150 YEARS

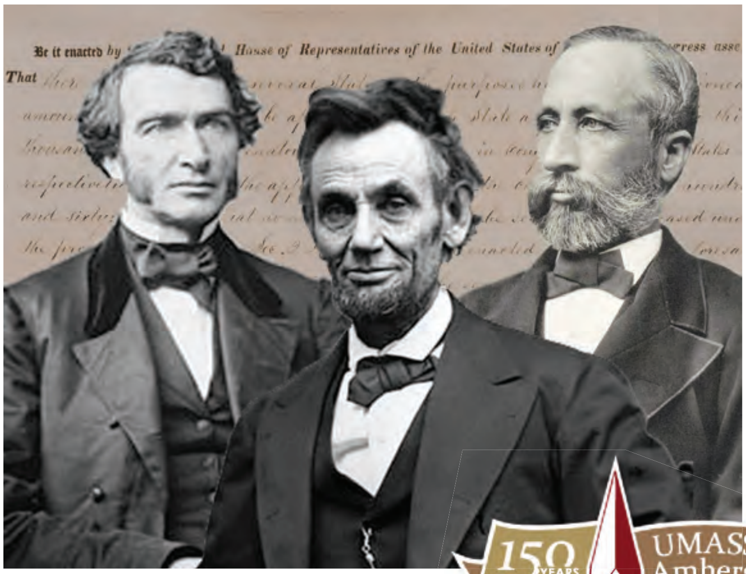
PHYSICS Newsletter

DEPARTMENT OF PHYSICS AT THE UNIVERSITY OF MASSACHUSETTS AMHERST

SPRING 2013 Issue No. 13

the Morrill Act

It could be readily argued that the most significant piece of federal educational legislation ever enacted by the U.S. Congress is the "Land Grant College Act." Better known as the MORRILL ACT, it was signed into law by President Abraham Lincoln on July 2nd, 1862. The University of Massachusetts owes its origins to the Massachusetts Agricultural College (MAC) that came into being as a consequence of the Act the next year.*



Prior to the Civil War there had been over five hundred private colleges in the United States. Many turned out to be on a sound footing, but many not. In fact, by the twentieth century only about one hundred of them had survived. Enrollments were low. For example, in 1846, New York, with a population of one half a million, enrolled only 241 students in two colleges. The curriculum tended to be in the classical tradition in preparation for careers in law or the ministry. There were very few public institutions of higher learning. Perhaps the best known was the University of Virginia, established by Thomas Jefferson in 1819. Wisconsin in Madison got started in 1836, Michigan in Ann Arbor in 1837, and the University of North Carolina at Chapel Hill much earlier in 1789.

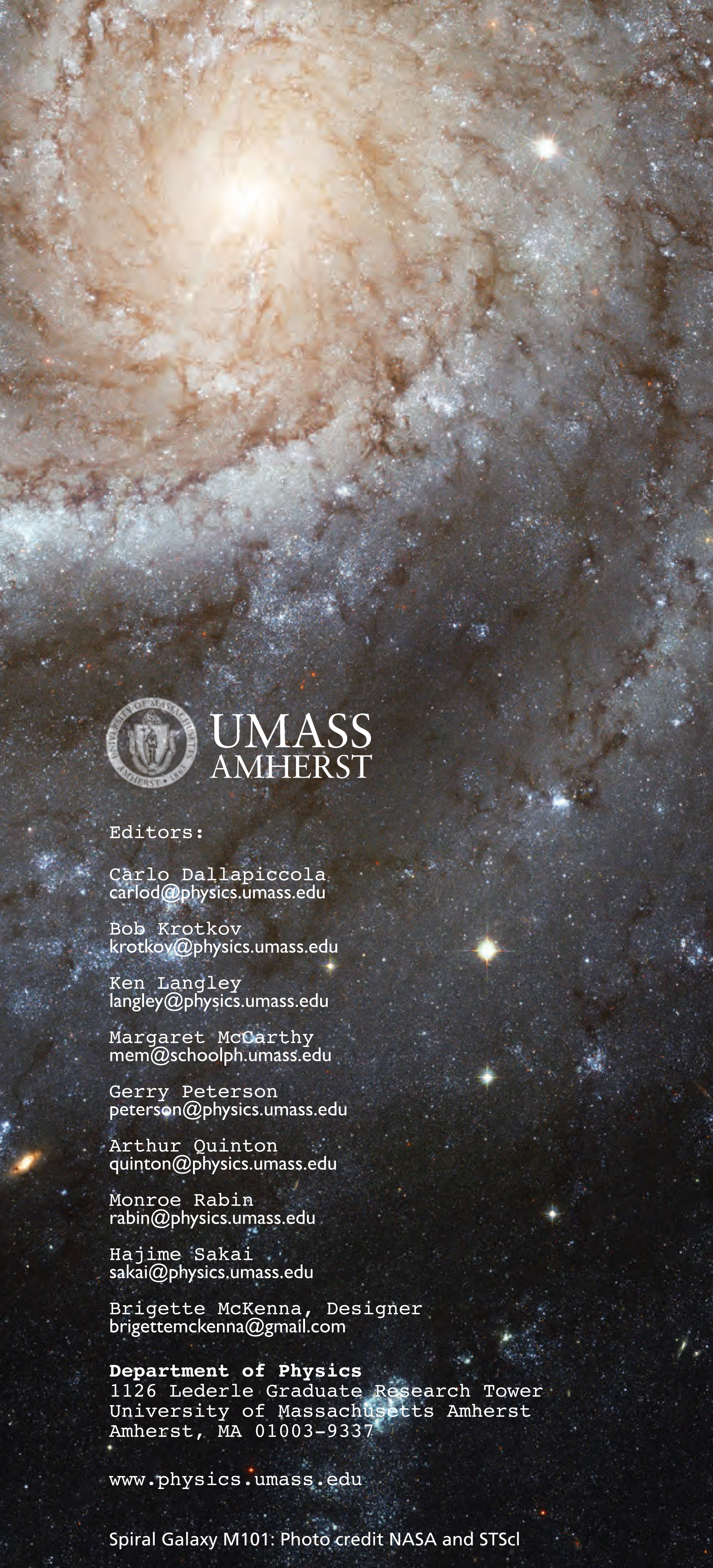
The Land Grant Act changed the situation dramatically. The concept of the creation of public colleges with agriculture and engineering as important components of the curriculum was first proposed in 1857 by the Illinois delegation to Congress. At this stage Justin Smith Morrill, son of a blacksmith and the congressional representative from Vermont, took control and actually got a bill to this effect through Congress in 1859. But it was vetoed by President Buchanan on the grounds that the federal government had no such role in educational matters. But Morrill persisted and resubmitted the bill

Continued page 16

Soft Condensed Matter:

The Buckling and Wrinkling of Thin Sheets

Professor Narayanan Menon's Soft Condensed Matter Group has pioneered the study of elasto-capillary phenomena in ultra thin sheets as thin as 20 nanometers. The image shows such a sheet floating on a water droplet. The yellow ring is the top of a metal jar filled with water that can be pushed upward by a piston below the plane of the figure. The white area is a polyester film floating on a droplet whose surface is between the white and yellow areas. The piston controls the curvature of the drop's surface. If the surface were flat, the film would be a flat disc. As the curvature is increased, wrinkles develop toward the outer radius of the film, introducing bending energy. Full story page 5.



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UMASS AMHERST

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Spiral Galaxy M101: Photo credit NASA and STScl

Dear Alumni and Friends of the Physics Department,

It's a bit hard for me to believe, but as you read this I will have completed my sixth and final year as department head – next year you will get to read a letter from our next head. Far from winding down, however, there have been a lot of exciting new developments in the Physics Department this year.

The most exciting development for a department is the addition of new faculty members, bringing fresh faces to teach our students and opening up new research areas for the department. Our last departmental review identified two key areas we should strengthen with new hires: Condensed-Matter Experiment and Particle Theory. This year, we've met both objectives by bringing to the Department Assistant Professor **Jun Yan**, a young condensed-matter experimentalist, and Professor **Michael Ramsey-Musolf**, a prominent senior particle theorist. Please see the separate articles to learn about Jun's research on the amazing two-dimensional material graphene, and Michael's plans for a new theory center in our department to explore fundamental interactions.

Almost as exciting as new people are new buildings, and we have news on that front as well. Ground will be broken soon for a new Physical Sciences Building, which will house labs and offices for faculty members in Physics and Chemistry as well as a big new "clean room" – a high-tech, ultra-clean facility full of tools to construct nano-scale devices that could be the next generation of computer chips and biomedical devices. The Physical Sciences Building will be located between Lederle and Hasbrouck, so it won't make the Physics Department any more spread out than it is now – in fact it is part of a larger plan to bring the department closer together. In addition to the clean room the new building will include "high bay" labs with twenty-foot ceilings, to enable our condensed-matter experimentalists to install tall cryostats and big magnets, and to enable our nuclear and particle experimentalists to construct large detector assemblies for shipment to national particle accelerator facilities and deep-underground labs.

One thing I am particularly happy to report is our ever-increasing number of physics majors. There have been some growing pains, as the number of students in our courses for majors has exceeded the number of seats in some classrooms and the number of setups in lab courses and computer rooms. However, the result is we are now graduating 20-25 Physics majors every year, up from 10-15 a decade ago. As the readers of this Newsletter well know, our majors bring their knowledge and problem-solving skills to many endeavors: scientific research, teaching, medicine, law, businesses large and small, and many other areas. If you haven't done so already, please do consider sending a brief report to our Newsletter staff so we can learn what our former students are doing now.

Finally, if you are able to make a donation to UMass, consider directing it to your old Department – that way it can directly benefit the next generation of UMass physics majors. For example, we have used some recent donations to set up a fund that helps undergraduate students attend scientific conferences and meetings. Things like this can make a real impact on young minds.

Sincerely,

Don Candela

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413-545-1940

research

HIGGS BOSON

The UMass ATLAS group, consisting of Professors **Ben Brau**, **Carlo Dallapiccola** and **Stéphane Willocq**, together with their graduate students and postdoctoral researchers, has had another banner year in its efforts to shed light on some of nature's deepest mysteries. The story begins with one of the great scientific achievements of the 20th century: the formulation of the "Standard Model" of particle physics, built upon earlier, revolutionary accomplishments in both theoretical and experimental physics. Pieced together throughout the 1960's, it has been the focal point of the ensuing five decades of particle physics research. Ever more ambitious collider projects, stationed at international laboratories spanning the globe, have been carried out to explore every corner, crevasse and wrinkle of the Standard Model.

Given its astounding success, you may wonder why it is then still called a "model." The answer lies in the one aspect of the model that, in all those five decades of experimental probing, had remained mysteriously unexplained. How is it that elementary particles such as electrons and quarks can have mass? The cornerstone of the unification of the fundamental forces is a cherished principle called "local gauge invariance," the validity of which has been rigorously tested by experiments. The price to be paid for endowing fundamental particles with mass is to break the gauge invariance, however. Something has to give – enter the Higgs mechanism! Independently developed in the early 60's by a number of physicists, it was incorporated into the Standard Model as a means to describe a universe with massive elementary particles and unbroken gauge symmetry. It involves postulating a new field, dubbed the Higgs field, that permeates all of space, the quanta of which are observable particles called Higgs bosons. The mass of particles is nothing other than consequences of the interaction of what are fundamentally massless particles with this Higgs field. But what is the nature of this field, if it is even the correct description of how particles obtain mass? Is it a fundamental field, described by a fundamental Higgs boson? Or is it derived from something called "technicolor," whereby the Higgs boson is a composite particle, a bound state of new kinds of particles thus far undiscovered? The Standard Model is only a model because, as of yet, the Higgs mechanism, central to the framework, remains experimentally unexplored.

