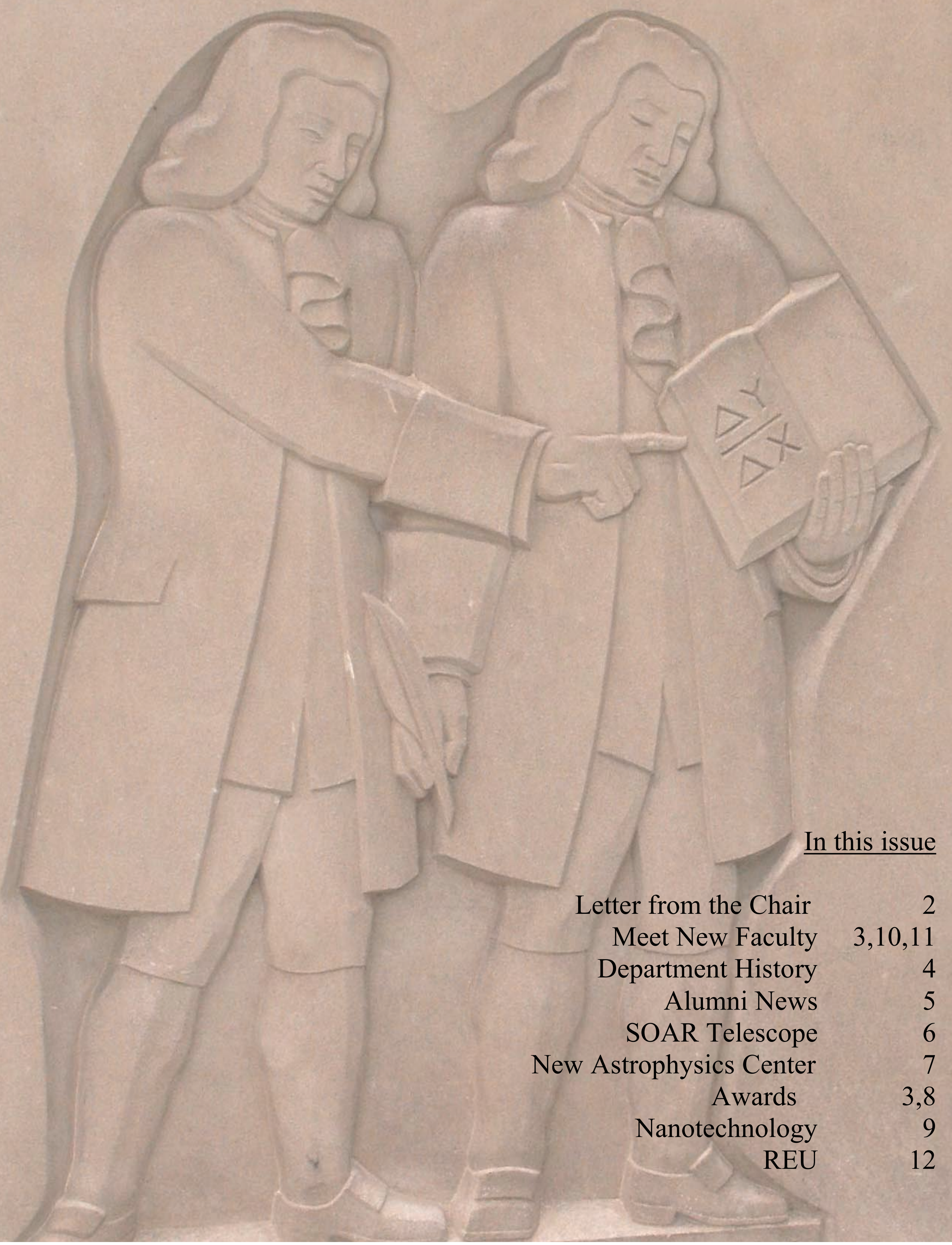
Physics and Astronomy

Michigan State University Fall 2004



In this issue

Newsletter

MSU Physics and Astronomy Department

Volume 6
Fall 2004

A letter from the Chair

Dear Friends of the Department of Physics and Astronomy,

The most exciting news of the year for our department was the completion of the SOAR Telescope in Chile. In April, we had a tremendously successful inauguration event, during which we also unveiled our remote observing and control room in the atrium of our Biomedical and Physical Sciences building. The state-of-the-art Spartan Infrared Imager, which Prof. Ed Loh is building, is also almost finished. Together, these two instruments will make sure that our astronomy group can work at the cutting edge of their field for many years to come.

While it has been very hard to raise the large sum of cash needed to pay off our SOAR construction obligations, I am happy to report that we received a very generous $500,000 pledge from George Brown. Now it appears that SOAR funding is on a very stable and sustainable trajectory. This would not have been possible without the great help received from the College of Natural Science development office and, in particular, Dean Leroi. A big thank you goes to all of them. Our biggest thanks have to go to our alumni and friends, who made so many contributions to this project.

In the previous newsletter I reported on hiring nine new faculty members. The momentum created by these additions has carried over to the past year. Thus I am very pleased to be able to announce four more outstanding additions to our faculty.

Assistant Professor Ed Brown is joining our astrophysics effort. His research is on theoretical modeling of supernova explosions and other systems at the interface of astronomy and nuclear physics. He left the University of Chicago to work with us because of the outstanding strength of our nuclear astrophysics effort.

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

Dr. Lisa Lapidus left the group of Nobel Laureate Steve Chu at Stanford University to build up her own group at Michigan State University. Her expertise is at the interface of physics and biochemistry.

