2009

Ohio State Physics

Colleges of Biological and Mathematical and Physical Sciences

A PUBLICATION OF THE OHIO STATE UNIVERSITY DEPARTMENT OF PHYSICS

physics.ohio-state.edu

Ohio State

Table of Contents

Vice chair and professor Richard Hughes is pictured with undergraduate students who meet Thursdays for T.E.A. (Talking, Eating, Action) in the Vernier Physics Commons (named by a gift from David and Christine Vernier).

Ohio State Physics magazine is published by The Ohio State University Department of Physics.

Chair, Department of Physics ..... James J. Beatty
Editor ..... Susan McGarvey
Contributing Writers ..... John Beacom, Terri Brandt, Julie Dials, Kris Dunlap, Arthur Epstein, Pam Frost Gorder, Richard Hughes, Thomas Humanic, Adam King, Richard Noll, Kim Palladino, Jon Pelz, Lindsey Perry, William Riley, Nandini Trivedi, Linn Van Woerkom, Greg Vieira
Design ..... Ed Maceyko Jr., University Marketing Communications/Creative Services
Style Editor ..... Pamela Hill, University Marketing Communications/Creative Services

Please send address changes and other correspondence to
Ohio State Physics
191 W. Woodruff Ave., Columbus, OH 43210
(614) 292-2653
mcgarvey.16@osu.edu

Physics

Dear Alumni and Friends,

There have been many exciting developments in the Department of Physics since we last published this magazine in late 2006.

Ohio State is playing a key role in physics at the Large Hadron Collider at CERN in Geneva, Switzerland. We are unusual among U.S. universities in that we are involved in three of the largest experiments: ALICE, ATLAS, and CMS. Look for exciting results from these experiments in the next edition of this magazine.

The National Science Foundation has funded a Materials Research Science and Engineering Center (MRSEC), the Center for Emergent Materials (CEM). This center is one of only 27 such centers across the country and was selected as one of five new centers from a highly competitive pool of 100 applicants. Our success in this competition is an indication of the strength of our program in condensed matter and materials physics.

Our Targeted Investment in Excellence programs include the Center for Cosmology and AstroParticle Physics (CCAPP) and the Center for Electronic/Magnetic Nanoscale Composite Multifunctional Materials (ENCOMM). CCAPP serves as a magnet for young researchers in cosmology and astroparticle physics and has attracted endowment support from friends of the department as well as university support. ENCOMM was instrumental in the effort to obtain support for our new MRSEC and continues to foster interdisciplinary innovation in the field of novel materials.

Other areas of research featured in this magazine include our efforts in high-energy density physics using terawatt lasers, the first images of the gamma-ray sky from the Fermi satellite, searches for cosmic neutrinos using balloons flown above the Antarctic ice sheet, and efforts to understand better how students learn physics concepts.

Our faculty continues to be known for excellence in teaching as well as in research. Brian Winer (2007), Robert Perry (2008), and John Beacom (2009) have won the university's highest teaching honor, the Alumni Award for Distinguished Teaching. Eight physics faculty have garnered this award over the last eight years.

Our undergraduate majors program has nearly doubled in size over the last several years. Fifty students earned bachelor's degrees in physics or engineering physics during each of the last two academic years. Many of our undergraduates have won national awards, including 11 Goldwater Fellowships over the last nine years. We are especially proud of our 2008 Rhodes Scholar, Jessica Hanzlik, who is now pursuing a PhD at Oxford University (cover story).

Our graduate program continues to grow and prosper. We currently have 160 graduate students in the program. About 100 are supported as graduate research assistants on grants, up from 60 a few years ago. We are recruiting academically strong and diverse entering classes each year. Prospective students who visit campus are impressed by the intellectual vibrancy of our department and the strong sense of camaraderie among our graduate students.

Students benefit from the generosity of friends of the department. Newly established scholarship programs include the Harold McMaster Scholarship and the Clifford Heer Graduate Student Scholarship Award. We very much appreciate the continued scholarship support from Edward Grilly, Bunny and Tom Clark, the Smith family, Hazel Brown, and the estate of Michael Valentino. In addition, generous gifts have recently been given by Steve Price and Jill Levy as an endowment to CCAPP, Norman Gearhart and Carolyn Piper in honor of Professor Emeritus Hershel Hausman, and Gregory and Carol Steele in support of our computing and network infrastructure.

Our outreach efforts bring the excitement of physics to a broad audience in central Ohio, including 1,300 visitors to COSI for the Festival of Physics and participants in our summer camp for middle school girls. Public lectures such as the Alpheus Smith Lecture and the CCAPP Biard Lecture continue to appeal to a wide audience.

Chair Will Saam retired last July. Will is enjoying his newfound freedom from administrative duties and can often be found in his research office on the second floor of the Physics Research Building. Recent retirements also include particle theorist Stephen Pinsky and Nobel Laureate Kenneth Wilson.

I encourage you to visit the department in the Physics Research Building and experience the excitement of the research and learning happening here every day.

I hope you enjoy this issue of *Ohio State Physics*. Thanks go to Susan McGarvey for coordinating the process of putting this publication together.

Best wishes,

James J. Beatty
Professor and Chair

Tiny Particles, Big Results:

Ohio State Physics at the Large Hadron Collider

There are many theories as to what will result from these collisions, but what's for sure is that a new world of physics will emerge from the LHC, as knowledge in particle physics goes on to describe the workings of the universe.

The Large Hadron Collider (LHC) at the CERN laboratory in Geneva, Switzerland, is a gigantic particle accelerator designed to greatly enhance our understanding of the universe. The LHC is made up of intersecting rings 27 km in circumference and spans the border between Switzerland and France about 100 meters underground. The LHC will revolutionize our understanding, from the miniscule world deep within atoms to the vastness of the universe. Two beams of the subatomic particles called "hadrons"—either protons or lead ions—will travel in opposite directions inside the circular accelerator, gaining energy with every lap. Physicists will use the LHC to recreate the conditions just after the Big Bang, by colliding the two beams head-on at very high energy. Teams of physicists from around the world, including those from Ohio State, will analyze the particles created in the collisions using special detectors in a number of experiments. There are many theories as to what will result from these collisions, but what's for sure is that a new world of physics will emerge from the LHC, as knowledge in particle physics goes on to describe the workings of the universe. For decades, the Standard Model of particle physics has served physicists well as a means of understanding the fundamental laws of nature, but it does not tell the whole story. Only experimental data using the higher energies reached by the LHC can push knowledge forward, challenging those who seek confirmation of established knowledge, and those who dare to dream beyond the paradigm. (The first proton beams were successfully injected into the LHC on September 10, 2008. However, technical problems required the collider to be shut down temporarily for repairs on September 19. The LHC is due to be up and running again in autumn 2009).

The experiments at the LHC are run by international collaborations. Each experiment is distinct, characterized by its unique particle detector. Ohio State's Department of Physics is collaborating on the three largest experiments, ALICE, ATLAS, and CMS, all of which are based on general-purpose detectors to analyze the myriad of particles produced by the collisions in the accelerator. The ALICE, ATLAS, and CMS detectors are installed in three huge underground caverns located around the ring of the LHC (Figure 1).

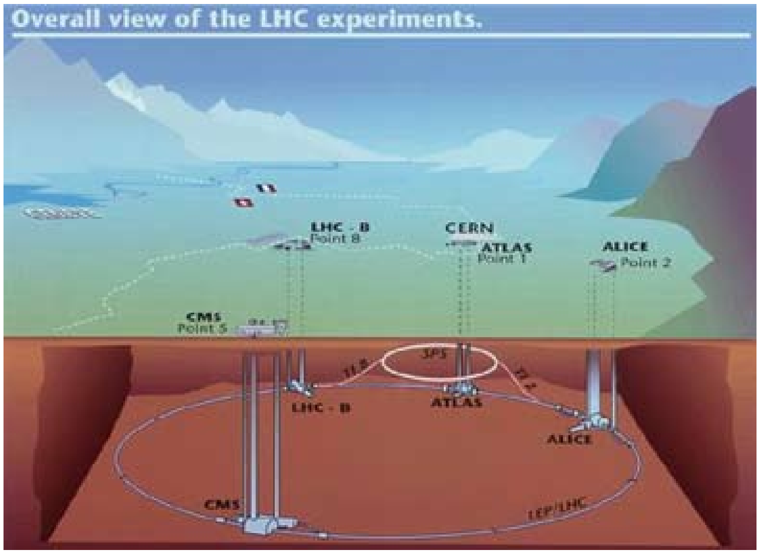
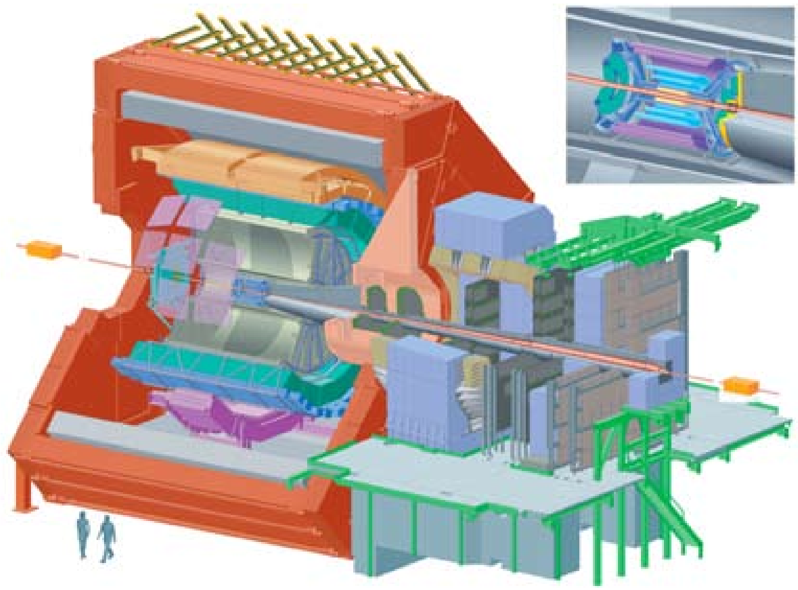


Figure 1. Layout of experiments around the LHC ring



The data obtained will allow physicists to study a state of matter known as quark-gluon plasma, which is believed to have existed soon after the Big Bang.

Figure 2. The ALICE Detector

ALICE

Ohio State collaborators, T. Humanic and M. Lisa

For the ALICE (A Large Ion Collider Experiment) collaboration, in addition to protons, the LHC will collide lead ions to recreate the conditions just after the Big Bang under laboratory conditions. The data obtained will allow physicists to study a state of matter known as quark-gluon plasma, which is believed to have existed soon after the Big Bang. A collaboration of more than 1,000 scientists from 94 institutes in 28 countries works on the ALICE experiment (Figure 2). Ohio State's ALICE group, funded by NSF, has been participating in both hardware and software projects in the collaboration for the past 10 years, taking responsibility for two hardware projects: testing silicon drift detectors for the Inner Tracking System (ITS) and designing, fabricating, and installing the ITS laser alignment system. The group's software efforts have been focused toward ITS tracking software and developing and implementing a software chain for physics analysis of two-particle femtoscopy. Since 2002, the group has been collaborating with the Ohio Supercomputer Center to contribute large-scale resources to the ALICE computing effort, participating in simulated data challenge exercises, in order to quickly analyze first data.

