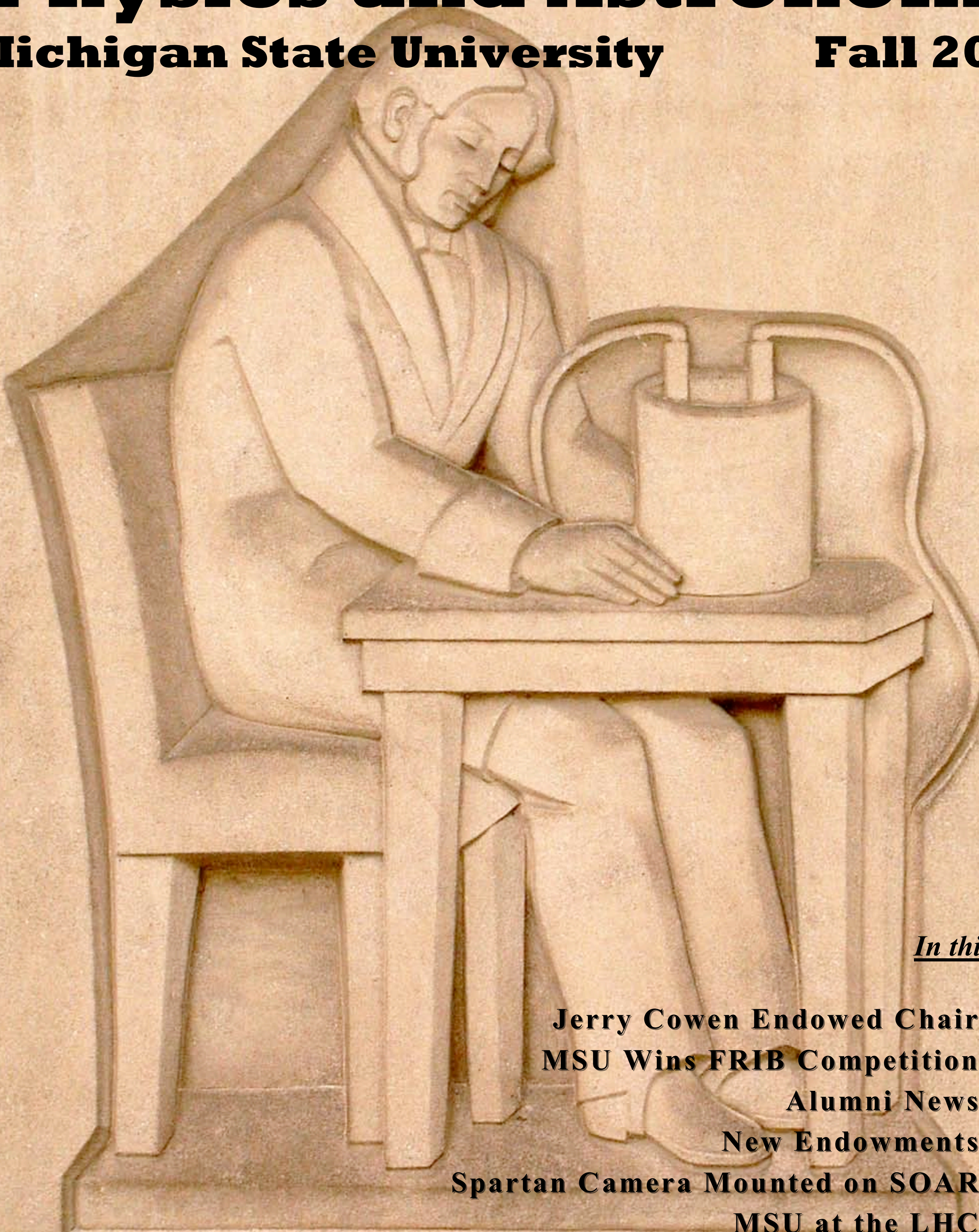
Physics and Astronomy

Michigan State University Fall 2008



In this issue

Newsletter

MSU Physics and Astronomy Department

Volume 10
Fall 2008

Dr. Wolfgang Bauer, Chairperson
Dr. Daniel R. Stump, Undergraduate Program Director
Dr. S.D. Mahanti, Graduate Program Director
Dr. Jack Baldwin, Associate Chair, Astronomy

A Letter from the Chair

Dear Friends of the Department of Physics and Astronomy,

It has been a year of economic turmoil, not just in Michigan, and not just in the United States, but around the entire world. I sincerely hope that your and your families' fortunes were not impacted too negatively; and if they were, hopefully they will turn around soon.

If you are hungry for a bit of good news, then please read on, because we have lots of good news to report. Professors Berz, Bollen, Gade, Makino, and Tomanek received major awards, and our undergraduate major Andrew Keller received the 2008 Goldwater honorable mention.

Our particle physics group has finally been able to take part in the opening of the Large Hadron Collider (LHC) at the European CERN laboratory in Geneva, Switzerland. Over 10 years of preparation went into this project, but now the biggest particle accelerator on the planet is finally ready to conduct its science program. And our particle physics group is ready, providing one of the biggest US groups at the ATLAS detector at the LHC.

Our astronomy group is happy to report another milestone, the completion of the Spartan Infrared Imager, which has just been installed successfully on our SOAR telescope in Chile, and which has now taken its first images. Prof. Ed Loh, who has spent the last five years of his life on the design and then construction of this instrument, is happy to report that it now takes images and works as originally envisioned.

Our condensed matter group has been strengthened significantly through the addition of Chih-Wei Lai, who is the first Cowen Endowed Chair in Experimental Physics. In addition, MSU has given the green light for a six-faculty-position cluster hire in the field of complex materials, a promising new branch of nano-science and nano-technology. Prof. Phil Duxbury is chairing the search committee, and the first offers will be made soon.

But I am saving the biggest news for last. You may have noticed that this newsletter arrived later than usual in your mailbox. The reason we held up publication this year is that we waited on the FRIB (Facility for Rare Isotope Beams) decision from the US Department of Energy. And in the morning of December 13 it became official: Michigan State University has been selected as the site for FRIB! This is a $550 million construction project and will establish a new national laboratory for nuclear physics on the campus on Michigan State University, eventually replacing our NSCL. Prof. Konrad Gelbke and his team prevailed against tremendous odds in a competition, which took many years, and which was intensely fought. The importance of winning FRIB cannot be overemphasized, not just for our department, but for Michigan State University and for the entire State of Michigan as a whole.