Our condensed matter physicists have long-standing collaborations with the Department of Chemistry. Particularly noteworthy is the highly successful collaboration on complex materials. This effort received a huge boost by hiring Dr. Chong-Yu Ruan, who joined us from the California Institute of Technology as an assistant professor.

And, finally, Dr. Thomas Duguet was hired as an assistant professor in the NSCL nuclear theory group, with joint appointment in the Department of Physics and Astronomy.

Our decision to invest into the interdisciplinary area of nuclear and particle astrophysics continues to pay off. Last year, under the leadership of Hendrik Schatz and Tim Beers, and in partnership with Notre Dame University and the University of Chicago, we received the Joint Institute for Nuclear Astrophysics, and NSF-funded Frontiers Center. This year, we received very sizeable funding from Michigan State University to form the Center for the Study of Cosmic Evolution, under the leadership of Jack Baldwin. These centers and the research effort that they represent make perfect use of the National Superconducting Cyclotron Laboratory and our new SOAR Telescope, and they help position us in the quest to attract the Rare Isotope Accelerator, for which the US Department of Energy has just released a first draft request for proposals.

Not everything I have to report is good news. Just like during the previous three years, we had to absorb another sizeable budget cut. As a consequence we had to let go of another two very dedicated staff members. But despite trying budgetary constraints, we believe that we are in a very sound position to take advantage of present and future opportunities in research and teaching, and we look ahead with optimism.

Best wishes

Wolfgang Bauer

Wolfgang Bauer
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Meet Lisa Lapidus

Lisa Lapidus joined the Condensed Matter group in August of 2004. She started her career as an experimental atomic physicist, getting her Ph.D. from Harvard University in 1998. After finishing a dissertation on the dynamics of trapped electrons in a Penning trap, Lisa's focus shifted to biophysics and she took a postdoctoral position at the NIH with Bill Eaton and Jim Hofrichter. There she discovered that biophysics could be a lot like atomic physics, but wetter. Before coming to MSU she also worked with Steve Chu at Stanford University on single-molecule microscopy.

Lisa's research focuses on the protein and RNA folding problems. Both proteins and RNAs are linear chain molecules that must fold into a stable 3-dimensional conformation in order to function in a cell. Misfolding and aggregation has been identified as the cause of a growing number of human diseases, including Bovine Spongiform Encephalopathy (mad-cow disease), Type-II Diabetes, and Alzheimer's disease. The process of folding a protein or RNA into its native structure is spontaneous and depends in detail on the physical interactions between different residues of the polypeptide or RNA chain and the surrounding water. This suggests that one should, in principle, be able to predict the folding and final structure of such a molecule entirely from its sequence. This would convert the enormous amount of sequence data, such as that provided by the Human Genome Project, into 3-d structures, but such a general algorithm has eluded scientists for decades. One difficulty in solving the folding problem is that the folding process develops on many different timescales. The simplest structures form in several nanoseconds, while the complete native structure takes milliseconds or longer to form. While the longer timescales have been studied for many years, only in the recent decade have laser techniques been developed to probe folding dynamics below 1 millisecond.

While at the NIH, Lisa developed a new technique to measure contact formation within an unfolded protein chain between two naturally occurring amino acids, tryptophan and cysteine. Tryptophan can be excited to a long-lived triplet state using a pulsed UV laser and is quenched upon close contact with cysteine (all other amino acids quench much less efficiently). The tryptophan lifetime is a measure of the intramolecular diffusion rate between the tryptophan and the cysteine. Lisa hopes to apply this and other laser techniques to studying the fastest processes in folding, the formation of local structure and global collapse.

Departmental Awards

Thomas H. Osgood Award to an outstanding senior majoring in physics or astrophysics: **Anthony Kendall**, **David Oostdyk**; *Carl L. Foiles Award* to an outstanding graduating senior, who shows promise for graduate study. **Steven Kecskemeti**; *Bruce VerWest Award* to an outstanding junior: **Andrew Jones**, **Sarah Lockwitz**, **Amanda Prinke**; *Hantel Fellowship*: **Laura Chapin**, **Anthony Doemer**, **Andrew Jones**, **Sarah Lockwitz**, **David Oostdyk**; *Graduate Teaching Assistant Award*: **George Hitt**; *Graduate Teacher Award*: **Vladimir Zelevinsky**; *Sherwood K. Haynes Award* for an outstanding student receiving a Ph.D. this year: **Ryan Kruse**; **Savas Berber**; *Outreach Award*: **Horace Smith** for public viewing events at the MSU Observatory at the time of the Mars approach; *Staff Award*: **Jim Muns**, **Tom Hudson**; *Thomas H. Osgood Award* for Faculty Excellence in Teaching: Tenured: **Bernard Pope**, Untenured: **Kirsten Tollefson**, **Carlo Piermarocchi**

Before their annual user conference in January 2004, the LON-CAPA team (including Ed Kashy, Gerd Kortemeyer, and Wolfgang Bauer) had the opportunity to showcase their award-winning software for congressional staffers in the US House of Representatives Committee on Science conference room.

In September 2004 the department celebrated the 40th anniversary Prof. Jack Bass joining the MSU faculty.

History of the Physics Department: Physics - Mathematics Building (1949 – 2002)

Darlene Salman

This is part three in a series of articles outlining the building history of the Physics Department. The first article appeared in the Summer 2002 issue and covered the years 1857 through March 1916. The second article appeared in the Fall 2003 issue and covered the years 1916 through 1949.