ATLAS

Ohio State collaborators, K.K. Gan, H. Kagan, and R. Kass

The ATLAS group at Ohio State, supported in part by DOE and NSF, led the R&D and fabrication of the optical electronics for the pixel detector (Figure 3). The detector contains 80 million silicon pixels, much

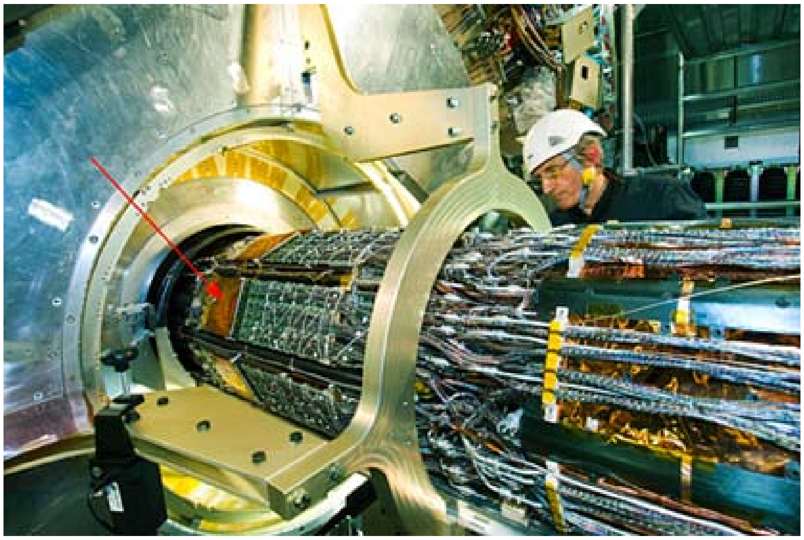


Figure 3. Installation of the ATLAS pixel detector into the cavern. The arrow indicates the location of the optical electronics.

Figure 4. Central part of the CMS detector. The left half shows part of an endcap muon system. Muon chambers are visible as the copper colored trapezoidal boxes. Ohio State-built electronics are mounted on the chambers inside electrostatic shields.
(Maximilien Brice, © CERN)

like the pixel detector in a digital camera, to precisely pinpoint the decay location of heavy particles produced in the collisions. The detector is situated closest to the collision region and hence is subjected to intense radiation. The Ohio State group also led:

- design of the radiation-hard chips (integrated circuits) for the optical readout system similar to those used in optical telecommunications
- assembly of the chips and optical components on printed circuit boards, using an exotic ceramic material
- construction of the beam condition monitors with diamond as the detecting media due to its high speed and radiation resistance.

The high-energy collisions at the LHC have the great potential of producing new particles or interactions that will revolutionize our understanding of the universe. The ATLAS group at Ohio State is searching for evidence of mini black holes that might be produced. In addition, the group is also searching for new phenomena by investigating the production and decay of the Z bosons, the neutral form of the weak interaction responsible for the radiative disintegration of the nucleus.

Signals of muons read out and measured by Ohio State electronics will be crucial in searching for the Higgs particle, a necessary ingredient of the Standard Model of particle physics, as well as for new physics beyond the Standard Model.

The high-energy collisions at the LHC have the great potential of producing new particles or interactions that will revolutionize our understanding of the universe.

CMS

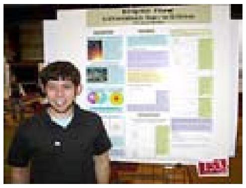
Ohio State collaborators, S. Durkin, R. Hughes, T.Y. Ling, and B. Winer

As with the other two experiments, Ohio State has a large and strong group working on the Compact Muon Solenoid (CMS) detector. The CMS detector is built around a huge solenoidal magnet with a field of 4 Teslas. The magnetic flux is contained and returned by a gigantic iron yoke surrounding the solenoid that dominates the weight of the detector at 12,500 metric tons. Interspersed within the iron yoke are tracking chambers to detect muons, hence the name Compact Muon Solenoid. Ohio State faculty members played a leading role in the construction of the endcap muon system for CMS, funded jointly by DOE and NSF. Over 200,000 channels of read out electronics for the endcap muon chambers have been designed and built at Ohio State. Shown in Figure 4 is a view of the central part of the detector when it is pulled apart. The total active area of all the endcap muon chambers is a little larger than a football field and this chamber system is capable of locating and measuring the position of any traversing muon to an accuracy of 100 microns. Signals of muons read out and measured by Ohio State electronics will be crucial in searching for the Higgs particle, a necessary ingredient of the Standard Model of particle physics, as well as for new physics beyond the Standard Model.

National Undergraduate Award Winners

Physics Students Receive Prestigious NSF Fellowships

Current undergraduate Doug Schaefer (photo this page) and 2008 graduate Greg Kestin were both awarded a 2009

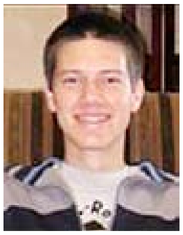


National Science Foundation Graduate Research Fellowship. Winners of this fellowship receive a three-year annual stipend of $30,000, a $10,500 allowance to cover tuition and fees, and a $1,000 travel allowance. The fellowship may be applied towards a graduate program at any accredited institution either in the United States or abroad. Schaefer will begin his fellowship at the University of Pennsylvania as a physics graduate student in autumn 2009. Kestin plans to use his fellowship to continue his physics graduate program at Harvard University.

In 1986, Congress established the Barry M. Goldwater Scholarship and Excellence in Education Program to foster and encourage outstanding students to pursue careers in the fields of mathematics, the natural sciences, and engineering.

Doug Schaefer
2008 Goldwater Scholarship

When Doug Schaefer got involved in particle physics research in his freshman year, he had already been interested in physics



for several years. "I had a great teacher for high school physics so I took two years of it," he explains. "At the same time, I started flying rubber-band powered model air planes, which got me even more interested in physics." Schaefer has spent the past several years as part of the Collider Detector at Fermilab (CDF) collaboration and has dedicated much of his time to data analysis, which has been essential to the collaboration. Schaefer has some advice for students interested in getting involved in research: "Figure out what you are interested in and read up on who is doing that kind of research at Ohio State. Also, talk to your physics professors to see what research is currently being done in the department." As for the future, Schaefer is planning to get his PhD in particle physics, stating, "I would love to go to graduate school in England and work on the Large Hadron Collider (LHC) at CERN."

Christine Zgrabik
2008 Goldwater Scholarship

Christine Zgrabik, a double major in engineering physics and Spanish, got involved in research at the end of her freshman

year. "I got involved in research and internships by pursuing opportunities I heard of from various sources such as e-mails, web sites, and posters," she says. Zgrabik has done research in Dr. Brillson's electronic materials and nanostructures lab in the Department of Electrical and Computer Engineering. In 2006, Zgrabik participated in a study abroad program in Spain, stating, "I loved the opportunity to view how different life could be in different parts of the world. Traveling there and experiencing the Spanish way of life put things in a different perspective for me." Zgrabik plans to begin graduate school in the fall of 2009 with a possible focus on applied physics or medical imaging.

The Rhodes Scholarship is one of the most prestigious honors available for college seniors worldwide; only 32 Americans each year are chosen to spend two years in graduate school at Oxford University in England.

Jessica Hanzlik
2008 Rhodes Scholarship

Jessica Hanzlik, who majored in physics and French, is Ohio State's first female

Rhodes Scholar. Four other Ohio State graduates have received a Rhodes Scholarship, most recently in 1986. Students are selected who demonstrate superior academic ability, leadership, and the potential to make an effective and positive contribution throughout the world.

Hanzlik began doing research in the physics department as a sophomore and continued until she graduated. She did research in Dr. Andrew Heckler's physics education lab and in Dr. Brian Winer's and Dr. Richard Hughes' high-energy physics lab.

Hanzlik started classes at Oxford University in October 2008 where she began her research with ATLAS at CERN and is pursuing her PhD in high-energy physics. She plans to earn her doctorate in particle physics, both because of her love of science and to put some teeth behind her passion to open the field to more women. Hanzlik started the Women in Physics and Women in Math and Science student organizations at Ohio State to promote gender equity.

"This award will help me with both of these goals," she said. "I will have access to the excellent scholars and superb resources at Oxford, which will provide me with great training. And I hope that the label of Rhodes Scholar will give my efforts to fight for the gender's equal access to science just a little bit more force."

Center for Electronic/Magnetic Nanoscale Composite Multifunctional Materials

P. Chris Hammel, Director

Created in 2006 from a Targeted Investment in Excellence (TIE) award, the Center for Electronic/Magnetic Nanoscale Composite Multifunctional Materials (ENCOMM) builds on the existing broad strengths in electronic, magnetic, and organic materials at Ohio State. ENCOMM's mission is to address cutting-edge challenges in discovering, understanding, and developing complex multicomponent materials through creating an environment in which interdisciplinary research groups can form and interact and also through providing the equipment infrastructure (ENCOMM NanoSystems Laboratory) needed to perform the research that will define this field. This approach has led to dramatic advances in interdisciplinary materials research at Ohio State as exemplified by the recent award of a prestigious Materials Research Science and Engineering Center (MRSEC) from the NSF. Ohio State competed with over 100 top research universities in a two-year process. Sixteen proposed interdisciplinary research groups (IRGs) were winnowed down to four via a highly selective internal selection process. These four IRGs then competed nationally as the Center for Emergent Materials (CEM), with the NSF eventually selecting two ENCOMM-nucleated IRGs for center funding (Towards Spin-Preserving, Heterogeneous Spin Networks and Double Perovskite Interfaces and Heterostructures). The CEM involves 20 Ohio State faculty from four departments and two colleges (of which 14 are affiliated with the Department of Physics) and is funded at $10.8 million over a period of six years.

In 2009, ENCOMM membership extends across six departments including Physics, Chemistry, Electrical and Computer Engineering, Mechanical Engineering, Materials Science Engineering, and Biomedical Engineering. For more information, please go to physics.ohio-state.edu/ENCOMM and ENSL .ohio-state.edu.

Center for Cosmology and AstroParticle Physics

Terry Walker, CCAPP Director

The Ohio State University Center for Cosmology and AstroParticle Physics (CCAPP) is supported by a $5 million award from the provost's Targeted Investment in Excellence Program, by a $5 million Exploration of Space endowment, and several other private endowments. CCAPP's mission is to support collaborative research between Ohio State's Departments of Astronomy and Physics in areas in which the university can make a fundamental impact: dark energy, dark matter, and multi-messenger particle astrophysics. Through the center, Ohio State has joined some of the world's leading research efforts: DES, GLAST, AUGER, IceCube, and SDSS-III, which you can read about on our web site. Of particular importance is the center's identity as a collection point for the world's best young researchers in the areas of cosmology and particle astrophysics. CCAPP is proud to co-sponsor the annual R. Jack and Forest Lynn Biard Lectures in Cosmology and Astrophysics.

The center houses approximately 30 faculty, seven CCAPP postdocs, and other mission specific postdocs and staff. CCAPP researchers receive federal support from the Department of Energy, NASA, and the National Science Foundation. For further information, see ccapp.osu.edu.

