professor [Laura Cadonati](#) leads an international team that is analyzing data from the LIGO and Virgo laser interferometers, looking for evidence of gravitational waves from catastrophic events in the nearby Universe. The team is interested in all astrophysical signatures that are transient in nature, but in particular Professor Cadonati's group is pursuing the coalescences of black hole pairs that are about 100 times more massive than the sun. The expected signal depends on how far away the system is, how massive the black holes are, and how fast they spin around their axis. The exact signature has several uncertainties, so we collaborate with theorists, such as Dr. [Joan Centrella](#) (BS'75), who are solving Einstein's equations on super-computers. She is a UMass Amherst alumna who is now leading the gravity group at NASA Goddard. The team is busy analyzing data taken in LIGO's initial configuration. Meanwhile, upgrades



UMass Amherst graduate student Emily Thompson beside the ATLAS Detector at the LHC.

have begun that will lead to Advanced LIGO, scheduled to acquire data in 2015. Advanced LIGO will be sensitive to signals coming from ten times farther away than were the initial detectors. According to stellar population models, the coalescence of black hole pairs is the most promising source for Advanced LIGO, which will “hear” them on a weekly basis, if not daily.

LIGO is sensitive to gravitational waves with frequency 10-10,000 Hz, limited by the seismic ground motion. Future detectors include the space-based LISA, which will observe astrophysical and cosmological sources of gravitational waves of low frequencies (0.03 mHz to 0.1 Hz, corresponding to oscillation periods of about 10 hours to 10 seconds) caused by the coalescence of supermassive black holes with each other or with smaller black holes or neutron stars. Additional plans are being made for underground detectors, to defy the seismic barrier and look for gravitational waves around 1 Hz. These are exciting times for gravitational wave physics, as we search for events that may change the way we understand our Universe.

Black Holes Fundamentals and Thermodynamics

Professors Jennie Traschen and David Kastor have had the thermodynamics of black holes as a core area of their research for many years. They outlined a few simple relationships that lead to thermodynamical concepts.

In appropriate units the area of the event horizon of a Schwarzschild static black hole without spin is given by $A = 16\pi GM^2$. In 1971 Stephen Hawking proved a foundational result about black holes, the Area Theorem, which states that the area of a black hole horizon can only increase or stay the same, $\Delta A \geq 0$; if mass goes into a black hole, it gets bigger. Then, in 1973, Bardeen, Carter, and Hawking developed a theorem that relates small changes in M and A due to perturbations about the static black hole. In its simplest form it says $\delta M = \kappa / 8\pi G \delta A$, where κ is the surface gravity of the black hole, a measure of the curvature near the black hole horizon. For the Schwarzschild black hole, $\kappa = 1/(4M)$. So smaller black holes have higher surface gravity, reflecting the fact that a smaller sphere is more tightly curved. These two ideas led to the suggestion that these relations actually describe black hole thermodynamics,

in analogy with the second and first laws $\Delta S \geq 0$ and $\delta E = T \delta S$, where E is energy, T temperature, and S entropy. According to special relativity, mass and energy are equivalent. The analogy implies that the area is entropy and that the surface gravity is a temperature. However, if a black hole has a temperature, then black holes should radiate, contradicting the definition of a black hole! Then in 1975 Hawking published "Particle Creation by Black Holes," a calculation that has been a cornerstone in any attempt to understand quantum gravity. The particles have a black-body spectrum at temperature $T = \hbar \kappa / 2\pi = \hbar / (8\pi M)$, where \hbar is Planck's constant. Accordingly the process is unstable: as the black hole radiates, it loses mass, the temperature increases, and it radiates even faster. It is not clear what the endpoint is. This has turned out to be a challenging problem. String theorists present models in which the black holes are described by branes inside higher dimensional spaces, and use classical statistical mechanics to compute the excitations of the branes, an area of research in progress in the department. (A brane is a concentration of mass on a lower dimensional surface: e.g., our 4-D world could be a 4-D brane embedded in a 10 D spacetime.)



The two perpendicular arms of the Laser Interferometer Gravitational wave Observatory (LIGO) in Hanford, Washington. Image credits: LIGO Laboratory.



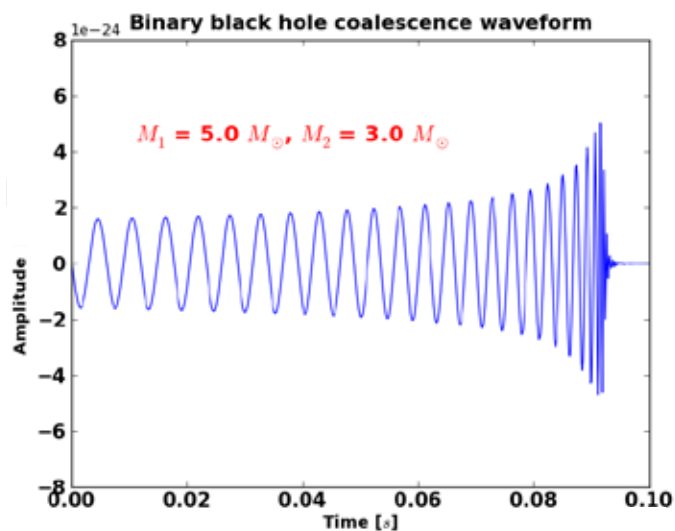
Simulation of gravitational radiation produced by the merger of equal mass black holes. Simulations carried out by the NASA Goddard Space Flight Center Numerical Relativity Group; visualization by Chris Henze at NASA Ames

Black Holes in Cosmology: From the Beginning to the End of the Universe

Professor **Lorenzo Sorbo** considers the role of black holes in cosmology, i.e., in the history of the Universe. He pointed out that although Schwarzschild hypothesized black holes in 1916 from the theory of General Relativity only a few months after Einstein formulated it, more than twenty years elapsed before it was realized that black holes would be the end point of the collapse of massive stars. Only in the '50s and '60s the meaning of the black hole horizon as a one-way membrane was clarified. And only in the '70s was there evidence of actual, astrophysical black holes in our Universe. *What role might black holes play in the past, the present, and the future of our Universe?* Starting with the past, it is usually assumed that a black hole can only appear when a very large mass, e.g. a star, collapses under its own weight. In order for this to happen, the mass of the object has to be a few times larger than the mass of the Sun. This is why we usually think of black holes as very

massive objects that started populating the Universe after the birth and death of the first stars. However, in some of the models describing the first fraction of a second of the Universe, densities were so large that even black holes of smaller masses could form. But black holes evaporate through quantum Hawking radiation, and black holes lighter than 10^{11} kg should have already evaporated during the 14 billion years between their formation and now. So while we do not expect primordial black holes lighter than 10^{11} kg to still exist, our Universe could nevertheless contain a population of heavier primordial black holes that are much less massive than the Sun, whose mass is about 10^{30} kg. Such a population might even constitute dark matter, that mysterious substance making up the ~25% of the content of the Universe. Every now and then the lightest of these primordial black holes would disappear, evaporating into a spectacular explosion of gamma rays that might be observed by some of our experiments. Today black holes store the largest amount of entropy of the Universe. Indeed, each galaxy

harbors a supermassive black hole of millions solar masses, and each black hole has an entropy proportional to the square of its mass. It turns out then that the total entropy in black holes in our observable Universe is about 10^{100} in units of Boltzmann constant (!), about 10 orders of magnitude larger than the next largest contribution to the entropy of the Universe that comes from photons. This means that the most irreversible of all processes, the formation and accretion of black holes,



Waveform that would be observed at LIGO for the collision of two Schwarzschild black holes. Other phenomena, such as seismic events, would have vastly different waveforms. Courtesy of Satya Mohapatra.

has already created most of the entropy in the Universe, and that in a sense the Universe is already closer to its final thermodynamic state than to its initial one.

