Strong UMass Connection to the 2017 Nobel Prize in Physics

Gravitational waves, which could be predicted using Einstein’s theory of General Relativity, propounded in 1916, were not directly observed until the LIGO experiment, a century later. LIGO detected gravitational waves using two detectors, one in Livingston, Louisiana, and the other in Hanford, Washington. The detectors are located 3002 km, or 1865 miles, apart, and detect changes in their lengths which are a small fraction of the diameter of a proton. To rule out noise in the detectors due, among other things, to natural, and human caused vibrations in the Earth, it is required that both detectors detect the same signal almost simultaneously. The graph shows a superposition of the signals from both LIGO detectors, with a slight shift to account for the slightly different arrival times of the signal as seen by the two detectors. The alignment at 0.40 seconds is perfect, showing that the signal was real, not due to noise. The signal was that predicted to be seen for the merger of two black holes.

However, there was indirect evidence of gravitational radiation discovered in the 1970s in an experiment done by 2 UMass people (not the cast of about a thousand, from 138 institutions, who reported on the LIGO observation), namely, Prof. Joseph Taylor and his graduate student, Russell Hulse. What follows are two articles, the first on Joe Taylor’s visit to UMass this past fall, followed by reminiscences of Russell Hulse. Taylor and Hulse received the Nobel Prize in 1993 for their discovery of the binary pulsar, which implied the existence of gravitational radiation, and which ultimately led to the construction of the LIGO experiment, which actually observed the gravitational waves.

Binary pulsar in the crab nebula.

Gravitational waves from both LIGO detectors.
Joe Taylor has agreed to make available the The Power Point slides he used in his two talks. For permission to access them on a UMass Box Drive, send an email to Monroe Rabin at rabin@physics.umass.edu with subject line: Request Joe Taylor slides.
Dear alumni and friends of UMass Physics:

It’s a privilege and a pleasure to be writing to you as the new head of the Physics Department. I entered the Department as a beginning assistant professor in 1998. Having spent most of my professional life occupied with teaching and research, I am enjoying the process of learning to work with students, staff, and faculty colleagues in a completely new role. I thank my immediate predecessor, Rory Miskimen, for his years of devoted service to the Department.

Before I get to new and exciting developments, I want to remember a couple of recent losses in our family. In mid-November, we lost our computer systems administrator, Joe Babcock, who had been fighting cancer for over a decade. Not a month earlier, we lost retired Professor Po-zen Wong, who died unexpectedly at his home in Amherst. They are both missed, and their contributions are detailed elsewhere in this newsletter.

Every time we bring in a new faculty member we add vitality to our research portfolio and expand the research horizon for our undergraduates, graduate students and postdocs. We have been fortunate to attract three very promising young faculty members to the Department this Fall. Verena Martinez Outschoorn and Rafael Coelho Lopes de Sa join our experimental high energy physics group, working on the ATLAS experiment at the giant Large Hadron Collider. Their presence makes us one of the largest US university groups at the LHC. In addition, their hardware expertise adds a new dimension to our existing group. Romain Vasseur joins our condensed matter theory group, and is an expert at modern aspects of many-body quantum physics, including strongly correlated electronic systems and non-equilibrium quantum phenomena.

While individual faculty research continues to flourish, three active centers have grown in our Department. Each of these has a different audience and mission. The Amherst Center for Fundamental Interactions is in its fourth year under the leadership of Michael Ramsey-Musolf, joined recently by Andrea Pocar. ACFI is research-focused and brings in groups of faculty, postdocs and students for targeted workshops and schools in topical areas. The Massachusetts Center for Autonomous Materials is led by Jenny Ross and Tony Dinsmore. MassCAM advances forward-looking opportunities in materials physics, and targets group funding towards these goals in addition to making connections with industry as a source of research problems and a destination for student training and employment. The Center for Biological Physics, revitalized in the last year by Lori Goldner, is a hub for biological physicists on campus to form a network of shared expertise and inter-disciplinary collaborations.

Over the years, we have had a deeply experienced and tightly-knit crew of staff supporting Department operations. The retirements of Jane Knapp and Kris Reopell this year cap a recent period of turnover where we have lost well over a century of cumulative administrative experience with five staff retirements. The new faces on our staff are rapidly coming up to pace with the complexities of keeping the wheels spinning at UMass, and we look forward to working with them going forward.

The campus has grown considerably in the last few years with an increasing student population (the number of Physics majors has more than doubled!), and construction of many new buildings to house both instructional and research activity. We anticipate new research laboratory space in the Physical Science Building to be completed in April 2018; more on that in next year’s newsletter! We welcome you to visit to see the new landscape of the university. We’re most appreciative of the continuing financial contributions many of you have made to the Department that support activities outside the scope of our normal funding resources. We would also appreciate sharing your life experience and career advice and opportunities with our students. In short, please do keep in touch with us, and visit when you can!

Sincerely,

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was most recently the home for UMass Ag Extension. Because of the fragility of the WES, contractors decided that it was not possible to move the building into its new position next to PSB. For this reason the building was disassembled, and then reconstructed around a new core with modern utilities to serve as an office building for faculty working in the PSB. However, the building retains much of its original 19th century charm, complete with faux chimneys on the exterior, as well as many interesting interior architectural features, including original casework.

The Physical Science building is a completely new building for the campus, representing the largest single investment in the Physics Department’s infrastructure since the construction of the Lederle Graduate Research Towers in the early 1970s. Construction costs for the PSB are approximately $90 million. The PSB has three floors, the upper two floors are for the Chemistry Department, with the Physics Department occupying the ground floor. The PSB will house the Department’s experimental nuclear and particle physics groups, as well as groups working in experimental quantum condensed matter and hard condensed matter. The physics floor of the PSB has seven “low-bay” labs for experimentalists, where the ceiling height is approximately 10 feet, and 12 “high-bay” labs, where the ceiling height is 15 feet. Many of the high-bay labs have “x-y” cranes that allow for heavy loads, such as radiation shielding or vacuum equipment, to be picked up and moved around. In addition to lab modules for individual PIs, the PSB also has shared spaces for semiconductor processing, a chemistry lab, an electronics shop, a machine shop, and a Class 10,000 cleanroom for assembling nuclear/particle physics detectors.

The PSB has also been fitted out with a helium reclamation and liquefying system. Liquid helium is a commonly used cryogen in quantum condensed matter experiments, and is also used to cool down certain classes of particle physics detectors. Unfortunately liquid helium has also become very expensive in recent years, to the extent that helium costs have become a limiting factor in the ability of PIs to run experiments. The PSB helium reclamation and liquefying system will allow PIs to capture helium boiled off in their experiments, re-liquefy the helium, and then reuse it. Even with the cost of running a liquefying plant, helium costs will be significantly less when doing reclamation and liquefaction, as compared to letting the helium boil off and buying more.

The experimental condensed matter faculty assigned to PSB are D. Candela, M. Tuominen, C. Wang, J. Yan; the experimental nuclear/particle physics faculty assigned there are S. Hertel, D. Kawall, R. Coelho Lopes de Sa, A. Pocar, and R. Miskimen. There are currently three unassigned physics lab modules in the PSB, as well as two shared spaces there. These open lab spaces will allow the department to do future faculty hires in the areas of nuclear/particle physics, and quantum condensed matter. It is anticipated that approximately 1/3 of the Physics Department’s faculty, postdocs and graduate students will eventually be housed in the PSB-WES complex.
The Helen and Morton Sternheim Distinguished Lecture for 2017 was delivered on October 10th and was followed by a colloquium lecture the next day by Nobel Laureate and former UMass Professor Joseph H. Taylor, Jr. The first lecture, “From Einstein’s Theory to Gravity’s Chirp,” was intended for a general audience. No pre-requisites were required beyond an interest in Nature’s truths! The second lecture, the Physics Department Colloquium, “Binary Pulsars and Relativistic Gravity,” was given the next day.

Joe Taylor is the James S. McDonnell Distinguished University Professor of Physics, Emeritus, at Princeton University. He received his BA in 1963 from Haverford College and his PhD in 1968 from Harvard University.

Only weeks after their discovery in 1968, Taylor has studied the dense, rapidly spinning, neutron-star remnants of supernovae known as pulsars. Together with his students and colleagues, he has discovered hundreds of these objects, including a number that orbit around other stars. Studies of these “binary pulsars” have provided unique astrophysical clues regarding the origin and evolution of neutron stars, as well as the first conclusive evidence of the existence of gravitational radiation, as predicted by Einstein’s general theory of relativity.

Published in 1915, Albert Einstein’s theory of General Relativity appeared to imply the existence of gravitational waves, an entirely new form of energy and radiation. However, physical reality of these implied waves was doubted by many, including Einstein himself, for well over half a century. A 1974 discovery made in the UMass / Amherst Department of Physics and Astronomy, together with physics graduate student and fellow Nobel Laureate Russell Hulse provided the first strong evidence for their existence. More detailed follow-up measurements extending over many years have laid any doubts to rest. Moreover, they provided persuasive justification for funding what became a successful billion-dollar experiment (LIGO) to detect gravitational waves directly.

Professor Taylor’s talk, Binary Pulsars and Relativistic Gravity, described the century-long effort to understand better some of Nature’s most fundamental laws, a fascinating and entertaining story. Many in the audience thought it was one of the very best talks ever given at UMass. It described a superb example of the scientific method at work—warts, blind alleys, and all.

Gravitational radiation caused by the motion of the pulsar.

Radical velocity of pulsar observed by the (Doppler) shift.
“After receiving my bachelor’s degree in physics from The Cooper Union in 1970, I started graduate school at the University of Massachusetts in Amherst. While I knew that I eventually wanted to do my thesis research in astronomy, preferably radio astronomy, I wanted a broader scientific background and decided to get my doctorate in physics rather than astronomy. I went to UMass not only because its graduate program offered this type of flexibility, but also because it was located not too far from my parents in New York, in a rather beautiful part of rural western Massachusetts. UMass provided an attractive PhD program of study and research in physics and astronomy, and as I discovered, one that was taught by some very capable faculty.

“When I was approached by Professor Joe Taylor to see if I was interested in doing a new, high-sensitivity pulsar search for my thesis, it did not take long for me to agree. Such a project combined physics, radio astronomy, electronics and computers--a perfect combination of four different subjects, all of which I found particularly interesting. I really appreciated the opportunity to work with Joe. In addition to being a creative scientist, he always treated me as a colleague, not just a student.

“Little did I know how exciting the research I was doing would prove to be, nor how it would impact our understanding of Einstein’s Theory of Relativity and gravitational physics.

“The research was carried out using the Arecibo 1000 ft. radio telescope in Puerto Rico, using a ModComp minicomputer on which I programmed the novel digital signal processing search algorithm and a rudimentary operating system, both entirely in assembly language. The result of this research was the discovery of 40 new pulsars, among which was the first pulsar ever found in a binary system.

“When I received my PhD from UMass, I accepted a post-doctoral position at the National Radio Astronomy Observatory (NRAO) in Charlottesville, Virginia, to continue my research.

“During my post-doc, I began to become concerned about the lack of further career opportunities in Astronomy. I also wanted to be close to my girl friend (now wife), Jeanne Kuhlman. Jeanne was a Smith College physics & astronomy major whom I met while at UMass who was then attending graduate school at UPenn. So, I took advantage of the flexibility of having a PhD in physics and a broad interest in science to pursue a wide range of research interests.
of possibilities for my future career. In the end, I took a position at the Princeton Plasma Physics Laboratory (PPPL) doing computer modeling of atomic physics and particle transport in magnetically confined controlled thermonuclear fusion plasmas. The opportunity to learn the intricacies of computer modeling using state-of-the-art supercomputers was in itself very exciting.

I accepted an invitation in 2004 to become a visiting professor at the University of Texas at Dallas (UTD) with a focus on science education using community based outreach programs. I found that so rewarding that I took early retirement in 2007 from PPPL and joined UTD as a Regental Professor and founded the Science and Engineering Education Center (SEEC) there. The SEEC focuses on providing informal, hands-on, project based STEM (Science, Technology, Engineering and Mathematics) education in libraries, science centers, and other community venues. I've continued to work at UTD part time ever since, along with other advisory activities, mostly from my home in New Jersey.