Generous Gift Establishes Endowment

Steve Price and Jill Levy have recently made a gift of $127,000 to support the Center for Cosmology and AstroParticle Physics in the Department of Physics.

Their generous gift will establish the Dr. Pliny A. and Margaret H. Price Endowment named after Steve's parents. The distribution from this endowment will be used to support the research of young scholars visiting the center. Award recipients will be selected based on a review of their research in the areas of cosmology and astroparticle physics.

Steve and Jill reside in Westerville and are admirers of the study of cosmology and astroparticle physics.

Center for Emergent Materials at The Ohio State University—a National Science Foundation Materials Research Science and Engineering Center

> The National Science Foundation announced on September 30, 2008, that Ohio State would receive funds over six years to establish a Materials Research Science and Engineering Center (MRSEC). With this, the university joins a national network of 27 MRSECs that foster active collaboration between universities and industry.

Ohio State Awarded Prestigious Materials Research Center

We are pleased to announce that Ohio State has won its first ever National Science Foundation (NSF) Materials Research Science and Engineering Center (MRSEC), titled Center for Emergent Materials (CEM). This is also the first and only MRSEC in the state of Ohio since the 1994 inception of this highly competitive NSF program. Ohio State's CEM was established on September 1, 2008, for a duration of six years with $10.8 million funding from NSF, which is augmented by $6.2 million cash cost share from the university. The CEM is among five new MRSECs selected for funding by NSF from a pool of 100 applicants that compete in a national competition held every three years. The MRSEC award puts Ohio State squarely in the top echelon of U.S. universities with significant materials research programs.

The CEM performs integrated research on emergent materials and phenomena in magnetoelectronics. The aim of the CEM is to lay down the scientific foundation for building both future oxide-based electronic devices that can perform multiple functions, and energy-efficient, fast computers that have integrated memory and logic. The scientific foundation is in the form of deep and comprehensive understanding of the emergent materials and phenomena, and the development of highly sophisticated experimental and theoretical tools required to study them.

At the heart of the CEM are two interdisciplinary research groups (IRGs). IRG-1, titled Towards Spin-Preserving, Heterogeneous Spin Networks, develops a new understanding of electron-spin injection and transport in low-dimensional, spin-preserving materials such as silicon and carbon. This understanding provides a new materials-basis for creating novel high-density spin networks for next-generation computing. The IRG-1 faculty team of 11 is co-led by Professors P. Chris Hammel and Ezekiel Johnston-Halperin, both of the Department of Physics. Other faculty team members include: Professors Arthur J. Epstein (Physics and Chemistry), Jay A. Gupta (Physics), Roland K. Kawakami (University of California Riverside; Physics), Julia S. Meyer (Physics), Nitin P. Padture (Materials Science and Engineering), Jonathan P. Pelz (Physics), Steven A. Ringel (Electrical and Computer Engineering), David G. Stroud (Physics), and Wolfgang Windl (Materials Science and Engineering).

IRG-2, titled Double Perovskite Interfaces and Heterostructures, studies these unique materials whose properties can be widely varied through chemical substitution. Of particular interest are the ones that possess metallic ferromagnetism with 100% spin polarization of the charge carriers and Curie temperatures that lie far above ambient. These unparalleled properties open new avenues to create state-of-the-art magnetoelectronic devices such as spin injectors and magnetic tunnel junctions. Through a comprehensive understanding of electronic structure, defects, and magnetotransport at interfaces, the research advances will enable the emerging field of oxide electronics to expand in new directions. The IRG-2 faculty team of nine is co-led by Professor Patrick M. Woodward of the Department of Chemistry and Professor Leonard J. Brillson of the Departments of Electrical and Computer Engineering and Physics. Other faculty team members include: Professors Hamish L. Fraser (Materials Science and Engineering), Thomas R. Lemberger (Physics), Patricia A. Morris (Materials Science and Engineering), Mohit Randeria (Physics), Nandini Trivedi (Physics), Wolfgang Windl (Materials Science and Engineering), and Fengyuan Yang (Physics).

A theory/modeling cluster consisting of five faculty members from both IRGs is organized to help integrate experimental and theoretical efforts across the CEM. Professor Nandini Trivedi leads this effort.

The CEM also sponsors a Seed Funding program, which provides the necessary flexibility and vitality to the CEM to develop into new areas within the rapidly changing landscape of advanced materials research. Professors Ezekiel Johnston-Halperin and Julia S. Meyer co-lead this effort.

Ohio State's multidisciplinary advanced materials community is already home to major world-class shared experimental facilities, which are brought to bear on CEM research and education. The CEM collaborates with the electronics, storage, and instrumentation industries; national laboratories and institutes; other U.S. universities; and international universities and laboratories in China, Germany, India, and United Kingdom. These efforts are led by Professor Steven A. Ringel.

Integrated with the research activities, the CEM enhances classroom education, creates research internship opportunities, widens the science-technology-engineering-math (STEM) "pipeline," and enhances diversity in STEM. Activities include an innovative education research program aimed at cognition of materials science concepts, K-12 outreach and visitation programs, undergraduate research programs, and graduate education enhancement programs. Professor Katharine M. Flores (Materials Science and Engineering) leads this overall effort. Professor Andrew F. Heckler (Physics) leads the education research effort, Professor Thomas R. Lemberger leads the Research Experience for Undergraduates (REU) effort, and Dr. Christopher Andersen coordinates the outreach/education effort.

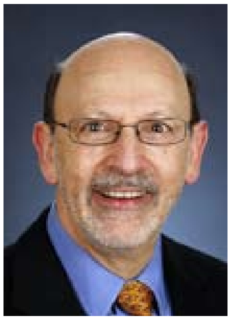
There are about 80 personnel involved in the CEM, including 21 faculty members from two colleges and four departments; four senior investigators; 24 graduate students; four postdoctoral scholars; 24 undergraduate students; and three staff members.

Professor Nitin P. Padture serves as the director of the CEM. Please visit cem.osu.edu for more information.

Major National and International Awards

Epstein Wins McGroddy Prize

Professor Arthur J. Epstein, Distinguished University Professor of Physics and Chemistry, received the 2007 James C. McGroddy Prize for New Materials "for his discovery and characterization of organic-based magnets, and for observation and study of predictable and previously unknown magnetic phenomena in these fascinating materials leading to fundamentally new science and the demonstrated potential for creative new technologies."



Epstein's extensive research includes discovery of phenomena that result from organic molecules as the repeat units in magnets. New concepts developed in his labs include fractal magnetism, magnets with multiple photonic responses, and fully spin polarized room temperature magnetic semiconductors. Epstein also has extensively investigated the metal to insulator transition and charge motion in organic systems. In addition to his more than 600 papers he has been awarded over 30 patents. He is listed by ISI Web of Science as among the 250 most cited physicists worldwide.

Epstein Elected to APS Post

Professor Art Epstein has been elected councilor for the American Physical Society's Division of Condensed Matter Physics. His five-year term began January 2008.

The council is the main governing body of the American Physical Society. It sets policy and has the ultimate responsibility for the actions of the society.

Agostini Receives OSA Meggers Award

Pierre Agostini was selected by the Optical Society of America as the 2007 recipient of the William F. Meggers Award. He is recognized "for leadership in the development of innovative experiments providing major insights into the dynamics of the nonlinear response of atoms and molecules submitted to strong infrared laser pulses." This award, endowed by the family of William Meggers, several individuals, and a number of optical manufacturers, honors Meggers for his notable contributions to the field of spectroscopy and metrology.

Onsager Prize to Jason Ho

Professor Tin-Lun (Jason) Ho received the 2008 Lars Onsager Prize of the American Physical Society, together with Gordon Baym, University of Illinois, and Christopher Pethick, NORDITA. The Onsager Prize was established to recognize outstanding research in theoretical statistical physics including the quantum fluids. The 2008 Onsager Prize is the first award in quantum fluids since the establishment of this prize in 1995. Ho is the youngest so far to receive it. His citation reads: "For his contributions to quantum liquids and dilute quantum gases, both multi-component and rapidly rotating, and for his leadership in unifying condensed matter and atomic physics research in this area." The prize was presented at the March 2008 APS Meeting, at which Ho gave an invited talk on the work for which the prize is being awarded.

Ho has contributed to a variety of areas in condensed matter physics, including quantum liquid, quasicrystals, and quantum Hall effect. His early work on superfluid He-3 is among the earliest applications of topological ideas in condensed matter. In the last decade, he has been working on a wide range of problems in dilute quantum gases, and fostering communications between condensed matter physics and atomic physics communities.

National and International Honors and Professional Activities

Fellows of the **American Association for the Advancement of Science (AAAS)** are recognized for meritorious efforts to advance science or its applications. Ohio State professors of physics recently named AAAS Fellows are:

Richard J. Furnstahl – For pioneering contributions to the nuclear many-body problem, including developments in relativistic many-body theory, QCD sum rules at finite density, and effective field theory at finite density.

Robert J. Perry – For the development of renormalization group coupling coherence and the identification of a simple confinement mechanism, which led to a constituent picture in light-front quantum chromodynamics. Perry also received the 2008 Alumni Award for Distinguished Teaching.

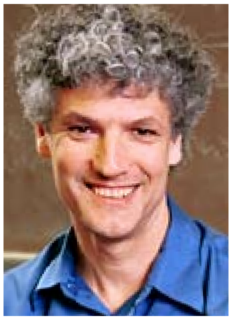
Vladimir Prigodin was named a Fellow of the **American Physical Society** for his pioneering studies of electronic properties of low-dimensional systems, proposal and development of fundamentals of charge transport in quasi-one-dimensional disordered structures, and of operating principals of new organic-based electronic materials/devices and fully spin polarized organic spintronic materials/devices.

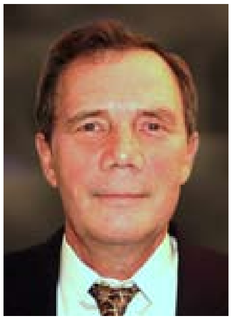
The highly selective **APS Outstanding Referee** program was instituted in 2008 to recognize scientists who have been exceptionally helpful in assessing manuscripts for publication in APS journals. Outstanding Referees **Eric Braaten**, **Ulrich Heinz**, **David Stroud**, **John Wilkins** (not pictured), **John Beacom** (see next page), and **Richard Furnstahl** were selected based on two decades of database records on over 50,000 referees who have been called upon to review manuscripts.

Eric Braaten received a 2009 **Humboldt Research Award**. These awards are granted in recognition of a researcher's entire achievements to date to academics whose fundamental discoveries, new theories, or insights have had a significant impact on their own discipline and who are expected to continue producing cutting-edge achievements in the future. Award winners are invited to spend up to one year cooperating on a long-term research project with specialist colleagues at a research institute in Germany.

DiMauro Named Chair for APS Division
AMO experimentalist, Edward and Sylvia Hagenlocker Chair, and physics professor Louis DiMauro was announced as chair for the APS Division of Atomic, Molecular, and Optical Physics, effective April 2009.


