Physics

Dear Alumni and Friends,

William Saam, chair, Department of Physics

This past year has been one of many highlights and a key milestone in the history of our department. The milestone is the beginning of construction of our new building this past August. Construction has gone very well, and, as I write this, work on the third deck is proceeding. Watch progress on our webcam at www.physics.ohio-state.edu. At the center of the building site is a 180-foot stationary crane. In March of this year I was fortunate to have the opportunity to climb to the top of this magnificent machine. The view was spectacular on a cloudless day.

Hiring of new faculty was very successful last year. P. Chris Hammel, formerly a Fellow of Los Alamos National Laboratory, joined us last summer as Professor and Ohio Eminent Scholar in Experimental Physics. His research program at Ohio State is developing rapidly. See his interview in this issue.

Joining us last summer from Caltech was new Assistant Professor Dongping Zhong, our lead hire in our Selective Investment thrust area of Experimental Biophysics. His laboratories are up and running, with a research focus on fast pulse laser studies of proteins.

Our 2002 Distinguished Alumni Award was presented to Ren Jye Yeh, founder and owner of Bason Computers Inc. of Chatsworth, Calif., a major distributor of computer and electronic components. Dr. Yeh received his Ph.D. in 1982 under the direction of Professor Philip Wigen.

A noted highlight of last summer was the presentation of an honorary doctorate in science to Harold A. McMaster, our 2001 Distinguished Alumni Award winner. Please note the interesting article in this issue.

The Physics Department was featured at new President Karen Holbrook's brunch prior to the Michigan football game in November. The theme was "The Power of Physics," animated by captivating demonstrations by Linn Van Woerkom. The football team was duly energized, going on to beat Michigan and to later capture the national championship. For the moment, the football team outranks the Physics Department (24th in the nation and rising), but this is not the case every year.

I hope you will take special notice of the "Research in the News" section describing a portion of the breadth and depth of physics research at Ohio State. Highlighted are the research of Brian Winer and Richard Hughes on their search for the elusive Higgs boson at Fermilab, that of Tom Lemberger on the unusual high temperature superconductivity of the cuprates, and that of Art Epstein on light-tunable magnets.

This issue also contains an update on the work of Lei Bao in our Physics Education Research group, focusing on response and feedback in the classroom, as well as the story of the first African American physicist, as recounted by Ronald Mickens during his visit to our department.

Our faculty and students again garnered more than their share of awards and honors as described in the news sections of this magazine. Additionally, take note of a new section for 2003 on "Alumni in the News," this year describing Paul Cover's (B.S. 1955) work with the Inventors Network.

Society of Physics Students President Becky Weber has brought renewed energy and much increased attendance to student SPS events this year with an imaginative and interesting slate of activities. A highlight is the reinstatement of the Sigma Pi Sigma honorary following a long period of dormancy.

During academic year 2002-2003, 23 new bachelors of physics (20 in physics and three in engineering physics) left our doors. Of these, six are going on to graduate school in physics and seven to graduate school in other areas, including astronomy, education, mathematics, medical school and law school, while others are going into the private sector. During the same period, we graduated 20 new Ph.D.s, who have found jobs in areas as disparate as finance and national security in addition to postdoctoral positions at other universities.

In May of last year, 2001 Nobel Laureate Eric Cornell of the University of Colorado gave one of the best Alpheus Smith Lectures in my memory. Speaking on the topic "Stone Cold Science: Bose-Einstein Condensation and the Weird World of Physics a Millionth of a Degree from Absolute Zero," he fascinated a large audience in Hitchcock Hall with the story of his discovery, with Carl Weiman, of Bose-Einstein condensation in atomic gases. This area, with its offshoots, has become one of the hottest areas in physics, with implications not only in fundamental physics but also for quantum computing.

Annual events in the department continue to foster our community of scholars. The winter party and the Women in Physics lunches are recorded on film for posterity and displayed on these pages.

In closing, I report recent and imminent departures from our ranks. Alan Van Heuvelen, the senior leader of our Physics Education Research group, retired at the end of December, taking a new post at Rutgers University. Retiring in the same month was Shirley Royer, a truly indispensable member of our staff, whose contributions won her a 2002 Distinguished Staff Award. Charles Ebner will retire in June after a 35-year career as a fine researcher and teacher. Howard Dyke will also retire in June after many years of valued service as a senior design engineer in our van de Graaff Laboratory.

I invite you all to visit the department and to see the massive new Physics Research Building rising in the sky.

With best wishes,

William F. Saam
Professor and Chair

Eric Cornell answers questions following the Smith Lecture.

Slice of Nobel life

Young physicist prizewinner thrives on innovation Eric Cornell delivered the 2002 Smith Lecture

By Pam Frost Gorder, Research Communications

The May 7, 2002, Alpheus Smith Lecture began with an unabashed attempt by physics Nobel Prize winner Eric Cornell to recruit Ohio State students for graduate study at his home institution, the University of Colorado at Boulder.

"Consider the next hour an infomercial," he said.