This brings us to the role of black holes in the future of the Universe. In about a trillion years all stars will have exhausted their fuel, ending up either as black holes (if they are massive enough), or as black, cold objects known as brown dwarves. The Universe will then be a very dark place. As the brown dwarves orbit around the center of the dark galaxies, they will lose energy by emitting gravitational waves, and will eventually be swallowed by the black holes at the center of the galaxies. Thus, if quantum mechanics did not exist, the final state of our Universe would be that of a collection of supermassive black holes. But quantum mechanics does exist! Even these supermassive black holes will eventually evaporate via Hawking radiation (in about 10^{100} years!), leaving a basically empty Universe, with a few photons, neutrinos, and some more massive particles here and there.

The End!

DOES THE EARTH HAVE A NATURAL NUCLEAR REACTOR AT ITS CORE?



Laura Candonati

San Diego scientist J. Marvin Herndon thinks the Earth may have a nuclear fission reactor at its core that uses uranium as a fuel. Uranium is one of the heaviest elements with a density of 19.1 g/cm^3 . He conjectured that when the Earth was molten, the uranium

sank to the center of the Earth, and then could undergo fission by absorbing fast neutrons. Such a natural reactor, now extinct, was discovered in Gabon, Africa, in 1972. However the Gabon reactor could undergo thermal fission as its neutrons could be slowed down by water near the uranium. There should be no water near the center of the Earth for thermal fission, but fast fission is a possibility. Such an Earth-centered reactor would give off heat until neutron absorbing fission products would accumulate to shut the reactor down. When these fission products decayed away, the reactor could start up again. The heat from the reactor could be the energy source contributing to various phenomena, including the production of the Earth's magnetic field. When the reactor shuts down, the field would reach a minimum, and when it starts up again, the field could either reverse, or start again in the same direction. The last reversal of the field was about 780,000 years ago, and some anomalies in the Earth's field have appeared recently. Can this controversial theory explain such anomalies?

Working in an underground laboratory in Italy, UMass Amherst physicists [Laura Candonati](#) and [Andrea Pocar](#), and other international researchers from the Borexino Collaboration measured the flux of antineutrinos from the Earth. They discovered that a significant fraction of our planet's heat is due to decays of primordial isotopes rather than a huge nuclear reactor at the Earth's center. Either there is no such reactor or it is in a quiescent state. Although more work is needed, the Borexino facility provides a new tool for gaining an understanding of the Earth's interior.

NANOPHYSICS

The Physics Department continues to expand its contributions to nanoscale physics and technology. Prof. [Mark Tuominen](#) co-directs the NSF-funded Center for Hierarchical Manufacturing, a research center based on developing new techniques for fabricating nanoscale materials and devices.

Directed self-assembly is one of the cornerstones of the center's research activity. Getting molecules or

nanoparticles to organize themselves into desirable structures that can be used directly or as lithographic templates is of growing importance to the scientific and technological communities. Besides developing new techniques, Tuominen has used these methods to make nanomagnetic materials and devices, including nanoscale rings made of ferromagnetic materials. Alumnus **Deepak Singh** (PhD '06) and Tuominen recently published work in which directed self-assembly was used to construct an artificial Kondo lattice as a prototype system for studying the role of magnetism in unconventional superconductors. The physics of a completely different type of self-assembled system is also being investigated by his group: the properties of conducting biological nanowires. Graduate student **Nikhil Malvankar** has found that the nanoscopic filaments, pili, of specific bacteria show the behavior of organic synthetic metals. The electrical conductivity of these bacterial nanowires can be modulated by electrochemical gating, much like the operation of a field effect transistor.

In other nanophysics research, the group of Prof. **Tony Dinsmore** has investigated the physics of nanoparticles at interfaces. In one project, his group has used self-assembly to place nanoparticles at the interface of two metals, making a Coulomb blockade device that exploits the charging energy of a single electron transfer. In other work, Dinsmore has investigated the adsorption energy of nano- and micro-particles at the interface of two immiscible liquids.

Professors **Narayanan Menon**, **Benny Davidovitch**, **Chris Santangelo** and collaborators have investigated the wrinkling physics of polymer nanofilms. Subject to uniaxial compression, these sheets produce periodic wrinkling patterns that are parameterized by a new “softness” number that quantifies the relative strength of capillary forces at the edge and the rigidity of the bulk pattern.

UNDERGRADUATE RESEARCH

*Editor's note: This article was contributed by **John Quirk**, one of our senior physics majors.*

Undergraduate physics students have the opportunity to sample several areas of research in the department, including high-energy particle-, astro-, condensed matter-, and bio-physics.

Finding a research position is easy. Professors and the Society of Physics Students (SPS) work together to inform physics undergraduates of available positions. The SPS maintains a website with an updated list of research opportunities. Also students currently involved

in research provide help, and last fall the SPS even held a meeting to facilitate student-faculty interactions.

Undergraduates currently involved in undergraduate research have good things to say about their experiences. Senior **Patrick Rogan** says he enjoys the work because he is “seeing an idea from conception to implementation.” Rogan is referring to a device that was built in our machine shop based on his CAD drawings. This allowed him to see his design come to fruition. “There are no courses that offer the same comprehensive experimental training and experience,” says **Colin Jermain**, a senior under the guidance of Professor **Mark Tuominen**.

There are other reasons for undergraduate research. In graduate school or industry, once you have started in one direction, it can be difficult to change directions. Spending some time learning what interests you now can save years in the future. Rogan has had the opportunity to work in several different labs since his junior year. From nuclear to biophysics, he is taking time to diversify his experiences so he can better decide what to focus on later.

Even in the event one changes focus in graduate school, the programming skills learned while doing research are portable. Programs used in many experiments, such as the analysis program ROOT or simulation software GEANT, are not encountered in the physics curriculum. Senior **Alex Lombardi**, one of Professor **Laura Cadonati's** many students, comments that working on the gravitational wave detectors LIGO and GEO “has certainly been a great opportunity to learn some valuable skills.” Not only do undergraduates get the chance to use new software, they also improve their skills with familiar programs, for example, the computational physics course introduces students to programming in MATLAB that can be extended to real research problems, as both Lombardi and another senior, **Kyle Lafata**, acknowledge.

There are still other benefits from undergraduate research. If a student is involved in a research project, the professor in charge can write a letter of recommendation for the student that bears on more than the student's grade record. Research is also a great résumé builder, and in today's job market having a leg-up on other recent graduates can make all the difference.

“A foolish consistency is the hobgoblin of little minds” - Ralph Waldo Emerson

new faculty

DR. NICHOLAS DARNTON



Nicholas Darnton writes: After an undergraduate physics degree at Harvard, I took a several-year break working on a prototype of the Borexino solar neutrino detector in the group of Frank Calaprice, a Princeton University nuclear physicist. I concluded that, although I loved doing physics, I was uneasy working on an experiment so large that I couldn't realistically

understand all its parts. More importantly, during my time under the Gran Sasso Mountain in Italy helping construct the detector on-site, I met my future wife, Laura Cadonati, who accompanied me back to Princeton for graduate school, where I turned to biophysics. In Bob Austin's group I worked on protein folding experiments and modeling and construction of low-Reynolds number mixing devices. This was the scale of experiment I was looking for – a handful of people working on a table-top-sized experiment – but I found the theory of protein folding to be frustratingly far from experiment. As a postdoc, I moved closer to “real” biology: I worked with Howard Berg at Harvard, who, though trained as a physicist, operates out of the Department of Molecular and Cell Biology. Howard works principally on the signal sensing and processing that lead to statistically well-defined swimming behavior in *Escherichia coli*. This science appealed to me: a simple, elegant, biologically important phenomenon that can be described by simple physical and chemical interactions and probed on a table top with thousand-dollar rather than million-dollar experiments. There are many unanswered questions about how *E. coli* senses and responds to its environment, despite the fact that it is probably the best-studied organism on Earth. Equally important for a physicist trying to do biology, the care, feeding and genetic manipulation of *E. coli* has been worked out by a generation of biologists: the techniques are well-established and often commercially available.