Finally, universities depend more and more on private donations, in particular endowments, for their financial well-being. This year our own Marc Conlin, who is the department's business manager, has led the way with a significant endowment gift. Marc is a life-long Spartan with BA ('69) and MBA ('72) degrees from MSU. And for almost 40 years he has served our department in various roles. As all my chairperson predecessors can tell you, it would be impossible to run the department without Marc. I am also thrilled to report that Randy Cowen has finalized a second endowed Cowen Chair to continue expanding on his father's legacy. Finally, University Distinguished Professor Emeritus Henry Blosser has endowed a professorship. It has now been 50 years that Henry started his career at MSU. He, more than any other person, has been responsible to the world-class status of our nuclear physics group. And his generous gift constitutes one more way in which the work he started will be continued at MSU.

Looking back on this year, despite the economic hardship our country currently experiences, I cannot help but be tremendously excited about the future prospects for our department.

Best wishes,

Wolfgang Bauer
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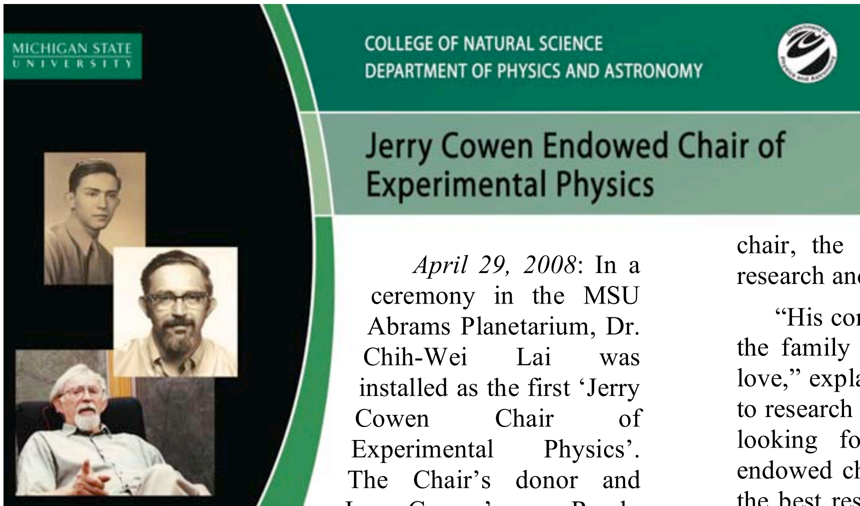


April 29, 2008: In a ceremony in the MSU Abrams Planetarium, Dr. Chih-Wei Lai was installed as the first 'Jerry Cowen Chair of Experimental Physics'. The Chair's donor and Jerry Cowen's son, Randy Cowen, two daughters of Jerry's, as well as his widow Elaine, were in attendance to help celebrate the occasion. MSU Provost Kim Wilcox, College of Natural Science Dean James Kirkpatrick, and Department of Physics and Astronomy Chairperson Wolfgang Bauer took turns at the podium to highlight the importance of the new endowed chair, before Chih-Wei gave a brief overview of his research program and how it ties in with the tradition that Jerry established. Randy then gave a brief address, outlining what filling the chair in honor of his father means to the family.

For the department it is now time to start another search … for a second Cowen Chair of Physics, which Randy Cowen graciously authorized.

From left to right: Provost Wilcox, Chairperson Bauer, Elaine Cowen, Randy Cowen, Chih-Wei Lai, and Dean Kirkpatrick.

Dr. Lai joins our faculty from Stanford University and is an internationally recognized expert in condensed matter physics and quantum optics. His research program promises to strengthen our already strong research efforts in nano-science and nano-technology.

Jerry Cowen received his Ph.D. in physics from Michigan State University in 1954. In 1955, Jerry and his wife Elaine moved to Okemos when he returned to teach in the department – a position held until weeks before his death in 1999.

Professor Cowen excelled in both materials science research and teaching, particularly at the undergraduate level. His research spanned five decades and included many international collaborations.

Randolph Cowen donated $2.5 million to create the Jerry Cowen Endowed Chair of Experimental Physics in memory of his father's life and physics career at Michigan State University. In creating this endowed chair, the Cowen family is recognizing Jerry's love for research and instruction in the area of experimental physics.

"His commitment to research inspired all the members of the family to strive to have an impact in a field that we love," explains Randy Cowen. "My father dedicated his life to research in the field of solid state physics. He was always looking for new techniques and materials. With this endowed chair, Michigan State University will have one of the best research efforts in the country in the field of solid state physics so that cutting-edge research can attract a new generation of graduate students like my father."