In reality, Cornell had even larger goals. He hoped that the annual lecture, sponsored by the Department of Physics and the Graduate School, would not only draw people to the discipline, but also "give people who may never actually do science or technology a sense of what the enterprise is about, because it affects everybody."

He succeeded by giving the audience a slice-of-life view of the events that led to the 2001 Nobel he received for his work with Bose-Einstein condensates—ultra-cold, unearthly materials that defy description as a solid, liquid or gas. Albert Einstein and colleague S.N. Bose hypothesized that such materials could exist back in 1925, but Cornell and physicists Carl Wieman and Wolfgang Ketterle were the first to actually create them in 1995, using lasers and magnetic fields.

Part of what led Cornell to a Nobel at the remarkably young age of 39 was the realization, just out of graduate school in 1990, that his preferred field of atomic physics was a highly competitive one. The area he found most interesting—laser cooling, or using lasers to cool materials to very low temperatures—had already become a booming enterprise.

Eric Cornell (left) displays the Smith Lecture plaque presented by William Saam, Chair.

"It was clear to me that if I wanted to make my mark in that field, I couldn't just work on new ways to use lasers to make things cold; I had to think of good things to do with cold stuff once you had it," he said. A postdoctoral position with Wieman at Colorado led to a permanent job, and the two undertook the challenge of creating a Bose-Einstein condensate just as Ketterle was doing the same thing at the Massachusetts Institute of Technology.

But how do you convince a funding agency that you will be able to make a material that no one has been able to make in 70 years of trying?

"You don't," Cornell said. "You convince them that if they let you try, along the way you're going to work on other technologies with desirable applications."

For instance, this revolutionary control of matter in the laboratory could lead to more precise time measurement, as well as techniques for building tiny devices for nanotechnology. Though Cornell considers the latter a far-off "pie-in-the-sky" application for the technology, he sees better time measurement as paying off in the short term, perhaps in five to 10 years. Satellite navigation, global positioning systems, and the alignment of astronomical telescopes all depend on precise time measurements, he explained.

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 physicists renowned not only for their scientific achievements but also for the ability to communicate their scientific breakthroughs to the general public. As of 2002, 17 Smith Lecturers have been Nobel Prize winners.

The "Erics" of Ohio State physics (from left): Erich Mueller, postdoc, Eric Cornell, Eric Braaten, Eric Herbst.

From left, Phillip Wigen, R.J. Yeh, Minzu W. Yeh, William Saam, Robert Gold.

2002 Distinguished Alumni Award:

Dr. Ren Jye Yeh

The winner of the **2002 Department of Physics Distinguished Alumni Award was Dr. Ren Jye Yeh**, a 1982 Ph.D. graduate in physics from Ohio State.

Dr. Yeh is founder and owner of Bason Computer Inc., Chatsworth, Calif., a major distributor of computer and electronic components.

After receiving his degree in 1982, Dr. Yeh worked on a variety of projects, including nuclear magnetic resonance, thin film processing, semi-conductor type processing and magnetic recording heads, among others, at companies such as General Electric, Memorex and Litton.

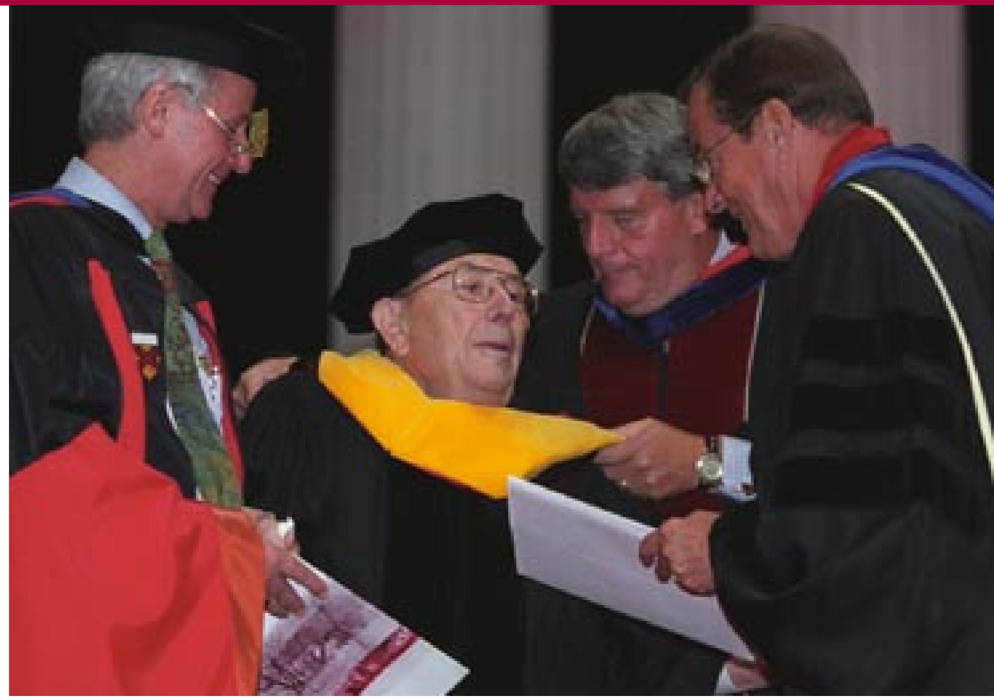
In 1985, he founded Bason Computer Company, starting as a supplier of hard drive controllers. By 1991, the company had grown into one of the largest suppliers of MFM and RLL controllers; soon it evolved into system manufacturing and assembling and then into distribution and wholesale of computer hard drives. In 1999, Dr. Yeh developed tools to put Bason at the forefront of e-commerce technology.