1948 photo of the building nearing completion
Courtesy of MSU Archives and Historical Collections

New Building: In 1949 the Physics Department was finally able to move into a modern building, which it occupied jointly with the Department of Mathematics. This new building was state-of-the-art for the time. It was also built with plenty of space for expansion of the faculty in mind. The 1948 Michigan State College catalog lists only two Professors, Osgood and Hause; two Associate Professors, Bowersox and Dickinson; two Assistant Professors, Dwight and Kikuchi; eight instructors, and three Graduate Assistants. Many of the basement research labs were empty. (For comparison, currently the Physics/Astronomy department has more than 60 faculty, 132 graduate students, 150 undergraduate students, 13 support staff, and 4 machinists.)

Building Reliefs The reliefs mounted on the building exterior relate a small portion the history of physics and mathematics. Professor Osgood, former chairperson of the Physics Department, selected the images to be used from various physics textbooks. Plaster casts of the photographs were created by New York sculptor Carl L. Schmitz. He used the rare method of "incised carving" to produce the models, and stone masons completed the work in limestone using Schmitz's plaster casts as models.

For many decades there has been an ongoing discussion (really an argument) of who/what is represented on the PA Building. The following list of façade designs was taken from the College's "official" documentation located at the Archives and Historical Collections Division. The photocopied article lacks sufficient documentation but, was marked D-5 and may have come from page 100 of *The Record*. **Front Main Doorway:** starting on the left are Newton (represented here for the discovery of gravity), Galileo, Archimedes, and Huygens. Above the main doors are the simple machines (lever, pulley, gear, screw and inclined plane). To the right of the doors are Franklin, Faraday, Leibnitz and Newton ("co-invented" calculus independently of one another, *see also front cover of this newsletter*), and Oersted. You can see most of these images in the photo at the end of this article. **Southeast Entry:** Roentgen (standing) and Crookes (seated). **North Entry:** Einstein standing in front of the cyclotron invented by Lawrence. Since Einstein was the only living person represented, written permission has to be obtained before using his likeness. The letter Einstein wrote granting permission to use his likeness was a highly prized treasure for many years. Sadly, the letter disappeared sometime in the early 1990's. **North Entry:** Helmholtz (standing) and Michelson (seated); **Southwest Entry:** Marconi and Maxwell. On the right is a photo of Schmitz working on the plaster cast of the north entry relief which shows Helmholtz holding a resonator to his ear to amplify sound from a tuning fork and Michelson, who measured the velocity of light, looking through a telescope at an eight-sided mirror.

Carl L. Schmitz (1900 – 1967)
Photo courtesy of MSU Archives and Historical Collections

In the 1960's the building name was changed to the *Physics - Astronomy Buil*ding after the Mathematics Department moved to Wells Hall and the Astronomy Department was established. The limestone piece bearing the name *Mathematics* was replaced by *Astronomy* at that time.

The Department of Physics and Astronomy vacated the Physics and Astronomy Building in April 2002, moving into the new Biomedical and Physical Sciences complex. In 2003 extensive renovations began and the old Physics and Astronomy Building is now the new home for the Psychology Department. Removal of the original limestone reliefs proved impossible without damage. Replicas were then created in fiberglass. These replicas can be found on some interior walls of the new Biomedical and Physical Sciences Building. As of this writing, there are no further plans to remove the limestone reliefs or to rename the building by changing the limestone panels. In addition, the road on which the building is located, Physics Road, will likely retain its name, despite the fact that physics has moved across the Red Cedar River.

Following is a group photo of the Physics and Astronomy faculty, staff and student group photo taken in front of the main doors of the Physics - Mathematics Building during the 1959 – 1960 academic year. Does this bring back any memories?

1959 – 1960 Academic Year (Photo credit is unknown)

Row 1 Spahn, Gauser, Wagner, Hargrove, Riedel, Hill, A. Smith, Adler, Huang, Yin, Achyuttian, Ban Pascual, Killoran, Murty
Row 2 Schlegel, Hause, Garber, Albass, Narasiniharmurty, Wangler, Haynes, Velinsky, Mayer, Vogt, Zukokas, Cowen, Spence, Tester
Row 3 Kleinberg, P. Parker, Edwards, Forstat, Talyor, Wigen, Genusa, Tangford, Cook, Tichtenberg, Hudec, J. Parker, Kovacs, Gordon, Beard
Row 4 Blosser, Misho, Mann, Aubel, Connors, McNeely, Halkides, D. Parker, Kvisciokaitis, Mallory, Vieth, Carter, Boyd, Blass, Teffler, Fincher

MSU Physics and Astronomy Department Alumni News

We have received some news and visits from alumni and encourage more of you to do so. Since the last newsletter we can report the following.