The cover article of the last newsletter, Spring 2012, ended with the words "Stay tuned!" It was referring to the tantalizing first hints coming from the ATLAS and CMS experiments at the Large Hadron Collider (LHC) of a particle with mass in the range 122-138 GeV/c^2 that could very well be the elusive Higgs boson. In the intervening year, the two experiments have collected roughly three times as much data as was collected in 2011, and at a higher LHC collision energy: 8 TeV in 2012, compared with 7 TeV in 2011. The first results from the 2012 run were famously reported on July 4th, generating headlines throughout the world and even earning ATLAS spokesperson Fabiola Gianotti a spot on Time Magazine's list of runner-ups for "person of the year." Each of the experiments had clear evidence of the existence of a particle with mass around 125 GeV/c^2, but little else could be said about its properties. By the end of the year, when nearly the full 2012 data set had been analyzed, the experiments were declaring unambiguous discovery of a new particle with properties perfectly in line with what would be expected were it the Higgs boson. The figure shows the significance of the excess of events, over the expected background, for different hypothesized values of the Higgs mass. There is a clear peak at 126 GeV/c^2 of around 6σ (where 5σ is considered the threshold at which discovery of a new state can be claimed). The discovery of the Higgs boson is the first of what is hoped to be many exciting discoveries at the LHC.

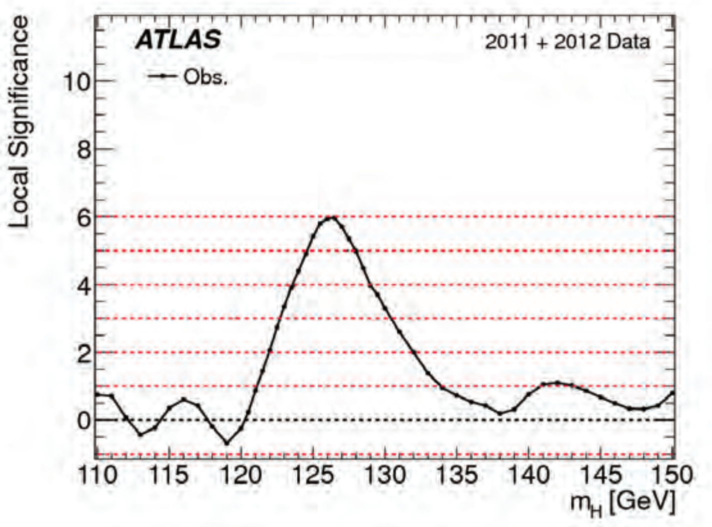


Figure 1: The significance (solid line), in standard deviations, of the observed excess of data over background for different assumed masses of a new particle. There is a clear signal at a mass of around 126 GeV/c^2 (nearly six standard deviations above zero).

The UMass ATLAS group continues to make instrumental contributions to reconstruction and analysis of the data. Their main focus is now on searches for new, exotic phenomena that the discovery of a Higgs boson makes ever more compelling. The LHC is entering a two-year shutdown, during which time the collider will be upgraded so that in 2015 it can begin running at close to its design energy of 14 TeV. Even more exciting results are to be expected!

SOFT CONDENSED MATTER: THE BUCKLING AND WRINKLING OF THIN SHEETS

The theoretical work of Professor **Benny Davidovitch** and his collaborators has been inspired by such experiments. Their work has defined a family of problems that has been dubbed “radial stretching” systems, and may be thought of as the “hydrogen-atom” of morphological complexity in solid sheets.

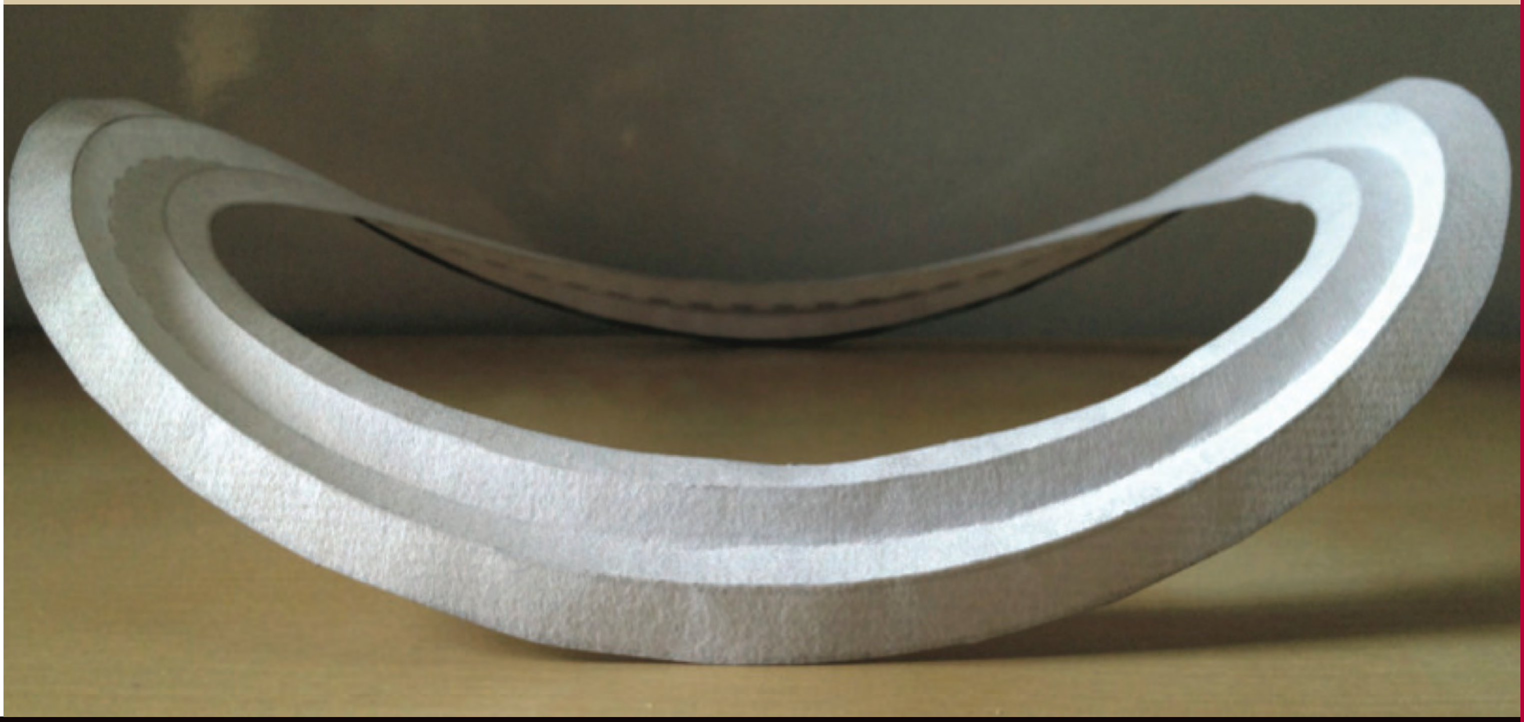
Our Soft Condensed Matter Group carries out research that involves only classical physics. For example, consider the figure below showing an ordinary piece of paper that was originally a flat ring with three concentric circles drawn on it. A fold was made at the middle circle by pressing down on the paper with a thin wheel rolling around the circle. Similar folds were made at the inner and outer circles, this time by a wheel pressing in the opposite direction. When the wheel was taken away, the paper spontaneously buckled to the shape shown.

The work of Professor **Chris Santangelo** has focused on buckling arising from spatially heterogeneous growth or from folding. The figure below is an example of buckling induced by folding. When a thin elastic sheet is bent or stretched, its total elastic energy (the sum of a bending energy and a stretching energy) is minimized. The regions between the folds have no stretching energy.

In general, solid sheets exhibit highly complex morphologies that are often described as wrinkles, creases, crumples, folds, scars, and blisters. A close inspection of a candy wrapper, human skin, or a stretched plastic bag, reveals that many of these patterns often coexist on scales ranging from nanometers to meters. One might ask: Why do films become folded whereas a thick slab of an identical material does not fold? Why does paper tend to crumple whereas rubber sheets smoothly wrinkle? Why do certain plant leaves have a buckled shape, whereas others are flat? Understanding the mechanisms by which complicated patterns in solid sheets emerge spontaneously under featureless forces and geometrical constraints may inspire efficient methods for tailoring desired patterns, or self-assembly of structures at will from a homogenous piece of matter.

Our Soft Condensed Matter group has been a prominent driver in this research frontier, with fruitful collaborations between the experimental work of Narayanan Menon, and the theoretical work of Benny Davidovitch and Chris Santangelo. The group has also developed close ties with members of the Polymer Science and Engineering Department, which has led to numerous publications in high-profile journals such as Science, Proceedings of the National Academy of Sciences, and Physical Review Letters. Furthermore, this work is well funded. See the section on Faculty Awards.

Below: Flat ring of paper with three concentric circles drawn on it, middle folds made by scoring paper with a compass and folding.



MICROBIAL NANOWIRES

Geobacter sulfurreducines is a common bacterium living in soil. Like many bacteria, *Geobacter* has a lot of pili (hair-like structures), each individual hair being a long protein filament. The typical size of a *Geobacter* cell is 500 nm, while a typical hair length can be tens to hundreds of times greater. The width of a hair is only 3 to 5 nm. (See Fig. 1)

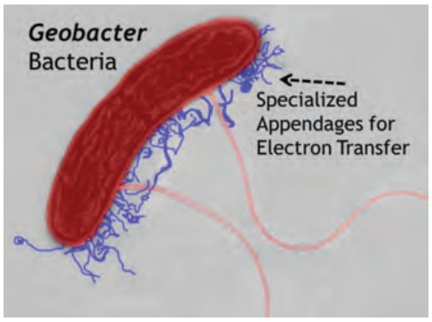


Fig. 1. A Geobacter bacterium (dark red), its pili ("hair") in blue and two flagella (light red).

In 2005, Prof. **Derek Lovley** from the UMass Microbiology department (who discovered the Geobacter species 25 years ago) began a collaboration with Prof. **Mark Tuominen** of our department, a collaboration which led to measurements suggesting that the pili were electrically conductive and could function as "microbial nanowires." Such wires would be very useful to a bacterium: they would help it to "breathe" in harsh environments.

The oxygen breathed in by a human is taken up by mitochondria in cells and takes part in chemical reactions that produce ATP, a molecule that transports energy for many reactions occurring in digestion. A bacterium in soil does not have access to oxygen and instead uses Fe, which is abundant in iron oxides. Geobacter does not "breathe in" the iron but instead sends an electron to reduce Fe(III) to Fe(II). (The bacterium remains electrically neutral by pumping a proton across its membrane.) Long conductive pili give a soil bacterium access to much more iron than would be available immediately next to it, and hence help the bacterium to "breathe."