After a three-year stint as a visiting professor at Amherst College, where I confirmed that I love teaching, I started at UMass Amherst as a lecturer this September. This position offers me opportunities on all levels, from teaching introductory courses (a chance for showmanship), to graduate courses (a chance to think deeply about physics), with the option of doing as much research as I find enjoyable (with the support of my biophysicist colleagues).

I plan to continue some experiments that I began at Amherst College. They could be described as being on “statistical mechanics in bacterial locomotion”. Two of the projects are:

- *Thermodynamics of flagella*. Bacterial flagella are helical propellers that occasionally switch from left-handed to right-handed helical forms. This involves the massively cooperative transformation of tens of thousands of identical protein subunits. By measuring the statistics of the transformation under controlled conditions, I should be able to calculate the relative free energies of different polymorphic forms.
- *Chemotaxis*. Bacteria usually swim around in media with

chemical gradients: e.g. a solution in which the concentration of glucose is non-uniform. Without such a gradient, a bacterium would swim around in a random walk. In the presence of a gradient the random walk becomes biased. The biochemistry of this behavior is well understood at the single-flagellum level, but there is clearly some cooperativity (perhaps due to hydrodynamic interactions) between different flagella. This cooperativity has rarely been measured, and its implications for the statistics of the biased random walk have not been fully thought out. By measuring the motion of cells with different numbers of flagella, I should be able to determine how independent flagella actually are, and whether the interaction between flagella affects the chemotactic sensitivity of *E. coli*.

DR. MARIA KILFOIL



Maria Kilfoil is an Assistant Professor and a Principal Investigator in the Biological Physics group. Her main area of research is in cell mechanics. This includes a study of complex fluids and gels that make up the background polymer skeleton of the cell, the cytoskeleton. This cytoskeleton is made up of actin filaments and microtubules against which forces may be exerted by the cell to perform its various movements. She is also studying the motion of the other parts of the living cell's architecture during these movements so as to gain insight into the dynamics and forces exerted. In the latter projects, her main interest is cell division, where the components of the cell cytoskeleton form an architecture called the mitotic spindle. In these studies, the motions of the force generating molecules or the DNA itself are tracked by using a type of microscopy that can acquire sample images in three dimensions. Analysis of the 3D images with software she developed can extract the motions in fine detail. By tracking the motions of microscopic beads in a rheological characterization, she can also study the viscoelastic fluid response to an applied deformation. She finds it extremely fascinating to try to learn about the design principles of the cell as well as possibly contribute to new therapeutic methods by viewing the motions of actual processes in living cells.

Maria has taken advantage of the opportunity her research provides to travel. In a postdoctoral position in New Zealand she developed a method to measure the orientation of polymer segments subjected to strong flow. This was done by combining spectroscopy with the use of pulsed magnetic field gradient NMR microscopy to study velocity of spins in rheological devices built to work inside the bore of an NMR magnet. She moved to light microscopy in her postdoctoral position at Harvard University in the soft condensed matter group of David Weitz. Maria was an Assistant Professor of Physics at McGill University in Montreal, before joining our faculty in September. Now Maria feels lucky and delighted that she can teach and conduct research in beautiful western Massachusetts, which reminds her of New Brunswick, Canada, where she was born and grew up on a farm. When not working, Maria can be found enjoying her surroundings and skiing or running in the woods and hills, depending on the season.

graduate students, new and old

GRADUATED IN 1990



Huxiong Chen



Alina Cichocki



Robert Dionn



Kimberly Godshak



Morgan Evans



Marc Frodyma



Christopher Koh



Sukeshi Sheth



Ira Smailer



Eva Vernerova

1990 MS and PhD graduates not pictured: David Buckley, Judith R. Fleischman, Suzanne C. Madden, James A. Morgan, Sudha A. Murthy, Kenneth A. Ritley, Jacqueline A. Schoendorf, Satoru Suzuki, Axel Weichert

ENTERED IN 2010



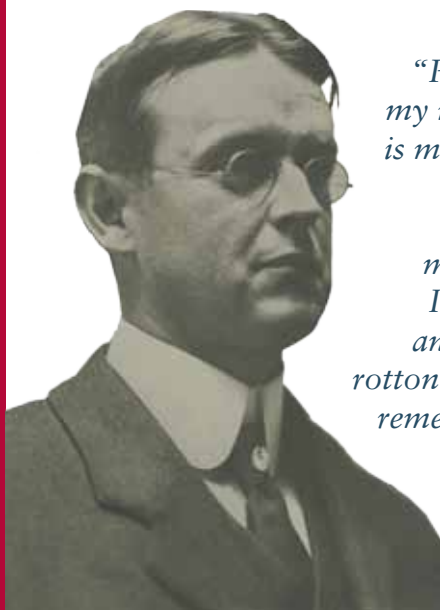
From Left to Right: Derek Wood, Thorsten Heusser, Nikolai Leopold, Tom Goldstein, Tom Hall, Wenming Ju, Keith Otis, Candace Harris, Kieran Ramos, Nina Zehfroosh, Wen Long Wang, Qingze Wang

Not pictured: William Barnes

A CENTENNIAL YEAR

Philip Bevier Hasbrouck Jr.
by Barbara Scudder Wilson BA'70

Barbara Scudder Wilson, great-granddaughter of Philip Hasbrouck, has written a biographical sketch of Hasbrouck that also gives the academic flavor of the college at the turn of the 19th century. In 1911, the year the department was founded, post-Newtonian physics was just emerging. After Einstein's interpretation of Brownian motion showed that atoms were real, Rutherford discovered that at the center of every atom was a tiny massive core, the nucleus. The department was slow in getting started, as was modern physics.



Philip Bevier Hasbrouck Jr. in 1906.
Photo courtesy of the University Archives.

*“Philip Hasbrouck is
my name and Guilford
is my Station this earth
to be my dwelling
place and Christ is
my Salvation; When
I am dead and gone
and all my Bones are
rotton When this you See
remember me that I am
not forgotton.”*

Philip Hasbrouck's
Book of Arithmetic,
December 4, 1798

The quote above was written in a script so perfect it belied the youth of the author. The misspelled words and wit were evidence of a late eighteenth century youth who had tired of his studies and dared to put to pen the question of his mortality knowing that his schoolmaster would see the clear evidence of a lapse in concentration. Two generations later, Philip Bevier Hasbrouck Jr. (1870-1924) at 16 was continuing the Hasbrouck scholastic tradition at the New Paltz (New York) State Normal School, never knowing that he would ensure his own immortality by creating the Department of Physics at Massachusetts Agricultural College.

Philip Bevier Hasbrouck Jr. was born on March 2, 1870, the only child of Louis and Amelia DuBois Hasbrouck, 6th generation descendants of French Protestants who fled the Reformation in Europe and landed in New York in the flourishing settlement of Kingston between the years of 1661 and 1675. By September 1677, the Huguenots were able to secure for twelve of their number land grants from James I of England. The land the Huguenots settled was to become New Paltz, New York. Philip's ancestors worshipped in the Protestant Reformed Church and became involved in farming and commerce. They were a hard working, devout and proud people who passed their land and stone houses down through their families for generations, and also contributed many exceptional leaders to the growth of this country.

At the Normal School Philip did well. His quarterly reports present the first evidence that Philip studied physics. In the semester before his graduation, his physics grade was 88. Philip attended Rutgers College, graduating in 1893 with a BSc in civil engineering. In 1895, he applied for a teaching position at Massachusetts Agricultural College.

Henry Hill Goodell, president of the college, was an administrator who was open to change and growth. Enrollment had been slow during the 1870's: "Mass Aggie" had three presidents before it had one student! With President Goodell's administration momentum was building. Philip was hoping to become a part of the new energy at Mass Aggie. Though Philip had no teaching experience, in 1895 President Goodell hired him to teach mathematics. Goodell had full confidence in the ability of each faculty member to advance his own department. He granted his newest faculty member the same respect. He was not disappointed. A letter has been in Philip's family for years that demonstrates the affection President Goodell had for Philip when he addressed it "To the quiet eyed Philip..."