“Unfortunately, in 2012, I was diagnosed with Parkinson’s Disease which has severely limited the scope of my activities ever since. However, it has not dimmed my lifelong fascination with and interest in science and technology.”

*A more detailed account of the discovery of the binary pulsar can be found in my Nobel lecture on the Nobel web site (NobelPrize.org). This web site also includes Joe Taylor’s Nobel lecture. For more information on subsequent research on the binary pulsar and gravitational physics, see research publications from Joe Taylor and his colleagues. The recent direct detection of gravitational waves has been extraordinarily exciting and opened the door to an entirely new view of the universe. It also led to the 2017 Nobel Prize in Physics. [ed. note: Rainer Weiss, Kip Thorne, and Barry Barish, for the discovery of ripples in space-time known as gravitational waves]*
AXION RESEARCH AT ACFI

An area of active research at the Amherst Center for Fundamental Interactions (ACFI) being performed by theorist and Assistant Professor Patrick Draper involves the study of "axions." In particle physics the theory of Quantum Chromodynamics (QCD) describes the strong interactions of quarks and gluons. The strong force is responsible for binding quarks into protons and neutrons, and binding protons and neutrons into atomic nuclei. The QCD axion is a hypothetical, extremely light scalar particle, thought to have mass in the range $10^{-9}$ eV to $10^{-4}$ eV.

The QCD axion was first proposed to address the strong CP problem, the puzzle of why the strong interactions preserve CP symmetry. CP symmetry refers to a combination of charge conjugation with a parity (or mirror) transformation. For generic values of parameters, QCD would exhibit large CP-violating effects, but measurements of the neutron electric dipole moment indicate that QCD preserves CP to better than one part in ten billion. The proposed QCD axion field provides a natural explanation for this smallness through a "dynamical relaxation" mechanism: the field itself provides an effective contribution to the CP-violating parameters, and the minimum of the field’s potential -- the ground state of the axion -- lies at a point where the net CP violation is zero.

The existence of the QCD axion could also solve another physics mystery - the nature of "dark matter," which makes up a substantial fraction of the known universe. The QCD axion is a candidate for cold dark matter, which has a very different character from weakly-interacting massive particles (WIMPs). Instead of a dilute, incoherent gas of particles, the axion contributes to the energy density through small, coherent oscillations of the scalar about its minimum. In some scenarios for early universe cosmology, the axion relic density, produced at the very earliest times after the big bang, is determined by a single parameter, its mass.

A precise calculation of this axion relic density as a function of parameters is useful to guide and interpret experimental searches for the axion. In work last year involving UMass researchers and collaborators at the University of California at Santa Cruz, a careful study is being done of the theoretical uncertainties in the standard computation. Currently, an ongoing project with Hiren Patel (UMass postdoc) aims to shrink the theoretical error bar by computing the next quantum corrections to the high-temperature axion mass.

Another area of study involves the possibility that collider experiments could provide "indirect" evidence for the QCD axion. Among the proposed solutions to strong CP, the axion is special in that it works regardless of how strongly other possible beyond-the-standard-model (BSM) physics violates CP. By searching for new physics and CP-violating couplings, the LHC and future collider experiments may be able to weigh in on the strong CP problem. A particularly striking example of this is would be new QCD-like sectors, which provide a variety of dark matter candidates and rich collider phenomenology. In ongoing work involving UMass postdocs Jonathan Kozaczuk and Jiang-Hao Yu, the collider signatures of CP-violation in these models are being studied together with the possible realizations of dark matter.

Beyond dark matter, axion-like particles have been proposed as candidates for the "inflaton," the field responsible for driving cosmic inflation, a period of exponential growth in the early universe. In work last year by Draper, Kozaczuk, Patel, and Matt Dolan (Melbourne), some of the theoretical properties of toy models of axion inflation were studied. New dualities (equivalences) were found, which relate to the spacetime structure of cosmic strings, string-like solutions of the classical field equations that are a hallmark of axion fields. In ongoing follow-up work cosmic string spacetimes are being studied in an interesting class of "Kaluza-Klein" models, where the axion arises from a higher-dimensional gauge field.

THE LZ DARK MATTER EXPERIMENT STARTS CONSTRUCTION

We live our lives immersed in a diffuse galaxy-scale bath of particles (local density ~0.3 GeV/cm³), a bit more than 1.5 times a proton-mass per teaspoon [m_proton ~ .938 GeV], 1 teaspoon = 5 cm³) whose properties are completely unknown, other than that they have not yet been observed to interact any way but gravitationally. This enormous and weighty sea should make
any particle physicist feel a bit embarrassed, or at least humbled by the mystery of it all. Our famed ‘Standard Model’ describes just about 15% of the mass of the universe, and any attempt to add a single particle to that system might disrupt its elegant symmetries. The presence of dark matter is therefore bluntly informing us that we are, at this time, completely ignorant of some fundamental truths. The hope is that if we can measure the particle properties of dark matter (mass, interactions, spin, etc.), it will point us towards the bigger picture, i.e., how our existing standard model fits inside some enveloping and more fundamental set of truths.

That’s the dream. The reality is that so far our experiments have not been lucky. The most favored dark matter particle mass hypotheses have long been in the GeV to TeV mass range, a mass range in which we would naively expect new particles to appear to solve other questions in particle physics (the hierarchy problem foremost among them). We are a bit lucky that the GeV-TeV scale is our most strongly favored search window, because this is also a window for which existing detector technologies can be extremely sensitive. At galactic dark matter velocities, an interaction between an order-GeV dark matter particle, and an order-GeV atom will cause that atom to recoil with order-keV kinetic energy, sufficient to produce standard particle signals in ionization and scintillation detectors. The challenges of dark matter direct detection in this GeV-TeV regime are two-fold: supply enormous numbers of target particles in order to boost the probability of interactions (we are at the tons-scale now, or $10^{30}$ target nucleons) and reduce the natural background radiation to rates low enough that the massive target can be exposed for years at a time with only a handful of order-keV background events appearing.

The LZ experiment is the next generation in this search, poised to have a world-leading sensitivity starting in 2020. The LZ collaboration was formed by the merger of the predecessor LUX and Zeplin collaborations (“LZ” = LUX-Zeplin) and now includes over 200 researchers based around the world. The LZ detector itself will be both the largest dark matter detector ever built (7 metric tons of central xenon target atoms, surrounded by many tons of additional detector layers) and it will be the lowest in background event rate (roughly one background event every two years, after all signal event selection criteria are applied). These technical achievements will allow a search for dark matter down to nucleon interaction cross sections of only a few times $10^{-48}$ cm$^2$. This cross section regime is interesting because there is a natural mechanism for forces of this scale: this is the scale of Higgs-mediated forces (in which the Higgs particle serves the role of force mediator, rather than the standard force carriers Z, W ±, photon, and gluon).

The background suppression goals are greatly helped by the xenon target atoms themselves, existing as a dense liquid (3.1 g/ml). The liquid xenon stops external radiation much as lead does, preventing external radiation from penetrating more than a few cm into the xenon target. This ‘self shielding’ of external radiation is essential to achieving the low background rates and the dark matter sensitivity goals, but comes with the downside that detector calibration requires fairly novel methods. Instead of simply placing radioisotopes next to the detector and observing the detector response, liquid xenon experiments of LZ scale require calibration isotopes internal to the detector material, mixed into the liquid xenon itself. These calibration isotopes start as radioactive gases, are precisely released into the xenon as needed, and then either decay away or are purified. These gaseous calibrations are a UMass hardware contribution to the experiment, the Hertel Group is building systems for controlling exactly the quantity

A cross section view of the LZ dark matter detection experiment, showing the central liquid xenon vessel, surrounded by layers of liquid scintillator and water for shielding and background tagging. The person to the right gives a sense of the large scale of this largest-yet dark matter experiment.
of calibration isotope released into the detector and is supplying the radioactive material itself. The Group is currently setting up a test stand here on campus to test the hardware and practice the calibration procedures, before moving on to build the final ‘source injection’ hardware.

2018 will be the busiest year in LZ construction and major components are already taking shape. The central liquid xenon vessel (made of ultra-pure titanium) has been formed and will arrive at the South Dakota experiment site in January. A special low-radon clean room has been constructed to receive it and begin detector assembly. Many components of the interior detector structures have been constructed in mock-up form and are now entering final fabrication using special low-radioactivity materials. At UMass, the spring will be spent testing the source injection system, and construction of the final system will occur over the summer. The Hertel Group is working towards having the detector ready for dark matter search data in early 2020, after some initial calibrations. And then, who knows? The standard Higgs-mediated interaction may be ruled out, or we may be on the verge of a new era of extending the standard model in radical ways.

A day has been selected to celebrate dark matter with the inaugural day, the 31st of October 2017. The global events that took place that day are listed in the URLs in this article. Dark matter comprises about 85% of the mass of the Universe, and its particle nature is still unknown. For a more detailed scientific discussion and experimental images, go to: http://lz.lbl.gov/laboratory/, or look into Prof. Scott Hertel profile where he describes a UMass experiment searching for dark matter in the Research section of this Newsletter.

For additional resources such as visualizing dark matter with images, animations, PowerPoint slides and videos, or educational resources, or news and experiments, visit https://www.darkmatterday.com/. This URL is chocked full of educational material for elementary to college school students. Coupled with the spooky days around the 31st of October, the 2018 dark matter day could spice up the agenda for physics clubs and outreach programs.

Learn more about dark matter at the https://www.interactions.org/hub/dark-matter-hub. These scientists were the originators of Dark Matter Day to act as a medium to educate the public. Of course, there’s always Twitter: @lzdarkmatter. Don’t be afraid of the dark [matter]!
The Science and Engineering Saturday Seminars (SESS) are in their eighteenth year of presenting engaging science and engineering half day seminars to STEM teachers. Offered for five Saturdays once or twice a year, there have been 140 sessions altogether. The average attendance is 30 or so middle and high school teachers. Each teaches about 100 students, so the potential impact is impressive.

The program is managed by Physics Professor Emeritus Mort Sternheim, Director of the STEM Education Institute (STEM Ed), and Chris Emery, a UMass physics and education alum and retired Amherst Regional High School physics and electronics teacher.

Some background: The draft version of the Massachusetts Frameworks for Science, Technology and Engineering was published in 1996, followed five years later by the revised version. Although progress was being made with incorporating the Learning Standards for science, there was still not a clear sense of how teachers should proceed to implement the curriculum described by the Technology/Engineering section of the Frameworks.

In the Fall of 2000, Mort and Chris met with Kathy Rubin, Associate Dean of the College of Engineering and developed the concept of the Saturday Seminars as a way to assist K12 teachers in making sense of, and creating useable curriculum materials. The program started with funding from the Raytheon Corporation, followed by NSF support for a few years. Modest user fees now cover most of the costs.

The goal is to provide teachers with background information and lab-based activities that will provide the foundation and incentive for development of teaching and learning materials to be implemented in the classroom. Saturday programs run from 8:30 AM to 1 PM, and are led by UMass and other Five College faculty as well as by K12 teachers. The presentations typically model an inquiry approach to learning, and include handouts that can be customized for use in designing individualized lesson plans. Most of these materials are posted online and are publicly accessible.

The seminars typically include a mix of topics from the physical, biological, and earth sciences, engineering and technology, math, and computer science. Occasional sessions are devoted specifically to pedagogic issues. This year’s list includes: Concentration, Amount, Counting by Weighing, Air Pressure, Clouds and Weather, Engagement and Positive Psychology for STEM Learning and Beyond, Brain Science = (Biology + Engineering), and Sustainability.

Teachers have proven themselves very adept at taking one or more ideas from a session having a focus on a specific science or engineering topic outside their area of expertise and adapting it for their specific curriculum. This has occurred across the entire K12 grade level spectrum.