C. Bradley Moore, then-vice president for research, was on hand in May to help give Dr. Yeh his award. He acknowledged excellence in the Department of Physics, and went on to remark, "We also recognize that part of what makes physics research great is the collaborative relationships—among faculty and between faculty and their students. We know that these relationships last a lifetime. In fact, it is this type of relationship between Dr. Yeh and Phil Wigen that is part of the celebration today. Phil is the type of researcher who gets invited to work at other prestigious institutions even *after* his retirement. (He's been at Caltech this past year and has been invited to return next year.) He's the kind of mentor whose students remember him, continue to collaborate with him and stay in touch with him. Today is the best type of occasion: a recognition of a great friendship, a great collaboration and an alumnus of a great university who went on to do great things with his career."

The Department of Physics Distinguished Alumni Award honors those graduates of the department who have made exceptional contributions in academic and professional fields. Previous recipients include Dr. Edward E. Hagenlocker, Robert B. Smith and Dr. Harold A. McMaster.

R.J. Yeh, Minzu W. Yeh, Tom Lemberger

From left, Department of Physics alumnus Nelson Marshall, Philip Wigen, Bob Gold.



Harold McMaster (center) receives his doctoral hood with assistance from William Napier, Vice President of Government Relations, as Interim (and former) President Edward Jennings (far right) and former Provost and Executive Vice President Ed Ray (left) look on.

Harold A. McMaster Receives Honorary Degree

The Ohio State University 361st Commencement, Summer 2002

Harold A. McMaster, founder of four companies and holder of nearly 100 patents for glass tempering and solar energy, was awarded an honorary doctor of science degree at the 361st Ohio State commencement ceremony, held August 30, 2002. Following the ceremony, a luncheon was held in McMaster's honor at the Schottenstein Center.

Family members able to attend the ceremony included Dr. McMaster's wife, Helen; daughters Jeanine (McMaster) Dunn and Nancy (McMaster) Cobie; Nancy's husband, Bob Cobie; and Heather (Cobie) Merkle and Rob Merkle.

By revolutionizing the glass industry, creating cost-effective solar panels and inventing the McMaster Rotary Engine, McMaster has dedicated his life to changing the world for the better. His environmentally conscience inventions and innovations simplify the lives of hundreds of thousands of people every day.

Following his graduation from Ohio State with a combined master's degree in physics, mathematics and astronomy in 1939, McMaster accepted a job as a research physicist at the Toledo-based Libbey Owens Ford Glass. After several years with Libbey Glass, McMaster started his own company, Permaglass. By taking advantage of the expanding automotive and electronics

Commencement exercises took place at the Schottenstein Center.

Harold McMaster with his wife, Helen, daughters (from left) Nancy Cobie and Jeanine Dunn, and son-in-law Bob Cobie.

Seated, Helen and Harold McMaster with William Saam and Edward Jennings.

market fueled by the growth of the post-World War II economy, Permaglass became an incredibly successful venture. Through a merger with Detroit-based Guardian Industries in 1969, McMaster created the third-largest glass company in the world. Two years after this successful merger, McMaster started another glass company, Glasstech, which now manufactures 80 percent of the world's automotive glass. These ventures, his thirst for knowledge and his continuing need to improve on old techniques have made McMaster the world authority on glass tempering (the process of adding tensile strength to glass by compressing it).

Although he was already providing windshields for the majority of the world's cars, McMaster had bigger dreams. A vacation in sunny Arizona gave McMaster an idea that would solve the energy crisis in the United States without harming the environment. By covering 2,000 square feet of the Southwest desert with solar panels of high efficiency, McMaster believed enough energy could be harvested to satisfy the energy needs of the entire country. By creating Solar Cells, a company that produces cost-effective solar cells, McMaster has taken steps toward making widespread use of clean solar energy a reality.

McMaster works to better the world through inventions and innovations that not only make life easier but also are environmentally sound and cost-effective. Since his early roots as an inventor, McMaster has sought an alternative to the internal combustion engine—a design that hasn't changed since its introduction more than 150 years ago. McMaster believed that there had to be a better way to power a car.

Starting in the 1940s, he began drawing up diagrams and tinkering with models, continuously reworking various designs that would ultimately become the McMaster Rotary Engine (MRE). The MRE is a third lighter than the typical car engine and is being tested for compatibility with alternative fuel sources, such as gaseous hydrogen and oxygen. With such sources, the engine's only output would be power and water.

McMaster's contributions to the world go beyond his numerous inventions. In 1988, McMaster and his wife, Helen Clark McMaster, established The Harold and Helen McMaster Foundation. This foundation supports a variety of philanthropic interests, from higher education and medicine to museums and performing arts. It is estimated that the foundation has collected more than $150 million in donations since its beginning.