By 1897, Philip Hasbrouck had settled into his teaching position and was planning to marry Carrie Van Valen of Poughkeepsie, New York. Letters written in the year before their marriage are mostly about planning to set up housekeeping in Amherst. Philip had found a house to rent from a "Mr. Phillips." He considered it to be perfect for its view and privacy, but worried that it might be too remote a location for Carrie. It was a ten-minute walk to the Post Office in Amherst. The house has now been razed, but it stood on the land where the new Visual Arts Building now stands.

From 1895-1902, Philip was Assistant Professor of Mathematics at Mass Aggie. The Hasbroucks loved Amherst, but each summer they traveled with their young son Louis to the family farm in New Paltz, always returning to Amherst in time for Philip to greet the incoming freshman class in the fall. Professor Hasbrouck was intimidating to the young students entering the college, but soon he was in great demand as an advisor. His "boys" loved him. A story was told several years ago by one of his students who laughed affectionately as he remembered "Billy" Hasbrouck. It seems that Professor Hasbrouck was a demanding taskmaster who was able to get his students to achieve what he expected of them. In doing so he was "stubborn as a billy goat." He soon earned the nickname "Billy", and it stayed with him until the day he died.

From 1902-1911, Philip Hasbrouck was an Associate Professor of Mathematics. In 1905, he became Registrar of Massachusetts Agricultural College. Though every student was required to take a one-semester "General College Physics" course, there was no separate physics department. In 1911, one was created and Philip Hasbrouck became its first professor.

It was during this time that Philip hired an architect to build a home for his family on Fearing Street in Amherst. It was to be a stone house reminiscent of the stone houses of New Paltz. The house still stands today at 93 Fearing Street, and was recently acquired by the University from the Hasbrouck

UMASS AMHERST PHYSICS CLUB PROSPERS IN 2011

*The Physics Department has a chapter of the national Society of Physics Students (SPS), and this year the 20 members are more active than ever with **Kyle Lafata**, one of our senior physics majors, as its president. He contributed this article to our newsletter. Another contribution from the SPS on undergraduate research may be found on page 9.*

One of the main focuses of the club is to encourage undergraduate research. Students are actively involved in a wide array of projects, which include work in particle, nuclear, condensed matter, medical, and biological physics, gravitational wave detection, and neutrino oscillations. At weekly SPS meetings students present their research to fellow classmates, followed by time allocated for critiques. Results were also presented at the Five College Undergraduate Physics Symposium held at Amherst College in early November. Eleven students gave oral presentations or discussed their work in poster sessions. A similar event is planned at Stony Brook University in April. Through the national SPS students have the opportunity to do research at laboratories such as the Jefferson National Laboratory in Virginia, the Mayo Clinic in Minnesota, and even at institutes in Germany and Italy.

Our local SPS chapter is also trying to develop a network dedicated to interacting with alumni. This effort was put in motion when Ben Scott, class of '99, talked to the group in November about how his physics education led him to financial services, giving majors a rather different perspective of the many options the physics degree offers. A strong alumni connection will continue to provide students with a remarkable resource as they consider their futures as young physicists. SPS is looking for other alumni to speak to our group. If you could do so, contact us at umass.edu.sps@gmail.com.

Community outreach is an important part of SPS, a valued feature passed down from the national to the chapter level. Our group reaches out to the campus community by holding weekly tutorials for the introductory freshman physics courses, thus helping younger students in making the sometimes-demanding transition from high school to college level course work. During the spring semester, the group is also planning a science fair for elementary school students in the Amherst community in an effort to get them involved with science at an early age.



before his 54th birthday Philip Bevier Hasbrouck Jr. died of heart failure. Memorials were planned which gave the college community, his Amherst friends, and his “boys” a chance to share memories of a life well lived, but cut tragically short.

Massachusetts Agricultural College continued to grow, though rather slowly. In 1931 it became the Massachusetts State College. The first “physics majors” graduated in 1939, and in 1941 the department had three faculty members. The second world war brought many changes, in part because of many new students, who came primarily from military programs and were seen marching formally from building to building. In 1947 Massachusetts State College became the University of Massachusetts. The Physics Department grew too, with a further major expansion in 1963 when the “Gluckstern era” began.

The department was located at various times in the Botanic Museum, one of the five original buildings on campus (1867), and the Old Flint Chemistry Building. In 1949, the Physics Department was able to move from cramped quarters in one of the original buildings to the three-story Hasbrouck Laboratory. On October 30, 1965, a new south wing of the Laboratory was dedicated, so-called New Hasbrouck.

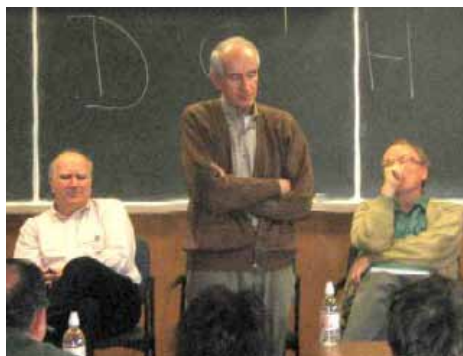
One hundred sixteen years ago the Physics Department at Mass Aggie was a seed beginning to germinate in the mind of a determined young man from New Paltz. The decades following his death saw numerous successors who shared Philip Hasbrouck’s passion for the Physics Department and helped shape it into the department it is today. Today the words “Hasbrouck Laboratory” are chiseled into stone above the main entrance of the Physics Building reminding us of its beginning. The words of another Philip Hasbrouck might be recalled, “When this you see Remember me ...” Philip Bevier Hasbrouck Jr. (1870-1924) will not be forgotten.



AMHERST PHENOMENOLOGY WORKSHOP

On October 22-23, 2010, our department was host to the Amherst Phenomenology Workshop, also called the “DGH Fest,” held to honor the high energy/nuclear phenomenology group: Professors **John Donoghue**, **Gene Golowich**, and **Barry Holstein** (DGH). The meeting was organized by two of their former students, German Valencia of Iowa State University and Alexey Petrov of Wayne State University. Many of the nearly two-dozen students who received PhDs under the group’s direction since 1980 returned to campus for the meeting, together with previous and current postdocs and collaborators.

In addition to local participants, among those who attended were former students from India (K.S. Sateesh) and Colombia (William Ponce and Carlos Ramirez), collaborators from Switzerland (Daniel Wyler) and Hawaii (Sandip Pakvasa), and former postdocs now at Penn State (Rick Robinett) and NC State (Dean Lee). During the two-day meeting many of these participants spoke about their research in nuclear/particle theory covering a wide range of topics, including charm (Petrov), beauty decays (Ramirez), nuclear physics on the lattice (Lee), momentum space quantum mechanics (Robinett), and galactic neutrino communication (Pakvasa). In addition three former students gave very interesting talks about their work outside of physics: Antonio Perez spoke of his work as a New York City investment banker, Fabrizio Gabbiani discussed his position in the IT department at Epic Systems Corp., and K.S. Sateesh outlined his work for IBM in India. Emeritus Professor Lincoln Wolfenstein, from Carnegie-Melon University (CMU), still vigorous at age 87, spoke on neutrino physics, and reinforced the local connection to CMU, since both Donoghue and Golowich had postdocs at CMU, and Holstein received his PhD there. The connection with CMU is being renewed by former student Andi Ross, who is beginning a postdoc there. Later in the meeting a poster was presented which traced DGH’s academic genealogy back to F. Leibniz in the 17th century!



Over the years the DGH group worked on many projects of mutual interest. Indeed, the SPIRES search engine shows four papers co-authored by Holstein and

Golowich, 50 by Donoghue and Holstein, 25 by Donoghue and Golowich, and 15 by Donoghue, Golowich, and Holstein, including their well-known text, *Dynamics of the Standard Model* (Cambridge University Press, 1992), an oft-cited reference nearly 20 years after its publication. The group has been supported by the National Science Foundation for its entire 30-year period of existence.