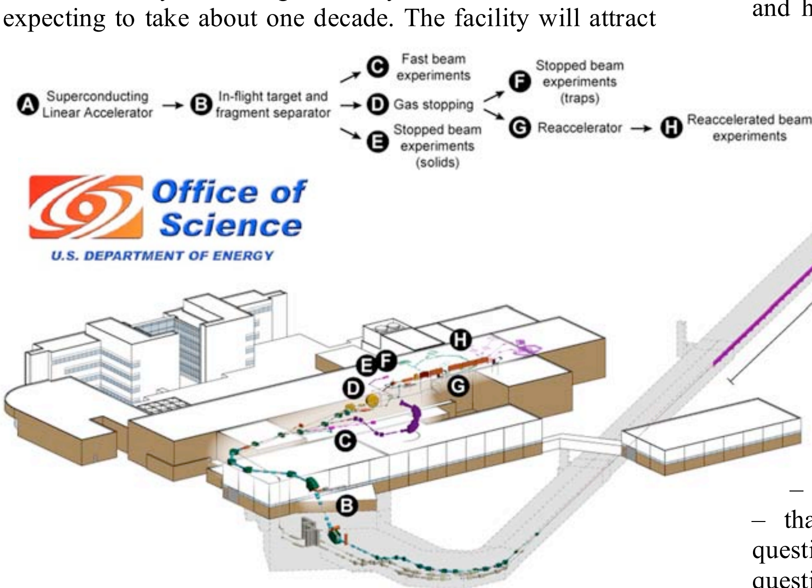
Honors and Awards

- Vladimir Zelevinsky has been appointed co-editor of Europhysics Letters.
- Stuart Tessmer and collaborators had their work featured in the News & Views section of the March issue of Nature Physics in an article titled "Probing dopants at the atomic level".
- The paper "Tunneling of a composite particle: Effects of intrinsic structure" by C. Bertulani, V. Flambaum, a V. Zelevinsky (J. Phys. G 34, 2289) was recognized as the best article in 2007 in this journal.
- Simon Billinge received the 2008 MSU Distinguished Faculty Award.
- Gerd Kortemeyer, Assistant Professor at Lyman Briggs College and Adjunct in our department, received the 2008 MSU Teacher Scholar Award.
- Phil Duxbury received the CNS Distinguished Faculty Award. Phil is also driving the Complex Materials initiative at MSU.
- The American Physical Society has decided to present awards for their outstanding referees. In the inaugural year of this awards program only 534 persons (from 33 countries) out of the ~42,000 active referees were chosen for this award, and 5 of our faculty members are included in this group. They are (in alphabetic order): B. Alex Brown, Scott Pratt, Elizabeth Simmons, David Tomanek, and Vladimir Zelevinsky.
- Pawel Danielewicz ("For outstanding contributions to the theory of quantum transport, particle production in nuclear collisions, the nuclear equation of state and the development of important new methods of analyzing experimental data.") and Piotr Piecuch (Adjunct, "For his outstanding contributions to electronic structure and quantum many-body theories, in particular developments in coupled-cluster theory, important advances in understanding molecular properties, chemical reactivities and intermolecular interactions as well as nuclear structure, through discerning use of computational methods.") were named Fellows of the American Physical Society.

US Department of Energy Awards FRIB to MSU

On Dec. 13, 2008, the U.S. Department of Energy Office of Science named Michigan State University as the site for the Facility for Rare Isotope Beams.

Conceptual design work for the proposed new $550 million facility will begin this year, with construction expecting to take about one decade. The facility will attract



top researchers from around the world to conduct experiments in nuclear science, astrophysics and applications of isotopes to other fields.

"This is a great day for science," said MSU President Lou Anna K. Simon. "We are grateful to the Department of Energy's commitment to address this critical priority for the nation's physical sciences research infrastructure, and we are proud to have been selected as a partner. We are deeply dedicated to working with the Department of Energy's Office of Science to develop an exceptional user facility serving the needs of national and international scientists.

"This is the first step on the journey," Simon said, noting that subsequent allocations must be appropriated by Congress to make the FRIB a reality. Simon said she will work closely with Michigan's congressional delegation to ensure the facility's funding.

The facility is expected to bring $1 billion in economic activity and 400 jobs to Michigan, according to an analysis by the Anderson Economic Group.

Simon acknowledged the role of Michigan's congressional delegation in supporting the MSU proposal and expressed appreciation to the FRIB Leadership Advisory Committee, as well as faculty, students, and alumni, who "joined Team MSU" to back the project.

The selection of MSU by DOE was the result of a competitive, merit review process that utilized a panel of world-renowned experts from universities, national laboratories and federal agencies. The appraisal included rigorous evaluation of competing proposals based on the merit review criteria described in the original DOE Funding Opportunity Announcement, presentations by the applicants, and visits by the merit review panel to each applicant's site.

FRIB will build on the successes of MSU's National Superconducting Cyclotron Laboratory, which submitted the proposal to DOE. NSCL has been the key driver for MSU's leadership in nuclear science education and research. The lab has been recognized as a world leader in rare isotope science and has produced research that has led to important breakthroughs in medicine, materials research, national security, and physics. NSCL Director and University Distinguished Professor Konrad Gelbke will serve as the FRIB director.

"The opportunities to advance human knowledge through science, and the potential for the scientific discoveries made at the FRIB to improve the human condition are tremendous," Gelbke said.

FRIB will provide intense beams of rare isotopes – short-lived atomic nuclei not normally found on Earth – that will enable researchers to address leading-edge questions in nuclear structure and nuclear astrophysics. Such questions include: What is the origin of the elements we find in nature? Why do stars sometimes explode? How can we better model atomic nuclei and their interactions? What combinations of neutrons and protons can make an atomic nucleus? What are the new applications of isotopes that can better diagnose and cure disease?

The heart of the new facility will be a high-intensity heavy-ion linear accelerator that will provide world-unique technical abilities. These will include the ability to conduct experiments with fast, stopped and reaccelerated beams, which will help users extend the reach of nuclear science. FRIB will establish world-leadership in rare-isotope science conducted in the United States in the future.

"The development of the FRIB will be guided by a spirit of partnership and collaboration from day one," said Gelbke. "We look forward to working with DOE to build a world-leading national user facility. We will actively seek to combine the deep expertise at MSU with the advice of leading scientific and technical experts and will collaborate broadly with the science community to ensure that the FRIB meets user needs to do cutting-edge, world-leading science."

MSU has an exemplary record regarding all aspects of safety, from new construction projects to daily operations. The university has a broad scope NRC license, recognizing deep capacity for radiation safety across the college. NSCL is registered compliant with the OHSAS 18001 standard for occupational health and safety and has logged 1,800 days without a lost work day due to injury. The university is committed to safe execution of all aspects of the FRIB project and will apply its many existing health, public safety, and environmental management resources to ensure success.

MSU has a half-century history of commitment to accelerator-based science and recently invested in a significant upgrade to NSCL's experimental capabilities. The upgrade includes a new low-energy linear accelerator for nuclear astrophysics experiments and a 10,000-square-foot expansion of the laboratory's experimental area. Slated for completion by summer 2010, the upgrade will enable researchers to conduct experiments with fast, stopped and reaccelerated beams of rare isotopes – three technical capabilities required for major advances in the field.

With the upgrade, Gelbke said NSCL will provide researchers the ability to do world-class rare isotope science seven years prior to FRIB becoming operational.

"The research community will hit the ground running when FRIB turns on without missing a beat," Gelbke said. "This means uninterrupted world leadership for the United States in rare isotope science and education for two decades."

The selection of MSU is subject to the successful negotiation of a cooperative agreement between DOE and Michigan State and a National Environmental Policy Act review of the proposed site.

