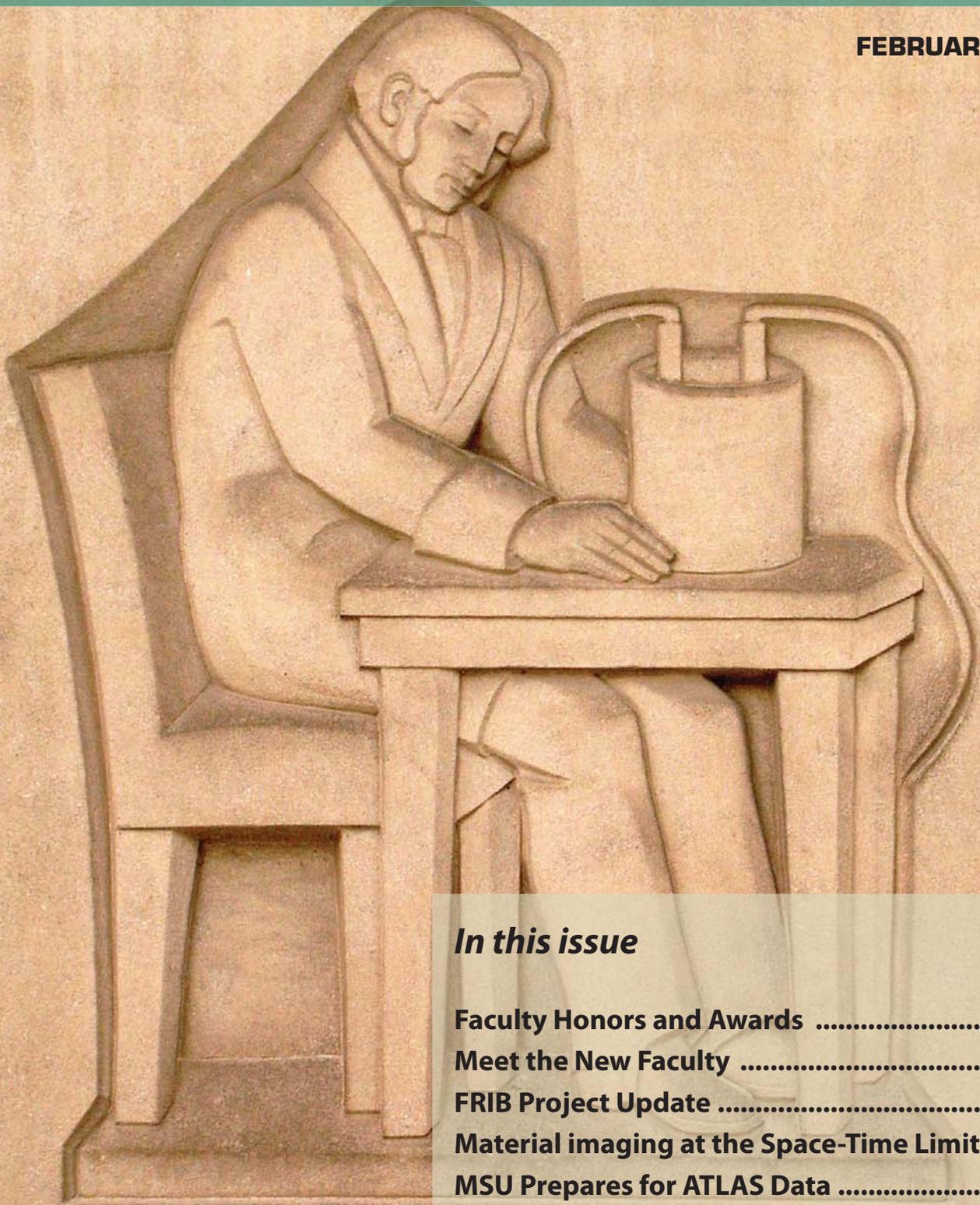


FEBRUARY 2010



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# A Letter from the Chair: The International Dimension

Dear Friends of the Department,

Michigan State University has made it part of its mission to engage in global outreach. Our department has a long tradition of leadership in the area as well. We draw some of the best students from around the world into our graduate program, and almost half of our faculty members were born outside the US. Many of our alumni have gone on to distinguished careers in countries around the world.

Our research has long had a global dimension, which was strongly amplified when we partnered with Chile and Brazil, as well as the University of North Carolina and the NOAO in Tucson, in building and operating our SOAR Telescope. This year our particle physics group moved its main research activity to CERN in Europe, where we are partners in the ATLAS detector collaboration at the Large Hadron Collider. Together with the University of Michigan, we have constructed one of the Tier II computing centers that will digest the vast flow of data generated by ATLAS.

Our nuclear physics program can also point to a long tradition of international collaborations. Yet the new FRIB facility will bring even more international users to our campus and will provide a major economic stimulus to the entire state of Michigan.

MSU has started a branch-campus in Dubai, and of course, physics is part of the initial set of instructional offerings. One of our recent Ph.D. graduates, Salameh Ahmad, was hired to be the first physics instructor in MSU's Dubai location. Instruction started in September 2009, and Ahmad's experience has been a great one.

Our brilliant undergraduates continue the great tradition of winning the most prestigious international scholarships for graduate school study.



A few years ago Stephanie Palmer was named a Rhodes Scholar, and two years ago Victory Moeller received a Gates Cambridge scholarship. This year it was Jessica Muir, who won the equally prestigious Marshall Scholarship and a Goldwater Scholarship, and Nate Sanders, who also won a Goldwater Scholarship.

The above list of outstanding accomplishments again underlines that our department continues to excel despite the tough budgetary boundary conditions that we are experiencing at present. There is good reason to look optimistically toward the future.