Of course things evolve, as is true of the DGH group. Holstein retired in 2008 after 37 years in the department, and Golowich will retire at the end of the year after 43 years. Only Donoghue will remain. Nevertheless, both Golowich and Holstein will no doubt remain active.

All who attended the DGH Fest enjoyed the opportunity to meet old friends and catch up on news. Thanks go to Alexey Petrov and German Valencia, and their “collaborators” from the 11th floor, Ann Cairl and Mary Ann Ryan, for their hard work in organizing a memorable occasion. Pictures from the event, content of the talks, as well as the academic genealogy can be found at <http://physics.wayne.edu/DGHfest/>.

OUR NEW MAN IN THE MACHINE SHOP



Our machinists Walter Pollard, Rick Miastkowski, and Richard Letendre

Rick Miastkowski has come to us from the Civil and Environmental Machine Shop in Engineering, here at UMass Amherst. One of his principal jobs in the physics machine shop will be to revive our student shop.

Some of you may remember the good old days when you went to the student shop in Old Hasbrouck to drill some holes, or make a simple gadget quickly for yourself. In addition, there were classes to help students get started. All that has somehow faded away. But now the student shop in Old Hasbrouck has moved to what used to be the carpentry shop in New Hasbrouck and Rick is going to revive it.

Rick is interested in research and design, and before coming to us had extensive experience with Pioneer Valley businesses. At UMass Amherst, many departments used to have machine shops, but no longer; the Physics Department is one that still **does** have a shop – which is used both by the department, and also by other departments.

faculty awards

DEPARTMENT WINS TWO PRESTIGIOUS NSF CAREER AWARDS

Egor Babaev has been awarded a \$425,000 Faculty Early Career Development (CAREER) grant by the National Science Foundation. Babaev's research focuses on condensed matter physics. He will use the funding to investigate possible new states of matter that may arise at extreme conditions, such as ultra-low temperatures and/or ultrahigh pressures. See the back page for Egor's picture.

Laura Cadonati has been awarded a \$700,000 CAREER grant by the National Science Foundation to foster her research group's efforts to detect gravitational waves as part of the LIGO project. This award is NSF's primary vehicle to "support junior faculty who exemplify the role of teacher-scholars through excellent teaching and outstanding research."

As an outreach activity, Cadonati is preparing lectures on gravitational waves and their detection together with hands-on activities for K-12 students, Girl Scouts, and other groups of young people.



Laura with husband Nick Darnton, Byron (5), Chiara (11), and Leonardo (born 12/6/10).

DONOGHUE AWARDED: "OF TIME AND EMERGENT SYMMETRY"

Professor and formerly Department Head **John Donoghue's** research exploring the possibility that light and other waves could be manifestations of a different reality than we have always believed is so daring it had little chance of being funded through normal channels, he acknowledges. But he recently was awarded \$89,610 to pursue it, thanks to the nonprofit "virtual institute," Foundational Questions Institute (FQXi), whose mission is to support ideas that advance "a deep understanding of reality but are unlikely to be supported by conventional funding sources."

This year's competition gave special emphasis to the study of time. "Science, and particularly physics, has produced dramatic insights into the nature of time. . . Careful consideration of time has likewise caused

revolutions in physics, and may again do so." Winning proposals addressed questions such as whether time can run differently in different universes; if time started, when and how; whether the nature of time is intrinsically different from the nature of space; whether according to FQXi, we can travel back in time, and if not, why not?

In describing his own project, Donoghue points out that in everyday life, we encounter sound and water waves as the large-scale result of atoms interacting with each other at the microscopic level. By contrast, light waves are thought to be completely fundamental and present at all scales, no matter how small. Donoghue's "Time and Emergent Symmetry" project explores phenomena dubbed "emergent," which describes the situation where features we see at large scales are not themselves part of the more fundamental theory. He will explore the possibility that light waves and Einstein's Special Theory are also emergent.

This article was adapted from UMass Amherst news "In the Loop" March 2, 2011.

GOLDNER AWARDED 'OPTICS SUPERHERO' GRANT

Lori Goldner has been awarded an "Optics Superhero" Higher Education Grant from Edmunds Optics, Inc. Goldner is developing state-of-the-art optical equipment that allows microscopic examination of single biomolecules and their interactions with their environment. Tightly focused laser beams serve as "optical tweezers" to position submicron sized droplets of fluid containing the molecule, thus acting as a tiny test tube. She then investigates the structure and actions of the molecule by using a confocal fluorescence microscope. Ultimately the studies will aid in the development of more effective drugs and advanced nanofabricated materials.



JENNIFER ROSS NAMED COTTRELL SCHOLAR

Jennifer L. Ross has been named a 2010 Cottrell Scholar, one of the most prestigious fellowships for early career faculty in the sciences. Given by the Research Corporation for Science Advancement, the award recognizes leaders in integrating science teaching and research at leading U.S. research universities. Ross' Cottrell project involves research on single molecule imaging of microtubule motor proteins. The Cottrell award also supports an interdisciplinary optics course created by Ross.



student awards

UNDERGRADUATE AWARDS MAY 2010

Chang Freshman Award
Jason Stockwell

Chang Transfer Student Award
Vinay Shah

LeRoy F. Cook Jr. Memorial Scholarship
David Sliski

Kandula Sastry Book Award
Colin Jermain

Hasbrouck Scholarship Award
Karthik Prakhya
John Quirk
Patrick Rogan

Morton & Helen Sternheim Award
Sebastian Fischetti

GRADUATE AWARDS MAY 2010

Quinton Teaching Assistant Award
Adam Blomberg
Jessica McIver

Kandula Sastry Thesis Award
Barbara Capogrosso-Sansone

COLLEGE/NATIONAL AWARDS MAY 2010

William F. Field Alumni Scholarship
Ashley Bemis
John Quirk



Back row (L to R) David Sliski, Sebastian Fischetti, Vinay Shah, Colin Jermain
Front row (L to R) John Quirk, Jessica McIver, Jason Stockwell, Patrick Rogan

**Beyond the Search Engine:
Computable Knowledge**

Christopher Haydock received his PhD in 1982 under the guidance of Professor Kandula Sastry. He has worked as a biophysicist at the Mayo Clinic in Minnesota and is now president of Applied New Science LLC. Here he gives us his vision of how Computable Knowledge may be used in academia.



Editors' note:

We all realize that computers have dramatically affected our lives. Another great transformation may be in progress. What might it be? Perhaps you have seen the quiz show "Jeopardy!" that pitted IBM's Watson, a robot answering machine, against two humans. Such machines may eventually force us to change what we learn and how we think. Questions will be raised, such as "How do we educate students for a labor market in which machines answer a growing percentage of the questions, and how do we create curricula for uniquely human skills, such as generating original ideas?"¹

In the past decade most of the undergraduate level knowledge across a very broad range of disciplines is only a few clicks away on the Internet. The next decade probably will see this extended to graduate level core knowledge. This is searchable knowledge. All this knowledge in the form of text and formulas that exist somewhere on the Web can be accessed by entering a natural language query in your favorite search engine. But wait, why can't the same natural language query access solutions to specific problems? This is computable knowledge. Enter your query not in a search engine, but in a computable knowledge engine. Potentially, a non-physicist could solve a physics problem by describing it in plain English without any in-depth understanding of the detailed steps necessary to solve it.

The recent introduction of Wolfram Alpha² dramatically increases everyone's access to computable knowledge. Further advances tailored for scientists and engineers may enable physics departments to expand interdisciplinary programs while maintaining their traditional strength in teaching core courses and training future physicists. These educational benefits should result from the ease with which computable knowledge can flow between departments in many different disciplines.