Nikhil Malvankar was a graduate student in Prof. Tuominen's group, and is now a postdoc with Professors Lovley and Tuominen. To test the idea of conductive pili, he grew living biofilms of Geobacter lying on multiple electrodes. Such biofilms contained a network of pili; it turned out that a biofilm had an electrical conductivity of order 0.5 Siemens/Meter. That is not as large as would be the conductivity of the biofilm if its pili were replaced by copper nanowires, but it is about the same as the conductivity of similar films of conducting polymers.

In many polymers the repeating units are connected by single bonds and such polymers are typically insulators. In polymers where the repeating units are connected by alternating single and double bonds an electron in one of the double bonds is "delocalized" (spread across the polymer chain) and confers a high conductivity to the polymer.

Biofilms of Geobacter have many applications. In one of them the biofilm is the active ingredient in a fuel cell, as shown in Fig. 2. A biofilm of Geobacter coats the anode, while the cathode is in a chamber through which flows an iron-containing compound. Acetate "food" is fed into the anode chamber. To digest this food the biofilm sends out electrons in the direction shown. Protons emitted by the film flow to the cathode through the proton exchange-membrane (PEM) separating the two chambers, completing the electric circuit. Such fuel cells have been found to improve current and power density due to higher biofilm conductivity.

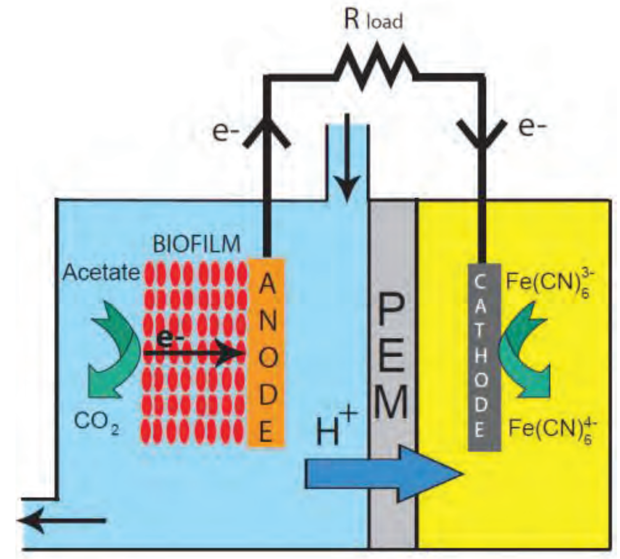


Fig. 2. A fuel cell built around a geobacter biofilm. Acetate "food" flows into the left hand chamber while CO_2 flows out. To "digest" this food the bacteria need to oxidize iron and to do this send electrons and protons in the directions shown.

Another application is in cleaning up radioactive waste. Geobacter in contaminated soil use uranium instead of iron to "breathe." Reduction of oxides in which the uranium is in oxidation state uranium (VI) to oxides with uranium (IV) converts oxides from high solubility ones to low solubility ones. Uranium becomes immobilized in the soil and does not spread.

Other applications include "super-capacitors" in which one electrode of a capacitor is coated with a biofilm. The tangled web of conductive pili increases the effective area of the capacitor electrode and has been found to increase the capacitance by a factor of 60. The specific capacitance and the electrochemical performance of these living super-capacitors are comparable with synthetic carbon-based super-capacitors.

INTEGRATED CONCENTRATIONS IN SCIENCE (iCons)

The world faces daunting challenges in areas such as developing new sources of clean energy, and new ways of generating affordable medicines. Tackling these problems requires big brains working in collaborative teams, focusing many kinds of complementary expertise on developing solutions that last. Providing such academic experiences is precisely what the new Integrated Concentration in Science (iCons) program at UMass Amherst is all about. In its third year, the iCons Program is paving the way as a pioneer in the field of integrative science education. In short, the iCons Program at UMass Amherst is the only one of its kind in the world.

All students in iCons are majors in some field of science, engineering, mathematics, and/or public health. iCons does not replace the major; rather, it enhances a student's major by providing challenges and opportunities to apply knowledge derived from major study, while developing transferable skills in leadership, communication, and problem solving. This is accomplished through an 18-credit program comprising one course per year for the first three years, culminating in a year-long senior thesis project. Two tracks are available in iCons: one in Renewable Energy, and the other in Biomedicine. In the future we hope to open new tracks in areas such as Climate Change and Clean Water. All these are areas of research strength at UMass Amherst.

In the fall of 2012, the program recruited its third cohort of 50 iCons scholars, denoted the Third Axis. (The first cohort is the "First Class" while the second is the "Second Wave.") The three cohorts of iCons students hail from 19 departments across the College of Natural Sciences, the College of Engineering, the School of Public Health and Health Sciences, the Isenberg School of Management, and the Bachelor's Degree with Individual Concentration (BDIC) Program housed in the Commonwealth Honors College. Congratulations to this diverse and trailblazing group of iCons scholars! The Third Axis kicks off their iCons career in iCons 1: Global Challenges, Scientific Solutions. In iCons 1, multi-disciplinary student teams collaborate to develop solutions to real-world problems such as malaria, deforestation, and biomass utilization.

The iCons 2 Renewable Energy class recently visited the UMass Central Heating Plant, and is developing an energy flow diagram for the University. While data abound regarding the campus' energy use, creating visual representations is an unprecedented effort for the UMass Amherst campus. Many campus administrators anxiously await the results of this project, which will inform campus efforts to "go green."

This semester marks the launch of the NSF-funded iCons 3 Renewable Energy lab course. Led by Professor Mark Tuominen of the UMass Physics Department, the iCons 3 Renewable Energy lab begins with a "bootcamp" that trains students in safe and informed operation of lab equipment relevant to renewable energy experiments. Over the course of the semester, iCons students in the lab will transition to designing their own experiments to investigate important problems in energy sciences.

Next year, iCons 4 Interdisciplinary Research, a senior thesis project involving student laboratory research and a capstone project based on their chosen theme, will be taught by physics Associate Professor Courtney Lannert. The Physics Department has strong ties to the iCons program with three faculty members partaking in various levels of involvement. In addition to his teaching role, Professor Tuominen is a member of the steering committee along with physics Professor Tony Dinsmore.

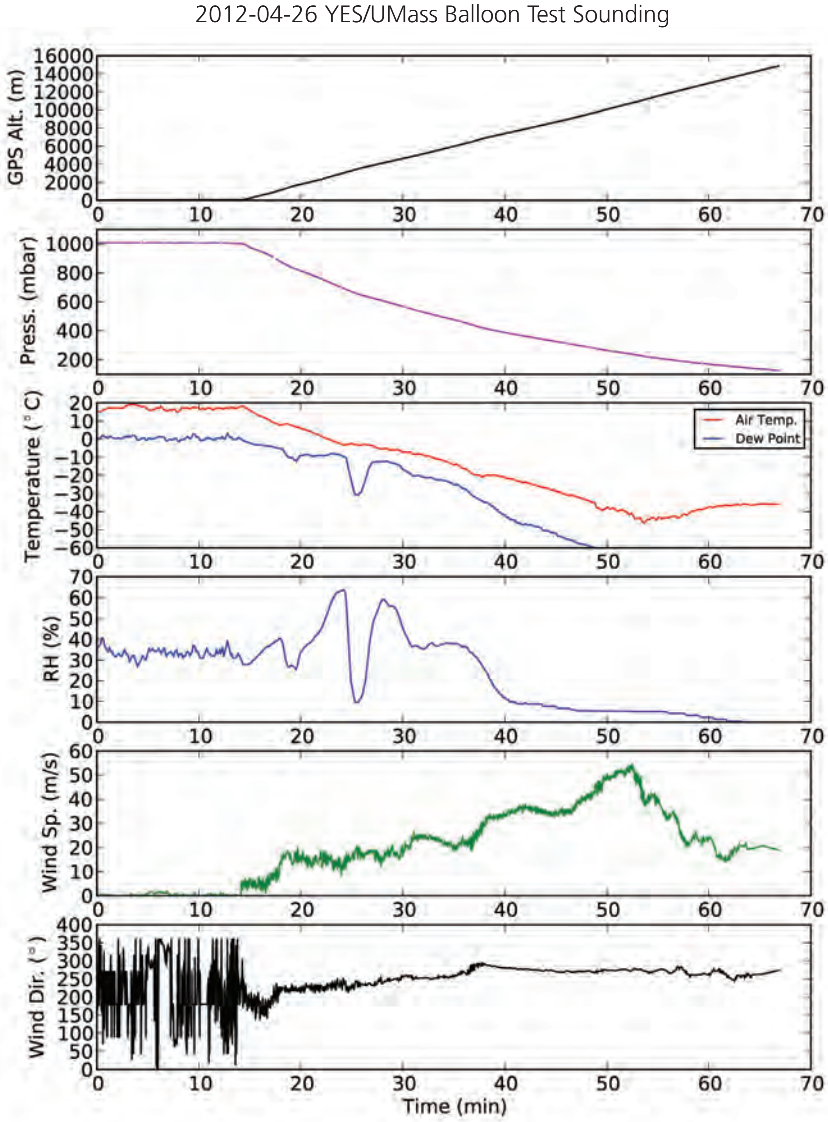
We are particularly proud of the iCons Student Forum with the motto: "by the students, of the students, for the students." Conceived and developed by iCons students, the Forum is a venue for peer review, cross-cohort collaboration, mentoring, and community building. The Forum has been a great success thus far. It's wonderful to see our students taking ownership of the iCons Program and making their mark on it.

Be sure to check out the iCons promotional video, and other important program information at http://www.cns.umass.edu/icons-program.

teaching

WEATHER BALLOONS

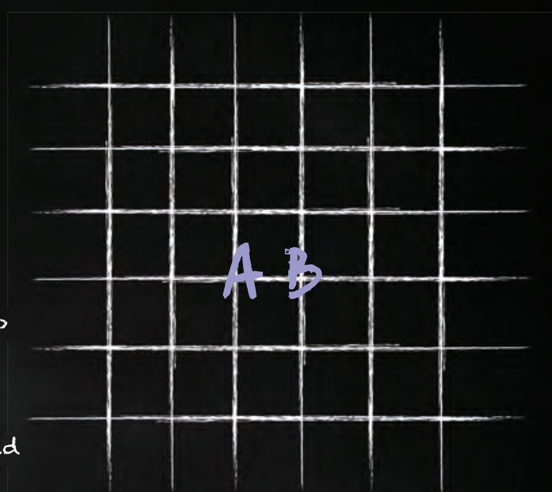
Last spring the "Weather and Our Atmosphere" class (Astronomy 105), taught by Heath Hatch, successfully launched a weather balloon into the upper atmosphere. The balloon was airborne for around two and a half hours, touching down safely on the roof of the Veterans Administration Hospital 80 miles east in Bedford. The class was taught as part of the new Team-Based Learning initiative which hopes to provide a more dynamic classroom experience for students. Physics Teaching Assistant Benjamin Ett, along with Physics Graduate Students Dominique Cambou and Donald Blair, incorporated open-source electronics into the payload to easily and cheaply measure the temperature and pressure of the atmosphere for the entire duration of the trip. Preliminary calculations show a maximum height of around 90,000 feet, a minimum pressure of 3 kPa (23 mm Hg), and a minimum temperature of -40 degrees Celsius. A video of the journey, taken by a Go Pro camera mounted to the front of the set-up can be seen on the UMass Amherst Physics YouTube channel. (To see this fascinating video, simply type the underlined words into your favorite search engine!). This spring semester more open-source technology, such as Arduino and Jeenode, and real-world application-based projects are currently being implemented into the classroom environment. The quality of the data can be seen in the accompanying plots of altitude, pressure, temperature, relative humidity, wind speed, and wind direction, all versus the time. This is truly bringing teaching into the 21st century!