MSU's dedicated subcontractor is the URS Corp. As the dedicated subcontractor, they will have responsibility for project and construction management. To see more about FRIB go to http://www.energy.gov/news/6794.htm. For additional information, please visit the Department of Energy Office of Science Web site at www.science.doe.gov.

(*from* http://news.msu.edu/story/5768/, *by Geoff Koch*)

Honors and Awards

Dean Elizabeth Simmons chosen to be a member of the U.S. Delegation to the 3rd International Conference on Women in Physics

The International Conference on Women in Physics (ICWIP), which is sponsored by the International Union of Pure and Applied Physicists (IUPAP), was held in Korea in October 2008. The ICWIP 2008 is committed to providing an opportunity to share the scientific accomplishment of participants as well as analyzing international progress in promoting women in physics. ICWIP 2008 brought together the top decision-makers and practitioners interested in the women-in-physics agenda, thereby aiding the physics community to promote women-in-physics activities. Dean Simmons' participation not only recognizes her reputation as a scientist, but also reflects her desire to encourage more women to consider careers in science. At the 1998 IUPAP General Assembly the concern that women are grossly under-represented in the field of physics in most countries led to the creation of a Working Group on Women in Physics. For more information on the conference visit: ICWIP - Korea, 2008 (http://www.icwip2008.org/file/brochure/Brochure_Eng_final.pdf).

Assistant Professor Alexandra Gade Wins Prestigious Alfred P. Sloan Research Fellowship Award

Gade, one of just 22 researchers receiving the award in the physics category this year, focuses on exploration of the structure of atomic nuclei, including rare isotopes not normally found on Earth. The study of rare isotopes is part of a larger effort to understand the origins of the chemical elements and is relevant to applied work in medicine, national security and nuclear energy. The Sloan Research Award is an early career award and has been awarded since 1955. So far 35 of the awardees have gone on to win the Nobel Prize.

Professor Georg Bollen Wins the IUPAP SUNAMCO Senior Scientist Medal

The International Union of Pure and Applied Physics (IUPAP) makes awards for excellence, including the SUNAMCO Medal. The 2008 Medal was awarded to George Bollen, H.J. Kluge (GSI), and D.E. Pritchard (MIT). Bollen's and Kluge's citation reads "For the innovation of the Penning trap mass spectrometry technique for short-lived isotopes and developing the highest precision in on-line mass measurements", and Pritchard's medal was awarded "For contributions to the use of Penning ion trap mass spectrometers in the ultra-high precision determination of atomic masses".

Departmental Awards:

Outstanding Teaching: Tenured: **Mark Voit** & **Dan Stump**; Non-Tenured: **Reinhard Schwienhorst** and **Tibor Nagy** *** Graduate Teacher: **Vladimir Zelevinsky** *** Staff Award: **Richard Hallstein** *** Outreach Award: **David Batch** (for Grandparents University, assisted by **John French** and **Sean Horvatin**) *** Graduate TA: **Eric Gingrich** (advanced lab) *** Haynes award: **Young Sun Lee** (Beers), **Kenneth Cavagnolo** (Donahue), and **Christian Hicke** (Dykman) *** Osgood (senior): **Michael Schecter** and **Michael Saelim** *** Foiles (senior): **Kurtis Geerlings** *** VerWest (junior): **Richard Worhatch**, **Andrew Keller** and **Eric Wolf** *** Hantel Fellowship: **Richard Worhatch**, **Katie Rabidoux**, **Michael Saelim**, **Kurtis Geerlings** and **Hamood Arham**.

MSU Physics and Astronomy Department Alumni

NEWS --- NEWS --- NEWS -- NEWS

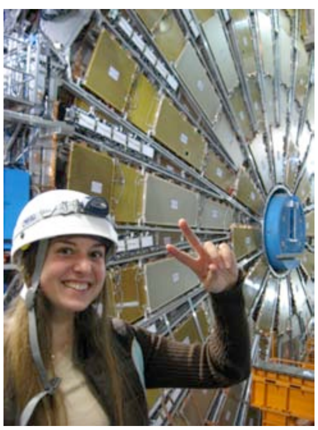
With the recent turmoil on Wall Street many people put part of the blame on computer trading and forecasting models. More often than not these models are made by physicists, called "quants" in Wall Street lingo. But as is the case in all professions, there are good quants and bad quants. And two of our own alumni definitely belong to the *good* category and are weathering the storm that is tearing through the financial industry, thanks to quantitative models developed by them, which are taking into account volatility and risk. **Damian Handy** (Ph.D. 1995) and his company Investor Analytics (http://www.investoranalytics.com/) provide risk analysis for individual funds and funds of funds and are doing brisk business in these uncertain times, adding more clients in 2008 than in the previous 4 years combined. **Philip Zecher** (Ph.D. 1996) and his hedge fund EQA Partners (http://eqapartners.com/) are up close to 10% for the year, which is a sensational performance.

Diandra Leslie Pelicky (Ph.D. 1991) has just moved from the University of Nebraska to the University of Texas at Dallas, where she continues her work on experimental nanotechnology research. But this is by far not the biggest news about her. Her book "The Physics of NASCAR" has just come out and is a huge success. It is now very hard to book her for a speaking engagement, but this fall she made a "pit stop" at her *alma mater* and gave a colloquium on this topic of very broad public appeal.

Last year we reported on **Bao An-Li** (Ph.D. 1991) moving to Texas A&M University to assume the duties of the head of the physics department. Now he hired another nuclear physicist with a very strong MSU connection, **Carlos Bertulani**, who was a professor in Rio de Janeiro, Brazil, and a long-time visitor at the NSCL and MSU. His wife **Eliete** worked in our department's computer group and now is working for JP Morgan in Dallas, where she runs the IT department.

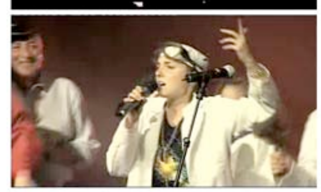
Rapping Physics

Katie McAlpine, a graduate of the Physics-Astronomy department at MSU, is a rising star on YouTube thanks to an original rap performance – about high energy particle physics. Her performance has already attracted more than 4 million views on YouTube. McAlpine (rapping under the pseudonym of *alpinekat*) raps about the Large Hadron Collider (LHC), the huge particle accelerator built in the 17-mile circular tunnel at the CERN laboratory near Geneva, Switzerland.