McMaster serves as a trustee at Defiance College and as director of the Bowling Green State University Foundation. He was also a former director of the University of Toledo Foundation. He is a member of the Scientific Advisory Board for the Bowling Green State University Center for Photochemical Sciences.

McMaster's ingenuity and entrepreneurial expertise have been recognized with numerous awards, including The Ohio State University Department of Physics Distinguished Alumni Award in 2001, the Ohio Department of Development Entrepreneur of the Year Award in 1998, the National Glass Industry's Phoenix Award in 1993 and induction into both the Engineering and Science Hall of Fame in Dayton and the Ohio Science and Technology Hall of Fame.

More information on the McMaster Rotary Engine and the presentation of the 2001 Distinguished Alumni Award to Harold McMaster can be found in the 2001–2002 Ohio State *Physics* magazine.

Linn Van Woerkom, associate professor in physics, offers Buckeye fans a pre-game physics demonstration.

November 23, 2002
The Power Of PHYSICS
Ohio State vs. Michigan

President's Pre-Game Brunch
Ohio State vs. Michigan, November 23, 2002

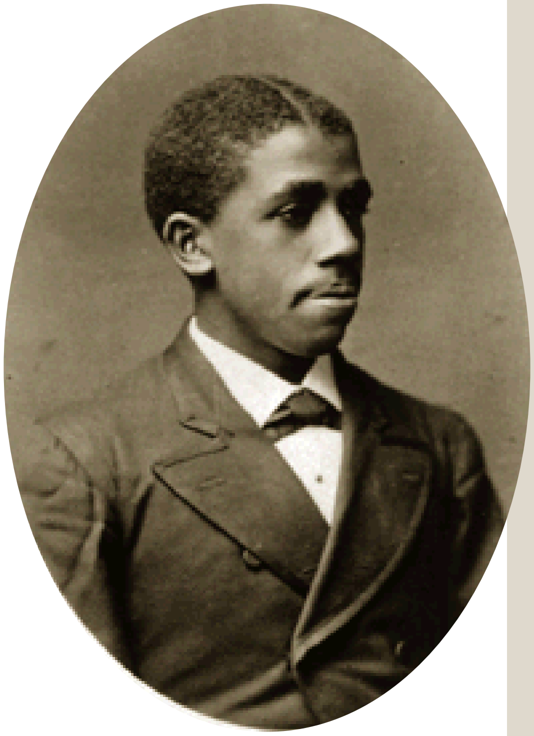
"The Power of Physics," the theme of this year's President's Pre-Game Brunch, brought additional fun and excitement to an already auspicious occasion: the Ohio State vs. Michigan game, which would eventually lead the Ohio State Buckeyes football team to a National Championship matchup in Tempe, Ariz.

First, Ohio State had to face Michigan, and new Ohio State President Karen Holbrook had the foresight to invite the Department of Physics. The private reception, held in Drake Union, also featured performances by Ohio State's cheerleaders and the pep band.

Administrators and friends of the university enjoyed a brief talk by Society of Physics Students' President and undergraduate physics major, Becky Weber, as well as a demonstration by Linn Van Woerkom, professor of physics.

Becky Weber, president of the Society of Physics Students, offers guests an undergraduate's view of the vast opportunities at Ohio State.

Ohio State cheerleaders and Brutus Buckeye bring their energy to the brunch.



Edward Bouchet

The son of a Yale University student's "body servant," Edward Bouchet overcame great odds to become the first African American to receive a doctorate in any field of knowledge in the United States. That field was physics.

On February 25, 2002, Ronald E. Mickens, professor of physics at Clark Atlanta University, presented Edward Bouchet's story. The lecture was hosted by the Ohio State Office of Research and the Department of Physics. A discussion of the African American presence in science followed the talk.

The First African American Physicist

The Story of Edward Bouchet as told by Professor Ronald E. Mickens

Edward A. Bouchet was born in New Haven, Conn., on September 15, 1852. Edward's father, William, came to Connecticut from South Carolina as a valet. When the Yale student he was serving graduated, William was granted his freedom. While in Connecticut, William became active in the African American community, serving as a deacon of the Temple Street Church while working as a porter at the Palladium Building and at Yale. Edward's mother, Susan, was a Connecticut native, and it was in New Haven that Edward was raised.

Edward's parents encouraged his craving for knowledge, and in 1870, Edward graduated as valedictorian of his Hopkins Grammar School class. Edward went on to be accorded highest honors in college and was initiated into Phi Beta Kappa after earning his bachelor's degree from Yale.

Edward was not satisfied with his bachelor's degree and still had a hunger to learn more, so he continued his study of graduate physics at Yale, earning his Ph.D. in physics in 1876. He was the first African American to earn a doctorate degree from an American university.

After graduating from Yale, Bouchet gave back to the community, playing a significant role in the education of African American youth by teaching both chemistry and physics at the Institute for Colored Youth in Philadelphia. The school was a Quaker institution founded in 1837, with a reputation for high academic standards.