Most of the participants are experienced secondary teachers, but there are often new teachers or science education grad students, as well as occasional elementary educators. For attending and participating in the seminars, teachers receive Professional Development Points, needed for continued certification. They also have the option of enrolling in a 3-credit, structured, independent study course at a reduced tuition rate. Those who choose the credit option are required to do outside reading as well as to develop a curriculum plan for their students based on some learning experience from the seminars. This work culminates with an additional Saturday session for sharing teachers’ lesson ideas. Over 300 teachers have elected this option.

Several years ago Education Professor Joe Berger used questionnaires and focus groups to evaluate the SESS program. Many respondents noted that other teachers in their schools have asked them what they learned in the seminars, especially regarding the hands-on demonstrations. Participants felt that seminars addressed content with inquiry-based techniques and are very valuable because there are a lot of projects out there being passed off as inquiry-based that only keep the students busy, but do not really teach the concepts. The seminars were said to provide the “nuggets” to further develop and expand the projects. One commented that “The kids love it!” Berger concluded that “respondents were nearly unanimous in their belief that the seminars are outstanding.”

It is clear that the short, focused content presentations, coupled with a mix of background information presented by talented seminar leaders and the opportunity for teachers to “practice” working with lab materials is a viable model for school year professional development.

For additional information about the SESS, including a list of presenters and their topics plus many seminar materials, go to www.umassk12.net/sess. These materials and many others from a variety of STEM Ed programs are archived by the library at https://scholarworks.umass.edu/stem/.
## UNDERGRADUATE RESEARCH PROJECTS

Physics students to engage in a wide variety of original, cutting-edge research projects and teaching projects. Here is a list of 52 undergraduate projects that were under way in Fall of 2017 and Spring of 2018.

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<th>Student</th>
<th>Faculty Advisor</th>
<th>Research Project</th>
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<td>Mufid Alfaris</td>
<td>Pocar</td>
<td>Prototyping the cathode in the nEXO enriched xenon observatory</td>
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<tr>
<td>Justin Alfonse</td>
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<td>Setting up fluorescence correlation measurements to determine simultaneous size and pH of nanodroplets.</td>
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<tr>
<td>Abdoul Ayouba</td>
<td>Dinsmore</td>
<td>Measuring the electric discharge rate at the surface of a charged powder.</td>
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<tr>
<td>Bren Backhaus</td>
<td>Traschen</td>
<td>Studying the theory of a dilution-Maxwell system in an expanding universe with small amounts of electric and magnetic fields.</td>
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<tr>
<td>Allyson Bergeron</td>
<td>Goldner</td>
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<tr>
<td>Anshul Bhargava</td>
<td>Yan</td>
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<tr>
<td>John Blatchford</td>
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<td>Cryogenic testing of silicon photomultiplier tubes for the nEXO enriched xenon observatory.</td>
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<td>Jack Bolster</td>
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<td>Matthew Burke</td>
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<td>Temperature stability control for silicon photomultiplier tubes and cryogenic operation.</td>
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<td>Matthew Burke</td>
<td>Yan</td>
<td>Making and studying two dimensional crystals of BN and MoTe$_2$ to study stacking phase transitions.</td>
</tr>
<tr>
<td>Josh Carey</td>
<td>Wang</td>
<td>Programming microwave pulse control hardware/software for advanced superconducting qubit and cavity experiments.</td>
</tr>
<tr>
<td>Josh Carey</td>
<td>Pocar</td>
<td>Characterization of background sources and Monte Carlo simulations of Darkside-50 detector. (Supported by a Commonwealth Honors College research fellowship)</td>
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<tr>
<td>Chris Caron</td>
<td>Wang</td>
<td>Set up, evaluate, and integrate electronic instruments for quantum control measurements.</td>
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<td>Thomas Connolly</td>
<td>Wang</td>
<td>Analyzing microwave propagation in ferrite-loaded devices and designing a microwave circuit in the quantum regime.</td>
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<tr>
<td>Devan Dhand</td>
<td>Kastor</td>
<td>Learning string theory through Brian Greene’s “The Elegant Universe.”</td>
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<tr>
<td>Freeman Dong</td>
<td>Sedrakyan</td>
<td>Studying quantum spin systems that constitute the basic models of quantum magnetic insulators.</td>
</tr>
<tr>
<td>Matthew Downing</td>
<td>Pocar</td>
<td>Studying the Presence of Krypton-85 in the DarkSide Detector. (Supported by a Commonwealth Honors College research grant)</td>
</tr>
<tr>
<td>Kenneth Eva</td>
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<td>Making high quality two dimensional crystals (graphene, boron nitride, and chalcogenides)</td>
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<tr>
<td>Ben Farrell</td>
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<td>Encapsulation with thin polymer films</td>
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<tr>
<td>Yihan Gao</td>
<td>Dallapiccola</td>
<td>Assemble, calibrate, and design a software for the tape robot.</td>
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<td>Alex Gekow</td>
<td>Dallapiccola</td>
<td>Data analysis and simulations of particle physics as observed with ATLAS, and the Bus Tape Robot Project.</td>
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<tr>
<td>Matthew Golben</td>
<td>Ertl</td>
<td>In-depth investigation of James Clerk Maxwell’s equations describing electromagnetism. (Honors project)</td>
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<td>Matthew Harris</td>
<td>Dallapiccola</td>
<td>Data analysis and simulation.</td>
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<td>Scott Israel</td>
<td>Kawall</td>
<td>Learning aspects of magnetic field measurement using NMR and other techniques.</td>
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<tr>
<td>Shashank Jayakumar</td>
<td>Pocar</td>
<td>Geant4 simulations for the DarkSide experiment</td>
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<tr>
<td>Robert Keane</td>
<td>Dinsmore</td>
<td>Studying electrostatic forces at fluid interfaces and the formation of particle-stabilized emulsions.</td>
</tr>
<tr>
<td>Jeremy Laprade</td>
<td>Dinsmore</td>
<td>Studying charged granular media</td>
</tr>
<tr>
<td>Martyna Laszcz</td>
<td>Lannert</td>
<td>Analyzing Ground State Densities for the Cold Atom Lab Bubble Project.</td>
</tr>
<tr>
<td>Sonya Leaf</td>
<td>Pocar</td>
<td>DS-50 data analysis.</td>
</tr>
<tr>
<td>Mingquan Li</td>
<td>Goldner</td>
<td>Measurement of pH in water-in-oil nanoemulsion droplets using pH sensing dyes.</td>
</tr>
<tr>
<td>Nikolaos Marmanis</td>
<td>Ross</td>
<td>Basic training in biophysics, including the BioBootCamp.</td>
</tr>
<tr>
<td>Michael Maxwell</td>
<td>Wang</td>
<td>Making PC-board based microwave circuit and characterizing microwave components.</td>
</tr>
<tr>
<td>Alexander Moschella</td>
<td>Miskimen</td>
<td>Development of a fast-analog current-summing amplifier for use on the muon detection chambers at Jefferson Lab.</td>
</tr>
<tr>
<td>Name</td>
<td>Advisor</td>
<td>Research</td>
</tr>
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</tr>
<tr>
<td>Ian Murphy</td>
<td>Pocar</td>
<td>Cryogenic testing of photosensors.</td>
</tr>
<tr>
<td>Mackenzie Naseery</td>
<td>Ross</td>
<td>Measuring single GFP molecules as tracers in a bath of active urease enzymes.</td>
</tr>
<tr>
<td>Bela Nelson</td>
<td>Traschen</td>
<td>The theory of dynamical black holes in inflationary universes.</td>
</tr>
<tr>
<td>Liam O’Brien</td>
<td>Sorbo</td>
<td>The theory of decay of three-dimensional spacetime into a pair of particles connected by a string. (Honors project)</td>
</tr>
<tr>
<td>Kyle O’Connell</td>
<td>Kawall</td>
<td>Development of a high sensitivity, high bandwidth Faraday magnetometer.</td>
</tr>
<tr>
<td>Linda Oster</td>
<td>Ross</td>
<td>Measuring single GFP molecules as tracers in a bath of active urease enzymes.</td>
</tr>
<tr>
<td>Jonathan Powers</td>
<td>Wang</td>
<td>Assemble microwave measurement setup and control software and to measure superconducting qubits.</td>
</tr>
<tr>
<td>Justin Roberts</td>
<td>Tewari</td>
<td>Using LAMMPS simulations to track the forces and stresses on tracer particles in gravity-driven granular material flow.</td>
</tr>
<tr>
<td>Anwesha Saha</td>
<td>Pocar</td>
<td>Cryogenic testing of photosensors.</td>
</tr>
<tr>
<td>Neil Shah</td>
<td>Tewari</td>
<td>Simulating granular hopper flow using LAMMPS.</td>
</tr>
<tr>
<td>Eleanor Scott</td>
<td>Draper</td>
<td>Numerical simulations of systems from statistical physics and particle physics.</td>
</tr>
<tr>
<td>Tom Schneer</td>
<td>Machta</td>
<td>Learning nonlinear dynamics and chaos theory by using numerical methods to study coupled map systems relevant in ecology.</td>
</tr>
<tr>
<td>Anushka Shrivastava</td>
<td>Kawall</td>
<td>Studying NMR free induction decays in the presence of inhomogeneous magnetic and RF fields.</td>
</tr>
<tr>
<td>Ben Strain</td>
<td>Ross</td>
<td>Measurements of liquid crystal emulsions in water.</td>
</tr>
<tr>
<td>Zachary Gao Sun</td>
<td>Tuominen</td>
<td>New materials and devices for energy conversion and storage.</td>
</tr>
<tr>
<td>Ishan Srivastava</td>
<td></td>
<td>Teaching assistant for Physics 131 and 132: Supervising students, helping with questions, editing youtube videos of the lectures.</td>
</tr>
<tr>
<td>Kathryn Tweedie</td>
<td>Miskimen</td>
<td>Teaching assistant for Physics 114.</td>
</tr>
<tr>
<td>Makayla Vessella</td>
<td>Dallapiccola</td>
<td>Studies of searches for dark photons in the High-Luminosity LHC program using simulated samples.</td>
</tr>
<tr>
<td>Darrell Workman</td>
<td>Wang</td>
<td>Setting up a dilution refrigerator and device holder for low-temperature microwave measurements.</td>
</tr>
</tbody>
</table>

**ILAB COURSE WORK POSTER SESSION**

George Metzler, Justin Archibald, and Olivia Comeau  
"Measurement of local acceleration due to gravity using Bessel Pendulum"

Guangfeng Yu, Alexander Moschella, and Rex Tufts  
"Investigation of Chaotic Double Pendulum"

Frederick Coburn, Jonathan Pham, and Kendall Sullivan  
"The Gravitational Constant"

Lisa Himuro and Mufid Alfaris  
"Dynamic light scattering"

Matthew Burke, Neil Shah, and Nicholas Miller  
"Determining the transition Point of a High Tc Superconductor"
teaching

PHYSICIST IN INDUSTRY SEMINAR SERIES

Under the sponsorship of the Massachusetts Center for Autonomous Materials (MassCAM; see last year’s Newsletter for more information), we have continued the seminar series called "Physicists in Industry." This series features physicists working in various fields outside academia, both in industry and national labs, who visit campus and present seminars and join small-group meetings with students. We intend these visits as an opportunity for our students to broaden their knowledge of their career options and to talk to our visitors about careers paths.

This year, physics students met with physicists working in diverse fields. We hosted Michael Buckley (Physics & Astron BS ’15) who is working as a mechanical engineer at Medrobotics, a medical device company in Raynham, MA; Michael also talked about his work with the maker-space Artisan’s Asylum in Somerville, MA. We hosted three visitors from FormLabs: Brendan Pratt, Maximilian Zieringer, and Dana Djerf (UMass alumna, 2014). We heard from a Quantum Computing company, Rigetti, where our alumna Genya Crossman (Physics BS ’17) presented her work. (See the letter from Genya elsewhere in this newsletter.) Most recently, we hosted physics alumnus Jack Lareau, who has had many years’ experience in private industry and at the Pacific Northwest National Lab. These visits were a great opportunity for students to learn about the many career options in physics. We thank all of our visitors. If you are interested in participating in this program, please contact us.