"Rap and physics are culturally miles apart," McAlpine has said, "and I find it amusing to try and throw them together." She was also motivated by a desire to educate people about the LHC, and about physics and science in general. Physicists at CERN and at MSU are unanimous that Katie's efforts are both amusing and instructive. "The science is spot on," says CERN spokesperson, James Gillies. McAlpine received permission to film herself and several friends dancing and singing in the underground tunnel where the experimental apparatus is located.

Her rapping success got *alpinekat* a gig at the grand opening of the LHC, where she performed her LHC rap "live". (see picture on the right)



McAlpine honed her physics rapping skills at the Cyclotron laboratory at MSU where she was part of a student research program two years ago. She started at MSU with science writing in mind. Despite attempts to lure her into research, she has remained on that path. The year after graduation took her to Washington DC, where she worked for the American Physical Society as a science writing intern. From there, she went to Geneva, Switzerland to serve as a press contact at CERN while the usual US LHC Communicator was on maternity leave. (As a coincidence and a particular coup for MSU, that permanent CERN Spokesperson is Katie Miller Yurkewicz , who graduated from the Physics/Astronomy and the NSCL in 2003.)

You can view Katie's rap video at http://www.youtube.com/watch?v=j50ZssEojtM

Physics-Astronomy alumni: Please stay in touch and let us know about your successes. We would love to feature them here!

Emeritus Henry Blosser Endows Professorship

A prominent figure in the world of nuclear science at MSU and around the world has made a gift to help ensure MSU remains in the forefront of nuclear physics. University Distinguished Professor Emeritus Dr. Henry Blosser, founding director of the National Superconducting Cyclotron Laboratory (NSCL), and world-renowned nuclear physicist, recently established the Henry Blosser Endowed Professorship. His gift will enhance the ability of MSU's Department of Physics and Astronomy and the NSCL to continue to attract prominent faculty, according to Department Chairperson Wolfgang Bauer.

"Henry Blosser, more than any other person on campus, has had the leading role in building MSU's nuclear physics program to the world-class status it enjoys now," Bauer said. "I think it is tremendous that a person who has been a world leader in nuclear physics is now taking leadership in ensuring a bright future for nuclear physics at MSU."

Dr. Blosser received his B.A., M.S. and Ph.D. from the University of Virginia. He became a physicist at Oak Ridge National Laboratory, where within two years he was promoted to Group Leader of the "Cyclotron Analogue One" project. Michigan State University successfully recruited Dr. Blosser in 1958. He became a full professor in 1961 and a University Distinguished Professor in 1990. He was instrumental in making MSU a world center for cyclotrons, having been involved with the construction of all four MSU cyclotrons. He served as the first director of the NSCL at MSU, a position he held for 24 years. His areas of expertise include the design and development of advanced particle accelerator systems, superconducting magnets for cyclotrons, apparatuses for nuclear physics research, and accelerators for cancer therapy.

College of Natural Science Dean R. James Kirkpatrick noted that Dr. Blosser's gift is an opportunity to carry on the legacy he developed at MSU. "Our nuclear physics program is one of the best in the world, in no small part because of Henry Blosser," Dean Kirkpatrick said. "His gift is a tribute to his commitment to nuclear science research and education at MSU."

Dr. Blosser's lifelong commitment to education is evident in the design of his endowed professorship. He has stipulated that the person selected to fill the Henry Blosser Endowed Professorship will have demonstrated a successful career highlighted by productive research, creative teaching and effective community service, as well as being particularly well-known for his or her ability to communicate concepts, theory and practice to students at all levels.

Endowments are particularly meaningful gifts to MSU as they offer a dependable, long-term source of funding. Endowed funds differ from others in that the total amount of the gift is invested. Each year, only a portion of the interest earned is spent while the remainder reverts to principal. In this respect, an endowment is a perpetual gift and is a permanent part of MSU's heritage. "It falls on us to continue the legacy Henry has built and this endowment will really make a difference in our ability to do this," Bauer said.

Marc Conlin Makes a Major Gift

The Physics and Astronomy department in the College of Natural Science has been well served by one of their own. Marc Conlin has served the department in various roles for nearly 40 years. He recently established a bequest through his personal trust to fund an endowment that will benefit support staff in the department.

The Marc Conlin Endowment will be awarded to non-academic staff in Physics and Astronomy at the discretion of the chairperson. In addition to documenting the charitable bequest, Conlin hopes to partially fund the endowment through a gift of stock and cash gifts. "My goal is to see the department benefit from this gift as soon as possible," explained Conlin. "There is a great need to fund staff education opportunities and recognition for excellence. Currently the department has limited funding for these purposes."

Conlin already has ideas about how the award will be used, including providing funds for the distinguished staff award, training and associated travel expenses, and other activities. "Staff members make a great contribution to the university," Conlin said, "and these are some meaningful ways the university can give back to staff."

Conlin is a Spartan through and through. He received his B.S. in Engineering in 1969, and an MBA in 1972, both from MSU. Even before graduation he began his tenure in Physics and Astronomy, overseeing the stockroom. After several promotions over the years, he is now the business manager for the department. His exemplary service has been recognized with the Physics and Astronomy Distinguished Staff Award.

Conlin has also supported the department through his gifts to the Biomedical and Physical Sciences Building and the SOAR telescope. Other areas at MSU that have benefited from Conlin's gifts include Engineering, Business, and Communication Arts and Sciences. With his documented planned gift, he became a member of the Abbot Society, one of MSU's most prestigious donor societies.

For more information about making a gift contact Director of Development Suzette Hitner at (517) 353-1637.

The Spartan Camera Sees the (*infrared*) Light

Culminating years of work led by astronomy professor Ed Loh, MSU's Spartan Infrared Camera was delivered to the SOAR Telescope in October, 2008, and took its first images of the infrared sky in November.