PROBLEM

At the heart of the education of a physicist is the development of the ability to solve the problems. The oft-heard plea that "I know the material but I can't do the problems" is inadequate. Here is a famous problem which many will have seen before. If so, solving it will give you renewed pleasure. If it is new to you, finding a solution will demonstrate to you, once again, the elegance of our subject.

Consider a very large infinite rectangular grid of 1 ohm resistors.



Calculate the resistance presented to a DC power supply connected to adjacent points A and B.

(A hint to the solution is on page 23.)

graduate students, old and new

GRADUATED IN 1992


Carlos Avila


Christoher Baeuerle


Beena Gramopadhye


Evan Heller


Jay Klotz


Seoktae Lee


Laurel Mayhew


Donald McAllaster


Katherine McCall


Peter Morgan


Bruce Reinhold


William Tiernan

1992 MS and PhD graduates not pictured: Geoffrey Feldman, Neal Kalechofsky, Kleanthes Koniaris, Shyu Lee, John Rahn, Friedel Vongoeler, Ziming Zhou

ENTERED IN 2012

Back: Carlos Duque, Christopher Amey, Alexander Lombardi, Thomas Alexander, Mattieu Leclerc, Bastien Loret
Middle: Chen Kun, Tyler Kutz, Cody Goolsby, Pascal Weckesser, Asanka Weerasinghe, Sabin Adhikari
Front: Yuan Huang, Juliana Stachurska

new faculty

DR. COURTNEY LANNERT

The department welcomes **Courtney Lannert**, who has joined the Smith College Physics Department with an adjunct appointment at UMass. She comes to us following ten years on the faculty of Wellesley College, doctoral work at UC Santa Barbara, and undergraduate studies at Brown University. Her research is in theoretical condensed matter physics with emphasis on collective quantum-mechanical phenomena using both numerical and analytical tools. It includes studies of high-temperature superconductivity, quantum properties of ultra-cold atoms, and the behavior of quantum magnets. She enjoys teaching across the physics curriculum and strives to bring a field that is often considered abstract into her students' daily lives. In the fall she teaches two courses in our department and in the spring two courses at Smith.

DR. MICHAEL RAMSEY-MUSOLF

The department is pleased to welcome Professor **Michael Ramsey-Musolf** who will be joining us in the fall as a newly hired full professor in the field of theoretical nuclear and particle physics. He earned a PhD at Princeton University in 1989, with UMass' own Professor Barry Holstein as one of his thesis advisors! After a postdoctoral research appointment at MIT, followed by a number of prestigious appointments at national laboratories and universities, he became full professor at the University of Wisconsin-Madison in 2006. His research interests include physics beyond the Standard Model and its possible signatures in experiments that span the fields of nuclear and high-energy physics, cosmology, and neutrino physics. He has secured funding to establish the Amherst Center for Fundamental Interactions at UMass that will bring in visiting scientists, organize workshops, and foster collaborations. The addition of Michael and the Center will greatly strengthen the department.

DR. JUN YAN

The department welcomes Assistant Professor **Jun Yan**. He obtained his PhD at Columbia University where he used light scattering to study spin excitations in semiconductors and interaction effects of excitations in amazing two-dimensional graphene. This was followed by a postdoctoral position at the University of Maryland where he continued investigations of graphene using diverse techniques such as charge and heat transport, optoelectronic response, and ultrafast dynamics. Such studies led to the recognition of graphene as a fast and sensitive low-energy photon detector potentially useful for detectors in astronomy. He is starting a new laboratory where he will continue his studies of the electronic properties of two-dimensional crystal nanostructures by optical and electrical methods at low temperatures and high magnetic fields. Planar confinement of charge carriers in these structures permits large tunable ranges of charge densities and interaction effects, opening doors to new physics and potentially new applications.

new staff

INGRID POLLARD

We welcome **Ingrid Pollard**, who came to us from the Physical Plant, where she worked for 14 years paying all their bills, and making sure that the vendors were adhering to their contracts with the University. Prior to that position, Ingrid was employed by the Workers Credit Union in Orange, Massachusetts, by the Town of Orange as a teacher's aide in the grade school system, and as a clerk for a local pediatrician. She will now take care of all purchasing for the Department, for grants and contracts, as well as other financial matters. Ingrid is married to Walter Pollard, a research machinist and toolmaker for our Department in the Hasbrouck Lab. They live in Orange, and are very active in the Orange Historical Society. Ingrid and Walter have three adult children, and were very involved in the school system while their children were in attendance.

THE STEM EDUCATIONAL INSTITUTE

Morton M. Sternheim came to UMass in 1965 and "retired" in 1997 after a career in theoretical nuclear physics and related fields. He is still the Director of the UMass Science, Technology, Engineering, and Mathematics (STEM) Education Institute, which aims to improve STEM education at all levels. His involvement in this area began rather casually in 1986 when he received a $10,000 grant from the UMass President's office to start an electronic bulletin board for physics teachers, which has evolved into an internet service for teachers. Since then he and his colleagues have received over $15,000,000 in federal and state grants for a wide range of educational programs. This illustrates very clearly the potential impact of small startup grants.

Current Institute programs:

- Nanotechnology programs for teachers. Physicist **Mark Tuominen** is the co-PI of the Center for Hierarchical Manufacturing (CHM), a large, NSF supported, UMass multi-disciplinary nanotech research center. Together with Tuominen and several other UMass faculty members, using CHM funds, a successful program was created that is now in its seventh year, and that attracts teachers from all over the country. The key to its success is a wealth of engaging materials that were adapted or developed from scratch, and that can be used very effectively in a wide variety of courses to bring exciting contemporary concepts into the classroom. During the past year, a one-week summer institute was offered on campus, a three-day workshop at the Rensselaer Polytechnic Institute, and workshops at meetings of the National Science Teacher Association, the Massachusetts Association of Science Teachers, the American Association of Physics Teachers, at the UMass Science Quest for high school students, and at the January Family Day program in Boston of the American Association of Science. In addition, professional development workshops were held for the Utica, New York, schools.

- The STEM DIGITAL program, or more formally STEM Digital Images in Geoscience Investigations: Teaching Analysis with Light. The big idea here is that students and teachers all have digital cameras, but they mainly use them for creating presentations, posters, etc. However, these images may contain a wealth of data including spatial, spectral, intensity, and temporal information. The NSF funded summer institutes show teachers how digital image analysis can be applied to environmental research in STEM courses with the aid of free software called Analyzing Digital Images.

- Science and Engineering Saturday Seminars. Started over 10 years ago with grant funding and now supported by modest fees, these half-day programs for STEM teachers on a variety of contemporary topics are offered five times each semester by UMass researchers. Teachers can earn the "Professional Development Points" they need for continued certification; they can also obtain graduate credits at a reduced cost with additional work. Two physics faculty will give presentations next spring: **Benny Davidovitch** will discuss Patterns in Nature, and **Andrea Pocar** will talk about Everyday Particle Physics.

- Tuesday afternoon STEM Ed Seminars. Twice each month these address a wide range of STEM education related topics of interest to school and college faculty.

- Pioneer Valley STEM Network. STEM Ed manages this network, one of seven regional networks established by the Department of Higher Education to foster improvements in STEM education and support the STEM workforce pipeline through collaborations among the school, higher education, nonprofit, and business communities.

- STEM Solar Laboratories. **David Marley**, a UMass graduate and local contractor, obtained a US Department of Education small business grant and is installing small solar photovoltaic systems at 13 area schools as teaching tools. The STEM Ed staff is developing curricula for this project and training teachers to use the materials.

- Broader impact. NSF and other federal agencies are asking researchers to include a broader impact component to proposals. We have advised many faculty members from physics and other departments on a range of educational outreach plans they might offer. Reviewers have given high marks to these plans.

Links to all these programs, including a wealth of educational resources, can be accessed at www.umassk12.net.

SOCIETY OF PHYSICS STUDENTS

The primary aim of the Society of Physics Students (SPS) is to perpetuate knowledge of and appreciation for science, and in particular for physics. While the club has only recently regained its status as a registered student organization, it has been active for decades. Currently, the club has around 60 voting members. We are on-line at http://blogs.umass.edu/umasssps/.

One of the biggest events for the SPS is a biannual "Getting Into Research Night," where physics faculty and other faculty are invited to talk about their research and advertise any openings in their labs. Faculty and students come together for the biggest student-run networking event in the department. Even for students who do not find a niche for themselves in research, it's a great opportunity to find out what's going on in the department.

Students are encouraged to talk to professors year-round, attend colloquia, participate in research, and attend conferences around New England. This spring, members of the club will give presentations at the fifth annual Northeast Undergraduate Research and Development Symposium (NURDS), as well as the Undergraduate Research Conference here at UMass.

Another way the club aids undergraduate development is through a long-standing tradition known as "Choc Talks," for which the attendees receive candy, which has now become a staple in the SPS diet. For Choc Talks, either a student or a faculty member comes to discuss their research. This academic year, the club has hosted several faculty members who have covered topics from condensed matter and neutrino oscillations to supersymmetry and the Higgs boson. The SPS is always looking for more guests to impart knowledge and share ideas. If you are interested in talking to us, contact President **Gary Forster** at gforster@student.umass.edu (We are open to any interesting science topic, not necessarily research!).

One of the ways the SPS provides resources to students is with their website, http://blogs.umass.edu/umasssps/umass-amherst-physics-alumni/ that has contact info for a handful of alumni who have volunteered to offer support to undergraduates and recent graduates. The alumni page includes a brief professional biography for each alumnus/alumnae so students can select a mentor based on their own interests. (We are always looking for more.)