Suppose that a physics department hires a new faculty member who is interested in energy conservation in buildings, and who develops tools and methods to maximize the energy performance of buildings. Many other academic departments may have useful knowledge. The American Society of Heating, Refrigerating and Air-Conditioning Engineers³ gives an overview on building performance. Public health and industrial psychology departments have knowledge of worker productivity and comfort. Architecture departments have knowledge about building code standards that integrate design, construction, operation, maintenance and refurbishment processes. Computer science departments have knowledge about algorithms and software applicable to building systems. Other examples could be given.

Various kinds of departmental knowledge probably have sufficient structure to be computable and accessible in completely free-form unstructured ways. Students and researchers could get answers to natural language questions, not just preexisting documents that match keywords. The basic methods by which Wolfram Alpha could accomplish this are outlined in Stephen Wolfram's January 26, 2011 blog post,⁴ which was inspired by the recent publicity surrounding IBM's Watson project. The opportunity might be apparent to a physicist who wants to solve ordinary differential equations that describe the interaction of heating systems, structural components, air masses, and external energy sources or sinks. At present this would probably be done with a software package such as EnergyPlus and only after studying its inner workings.⁵

Clearly academics have a great deal of work to create structured knowledge such as inside the EnergyPlus building model and realize the promise of the easy interdepartmental flow of computable knowledge, but such advances should bring new opportunities to solve real world problems.

¹Stephen Baker, Wall Street Journal, page A17, March 14, 2011.

²Wolfram Alpha, www.wolframalpha.com

³ASHRAE Research Strategic Plan 2010-2015, www.ashrae.org/technology/page/39

⁴Stephen Wolfram, "Jeopardy, IBM, and WolframAlpha," log.stephenwolfram.com/2011/01

⁵EnergyPlus Engineering Reference, www.energyplus.gov

chrishaydock137@mac.com

Matthew Breuer (MS '02) writes: Working in Mark Tuominen's lab as an undergraduate and then with the Medium Energy Nuclear Physics group under the guidance of Prof. Ross Hicks were great experiences



that led after graduation to work in industrial research labs. I spent nearly a year on a fuel cell project at the University of Connecticut Storrs Environmental Research Institute working with a team building a prototype fuel cell stack as a pilot project for Connecticut Light and Power. After that I worked about a year at Molecular Metrology in Northampton. There I

supported fabrication and delivery of multi-wire drift chambers and overall small angle X-ray scattering systems used in materials research in molecular structure measurements. Since 2004 I have worked in West Springfield as a device and design engineer for ITT Geospatial Systems in the Scientific Instrumentation Group doing R&D on channel electron multipliers and systems that are principally used in mass spectrometers. We make devices sensitive enough to detect single electrons and which have a gain on the order of 1×10^6 . I am twice a co-patent holder with the lab's principal scientist. Much of the work involves CAD design of detectors, related structures, vacuum chambers, and production fixturing. I'm often given general design directions for detectors, structures, or fixturing and have a lot of freedom in developing the details. It's great fun to get new parts from machine shops and put things together for the first time. Seeing an idea evolve to a final optimized and fully functional design is very satisfying. Some of our detectors are used in mass spectrometers that have shown up in television shows such as the original CSI (Las Vegas).

A few years ago I became involved in co-founding a local 501(c)(3) non-profit organization interested in doing various kinds of research, including alternative energy. We are putting together a lab here in the Pioneer Valley, designing and building an apparatus and planning experiments to investigate plasmas and various types of plasma discharges. I have been interested in plasmas for some years now and look forward to what we may find. During a trip with a collaborating fellow physicist to test and purchase a high voltage power supply near Boston just this week we met a gentleman involved in an MIT lab small scale chamber reproduction of high altitude upward electrical discharges from the tops of

thunderheads – called sprites, elves, or jets depending on the type – a phenomenon being newly studied and characterized. It turns out one of the main professors in the project – Dr. Earle Williams – was whom Prof. Robert Krotkov and I visited in his lab at MIT during my grad days at UMass Amherst. Small world! mbreuer@charter.net

Roger Howell (BS '82, PhD '87) writes: Greetings from New Jersey Medical School Cancer Center. It was a joy to read about the expanding biological physics program at UMass Amherst, especially the addition of new



faculty members to the program. As mentioned, several faculty members contributed to the early efforts of the department in this arena. Their seeds, in the form of graduates, companies, etc., have been planted in many parts of the USA. They, in turn, have produced many more scientists in the field. For example,

here are some of Professor Kandula Sastry's undergraduate and graduate students who went on to become academicians as well as the president of a science company.

Dandamudi Rao (MS '70, PhD '72), Professor Emeritus, UMDNJ New Jersey Medical School
Frederick Fahey (BS '74), Associate Professor, Harvard Medical School

Christopher Haydock (PhD '82) President, Applied New Science LLC

Roger Howell (BS '82, PhD '87), Professor, UMDNJ New Jersey Medical School

Michael Azure (PhD '93), Associate Professor, University of Alabama, Birmingham

I am sure that Drs. Langley, Ford, Rabin, and Rosen had many students as well. Their successes would be of interest to your current biological physics faculty and students, as well as prospective students who are considering enrolling in UMass Amherst.

Wishing you all the very best,
Roger W. Howell
rhowell@umdnj.edu

Alexey Petrov (PhD '97) writes: I received my PhD under the direction of John Donoghue. A year before I graduated, a couple of friends, my wife Tanya (a UMass Amherst Engineering graduate), and I, decided to drive to Washington DC to visit its museums. On the way there I saw a direction sign to Baltimore and suggested we stop to have a look at the city. "No way," I was told, "There is absolutely nothing to see there!!!" A year later I accepted a Postdoctoral Fellowship from Johns Hopkins University in Baltimore. Despite my friends' conclusions, we loved Baltimore! I spent three happy years there before moving to Cornell as a Postdoctoral Research Associate.



Ithaca, where Cornell is located, is a small beautiful town in New York's Finger Lake region, with gorgeous parks and almost no industry. So it was a pleasant surprise for my wife and I when she got an offer from a local company right in the city. She was told "The position opened suddenly, as the engineer who was there before quit to move to Detroit to work in one of the automotive companies. They must have offered him a lot of money," she was told, "Indeed, who in their right mind would move to Detroit!" Sure enough, a year later I got an Assistant Professor offer at Wayne State University in Detroit. So we moved to Michigan!

Wayne State is one of the three Michigan premier research universities. Its physics department is one of the few nationally ranked departments in the university. At that time the department was going through the process of rebuilding. While many groups were already settled (like the Experimental Nuclear Physics Group, one of the largest in the country, with four professors involved with research in heavy ion collisions at STAR and ALICE at RHIC), theoretical particle physics was not quiet there yet. But I embraced

the challenge! Having the Michigan Center for Theoretical Physics in nearby Ann Arbor, where I was elected to an Associate Membership, was a great help.

Nine years later, my research group has a postdoc and four graduate students and receives steady funding from a DOE grant and my NSF CAREER Award. We work on projects ranging from heavy flavor physics to LHC collider phenomenology and dark matter. We try to be visible! In 2009 I organized a meeting of the Division of Particles and Fields of the American Physical Society (DPF-2009), which was held on the Wayne State campus. It was great to see UMass-Amherst professors, students and postdocs among about 400 participants of this conference! It was so nice to see old friends, that last year German Valencia (UMass Amherst PhD '88) and I decided to organize a meeting in Amherst to celebrate the achievements of the Phenomenology Group headed by John Donoghue, Gene Golowich and Barry Holstein (see page 14). It was a memorable occasion to see familiar faces after so many years. Next time I visit, I'll definitely bring Tanya and our two kids to see their parent's remarkable alma mater!

apetrov@wayne.edu

K.S. Sateesh (PhD '91) writes: I am now in Bangalore, India, working for IBM. It has been just over 20 years since I left UMass Amherst, and it is a good time for reflection. As luck would have it, I was in Amherst just a few months back, walking down memory lane and thinking about things past.