ACFI SCHOOL ON NEUTRINOLESS DOUBLE DECAY

During the week of October 31-November 4 a school for experimental students involved in neutrinoless double beta decay experiments was held at the Amherst Center for Fundamental Interactions (ACFI). Nearly two dozen students from all the major experiments came to hear about the basic theory behind such searches. Lecturers were Petr Vogel from CalTech, Jon Engel from the University of North Carolina and Michael Ramsey-Musolf, the ACFI director, of UMass.

The search for neutrinoless double beta decay has become ever important, with experiments planned and underway around the world. In ordinary beta decay, a “parent” nucleus with \( A \) nucleons, consisting of \( Z \) protons and \( A-Z \) neutrons, decays to a “daughter” nucleus having \( Z+1 \) protons and \( A-Z-1 \) neutrons and emits an electron and an antineutrino. In some cases, wherein the parent nucleus is strongly bound, the beta decay cannot take place because the daughter nucleus is higher in energy than the parent. In this case, it may be possible for a double beta decay to occur, wherein the parent decays to a different daughter nucleus, having \( Z+2 \) protons, \( A-Z-2 \) neutrons, and emits two electrons and two antineutrinos. Because two weak interactions are required, such decays are relatively rare. They have nevertheless been detected in a number of systems, with lifetimes of order \( 10^{21} \) years--much longer than the \( \sim 10^{10} \) year lifetime of the universe. Despite this mismatch, observation of such double beta decays is made possible by utilizing very large numbers \( >10^{25} \) of parent nuclei in the target.

Even more elusive is the possible existence of neutrinoless double beta decay, wherein the transition to the daughter having \( Z+2 \) protons and \( A-Z-2 \) neutrons occurs accompanied by two electrons but no antineutrinos. This type of decay is only possible if the neutrino is of “Majorana” type, meaning that it is its own antiparticle. At the present time, no such events have been observed, and lifetime limits are at the >10\(^{25}\) year level. This probe of fundamental neutrino character is so important that experiments involving different parents and various detector technologies have been set up in various laboratories around the world. One such experiment, EXO, uses the parent isotope \(^{136}\)Xe and involves UMass ACFI deputy director Andrea Pocar. It is the students from these efforts that came to ACFI to learn the associated theoretical basis for such processes. The students were very enthusiastic about the school and returned to their various experiments with a much deeper understanding of the significance of their work.
REU SUMMER 2017 BIOLOGICAL AND SOFT MATTER RESEARCH TRAINEESHIPS

During the summer of 2017, the Physics department ran the fourth year of the Biological- and Soft Matter Research Traineeships (B-SMaRT) REU program. This year we had 7 participants, of whom five came from Springfield Technical Community College or Holyoke Community College, or had transferred to UMass from these institutions. For many of the participants, it was their first introduction to research. Students were partnered with faculty within physics and (in one case) with Polymer Science and Engineering. They were immersed in research shortly after arrival in campus. Our participating faculty designed projects that build on the existing skills of the students, to allow them to contribute to the projects with the guidance of faculty, postdocs and graduate students. REU students also attended scientific talks and professional development classes held each week. They also enjoyed campus life and saw a little bit of what UMass research and the town of Amherst have to offer. At the end of the nine-week program, our students participated in a poster session showcasing their research.

WORKSHOP ON ’WORK FROM NOISE’

The Physics department hosted a 3-day workshop on the topic “Work from Noise: Harnessing Fluctuations to Manipulate Matter.” The event was held during the beautiful foliage season (Oct 26-28, 2017). Approximately 20 invited researchers from the US and Europe and 10 UMass faculty, plus some of their students, attended. The workshop included short presentations plus extended discussions of the question: what basic science do we need in order to understand systems that are driven out of equilibrium, their function in biology, and their use in human-made materials? The principal organizers were Professors Narayanan Menon, Jon Machta, S. “Thai” Thayumanavan, Tony Dinsmore, and Jenny Ross. The event was supported by the Massachusetts Center for Autonomous Materials (MassCAM).

NEW AT THE GORDON RESEARCH CONFERENCES

The Gordon Research Conferences now have an informal session for attendees called the “Power Hour.” https://www.grc.org/the-power-hour/default.aspx.

First initiated in 2016 the Power Hour is an open informal session, which can be attended by all conferees, for discussion on the challenges women face in science. The intent is to provide small group interactions in a select professional field with participants across different stages in each person’s scientific career. It also gives a voice to different minorities who can discuss their perspectives for professional growth. For protocol, the Chairs select a woman to serve as the organizer of the session. Then the program is adapted to the needs of the group. The GRC organizers provide initial topics and support materials to initiate discussion.

In 2017 there were over 108 Power Hours.

ACFI SCHOOLS AND WORKSHOP TOPICS 2017- 2018

- Testing CP-Violation for Baryogenesis, March 29-31, 2018
- Making the Electroweak Phase Transition (Theoretically) Strong, April 6-8, 2017
- Neutrinos at the High Energy Frontier, July 18-20, 2017
- The Electroweak Box, September 28-30, 2017
- School on the Physics of Neutrinoless Double, Beta Decay, October 31- November 3, 2017
- Nuclear Theory Topical Collaboration, February 3-4, 2017
graduate students, old and new

GRADUATED IN 1997

Kai Bolay  Yongsoo Choi  Aimin Ding  Kevin Flood
Fabrizio Gabbiani  Stefan Heinrichs  Thomas Hemmert  Yury Kolomensky  Hans Kutschera
Michael Lilly  Alexey Petrov  Erik Schaeffer  Oliver Strauss

1997 MS and PhD graduates not pictured: Paul Finley, Radu Mondescu, Jusak Tandean, Friedel von Goeler

ENTERED IN 2017

Back from the left: Sebastian Urrutia Quiroga, Yuan-Tang Chou, Samyukta Krishnamurthy, Brendan Sheehan, Ke Wang, Utkarsh Agrawal, David Kessler, Jesse Underland
Front: Matt Decapua, Michelle Berry, Tristan Winick, Mingzhu Cui, Tao Wang, Guanghui Zhou, Siao-Fong Li
Not pictured: Xiansheng Caimm
DEPARTMENT OF PHYSICS - UNIVERSITY OF MASSACHUSETTS AMHERST

Outreach

The UMass Science Outreach Club continues its mission to bring science lessons and demonstrations to local area schools. The club is sponsored by the Physics Department and supervised by physics faculty and staff, but its membership derives from all over the College of Natural Sciences. The club offers a wide range of science topics with a heavy dose of drama and fun, from charging soap bubbles, to freezing balloons in liquid nitrogen, to levitating foil kites with a hand-held Van de Graaff machine. In Fall 2017 they traveled to Pelham Elementary, Crocker Farm Elementary, Fort River Elementary, and the Amherst Boys and Girls Club. Arrangements to have the club perform at your institution can be made by contacting them atsciout@stuaf.umass.edu.

WEB-BASED TOOL TO TEACH SCIENCE

In an effort to support science education beyond the university, Professor Guy Blaylock has developed a web-based tool to help teachers and parents teach science. The site is available at https://sciphile.org/, where it hosts a database of short science lessons and activities for use in the classroom or at home. The aim of the site is to provide the kinds of active-learning activities and topics that science professionals know about, while packaging them in a highly indexed and searchable way, so that non-specialists can easily discover them and incorporate them into their classes. (Think Wikipedia for science teachers.) The site has been active since early 2014, and currently receives over 300 visits/day from about 200 different countries. At sciphile.org, you can find lessons on such topics as static electricity, electric motors, magnetic levitation, optical illusions, super-absorbent polymers, friction, color perception, Bernoulli’s principle, vortexes, smoke rings, siphons, rockets, and pendulums, to name but a few. Each lesson includes a hands-on activity to engage students in the fundamental science. For example, the lesson on hurricanes includes construction plans for generating a tabletop flaming tornado in a waste paper basket. As Blaylock says, science should always have an element of excitement to it.

NEW MASTER’S DEGREE PROGRAM!

The department has started admitting students into a Physics MS program to begin Fall 2018.

This Physics MS program will nominally be completed in 3 semesters and is course-based. It prepares students for one of a number of things, depending on how they choose to customize their course selection:

a) a springboard to admission into a PhD program
b) a means to acquire skills and prepare for jobs in industry with advanced specialization in a particular area of physics (fundamental interactions, condensed matter, biophysics, etc.)
c) an instrumentation specialization.

The Physics Department is also considering starting a new degree track in Physics. The new track would be a ‘4+1’ masters program, where students start taking graduate level courses in their undergraduate junior and senior years, and then stay one additional year to complete a masters degree.

For more information or applications, please see http://www.physics.umass.edu/graduate

ACADEMIC QUALITY AND DEVELOPMENT (AQAD) REVIEW

In March of 2017, the Physics Department hosted a visiting committee appointed by Dean Goodwin to examine the Department’s teaching, research and service missions. The external committee visit is a central part of the University’s AQAD (Academic Quality and Development) review process, where UMass academic departments and programs are reviewed every seven years. Members of the visiting committee were Paul Goldbart (Georgia Tech), Alex Kusenko (UCLA), Bob Redwine (MIT), with Dan Reich (Johns Hopkins) chairing. The committee spent a day and a half on campus meeting with faculty, staff, and students. The summary report written by the committee strongly endorsed the research directions and teaching programs the department has been pursuing, recommending to the dean and provost that further faculty investments in the department are strategic and warranted. One area the committee felt additional efforts are needed is in improving departmental climate for female, LGBT and underrepresented minority faculty members and students. The Department and College have made departmental climate a standing priority, and are looking to build sustained efforts to improve everyone’s experience in the Department.

UMASS SCIENCE OUTREACH CLUB

The UMass Science Outreach Club continues its mission to bring science lessons and demonstrations to local area schools. The club is sponsored by the Physics Department and supervised by physics faculty and staff, but its membership derives from all over the College of Natural Sciences. The club offers a wide range of science topics with a heavy dose of drama and fun, from charging soap bubbles, to freezing balloons in liquid nitrogen, to levitating foil kites with a hand-held Van de Graaff machine. In Fall 2017 they traveled to Pelham Elementary, Crocker Farm Elementary, Fort River Elementary, and the Amherst Boys and Girls Club. Arrangements to have the club perform at your institution can be made by contacting them atsciout@stuaf.umass.edu.
TUOMINEN NAMED ASSOCIATE DEAN FOR RESEARCH AND INNOVATION IN CNS

Professor Mark Tuominen has been named Associate Dean for Research and Innovation in the College of Natural Sciences (CNS), effective Oct. 1, 2017, CNS Dean Tricia Serio announced.

As a member of the Dean’s leadership team, Tuominen will have broad responsibilities for the success of research and faculty advancement for the 13 departments and two schools, encompassing more than 450 faculty, within CNS.

“Mark’s research career has epitomized excellence, innovation and bold thinking, and importantly, his achievements are coupled with a strong commitment to mentorship and the advancement of others,” Serio said. “I am thrilled to have this opportunity to work with him to support the aspirations of this college and the inspiring people who make it a success.”

Tuominen has been at UMass Amherst since 1993. He received a bachelor’s degree in chemical engineering and materials science and a PhD in physics from the University of Minnesota and was a postdoctoral research associate at Harvard University.

A fellow of the American Physical Society, Tuominen is also director of the NSF National Nanomanufacturing Network, co-director of the NSF NSEC Center for Hierarchical Manufacturing, and co-director of MassNanoTech at UMass Amherst.

He was an NSF National Young Investigator and a Cottrell Scholar, among other honors. At UMass Amherst, he was awarded a TEACHnology fellowship and an Outstanding College Teacher Award. He was an instrumental member of the team that created the Integrated Concentration in Science (iCons) program in the college.