Especially for the underclassmen, the SPS also has a weekly homework help session run by senior officer John Karlen. At the help session students can work with their peers as well as be tutored by someone who has already taken the course.

physics student awards

UNDERGRADUATE AWARDS MAY 2012

Chang Freshman Award
(freshman, academic excellence)
Ryan Horton

Chang Transfer Student Award
(transfer student, academic excellence)
Robert Cyr

LeRoy F. Cook Jr. Memorial Scholarship
(involvement in outreach or teaching)
Alexander Nemtzow
Zachary Nemtzow
Nick Wankowicz

Kandula Sastry Book Award
(academic excellence and versatility)
Colleen Treado

Hasbrouck Scholarship Award
(junior, academic excellence)
Henry Byrd
Kelly Malone
Morgan Opie

Cervo Summer Research Awards
listed on page 25

GRADUATE AWARDS MAY 2012

Quinton Teaching Assistant Award
(outstanding teaching assistant)
Ramesh Adhikari
William Barnes
Qingyou Meng

Kandula Sastry Thesis Award
(presentation of outstanding thesis)
Emily Thompson

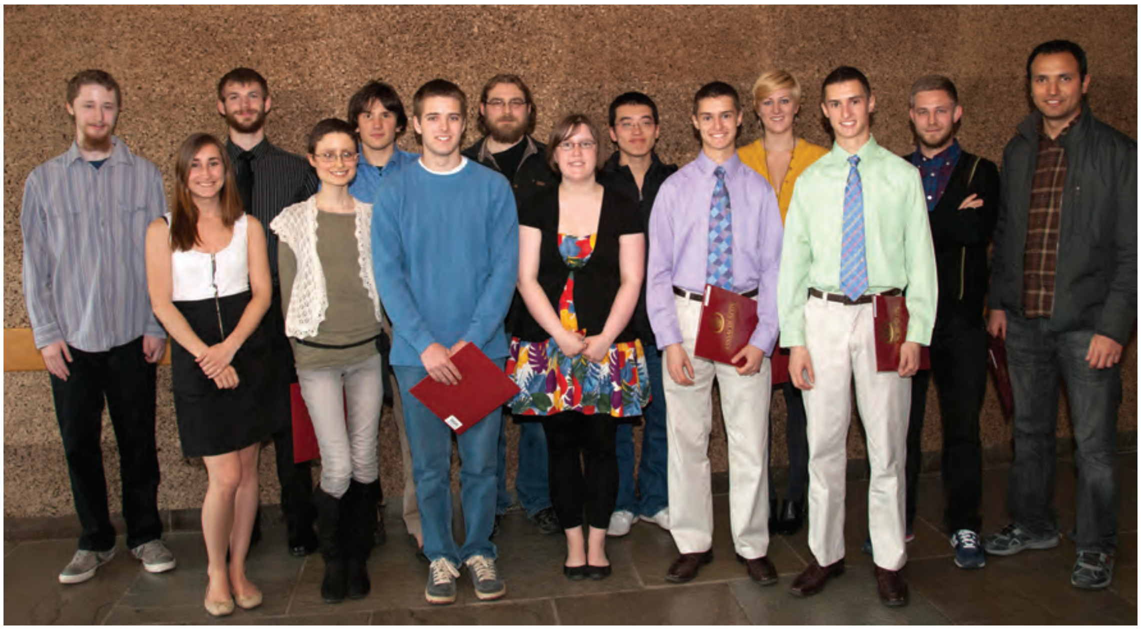
Dandamudi Rao Scholarship
(research in biological physics or closely related area. In memory of Kandula Sastry)
Benjamin Gamari

Morton & Helen Sternheim Award
(educational outreach and/or teacher preparation)
Benjamin Ett

COLLEGE/NATIONAL AWARDS MAY 2012

William F. Field Alumni Scholarship
(junior, academic excellence in the College of Natural Sciences)
Jamie Budynkiewicz
Mark Lodato

AWARD RECIPIENTS, PHYSICS DEPARTMENT, MAY 2012



Back: Henry Byrd, Mark Lodato, Benjamin Gamari, William Barnes, Qingyou Meng, Colleen Treado, Benjamin Ett, Ramesh Adhikari
Front: Jamie Budynkiewicz, Morgan Opie, Ryan Horton, Kelly Malone, Alexander Nemtzow, Zachary Nemtzow

faculty awards

TENURE FOR CADONATI

Laura Cadonati was awarded tenure and promoted to associate professor. Her research focuses on the detection of gravitational waves by using the LIGO laser interferometer detectors. She also continues a long association at the Laboratori Nazionali del Gran Sasso in Italy with the Borexino solar neutrino experiment, as well as the DarkSide project to detect dark matter. We wish her continued success in research and in the classroom in the years ahead!

TENURE FOR KAWALL

David Kawall was awarded tenure and promoted to associate professor. He is an experimental nuclear physicist whose current research involves the study of the origin of the proton's spin with the PHENIX collaboration at the Brookhaven National Laboratory. He also has long-term interests in studying the magnetic and electric dipole moments of nucleons and leptons. Our best wishes for his future endeavors!

DAVIDOVITCH WINS NSF CAREER AWARD

Benny Davidovitch has been awarded the prestigious CAREER grant by the National Science Foundation in support of his theoretical research on the development of complex shapes in thin elastic films. The CAREER award is NSF's primary vehicle in "support of junior faculty who exemplify the role of teacher-scholar through outstanding research and excellent education." The grant also funds outreach activity via a summer workshop for middle school teachers titled "Patterns around us."

LORI GOLDNER WINS ARMSTRONG FUND FOR SCIENCE AWARD

The award grant is intended " to encourage transformative research that introduces new ways of thinking about pressing scientific or technical challenges." The award will fund Goldner's Armstrong Award for experiments to observe individual protein molecules. The technique, unique to her laboratory, traps molecules in tiny water droplets dispersed in oil so that they can be observed by a sensitive fluorescence microscope.

ROSS WINS 2013 MARGARET OAKLEY DAYHOFF AWARD

This prestigious early-career award is presented annually to a "woman who holds very high promise or has achieved prominence while developing the early stages of a career in biophysical research within the purview and interest of the Biophysical Society." Jennifer Ross is being honored for her "innovative and productive research in the field of molecular motors by using model systems to define how motors are regulated in the complex environment of the cell."

SANTANGELO AND CO-WORKERS RECEIVE $2 MILLION NSF GRANT

A group of scientists and mathematicians led by our **Christian Santangelo** have received word that they has won a National Science Foundation "Emerging Frontiers in Research and Innovation" grant.

Chris and his colleagues are experts in developing self-folding polymer sheets, which take advantage of origami principles to provide highly tunable mechanical responses. They aim to produce new polymer materials whose static mechanical properties can be tuned over a wide range of behaviors, and which can buckle and fold dynamically. The research is expected to have broad applicability in many industries ranging from packing materials to artificial tissues and muscles.

The research team includes scientists at Cornell and Western New England University. They will train undergraduate, graduate and postdoctoral polymer science and engineering students and give them the opportunity to attend conferences and workshops with other scientists, origami artists and mathematicians.

The group will also contribute to a teacher-training program at Western New England University to use origami as a hands-on way to teach mathematics and material science to K-12. A theatrical performance is currently being written. The artistic prototypes and models produced will be part of a traveling exhibit for science museums.

Folded sheets of "Soft Matter" are also studied by others at UMass Amherst. See the Research article on page 5 for more information.

KECK GRANT TO UMASS

Physicists **Narayanan Menon, Benny Davidovitch** and **Chris Santangelo**, together with Tom Russell from PS&E, have been awarded a $1M grant from the Wm. Keck Foundation to develop the basic science needed to spontaneously deliver ultrathin films to fluid interfaces. The films may then serve as microscopic and functional wall paper or shrink-wrap. The Keck Science and Engineering program funds "endeavors that are distinctive and novel in their approach. It encourages projects that are high-risk with the potential for transformative impact."

CENTRAL HEATING PLANT TOUR

On a very hot, humid August afternoon some of our retired faculty, their wives, and others, toured the new award-winning state-of-the-art power plant located west of the Mullins Center. The new plant replaces the old coal- and oil-fired power plant that had two tall red brick chimneys that were familiar to many generations of students. It operated until 2009 for the production of steam and some electricity.

From Left to Right: Prof. Phillips Jones, Luke Lavin (Amherst College '13), Prof. Gerry Peterson, Prof. Margaret McCarthy (STCC, EHS UMass), Ereda Jones, Prof. Stanley Engelsberg, Steven Lemay (Assistant Plant Manager), Doris Peterson, Prof. Arthur Quinton.

The new gas-fired plant is a highly efficient co-generation facility that provides steam for heating, electricity, and chilled water for air conditioning and research. Greenhouse gas emissions have been reduced by more than 30%. In 2011 the plant was recognized as the cleanest plant in New England. The web site http://www.umass.edu/livesustainably/projects/award-winning-central-heating-plant provides an external view of the plant's curved roof encompassing a glass façade. Chimneys were placed in the center of the complex such that it resembles a field house blending in with its surroundings. A single operator in a small control room directs energy distribution to the entire campus. The old power plant's 35-40% efficiency contrasts with the 85% efficiency of the new plant that includes gas burning turbines to provide 16.5 MW of electricity. Fuel oil can be used in the event of disrupted gas supplies.

Heating Plant: Photo credit Jim Ricci

Continued/Awards

DOE RENEWS SUPPORT OF UMASS ATLAS TEAM

Co-PIs **Ben Brau**, **Carlo Dallapiccola** and **Stéphane Willocq** have been awarded a DOE grant of $1.71 million to fund their research activities on the ATLAS experiment for the 3-year period 2013-2015. In addition to the three faculty PIs, the UMass ATLAS group is currently comprised of a research scientist, two postdocs and five graduate students. It maintains leadership positions in muon reconstruction software, muon detector upgrades, precision measurements of Standard Model processes and searches for new physics phenomena, including: extra dimensions, new interactions and hidden sectors of new particles. Information about their research may be found at their website http://blogs.umass.edu/eppex/.

HOW THE HIPPIES SAVED PHYSICS

Last October at the annual Friends of the UMass Amherst Libraries reception in the Graduate Research Center Science Library, MIT Professor David Kaiser gave a review of his 2011 book "How the Hippies Saved Physics: Science, Counterculture, and the Quantum Revival." Kaiser heads MIT's Program in Science, Technology, and Society. He has a PhD from Harvard in theoretical physics, and another one in the history of science. His physics research is directed at early-universe cosmology at the interface of particle physics and gravitation. His historical research covers the development of physics in the USA during the Cold War under the influences of politics, culture, and our educational system.

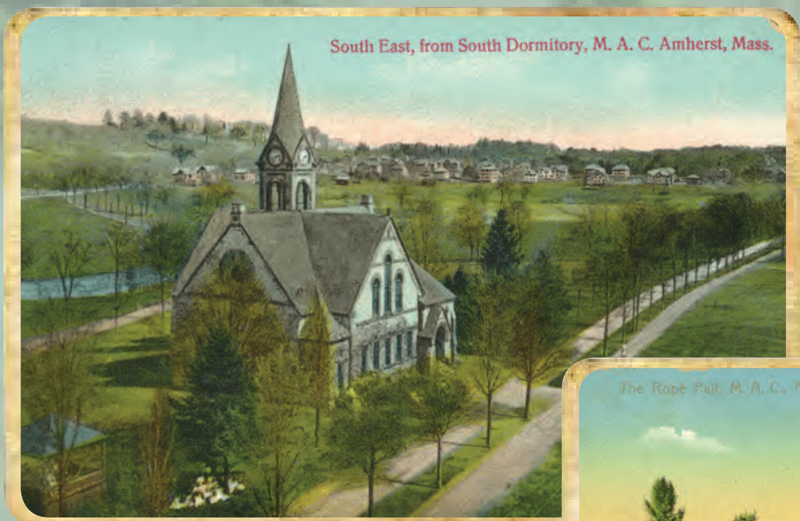
Physics jobs in the 1970's plummeted below the number of newly minted physics degrees. PhD programs closed and research funding fell. To provide mental exercises for unemployed physicists, Werner Erhard established a hippie common ground at his Esalen Institute in Big Sur, California. Philosophical ideas in physics were discussed starting with Bell's theorem. Ideas that now occupy the core of quantum information science were touched upon. Fritjof Capra was there. His "The Tao of Physics," published in 1975, is a countercultural classic that is in in its 43rd edition in 23 languages. Esalen fellows Alain Aspect, John Clauser and Anton Zeilinger were awarded the prestigious Wolf Prize in 2010 "for their fundamental conceptual and experimental contributions to the foundations of quantum physics, specifically an increasingly sophisticated series of tests of Bell's inequalities, or extensions thereof, using entangled quantum states." Richard Feynman stopped by Esalen. So did Timothy Leary. Professor Kaiser's fast paced and entertaining lecture traced the transition from the Esalen New Age Movement of the 1970's to the cutting edge of today in the evolution of physics concepts.