Best wishes,  
Wolfgang Bauer, Chairperson  
bauer@pa.msu.edu

## Department of Physics and Astronomy Newsletter Volume 11, Spring 2010

Wolfgang Bauer, Chairperson  
Daniel Stump, Undergraduate Program Director  
S.D. Mahanti, Graduate Program Director  
Steve Zepf, Associate Chair, Astronomy

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Contributing writers: Wolfgang Bauer, Thomas Glasmacher, Raymond Brock, Joey Huston, Gordon Shetler, Mike Steger and many other faculty and alumni provided content for the publication.

[www.pa.msu.edu](http://www.pa.msu.edu)



**Wolfgang Bauer, Bhanu Mahanti, and Carlo Piermarocchi** (*l-r*) traveled to the Dayalbagh Education Institute (DEI) in Agra, India, where each gave an invited talk at QANSAS09 - an international conference on quantum computing. The DEI is owned by the Radha Soami faith which boasts 2 million followers. Among the participants was Satsangi Sahab, the spiritual revered leader of the faith, who received his degree from MSU in the 1960s. During the visit, they explored future scientific collaborations with DEI, as well as possible study-abroad opportunities for undergraduate students.

# Faculty and Staff Honors, Awards and News

**Jack Baldwin** of the astronomy group received the 2009 Lorena V. Blinn Endowed Teaching Award from the MSU College of Natural Science. This award recognizes teaching excellence in the integrative studies.

**Tim Beers** of the astronomy group was a 2009 recipient of the Alexander von Humboldt Foundation Senior Research Award. Humboldt awards are given annually to researchers whose fundamental discoveries have had a significant impact on their discipline and who are expected to continue producing significant achievements. Beers is a leader in the search for the oldest and most chemically primitive stars, and is a co-discoverer of the two most primitive “still shining” stars known. In addition, Beers was identified in 2009 by Thomson Reuters as an ISI Highly Cited Researcher. Being acknowledged means that an individual is among the 250 most-cited researchers in a defined discipline within a specific time period. Citation is a direct measure of influence on the literature of a subject. This distinction is given to typically less than 1% of workers in any given field of study. Beers joins **Jack Baldwin** as one of the two researchers in the department who have garnered this honor.

**Sekhar Chivukula** and **Elizabeth Simmons** of the high energy group were invited to become members of the School of Natural Sciences at the Institute for Advanced Study in Princeton, New Jersey, during their sabbatical leave in fall 2009. The school includes fifty postdoctoral scholars and sabbatical visitors working on frontier topics in astrophysics, theoretical biology, mathematical physics, quantum theory, particle phenomenology, string theory, and quantum gravity. Simmons and Chivukula took advantage of this opportunity to advance their research on “higgsless” theories of the origin of mass for the elementary particles, with a special focus on signals that may be visible at the LHC.

**Marc Conlin**, administrative assistant for the department, received the Jack Breslin Distinguished Staff Award from MSU. He received the award in recognition of his overall excellence in job performance, supportive attitude, contributions that lead to improved efficiency or effectiveness, and his valuable service to the University. Conlin oversees all business functions of the department and building facilities, and supervises all department accounts.

**Thomas Glasmacher**, project manager of FRIB, was conferred a University Distinguished Professor in 2009. The title is among the highest honors bestowed on an MSU faculty member. Those selected for the title have been recognized nationally and usually internationally for the importance of their teaching, research and public service achievements.

**Joey Huston** of the high energy group was awarded the 2009 MSU Distinguished Faculty Award. He is an elementary particle physicist and received the award for his excellence in teaching, advising, research and outstanding total service to MSU.

**Chih-Wei Lai** received the 2009 Ralph E. Powe Junior Faculty Enhancement Award from Oak Ridge Associated Universities. The award provides funding to young faculty to enrich their research and professional growth.

**Jim Linnemann** of the high energy group was elected to Fellowship in the American Physical Society for outstanding contributions to physics. He was elected for his original research in high energy physics and particle



Aaron Galonsky of the nuclear physics group was awarded an honorary doctorate by the Eötvös University/Budapest, the highest honor the university bestows. He was presented the award in May on the 374<sup>th</sup> anniversary of the university's founding by Péter Pázmány. Golansky is shown in this photo taken during the ceremony and is on the right among the four seated at the table on the left.

astrophysics through electronics and software applications, seminal contributions to the discoveries of the top quark and TeV gamma-ray sources, searches for supersymmetry, and applications of statistics.

**Chong-Yu Ruan** of the condensed matter group received the 2009 Outstanding Young Researcher Award of the Overseas Chinese Physics Association. Ruan was recognized for his work on ultra-fast electron diffraction. His earlier work with A.H. Zewail at Caltech involved combining the spatial resolution of electron diffraction with the temporal resolutions of femtosecond laser to probe the real-time dynamics of complex molecules. This ultrafast electron diffraction technique employs the “pump-probe” scheme to make movies for molecular reactions. His recent work at MSU involves applying focused beam UED approach to investigate nanoscale materials and charge dynamics at interfaces.



# Meet the New Faculty

**Hironori Iwasaki** began a joint appointment with the department and the cyclotron in September 2009. He is an experimental nuclear physicist focusing on spectroscopy of exotic nuclei. He came to MSU after spending a year at IPN-Orsay (Paris) and two years as a Humboldt research fellow at University of Cologne in Germany.

Iwasaki received his PhD in 2001 at the University of Tokyo in Japan, where he then spent five years as an assistant professor. His research has focused on structure studies of unstable nuclei with very unusual proton-to-neutron ratios (exotic nuclei), which often show surprising phenomena, such as nuclear halo and changes of magic numbers, and then present important challenges to our understanding of atomic nuclei.

Iwasaki's research interests include structure and reaction studies on exotic nuclei, physics at and beyond the drip lines, and exploration of exotic nuclear resonances. He has developed a variety of experimental techniques by means of gamma-ray and particle spectroscopy with rare isotope beams. By exploring the isospin degree of freedom of the shell structure and collective properties of nuclei, as well as by developing new experimental techniques which often facilitate serendipity in physics, Iwasaki expects to be able to contribute to advances in physics with fast and re-accelerated rare isotope beams available at the cyclotron and FRIB.