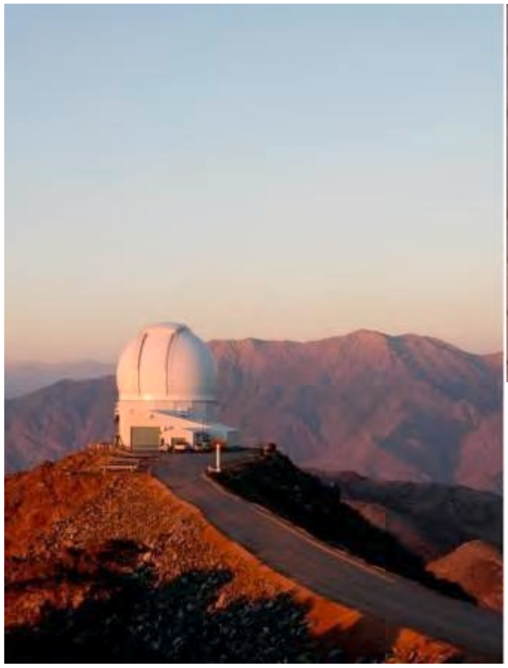
Ramzi H. Misho (PhD, 1961) visited East Lansing for the first time since he left here after completing his PhD (as a student of D. J. Montgomery). He visited the department and brought us up to date about his activities. He has been on the faculty of Universities of Basrah, Baghdad, and Al Mustansiriyah in Iraq as well as at Universities in Algeria and Libya. He now resides in Bulgaria. **Donald W. Olson** (B.S., 1969) was an author of a recent article in *Sky and Telescope* (September, 2004) which appeared at the time of the Athens Olympics. The authors of this article, among whom is Olson's wife, Marilynn, also an MSU graduate, supported the conclusion that the battle of Marathon in 490 BC took place in August instead of the generally accepted September date. They arrived at this date based on the Spartan's reason for delaying sending assistance to the Athenians against the Persians until after the next full moon after the religious holiday that was occurring at the time of the request. The more widely accepted date is a month later due to the assumption that the holiday in question was an Athenian holiday instead of a Spartan one. Olson was an early recipient of the Thomas H. Osgood Award (1969) in the P-A Department. He got his PhD from the University of California, Berkeley in 1975 and had held post-docs at Cornell (1975-1979) and University of Texas at Austin (1979-1981). He has been teaching physics and astronomy since 1981 at Texas State University, San Marcos, Texas where he teaches an honors course "Astronomy in Art, History, and Literature" . He has published other articles in *Sky & Telescope* on astronomy in art, history, and literature.

Michael Franklin (PhD, 1997) made a visit to the department recently with a group of students. He is in his fourth year of teaching at Northwest Michigan College. Before moving to the Traverse City school he had been at Cornerstone University since completing his PhD. **Joelle Murray** (Ph.D., 1997), now Associate Professor at Linfield College, Oregon, and **Boa-An Li** (Ph.D., 1991), now Associate Professor at Arkansas State University, have both decided to follow the lead of their former advisor, W. Bauer, and became chairpersons of their respective departments. **Tim Tait** became a tenure-track Assistant Scientist at Argonne National Laboatory.

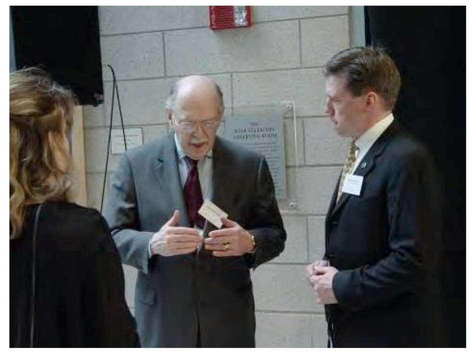
We have been informed that **Horst Brauner**, (BS, 1968; MS, 1970) died in 2001. While a graduate student Brauner participated in research at the Cyclotron Laboratory.

Dedication of the new SOAR Telescope

MSU's new SOAR Telescope was dedicated on April 17. An intercontinental celebration reached from our East Lansing campus all the way down to the SOAR site in Chile.



Here at home, hundreds of faculty, students, dignitaries and guests assembled in the Biomedical Physical Sciences (BPS) Building for a gala reception. MSU President Peter McPherson expressed his wonder at the ability of telescopes such as SOAR to "look back in time" to much earlier phases in the life of the universe. This is possible because the light from the most distant observable galaxies has taken most of the lifetime of the universe to reach us, and we see those objects as they were when they originally emitted the light. Provost Lou Anna Simon spoke about the educational and outreach benefits of the SOAR project.



President McPherson with Physics & Astronomy Dept. Chair Wolfgang Bauer and Professor Megan Donahue.

Part of the campus ceremony was the unveiling of MSU's new SOAR Remote Observing Room, which can be seen from the BPS atrium through large glass windows. MSU astronomers will operate SOAR from this location, via a high speed Internet 2 link that reaches clear down to Chile.

Meanwhile, on 9000' Cerro Pachón in Chile, a parallel celebration included representatives of all of the partners in the SOAR project: MSU, the University of North Carolina at Chapel Hill, the U.S. National Optical Astronomy Observatory, and the countries of Brazil and Chile. The telescope itself was unveiled and put through its paces. MSU's representatives were Vice President for Research and Graduate Studies Robert Huggett, and astronomers Gene Capriotti and Jack Baldwin. In his speech, Vice President Huggett commented on the important effect that SOAR has already had on MSU's astronomy program, through its ability to help us attract additional first-class young astronomy faculty to MSU.

As has been described previously in these pages, SOAR is a 4.1m diameter optical/infrared telescope that will deliver the highest quality images of any similar telescope on Earth. Chile is one of the very best observing sites on Earth, and its southern hemisphere location offers the opportunity to observe objects of special importance that can only be seen from the south. SOAR presently is going through its engineering shakedown. We plan to start "early science" observing in February, and to be in full swing by late 2005. MSU is building SOAR's premier instrument, the Spartan Infrared Camera, which will be delivered in early 2005

Vice President Huggett addressing the SOAR partners in Chile.

Provost Simon answers a question from the audience.