In 1902, Bouchet resigned from the institute because the school had discontinued its college preparatory program and relocated to Cheney, Penn., as a vocational and teacher-training school at the height of the Du Bois–Washington controversy over industrial vs. collegiate education. After resigning, Bouchet held several jobs, most related to the education of African American youth, until he retired in 1916 due to illness.

Edward Bouchet was among a small number of African Americans who achieved advanced training and education within decades of the Civil War. He provided direction and leadership for what eventually became the civil and human rights movements.

Image courtesy of Yale University

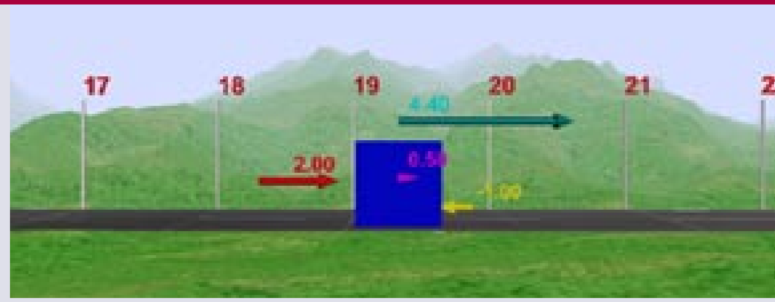
Ronald E. Mickens

Ronald E. Mickens has edited a book entitled *Edward Bouchet: The First African American Doctorate*, which gives greater details not only about Bouchet's life and achievements, but those of others, such as Elmer Imes, who, in 1918, became the second African American to earn a doctorate in physics, and Willie Hobbes Moore, who in 1972 became the first African American woman to earn a doctorate in physics, nearly a century after Bouchet received his. Imes' research involved the spectroscopy of diatomic molecules; Moore's research covered such topics as the vibrational analysis of secondary chlorides.

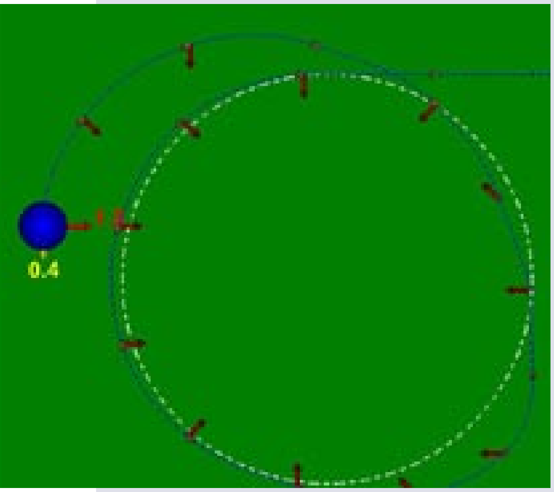
Mickens received his Ph.D. in theoretical physics from Vanderbilt University and is currently the Distinguished Fuller E. Callaway Professor of Physics at Clark Atlanta University. His research interests include nonlinear oscillations, numerical integration of differential equations using nonstandard finite difference schemes, mathematical modeling of periodic diseases and the history and sociology of African Americans in science.

The Physics Education Research Group

Closing the Learning Loop



1-D motion for Newton's second law



2-D circular motion

It happens in every introductory physics class: the professor asks the class a general question—anyone is welcome to provide the answer—but rather than the cascade of eagerly waving arms the professor is hoping for, he or she is met with a trickle of sheepishly raised hands amid a sea of blank stares.

"Students hesitate to raise their hands and answer questions in class, so teachers do not know what students are having problems with until after the exam," said Lei Bao, assistant professor of physics and member of the Ohio State Physics Education Research Group (PERG). "This is an 'open loop' system, where there is no feedback from the students until after the exam. We want to move to a 'closed loop' system so that the teacher and the students will know how they are doing throughout the course."

Starting winter quarter, students in some introductory physics courses will have a test drive of "voting machines," which look somewhat like an old cell phone. With these devices, the professor can ask the class a question, and the students can use the push-button devices to answer the question anonymously. The results are tabulated immediately, so the professor can find out what subjects the class is struggling with and the students can find out what they don't understand right away. Steps can then be taken to correct these problems during the learning process.

Bao hopes that the voting machine system as well as feedback from weekly Web surveys will provide information on the misconceptions that students tend to bring with them to physics classes. Bao and PERG also study how people learn so they can create better teaching methods.

"A new baby learns about the world by touching, feeling, seeing, tasting and smelling its environment—all sensory perceptions," explained Bao. "This type of learning leads to our common sense conceptions about the physical world, which are often incorrect in physics. We need to study these fundamental sensory cues to discover how they are integrated into the learning process. We can then take this knowledge and use it to help students really make sense of physics at a more intuitive level."

"Having students come to the correct conclusions on their own is so rewarding because it means that the student not only learned a physical concept, but also learned how to learn it—this is the key,"
— Lei Bao

To aid in this kind of teaching, PERG has been developing virtual reality computer simulations that allow students to see and then manipulate 3-D representations of moving objects. Students can make a prediction about a physical phenomenon based on their preconceived knowledge of how they think an object should behave. They can then test out their predictions on the computer simulation and discover for themselves any misconceptions they may hold using their senses—through the movement of the joystick and what they see happening in 3-D on the screen.