Richard Furnstahl

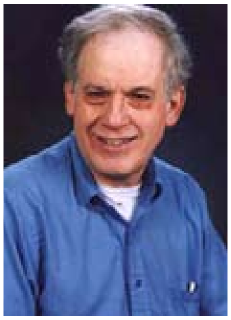

Robert Perry


Vladimir Prigodin


Eric Braaten


Ulrich Heinz


Louis DiMauro


David Stroud


Gordon Aubrecht

Ohio State Honors and Recognitions

Ulrich Heinz was awarded the 2007 **Distinguished Scholar Award**. This award recognizes exceptional scholarly accomplishments by senior professors who have compiled a substantial body of research, as well as the work of younger faculty members who have demonstrated great scholarly potential. Heinz was honored for his research on the dynamical evolution of quark-gluon plasma created in nuclear collisions at high energies.

Gordon Aubrecht won the 2007–2008 **Faculty Award for Distinguished Service**. The award honors faculty members whose contributions to the development and implementation of university policies and programs through non-administrative roles have been extensive and have made documentable impact on the quality of the university.

Brian Winer, professor of physics, joined the University Honors & Scholars Center in January 2009 as director of the Honors Collegium, a program for purposeful undergraduates who expect to distinguish themselves beyond the baccalaureate degree.

Brian Winer

Winer has been teaching and working in the area of high-energy physics at Ohio State since 1996 and has received numerous awards, including the University Alumni Award for Distinguished Teaching and Distinguished Undergraduate Research Mentor Award.

John Beacom received the 2009 **Alumni Award for Distinguished Teaching** with a surprise classroom visit from President Gee. The award annually recognizes a maximum of 10 faculty for their teaching excellence. Beacom also received the 2008 **ASC Outstanding Teacher Award**, the only completely student-run award at Ohio State and administered by the Colleges of the Arts and Sciences Student Council.

Multiple Award Winners

Dongping Zhong is one of the 2008 winners of the Camille Dreyfus Teacher-Scholar Awards, supporting the research and teaching careers of talented young faculty in the chemical sciences.

Also in 2008, Zhong was awarded the **NSF CAREER Award**. The Faculty Early Career Development (CAREER) program offers the National Science Foundation's most prestigious awards in support of the early career development activities of those teacher-scholars who most effectively integrate research and education.

Dongping Zhong

Zhong was also awarded the **Sloan Research Fellowship in 2008**. The Alfred P. Sloan Foundation offers research fellowships to the best and brightest young scientists from selected colleges and universities throughout the United States and Canada. In 2007, Zhong was appointed the first holder of the Robert Smith Endowed Professorship in Physics. Established in 2005 with a gift from Robert Beaton Smith, this endowment provides support for a distinguished faculty member's research in physics throughout a five-year appointment.

And in 2008, Zhong was a recipient of the **Elizabeth L. Gross Award**, selected by the students in recognition for excellence in student mentoring, teaching, research, and numerous contributions to the Biophysics Program.

Jay Gupta has received an NSF CAREER Award, supporting research into the electronic and optical properties of nanostructures. This research will be integrated with educational and outreach activities at Ohio State revolving around web-based videoconferencing tools. The Faculty Early Career Development (CAREER) program offers the National Science Foundation's most prestigious awards in support of the early career development activities of those teacher-scholars who most effectively integrate research and education. This integration is intended to improve the participation and training of students in science, technology, engineering, and mathematics related fields. Gupta's CAREER award totals $500,000 to cover research expenses over a five-year period.

Jay Gupta

Gupta is also a 2007 winner of a **Beckman Foundation Young Investigator Award** ($300,000 over three years) for "studies of chemical reactivity at the single molecule level." The Arnold and Mabel Beckman Foundation makes grants to nonprofit research institutions to promote research in chemistry and the life sciences. The Beckman Young Investigators (BYI) program is intended to provide research support to the most promising young faculty members in the early stages of academic careers in the chemical and life sciences.

The American Chapter of the Indian Physics Association has also recognized Gupta's work by awarding him its inaugural **Outstanding Young Physicist Prize**.

From Lasers to Fusion: High-Energy Density Physics

It's high-energy density physics (HEDP), *not* high-energy physics, and it represents a burgeoning new field of physics that spans many of the traditional disciplines.

Linn Van Woerkom

The HEDP research group in the Department of Physics pushes back the frontiers of science using ultra-intense laser pulses to excite matter to extreme states of density and temperature found in nature only in stars.

Professors Richard Freeman, Linn Van Woerkom, and Douglass Schumacher lead a team of students and staff on a journey to probe these laser-induced extreme states in an attempt to exploit some of their remarkable properties. "The ultimate goal of HEDP is to produce a miniature sun in the laboratory," Van Woerkom said, "and our team works on the very large laser systems with colleagues at the National Laboratories to achieve this goal." Recently, the HEDP group has begun building an ultra-intense, short pulse laser system on the fourth floor of the Physics Research Building (PRB). This laser system, made possible by nearly $5 million of federal funding, is designed to investigate the by-products of the interaction of extremely intense light with matter. "We can't build a laser the size necessary to create a miniature sun here at Ohio State," explained Van Woerkom,"but we can build a laser that allows us to create the initial conditions."

The laser under construction in the PRB is being constructed in two phases. The first phase, due for completion in the summer of 2009, will produce single pulses with a peak power of 40 terawatts (a terawatt is one million million watts). Although this power is greater than the summer electricity capacity of the total electrical grid of the United States, the total energy of the laser is quite small, since the pulse duration is only 30 femtoseconds (one femto-second is 10^{-15} seconds). The second phase, due for completion in early 2010, will boost the power by a factor of ten. When this laser power is focused onto a target with a spot size of a few microns, the electric field of the laser far exceeds the fields holding the atoms together. That is, the laser strips all the electrons from the target atoms and creates a high-density, hot plasma ball of fully stripped ions and their electrons. These are the initial conditions necessary to create the extremely high densities and temperatures of a miniature sun.

These initial conditions produce a plethora of remarkable processes, ranging from the production of gamma-ray radiation to high-energy electrons, protons, and neutrons to the prospect of a fusion energy source. Furthermore, the interaction region can mimic the physics of exotic states of matter with pressures as high as 100 billion atmospheres and magnetic fields exceeding 1,000 Tesla. The team plans on investigating the practical uses of these by-products as well. For example, since the high-energy protons and neutrons come from a small spot (where the laser is focused onto the target) these high-energy neutrons and protons have the potential for use in high-resolution radiography, especially where time and space resolution is required. The potential exists for compact radiation and particle sources important to national defense and medicine.

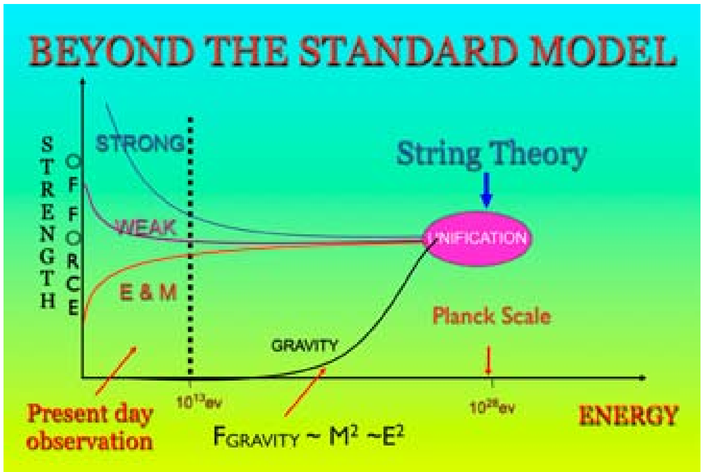
Laser scientist Dr. Enam Chowdhury (middle) works with graduate student John Morrison (foreground) and undergraduate student Ryan Richards (back) on the 40 TW laser system.

"The ultimate goal of HEDP is to produce a miniature sun in the laboratory," Van Woerkom said, "and our team works on the very large laser systems with colleagues at the National Laboratories to achieve this goal."

Nobelist on the Future of Physics

by Pam Frost Gorder, Research Communications

Our notions of space and time are doomed, said David Gross—and that's a good thing. The winner of the 2004 Nobel Prize in physics delivered the annual Alpheus Smith Lecture in March 2009, discussing scientists' efforts to merge what they know about the fundamental forces of the universe into a single theory, sometimes called the "Theory of Everything." How we think about the universe has changed a lot in the last two centuries—first because of Newton and then Einstein, Gross said. Each time, we had to revise old ideas of how space and time are connected. Both relativity and quantum mechanics caused fundamental shifts in physics. "Now we are wondering whether our notions of space and time are again going to have to be altered," he said—this time, to make room for string theory. Gross, director and holder of the Frederick W. Gluck Chair in Theoretical Physics at Kavli Institute for Theoretical Physics, won the Nobel for his discovery that quarks—the building blocks of protons and neutrons—are drawn together by a special kind of charge that forms what is called the strong nuclear force. He shared that discovery with physicists Frank Wilczek and David Politzer. Because the strong force merged so well with ideas about other fundamental forces, it hinted that a Theory of Everything was indeed possible. Gross has since made seminal advances in string theory, which holds that quarks are made of vibrating strands of energy called strings. String theory may one day tie all the fundamental forces together, he said. In his lecture, he also discussed how physicists are probing that possibility—in part, through experiments happening at the Large Hadron Collider at CERN.



The Smith Lecture began in 1960 and honors Alpheus Smith, former chair of Ohio State's Department of Physics and dean of the Graduate School. The lecture is funded by a gift from the Smith family and is given yearly by a physicist renowned not only for his or her scientific achievements but also for the ability to communicate scientific breakthroughs to the general public. Gross is the 24th Nobel Prize winner to give the lecture.

> "Now we are wondering whether our notions of space and time are again going to have to be altered."