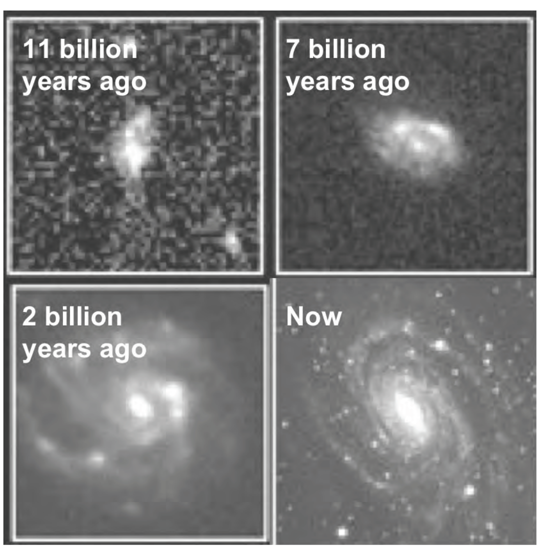
MSU funds new Center for the Study of Cosmic Evolution

The office of MSU's Vice President for Research and Graduate Studies announced funding starting this fiscal year for the Center for the Study of Cosmic Evolution (CSCE), a new research unit within the Physics & Astronomy Department. The CSCE will focus on understanding the evolution of the universe over its 14 billion year history, which is a fundamental goal of science in general and of astronomy and astrophysics in particular.

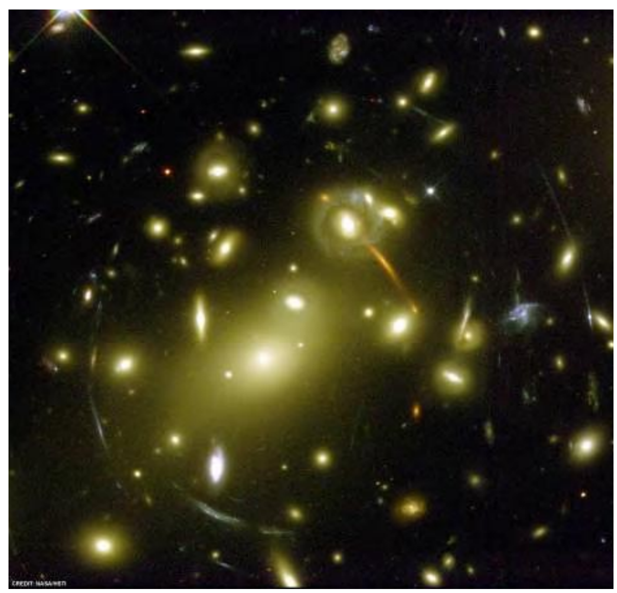
Experimental advances are now revolutionizing our understanding of the large-scale nature of the universe, leading to a far clearer knowledge of cosmic evolution than seemed remotely possible even as recently as ten years ago. Among the major advances was a huge breakthrough first suggested in 1998. Most astronomers had long thought that gravity should be slowing down the expansion of the universe. Instead, observations of supernovae showed that the expansion is speeding up, owing to the repulsive effects of a previously unknown form of energy. Because we have no idea what this energy is, it has been called "dark energy" to go along with "dark matter", our term for the mysterious and invisible form of matter whose gravity drives the formation of galaxies.

Astrophysicists now believe that our universe is made up almost entirely of dark matter and dark energy. All of the elements in the periodic table comprise only a small fraction of the total mass, although they still are vitally important because all the stars in all the galaxies we can see, not to mention all the people and all the planets, are made up of these elements. According to our best models of cosmic evolution, dark matter triggered the process of structure formation, pulling together the universe's primordial gases into the first stars and galaxies. These early stars later made the elements necessary for life, beginning a cosmic recycling process of gas through stars that ultimately led to life on Earth. Dark energy, however, will probably grow increasingly dominant in the future, driving all the universe's galaxies apart ever faster and putting an end to the process of structure formation.

Evidence supporting this grand story of cosmic evolution is rapidly accumulating, but many details are still missing. The CSCE will be MSU's front-line organization for working to fill in those blanks, in order to extend and test the overall picture. The Center is designed to pull together the efforts of astronomers, nuclear physicists and particle physicists within the Physics & Astronomy Department who share research interests in questions about the processes driving the general evolution of the universe. Their primary tool for observational work on cosmic evolution is the SOAR Telescope, and a major focus of the Center is to strengthen MSU's participation in the SOAR consortium. In addition, the CSCE is funding a scientific seminar series and several public outreach efforts. The work of CSCE will closely complement that of the Joint Institute for Nuclear Astrophysics, another on-campus research center within the Physics & Astronomy Department.



Looking back in time to see how galaxies formed. This montage of Hubble Space Telescope pictures of galaxies at different distances, and hence at different "lookback times", shows what are thought to be successive stages in building up today's well-ordered spiral galaxies under the gravitational influence of dark matter. The CSCE will bring together observation and theory to further test whether this is really the correct sequence.



Using giant clusters of galaxies to probe the Universe. The bright elliptical galaxies are in a cluster at an intermediate distance. Also visible are images of very distant background galaxies, distorted into long arcs due to the general relativistic bending of light in the strong gravitational field of the foreground cluster. This lensing effect permits an unambiguous measurement of the total mass of the intervening cluster, including that of its dark matter. Using SOAR and other telescopes, CSCE will study the properties of such clusters in order to better measure the properties and relative amounts of normal matter, dark matter and dark

University Awards

This year's awards winners include Stuart Tessmer (CNS Teacher Scholar Award), Eugene Parker (BS '48, CNS Outstanding Alumni Award), Ed Kashy (CNS Meritorious Faculty Award), B. Alex Brown (CNS and MSU Distinguished Faculty Award), and Chip Brock (CNS and MSU Distinguished Faculty Award). All are shown with CNS Dean Leroi at the awards ceremonies.

Meet Edward Brown

Edward Brown joined the Astronomy group in February. He is also affiliated with JINA, the *J*oint *I*nstitute for *N*uclear *A*strophysics, an NSF frontier center. Edward came to MSU from the University of Chicago, where he was an Enrico Fermi Fellow and affiliated with the ASC Flash Center. While at Chicago, he presented the spring 2001 Compton lecture series, *Brown Dwarfs and Extrasolar Planets*. Edward received his Ph.D. in physics from the University of California, Berkeley in 1999.