**John McGuire** joined the department in 2008 as an experimentalist in condensed matter physics. McGuire earned his PhD in physics from the University of California at Berkeley in 2004 where he carried out research on silicon and water surfaces by nonlinear optical techniques under Yuen-Ron Shen. He did a post-doc at Lawrence Berkeley National Laboratory and also at Los Alamos National Laboratory with Victor Klimov.

McGuire's research focuses on the study of the dynamics of reduced dimensional and quantum confined systems



Iwasaki

McGuire

Spyrou

Zhang

by ultrafast (sub-picosecond) nonlinear optical techniques. At Berkeley, McGuire was able to perform the first study of sub-picosecond vibrational dynamics at hydrophilic and hydrophobic water interfaces. At Los Alamos, his research centered on interactions between multiple electron-hole (e-h) pairs in semiconductor nanocrystal quantum dots (NQDs).

McGuire plans to extend his work in the ultrafast dynamics of surfaces and nanoscale systems. In addition to continuing work on vibrational dynamics at water interfaces, he studies new systems, such as the interfaces between insulating oxides where novel interfacial states appear. Significant technical challenges to such studies will entail developing techniques for more detailed studies of surface dynamics. McGuire plans to study nanocrystalline systems displaying confinement-enhanced interactions between optically generated charge carriers and between charge carriers and dopants. Such systems have the potential to yield alternative routes to, e.g., single-exciton gain and spintronic media.

**Artemis Spyrou** started a joint appointment between the department and cyclotron in May 2009. She did her PhD in the field of experimental nuclear astrophysics in Athens, Greece, and came to MSU in 2007 as a post-doc with Michael Thoennessen where she studied the structure of neutron-unbound nuclei using the Modular Neutron Array (MoNA).

Spyrou's research interests span two fields in experimental nuclear physics.

As a member of the MoNA Collaboration, she is using fast exotic beams at the cyclotron to study the characteristics of very neutron-rich nuclei at the bottom of the nuclear chart. These nuclei live for such a small time that no device can capture them to study their properties. Spyrou and the MoNA Collaboration have recently studied several neutron-rich nuclei with many exciting findings such as new magic numbers and halo structures.

Spyrou is also interested in the stellar processes responsible for the synthesis of the observed elements, specifically the medium-heavy ones. As an experimentalist, she contributes to the understanding of this complicated problem by measuring the cross sections of important nuclear reactions that take place during these nucleosynthetic processes. Her work in this field has been limited to experiments with stable beams. She will perform experiments using low energy exotic beams from ReA3 - currently under construction at the cyclotron.

**Pengpeng Zhang** joined the condensed matter physics group in August of 2009 as an experimentalist specializing in surface science. She received her PhD in 2006 from the University of Wisconsin-Madison where she studied the structure and electronic transport properties of nanometer-scale semiconductor materials. This work earned an American Vacuum Society Graduate Research Award. She served as a post-doc at Pennsylvania State University with Paul Weiss and

*Continued...*

## Students Receive CNS Scholarships

Five undergraduate students from the department received scholarships from the College of Natural Science for the academic year 2009-2010.

- Sophomore **Sage Kramer**, from Okeemos, Mich., received an Undergraduate Research Support Scholarship for work in Ruby Gosh's lab.
- Astrophysics senior **Michael Tiano**, from Canton, Mich., received the William G. and Zelda Keck Memorial Scholarship.
- Physics and Astrophysics senior **Gabrielle Tepp**, from Muskegon, Mich., received the Thomas and Mary Krigas Endowed Scholarship in the College of Natural Science.
- Physics and Astrophysics senior **Nathan Sanders**, from Sault Ste. Marie, Mich., received the Lumsden-Valrance Scholarship.
- Physics senior **Sean Wagner**, from Rochester, Mich., received the Dr. Leroy Augenstein Memorial Scholarship.

## New Faculty (continued)

Dave Allara where she concentrated her studies on surface chemistry, molecule-substrate interaction and chemical patterning in self-assembled systems.

Zhang's research interest focuses on understanding the fundamental properties of electronic and photovoltaic nanomaterials using scanning probe microscopy in conjunction with device characterization, and manipulating the properties of nanomaterials via surface and interface engineering. In her earlier work, she discovered that when the surface of nanoscale silicon membrane is specially cleaned, the surface itself facilitates current flow in thin layers that ordinarily will not conduct.

An understanding of problems emerging at the nanoscale can lead to solutions enabling robust technologies. This will come from careful characterization of surfaces and interfaces, and the correlation of nanoscale phenomena with macroscopic device performance, which is the primary objective and methodology of Zhang's research.

## Marshall, Goldwater Scholars



**Jessica Muir**, of Romeo, Mich., was named a Goldwater Scholar in 2009 and a Marshall Scholar in 2010. Muir is the university's 14th Marshall Scholar and the only Michigan student receiving the honor in 2010. The 2010 class of Marshall Scholars includes 35 students throughout the United States who will use the scholarship for two years of graduate study in the United Kingdom. It covers university fees, cost-of-living expenses, research and travel grants and fares to and from the United States. Muir will graduate in May 2010 with degrees in physics and astrophysics. Muir has conducted undergraduate research in experimental high energy physics in the laboratory of Joey Huston. She also participated in a competitive summer student program at the European Laboratory for Particle Physics in Geneva. She is the assistant physics director for MSU's Science Theatre and also a member of Phi Beta Kappa. She serves on the Dean's Student Advisory Council for the College of Natural Science.



**Nathan Sanders**, of Sault Ste. Marie, Mich., was named a Goldwater Scholar for 2009-10. The Barry M. Goldwater Scholarship and Excellence in Education Foundation awarded 287 scholarships to budding mathematicians, scientists and engineers in 2009. MSU has produced 27 Goldwater scholars. Sanders is a physics and astrophysics major and has worked with faculty members Stephen Zepf and Ed Loh to study early-type galaxies and the development of the Spartan Infrared Camera for the SOAR Telescope. Sanders also used a transmission electronic microscope to analyze comet material from the NASA Stardust Mission along with MSU geology faculty. He also serves as the assistant director for MSU's Science Theatre.