Continued/Cover

Morrill Act

with the amendment that the proposed institutions would include the study of military tactics (now called Reserve Officers Training Corps, ROTC) in the curriculum. Passage of the bill was aided by the secession of some states from the Union, states that in general did not support the plans.

The bill that President Lincoln then signed allocated land to the states based upon their congressional representation. Each state was given 30,000 acres of federal land for each congressional representative.



This land was then available for sale and the proceeds used, in Morrill's words, to establish "a college in every state, upon a sure and perpetual foundation, accessible to all, but especially the sons of toil." After the war the Act was extended to the former Confederate States and eventually to every state and territory of the Union. The 69 colleges so founded were especially appropriate to a growing and democratic country, based initially upon agriculture, but becoming more and more industrial in nature.

Annual rope pull over the campus pond, freshmen versus sophomores.

MAC had a rather inauspicious beginning. In its first four years, two presidents had been appointed and had departed without the enrollment of a single student! The first president was Henry F. French and was succeeded by Paul A. Chadbourne. Then came William S. Clark in 1867. He quickly appointed some faculty, completed a building plan and in the fall enrolled the first class of 49 students. Earlier he had been a colonel in the Union Army. A Western Massachusetts native, it was he who was mainly responsible for the selection of Amherst as the site of the College. Besides holding the office of President he was also the Professor of Botany and Horticulture even though he was a chemist by training (PhD Gottingen). The first buildings, planned and completed in the Clark era, consisted of the dormitories Old South and North College, the Chemistry Laboratory, a dining hall, the Botanic Museum, and the Durfee Conservatory Plant House. Clark was certainly the first functioning President and could well be considered to be the primary founding father of the College.**

**The Massachusetts Legislature designated two land grant institutions, namely Massachusetts Agricultural College, that became UMass Amherst, and the Massachusetts Institute of Technology (MIT). Like all land grant institutions, MIT, even though private, was required by the Morrill Act, to include military tactics in its curriculum.*

*** Quoting the biographer of Clark, the late Professor John Maki of the UMass Amherst Political Science Department: "In 1876, the Japanese government hired Clark as a foreign advisor to establish the Sapporo Agricultural College (SAC), now Hokkaido University. During his eight months in Sapporo, Clark successfully organized SAC, had a significant impact on the scientific and economic development of the island of Hokkaido, and made a lasting imprint on Japanese culture. Clark's visage overlooks Sapporo from several statues and his parting words to his Japanese students, "Boys, be ambitious!" have become a nationally known motto in Japan."*

Pictured on the cover: Justin Smith Morrill, President Abraham Lincoln, and William S. Clark.

October 1927

THE TROLLEY STATION

In 1994 a faculty member passing by Hasbrouck noticed that a demolition squad was about to dismantle the Waiting Station Shelter, the small, neat structure built in 1911. He was able to intervene and halt the destruction. We were not so fortunate in 2012. Sadly this elegant but modest structure, a shelter for the Amherst to Sunderland trolley line, is no more. It was recently demolished without fanfare during the construction of the New Academic Classroom Building. According to the archives it was designed by a student of landscape gardening, Arthur H. Sharp, class of 1910. The low hipped roof and extended eaves were perhaps part of a design to evoke Japanese architectural styles, in recognition of our connections with the College of Agriculture at Sapporo. Some others, knowledgeable in such matters draw attention to its Craftsman style and Italianate architectural elements.

The illustrations show the Shelter and its environment at various times in the past. The picture dated October 1927 has been taken, with permission, from the University Photograph Collection: Buildings and Grounds (RG 150), Special Collections and University Archives, University of Massachusetts Amherst Libraries.

September 2008

January 2013

IN MEMORIAM

Randolph W. Bromery (1926 – 2013)

Randolph William Bromery, second Chancellor of the University of Massachusetts Amherst from 1971-1979 and Commonwealth Professor Emeritus of Geophysics, passed away February 26 in Danvers, Massachusetts, at age 87.

Growing up in segregated Cumberland, Maryland, he had a humble beginning.

At age 17 he enlisted in the U.S. Army Air Corps and served with the segregated Tuskegee Airmen during World War II. After the war, with the help of the GI Bill, he took night courses at Howard University and earned a BS in mathematics and physics. He then went to American University to earn an MS in geology and geophysics. In 1968 he received a PhD in geology and oceanography from Johns Hopkins University.

Beginning in 1948, he worked for nearly 20 years as a research geophysicist for the U.S. Geological Survey doing airborne exploration in two-motored DC-3s, sometimes using survey instruments of his own design. In 1967 he joined the our geology faculty. Our physics students today use as a reference Bromery's measurements of the acceleration due to gravity (g) on the steps of the Morrill Science Center, where he established a gravity base station (outside the Morrill IV south door-under the bridge to Morrill north). He used a gravitometer made of a long quartz spiral spring with a mass hanging on it. Immediately after making the measurement, he flew the gravitometer to Washington, DC, to the National Bureau of Standards for recalibration. His measured value of g was 980.37441 cm/sec^2 stands today as an example of accuracy in geological measurements. (Information courtesy of Prof. Laurie Brown of the Geology Department.)

When he came to our campus, he was one of seven African-American professors in a faculty of 1,000. And there were only 36 African-American students in a student body of 14,000. He helped found the Committee for the Collegiate Education of Black Students; together with his wife he established a fund for graduate fellowships and undergraduate scholarships for minority students in geo- and earth sciences. In 1970 he became the campus' first Vice Chancellor of Student Affairs.

In April 1972, while he was Chancellor, he was also appointed Executive Vice President for the three-campus UMass system. After his retirement from these posts in 1979, he returned to teaching. He subsequently was asked to serve as Interim President of Westfield State College from 1988-90, Chancellor of the State Board of Regents for Higher Education from 1990-91, President of Springfield College from 1992-97, and President of Roxbury Community College from 2002-03, finally really retiring in 2003.

He was a trustee of Johns Hopkins University, Mount Holyoke College, and Woods Hole Oceanographic Institution, and sat on the boards of many major corporations. In 2003, President Bush appointed him to the President's Committee on the National Medal of Science. He was the recipient of nine honorary degrees, served as President of the Geological Society of America and was named the National Academy of Science's Outstanding Black Scientist in 1997.

On a personal level, he was an excellent cook and could be seen shopping in the local groceries for just the right ingredients for his dishes. He was also a musician who played saxophone, and a jazz enthusiast who helped to recruit jazz legends Max Roach, Archie Shepp, and Fred Tillis to the faculty.

"Randolph Bromery was a pioneering scientist and educator whose legacy still resonates daily at UMass Amherst," said our current Chancellor Kumble Subbaswamy. "His lifelong commitment to higher education was demonstrated through his willingness after retirement to lead several public and private colleges as well as the Commonwealth's higher education system. All of us in the UMass Amherst community mourn his passing."

G. Richard Huguenin (1937 - 2012)

Former Professor in the Department of Physics and Astronomy Richard Huguenin, died on November 22, 2012, at Sedro - Woolley, Washington, where he lived after retirement in 2002. He was an undergraduate in physics at MIT (BS 1959).

By 1963 he had earned his PhD from Harvard and he became the Director of the Space Radio Astronomy Program in the same year. He early recognized that new results in radio astronomy would emerge with the development of innovative instrumentation. With this in mind he built a team of young, creative engineers and scientists in order to study the rapid time variations in the radio emission from solar flares.

About this time Head of the Department Robert Gluckstern and Astronomy Chair William Irvine were putting together, essentially from zero, our own astronomy program. With great foresight, in 1968, they lured Richard and the entire team from Harvard. By 1970, radio observations were being made. Richard understood that the instrumentation he had developed at Harvard was a perfect fit for the study of pulsars. The first discovery of a pulsar had been made by Jocelyn Bell at Cambridge U. But Professor Huguenin and his coworkers were the first discoverers of pulsars in North America, and at one time held the record for the number that had been observed.

The observatory for this work had been constructed at the Quabbin Reservoir by the team in a truly DIY endeavor. For example, the engineers poured the concrete for the control building. An old telephone company line truck was obtained to drill the holes for the poles which supported the antenna wire. Under GRH's supervision in record time they had put together a world-class observatory. As an extra dividend, some of the instrumentation was used by his colleagues Joseph Taylor and Russell Hulse in their Nobel Prize winning research at Arecibo, Puerto Rico.

In 1982, he left the academic community to found several corporations in the millimeter wave technology industry, most notably Millitech, Inc. As a pioneer in his field he received several honors , including an honorary Doctor of Science from the University of Massachusetts. In 1987 he was appointed by Governor Michael Dukakis to be a Trustee of the University.

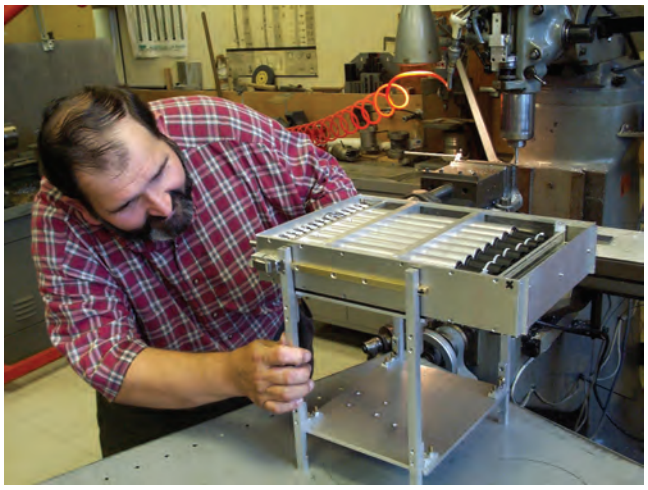
His one regret in a remarkable career was the failure to publish a paper with his brother Robert and his wife Ellen Moore under the title " Huguenin, Huguenin and more Huguenin!" Internment took place at the Moravian Cemetery in Canadensis, Pennsylvania, on December 18, 2012.

Al Mathieson

Professor Al Mathieson, 1917-2012, passed away at his home in Amherst on May 2. (In last year's Newsletter, there was an article about Matty celebrating his 94th birthday.) Matty graduated from Columbia University in 1939, and served in the Marine Corps in WWII as a flight instructor and later as a squadron commander in the South Pacific. After the war, he came to Amherst to teach physics to the returning GI's who were attending college under the GI bill. From the late 1960s to 1978, he was Department Business Manager, and later worked for the School of Natural Sciences and Mathematics on building design and modifications. This included work for our department, especially in the Graduate Research Center Towers. Matty retired in 1990.

Richard Letendre (1946 - 2012)

We are deeply saddened by the loss of our long-time friend and colleague Richard Letendre, who passed away at his home in Ware on Sunday, April 22nd, 2012. Dick was a toolmaker and machinist with our department



since 1987. In 1996 he moved to the machine shop in the Graduate Research Center Tower, where he started a long and fruitful collaboration with nuclear and particle experimentalists and worked on many detectors that saw use in experiments at the Bates Linear Accelerator, SLAC, and the Jefferson Lab. Dick was fascinated by the science being conducted, and he always had useful suggestions about the best way to design and construct experimental apparatus. Many generations of undergraduate and graduate students learned important and useful lessons from Dick; he will be greatly missed by all of us. This article about Dick first appeared in April of 2012 on the Department website which may be accessed at http://www.physics.umass.edu.

alumni news

Edward A. Clerke (BS '75) Editor's Note: Ed Clerke is the Principal Geoscientist for Saudi Aramco, the highest technical position in the world's most valuable company. He is a member of several prestigious scientific societies, has published in many journals and worked for many large companies. Ed's innovative "Rosetta Stone" work applied decoding techniques to unlock important subsurface reservoir property links for major carbonate fields for Saudi Aramco. These techniques are opening new avenues for carbonate reservoir characterization and carbonate reservoir simulation for ultimate oil and gas recovery.