LORENZO SORBO PROMOTION

The Department is pleased to report that Professor Lorenzo Sorbo has been promoted to the rank of Full Professor effective September 1, 2017. Professor Sorbo’s main field of research concerns the Physics of the Early Universe. In particular, it is widely believed that the very early Universe (about 10-35 seconds after the Big Bang) underwent a period of inflation, a phase of accelerated expansion that made the Universe very large and homogeneous. Prof. Sorbo has studied how processes that occurred at such an early stage could lead to effects that might be observable today in the measurements of cosmological quantities, such as the (polarized) spectrum of photons in the Cosmic Microwave Background. Sorbo has also worked on various theoretical aspects of gravity, as well as on the possibility that gravity might deviate from Einstein’s theory of general relativity at very large scales.

MENON WINS CNS RESEARCH AWARD

Each year the UMass College of Natural Sciences presents a research award to one of its members. The 2017 CNS Outstanding Faculty Award for Research was given to UMass Physics Professor (and now Department Head) Narayanan Menon. Menon has been at UMass for two decades, having obtained his PhD at the University of Chicago. His group performs research in the area of soft experimental condensed matter physics. Specifically, he has recently been looking at symmetry breaking in macroscopic systems. An example is the work with UMass Physics Professor Benny Davidovitch, UMass Polymer Scientist Tom Russell, and Oxford University Mathematician Dominic Vella, which proposes a new law for predicting the wavelength of complex wrinkle patterns, including those found on curved surfaces and presents experimental work to support it. The work is expected to help materials scientists to use wrinkles to sculpt surface topography, or to use the wrinkles on surfaces to infer the properties of the underlying materials, such as textiles or biological tissues. Additional details can be found at the website.

Awards

undergraduate awards

iCONS STUDENTS HONORED FOR SOLAR PANEL COOLING PROPOSAL

Four students in the Integrated Concentration in Science (iCons) program have been awarded first place in the UMass Amherst Undergraduate Sustainability Research Award for their research paper, “What is it Going to Take to Make Solar Panels Cool?” One goal of the iCons project is to allow students the freedom to continue building upon an idea throughout their four years in the program. The Friends of the UMass Amherst Libraries bestowed this honor and $1k prize for their spring 2016 paper on using water to cool solar panels to render the panels more efficient.

The integrated team of students of the Class of 2018 (Cameron Lane, physics; Cameron Smith-Freedman, biology; Matthew “Donnie” Rollings, chemistry; and Luke Fateiger, computer science) is enrolled in the renewable energy track of the iCons program. Their 2016 research proposal was presented in the iCons 2 course, Integrated Scientific Communication, which serves as a literature research experience.

In June 2017 Lane said, “Implementation on the UMass campus in some form is one of our next goals for this project. As we will all be seniors next year we would love to see it working to some effect before we leave.” He continued that the team will also investigate filing a patent through UMass technology transfer office. First, they must develop a complete design and parts list, which will require more data collection and analysis using the model system.

“We have only tested our system in idealized lab environments,” Lane said. “We would like to try it outside in real weather situations to get a better idea of what will be possible. Through this experimentation we have a goal in mind of finding a way to increase the panel efficiency by at least 10 percent in a realistic outdoor environment. If we can find this to be possible we can prove definitively that our system can have an immense impact on the sustainability of campus.”

As an update, Cameron is continuing to work on the project this year for his honors research thesis that will outline the feasibility and prototype of a system for UMass campus.

Liam Christopher O’Brien ’18

Last spring, Liam Christopher O’Brien, ’18, Physics, Mathematics, Computer Science major, received the William F. Field Alumni Scholar Award. This prestigious award recognizes third-year students for their academic achievements at UMass / Amherst, and only 56 students each year from the entire junior class are chosen to receive this award.

Liam has been very active in doing research at UMass, taking on two different independent projects. In the first, an experimental project with Professor Narayanan Menon, Liam has been studying how rigid plates attach to fluid-fluid interfaces. Such processes at fluid interfaces have a vast array of applications, yet are not well understood. As such, Liam has designed and performed his own experiments from scratch and developed techniques for extracting and analyzing data detailing the motion of the plates. He presented some of his findings at last year’s APS March Meeting (one of the largest physics conferences in the world), and is working towards publishing the results of the project.

In his second project, Liam and Professor Lorenzo Sorbo are tackling a theoretical problem in cosmology. Specifically, they are studying the process by which the vacuum decays into a pair of particles connected by a string. Liam has been finding solutions to the Einstein Field Equations describing this process, and then computing various important quantities for these solutions. Most notably, Liam is computing the probability for this process to actually occur. Once
having the probability, Liam and Professor Sorbo intend to use this model in the context of inflation to describe inhomogeneities in the early universe, one of the major persistent problems within an otherwise very successful theory. This project will become the topic of Liam’s senior thesis beginning next spring.

As to the future, he intends to further his love of physics by attending graduate school in physics, and earning a PhD. After that, he hopes to pursue a career in physics research. Outside of physics, Liam has been a contributing member of his community. Most notably, he has worked as an umpire for his hometown Little League for years, including regular season, post season, and championship games for the local league. He was chosen as an umpire in various tournament games, including Little League World Series qualifying games. He is also an avid lover of basketball and football, and frequently takes part in games at all levels.

RYAN BOYDEN ’17

The University of Massachusetts Amherst honored ten members of the Class of 2017 for exemplary achievement, initiative and leadership of some of its most talented and accomplished graduating seniors during Undergraduate Commencement in May as 21st Century Leaders.

The 21st Century Leader Award recognizes the strong academic record and exemplary achievement of undergraduate students who further distinguished their intellectual accomplishments and enhanced the reputation of the University by contributing to the campus community. Recipients receive a plaque and an award of $1k from the Alumni Association.

Ryan Boyden, a double major in physics and astronomy from Leominster, was the lead author of a scientific paper on stellar feedback published in Astrophysical Journal. He had been a summer research intern at UCLA and worked with a scientist studying star clusters in the Milky Way. He was also a resident assistant, a New Students Orientation leader and secretary of his fraternity. He is pursuing a PhD in astronomy and astrophysics and a PhD minor in astrobiology at the University of Arizona in Tucson.

IDA AND JOSEPH SIMENAS AWARD

The Physics department has been given a new endowment for an annual undergraduate award, the Ida and Joseph Simenas Physics Scholarship, for academically excellent physics majors. Scott Simenas (BS, 1971) donated the funds for this award in memory of his parents. Ida and Joseph Simenas had remarkable lives and were ground-breakers in their respective fields of business administration and teaching (Ida) and lumber retail and engineering (Joseph). Readers can find a fascinating biography online at http://www.physics.umass.edu/undergraduate/awards. In making this generous donation and establishing this award, Scott aims to recognize and support physics majors who are hard-working, resilient in the face of adversity, able to collaborate with all kinds of people, and enthusiastic with a positive attitude like those of Ida and Joseph.

Tara Dowd (class of 2018) was named the first recipient of the Ida and Joseph Simenas award in May, 2017. Tara is a physics major with a secondary major in astronomy, part of the Commonwealth Honors College. Tara has an outstanding academic record and has been active with the UMass Science Outreach Club.

CHANG RESEARCH AWARD

Professor Edward Shih-Tou Chang had an enduring special interest in undergraduate teaching and advising. He was the Physics Department Chief Advisor and Undergraduate Program Director before becoming the Associate Dean for Advising. After his retirement in 2008, Professor Chang established a generous endowment – the Edward S. Chang Fund for Undergraduate Research – to provide funds in perpetuity for small grants to undergraduate physics majors pursuing research projects. The Physics Department is very grateful for the generosity of Professor Chang and his family. These awards will provide valuable enriching opportunities for students for many years to come.

This year, four Chang awards have been offered to physics majors Yihan Gao, Anthony Raykh, Justin Roberts, and Anwesha Saha. Yihan is a sophomore and she proposed a project on the ATLAS muon detector, working with Professor Verena Martinez Outschoorn. Anthony is a sophomore and proposed to work with Professor Scott Hertel on the LZ dark-matter detector. Justin is a junior and will work with Professor Shubha Tewari on simulating granular flows. Anwesha is a junior physics major, who proposed work with Professor Andrea Pocar on cryo-coolers for the Darkside and nEXO detectors.
DEPARTMENT OF PHYSICS - UNIVERSITY OF MASSACHUSETTS AMHERST

awards

UNDERGRADUATE AWARDS MAY 2017

Hasbrouck Scholarship Award
(junior, academic excellence)
Matthew Bissaillon
Thomas Bogue
Bela Nelson

LeRoy F. Cook Jr. Memorial Scholarship
(academic excellence and activity in outreach or teaching)
Daniel Sanchez Rosales

Morton & Helen Sternheim Award
(educational outreach and/or teacher preparation)
Theodore Kareta
Alissa Roegge

Ida and Joseph Simenas Award
(academic excellence)
Tara Dowd

Kandula Sastry Book Award
(academic excellence and versatility)
Jonah Chaban

Richard Kofler’s Class of ’76-’77 Scholarship
(strong intention of career in Physics)
Amy Ralston

Edward S. Chang Fund
(supporting outstanding research)
Allyson Bergeron
Nathan Rose

GRADUATE AWARDS MAY 2017

Quinton Teaching Assistant Award
(outstanding teaching assistant)
Leila Farhadi
Sara Feyzbakhsh
Dario Rosenstock

Dandamudi Rao Scholarship
(research in biological physics or closely related area, in memory of Kandula Sastry)
Kieran Ramos

Kandula Sastry Thesis Award
(presentation of outstanding thesis)
Dr. Basem Mahmoud El-Menoufi

AWARD RECIPIENTS, PHYSICS DEPARTMENT, MAY 2017

Back from left: Kieran Ramos, Matthew Bissaillon, Dario Rosenstock, Nathan Rose, Daniel Sanchez Rosales, Theodore Kareta, Jonah Chaban, Thomas Bogue
Front: Tara Dowd, Leila Farhadi, Sara Feyzbakhsh, Bela Nelson, Amy Ralston, Alissa Roegge, Allyson Bergeron
Verena Martinez Outschoorn joined the physics department as an Assistant Professor in the fall of 2017. Her research is in experimental high energy physics, focused on the Large Hadron Collider (LHC) at CERN. She is currently a member of the ATLAS Collaboration, having previously been a member of the CMS Collaboration.

Verena received her bachelor’s degree in Physics and Mathematics in 2005 and her PhD in Physics in 2011 from Harvard University. She was a Lederman Postdoctoral Fellow at Fermi National Lab from 2011 to 2014, and was an Assistant Professor in the Department of Physics at the University of Illinois from 2014 to 2017.

Her primary physics interest is the search for new physics at the LHC. She is currently using the Higgs boson to look for new particles that could be indications of dark matter. She is also interested in seeking new particles that could explain why the Higgs boson is so light, such as additional scalar particles or top partners. In addition, she is working on improving the capabilities of the ATLAS detector, focusing on muon detectors. Muons are very powerful signatures of interesting events in LHC collisions and are therefore one of the most important triggers used to collect data. As a result, she works on new electronics to the trigger and readout muon detectors in order to improve their detection capabilities for the future.

Verena is also passionate about science education and outreach and particularly enjoys exposing students to career opportunities in science as well as mentoring students in research.

Rafael Coelho Lopes de Sa

The Physics Department to welcomes Rafael Coelho Lopes de Sa, who joined the faculty as an Assistant Professor in Fall 2017. As an undergraduate, Rafael majored in physics at the State University of Rio de Janeiro (Brazil), a large public research university with many similarities to UMass. Then, he did a Master’s Degree in theoretical physics at the Theoretical Physics Institute of the State University of Sao Paulo (Brazil), a small research institute located in the heart of the largest city in Brazil. Rafael got his PhD from Stony Brook University, the flagship research campus of the State University of New York, another large public research university. Before coming to Amherst, Rafael was a Lederman Fellow for four years at Fermilab, the premier US national laboratory for High Energy Physics.