## Physics Mailbox: Letter from Alumni

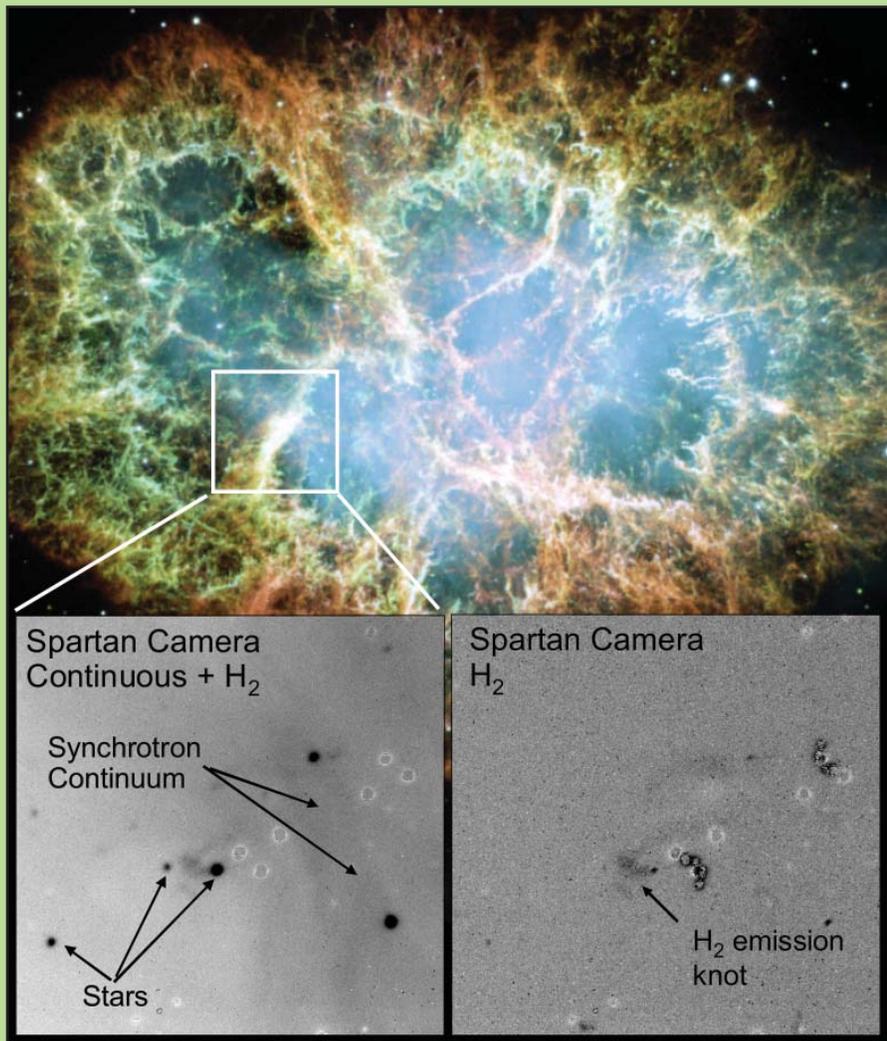
Dear Wolfgang,

Reading about Professor Betty Tsang's work on neutron stars reminded me of a personal incident 40 years ago. My first assignment at TRW, as a young engineer, was building optical sensors as components of the guidance and control system of the Advanced Vela Satellites whose purpose was to police atmospheric nuclear explosions. I got an urgent call to come into work one weekend. I was intensely grilled by program managers as to whether my sensors might have malfunctioned giving false information about the satellite's orientation. Because of the highly classified nature of the Vela mission, I was given no reason for this interrogation and it wasn't until many years later that what occurred that day came to light.

The Vela payload sensor package was to detect and (crudely) locate atmospheric nuclear explosions. Gamma-ray detectors were part of this sensor package. On the day in question these detectors had registered a mysterious gamma-ray burst that did not seem to come from the earth if the guidance and control sensors were functioning properly. However, if they were giving false orientation information perhaps someone was violating the Nuclear Atmospheric Test Ban Treaty. But if the orientation information was correct, which it was, this gamma-ray burst came from outer space! This very mysterious incident happened to be the first ever detection of a cosmic gamma-ray burst. Incidentally, the design life of the Advanced Vela Satellites was 18 months. In fact, they functioned nearly 15 years, not just policing nuclear test bans, but perhaps more importantly, serendipitously discovering and providing pioneering information on cosmological gamma-ray sources.

With best regards,  
Richard Wagner ('58, MS '64)

## Spartan Infrared Camera Discovers Emission Knot in Supernova Remnant



MSU's Spartan Infrared Camera on the SOAR Telescope discovered a molecular hydrogen ( $H_2$ ) emission knot in the Crab Nebula supernova remnant. The two grey-scale insets, shown on a negative scale where darker tones denote brighter light, are enlargements of images taken by the Spartan Infrared Camera that cover the entire supernova remnant. The left image is in the light of continuous emission + the  $H_2$  2.122 $\mu\text{m}$  emission line, while the right image is after subtracting off continuum measurements taken with a narrow-band filter at an adjacent wavelength. The bright  $H_2$  emission knot shows a very dense region in the filaments that have formed around the central bubble of hot synchrotron-emitting gas. These results are from a very preliminary reduction of observations made by Ed Loh and Jack Baldwin.

The Spartan camera is now coming into general use. Other MSU research projects using it have been started under the leadership of Steve Zepf and Megan Donahue.

## Timing of Vaccinations

Timing can be crucial if a vaccine is in short supply. Professor Mark Dykman and Visiting Research Associate Michael Khasin are part of a group of physicists who applied methods of quantum mechanics to show how to significantly reduce the time it takes to wipe out a disease. Their preliminary results suggest that vaccines in short supply should be given out in short pulses at regular intervals, so a small amount of vaccine can have a major influence in halting the spread of a disease.