My wife, Vonda and I live in Dhahran, Saudi Arabia, and on Lake Granbury in Granbury, Texas, where I plan to retire. The snapshot is of me is me in my back yard! I have four children all grown, graduated from college, and gainfully employed! (Thank God!) They all reside in Texas - all born Texans. No grandchildren at this point. I am an avid desert motorcyclist in Saudi Arabia, some of the best desert riding in the world! I took motorcycling up again here in Saudi Arabia 12 years ago after having ended my early riding days at UMass before going to grad school at Johns Hopkins in Baltimore. We are able to travel extensively and are about to set off on a 40-mile trek covering half of Hadrian's-wall (Corbridge to Brampton) across the UK. God has blessed me in so many ways, and I am thankful to Him.

I look back and cherish the time at UMass and especially the opportunities that I had at UMass, especially with the Medium Energy Nuclear Physics group, and for which I am deeply grateful. To tell you a funny short story, as an undergraduate I was able to work for Prof. Gerry Peterson. My work involved everything from interfacing with the machine shop, drafting for technical documents and electronics for detectors. When activities lulled, I also labeled all of our new tools and instruments with the MENP label in case they tended to wander. We knew that Gerry was quite fastidious about these labels and so

we hatched a plan to alter the labels of the restrooms in the wing of the Graduate Research Center Towers from MEN to MENP! After a year at Hopkins, I transferred to UMaryland – College Park and completed my PhD there. Professor Gluckstern soon followed me to Maryland as Chancellor, and I recalled him teaching our freshman class in Physics at UMass. I jokingly claimed that we had both come to Maryland in a package deal! I am not active on social media as I am in a critical position at Aramco. I would be glad to connect by email and tell you more about life in the Oil Patch. I have been fortunate to have worked on all of the biggest oil fields in the world, have traveled extensively, and analyzed world wide data sets for petroleum prospectivity. I have thought of writing a book using the whimsical title – *A Massachusetts Yankee in King Oil's Court.* edward.clerke@aramco.com

Frederic H. Fahey (BS '74) [Fred Fahey is an associate professor of radiology at Harvard and Director of Nuclear Medicine and Positron Emission Tomography at Boston Children's Hospital, one of Harvard Medical School's clinical sites. He is currently the 2012--2013 President of the National Society of Nuclear Medicine and Molecular Imaging.]

He writes: "At UMass Amherst, I learned about scientific investigations first hand. I had the opportunity during the summer before my senior year to work with **Professor H. Mark Goldenberg** on a project involving astrophysics. However, the real turning point in my studies came when I took a course called "Physics in Medicine and Biology" taught by **Professor Kandula Sastry**, which showed me how physics could be used to directly help patients. I even worked on a simple project demonstrating the concept of positron emission tomography, a topic to which I have dedicated the last 20 years. I am very grateful to Professors Goldenberg and Sastry and all of my professors during my time in Amherst. Lastly, I wanted to let you know that I would be more than happy to come out to Amherst and speak to students in the department about projects on which I am currently working and the role of physics in modern medicine. I am a bit busy this year, but I am sure we could find a time." ffahey@mindspring.com

Neal F. Kalechofsky (PhD '96) I've never taken a formal poll, but my guess is that I have followed one of the more unusual pathways to a career in physics. First of all my undergraduate degree wasn't in any kind of hard science at all, but in philosophy. Not long after graduating from college I discovered, to my great surprise, that gainful employment for professional philosophers would be hard to come by. So in 1985 I drifted into Amherst to live with my brother Hal. He was studying physics at UMass at the time. The talk around the kitchen table got interesting, and the next thing I knew I had spent a good part of my early 20s getting the equivalent of a BS in physics.

Cut to 1992. I had been accepted to the UMass Physics Graduate Program, but still had to make ends meet by tending bar at the Lord Jeffrey Inn while hoping to find a research assistantship. Don Candela was doing research in ultra low temperature quantum fluids (liquid 3He and 4He) and was looking for a grad student. We met on the 3rd floor of Hasbrouck and I will never forget my first look inside the lab. There was some contraption that looked to me like it had come right off the set of Star Trek, all tubing and wires and blinking lights, leading to a large black cylinder hanging from an anti-vibration table. "What's that?" I asked. Don told me: "It's a dilution refrigerator. It can cool materials down to a fraction of a degree above absolute zero."

A bell went off in my head and I thought (yes, pun and all): "there has got to be something cool you could do with this." I decided right then and there that this was the corner of the physics world for me.

Years of hard work and an invaluable hands-on education in ULT NMR (ultra low temperature nuclear magnetic resonance) under Don's tutelage followed before I got my PhD. After a rather disastrous post doc at Notre Dame in 1998, I was offered a job with Oxford Instruments (OI); soon after getting hired I found myself in the UK talking with OI's Director of Technology, Nick Kerley. Nick asked if I had ever heard of "hyperpolarized NMR." When I shook my head blankly he told me that OI was looking into using ultra low temperatures and high magnetic fields—so called "brute force" environments—to greatly increase the nuclear polarization in materials such as xenon gas. Normally the signal from xenon gas was much too low to be detected in an NMR experiment; but once hyperpolarized it could be used for a wide variety of cutting edge medical applications such as making images of the lungs.

Again that bell went off. I climbed over Nick's desk and told him I wanted—no, needed—to be a part of this. After detaching me politely from his sweater he said "All right, but only if you use your UMass education to invent a scalable method of hyperpolarizing a wide variety of materials using brute force." Okay he didn't actually say

Alumni News

DEPARTMENT OF PHYSICS - UNIVERSITY OF MASSACHUSETTS AMHERST that, but he did bring me in to OI's HP R&D (Oxford Instrument's hyperpolarized research and development) program and I did come up with a patentable method of efficiently polarizing just about anything (not just xenon) that drew heavily on knowledge of ULT technology and ^{3}He-^{4}He physics I had gained at UMass.

Again to conserve space I will jump forward many years. OI eventually abandoned brute force polarization to throw in their lot with a rival "dissolution DNP" technology. I understood their reasons but remained convinced that brute force offered fundamental advantages over DNP. Fortunately others agreed with me and in 2007 two partners and I founded Millikelvin Technologies (MKT) with a mandate to commercialize my approach to hyperpolarization as well as other industrial applications for low temperatures.

As Chief Technology Officer of MKT I still have the pleasure of working with, and learning from, the professors I got to know while at UMass: Don Candela, Mark Tuominen, and Bill Mullin have all been kind enough to contribute their expertise to our HP R&D program. Hyperpolarization is just one technology that MKT works on, but it is a particularly interesting one for me as applications for it intersect so many other areas: biotech, pharmaceutical development, and information technology, to name a few. These are unusual areas for a low temperature physicist to venture into, but I wouldn't have it any other way. neal@millikelvintech.com

Steven Moore (PhD '85) now writes sci-fi thrillers, short stories, and book reviews. He also has an active blog where he comments on current events and posts opinions about writing and the publishing business from the perspective of an independent author. http://stevenmmoore.com.

He received his PhD from UMass Amherst, and did a post-doc at RPI, before going to work for MIT's Lincoln Lab. The title of his thesis was "The Effect of Fluctuations on Optical Bistability," and his thesis adviser was Professor Jon Machta. He worked on the liquid-solid interface during his time at RPI. His wife and he now live in New Jersey.

Steve sent us this:
A Degree at UMass Provides More Than a Job. My one year at UMass represented a paradigm shift in my life. My degree doesn't begin to indicate what I learned during that brief sojourn. Sure, I had to put my research together and jump through administrative hoops—the Department of Physics in general, and Professor Jon Machta in particular, offered fantastic guidance through all that. But I also came down from my lofty theoretical castle and learned to interact with other scientists and engineers. Extracurricular work in disordered media (mostly done after finishing my thesis) and mingling with the experimentalists taught me about the wonders and challenges of real world data.

The lessons learned in that brief year served me well in a post-doc at RPI and twenty-three+ years at MIT's Lincoln Lab. Real world systems and associated data are full of surprises—understanding "dirty data" is also great fun and a challenge to the intellect. All your physics training can help you meet those surprises head-on, providing both tools and a minimalist approach that will help you solve research problems. The correct rejoinder to those surprises is not "Eureka!", but "Gee, that's funny!" UMass was a bridge from my teaching and research career in South America to a productive career in the Boston area.

Now, as a retired baby boomer, I have embarked on a third career—writing sci-fi thrillers. I say third career because people who knew me at UMass will remember that my degree was an end to a career of teaching and research in South America and the beginning of my life as an applied scientist in the U.S. Retirement is the time when you search for new paths, although they might seem a natural continuation of where you've been. I wasn't about to sit around and watch old TV shows or play golf—I needed to continue to learn and create as I did the summer I turned thirteen when I wrote my first novel (it was terrible) and learned group theory (I struggled with representations).

My books are traditional sci-fi and thriller tales offered to the reading public for entertainment; they are formatted for eBooks, which represent a paradigm shift in publishing that is shaking traditional publishing. Yet a novel remains a novel, and is wider in scope than a short story, in any format. There are more characters, a more intricate plot, and generally a more complicated and longer timeline. Keeping this all together as an author is not easy. Physicists are both generalists and specialists and physics thinking helps deal with the complexity.

Yes, training in physics lasts a lifetime. It's no wonder that so many of us embark on so many different adventures during their professional careers and in their retirement—even becoming sci-fi writers.
steve@stevenmmoore.com

HINT

The linearity of the circuit equations guarantees the validity of the principle of superposition. Two easy problems summed together constitute the original problem.

Here is the first of the two: use a DC supply to inject 1 ampere into the circuit at A and collect the 1 ampere with a heavy copper strap connected to the 1 ohm resistors around the entire outer rim. By symmetry 1/4 ampere flows from A to B. Now find the second easy problem such that added to the first you will be solving the original problem.

(Solution on page 26)

PHYSICS ALUMNI GROUPS

Dear Fellow Physics Alum:

Over the past year, I have met with several alums to discuss the creation of a UMass Physics Alumni Group. This has been fueled in part by the growing interest in the Society of Physics Students (SPS) and the absence of a similar organization after graduation. The SPS grew from a handful of students in 2009 to more than 60 students today. One of the keys to the success of SPS was the establishment of mentoring by upperclassmen as well as the peer support system for help with problem sets and finding research opportunities.

We would like to extend the success of SPS to the establishment of an alumni group. The proposed group would unite physics alumni, faculty, and current students by facilitating interactions between the three parties via online networking. We also hope the group can meet one or two times a year in a fun and social way.

One of the goals is to help current students prepare for life after graduation. Current students may have questions on the graduate school application process and/or career options for physics graduates. To address this, we have begun to compile a list of alumni who are willing to volunteer time to mentor students. We have already recruited 17 alumni in a range of fields and are looking for more. We hope to create opportunities for undergraduate internships as well.