Rafael’s research is in experimental high energy physics, broadly defined. He uses the data collected by the ATLAS detector at the Large Hadron Collider (LHC) to study the role of the Higgs boson in the structure of the laws of physics at high energies. The Higgs boson is the most recently observed elementary particle and is the main player in the mechanism of spontaneous symmetry breaking at the electroweak scale, the highest energy scale currently accessible in collider experiments. This is the mechanism through which elementary particles get mass and explains the nuclear weak force. Rafael designs new measurements that can elucidate the details of the electroweak spontaneous symmetry breaking mechanism.

Rafael also designs and constructs new detectors for the ATLAS experiment. The LHC is increasing the number of particle collisions every year and new detectors are necessary to handle the increasing intensity. Rafael is part of a large collaboration in the US developing a new detector to measure the directions of the particles produced in each collision, a small detector in the heart of the ATLAS experiment, as close as possible to the point where the collisions happen. Rafael is excited to be at UMass and is having an enjoyable time preparing his laboratory in the new Physical Sciences Building, where parts of this new detector will be built. He is also very happy to be part of the ATLAS group at UMass and to be able to work and discuss ideas with colleagues, postdocs and students.

In the Fall of 2017, Rafael taught an introductory laboratory course for physics majors, where they learned techniques in thermodynamics and waves. He is looking forward to teaching an advanced course in electrodynamics in the Spring of 2018 and finds teaching to be one of most enjoyable activities of his job as an Assistant Professor at UMass.
Romain Vasseur

The Physics Department welcomes Romain Vasseur, who joined the faculty as an Assistant Professor in Fall, 2017. Romain did his undergraduate studies in France, and majored in Physics at École Normale Supérieure (ENS) in Lyon and then attended graduate school in Paris and at CEA Saclay (Saclay Nuclear Research Centre) where he got his PhD in 2013, followed by postdoctoral appointment at the University of California, Berkeley and Lawrence Berkeley National Laboratory.

Romain is a condensed matter theorist working on strongly correlated quantum systems, with a focus on the interplay of strong interactions and quantum entanglement, leading to new emergent phenomena both in thermal equilibrium and in non-equilibrium quantum systems. Romain’s research addresses questions such as the following:

- What new states of quantum matter can one find in non-equilibrium systems?
- Are there new phases and dynamical phase transitions far from thermal equilibrium that go beyond the traditional dogma of statistical physics?

He has worked extensively on isolated strongly disordered systems for which the laws of thermodynamics can break down as a result of the localization of excitations that would ordinarily transport energy among distant regions to establish thermal equilibrium. Such “many-body localized” systems raise the intriguing possibility that quantum coherent phenomena such as quantum and topological order or quantum criticality, typically associated with zero-temperature systems, can occur in arbitrarily “hot” and strongly interacting matter. Romain is also interested in topological phases of matter that show exotic fractionalized excitations, and in topological phase transitions that go beyond the standard picture of symmetry breaking.

Brittany Bonefant

Brittany Bonefant joined the Physics Department in May, 2017, as an Administrative Assistant, initially working with the Massachusetts Center for Autonomous Materials (MassCAM). Her responsibilities have recently expanded to include the Amherst Center for Fundamental Interactions (ACFI), as well as other departmental programs. Based in Hasbrouck, Brittany organizes many of these research centers’ activities such as workshops, conferences, summer training and education programs, and grant proposals.

Brittany came to us from outside the University with a lot of experience helping others in need, such as mental health counseling and working on political campaigns. Currently, she is a member of the National Honors Society of Leadership and Success and is involved with Soldiers’ Angels. She enjoys learning new skills, meeting new people and most importantly, continuing to learn from those experiences. Coming to the University of Massachusetts has been a long-term goal, being a place full of culture, new experiences and new professional learning opportunities. She describes her time here in the Physics Department as “by far one of my favorite experiences. The students, staff and faculty are great and always full of life and adventure. There is always something new and exciting going on and at the end of the day, that is exactly where I want to be.”

Brittany has her bachelor’s degree in Criminal Justice with a minor in Sociology from the University of Hartford and will soon continue her journey with graduate School in Forensic Psychology come Spring of 2018 (while still working with us in the Physics Department!). Hobbies include reading, gardening, discovering new breweries and traveling to Canada, Maine and Arizona. She lives in Connecticut with her energetic Pomeranian, Jayjay.

Katie Bryant

The Physics Department welcomes Katie Bryant as our new Graduate Program Manager (GPM), as of Fall 2017. Katie comes to the Department from the far side of campus (Whitmore Administration Building), where she worked in Human Resources for 17 years. For the majority of this time she handled graduate student payroll.

Over the years, with increasing computerization of campus business, Katie had found her contact with colleagues around campus diminished. She took the job in Physics, in part, because it is more people oriented, as well as being more
The Physics Department welcomed Patty Ryan as its new Undergraduate Program Coordinator in Summer 2017. Patty has worked at UMass for 22 years, including 16 years as the Graduate Program Coordinator in the History Department. After a major reorganization in History, she moved to the Department of Environmental Health Sciences in the School of Public Health, where being the sole staff person she had an exceptionally wide range of responsibilities.

Patty is very happy with her new job in Physics, where she is able to focus on tasks associated with our undergraduate courses – getting courses set up and scheduled each semester; helping students get registered for overfilled classes. She finds the department to have a pleasant, comfortable and productive working environment, and particularly enjoys getting to interact with students on a regular basis.

Off campus, Patty is an avid gardener, cultivating two 20’ × 20’ plots each summer with flowers and vegetables at the Northampton Community Gardens, where she also manages new gardener registration (somewhat akin to her job in Physics). She was born in Northampton and now resides in Florence.

David Nguyen

David Nguyen joined the Physics Department in September 2017 as a Technical Specialist supervising the undergraduate laboratory infrastructure. He is tasked with the set up and troubleshooting of the undergraduate labs, as well as assistance in the design and creation of materials for the lab courses.

David was an undergraduate at UMass, in physics, and is now continuing his education at UMass, working toward a master’s degree in Education. In addition to his work on the undergraduate labs, he has served as a teaching assistant for the Physics 131 and 132 courses, and has aided in the creation of a custom textbook for the Physics 131 course this past summer. His interests lie in science education, with goals of helping to further improve instructional labs for the Physics Department, providing an educationally positive experience for students in these courses.

David was once a member of the marching band here at UMass, enjoys music and films, and considers himself a board game enthusiast. He is a Massachusetts native, and currently resides in Amherst.

INTERNATIONAL WOMEN’S DAY

Thursday the 8th of March was celebrated in many ways by scientists.

The IAEA, International Atomic Energy Agency, Director General Yukiya Amano remarked on how his agency is making progress in addressing the number and percentage of women. The EPWS, European Platform of Women in Science, is devoting its first focus issue featuring women researchers in a variety of fields and includes a special “round table” component. Full article <http://researchfeatures.com/2018/03/06/gender-equality-epws-european-research-policy/>

An interesting event is the electronic Global Marathon: Inspiring Women in Engineering & Technology.[ http://www.discovere.org/ interactive and archived. A special message from Canadian Prime Minister Justin Trudeau was broadcast. The Global Marathon, a free, online series sharing important career advice and informing scientists of the engineering application of emerging technologies. The 2018 event over two days centered on 1. Advancing Your Career and Personal Brand through Social Media and 2. Breaking Through: It’s Women’s Work. Offered is a full complement of teaching materials and directing information about involving girls in science.
GRADUATE PROGRAM MANAGER JANE KNAPP RETIRES

Physics grad students and faculty were sad to see Jane Knapp, the Department’s longtime Graduate Program Manager, retire in Fall, 2017. Jane started at UMass back in 1994, working at a number of jobs around campus, before finally landing in the Physics Department. Jane recounts how her friend Ann Cairl, Office and Personnel Manager in the Department, had been talking up the Physics as a friendly workplace to her for some time.

This indeed turned out to be the case, and Jane stayed in the Department for nearly 20 years, taking on a newly established position that gathered together in one office all the information, administrative tasks and resources for the graduate program, which had previously been split among a number of faculty members. Jane had a large number of formal tasks to attend to, e.g., interfacing with the Graduate School and faculty supervisors, so that graduate students would get paid on time, and organizing records for the yearly grad admissions process. She also carried out many less formal roles, such as welcoming new grad students from abroad and making sure they understood how to open up bank accounts and rent apartments.

Jane particularly enjoyed getting to know our graduate students, helping them with their progress through the graduate program, answering questions, and finding solutions to the truly wide variety of problems and situations that might arise. She was a sensible, helpful and sympathetic resource on any topic. Jane loved that, even after two decades, she would still be fielding questions she never encountered before. The fact that Graduate School rules changed continually over the years might not have been her favorite thing.

Getting to know faculty members was also a plus for Jane. Through the years she worked closely with many different Chairs of Graduate Admissions and Qualifying Exam Committees, TA Supervisors and Graduate Program Directors. All these people’s jobs were made greatly facilitated by Jane’s comprehensive knowledge of the graduate program and her institutional memory.

Jane was a central figure in the Physics Department staff. Our former and current Department Business Managers had these comments to pass along in honor of Jane’s retirement.

“There are many, many qualities that I could list when describing Jane Knapp. As her supervisor and friend, I came to rely on her good sense, practicality, and willingness to take charge of things when needed. I also relied heavily on her access to the department “grapevine” and what was happening that I might have missed! As a grad student program manager, Jane was as astute and as knowledgeable as any one person could be. As her colleagues in the Graduate School expressed at her retirement party - they knew that Jane would get it right every time.

“When Ann Cairl retired, Jane became the new ‘listener in chief’, hosting lunch in her office for the admin. staff from 12:30 to 1:30 most days. All the Mom’s would chat about their kids (and grandkids...) and vent their frustrations about happenings at work - and at home. Jane hosted this daily ritual with grace and good humor, and always knew when to kick everyone out!” - Mary Ann Ryan

“Basically, Jane is a beautiful, sparkly, refined rock, just so solid and capable. She is a straight-forward advisor in all aspects of life; from the best wording of a difficult email, to house renovations, to welcoming and guiding students through the details of their academic and research programs. Her thorough and caring approach to her work, co-workers and students are sorely missed.” - Sara Cooper

Jane grew up in western Massachusetts and upstate New York. After college, she lived in New York City and San Diego, before returning to this area to be near her family. She has two daughters, Jillian who lives in Richmond, VT, and Elizabeth who lives in Northfield, MA. She is looking forward to the birth of her first grandchild in winter, 2018. Jane’s husband, Peter, is a UMass alumnus in Art and was the owner/manager for many years of the Danco Modern furniture store in Hatfield.

Jane is looking forward to a relaxing retirement involving working on landscaping, gardening, renovations and updating around her house in Sunderland, travels to the ocean, and plenty of time to read and cook.
Joseph Haines Babcock, the computer systems analyst for the Physics Department for the past 20 years, died on November 17, 2017, at the Massachusetts General Hospital in Boston from complications caused by multiple myeloma, a plasma blood cancer. Bruce Carson, his spouse and partner of 34 years, was with Joe when he passed away.

Joe was born July 19, 1955, in Warren, Ohio, and moved with his family at a young age to Westfield, Massachusetts. He graduated from Kansas State University in 1978 with a BS degree in music education and taught music in the Pretty Prairie, Kansas, public schools for one year before returning to Massachusetts and earning a degree in data processing from Springfield Technical Community College. Joe began working at the University of Massachusetts Amherst in 1988, in the Office of Information Technology.

In 1997, Joe joined the Physics Department, where as a Systems Manager, he was responsible for supporting and enhancing the computing, network, and electronics environment for the teaching, research and administrative programs of the Department. His areas of responsibility included hardware, software and network devices, and applications for various computing platforms. During his tenure in the Department, computing changed from being primarily the use of isolated personal computers to include WiFi and networks of dedicated clusters of central processing units used by groups in theoretical condensed matter physics and experimental high energy particle physics. Among other things, Joe was responsible for maintenance of the computational clusters, configuring switches connected with both wired and wireless network management, backup of critical systems, monitoring of networks for outside intrusions, and research for the purchasing of networking equipment. This required him being in close and sometimes constant contact with numerous Department faculty, staff, or research personnel, sometimes on weekends and holidays. Joe was careful to always remain in contact, even when he was on vacation.