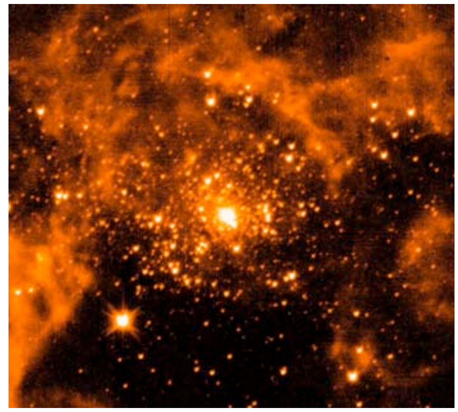
The Spartan Camera in the instrument test area at the SOAR Telescope, showing Ed Loh (second from right) with SOAR Telescope staff members.

This innovative $2.1M instrument is built around an array of four Rockwell 2048×2048 pixel HgCdTe infrared detectors. This adds up to a total of 16 megapixels, which is huge for an astronomical infrared camera. Interchangeable optical trains allow this array to cover either a 5×5 $arcmin^2$ field of view with a scale of 0.073 arcsec/pixel, or a 2.5×2.5 $arcmin^2$ field of view with a scale of 0.043 arcsec/pixel.

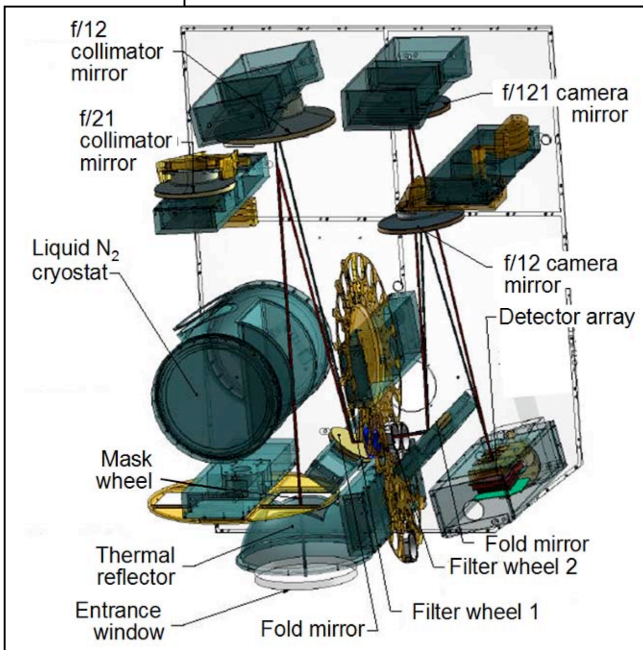
Both optical setups take advantage of SOAR's capability to produce super-sharp images over a wide field of view. The sharp images are achieved through the use of tip-tilt correction, provided by having a high-speed star tracker servoed to a movable mirror in the telescope that counteracts the rapid image jitter due to atmospheric effects. The Spartan Camera's wider field of view covers the full field over which this atmospheric jitter is correlated and can therefore be corrected (the so-called "isokinetic patch"), while the smaller field of view offers a sufficiently fine pixel scale to sample the diffraction-limited images that SOAR is capable of producing at the long wavelength end of Spartan's 1.0 – 2.5 µm wavelength response range.

The whole instrument is housed in a vacuum chamber that stands 4 feet tall, and contains a number of movable elements that work at liquid nitrogen temperature. As SOAR tracks stars through the sky, Spartan must rotate with respect to gravity while still maintaining all optical alignments to fractions of a wavelength.

Designing and building this complex instrument was a non-trivial task. Ed Loh was (and is) the heart and soul of the project, but he led a Physics & Astronomy Department team that also drew heavily on the efforts of Tom Palazzolo, Tom Hudson, Jim Muns and Rob Bennett in the machine shop, electronics technician Jason Biel, grad students Mike Davis, Ben Lien, Nathan Verhanovitz and Jianjun Chen, and undergrads Dustin Baker, Brandon Hanold, Elissa Samet and Brian Thomas. Tom Carter from the Chemistry Department worked on the software. The Spartan Camera is at the same time an international effort, built in collaboration with our Brazilian partners in the SOAR Telescope project. Besides contributing over $800,000 towards the purchase of the detectors, the Brazilians provided optical engineer René Laporte who spent most of a year working here on campus.

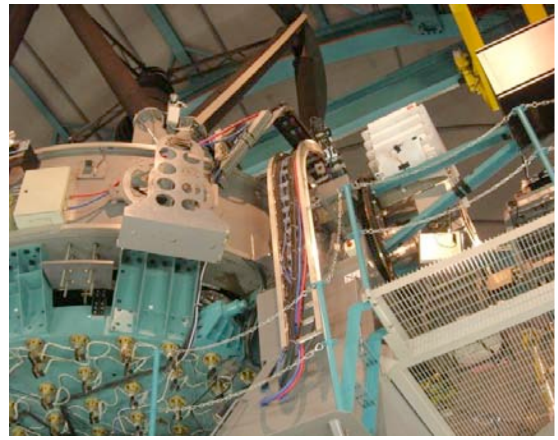


Spartan Infrared Camera image of R136, the massive star cluster at the center of the 30 Doradus nebula in the Large Magellanic Cloud. Thousands of stars, crowded together in the recently-formed central cluster, illuminate the surrounding remnants of the giant molecular gas cloud from which they formed. This image was taken on Spartan's second commissioning run on the SOAR Telescope. The area shown is ¼ of Spartan's full field of view. It is 150 arcsec across, corresponding to about 120 light-years at the distance of 30 Doradus.



Internal Layout of the Spartan Infrared Camera. Light enters from the bottom, passes through a field stop or coronagraphic mask, hits one of two collimating mirrors, hits a fold mirror, passes through two filter wheels, hits a second fold mirror, hits one of two focusing mirrors, hits a pyramidal mirror, and goes to the four detectors.

The Spartan Camera has so far been used on five engineering nights on SOAR. The software and electronics interfaces to the telescope are being tested and refined, and the instrument's basic sensitivity and image quality are being evaluated, and seem to be meeting the performance level that was specified. This first-pass performance testing will require another month or so. Then further time will be needed for "Science Verification" observations, when real scientific observations will be taken and evaluated by a team of highly experienced infrared astronomers. Then sometime in the latter half of 2009 the instrument will go into general use.



Spartan Camera mounted on the Nasmyth focus of the SOAR Telescope. Spartan is the white box to the right of center, while the bottom of SOAR's primary mirror cell and the ring at the top of the telescope that holds the secondary mirror fill the

Halo 2: Opposite Spin

A team of scientists, led by University Distinguished Professor Timothy C. Beers, have used data from the Sloan Digital Sky Survey to demonstrate that the halo surrounding the Milky Way comprises two stellar components rotating in opposite directions about the center of the Galaxy. The paper 'Two Stellar Components in the Halo of the Milky Way', appeared in Nature (450, 1020) in mid-December 2007.