Edward works on topics in theoretical and nuclear astrophysics. Of special interest are white dwarfs and neutron stars. These compact objects are the endpoint of stellar evolution for most stars and are a laboratory for matter under extreme densities and temperatures. Motivated by new observations with the *Chandra* and *XMM* X-ray telescopes, and the promise of gravitational wave detectors such as *LIGO*, our knowledge of these fascinating objects is developing rapidly.

Many compact objects have solar-like companions in a close orbit; so close, that the strong tides raised by the compact object strip gas from the companion. The gas spirals onto the surface of the compact star and liberates a great amount of energy. In addition to the light provided by accretion of matter, the accumulated pile of hydrogen and helium can become unstable to thermonuclear flashes. On a neutron star, every few hours to days, the accumulated matter on the surface explodes in a thermonuclear runaway, an *X-ray burst*. After several thousand bursts, the carbon in the ashes can fuse, producing a *superburst*. As the outer layer of the neutron star is gradually replaced by the ashes of these bursts, other nuclear reactions occur, heating the interior of the neutron star. For neutron stars that accrete intermittently, we can observe the heated surface directly with *Chandra* and *XMM* when the accretion stops. Accurate measurements of the thermal emission constrains the radius of the neutron star; moreover, sampling the population of these intermittently accreting sources informs us about the properties of matter at super-nuclear densities. Lately, Edward has been studying how to use the properties of superbursts to learn about the properties of matter at nuclear densities, and about the role of elemental sedimentation on the subsequent nuclear burning on the surface of neutron stars.

For white dwarfs, the analogous thermonuclear instability results in a classical novae. For some white dwarfs, the accumulation of matter eventually triggers the unstable fusion of carbon in the stellar center, and the white dwarf explodes, becoming a type Ia supernovae. Edward continues to collaborate with the Flash center at the University of Chicago on numerical simulations of these explosions. A better understanding of the physics will hopefully improve the use of type Ia supernovae to trace the expansion of the universe.

Boost for the Computational Nanotechnology Program

David Tománek

Within the framework of the National Nanotechnology Initiative (NNI), the National Science Foundation (NSF) established six new Nanoscale Science and Engineering Centers in the U.S. in Summer 2004. The MSU Computational Nanotechnology program, lead by David Tománek, has been elected partner in a university consortium called *Center for High-Rate Manufacturing*. To achieve the ambitious goals set forth in the proposal, the \$12.4 million research grant from the NSF has been augmented by a similar amount in matching funds from the partner universities in the New England area.

Theory and computer simulations play a crucial role in nanotechnology due to the quantum nature of phenomena dominating the behavior on the nanometer scale. In the quantum regime, even the most advanced experimental observations are subject to being fundamentally influenced by the measurement itself. Especially when addressing novel nanostructures and their properties, large-scale computer simulations emerge as an indispensable complement to the experiment. Recent progress in High Performance Computing technology allows us to perform such predictive computer simulations in relevant nanostructures.

The MSU Computational Nanotechnology group was particularly successful in computer modeling of nanostructures ranging from metal clusters to carbon fullerenes and nanotubes. The current computational progress has strongly benefited from collaborations established during David Tománek's recent stay as Distinguished Professor of Physics at the prestigious Seoul National University in Korea and the Tokyo Institute of Technology in Japan, where he taught courses on Nanotechnology. In partnership with Japanese colleagues, the MSU group has been using up to 70% of the CPU resources on the world's fastest supercomputer, the Earth Simulator in Yokohama, Japan.

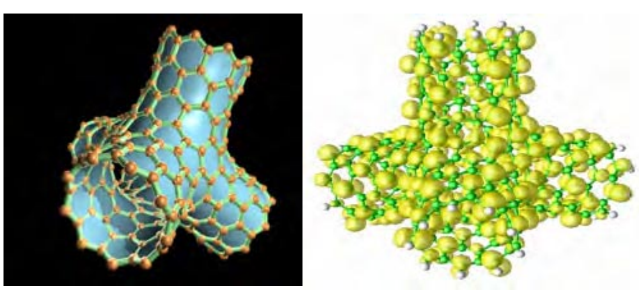


*Fig. 1: Structural model (left) and spatial distribution of majority-spin electrons responsible for magnetism (right) in an all-carbon nanostructure [from Phys. Rev. Lett. **91**, 237204 (2003)].*

Some of the recent results address unusual phenomena associated with nanostructures, including ferromagnetism in carbon (Fig. 1). Other phenomena, described by the MSU group, which are crucial for the self-assembly process to be studied at the new Nanotechnology Center, include the thermal and mechanical stability, as well as thermal contraction of nanotubes.

The activities at the *Center for High-Rate Manufacturing* will include design and development for a new generation of computer memories, such as that depicted in Fig. 2.

*Fig. 2: A fullerene molecule inside a nanotube as a prototype non-volatile memory element capable of storing one bit information [U.S. Patent 6,473,351; Phys. Rev. Lett. **82**, 1470 (1999)].*

Maybe most exciting is the recent progress in the excited-state dynamics of nanostructures. Applying to nanostructures what the Chemists and Biologists know to be true in molecules, namely that light can induce chemical reactions, may fundamentally change the way we think about inducing structural changes. By eliminating contamination associated with chemical treatment, or structural damage due to thermal treatment, selective nanosurgery using light has the potential of becoming a powerful tool in nanotechnology (see Fig. 3).