Outside of the Department, Joe participated in an exchange program with the Leningrad Polytechnic Institute in 1990, spending a month in the former Soviet Union helping to modernize computer systems within the Institute and studying Russian. He also attended night classes at local Stillpoint School of Advanced Massage Education and became a licensed massage therapist in 1999, working with various men’s sports teams at the University. In addition, Joe enjoyed taking classes at the Culinary Arts Institute in New York City.

Joe and Bruce frequently traveled to Italy. Among the highlights of those trips were riding bikes along a path through Alpine meadows outside Merano, watching the sunset over the Adriatic from a jetty in Pesaro, and sitting at the window of their "room with a view" in Verona, gazing down at the constant ebb and flow of daily life in a busy Italian piazza.

Joe’s family and friends have described him as being vibrant, strong, physically fit, and positive in attitude. Although he dealt with a terminal illness for nearly ten years, he never complained. He was an avid skier, enjoyed biking and insisted on continuing to live an active, rich life. The Department held a get-together Dec. 5, 2017, to honor Joe’s memory, where his colleagues spoke not only of his professional dedication and competence, but also his friendliness and generous spirit.
Emeritus Professor **Phillips Russell Jones** (1930-2017) passed away in May 2017 at the Cooley Dickinson Hospital in Northampton. Born in 1930, in Troy, New York, son of Rev. John Paul Jones and Helen Reed Jones, Phil graduated from Sanderson Academy in Ashfield MA in 1947 and received a BS in Physics from UMass in 1951. He then served in the US Army as an Instructor in the Radiological Defense Branch of the Chemical Core School at Fort McClellan in Alabama from 1952 to 1954 and earned Masters and PhD degrees in physics from the University of Connecticut in 1958.

He joined the UMass Physics Department as an Assistant Professor in 1958 before the department offered a PhD Program and continued at UMass until his retirement as Professor in 1993. He was respected as a researcher, teacher and a steady, dedicated departmental citizen. In many ways, his presence in the Physics Department was a harbinger of things to come. His work on electron scattering in Atomic Physics, conducted in the basement of the original Hasbrouck Laboratory, was one of the first NSF-funded modern research programs in the department.

Despite many medical struggles in his later years, he led a full life and adapted gracefully to his physical limitations. He is survived by daughters, Linda and Sharon, son, Kevin and their families. Predeceased by his beloved wife Ereda Jones. He and she travelled extensively and enjoyed camping, hiking and ballroom dancing.

A Memorial Luncheon attended by family, friends and many Physics colleagues was held in June 2017 at the Lord Jeffrey Inn.

**Po-zen Wong**, 1952-2017, retired professor of Physics, died unexpectedly at his home in Amherst on October 16, 2017. Colleagues at UMass and at other Physics departments across the country knew Po-zen as a uniquely talented experimentalist with an original take on both physics and life. He relished a good argument, would pursue a scientific debate with great tenacity, and loved demolishing the position of conventional wisdom.

After completing his early training in Hong Kong, Po-zen moved to the United States for a graduate degree at the University of Chicago. His PhD research was on disordered magnetic systems, a topic that he continued working on when he moved to his first job at Schlumberger-Doll Research. His major experimental tool at that time was neutron scattering, carried out at Brookhaven National Laboratory. His papers generated considerable controversy on the nature of the magnetic transition in random magnets; when the dust settled, there was some consensus that Po-zen’s point of view was essentially correct.

While at Schlumberger, his interests naturally turned to the structure and transport properties of sedimentary rocks, and this interest stayed with him for a considerable length of time. Po-zen was one of the pioneers in relating the properties of these complex natural materials to basic statistical physics issues like percolation, fractals, and nonequilibrium growth models. Writing in a review article in Physics Today on the physics of rocks, he summed up his attitude to the subject beautifully: “Sedimentary rock makes up much of the Earth’s surface and contains two of the most vital fluids for our lives—water and hydrocarbons. Yet physicists have paid little attention to rock, mainly because we are discouraged by its apparent complexity. We are well trained in working with idealized models, but when faced with a piece of rock, not only do we not know where to begin, but we also may question whether it is even possible to find interesting physics in such a ‘dirty’ and uncontrolled system. With further thought, however, we should realize that these are but the usual mental barriers that we have to overcome every time we study something new.”

When Po-zen moved to an academic life at UMass in 1988, his interests in ‘rock physics’ continued, but he developed new tools appropriate to a university lab. His interests in the emerging field of soft-condensed matter physics also broadened, as he started working on new problems in electrochemistry, and in pattern formation. He had an important influence on the future research profile of the department, in nucleating our now-well-established concentration in soft matter physics.

Po-zen was a dedicated but challenging teacher, who demanded much of his students and made a strong impression on them. Don Candela, in the adjoining office, recalls that “His conversations with students typically started with physics but often wound their way around to larger life issues.”

Po-zen retired early from his physics career, in 2007. He then spent an active life traveling and absorbed in his new interest - traditional Chinese art. It was a matter of great pride to him that he ended up writing academic articles in art journals as well. His death came in the midst of good health and robust activity. He leaves his wife Chiu-wun and his daughters Stephanie and Joyce. They have our deepest condolences.
‘Notable Women’ Playing Cards Honor Late Astronomers Judith Young and her Mother Vera Rubin

A project celebrating international women in science was launched online featuring a new deck of playing cards that honors 54 “Notable Women in the Physical Sciences,” including the late UMass Amherst astronomer Judith Young and her mother, Vera Rubin, also an internationally recognized astronomer.

The project is intended to draw attention to the accomplishments and contributions of women in several branches of physics, mathematics, electrical and computer engineering, planetary science, astronomy and in science communication.

Bunny Laden, founder and president of the California-based “Notable Women” card project, says that to the best of her knowledge, Rubin and Young are the only mother-daughter pair in the deck.

Among the “Notable Women,” Young appears on the Five of Diamonds and is also featured in a blog post by the project founder Laden. Young’s card notes that among many accomplishments, she won the Maria Goeppart-Meyer Award, which recognizes outstanding achievement by a woman physicist in the early years of her career, and that she is known for pioneering galactic structure research and for creating the UMass Amherst Sunwheel.

Young created the circle of standing stones that align with the rising and setting sun during solstices and equinoxes. She began building the astronomical calendar in 1997 near McGuirk Alumni Stadium and for more than 15 years led seasonal sunrise and sunset gatherings at the site. Astronomy department head Stephen Schneider and others have continued them since her death in 2014 at age 61.

Young had come to campus in 1979 as a postdoctoral research associate at the Five College Radio Astronomy Observatory, where she collaborated with Nick Z. Scoville on a study measuring carbon monoxide and the cold gas content of galaxies. They discovered the distribution of gas and light is proportional in galaxies. In 1982, the American Astronomical Society recognized this work by awarding her the Annie J. Cannon Prize for promising research by a young woman astronomer.

Her mother, astronomer Vera Rubin, appears in the deck on the Ace of Hearts card, and is noted as having been awarded the National Medal of Science and the Gold Medal of the Royal Astronomical Society. She was known for pioneering work on galaxy rotation rates, dark matter, the Rubin-Ford effect and for being one of the first women to use instruments at the Palomar Observatory. She died in December 2018 at age 88.

Laden, a former research assistant professor at the University of Washington, where she taught music cognition and psychology of music, later worked at Apple as a technical writer, authoring thousands of pages of documentation on a variety of topics. She is an amateur astronomer who obtained a Messier certificate and learned to grind a telescope mirror. She recalls attending a STARMUS “Life in the Universe” festival in 2016, saying she “couldn’t help notice the high male-to-female ratio of speakers.” And, “I wasn’t the only one who noticed,” she adds, a reporter for the U.K. Guardian newspaper asked organizers about the imbalance, who said it was not their problem.

Laden notes, “That got me to thinking about the pool of female physical scientists available to talk about astronomy, physics, cosmology, planetary science and related fields. Inspired by “The Notable Women in Tech” cards project, I decided to learn about women – present and past – who have and are making contributions to the physical sciences, make playing cards to highlight their achievements, and give the decks to schools and other groups where they could inspire girls to pursue the sciences.”

She adds, “The physical sciences are just the start. The purpose of the Educational Card Project is to make and distribute cards that highlight the achievements of any underrepresented group in any science, technology, engineering, arts or mathematics field.”

Among the 54 women scientists included in her first deck, Laden put science writers on the two Joker cards. She says, “Jokers are wild and flexible cards. The ability to write scientifically requires topic flexibility and perhaps a bit of a wild attitude.” The card decks are available for a $12 donation at the https://www.edcardproject.org/the-cards.html
PHYSICS DEPARTMENT FLASHBACK

Although the teaching of physics at UMass dates from the earliest part of the twentieth century and the presence of Philip Bevier Hasbrouck, the "modern" era began in 1964 when Professor Robert L. Gluckstern, an accelerator physicist at Yale University, was named head of the UMass Department of Physics and Astronomy and proceeded to vastly expand the faculty. He served in this role until 1970 when he became vice chancellor for academic affairs and provost. He left UMass in 1975 to become chancellor of the University of Maryland. In 1982 Gluckstern gave up his administrative post to return to teaching and research at the College Park campus until his retirement in 1997. At the time of his retirement, he was asked to write a brief history of the development of the UMass physics department, which appears below. Robert Gluckstern died in 2008 of lymphoma at his home in Baltimore. His son Steven M. Gluckstern endowed a chair in Physics at UMass in honor of his father. Due to the huge department expansion, the department split into separate Physics and Astronomy departments in the year 2000.

“I have been asked for my recollections of the start of the modern Department of Physics and Astronomy at UMass. Since this period began 33 years ago, in 1964, I cannot promise total accuracy of recall. Nevertheless, I will do the best I can, and ask forgiveness in advance for oversights and incorrect recollections.

“Starting in the early sixties, UMass underwent a period of enormous rate of growth. The enrollment was 9000 in 1964, and each year saw an increment of 1500 students and 100 faculty ("larger than Amherst College!"). The growth was overseen starting in 1961 by I. Moyer Hunsberger, the Dean of Arts and Sciences, and then by Oswald Tippo, who came as Provost in 1964. Overall success during this period was made possible by the demand for excellence in all new appointments, the ability of Hunsberger and Tippo to assess this excellence in individual cases, and to support it with resources.

“I was recruited from Yale by Hunsberger, whose overriding philosophy was to support quality appointments as the essential element of a doctoral program to be developed. Although I was not attracted by the opportunity to do administrative work, the prospect of working with Hunsberger’s support to build a quality graduate program was too exciting to turn down. So, I set about trying to construct a plan which would make the greatest sense for UMass. With advice from colleagues at Yale and elsewhere, we decided to build an experimental research base in the form of user groups in elementary particle physics and nuclear physics, and individual laboratories in solid state and atomic physics.

All this, of course, was to be supplemented by a spectrum of theoretical research programs.

“Of course, we wanted to make good use of the significant talent already at UMass. Phil Jones and Ed Soltysik already had research programs in atomic physics which were then federally supported at a modest level. We therefore focused our recruiting toward building a scanning and measuring facility for bubble chamber photographs to support an experimental elementary particle physics program. The group was co-led by Steve Yamamoto, who came to UMass in 1965 from Brookhaven, and Janice Shafer, who came from Berkeley in 1966, each with substantial research experience. The new group also included Dick Kofler who came from Wisconsin and Stan Hertzbach who came from Johns Hopkins, in 1965 as fresh PhDs. In addition, to build our efforts in theoretical physics, in 1965 Mort Sternheim was recruited from Yale and Roy Cook was recruited from Princeton. Finally, in 1965, Norman Ford came from MIT to build a laboratory to study critical phenomena, and Claude Penchina came from Illinois to build a laboratory to study semiconductors. This addition of 7 new people and programs was made possible by Hunsberger’s willingness to assign new faculty positions to individual departments based on the quality of the candidate, regardless of discipline, and to provide financial support to start new laboratories. We succeeded because we had established and made good use of an effective network to first class programs at Yale, MIT, Berkeley, Illinois, Princeton and Brookhaven.