While the inner part of the halo rotates in the same direction as the disk of the Galaxy, the outer part appears to rotate "backwards." The halo components also differ in their chemical makeup and orbital characteristics, prompting the team to conclude that the two components were likely formed in different ways and perhaps at different times in the history of the Galaxy.

"Although it was once considered a single component, an analysis of more than 20,000 stars from the Sloan Digital Sky Survey (SDSS-II) has shown that the halo is clearly divisible into two, broadly-overlapping structural components," Beers explained. "This discovery is important because it provides critical information on the formation of the first objects in the Universe and in our own galaxy. The difference in the metallicities of the two halo populations indicates that the lowest metallicity stars in the Galaxy may be associated with the outer halo," according to Beers. The lowest metallicity stars provide the clearest chemical 'snapshot' of the early Universe. Thus, the new discovery will help astronomers refine future searches for these 'jewels of the night sky', the stars that have recorded the elemental abundances created only a few hundred million years after the Big Bang, using MSU's access to the SOAR 4.1 m telescope, and other telescopes.

Meet Chih-Wei Lai

Chih-Wei Lai joined the faculty in January as an experimental condensed matter physicist and the first Jerry Cowen Endowed Chair of Experimental Physics. Chih-Wei earned his Ph.D. in experimental condensed physics from the University of California at Berkeley in 2004, where he studied Bose-Einstein condensation of excitons and quantum Hall effects of two-dimensional electron gases in semiconductor quantum wells. After graduation, he conducted postdoctoral research in a few institutes around the world, including two years at ETH Zurich in Switzerland, 9 months at the University of Iowa, and 14 months at the University of Tokyo in Japan and Stanford University.

Chih-Wei's research is in the broad field of light-matter interaction with an emphasis on the mesoscopic quantum optics and many-body physics of semiconductor nanostructures. By focusing on the many-body effects of excitons and the optical manipulation of spins, he has investigated both fundamental and practical aspects of condensed matter physics while developing experimental expertise in ultrafast laser spectroscopy and low temperature physics. He has contributed to this field by observing collective coherent effects in two leading candidates for excitonic "Bose-Einstein condensation" (BEC): (a) spatially indirect excitons in coupled quantum wells (Ph.D. research 2000-03), and (b) exciton-polaritons in planar microcavity structures (postdoctoral research 2006-07). For indirect excitons, we have observed macroscopically ordered states and a degenerate cold exciton fluid in confined areas. Cavity exciton-polaritons were characterized by polarization, first- and second-order coherence properties, and by the Bogoliubov-like excitation spectrum of dynamic exciton-polariton condensates. Metastable states were also studied in an array of exciton-polariton condensates, analogous to atomic BECs in optical lattices. He also made the first observation of dynamical optical pumping of nuclear spins in the absence of magnetic fields in single quantum dots (postdoctoral research 2004-05).

His current research focuses on the quantum many-body phenomena as well as the ultrafast dynamics and coherent laser control of nuclear and electron spins in nanostructure materials. By studying the quantum phenomena in nanostructures, Chih-Wei expects to be able to contribute to advances in novel excitonic optoelectronic devices for communications, in quantum simulation and information processing, and to nanoscale quantum engineering.

Physics-Astronomy Activity at CERN

CERN is the European Organization for Particle Physics, located just outside of Geneva, Switzerland. It is one of the world's leading laboratories for particle (or high energy) physics. The Large Hadron Collider (LHC) will be the world's most powerful particle accelerator. At present that record is held by Fermilab in Batavia, IL (about 40 miles west of Chicago). The MSU High Energy Physics (HEP) group does research at Fermilab, but has also been involved in the design and construction of one of the four large detectors at CERN since 1994. Our group consists of 15 researchers including 6 MSU faculty members, postdocs, engineers and students.

MSU scientists standing in front of, and sitting on, an LHC magnet at CERN.

The LHC is the largest, most complex particle collider ever built. It operates in a 17-mile circular tunnel about 300 feet underground beneath the French/Swiss border. Trillions of protons (hydrogen nuclei) will circle in opposite directions at almost the speed of light, making more than 11,000 turns per second! Thousands of superconducting magnets will guide the oppositely-directed (clockwise and counterclockwise) particles into collisions at 4 points, and the 4 detectors surrounding the collision areas will record the results of the collisions.

During the past few years we have been involved in two aspects of the largest particle detector (called ATLAS); the 2000-ton Tile Calorimeter, many of whose modules were instrumented at MSU before being shipped to CERN, and a set of custom-built fast electronics designed to separate interesting signals from large backgrounds. MSU, in collaboration with colleagues at the University of Michigan, is also home to a high density Grid computing center (called the ATLAS Great Lakes Tier-2 Center). We expect to make a major contribution to the processing of the large quantity of exciting data that will be produced by the ATLAS detector.

The experiment hopes to address some of the most basic and compelling questions of 21st century physics: Are there undiscovered principles of nature? What is the origin of mass? Do extra dimensions exist? What is the nature of dark matter and dark energy (hints from astronomy)?

After many years of designing, building and waiting, the first tests of the accelerator took place on Wednesday, September 10 (9:30 am Geneva time, 3:30 am in East Lansing). Within a surprisingly short time, both beams of protons were successfully guided around each ring, located over 100 m below the surface. While the beams did not collide with each other (they were injected at different times), the ATLAS detector was able to trigger on particles resulting from collisions of the beam with residual gas molecules in the beam pipe. These particles were detected and triggered upon by scintillation counters built at MSU. Over subsequent days machine physicists started to accelerate the beams to full energy and bring them into collision at the center of the detectors. Our hopes were very high that our large investment over the past years was about to pay off. Unfortunately, after just 10 days of beam-tuning activity, commissioning of the LHC came to an abrupt halt when a faulty electrical connection between two magnets melted at high current, leading to the rupture of the helium vessel, the release of high pressure gas into the cryostat and damage to about 50 magnets. This is a major problem that will involve warming the accelerator, bringing the magnets to the surface for repair and, of course, re-checking all of the electrical connections to insure that the problem doesn't reoccur. We will have to wait several months more before we can expect our long-anticipated data. Once the accelerator and detectors are finally working, studies are expected to last for at least 10-15 years, depending on what we find.