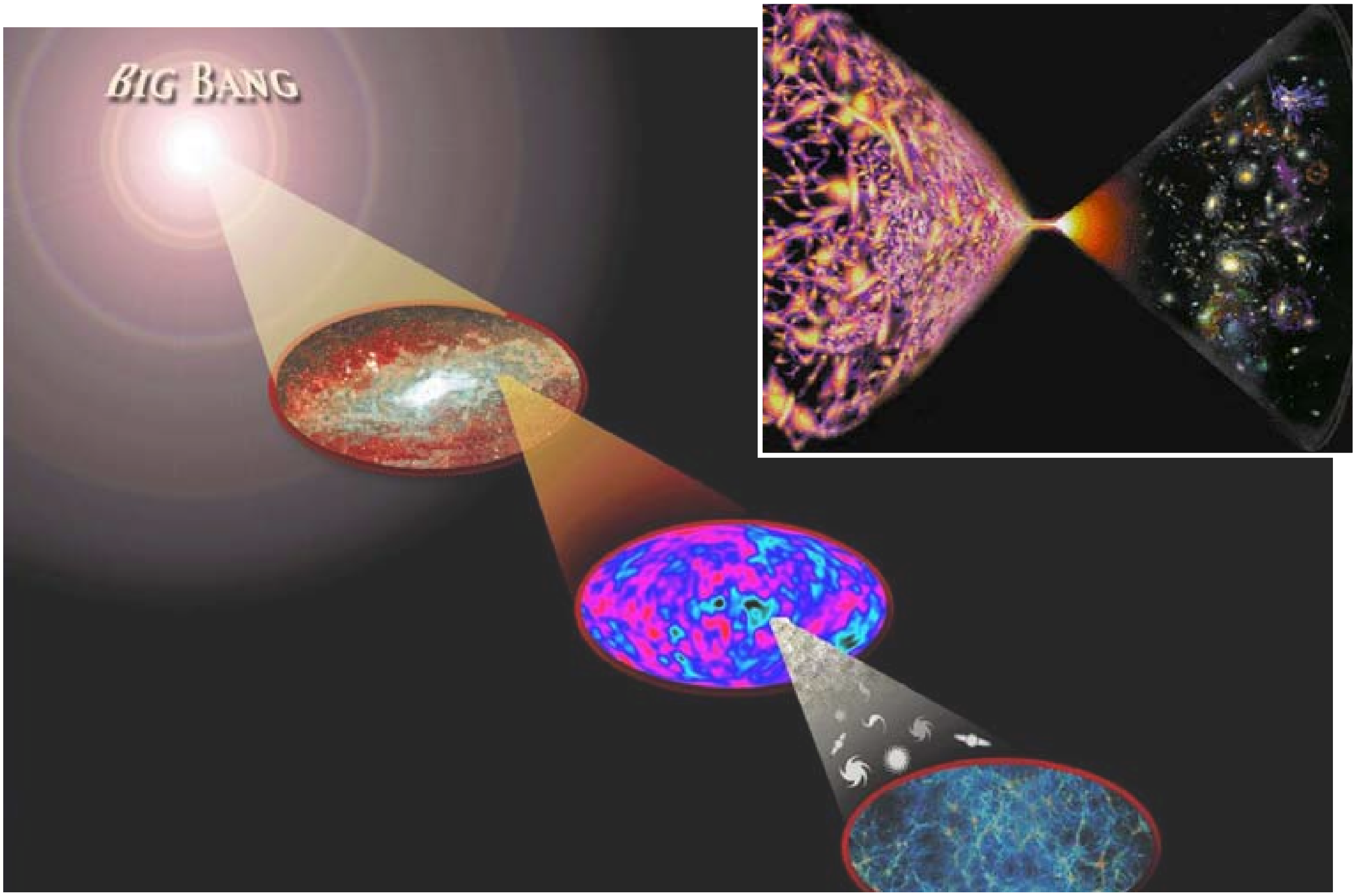
Mysteries of the Dark Universe

Rocky Kolb

Ninety-five percent of the universe is missing. Astronomical observations suggest that most of the mass of the universe is in a mysterious form called dark matter, and most of the energy in the universe is in an even more mysterious form called dark energy. We have no understanding of the nature of the stuff that makes up our universe.

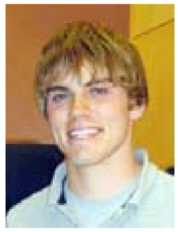
Professor Rocky Kolb, University of Chicago, presented the 2008 Biard Lecture in a nontechnical discussion, outlining the evidence for dark matter and dark energy. He addressed the reasons that cosmologists feel that unlocking the secrets of dark matter and dark energy will illuminate the nature of space and time and connect the quantum with the cosmos.

The Annual R. Jack and Forest Lynn Biard Cosmology and Astrophysics Lecture is supported by a generous gift from Captain Forrest R. Biard, U.S. Navy, Ret., a 1953 MS recipient from The Ohio State University. The Biard Lecture forms the cornerstone of CCAPP's outreach effort, bringing forefront research in cosmology and astrophysics to Ohio State undergraduates, the university community, and the general public.



2008 Department of Physics Undergraduate Awards

The Physics Undergraduate Scholarships are possible due to the generosity of Michael Valentino and Family, Alva and Clara Smith, Jack C. and Charlotte D. Smith, Robert Smith and Family, and Hazel Brown.



Jesse Parsons
2008 Valentino Academic Achievement Scholarship

Jesse Parsons has always pictured himself at Ohio State, stating, "I have always liked Ohio State and OSU football. The university is well known, and I know I can get a good education." Parsons began his freshman year as an engineering physics major in 2008. "I always had a lot of fun with physics in high school; I like how physics is in everyday situations." Parsons says he is very interested in doing research and hopes to get to know physics faculty and get started on a research project as soon as he can. For his first year at Ohio State, Parsons is looking forward to taking math, physics, and engineering classes.

(l to r) Caitlin Malone, Liana Bonanno (Clark Scholarship recipients)

Chris Williams (Smith Senior Award winner)

Tom and Bunny Clark Scholarship
Liana Bonanno
Caitlin Malone

2007–2008 Undergraduate Prizes

Senior Alumni Award
Garrett Elliott
Greg Kestin

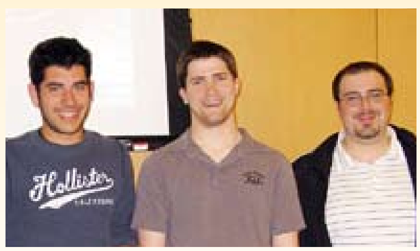
Smith Senior Award
Christopher Williams

Smith Junior Award
Jacob Eiting
Nathaniel Ross
Raman Talwar

Smith Sophomore Award
Jesse Buxton
Thomas Henighan
Randal Morgan
Michael Roe
Eric Suchyta
Song Wang

Helen Cowan Book Award
Joel Bailey
Jake Connors
William Corey
Joseph Garrett
Daniel Giglio
Li-Wei Hung
Jason Lawhead
Tyler Merz
Drew Myer
Anthony Vergis

(l to r) William Saam, Garrett Elliott, Greg Kestin (Senior Alumni Award winners), and Richard Hughes



(l to r) Raman Talwar, Jacob Eiting, and Nathaniel Ross (Smith Junior Award winners)

Richard Hughes and Academic Achievement Scholarship recipient Jesse Parsons

McMaster Family Creates New Scholarship

The Harold and Helen McMaster Family Foundation recently made a $100,000 commitment to support a scholarship in memory of Harold McMaster (MS '39). The Harold McMaster Scholarship Fund will support high-ability undergraduate students from the state of Ohio (where Harold resided the majority of his life) who are currently enrolled in classes and intend to major in physics or students with a currently declared major in physics.

Mr. McMaster received a combined master's degree in physics, mathematics, and astronomy from Ohio State. He started his own company, Glasstech, which made him the world authority on glass tempering. In 1940 he designed the McMaster Rotary Engine (MRE), which is one-third lighter than the typical car engine. He passed away August 25, 2003.

Ed Grilly

Grilly Summer Research Scholarship

The Edward R. Grilly Summer Research Scholarship supports undergraduate students pursuing research projects with an approved faculty sponsor during the summer. The program runs 10 weeks, but may extend further depending on the availability of funds.

2008 Grilly Scholars

Josh Emerick, with Dr. Zeke Johnston-Halperin

Tom Henighan, with Dr. R. Sooryakumar

Jason Lawhead, with Dr. Jay Gupta

Katie Malone, with Dr. Richard Kass

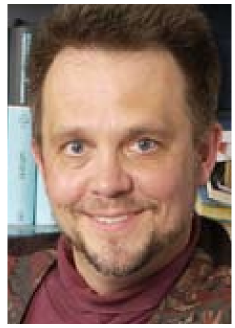
Scott Moreland, with Dr. Ulrich Heinz

Adam Reed, with Dr. Chris Hammel

Omar Tabbaa, with Dr. Richard Hughes


Richard Hughes

Vice chair for Undergraduate Studies **Richard Hughes** received the 2008 **Colleges of the Arts and Sciences Honors Faculty Service Award** for exemplary service to the ASC Honors Program and its students. He was recognized and received a $1,000 honorarium at the ASC Spring Reception Honoring Outstanding Achievement. Hughes is also a winner of the 2008 Distinguished Undergraduate Research Mentor Award.


Greg Kilcup

Greg Kilcup is the winner of the first annual **Outstanding Undergraduate Teaching Award**. Physics students nominated several professors for this award, and the winner was chosen by the Society of Physics Students, a student organization for Ohio State physics and engineering physics undergraduates.

Sigma Pi Sigma Physics Honor Society

Sigma Pi Sigma exists to honor outstanding scholarship in physics; to encourage interest in physics among all students; to promote an attitude of service of its members toward their fellow students, colleagues, and the public; and to provide a fellowship of persons who have excelled in physics. The main activities of the society involve outreach projects to enhance the teaching of science in middle and high schools in Ohio.

Girls Reaching to Achieve in Sports and Physics (GRASP) Summer Camp

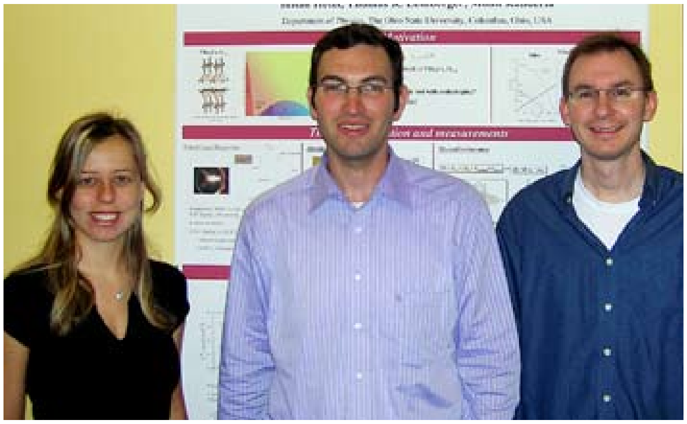
From June 23–27, 2008, Ohio State's Women in Physics organization hosted a five-day camp for middle school girls with help from physics department faculty, staff, and students. Each day consisted of hands-on, interactive physics demonstrations and projects followed by a physical activity that showed how physics relates to everyday phenomena. Ohio State undergraduate and graduate students were present at all sessions to help supervise and share their understanding and love of physics with the GRASP participants. Women in Physics plans to make the GRASP summer camp an annual event.

For more information, visit physics.ohio-state.edu/undergrad/GRASP/GRASP.php.

Graduate Student Poster Presentation

During spring quarters, the Physics Graduate Student Council sponsors the Annual Graduate Student Poster Presentation. This event is designed to foster interaction between students, promote discussion of current in-house research, and highlight the work done by graduate students. Fifteen posters are displayed in the atrium for two weeks each year. A cash prize goes to the top three posters for each year.

The 2008 winning posters were: Kevin Driver ("Quantum Monte Carlo study of the elastic instability of stishovite under pressure," Professor Wilkins); Kadriye Deniz Duman ("Reversible Photoinduced Magnetism in Room Temperature Magnet V-Cr Prussian Blue," Professor Epstein); and Louis Nemzer ("A Polyaniline-Based Optical Biosensing Platform for Continuous *in vivo* Glucose Monitoring," Professor Epstein).