“In 1966 we continued our growth with a variety of new appointments -- Stan Engelsberg in solid state theory from Princeton, Bob Krotkov in atomic experiment from Yale, Ken Langley from Berkeley, to join Norman Ford in studying critical phenomena, and Arthur Quinton from Yale to organize our program in experimental nuclear physics. And in a move which had a profound and lasting effect, we appointed Bill Irvine from Harvard to start our program in astronomy and astrophysics. His effort led to the addition to Ted Harrison from England in cosmology and Tom Amy from Amherst College in observational astronomy, also in 1966, as well as a shift in the center of the 4-college (later 5-college) astronomy program from Amherst College to UMass. Finally, Fred Byron arrived from Berkeley to start work in theoretical atomic physics, much to the surprise of several of the faculty who felt that Fred would change his mind during 1965-66, after accepting our offer a year earlier.

“Due primarily to the efforts of Roy Cook and Mort Sternheim, appointments in 1967 solidified our theoretical program in elementary particle and nuclear physics with the additions of John Brehm from
Northwestern, Gene Golowich from Carnegie-Mellon, Arthur Swift from Wisconsin, and Bill Mullin from Washington University at St. Louis. We also added Mark Goldenberg from Princeton to do experimental work in atomic/solar physics. Bill Irvine continued to strengthen astronomy and astrophysics by acquiring the senior physicist John Strong and his colleague, Bill Plummer, from Johns Hopkins to move their program and equipment in infra-red astronomy to UMass. We also added Bill Cleland to the high energy experimental group. Bill actually left to go to Pittsburgh a couple of years later and Mark Goldenberg died in an unfortunate accident, 7-8 years after coming to UMass.

“Our growth continued in 1968 with the addition of Gerry Peterson from Yale in experimental nuclear physics (to work as a user at Yale’s facilities as well as MIT’s Bates Laboratory). Jim Walker came from M.I.T. to do work in theoretical nuclear physics and Allan Hoffman came from Brown in solid state theory. In addition, Bill Irvine recruited Richard Huguenin from Harvard to start our very successful program in radio astronomy. The final appointment in 1968 was Bill Dent from Michigan to work in astrophysics.

“My final year involved in recruiting was 1969 which saw the appointments of Dieter Freytag in elementary particle experiments, Francis Pichanick from Yale to work in atomic experiment, Bill Gerace from Princeton to work in nuclear theory and Bob Guyer from Duke to work in solid state theory. We also added senior nuclear theorist and public policy expert David Inglis from Argonne and Klaus Schultz from Columbia who subsequently became interested in pedagogical issues. Finally, Bill Irvine recruited Joe Taylor to our radio astronomy program. As you know better than I, he was awarded the Nobel Prize in 1993 for his work at UMass and was eventually ‘stolen’ by Princeton.

“Considering that our base prior to my coming in 1964 was 11 faculty with federal support totaling about $30,000 per year, the additions listed above had a profound impact upon the department and its thrust. The PhD program was quickly approved during the 1964-65 year and by the time I departed for central administration there were about 45 faculty federally supported at about $1 million per year. We were always conscious of including the ‘old-timers’ in our changing thrust and avoided much of the ‘two tier’ hostility other places experienced. In fact, people like John Trimmer, Phil Jones, Ed Soltysek, Bob Gray, Bill Ross, Al Mathieson, Ben Crooker, Phil Rosen, Bill Poland, Shin Lin, Marshall Thiebault, and Ik-Ju Kang all made important contributions to our push toward excellence.

“Finally -- an early recruiting vignette. Our first recruit for 1965 was Mort Sternheim. As my family and I drove Mort around in Fall 1964 to see potential housing, Mort turned to my 10 year old daughter B.J. and asked whether she liked it in Amherst. She in turn asked him whether he had accepted the position. Only after he said yes did she admit that she didn’t like it (all her friends were back in New Haven). We ran a tight ship!”

alumni news

Genya Crossman (BS ‘17) writes: Quantum Mechanics with Professor Donald Candela and Electronics with Professor Mark Tuominen were two of my favorite classes at UMass; thus, retrospectively, it is no surprise to find myself pursuing the career of a Quantum Engineer. However, when I first received a text from a dear friend and lab mate from Professor Stephane Willocq’s group a couple of weeks before my last semester at UMass asking if I was interested in quantum computing, I responded, “I’m not sure, I don’t know much about it.” Who knew a simple text from a friend would be the start of this scientist’s great exploration? Knowing nothing about the topic other than that the technology had not yet been built, I spent the next few months learning all I could about the field, particularly how microwave delivery to superconducting qubits may be a viable option for building a scalable, universal, gate-based quantum computer.

One year later, I am still reading all I can find on the topic, but not solely for the purpose of feeding my curiosity. After graduating in Winter 2017, I joined Rigetti Computing, a quantum computing startup based in Berkeley, California. At the start, I was trained as a member of the fabrication team. Gearing up to train in and help bring up the world’s first dedicated quantum chip foundry was exhilarating, to say the least. I’d never stepped into a cleanroom before, but was quickly brought up to speed on how commonplace semi-conductor fabrication processes can be used for superconducting quantum devices. While assisting with production, I also facilitated data acquisition and analysis of our devices, which felt like a smooth transition after spending two years analyzing simulation results under Professor Willocq’s guidance. Understanding the device data requires an understanding of both the fabrication procedures as well as how the chip was designed. As I began to learn about the designs, I only wanted to learn more and ultimately transitioned to the design team. One mere year after first researching what quantum computing was, I am designing qubits.
Moataz Emam (PhD ’04) writes: I remember my time at UMass Amherst as the best years of my life. During those years I had the opportunity to work with and learn from some of the greatest professors I could ever hope to be associated with; Drs. David Kastor (my thesis advisor), Eugene Golowich, Barry Holstein, and John Donoghue, only to name a few. After graduation, I accepted visiting positions at Mt. Holyoke College and Clark University before finally settling down in a tenured position at the State University of New York College at Cortland, where I am currently Associate Professor and Chair of the Physics Department.

Over the years, I have continued on my research with a focus on symmetries in higher dimensional gravitational physics, usually within the context of string theory and supergravity. I have also edited and co-authored an e-book anthology of articles on various approaches to the theory of everything. Over the course of my career, I have taken particular interest in involving undergraduate students in theoretical physics research. For this purpose I have developed a curriculum specifically designed to teach students the material needed for advanced research in as short a time as possible. This has resulted in several graduation theses, conference presentations, and peer reviewed papers. I am currently working on a new book based on my experience supervising undergraduate research.

Most recently, I have begun a collaboration with researchers of the Center for Fundamental Physics at Zewail City of Science and Technology, Egypt’s newest and most advanced STEM oriented research university. I typically visit them over the summer, presenting seminars and leading advanced workshops for high-energy physics PhD students. I am hoping to continue developing this relationship in the future.

I am married to Manal Mansour and we have three beautiful children together: Miriam, a senior in high school, and the twins Mourad and Maya in junior high school. As a family, we enjoy going on trips together, watching movies, playing video games, and the theater. Every year we spend most of the summer in our native Egypt, staying deeply in touch with our heritage and culture.

Abe Phelps (BS ’97, MEd ’01) lives one mile north of campus adjacent to Puffer’s Pond and is currently teaching high school science in Easthampton MA. He lives with his wife, Laila, and 2 boys: Alessandro (9) and Luca (6). Upon graduating in 1997, he spent 3 years as a materials, friction, and gravity experimentalist ski instructor in Winter Park CO. He then attended the UMass 180 Days in Springfield MEd Program. He taught 12 years in Springfield at Central High School as a physics teacher and a teacher-coach. Along with many other roles, he has served on the MCAS (Massachusetts Committee Assessment Systems, student test required for grade advancement and graduation) Physics Committee and just had a recent UMass physics graduate (Tom LeDoux ’14) as one of his student teachers. Abe is now in his 6th year at Easthampton High School—teaching robotics, forensics, Earth science, and, joyfully, several levels of physics. When he is not grading or jumping on the trampoline with his kids, he often sights physics professors among the wildlife in his many walks around the pond.

WE WANT TO HEAR FROM YOU

We welcome all feedback and look forward to hearing about your adventures. Our editors can be reached at newsletter@physics.umass.edu.
2017 PHYSICS ALUMNI REUNION

The UMass Physics Department hosted its Alumni Reunion on June 3, 2017, as part of the annual University Alumni weekend festivities. The event was well attended by alumni, faculty and current Physics undergraduates, who participated in a poster session on their research. Department Head, Rory Miskimen, offered a brief overview of both current state and future prospects of the Department, after which there were brief talks by faculty members Jenny Ross on MassCam and Mort Sternheim on STEM ED. A good time was had by all.

Jenny Ross talks about Massachusetts Center for Autonomous Materials (MassCAM)

Rory Miskimen and the attendees.

In front: William Zamites (‘15), Michael Buckley (‘15), Margaret McCarthy (‘77 G) talking to a partially hidden Helen Sternheim, Steven Mahala (‘15), John Donoghue (‘76 G)

Adrian Parsegian, Benny Davidovitch, Jonah Chaban (‘18), Bela Nelson (‘18)

Don Candela, Paul Siva (‘00), John Donoghue (‘76 G)

Racquel Kirpan, Lace Stokes, Jason Stevens (‘92)

Alumnus or alumna, please officially update addresses via http://www.umass.edu/umassmag/contact/address.html, and also inform the department by using the newsletter address newsletter@physics.umass.edu.
NEW ALUMNI

Back row from left: Anubhab Halder, Trey Nasser, Teddy Kareta, Christopher Brissette, Mark Lewis, Daniel Todd, Craig Methot, Jordan Kornfeld, Russell Phelan.
Front row from left: David Nguyen, Jonathan Bond, Sean Bradley, Trevor DeMille, Samantha Cabral, Alissa Roegge, Ryan Boyden, Edward Gelberg, Saba Karimeddiny, Kaylee Spitaels, James Smith, Daniel Sanchez Rosales.
We are delighted to report a record number of students earned their bachelor’s degree in physics last year!
This list represents those who contributed to the Department of Physics from January 1, 2017, to December 31, 2017. We apologize for any omissions and kindly ask that you bring them to our attention at newsletter@physics.umass.edu.

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Thank you for your generosity.
RISING RESEARCHER AWARD

Rising Researchers, a special title for outstanding undergraduate researchers, exemplify the range and depth of talent that UMass/Amherst undergraduate students possess to conduct meaningful research. Six seniors with outstanding accomplishments were honored in April 2017 with the Rising Researcher award. Saba Karimeddiny ’17, a physics major and Commonwealth Honors College student, was the advisee of Professor Jonathan Machta, who says he made a “great decision” to supervise a freshman project when usually only upperclassmen conduct research. Karimeddiny had been working on an interdisciplinary project with mathematical ecologists from the University of California–Davis. “Saba’s project has involved exploring the connections between systems of coupled nonlinear oscillators, traditionally used to study spatially extended oscillating populations, and the Ising model, an important theoretical model in physics,” said Machta. He conducted simulations of both coupled oscillators and the Ising model, demonstrating that there is a correspondence between these two superficially different systems. The result was a paper titled "Critical fluctuations of noisy period-doubling maps" coauthored by Noble, Karimeddiny, Hastings, and Machta which was published in the European Physical Journal B. The manuscript of a second paper on the subject, authored by Karimeddiny, is in preparation and is tentatively titled, “Ising-like behavior of coupled, one-dimensional, noisy oscillators”. In this paper Karimeddiny shows that a system of one-dimensional nonlinear oscillators behaves quantitatively like the one-dimensional Ising model.

He has given several talks about his work at undergraduate research conferences and also described his work at the American Physical Society Meeting in March 2017. “This is the first time I have sent an undergraduate to this meeting,” says Machta. Saba is now in the Cornell Physics PhD program.