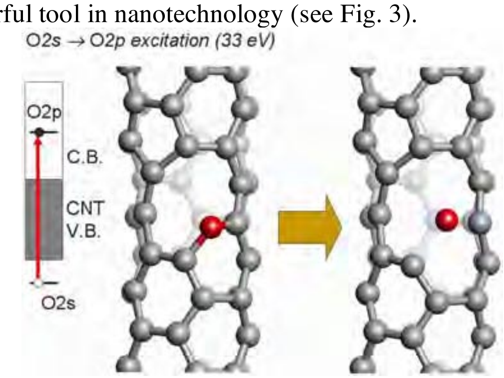


Fig. 3: Photo-induced de-oxidation of a defective carbon nanotube.

Workshop on Mesoscopic Physics

In October 2004 the NSCL nuclear theory group and the MSU Institute for Quantum Sciences joint forces to hold a workshop on mesoscopic physics, with Vladimir Zelevinsky serving as head of the organizing committee. Mesoscopic systems are systems of many constituents, for which the usual few-body approximations fail, and in which new phenomena of self-organization and complexity emerge. The workshop was well attended, with approximately 50 attendees from the USA, Mexico, Japan, Germany, France, and other countries. The proceedings of this workshop will be published by the American Institute of Physics.

Meet Stan Schriber

Stanley Schriber joined the College of Natural Science at Michigan State University as a full professor with a joint appointment in NSCL and the Department of Physics and Astronomy in April 2003. He came to MSU from an impressive career that began at Chalk River Nuclear Laboratories (CRNL) in Canada and continued at the Los Alamos National Laboratory (LANL). Schriber received his Ph.D. in nuclear physics from McMaster University in 1967, having researched and written on *The Beta Decay of* ^{105}*Ru*.

At CRNL, Schriber was internationally recognized for his expertise in the development of rf coupled-cavity linear-accelerators. He invented improved versions of such structures, investigated their properties analytically, supervised their construction, and used them in system applications. He led the medical accelerator group that designed, built, and commissioned a commercial 25-MeV electron accelerator for radiotherapy. In addition to leading numerous projects and studies, he was project manager for a Canadian proposal to establish a new accelerator laboratory in Quebec for accelerator breeding of fissile material.

Schriber relocated to LANL in July 1984 to lead the Accelerator Technology division; he remained at LANL until 2003 serving as the leader of the accelerator competency for most of this time while performing various laboratory management roles. Among many accelerator applications that he fostered and championed were tritium production, nuclear waste transmutation, neutral particle beams, FELs, high power microwaves, EPICS controls, and fusion materials testing. Because of his avid interest in accelerator science and technology, Stan requested and spent his last two years at LANL in a "Return to Research" program out of the LANL director's office, spending time working with accelerator groups at Saclay, CERN and Juelich.

Schriber was accelerator team chair for the Proton Therapy Cooperative Group and assisted in the Loma Linda University Hospital plans for a proton therapy system. Schriber holds eight patents and has more than a hundred and thirty publications. He has been actively involved in IEEE and APS affairs, serving on committees and councils. He is on the organizing committees for EPAC, PAC, and LAC, was the 1995 PAC conference chair in Dallas, and will chair the 2007 PAC conference in Albuquerque. Stan is a board member of the US Particle Accelerator School (USPAS), currently, serving as chair of the USPAS program committee that determines possible courses and instructors for future schools. Among much recognition, he is a fellow of the APS.

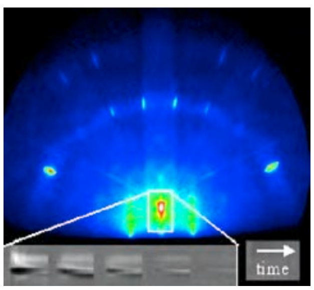
At MSU, Schriber is looking forward to continuing his research in the accelerator physics of high-quality, high-intensity charged beams. In particular he will continue analytic studies of coupled rf cavities with an emphasis on performance of pi-mode and zero-mode accelerating structures such as those used in superconducting applications and low-beta room-temperature systems. He also intends to enhance and improve several of his coupled-cavity analysis programs in use by the international accelerator community. Lastly he is leading the design and beam dynamics simulations for the post accelerator of the RIA project, and is investigating a host of related issues associated with accelerating various ion beams with stringent parameters. These issues lead to studies of interesting beam dynamics characteristics including beam halo and stability, of efficient rf accelerating structures to provide excellent beam performance, and of control/monitoring aspects related to operating complex rf accelerating systems.

Meet Chong-Yu Ruan

Chong-Yu Ruan joined the experimental condensed matter physics group in the Department in August 2004. He is originally from Taiwan and came to the United State for graduate school in 1994. After he received his Ph.D. in physics in 2000 from the University of Texas at Austin, he joined the Laboratory for Molecular Sciences at Caltech as a postdoctoral scholar. While at Caltech, he embraced the interdisciplinary atmosphere crafted in a small but friendly environment. There he worked closely with colleagues from traditional disciplines of physics, (bio-)chemistry, and engineering in tackling problems in broadly defined molecular sciences.

Chong-Yu's research emphasizes on developing new tools for real-time molecular imaging applied to the studies of complex molecules and nanometer scale materials. Atomic scale resolution in structures of complex materials has been achieved in the late 20th century through modern diffraction and microscopy. The question remains whether we can obtain temporal resolution required to characterize the molecular motions. This is critical for the understanding of mechanisms and functions in these systems, particularly those associated with bio-complexities. The electron diffractions are very useful tools in the studies of molecules, surfaces and nano-meter scale materials because of the large cross-section of electron scattering with matters (5-6 orders larger than that of X-ray). Taking advantage of this high sensitivity, Chong-Yu's earlier work 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 so-called ultrafast electron diffraction (UED) technique employs the "pump-probe" scheme to make movies for molecular reactions. His work lead to the elucidation of a decades long puzzle of radiationless decay in aromatic molecules and shed insights on how energy redistributes to activate dynamics in complex potential energy landscape of chemical bonds. The ability to freeze transition state structures with ultrashort time scale of probing is an important step towards quantum control for reactions.