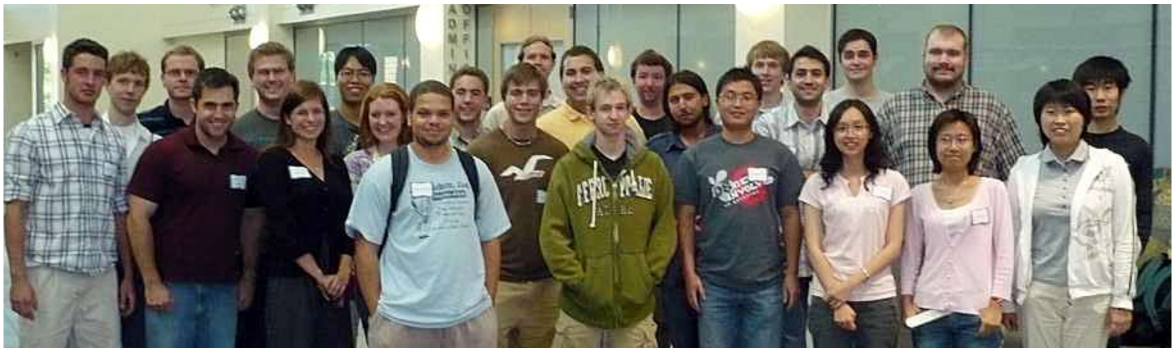
2008 poster presentation winners (l to r) Kadriye Deniz Duman, Louis Nemzer, and Kevin Driver

2008 Bunny and Thomas Clark Graduate Award

Congratulations to Sarah Parks for winning the 2008 Bunny and Thomas Clark Graduate Award for her outstanding service to the Department of Physics. Sarah is the first graduate student recipient of this award, which this year also comes with $2,700 to be used by Sarah for her research.

(l to r) Thomas Clark, Sarah Parks, and Bunny Clark

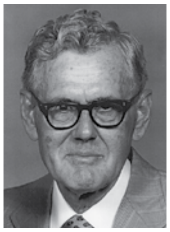
First-Year Graduate Student Class



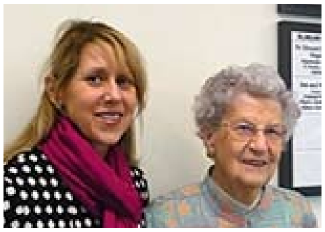
(l to r) Andrew Berger, John Cheairs, Geoffrey Smith, Christian Langmack, Daniel White, Marci Howdyshell, Howard Yu, Jennifer Thompson, Turhan Carroll, Aaron Adair, Kurtis Wickey, Eric Duchon, David Pignotti, Justin Young, Ryan Hupe, Onur Erten, Kaikai Zhang, Matthew Steinpreis, Arbi Moradian, Yi-Hsin Chiu, William Cole, Kyle Wendt, Jing Han, Sheng Jiang, Weiran Li. Not shown: Neesha Anderson, Anthony Bustamante, Brian Dainton, John Draskovic, James McMillan, Oinam Meetei, Marissa Rodenburg, Alfred Rossi, Stephen Schoun, Morgan Welsh

Heer Family Establishes New Graduate Scholarship

Esther Heer (BS '49), along with her family including Dan Heer (BS '80, MS '81), Debra Heer Fox (BS '78), and Barbara Heer Foerst, established the Dr. Clifford Heer Graduate Student Scholarship in the Department of Physics. This endowment is in memory of emeritus professor Dr. Clifford Heer (BS '42, PhD '49).



Dr. Clifford Heer



Debra Heer Fox and Esther Heer

Dr. Heer was a professor in the Departments of Physics and Astronomy at Ohio State from 1949 to 1990. He was a dedicated teacher and researcher who expected and received excellent work from his students. His accomplishments include co-inventing the cyclic magnetic refrigerator and being the first to measure angular rotation using a microwave interferometer. The focus of his research was low-temperature physics. He produced more than 80 published research works on topics such as low-temperature physics, atomic and laser physics, general relativity, and statistical physics. The Heer family's generous gift will provide annual scholarship awards to graduate students studying physics.

If you would like to make a gift in memory of Dr. Heer to support the Dr. Clifford Heer Graduate Student Scholarship Fund, please reference fund # 663159 and make your check payable to The Ohio State University Foundation. You can also make a gift online at giveto.osu.edu.

Department of Physics Outstanding Graduate Teaching Award

Julia Meyer

The **Outstanding Graduate Teaching Award** is given annually to one of four professors teaching the core courses (Quantum Mechanics, Electricity and Magnetism, Statistical Mechanics, and Classical Mechanics) that year. Students in these courses make the selection for Outstanding Graduate Teacher near the end of the academic year. **Julia Meyer** was the 2008 recipient.

Grad Student Profile: Xianwei (Josh) Zhao

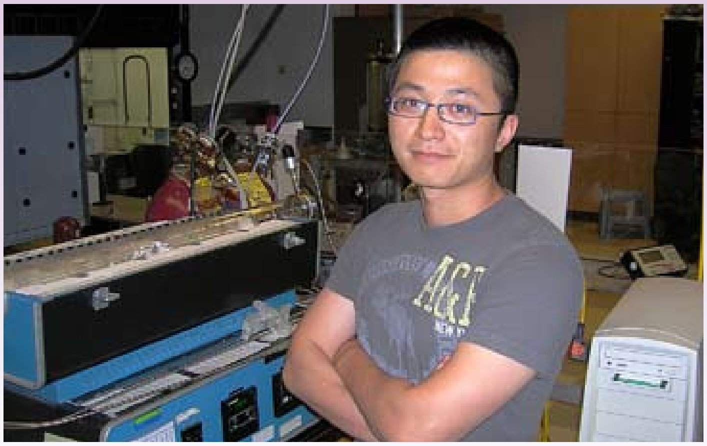
Josh Zhao is a condensed matter experimentalist in his fifth year at Ohio State, coming to the university from Jiangsu Province in eastern China. At an early age, he had an interest in science fiction magazines, which sparked his curiosity in the workings of the universe. In middle school and high school, he was involved in science camps and competitions. Specifically, astronomy intrigued Zhao, but when he started college, his father convinced him that physics was a superior subject. After graduating from nearby Nanjing University, Zhao began his grad school career at Louisiana State University in 2003. He came to Ohio State a year later to join a school with a larger condensed matter group.

Currently, Zhao works under Professor Fengyuan Yang synthesizing nanoscale semiconducting wires made of alloys from groups III and V of the periodic table, known as III-V nanowires. The wires are grown by pulsed laser deposition (PLD), chemical vapor deposition, and magnetron sputtering. As he explains, "Most of the time we use high-resolution scanning electron microscopy and transmission electron microscopy to calibrate the wires and x-ray diffraction to characterize the structure."

He also explores the electrical and optical properties of the wires using several methods. As one example, he conducts photoluminescence measurements in conjunction with Ezekiel Johnson-Halperin's group.

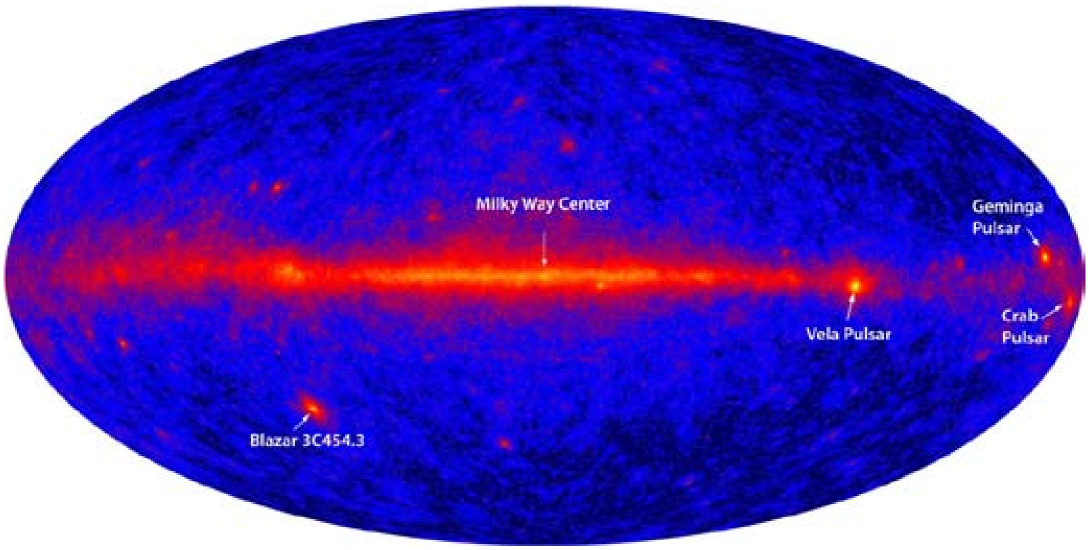
Nanowires can be used in the fabrication of devices such as light-emitting diodes and field effect transistors. These new nanowire-based devices may eventually be used in the semiconductor industry. "We use the focused ion beam and electron-beam lithography to fabricate these devices," Zhao says. In the last two years, he has been first author on two papers about nanowire growth, one discussing PLD and the other on magnetron sputtering.

Besides his research, Zhao also helps oversee the Electronic & Magnetic Nanoscale Composite Multifunctional Materials (ENCOMM) facilities in the Physics Research Building, where, among other things, he performs a variety of organizational tasks and trains undergraduate and graduate students on equipment. As he explains, "I'm in charge of the maintenance of the atomic force microscope, scanning electron microscope, and photolithography lab." In his free time, he plays sports—especially basketball—lifts weights, and follows politics.



Xianwei (Josh) Zhao is a fifth-year graduate student in condensed matter physics working with Professor Fengyuan Yang.

A Signal from the Dark Side? Ohio State Physicists use GLAST in the Search



With the recent launch of the Fermi satellite and the start of data acquisition, this is a very exciting time for the astrophysics community as a whole, and in particular for the Fermi LAT team at Ohio State.

The Gamma-Ray Large Area Space Telescope, or GLAST, is NASA's newest space observatory and was launched from Cape Canaveral Air Force Station in Cape Canaveral, Florida, in June 2008. A Delta II rocket boosted it into a circular orbit 350 miles above the Earth. On August 26, GLAST was renamed the Fermi Gamma-Ray Space Telescope in honor of the physicist Enrico Fermi. Along with the renaming came the official close of the initial instrument start-up and calibration period and the release of the First Light results, Fermi's initial view of the gamma-ray sky. Fermi will be able to provide new and improved information on many previously studied astrophysical objects, such as the Vela pulsar, in addition to the numerous discoveries Fermi is expected to make. In fact, Fermi has already discovered a new pulsar emitting at gamma-ray energies! In addition, Fermi was fortunate enough to turn on just as the gamma-ray emission from an active galaxy, Blazar 3C454.3 in the picture above, was flaring.

The Fermi satellite is a product of an international collaboration between the United States, France, Italy, Japan, Spain, Sweden, Department of Energy, and NASA. Fermi completes one orbit about every 90 minutes and can view the entire sky in only two orbits, or three hours. Its two instruments onboard are the Large Area Telescope, or LAT, which is capable of detecting gamma rays in the 20 MeV to >300 GeV energy range, and the Gamma-ray Burst Monitor, or GBM, designed to search for phenomena called gamma-ray bursts, or GRBs—short but very intense periods of gamma-ray emission. It detects gamma rays in the 8 keV to 25 MeV energy range and can view the entire sky at once.