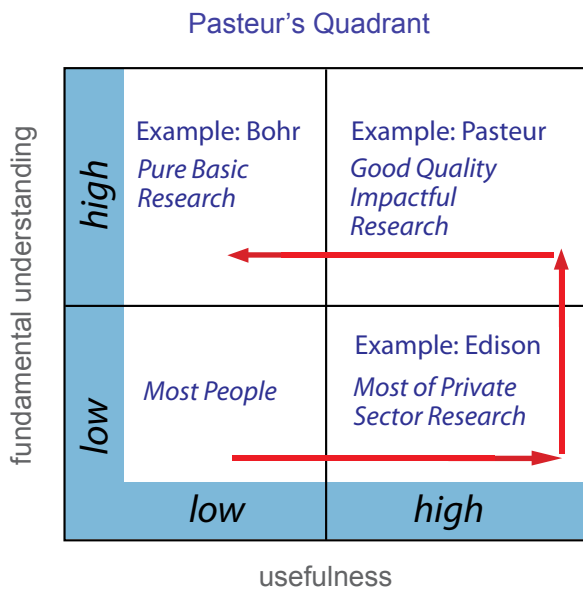
My career has taken me in unexpected directions. After graduating in particle physics with the DGH group (see page 14), I spent a couple more years in the world of physics. From then on it was computers and information technology all the way. My first stop was with a small company, since taken over by a bigger company (both are relatively unheard of and specializing in niche areas). Hewlett Packard was the next stop for nine years. For the last five years, as an IBMer I have played many roles.

I am now working on applying statistical techniques to analyze data from software development. Most analysis of such data is done assuming a neat gaussian

distribution, or at least a well-behaved distribution. In reality however, the distribution is far from that. We are looking at a predictive analysis to potentially determine the effectiveness of various processes adopted by project teams.

In addition I have just taken on the role of IBM's India Standards Leader. In this role I will be looking to work with National and International SW Standards bodies to bring IBM perspective to its attention.

A few days back I was discussing with a research colleague of mine, about life back when I was a student and the work I am doing now. He said "Oh, it looks like you have moved to a different position in Pasteur's Quadrant!" Needless to say he had to elaborate what that was.



Much of private sector research is in the lower right hand quadrant – the “Edison Quadrant.” High impact research is hard to come by and is in the upper right hand quadrant – the legendary “Pasteur’s Quadrant”. The arrows indicate a natural progression from practical to very fundamental questions.

As Lewis Carroll said in *Through the Looking Glass*, “Now, here, you see, it takes all the running you can do, to keep in the same place.” I have been running but not getting anywhere different in a hurry. But, I continue. The time I spent with DGH and the rest of UMass community prepared me with tools to be able to ask any question and start answering.
sateeshks@in.ibm.com

TONY PAPIRIO TO RETIRE

One of our faculty mainstays, Tony Papirio, who has been with us since 1979, has decided to retire before the start of the fall semester. Tony is known to generations of graduate students in his capacity as Senior Lecturer and Director of Teaching Labs. Tony is extremely well organized, and his job is big one, but he always found the time to be innovative in keeping the labs up to date. He gave it his all. It will be difficult for us to imagine our teaching labs without Tony at the helm.



We plan to have a longer article about Tony in next year’s newsletter. Alumni: how about sending us memories of your interaction with him? Send to newsletter@physics.umass.edu.

STUDENT AND FACULTY SURVIVORS

As we go to press, earthquakes, Japan’s tsunami and radiation from nuclear plants are still daily headlines. The editors thought that you would be relieved to know that the following former students and faculty have survived and are well after the recent tragedies.

Tokyo, Japan: Steve Yamamoto

Sendai, Japan: Akio Hotta, Yoshiyuki Sato, Toshimi Suda, Tadaaki Tamae

Osaka, Japan: Tomoaki Hotta

Christchurch, New Zealand: Steve Churchwell

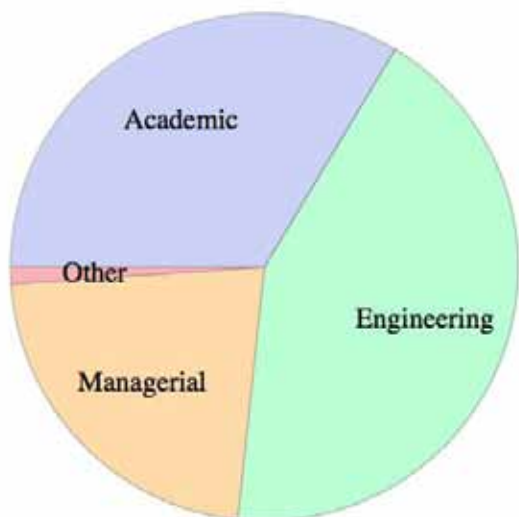
MARK YOUR CALENDAR!

Fall Meeting of the New England Sections of the APS and the AAPT

There will be a meeting on the UMass Amherst campus of the New England Section of the American Physical Society and the American Association of Physics Teachers (NESAPS/AAPT) on Friday and Saturday, November 18 and 19, 2011. The central themes are energy (nuclear and others) and climate change. There may be some Physics Alumni activities, and the Society of Physics Students (SPS) will also be involved. For details, email newsletter@physics.umass.edu.

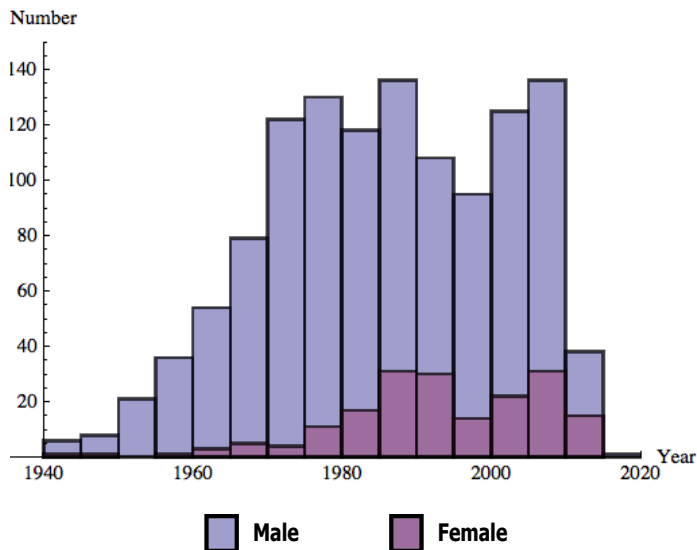
What are you doing? We have information about 500 alumni. The pie chart below shows the fractions in Academia, Engineering, and Management. (The division into these categories is somewhat arbitrary - our database lists occupations by names such as "Patent Lawyer", "Technical Director"...)

Alumni Occupations



We have about 1500 alumni and alumnae. Here is a histogram showing how many come from various class years:

Number of Alumni



We'd love to hear from you! Help us make your newsletter better by responding to a few questions or sending us your suggestions.



Please visit our survey site at www.surveymonkey.com/s/phys-newsletter, or share your comments via email to newsletter@physics.umass.edu or quinton@physics.umass.edu.

1. I read articles in this issue on
 Black Holes Centennial Year
 Departmental Research
 Alumni News All

2. Which sections of the newsletter are of the most interest to you?
 Research Teaching
 Department Head's Letter
 Alumni News Other

3. We have considered including articles concerning physics and society, for example, pros and cons of nuclear power or climate change. Do you think we should publish such material? Yes No

"Alumni News" is always popular. Please send us your news along with your responses and comments.

We, the editors, thank you for your input and look forward to your replies.