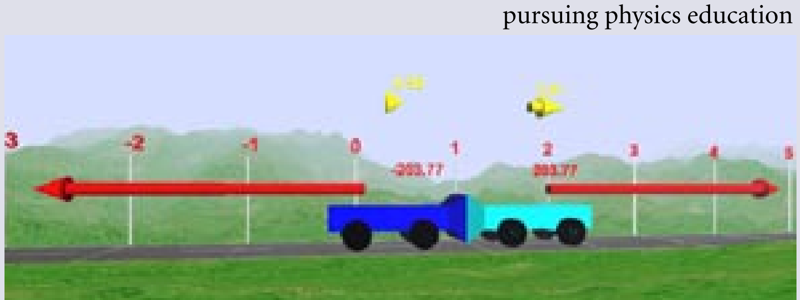
"Having students come to the correct conclusions on their own is so rewarding because it means that the student not only learned a physical concept but also learned *how* to learn it—this is the key," said Bao.

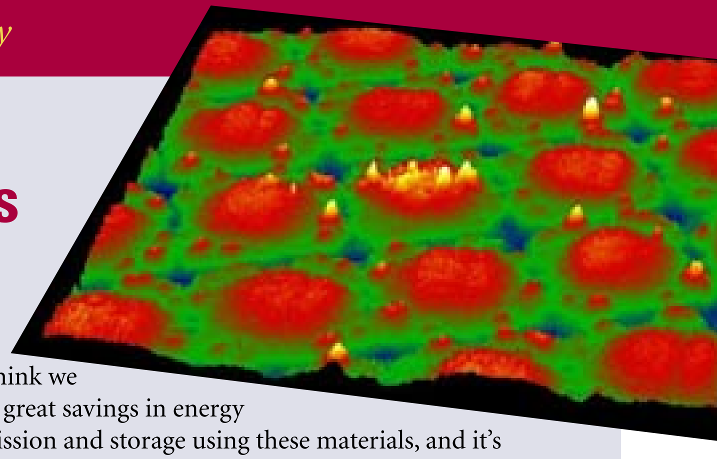
Bao is working on adapting the virtual reality computer simulations to a game that will be introduced to elementary school children. Early intervention to correct common misconceptions about the physical world may contribute in preventing such misconceptions from becoming ingrained into students' approaches to physics.

"It's like a tree," explained Bao. "You develop an incorrect idea at a young age, and it grows and grows, branching out into all aspects of your life. So correcting it earlier will save you a lot of time later on."

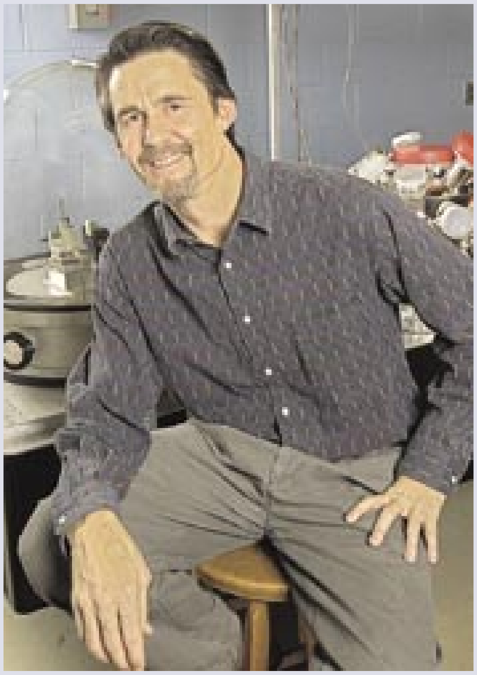
Bao received his Ph.D. in physics from the University of Maryland and accepted the position with PERG at Ohio State in the summer of 2000. Both Ohio State and Maryland are among the top institutions pursuing physics education research.

Collision for Newton's third law.





Department of Physics Welcomes New Eminent Scholar



Chris Hammel

The Ohio Eminent Scholar program entices outstanding researchers to set up shop in Ohio for a variety of reasons: the title, the prestige, the lab space. For Chris Hammel, Ohio Eminent Scholar in Experimental Physics at Ohio State, it's the students.

The students?

"I get so much energy from teaching and from the students," Hammel said. "It's fun to have this opportunity. I love the attitude and atmosphere at Ohio State."

Hammel was a second-generation physicist at Los Alamos National Lab. His father worked there also.

"Typically, Los Alamos was a much different place [than Ohio State]," Hammel said. "It was filled with physicists and analytical thinking. I think creativity can be more important. I loved working with postdocs who came to Los Alamos. They were always full of energy, so interested in learning, so willing to do whatever it took."

Hammel's current research includes the cutting-edge areas of high-temperature superconductivity and ultra low-temperature physics. He worked with Bob Richardson, who won the Nobel Prize in 1996, at Cornell University. "He worked at temperatures below 1 milli-Kelvin," Hammel said. "In other words, really, really cold."