At Ohio State, Professors Richard Hughes and Brian Winer are members of the Fermi LAT collaboration hoping to see a signal in the LAT from a mysterious form of matter called dark matter. Ordinary matter, such as protons, electrons, and all of the elements of the periodic table, makes up only about 4% of the energy density of the universe. Dark matter, however, composes about 22% of the energy density of the universe, but it interacts with electromagnetic radiation much more weakly than ordinary matter, which makes it very difficult to detect.

When dark matter particles annihilate, they produce a variety of particles, including gamma rays with characteristic energy signatures. Properties of the dark matter particle can then be inferred from the characteristics of the gamma ray signal observed. Many complementary searches are planned using the LAT, including searches at the Galactic Center, searches for dark matter satellites, and searches in dwarf galaxies. Along with graduate student Aaron Sander, Hughes and Winer are looking for a dark matter annihilation signal originating within our own Milky Way Galaxy. The dark matter in our galaxy is believed to be distributed in a roughly spherical volume that surrounds the galaxy but that extends out much farther than just the visible plane. The search for this signal involves looking for an excess of gamma rays beyond those expected from known processes, such as cosmic ray collisions with the interstellar dust. Therefore this search is highly dependent upon the understanding of these other processes as well, and as such the Ohio State group has recently begun to collaborate with other members of the Fermi LAT team to help better understand these gamma rays that act as a background to the dark matter signal.

In addition to searching for dark matter, Hughes and Winer are also interested in using the LAT to test the constancy of the speed of light. In some theories, the speed of light is not exactly a constant, but rather it is dependent upon the energy of the radiation. Because this effect would be very small, a very long flight path is needed in order to produce an observ-

able time delay between high- and low-energy gamma rays. Luckily gamma rays traverse the universe largely unimpeded, and so we can measure emission from even the most distant sources. Gamma-ray bursts provide an almost ideal source of the photons necessary to test these ideas. Former Ohio State graduate student Dr. Fred Kuehn began this work, and currently graduate student Patrick Smith is advancing the analysis. In September 2008, the first GRB observed by the LAT was detected, and work is underway to see if this effect is observable with this GRB.

With the recent launch of the Fermi satellite and the start of data acquisition, this is a very exciting time for the astrophysics community as a whole, and in particular for the Fermi LAT team at Ohio State. The many years of development that have gone into this project have finally come to fruition and the models can now be tested with real data. We can all look forward to many exciting results from the Fermi Gamma-Ray Space Telescope, with an expected lifetime of at least five years.

At Ohio State, Professors Richard Hughes and Brian Winer are members of the Fermi LAT collaboration hoping to see a signal in the LAT from a mysterious form of matter called dark matter.

Condensed Matter Experimental Physics

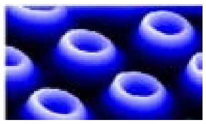
Our vibrant research efforts deal with the diverse and fascinating properties of condensed matter and encompasses metals, semiconductors, superconductors, polymers, fluids and superfluids, magnets, and insulators.

Imaging Nanomagnetism
P. Chris Hammel

The demands of high-density information storage and magnetoelectronics have fueled interest in understanding the properties of

nanoscale magnets and have highlighted the need for tools capable of high-spatial resolution, three-dimensional imaging, and study of ferromagnets. High-resolution imaging technologies such as atomic force microscopy (AFM) and magnetic resonance imaging (MRI) have transformed our ability to “see” microscopic details of subjects under study and have enabled new understanding in arenas ranging from electronics and magnetism to medical science.

By scanning this tiny spot of intense field over the sample, we have imaged tiny magnets with 200-nanometer resolution. This breakthrough reveals a new form of MRI for imaging ferromagnets with



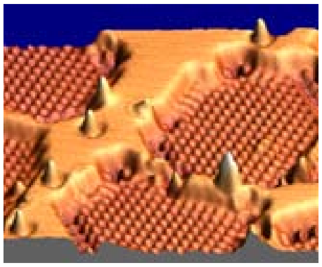
nm-scale resolution, and it points to a new tool for understanding the tiny magnets that are central to high-density disk drives and the spintronic elements poised to usher in the next information processing revolution.

Self-Assembly of Ultrathin Insulators
Jay A. Gupta

Insulators comprising only a few atomic layers represent a fundamental limit for the scaling of transistors in integrated circuits.

Gupta’s group at Ohio State has used a scanning tunneling microscope (STM) to characterize the atomic structure of Cu2N, an insulating material that is only one atomic layer thick. When grown on a Cu substrate, Cu2N self-assembles into nanoscale, square-shaped islands. These islands also self-assemble into a grid-like array that is potentially useful as a template for nanoscale electronics.

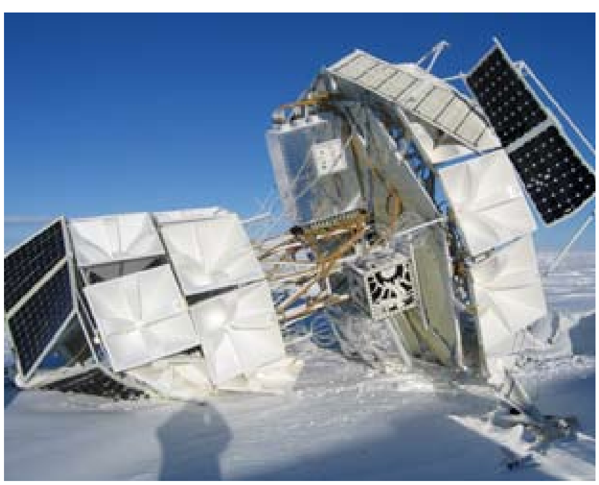
Scientific impact: Gupta has used an STM to study the electronic and atomic structure of ultrathin insulating films, a class of materials that represents a fundamental limit for the scaling of transistors in computer chips. These results and techniques will aid in the search for new materials for next-generation technologies.



Antarctica and the Quest for Particle Messengers from Outer Space

Peering down from its lofty perch over the Antarctic ice sheet, the ANtarctic Impulsive Transient Antenna (ANITA) looks for neutrinos...

"It's about opening a new window on the universe," says Professor Jim Beatty. In late 2006 and again in 2008, the physics department has participated in the pioneering ANITA experiment in Antarctica, looking for neutrinos at the highest energies. While astronomers classically use light to peer into the mysteries of the universe, particle astrophysicists are finding more and more ways in which particle messengers reveal the universe's inner workings.



ANITA after landing

Peering down from its lofty perch over the Antarctic ice sheet, the ANtarctic Impulsive Transient Antenna (ANITA) looks for neutrinos, the lightest, weakest-interacting particles known to us, listening for radio signals from neutrino interactions in the ice. Neutrino interactions result in showers of electrons and positrons in the ice that develop an electron excess and thus a macroscopic net charge moving faster than the speed of light in the medium. This motion results in radio Cherenkov radiation—an analog of the blue glow seen in the water around nuclear reactors. The vast ice sheets on the Antarctic continent combined with radio quiet and a large viewing area afforded by floating at ~125,000 feet make the coldest continent on Earth an ideal location for ANITA.

From its first flight in 2006–07, ANITA should set the best limit on the existence of astrophysical neutrinos originating outside our galaxy. Its second flight, during the austral summer of 2008–09, may detect the first neutrinos from outside our galaxy and at the highest energies (more sensibly discussed in Joules than electron-volts). These neutrinos have the potential to point back to astrophysical sources, such as gamma-ray bursters and active galactic nuclei (AGNs). Such observations can teach us much about the internal workings of these objects because neutrinos are typically the only particle to exit freely out of the center of these otherwise opaque regions.

ANITA should also detect a diffuse background of neutrinos coming from interactions of ultra-high-energy cosmic rays with the cosmic microwave background. The microwave background permeates the universe and is left over from when light and matter decoupled after the Big Bang. Detecting the resulting neutrinos would confirm current models of extragalactic cosmic ray production and propagation at ultra-high energies.

A Typical Day in McMurdo, Antarctica

McMurdo runs on New Zealand Daylight Time, 18 hours ahead of EST. As a reminder that McMurdo used to be run by the U.S. Navy, times there are often quoted in a 24-hour military clock.

0630 Alarm goes off—at least the sun is up!

0700 Breakfast in the galley, instant oatmeal packets seem the safest bet.

0730 All aboard Ivan the Terrabus for the commute to the balloon facilities at Willy (Williams) Field. Bets are placed on whether the driver can traverse the 13 mi. in under a half hour.

0800 Start of the workday. Who's in charge of making coffee?

0930 Call science computer support for more CAT5 cable and ethernet switches for setting up ground data system.

1000 Call science field support for a tent to house the pulser equipment outdoors. The Scott tents are almost identical in design to those used by expeditions in the early 20th century.

1030 Highbay doors are opened to bring the instrument outside.

1031 Temperature has dropped below freezing in the highbay; "Big Red" jackets and gloves are needed.

1035 We take refuge outside in the sun, where it is much more comfortable than inside.

1040 Highbay doors are closed. Temperature bottoms out at -8°C. Take laptops to the galley.

1145 Staff from McMurdo arrives with ethernet and tent supplies. They were smart to arrive for lunch, and just when the highbay has warmed back up to room temperature.

1200 Lunch is served at the Willy Field Quonset Hut—the best meal in McMurdo, made by trained chef Matt. Salad, soup, entrée, and dessert. Never any chicken since Matt refuses to cook something older than he is, and the chickens have been in the McMurdo freezers for decades.

1230 Cut lunch a little short for a cross-country skiing lesson from Anne Dal Vera, one of the four Americans who were the first women to ski to the South Pole in 1993.

1300 Nature calls. Though we work in new hi-tech highbays with radiant heat flooring, the bathroom facilities are primitive. Physics professors just can't seem to remember that you put the flag outside when occupied, and put it inside when it's available.

1330 Take snowmobiles out to check on test setup for a future experiment.

1445 A scheduled six-hour Internet outage begins. It really wasn't an excuse to get out of e-mailing people back in the U.S.

1500 Put up Scott tent to protect pulsing electronics that supply a signal to a calibration antenna that has been lowered into a borehole drilled 25 m into the ice.

1730 Ivan arrives to take us home to McMurdo.

1745 We make a quick bus stop to look at Adelie penguins that have come by the road.

1800 Yoga class in the chapel—they need someone to step up and lead/teach tonight....

1830 Dinner in the galley. No fresh vegetables today, but new friends are made when we sit at a table with nematode scientists and our 10th-grade biology class pays off in identifying nematodes as unsegmented worms.

1930 Tough decision to make: climb Ob(servation) Hill or go to a science talk about Mt. Erebus, the southernmost active volcano that also has a persistent lava lake.