- Bob Krotkov krotkov@physics.umass.edu
- Ken Langley langley@physics.umass.edu
- Gerry Peterson peterston@physics.umass.edu
- Arthur Quinton quinton@physics.umass.edu
- Monroe Rabin rabin@physics.umass.edu
- Hajime Sakai sakai@physics.umass.edu

Comments may also be sent to:
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 126 Lederle Graduate Research Tower
 University of Massachusetts Amherst
 Amherst, MA 01003-9337

For more information about our department, visit our website at www.physics.umass.edu

new alumni

Degrees awarded since the Spring 2010 Newsletter

BS and BA Degrees

Samuel Bingham	Alexandros Kiriakopoulos	Jessica O'Conner	Jonah Zimmerman
Jonathan B. Kim	Ian Mann	Shangita Paul	Matthew J. Webber

BS with Honors	Thesis Title	Advisor
Robert Deegan	Preparation of Fluorescence Correlation Spectroscopy System for Observation of Protein Folding	Goldner
Sebastian Fischetti	Analytical and Numerical Relativity in the Search for Intermediate Mass Binary Black Hole Coalescences in LIGO	Cadonati
Keith Fratus	Boosted Decision Tree Muon Tagging in the Borexino Solar Neutrino Experiment	Cadonati
Paul Hughes	Viability of Lead Oxide for Electron EDM Measurements	Kawall
Amanda Lund	Performance Study of the Borexino Solar Neutrino Detector with Calibration Data	Cadonati
Christopher MacLellan	Fabrication of Dielectric Loaded Surface Plasmon Polariton Waveguides via Electron Beam Lithography	Achermann
Matthew Mirigian	Microtubule Mechanics	Ross
Robert Pierce	A Study of the Antarctic Climate System with an Analysis of Increased Ocean Water Temperature and Its Effect on Ice Melting Rates	DeConto (Geosciences)
Richard Rines	Development of an FPGA Processor for Testing a Solid-State Photomultiplier Coupled to a High Speed ADC	Miskimen

MS Degrees

Kiyoto Akabori	Jared Vanasse	Xiangdong Xu
Adam Blomberg	Hao Wang	Yipeng Yang
Anne Dominique Cambou		

MS Degrees	Thesis Title	Advisor
Alessandra Baas	Theoretical and Experimental Aspects of the Higgs Mechanism in the Standard Model and Beyond	Golowich
Robert Boge	Ultrafast TRPL Using TPA	Achermann
Stephan Burkhardt	Efficiency of Parallel Tempering for Ising Systems	Machta

PhD Degrees	Thesis Title	Advisor
Mohamed Anber	Frontiers in Theoretical High Energy Physics: From Physics Beyond the Standard Model to Cosmology	Sorbo
Surachate Kalasin	Understanding and Exploiting Nanoscale Surface Heterogeneity for Particle and Cell Manipulation	Santore
Kan Du	Self-assembly of Nanoparticles at Liquid-liquid Interfaces	Dinsmore/ Russell (PSE)
Jiansheng Huang	Wrinkling of Floating Thin Polymer Films	Menon/ Russell
Nikhil Malvankar	Investigations of Electron Transport and Storage Mechanisms in Microbial Biofilms	Tuominen
Michael Ray	Experiments on Solid ^4He	Hallock
Hongqiang Wang	Experiments and Simulations on Granular Gases	Menon
Sibel Ebru Yalcin	Characterization and Interactions of Ultrafast Surface Plasmon Pulses	Achermann

This lists represents those who contributed to the Department of Physics from January 1, 2010, to December 31, 2010. We apologize for any omissions and kindly ask that you bring them to our attention.

Anderson, Richard
Armstrong, Karen
Azure, Michael
Barber, James
Barrows, Kenneth & Betsy
Blind, Jason
Bloore, David
Bonn, Matthew
Brackett, Elizabeth
Brehm, John
Brody, Herbert
Canning, Francis
Cao, Mengshe
Casali, Roderic
Centrella, Joan
Chan, Siu-Kau
Chang, Edward
Chase, Scott
Chen, Dansong
Clewley, Suzanne
Clinton, Eric
Connors, Raymond
Cote, Laurence
Cronican, Pat
Davis, Christopher
Demski, Edward
Dent, William
Derunk, Christine
Desjarlais, John
Ding, Aimin
Ding, Xuan
Donahue, James
Donoghue, John
Dutton, Laurence
Eisenberg, Jon
Emery, Christopher & Carol
Fahey, Frederic
Fernandez, Juan
Forster, James & Nancy
Fuqua, Stephen & Elaine
Gabbiani, Fabrizio
Galkiewicz, Robert & Rebecca
Gamache, Robert
Goldberg-Scheff, Faye
Gregor, Philip
Grillo, Conrad & Jane
Hamilton, Gregory & Joanne
Harding, Leroy
Heller, Evan
Higley, Robert
Holt, Michael & Karyn
Houmère, Pamela
Huffman, Robert & Kristina
Hulse, Russell
Jagodowski, David
Johnson, Julie
Jones, Phillips & Ereda
Kaufman, Lisa
Kellogg, Patricia
Kendra, Paul
Kepler, Grace
Kinard, Joseph
Kirstein, Per & Linda
Knapton, John

Knight, Joanna
Kolomensky, Yuri
Kuhn, Donald
Lareau, John & Margaret
LaFrance, Martha
Latimer, Margaret
Lawrence, David G. B.
Ledin, Phillip
Legare, Roger
Loring, Margaret
Lundquist, Theodore
Mann, William
Maps, Jonathan
Mathieson, Alfred
Mayo, Charles & Mary Ellen
McAllaster, Donald
McCall, Katherine
Mellberg, Leonard
Mills, Caleb
Mistark, Joyce & John
Montgomery, Edward & Claire
Moore, Steven
Nakos, James
Newton, Steven
Niu, Angela
Nuss, Elizabeth
Oren, Moshe
Ouellette, Elizabeth & Peter
Palecki, Michael
Parker, Karen
Parsegian, Vozken
Pavela, Shelley
Pavlin, Igor
Peltola, Martii
Perkins, William
Peterson, Gerald & Doris
Petrov, Alexey
Polansky, Joseph
Polo, John
Prasad, Satish
Pribram, John
Quinton, Arthur
Quinton, Keith
Radcliff, Thomas
Rogalski, Jeffrey
Roig, Francesc & Kathleen
Romejko, Robert
Rowland, Frederick
Ryan, Thomas & Mary Ann
Rynes, Philip
Sakai, Hajime & Sachiko
Sapp, Edwin
Scheff, Andrew
Schmidt, Ehud & Liora
Schmiedeshoff, George
Shramko, Karen
Shu, Ker-Li
Shurtleff, Richard
Silvia, Thomas
Simenas, Scott
Skinner, Mary
Slavkovsky, Thomas & Martha
Smart, Peter
Smith, Douglas & Kathryn

Smith, Luther
Smith, Peter & Kathryn
Solomon, Harold
Stockwell, Christopher & Joan
Strange, Richard
Takemori, Michael
Theofilos, George
Thompson, Paul
Thompson, Trevor
Tucker, Albert
Uribe, Jorge
Vatcher, Debora
Vokes, Robert & Judith
Wainer, Jonathan
Warner, Jairus
Wei, David & Anna
Woods, Sharon
Yang, Xiaoyu
York, Andrew
Zaff, David & Linda
Zhou, Jing

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In last year's Newsletter we noted that Professor Egor Babaev had been awarded the Tage Erlander Prize in Sweden "for pioneering theoretical work that predicts new states of matter in the form of superfluids with novel properties." The prize is awarded once every four years. This picture has become available since then and shows Egor shaking hands with Svante Lindqvist, the president of the Royal Swedish Academy of Sciences. Facing Egor is Christer Fuglesang, the first Swedish astronaut. The ceremony took place at the Stockholm Concerthouse, the same venue as the Nobel award ceremony.

Photo Credit: Markus Marcentic© The Royal Swedish Academy of Sciences

editor's survey



Did you enjoy reading this newsletter? Did it help you feel more connected to the physics department and your fellow graduates? How can we improve it?

Please turn to page 21 and take a few minutes to complete our short survey. We look forward to your comments or information about yourself for our alumni news section. We hope you enjoy the new look of the full-color newsletter, which we are able to bring to you at minimal extra cost.