The idea is to speed up the natural extinction of a disease. Such speedup occurs if vaccine is applied where a significant portion of the infected happen to be close to recovery, so as to minimize the probability that an infected and unprotected person come into contact. The effect of the vaccine can be resonantly enhanced by correctly choosing the interval between the vaccine pulses.

The researchers have yet to model their periodic vaccination scheme using real-world data. They have already produced one result with a strong implication – that a mistimed periodic vaccination may make things worse if the disease in question varies seasonally, like the common cold. The researchers found the phase and the frequency with which the vaccine is administered is crucial.

## Help Support Physics and Astronomy

*If you want to join me in supporting the long-term, financial viability of physics and astronomy at MSU, I suggest contributions to the department's discretionary endowment. Your gift will forever support essential components of the department. Use the envelope provided or for a list of other funds, go to [www.pa.msu.edu/donate](http://www.pa.msu.edu/donate). Every gift makes a difference. Thank you.*

*- Wolfgang Bauer*

# Facility for Rare Isotope Beams (FRIB) Project Update

Progress has been made on the Facility for Rare Isotope Beams (FRIB) project in the year since the U.S.

Department of Energy announced the selection of MSU to design and establish FRIB in December 2008. When completed, the facility will provide intense beams of rare isotopes for a wide variety of studies in nuclear structure, nuclear astrophysics, and nuclear theory.

FRIB could impact the study of the origin of the elements and the evolution of the cosmos, and offers exploring the limits of nuclear existence and identifying new phenomena, with the possibility that a more broadly applicable theory of nuclei will emerge. By creating exotic nuclei that have previously existed only in stellar explosions, FRIB would offer new glimpses into the origin of the elements and may lead to a better understanding of key issues.

“We have received nothing but strong support from federal officials, the university, the local community and our user groups from around the world,” said Thomas Glasmacher, University Distinguished Professor of physics and astronomy and FRIB project manager. “This is a complex undertaking and the process to bring the project to reality is starting out well.”

A cooperative agreement between the DOE Office of Nuclear Physics and MSU, signed on June 8, 2009, provides funding for the design and establishment of FRIB. The signing officially started the project and coincided with completion of a significant expansion to the National Superconducting Cyclotron Laboratory (NSCL) including new experimental areas and office space that houses the FRIB project team.

An event held June 12, 2009 marked the achievement and featured remarks from U.S. Senators Carl Levin and Debbie Stabenow, Steve Koonin, under secretary for science at the Department of Energy, MSU President Lou Anna K. Simon, MSU Provost Kim Wilcox,



and James Symons, director of nuclear science division at Lawrence Berkeley National Laboratory.

As part of a DOE-organized review process, representatives from national and international laboratories along with project stakeholders gathered in September 2009 to assess the technical, cost, schedule, and management status of the project. The review indicated that significant progress had been made and the project was on schedule. The feedback and guidance of content experts has been crucial as the FRIB team works to finalize the conceptual design by the summer of 2010.

In meetings organized by the FRIB project team, technical experts from around the world have met to evaluate technical design concepts, offer guidance and suggest alternatives for the conceptual design.

The Accelerator Systems Advisory Committee (ASAC) met in August and the Experimental Systems Advisory Committee (ESAC) met in November. These committees provides guidance and advice on technical choices, value engineering, measures to improve availability, maintainability, project risks and their potential impacts, and reliability of operations of the accelerator and experimental systems. The committee members are external experts trained in accelerator physics and engineering with familiarity in the design, construction and operations of major accelerator systems. Both committees will have additional reviews in February 2010.

The FRIB Users Organization has formed to serve the user community ([www.fribusers.org](http://www.fribusers.org)). The collaboration and input from the more than 800 FRIB users is extremely important during conceptual design to maximize the potential for scientific discovery when the facility begins operation. Meetings were held in August at Argonne National Laboratory to encourage and support collaboration as well as to allow researchers to join together to brainstorm and explore ideas. Another workshop will be on February 20-22, 2010, to offer users the oppor-



Konrad Gelbke, University Distinguished Professor, NSCL Director and FRIB Laboratory Director, accepts the Business Review West Michigan's 2009 "Deal of the Year Award" from Fred Keller, CEO of Cascade Engineering. Photo courtesy of Johnny Quirin and Business Review Western Michigan.

tunity to discuss concepts for specific experimental equipment and the physics they will enable.

Representatives from DOE visited MSU in November for a public scoping meeting as required by the National Environmental Policy Act. This allowed the DOE to identify potential environmental impacts and alternatives. During an educational open house prior to the meeting, more than 35 participants viewed exhibits, reviewed project materials, spoke with experts, and toured the NSCL. Fourteen people submitted comments at the meeting, including students, business owners, community officials, labor leaders, faculty and staff.

Local and regional groups have recognized FRIB as an important project for the state. Business Review West Michigan announced FRIB as the "2009 Deal of the Year" in the education category. The Lansing Regional Chamber of Commerce also recognized FRIB at its "Celebration of Regional Growth" event. The chamber and other economic development groups are collaborating to ensure those interested in working at FRIB know the assets available the area.

Construction of FRIB is anticipated to begin in late 2013 and FRIB will take about a decade to establish. More information about FRIB can be found at [www.frib.msu.edu](http://www.frib.msu.edu).

# Material Imaging at the Space-Time Limit

A collaboration of six research groups at MSU has received funding in the form of a Strategic Partnership Grant (SPG) in order to push the current limit of material imaging capabilities to the most fundamental level and help solve a major hurdle in complex materials. The SPG, funded by the MSU Foundation, is designed to concentrate on major projects in key areas of research for the development of new knowledge and to initiate centers of excellence.

The SPG funded a group of scientists based in physics (Chong-Yu Ruan, Martin Berz, and Phil Duxbury), NSCL (Marc Doleans), chemistry (Marcos Dantus), and material sciences (Martin Crimp). This collaboration between six research groups will allow them to work toward achieving the fastest, most precise and most efficient imaging instrument while solving complex material problems of the 21<sup>st</sup> century.