2030 After the lecture, stop at the Crary lab aquarium to see giant sea spiders, anemones, and more.

2100 It's American Night at the Kiwi Scott Base bar, so we take a shuttle over, and also make a stop at the gift shop.

2230 Bar-hopping Antarctic style as we head back to McMurdo for an intense backgammon game.

0000 Last call, and we head out-of-doors into bright sunlight for the walk back to our dorms.

0030 Time for bed—make sure the blackout curtains are secure!

Outstanding Alumni Profile: **Oludurotimi Adetunji**

Oludurotimi Adetunji began his PhD program in physics at Ohio State in 2002, the same year he graduated as valedictorian from Fisk University, a historically black university in Nashville, where he received his bachelor's degree in physics and computer science. As an undergraduate, he was extensively involved in II-VI materials research and won the 2001 MRS Undergraduate Material Initiative Research award. He also authored and coauthored several publications during this time. After earning his bachelor's, he was torn between starting a career in computer science and pursuing a graduate degree in physics. However, his father, a PhD degree holder from The Imperial College of London, a retired university professor, and an entomologist, encouraged Adetunji to follow a similar career path as his.

At Ohio State, Adetunji quickly found out that the graduate program is filled with many challenges, so he developed the resilience and the determination needed to succeed in his core classes and, especially, his research work. During his graduate work, he was an NSF-IGERT and NSF-NSEC fellow, which allowed him to work on several interdisciplinary projects with other fellows.

In 2006, Adetunji worked for six months as a physical scientist at the Naval Research Laboratory (NRL) in Washington, D.C. At the NRL, he worked on a bio-related project and later dedicated an entire chapter to this project in his dissertation.

Recently, Adetunji completed his PhD in experimental condensed matter physics under the advisory supervision of Distinguished University Professor Arthur Epstein. His dissertation is titled The Electronic States of Nanostructure Conducting Polymer Nano-Network. Adetunji's research unveiled that a usually metal-like transition in temperature dependent DC conductivity of the nano-network is mechanically induced while disorder and localization dominate charge dynamics in the nano-network. His research results earned him an invited talk at the International Conference on Science and Technology of Synthetic Metals held in Porto de Galinhas Pernambuco, Brazil, in July 2008, where he presented his work.

Adetunji is currently the assistant dean of Ohio State's College of Mathematical and Physical Sciences where he oversees the initiative to increase the underrepresented minority students' recruitment, retention, and graduation in the undergraduate and graduate programs in the Colleges of Biological and Mathematical and Physical Sciences. Adetunji is also still fully engaged and committed to research in collaboration with Professor Epstein, his colleagues at the NRL, and other interdisciplinary researchers and faculty at Ohio State. He currently lives in Columbus with his wife Olajumoke and son Ogooluwa.

Outstanding Alumni Profile: **David Cahill**

"I've always felt fortunate that I attended Ohio State," says 1984 engineering physics graduate David Cahill, "where I could pursue my interests in music and science at such a high level." Cahill loved having the opportunity to practice and perform with the jazz ensembles and enjoyed building and sharing a record collection. "Remember LPs?" he asks. "I still have all the vinyl I bought at Singing Dog records on High Street." Cahill believes that the mix of music and engineering physics was an excellent fit for him. "I think most successful scientists need to improvise just as creatively and effectively as jazz musicians do," he notes. "In class, I learned the beauty of classical mechanics and the strange world of quantum mechanics—and how to design electrical circuits and run an oscilloscope. My physics professors excelled in sharing their excitement for physics with their students. I was hooked from classical mechanics in the sophomore year to statistical mechanics and the senior lab and everything in between."

THEN & NOW

After leaving Ohio State, Cahill earned his PhD in condensed matter physics from Cornell University in 1989, and then did postdoctoral research at the IBM Watson Research Center. He joined the materials science faculty of the University of Illinois, Urbana-Champaign, in 1991. His research program currently focuses on developing a microscopic understanding of thermal transport at the nanoscale; the development of new methods of materials processing and analysis using ultrafast optical techniques; and advancing fundamental understanding of interfaces between materials and water. Cahill has coauthored more than 140 peer-reviewed publications and has presented nearly 100 invited talks. He received the Peter Mark Memorial Award from the American Vacuum Society (AVS) in 1998, is a fellow of the AVS and the American Physical Society, and was named the Willett Professor of Engineering in 2005.

A Festival of Physics!

A two-day Festival of Physics was held at COSI in October 2007 in a unique partnership between the Columbus science museum and The Ohio State University. The festival was the joint project of Professor Nandini Trivedi, Department of Physics, and Steven Whitt, COSI's director of Experience Programs Teaching and Learning.

An estimated 1,300 people attended the festival over the two days (teachers were admitted free). They visited carts (science a la carte) set up throughout the museum with exhibits and hands-on activities focusing on superconductivity, magnetism, cold atoms, and superfluids. The demos from Harold Whitt's lab at Ohio State and from COSI were wonderful for audiences of all ages. It was fantastic to see about 60 undergraduate and graduate volunteers in their festival T-shirts actively engaging the public. The levitated superconducting train floating above a magnetic track built by graduate student Julian Hetel was a big draw.

In addition, visitors attended lectures in COSI's Galaxy Theater by faculty from the physics department. Presentations included "The Revolutionary BCS Theory of Superconductivity" (Tom Lemberger); "Ultra Cold Atoms" (Mohit Randeria); "Phase Transitions in Magnets" (Chris Hammel); and "High-Temperature Superconductivity" (Nandini Trivedi).

Each day closed with the "superconducting dance." Choreographed by Rachel Boggia, dance faculty at Dickinson College and danced by eight of her students, they performed a stylized rendition of superconductivity. After this, audience members were called upon to become electrons and join in the dance. Bandannas, both blue and red, indicating spin up and down electrons, were distributed to over 200 people. The dance brought out the chaotic behavior of electrons at high temperatures, followed by pairing as the temperature was lowered, and then finally the entire troupe performed coordinated movements to show coherence of all the pairs.

The event was supported by ICAM (Institute of Complex Adaptive Matter) and Ohio State.

Mohit Randeria

Chris Hammel

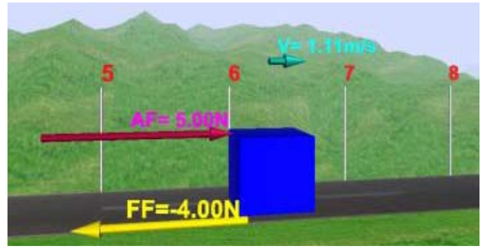
Tom Lemberger

Community Outreach

Richard Noll began his work in physics outreach in 1992 with a general presentation to his son's first grade class. Each year he presented more and varied programs covering different areas of physics: a general Flashy Physics Program; Electricity and Magnetism; and Physical and Chemical Change. He has made presentations to all ages, kindergarten to adult, in schools and libraries and for scouts and latchkey programs.

Andrew Heckler's Research in Cognitive Science

Andrew Heckler, physics professor and physics education researcher, has been working closely with researchers in Ohio State's Center for Cognitive Science. Along with colleagues Jennifer A. Kaminski and Vladimir M. Sloutsky, Heckler found that using lifelike examples instead of abstract examples may not be the best way to teach mathematical concepts. In the research presented in articles in *Science* and the *New York Times*, researchers did several separate experiments that examined how well undergraduate students learned a simple mathematical concept under different conditions. After learning math concepts using concrete examples or abstract, generic symbols, students took



a multiple-choice quiz demonstrating that they learned the principles involved. The study showed that most undergraduate students picked up the knowledge easily. However, the true test came later when researchers asked these students to apply the same principles in a totally different setting. Those who learned using an abstract example performed better than those who learned one, two, or even three concrete examples. "Students tend to learn concrete examples quickly, but that knowledge doesn't transfer well to other situations," says Heckler. "Commonly it is assumed that multiple concrete examples will benefit learning, but there are real advantages to abstract representations." The research was funded by the Institute of Educational Sciences in the U.S. Department of Education.

(l to r) Andrew F. Heckler, Jennifer A. Kaminski, and Vladimir M. Sloutsky

Learning of Content Knowledge and Development of Scientific Reasoning Ability: A Cross-Culture Comparison

Student content knowledge and general reasoning abilities are two important areas in education practice and research. However, there hasn't been much work in physics education that clearly documents the possible interactions between content learning and the development of general reasoning abilities. The research of Professor Lei Bao and collaborators in China investigates the possible interactions between students' learning of physics content knowledge and the development of general scientific reasoning abilities. Specifically, the study seeks to answer the research question of whether and to what extent content learning may affect the development of general reasoning abilities. College entrance testing data of freshman college students in both the United States and China were collected using three standardized tests—FCI, BEMA, and Lawson's Classroom Test of Scientific Reasoning (Lawson Test). The results suggest that years of rigorous training of physics knowledge in middle and high schools have made a significant impact on Chinese students' ability in solving physics problems, while such training doesn't seem to have direct effects on their general ability in scientific reasoning, which was measured to be at the same level as that of the students in the United States. Details of the curriculum structures in the education systems of the United States and China are also compared to provide a basis for interpreting the assessment data.

Many Ways to Give to Ohio State Physics

Office Space Named in Honor of Former Physics Professor

Norman Gearhart (MS '69, PhD '73) and Carolyn Piper Gearhart have named a faculty office space in the Physics Research Building in honor of Professor Emeritus Hershel J. Hausman. Professor Hausman joined the physics faculty at Ohio State in 1952, having earned BS and MS degrees at Carnegie Institute of Technology and his PhD in physics at the University of Pittsburgh. During most of his first decade here he served as supervisor of the cyclotron laboratory. In addition to being a superb classroom teacher, he was supervisor of the new Van de Graaff Laboratory from 1962 until his retirement in 1989. The primary foci of his research and that of the more than 20 students earning PhD and/or master's degrees with him were: nuclear scattering problems, nuclear reaction mechanisms, and nuclear capture reactions for a large variety of nuclei. If you would like to make a contribution in honor of Professor Hausman to support the Physics Building Development Fund, please reference fund #301915 and make your check payable to The Ohio State University Foundation. You can also make a gift online at giveto.osu.edu.

(l to r) Bill Riley, Mary Riley, Will Saam, Margy Saam, Jim Beatty, Carolyn Piper, Tom Humanic (rear), Norm Gearhart, Laura Hausman, Herb Hausman, Evan Sugarbaker

To learn more about making a gift to The Ohio State University Department of Physics, visit giveto.osu.edu or contact:

Gerri Bain
Director of Development
Biological, Mathematical,
and Physical Sciences
(614) 292-9200
bain.32@osu.edu

Donors contributing $2,500 or more are eligible for membership in the President's Club, Ohio State's donor recognition program. For more information about the President's Club, visit presidentsclub.osu.edu.

If you would like information about establishing a scholarship fund or making a gift to support the Department of Physics, please contact Gerri Bain, Director of Development, at (614) 292-9200 or bain.32@osu.edu.

Gregory and Carol Steele Support Physics Infrastructure

(l to r) John Heimaster, Jim Beatty, Gregory and Carol Steele

Gregory and Carol Steele recently gave a generous and thoughtful gift to support computing and network infrastructure in the Physics Research Building. A ceremony and luncheon were held on Friday, December 12, to honor the Steeles. Greg is an Ohio State retiree who has been a longtime friend of our computing staff.

THE OHIO STATE UNIVERSITY
DEPARTMENT OF PHYSICS

Physics Research Building
191 West Woodruff Avenue
Columbus, OH 43210-1117

Nonprofit Org.
U.S. Postage
PAID
Columbus, Ohio
Permit No. 711

ADDRESS SERVICE REQUESTED

06840-011000-61801 11219

UMC08445