It took almost five years to build the experiment, and Richardson spent his career making it work.

"Now, you can buy dilution refrigerators that cool to 2 milli-Kelvin," Hammel said.

"These were great experiments, but I always wanted to make a difference in the world."

When high-temperature superconductivity was discovered, Hammel worked hard to understand how it came about. These materials conduct without dissipation at much higher temperatures, so they could make superconducting applications much more affordable and readily usable.

"It has always been a dream to operate high-speed, energy-efficient superconducting trains."
— Chris Hammel

"I think we will see great savings in energy transmission and storage using these materials, and it's possible to envision transportation using these systems at higher temperatures," he said. "It has always been a dream to operate high-speed, energy-efficient superconducting trains."

Hammel is presently focusing on developing scanning magnetic resonance microscopy as a way to better measure sub-surface properties of many materials, including silicon and magnetic materials. The process utilizes nuclear or electronic spins as a probe of a local environment.

"MRI uses this same technique," he explained. "The nuclear moments at different locations in your body produce a unique signal that gives us an image from inside your body. We want to push this technique to get much finer images—possibly on the atomic scale. We have good high resolution tools for studying surfaces; we don't have good tools to look at buried features."

This could have a big benefit in medical situations. Hammel's research is focused on using the spin of the electron to enhance electronic communication and computation. Presently, electronics relies exclusively on electronic charge; by exploiting the spin of the electron, information processing electronics could be improved.

"Until recently, spin was ignored," Hammel said. "Information stored using charge is lost immediately when you turn off your computer. But we know that ferromagnets maintain their information. If we could incorporate ferromagnetism into the information processing elements, this could lead to computers that don't need to be booted."

Instead of a hard drive, billions of magnets (ferromagnets) would be incorporated into the logic elements of the central processing unit (CPU).

Carrying this idea to its limit suggests using an individual spin as the information processing unit—the bit in a computer. This is the basis for one approach to quantum computing.

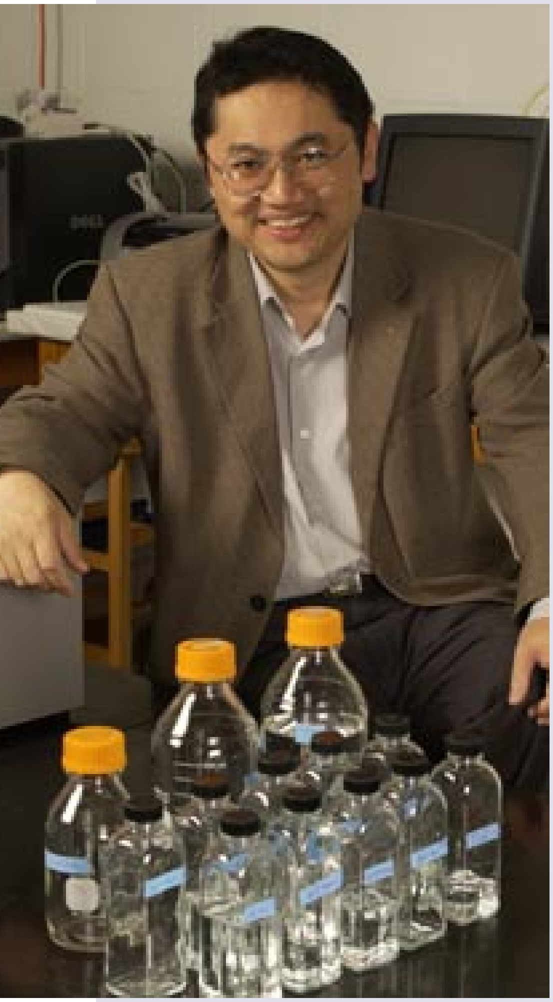
"This will be very challenging, of course," Hammel said. "This quantum information processing requires us to overcome many barriers. The cool part is that if it works, we could perform computations that cannot be conceived with conventional computers. The difficulty is that it's a really fragile state and difficult to protect and manipulate."

The immediate goal is to detect an individual electron spin at ultra low temperatures in very pure silicon.

"Detecting a single spin would be like finding the Holy Grail," Hammel said.

He is in the process of setting up his lab, hiring students and learning more about Ohio State. Students may find they get as much energy from Hammel as he claims to get from them.

Experimental Biophysics Program Begins at Ohio State



Dongping Zhong

Dongping Zhong, assistant professor in the Department of Physics, arrived at Ohio State in September 2002, just in time for one of the snowiest winters in Central Ohio.

"I escaped from Southern California," he said with a smile. "I grew up close to Shanghai, and I missed the different seasons."

In addition to snowy winters, he was drawn to Ohio State because of the tremendous opportunity.

"I had about 25 interviews [at various institutions]," he said, "but Ohio State's Department of Physics had a real commitment to biophysics. It was important to me that biophysics would be a separate area. There are many opportunities for collaborations and interdisciplinary work here at Ohio State." At this, he nods toward a large window where construction workers are busy adding a third level to what will be the new Physics Research Building. "Beautiful new building, too!"