The composition and atomic arrangement in nanostructured materials, with length scales of 1-100nm, play significant roles in defining their properties and behavior, including phase transitions, chemical reactions, electronic processes, and macromolecular functions. These non-equilibrium processes, which involve the exchange of charge and energy, control the material properties by adjusting the electronic and consequently the atomic configurations on the time scale of femtoseconds to picoseconds.

Studying the underlying physical and chemical properties at the most elementary level requires the development of an instrument capable of 3-D imaging of a nanomaterial with Angstrom spatial resolution and femtosecond temporal resolution. This is a grand challenge problem in studying complex materials that the research groups of Ruan, Duxbury, Dantus, and Crimp face.

An instrument capable of recording real-time movies of isolated nanostructures performing functions with atomic scale resolution is considered a holy grail in material research. Duxbury, a world expert in solving nanostructure problems with limited experimental information, understands the intricate

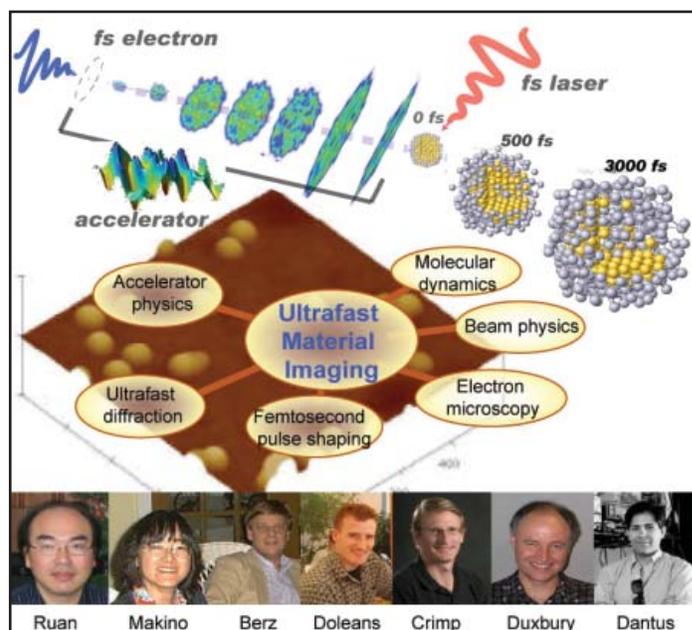
needs of reaching this goal. To solve the nanostructure problem, scientists must be able to reach space-time resolution on a single particle level - a research problem graduate student Zhensheng Tao is working on using the ultrafast electron diffraction (UED) method.

Currently, UED is a promising alternative approach to X-ray diffraction for high resolution space-time imaging, in particular for examining structural changes in nanostructured materials and macromolecules.

The amazing feature of using electrons rather than X-rays for studying nanomaterials is the high-sensitivity that allows only a handful of particles to be investigated at a time. This is in contrast to X-ray and neutron diffraction approaches where samples usually have high volume density in the micrometer to millimeter size scale. Materials studies with X-rays also face significant damage if a high flux source is used to boost the signal strength.

The jury is still out on the viability of electron pulse sources because it is fundamentally difficult to pack a large number of electrons into a narrowly confined space-time volume due to strong Coulomb forces between them. This makes achieving femtosecond-nanometer imaging fundamentally difficult when employing pulsed electron beams.

Crimp is an expert of implementing electron diffraction in a high-resolution transmission electron microscope. He understands the great advantage of using an electron microscope to investigate individual nanoparticles and functioning domain sites for material research. He worries about having strong Coulomb forces in the electron beam column that



will effect the spatial coherence of the electrons needed for resolving atomic details within the nanostructure. These fundamental issues pertaining to the so-called 'space charge' effects in a densely packed electron bunch will be solved using established accelerator physics concepts.

Berz is a world expert in beam physics and has been involved in the design of major accelerators, including the Large Hadron Collider. His expertise in solving the beam dynamics problem is key to the development of a new type of electron optical system specially tailored to the need of the dynamical electron microscope in solving the space-charge problem.

Working with Berz, Makino and graduate student He Zhang are working to extend their differential map approach to treat the beam dynamics of the femtosecond electron bunches. Based on their calculations, a mini-accelerator will be built to compress and shape the electron pulses into image forming rays. This is not possible without the insight of an accelerator physicist with expertise in bringing a highly technical design into reality.

Doleans will help design and construct the low energy accelerator. Doleans has significant experience in

*Continued...*

# MSU Scientists Help Detect Single Top Quark

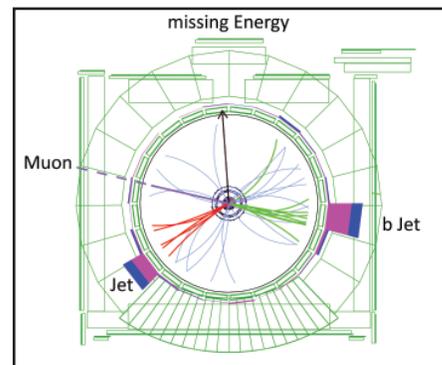
MSU physicists and colleagues around the world took a step closer to understanding the universe with the discovery of a single top quark at the Fermi National Accelerator Laboratory in March 2009.

“The discovery of single top quark production filled in a major piece of the puzzle in particle physics,” said assistant professor Reinhard Schwienhorst. This discovery “marked a milestone in physics,” he said.

Chien-Peng Yuan pioneered the study of heavy top quarks and their relationship to the Higgs boson. He proposed the relevant strategies for discovering single top quarks in 1989. Since then, Yuan has continued to theorize about top quarks and has collaborated closely with his MSU colleagues.

Scientists involved in the project have been working in two groups, each exceeding 600 physicists: the DZero and the Collider Detector at Fermilab collaborations. Reinhard Schwienhorst co-lead the DZero team and doctoral student Jorge Benitez was particularly active in that group, updating hardware and collecting and analyzing data. He also conducted theoretical work with Yuan and even relocated to Fermilab.