We have also set up groups on LinkedIn and Facebook to promote discussion and share ideas. This has been successful for students in the applications process and allowed them to connect with alumni who looked at or attended similar graduate programs. Furthermore, we have used these online groups to recruit alumni who are interested in mentoring undergraduates.

We hope this group would provide an avenue for faculty to reach out to the alumni if they need support in any way, or simply a way to share in the successes of many of the department's faculty members. While reading about the LHC or LIGO in the news is exciting, it would be even better if we could discuss the latest breakthroughs with the faculty.

If you are interested in supporting this effort, please reach out to me, David Sliski (david.sliski@gmail.com) and/or Morgan Cervo (morgan.cervo@gmail.com).

The UMass Amherst Physics Alumni websites mentioned above are https://www.facebook.com/groups/168245093312703/ and http://www.linkedin.com/groups?home=&gid=4287724&trk=anet_ug_hm

Sincerely,
David Sliski '10

Editor's Note: The UMass Amherst Alumni Association provides additional links to Alumni Networks.
http://www.umassalumni.com/clubs/index.html

new alumni

Degrees awarded since the Spring 2012 Newsletter

BS and BA Degrees

Allen, Douglas E.	Curran, Max Thomas	McCoy, Jake A.	Tiedemann, Charles A.
Bonatt, Joshua E.	Dunay, Christopher	Nemtzow, Alexander J.	Treado, Colleen J.
Bascom, Phillip A.	Fadel, Nathalie A	Nemtzow, Zachary A	Wankowicz, Nicholas Alexander
Bromberg, Benjamin Philip	Ivanov, Maxim S.	Ostrowski, Kyle J.	Whitebirch, Mary
Brown, Ian Mayo	Lovinger, Dylan	Owusu, Emmanuel A	Wu, Yuan
Clark, Andrew O.	MacDonald, Matthew J.	Shah, Vinay D	Yi, Joshua

MS Degrees

Buckman, Richard	Thantirige, Rukshan	Wang, Qingze	Wexler, Jonathan

PhD Degrees	Thesis Title	Advisor
Aydemir, Ufuk	Topics in High Energy Physics Beyond the Standard Model	Donoghue
Blackburn, Thomas J.	Quantum Corrections to the Gravitational Scattering of Massless Particles	Holstein
Datta, Amaresh	Understanding Hard Interactions in QCD and the Search for the Gluon Spin Contribution to the Spin of the Proton	Kawall
Dias, Marcelo	Swelling and Folding as Mechanisms of 3D Shape Formation in Thin Elastic Sheet	Santangelo
Dickert, Stefan	Conductivity of Gold Nanoparticle Thin Films and Magnetoresistance of Metallic Thin Films Embedded With Periodic Arrays of Cobalt Nanoparticles	Tuominen
Eliseev, Alexander	Theory of interacting polyelectrolytes under confinement	Muthukumar (PSE)
Feng, Jiansheng	Investigations of Surface Tension Effects Due to Small-Scale Complex Boundaries	Rothstein (MIE)
Hua, Jing	Phase Transitions in Polyelectrolyte Systems	Muthukumar (PSE)
King, Hunter	Pattern Formation in Floating Sheets	Menon
Martel, Philippe	Measuring Proton Spin Polarizabilities with Polarized Compton Scattering	Miskimen
Mercado, Luis	Probing Novel Properties of Nucleons and Nuclei via Parity-Violating Scattering	Kumar
Ray Pitambar Mohapatra, Satya	Wide parameter searches for gravitational-waves from binary black hole coalescences with ground-based laser interferometers	Cadonati
Vanasse, Jared	Parity-Violation in Neutron Deuteron Scattering in Pionless Effective Field Theory	Holstein

DONOR SUPPORT

We appreciate the support of our donors whose contributions enrich the educational experience of our students and help us to widen our outreach to the physics community and the public. Your contributions help to fund special activities beyond the scope of more restrictive state and federal funding.

MORTON AND HELEN STERNHEIM DISTINGUISHED LECTURE SERIES

A donation from Morton and Helen Sternheim, matched by the University, has reestablished the equivalent of the Commonwealth Lecture Series of the past.

CERVO AWARDS FOR UNDERGRADUATE RESEARCH IN PHYSICS

In recognition of the undergraduate research opportunities that their daughter Morgan received working in Professor Narayanan Menon's laboratory, Craig and Suzanne Cervo generously provided funding for other undergraduate research. Below is listed the awardee's name, the title of the summer research project, and his/her advisor.

Summer 2011

Ashley Berner–Potts, *Role of Molecular Motors & Forcing in Single Cell Mitotic Spindle*, Maria Kilfoil

Joshua Bonatt, *Study of UV Reflectivity and Participation in Darkside*, Andrea Pocar

Alex Nemtzow, *Darkside Installation and Testing at LNGS in L'Aquila, Italy*, Laura Cadonati

Victoria Porter, *Biophysical Characteristics of a New Mutant Kinesin*, Jennifer Ross

Summer 2012

Austin Barnes, *Scanning Probe Measurements of Surface Potential after Collision of Insulating Particles: A Microscopic Probe of Contact Electrification,* Anthony Dinsmore

Chris Howell, *Understanding Eddy Current and Active Shielding of Time-Dependent Magnetic Fields and Improvements to an Experiment on Quantum Entanglements*, David Kawall

Mark Lodato, *Xenon Scintillation Studies for EXO*, Andrea Pocar

Cameron MacKeen, *APD Calibration at UMass Amherst for Project EXO*, Andrea Pocar

Nicholas Mangini, *Detectability Studies for Astrophysical Signatures in LIGO*, Laura Cadonati

GEORGE H. AND LILLIAN MILLMAN SCHOLARSHIP

George H. Millman (BS '47) Born in Boston in 1919, George Millman attended Massachusetts State College, later to become UMass Amherst, but was forced to drop out after his freshman year due to financial hardship. Following the attack on Pearl Harbor, he enlisted in the Army Air Force and was sent to Harvard University to study theoretical aspects of radar. About this time, he and his soon-to-be bride, Lillian, decided to marry before he might be assigned to overseas duty, and indeed he was soon assigned to Brisbane, Australia, to train pilots on the use and operation of the newly developed airborne radar. During his tour of duty throughout the Pacific, Millman wrote to Lillian detailing aspects of his life, and offering a personal perspective of the impact of the war. These resulted in a book entitled *Letters to Lillian*.

After returning from the war, he obtained his BS degree from UMass Amherst in 1947, and his MS and PhD from Penn State in 1949 and 1952, respectively. During his career, he published more than 100 papers on radio wave propagation, tropospheric phenomena, ionospheric radio physics, radar astronomy, and radar system analysis. For example, he determined the geometry of the Earth's magnetic field by techniques of matrix-coordinate transformations in considering radio-wave propagation. He founded the company Millman Associates of Syracuse, New York. A George H. and Lillian Millman scholarship has been established for a full-time physics student who must demonstrate financial need.

PROFESSOR RICHARD KOFLER'S CLASS OF 1976-1977 FUND

Donations to this scholarship have reached endowment level and it will be awarded to support a student pursuing an undergraduate degree in physics.

What's New?

Is there news about yourself that you would care to share? Your fellow classmates of recent times, or of long, long ago, as well as your old instructors and staff of days past, would love to hear from you. Send us a note about yourself. It can be only a few words, or it could be quite a few. A picture is more than welcome.

Hearing from you will also give us the opportunity to keep you posted on upcoming events. If you want to visit the department, we welcome you.

Also we appreciate comments on how our newsletter could be improved and what you would like to read about.

Your newsletter editors
newsletter@physics.umass.edu

THANK YOU!

The UMass Amherst Department of Physics, including its undergraduate and graduate students, its faculty, and its staff, extent a sincere thank you for your continued interest in our department. For the year 2012 your gifts supported many activities that could not be funded by monies received from the Commonwealth or the Federal Government, for example, a well-attended graduate student seminar series. The largest use was for summer research projects for undergraduates. Other examples are this newsletter, other student awards, the Society of Physics Students, science outreach activities, the graduation reception for students and families, and the weather balloon project that is described in the Teaching section of this issue.

MAILING ADDRESSES

Has your address changed? If so, please keep the physics department current by sending your new address to Ann Cairl at cairl@physics.umass.edu or phone at 413-545-2545.

In addition, if you are an alumnus or alumna, update the University Development Office by going to http://www.umass.edu/giving/contact/contactform/ and filling out the change of address form.

We appreciate your help in keeping our department, and the university, up to date to ensure you continue receiving copies of the Physics Newsletter, and other university publications.

Solution

Inject 1 ampere into the circuit with the positive terminal connected to the heavy outer strap and collect the current at B for return to the power supply. By symmetry 1/4 ampere flows from A to B . Add the solutions. Hence the potential difference between A and B is 1/2 volt when the supply current is 1 ampere.

Answer: 1/2 ohm.

This list represents those who contributed to the Department of Physics from January 1, 2012, to December 31, 2012. We apologize for any omissions and kindly ask that you bring them to our attention.

Anonymous
Michael Azure
Kristen & Richard Baldacci
James Barber, Jr
Ellen & Mark Baxter
Gerald Bender
David Bloore
Michael Bonn
Paul Bourgeois
Elizabeth Brackett
Herbert Brody
Joanne & Nelson Burke
Gena Cadieux
Francis Canning
Joan Centrella
Siu-Kau Chan
Cary Chang
Scott Chase
Lisa Coates
Theodore Coletta
Raymond Connors
Marita Corcoran
Christopher Davis
Edward Demski
William Dent
Christine Derunk
Lorraine Dikant
Aimin Ding
John Donoghue
Thomas Dundon
Laurence Dutton
Christopher & Carol Emery
Howard Foster
Stephen Fuqua
Fabrizio Gabbiani
Robert & Rebecca Galkiewicz
Robert Gamache
Margaret Gralenski
Philip Gregor
Leroy Harding
Carl Hein
Evan Heller
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Charles & Mary Ellen Mayo
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Elizabeth Nuss
Moshe Oren
Ramona Osborn
Elizabeth & Peter Ouellette
Karen Parker
V. Adrian Parsegian
Igor Pavlin
Martti Peltola
John Polo, Jr.
Elizabeth Porter
Satish Prasad
John Pribram
Stanley Pulchtopek, Jr.
Arthur Quinton
Thomas Radcliff
William Reynolds
Francesc & Kathleen Roig
Hajime & Sachiko Sakai
Edwin Sapp
Leslie & Stephen Saunders
George Schmiedeshoff
Benjamin Scott
Ker-Li Shu
Richard Shurtleff
Thomas Silvia
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Louise Sironi
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Peter Smart
Kim Smith
Luther Smith, Jr.
Peter & Kathryn Smith
Timothy & Kathleen Smith
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Jay Stryker
Michael Takemori
Mark & Carol Taylor
George Theofilos
Paul Thompson
Trevor Thompson
Jorge Uribe
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James & Elaine Walker
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Jairus Warner
David & Anna Wei
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David & Linda Zaff
Joseph Zec
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Thank you for your generosity.

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Back to The Future?

In the early 20th century electrically powered trolley cars, such as these, ran between Holyoke, Amherst, and Sunderland, and by the trolley car station shown on page 17 that once stood outside where the Hasbrouck Laboratory now stands.
Will there be a renaissance for such trolleys if electricity for them can be generated relatively free of greenhouse gases?