The recent progress of UED takes advantages of the rapidly developing atomic scale preparations of functionalized nanocrystals and assemblies on surfaces, in line with the developments for molecular electronics and biosensors. By interfacing the UED with ultrahigh vacuum and precision sample manipulations and preparations, he and colleagues at Caltech were able to isolate the structures and dynamics of the surfaces and adsorbates from those of the lattices. This ability allows one, for the first time, to visualize the patterns of energy flow (phonons) from lattices to the surfaces and adsorbates or vice versa. Identifying dynamically controlled and charge-mediated processes on surfaces is central to understand the mechanism of catalysis, which remains unsolved till today. He also studied the hydrophobic and hydrophilic interactions of interfacial water on chemically modified surfaces, as well as the glass transition for supercooled water. These studies provide the clues to explore the biomolecular functions on the surfaces in the future.



At MSU, he plans to extend the flexibility in spatial and temporal resolutions of UED by implementing pulsed compression and electron-optical methods. He also plans to combine time-resolved electron energy loss spectroscopy to gain simultaneous chemical compositional information. He believes that oftentimes our perceptions and intuition evolve within the framework of our sensory scales. Compared to the atoms and electrons, we live in a very coarse-grained world. In the laboratory as well as from modern sophisticated molecular dynamics simulations, we now begin to have access to the multi-scaled world in nature with atoms, and molecules gradually zoomed in for our perceptions. Maybe one day, we can fulfill Schroedinger's dream of being able to understand and appreciate the life itself with the same conceptual beauty and elegance he found within an atom.

Meet Thomas Duguet

Thomas Duguet joined the Department and the Nuclear Theory Group at the NSCL in September 2004. He received his Ph.D. in France in 2002 from the University of Paris and the Commissariat a l'Energie Atomique after having graduated from the Ecole Centrale Paris and the Ecole Normale Superieure de Paris. In the two years before coming to MSU, he was a Post-Doc at Argonne National Laboratory.

Our knowledge of the structure of atomic nuclei is still far from complete, as it is mainly based on the properties of nuclei in the neighborhood of the line of beta stability. These nuclei are only a fraction of the possible bound combinations of protons and neutrons. The exploration of weakly-bound nuclides on the proton-rich and neutron-rich side of the "valley of stability" as well as for very heavy nuclei at the upper end of the chart of nuclei is a major interest of modern Nuclear Structure physics. Indeed, these so-called "exotic" nuclei are likely to exhibit some entirely different quantum many-body effects than their well-bound stable counterparts and to act as a magnifying glass for particular features of the nuclear many-body problem, and finite quantum systems in general. Also, neutron-rich nuclei are intermediate products in the astrophysical rapid-neutron capture process (r-process) that is expected to appear in exploding stars as supernovae and to be an important contributor to the nucleosynthesis. Thus, the properties of neutron-rich nuclei such as their mass, their fission barrier and their beta-decay half life, determine the mass-flow during the r-process and the abundances of nuclei after the end of it.

Thomas' research is focused on tackling the Nuclear Many-Body Problem from the point of view of developing new formal ideas appropriate to the description of those "exotic" nuclei studied intensively at the NSCL. His efforts mainly deal with establishing a fully microscopic model for medium to heavy mass nuclei based on self-consistent mean-field and beyond-mean-field calculations of finite nuclei. In that respect, reaching a better understanding of the properties of the effective nucleon-nucleon interaction inside the nuclear medium is a major goal. For instance, the modification of the effective interaction as a function of the isospin-composition of matter, increasing rotation, or with large amplitude vibrations, is studied. For the latter, Thomas has been lead to proposing a new Many-Body Perturbation Theory from which soft nuclei undergoing large amplitude collective motions, and/or displaying shape coexistence, can be described on a fully microscopic basis. This constitutes a long-term project that he will further develop at the NSCL.

One of the most striking properties of the nucleus is that it is superfluid. This particular feature strongly influences the structure of the ground state and of the excited states of the system, i.e. the energy necessary to rotate a deformed nucleus. In fact, very little is known about the nature of pairing correlations in nuclei, that is, the way Cooper pairs are formed out of the strong nucleon-nucleon force. At the present stage, the picture is to a large extent qualitative. During his Ph.D., Thomas studied in great detail the influence of pairing on the odd-even staggering of nuclear masses and worked out a way to extract from experiment precise information about the component of the nuclear force responsible for pairing. More recently, he has been working on the link between this component of the effective force and the nucleon-nucleon force in the vacuum which is much better known. It was possible in this way to disentangle the role of the in-medium effects from the role of the finite range of the interaction and also to understand the modification of the force when going toward more exotic nuclei.

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The Research Experiences for Undergraduates (REU) summer program had another outstanding year. Left picture: group photo with the visiting Notre Dame REU students on the BPS building rooftop observation platform (please note the hawk in the upper right corner). Right picture: Annual basketball game between faculty and REU students. Not in the picture are Profs. Pawel Danielewicz, Aaron Galonski, and Scott Pratt, who all had to leave the game early due to injuries. Chairperson Bauer joined the REU student's team, which may explain why the students lost the intensely competitive match.