Kirsten Tollefson led a different group of nearly 150 collider detector team physicists. “MSU is one of only a handful of institutions that have faculty members on both the CDF and DZero experiments, and that can make life in the department interesting,” Tollefson said. “For the last three years, the groups have been in direct competition with each other over which experiment would be the first to see single top quarks.”



This collision event display shows a single top quark candidate event. The red arrow indicates the direction of a neutrino and the purple line the direction of a muon escaping from the decay of the top quark. Courtesy of CDF collaboration.

## Material Imaging (continued)

working with time-dependent electron optics used to shape and control electron bunches. His insight into the key issues related to space charge problems has led to the materialization of the SPG project.

In terms of generating the most intense femtosecond electron bunches, the laser-material interactions at the photocathode surface need to be optimized to yield a well-defined initial condition for the downstream electron acceleration and compression. Dantus' pioneering femtosecond pulse-shaping technique will be incorporated to control photo-emission and to achieve this goal.

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and

Linked In

<http://bit.ly/CNSlink>.

## MSU Establishes Complex Materials Center

A center of research excellence in complex materials was established by MSU in June 2009. Physics professor Phil Duxbury is the inaugural director of the center. This commitment is part of the MSU initiative in complex materials and follows the recent hiring of five new faculty members in complex materials in physics, chemistry and engineering. Two of these hires were in physics, Pengpeng Zhang and John McGuire. Further support for infrastructure and one or two additional hires in complex materials is anticipated.

MSU's focus on complex materials is motivated both by the new science arising at the nanoscale and the realization that complex and nanostructured materials have the potential to cause a paradigm shift in energy technologies and nanomedicine. The broader Condensed Matter Physics (CMP) group plays a central role in the MSU complex materials initiative, both in setting research directions and in developing group projects for federal submission. The federal government is investing heavily in these areas and MSU received significant federal funding in 2009 through formation of a DOE thermoelectric materials center, an NSF solar group and an NIH airborne nanotoxicology group.

Bhanu Mahanti is one of the principal investigators of the DOE thermoelectric materials center and Duxbury is one of the PIs of the airborne nanotoxicology group. Emerging CMP group projects include Chong-Yu Ruan's next generation ultrafast electron diffraction group and Chih-Wei Lai's quantum dynamics group. The multidisciplinary nature of complex materials research is well understood across campus, with faculty from chemistry, engineering and mathematics forming part of the executive committee of the center and taking a leadership role in group initiatives. A variety of complex materials activities, including training programs, conferences, alumni relations and industrial innovation programs, are being developed to help expand the center activities and funding base.



## MSU Prepares for ATLAS Data

After a holiday shutdown, the Large Hadron Collider will be starting again in mid-February and MSU will begin processing some of the ATLAS data from the LHC. The accelerator at CERN will start with relatively low energy and slowly ramp up toward its maximum operating energy of seven tera-electronvolts over the course of the next several years. The run completed in December 2009 already surpassed the highest energy produced at Fermilab by 20 percent.

A team at MSU has been working on the design and construction of the ATLAS detector at CERN for more than 15 years. The detector weighs 7,000 tons and contains as much steel as the Eiffel Tower. When the LHC is running at full speed, ATLAS will be one of the sites where proton beams intersect; causing collisions between bunches of protons every 25 nano-seconds.

The MSU team constructed a significant portion of the 2,000-ton “Tilecal” hadron calorimeter, consisting of detectors within the ATLAS experiment designed to measure the energies of the particles produced in these high-energy collisions.

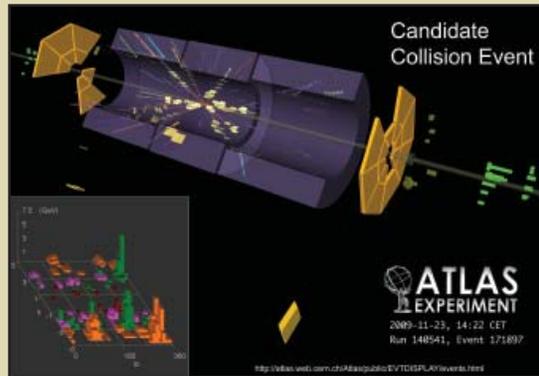
The Tilecal modules, each weighing nine tons, were instrumented and tested at MSU between 1999 and 2003 before being shipped to CERN for installation in the experiment. MSU physicists and technicians then spent considerable time at CERN during the past five years for the installation and commissioning of these detectors.

“This is the dream of every physicist,” said Joey Huston, who was involved in the construction of the detectors, “to be present when a new energy regime opens up, potentially offering answers to some of the most important scientific questions of our time.”

“The LHC creates so much data that it isn’t possible to process it all onsite” said Raymond Brock. “The US computing ‘cloud’ will process data from CERN and produce simulations. When the LHC is at design intensity, many 10’s of petabytes of data per year will be flowing through our grid – hundreds of billions of books worth of information.”

In the US, the data comes to Brookhaven National Laboratory, where it is split again among five “Tier II” locations. MSU and the University of Michigan combined to act as a single Tier II center. They are connected together, and to the rest of the world, via the Michigan Lambda Rail - a ten gigabit-per-second fiber optic loop around Southern Michigan. To process the data, approximately 2,000 cores of processing and 500 terabytes of storage area installed in MSU’s Biomedical Physical Sciences Building, which is about half of the ultimate total, Brock said.

Many hope the LHC will be able to answer fundamental questions of the universe. One goal is to find out why things have mass. Current theories point to an undiscovered particle, the Higgs boson. Many predict the higher energy of the LHC will make it possible to find this rare particle. Physicists also hope to find clues to understanding dark matter and a mysterious “dark energy” which invisibly make up 96 percent of the mass of the universe, and to better understand antimatter and the big bang.