NSCL Construction

NSCL is under construction. And despite the recent winter weather, including more than a foot of snow in one mid-December week, progress continues on various expansion projects. The upgraded facilities will include new office space for faculty and staff, and new experimental areas for research with stopped and reaccelerated beams, a laser program, and other new technical capabilities to benefit NSCL users.

Among the construction milestones this fall: completing all steelwork for the experimental addition; tearing down one of the original wings of the NSCL building to make space for the new office addition; completing the office addition grade beams and underground utilities; and drilling the elevator shaft hole.

Work to erect the steel superstructure of the office addition started December 15 and is ongoing (see photo), as is masonry work on the experimental addition, which is set to be enclosed in February.

Indoors, NSCL faculty and staff are making similar strides toward implementing new planned research capabilities related to the ReA3 project, many of which are expected to come online in 2010. The ReA3 linear accelerator will allow users to perform experiments with stopped and reaccelerated rare isotopes produced by fragmentation and fission of Coupled Cyclotron Facility beams. The project will provide a variety of new beams that are difficult to produce with more traditional Isotope Separation On-Line (ISOL) techniques.

NSCL office and experimental area addition in progress

The balcony that will hold ReA3 and associated beam lines is complete and ready for mounting of devices. And development continues on the various components to stop, transport, charge-breed and reaccelerate rare isotopes for research, most notably in nuclear astrophysics. These components include:

- the linear gas stopper (the momentum compression line to allow efficient capture of fragments is designed and magnets are under fabrication, while R-and-D continues on the optics of the cyrogenic linear gas cell and the RF carpet)
- the low-energy beamline system from the gas stopper to the EBIT and also to the new stopped beam area (the optics design is done and the electrostatic beam transport elements are under construction)
- the EBIT charge breeder and Q/A separator (the electron gun and collector is built and will be tested soon, while the superconducting magnet is ordered and scheduled to arrive in May 2009)
- the LINAC (the RFQ has been ordered and is under construction, as are the cavities and solenoids for the three cryomodules, and also the rebuncher cryomodule; the cavity used in the rebuncher module has been completed and tested)

In addition to building capability for research with stopped and reaccelerated beams, NSCL is implementing a laser program to measure fundamental properties of rare isotopes, including charge radii, quadrupole moments and magnetic moments.

NSCL's laser program will be somewhat unique in experimental nuclear science. This is largely because the laboratory's capabilities to produce and manipulate rare isotopes (via in-flight fragmentation and gas stopping) will provide access to nuclei not readily available at ISOL facilities, where laser spectroscopy programs have thrived for many years.

The first stage of the laser program will include a high intensity cooler/buncher, which is 70 percent complete, and a laser polarizer beamline, for which optics simulations have been performed. Among other project updates:

- detailed design of beam switchyard and sodium cell is underway
- the bid package for the laser system is being developed
- preliminary layouts of the low-energy beam transport lines and laser room are in progress

Support for NSCL's expansion efforts comes primarily MSU, recently selected by the U.S. Department of Energy Office of Science as the site for Facility for Rare Isotope Beams, or FRIB.

The construction of FRIB at MSU is contingent upon several factors, including the negotiation of cooperative agreement between the DOE Office of Science and MSU and completion of an environmental impact assessment. However, pending the successful completion of these and other milestones, MSU intends to contribute essentially all the new civil and technical infrastructure to the new facility, which according to the preconceptual design will be adjacent to NSCL.

NSCL, operated as a national user facility by the National Science Foundation, will continue to run and extend its science program even as the FRIB project gets underway. The laboratory has issued its latest call for proposals, due Feb. 26, for consideration at the April 17-18 Program Advisory Committee meeting.

Honors and Awards

Kyoko Makino and Martin Berz were awarded the R.E. Moore biannual prize for applications of interval methods for their work on high-order rigorous self-verified computational estimates for the flows of differential equations. The work builds on earlier theories developed by Martin before he first came to MSU, which are known as the differential algebraic approach, and are now the main staple of describing particle accelerators in the so-called transfer map picture. The method is now used in the majority of modern simulation codes, including the COSY INFINITY program developed at MSU that currently has more than 1000 users, the core engine of which is also the main simulation tool for the dynamics and stability studies of the LHC at CERN in Switzerland.

The recent work for which the award was given adds the ability to bound any errors of the differential algebraic flow approximations in a mathematically rigorous and fully automatic fashion. This greatly enhances the reliability of the methods for situations where this is of importance. In accelerator physics, this includes the estimation of long-term stability, where even very minute unaccounted errors in the repeated propagation through maps can lead to hard to detect instabilities due to breakup of Kolmogorov-Arnold-Moser tori, Arnold diffusion, and related mechanisms.

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Honorary Doctorate for Martin Berz

University President Lyudmila Verbitskaya and Applied Mathematics Dean Leon Petrosyan conferred the degree ‘Honorary Doctor of Saint Petersburg State University’ in the stately Petrovskiy Hall "For His Eminent Contributions to the Solution of Important Problems of Applied Mathematics and for Advancing Russian-American Cooperation in the Sciences". Martin subsequently gave a commencement speech titled "Chaos, The Large Hadron Collider, and Michigan Taffy"

Saint Petersburg University, founded by Peter the Great in 1724, is Russia's oldest and one of the most prestigious universities. Martin was told that the last German to receive an honorary degree at Saint Petersburg was former chancellor Gerhard Schröder.

Carbon Award for David Tománek

For his theoretical studies of carbon nanostructures, David Tománek has been awarded the 2008 Japan Carbon Award for Life-Time Achievement, the highest award of the Japan Carbon Society.

Among the myriad of complex nanostructures formed by carbon, each surprises by a unique combination of properties, commonly associated with other materials. Whereas many nanocarbons and their properties were studied first by experiment, theoretical predictions – many of them in the group of Professor Tománek at Michigan State University – preceded the experimental verification of other others. Some of these properties are the unsurpassed elastic modulus and toughness of carbon nanotubes, which make them hundred times stronger than steel at one-sixth of the weight.