Collision events were observed for the first time in the ATLAS detector at CERN on November 23, 2009. This event, along with almost all of the events taken by ATLAS so far, was triggered by the Minimum Bias Trigger Scintillators (MBTS), constructed at MSU and installed at CERN. The MBTS signals are represented by the gold quadrangles in this illustration of the first collision.

## Brock Provides Mythbusting for Moviegoers

When “Angels and Demons” premiered last spring, the worldwide High Energy Physics community used this to highlight the LHC and dispel any misgivings about antimatter. Public talks were given around the world, including 80 in the U.S. Raymond Brock gave a talk after one of the first showings of the film in Lansing.

“I was impressed that a nearly full theater of attendees would sit through a 2-hour movie and then sit through an hour long physics lecture and stay for nearly 45 minutes asking questions,” Brock said. “I was also impressed with how much fun it was to have your slides blown up behind you to the size of an enormous, movie theater screen.”

In his talk, Brock did some mythbusting about antimatter, drawing from his decades of participation in particle physics experiments at the Fermi National Accelerator Laboratory, Argonne National Laboratory and CERN.

Brock reprised his talk in June at the Bay Theater in Sutton’s Bay, Mich. By the way, the champion antimatter producer in the world is the Fermilab Tevatron. The annual antimatter production at the Tevatron? About a nanogram, enough energy to power a 100W light bulb for about an hour.

## LHC Theory Initiative Fellows Meeting

Sekhar Chivukula, one of the co-principle investigators for the LHC Theory Initiative, along with a group consisting of 17 fellows met in October at Fermilab to discuss their findings. The fellows gave summaries of their research at the two-day event. “The goal of this workshop was to talk about the research they’re doing and also to form collaborations beyond the length of the fellowship,” Chivukula said.

*Adapted from a story from Fermilab Today, written by Chris Knight.*

# ALUMNI CLASS NOTES



**Carl Brandon**, '66, received a \$195,000 grant from NASA to develop the technology to send a CubeSat to the moon. He is a professor at Vermont Technical College and is leading a team developing two mini-propulsion systems for the boosters, plus the lunar landing technology.

**Frederick Krauss**, MS '66, is retired and working on a live steam train engine in 1-1/2" scale which includes learning machining and welding skills.

**Richard Hill**, '68, is President of Atrax Marketing and recently launched a web site called DNA Testing Advisor to provide free advice to adoptees, genealogists, and others.

**Steven Mazurek**, '71, is Editor of MGA! magazine, a publication of the North American MGA Register, and received an APEX award last year for "Publication

Excellence: One to Two Person Product Magazine and Journals".

**David Lucas**, '75, is department head of physics and the premedical/pre dental program at Northern Michigan University.

**Rebecca Coalson**, '77, is a Research Patient Coordinator at Washington University and is the PI for the project "Functional connectivity MRI correlates of augmentative communication therapy in cerebral palsy."

**John West**, MS '77, received the Green Apple Teaching Award from the MSU College of Engineering in 2009. The award honors K-12 teachers who have inspired students to study math, science, and engineering. He retired from teaching at Bay City Central High School in June.

of Commerce Silver Medal for the development of the Virtual Cement and Concrete Testing Laboratory.

**Jeff Nico**, '83, was named a Fellow of the American Physical Society.

**Brian Winer**, '86, was elected as a Fellow of the American Physical Society. He is a professor at The Ohio State University working on High Energy Particle Physics and Astroparticle Physics and Director of the Honors Collegium.

**Charles Bloch**, PhD '87, is Associate Professor in the Department of Radiation Oncology at Washington University School of Medicine in St. Louis. Part of his job is helping the department prepare to start treating patients with 250 MeV protons from a compact high-field superconducting synchro-cyclotron.

**Scott Gaudi**, '95, was awarded the 2009 Helen B. Warner prize by the American Astronomical Society for his contributions to the field of exoplanet research, particularly in the area of microlensing detection and characterization of planetary systems, as well as for planets detected via transit and traditional radial velocity techniques.

**Dennis Kuhl**, MS '96, PhD '96, is chair of the physics department at Marietta College and recently helped oversee the design and construction of the Anderson Hancock Planetarium.

**Carlos Maidana**, MS '03, is a Research Associate at the Idaho National Laboratory, Space Nuclear Systems and Technology Division & Fuels Performance and Design Department in Idaho Falls, Idaho.

**Azam Niroomand-Rad**, PhD '78, received the Marie Skodowski-Curie Award from the World Congress of Medical Physics and Bioengineering. She is the immediate past president of the International Organization for Medical Physics and a retired professor of radiation medicine at Georgetown University Medical Center.

**Ed Garboczi**, '80, MS '83, PhD '85, moved to a NIST Fellow position in April and in October, 2009, was among six recipients of a Department



In May 2009, the department presented a plaque to **Nancy Zander Larson** (PhD '70) and **Duane Larson** (PhD '70) commemorating their 32nd wedding anniversary. The Larsons both obtained degrees in Physics at MSU and were married in the physics library. Sam Austin and Jack Hetherington were their advisors. Shown here are the Larsons with two of their grandchildren as the unwrapped the plaque. Sadly, Duane lost his long battle with cancer in July.

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A painted steel sculpture was recently installed outside the department offices and the South entrance to the Biomedical and Physical Sciences Building. The untitled sculpture was created by Russell Thayer, one of Michigan's most respected artists and art educators. "This sculpture is designed to be a bright arrow pointing to the recessed entry of the building complex that is otherwise invisible to the people or vehicles coming down the street," Thayer said. "It is a welcoming gazebo-like structure encouraging interaction between the people and the artwork, a place of congregation for the users of the building. It is not a sculpture on a pedestal separated from the people only to be looked at, but a piece to be involved with by walking through."



Actor Tom Hanks (standing on right) spoke with Dean Shooltz (seated in front center), Mike Nila (seated in front right) and Katie Yurkiewicz (standing in green jacket) in the ATLAS control room at CERN during a media tour for the film *Angels and Demons*. Read more about MSU's involvement in ATLAS and the LHC on page 10.