"We try to understand functions at the atomic scale: how biologic macromoledules recognize each other and even examining the small electron or proton movement from one to another"
— Dongping Zhong

Biophysics is an area of research that has been targeted for expansion thanks to the university's Selective Investment Award, which the Department of Physics was granted in 1999.

Biophysics studies biological systems through physics concepts, Zhong said. He was led to biophysics during his post-doctoral work. He spent five years at the California Institute of Technology in chemistry, working in femtosecond spectroscopy with Ahmed Zewail, the 1999 Nobel Prize winner in chemistry.

After Dr. Zewail won his Nobel, he and Zhong had a serious discussion, and Zhong decided to devote his research to biological systems. "I am looking at two main areas, both of which use ultrafast laser tools to examine biological dynamics. We try to understand functions at the atomic scale: how biologic macromolecules recognize each other and even examining the small electron or proton movement from one to another."

One area of his research looks at the dynamic repairing process of DNA damages by a protein, photolyase. The damaged DNA, which is induced by UV light, is the main cause for skin cancer. Zhong's research is working to develop an understanding of the mechanism of how electroncs and energy move between the protein and the damaged DNA.

He is also studying water movement on the surface of proteins. "Water is very important in the body," said Zhong. Within the past few years, supercomputers have helped researchers understand how quickly water moves on the surface of protein. Now he wants to learn more about the dynamic protein hydration and how this movement relates to protein structure and function.

Several other faculty in the Department of Physics are working in biophysics areas, including Ralf Bundschuh, as well as some faculty in biochemistry. In addition, Linn Van Woerkom and Bern Kohler are involved in using ultrafast laser tools.

"The opportunity for collaboration is important to me," said Zhong. They have already begun an informal biophysics seminar group. Although their work is focused on the very small, big things will come from this area.

2002 Alumni Award for Distinguished Teaching

Gregory W. Kilcup
Associate Professor, Physics

Gregory W. Kilcup received a 2002 Alumni Award for Distinguished Teaching. This award carries with it a salary enhancement of $1,200. According to one nominator, Kilcup's teaching ability may be best evidenced during his students' group study sessions, as their course work often inspires them to engage in heated late-night debates. But what makes Kilcup really special is that those students can e-mail him

a question at 2 a.m. to settle an argument and receive a genial reply by 2:30. After graduating summa cum laude from Yale University in 1981, Kilcup earned his doctorate from Harvard University in 1986 and joined the Ohio State faculty in 1990. For two years, he taught the sophomore-level series—considered the most critical courses in the entire undergraduate physics curriculum. Kilcup's innovative group study methods helped students persevere through these difficult classes and even drew students from other majors to physics. Students wrote appreciatively of his "physics of pool" demonstrations at Woody's Place in the Ohio Union and the "cafe hours" he held at a neighborhood coffeehouse so they could reach him easily outside of class.

2002 Distinguished Scholar Award

Jason Ho
Professor, Physics

Tin-Lun (Jason) Ho was surprised in his classroom by then-President Brit Kirwan as he was recognized with the University's Distinguished Scholar Award. Jason Ho, a condensed matter theorist who was appointed Distinguished Professor of Mathematical and Physical Sciences last year, has taught at Ohio State since 1983. He received his Ph.D. from Cornell University.

Professor Ho is a world leader in theoretical research on Bose-Einstein condensation, the condensation of many identical atoms into the same macroscopic quantum state. His research interests also include dilute quantum gases, quantum many body theory and quantum computation.

Nominators praised Ho's ability to bridge different areas of physics to cultivate a specialty in quantum fields. Superfluid helium and superconductors are examples of these kinds of phenomena, where materials flow without loss of energy. Much of Ho's research concerns Bose-Einstein condensation, a new state of matter for which three of his colleagues received the Nobel Prize in 2001. Ho was the first to propose the properties of the so-called spin-1/2 Bose gas, and went on to pioneer a new field called "spinor Bose condensate." One of the nominators—a world-renowned physicist in the area of Bose-Einstein condensation—commented that Ho taught him much of what he knows about superfluids. Ho has also been named Fellow of the Alfred P. Sloan Foundation, the John Simon Guggenheim Memorial Foundation and the American Physical Society.

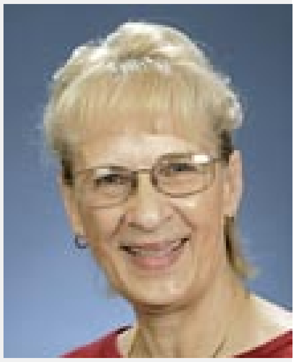
The Distinguished Scholar Award recognizes exceptional scholarly accomplishments by senior professors who have compiled a substantial body of research, as well as the work of younger faculty members who have demonstrated great scholarly potential. Recipients are nominated by their departments and chosen by a committee of senior faculty, including several past recipients of the award. Distinguished Scholars receive a $3,000 honorarium and a $20,000 research grant to be used during the next three years.

Revolutionary applications of Ho's BEC research could include tinier electronic circuits, extremely accurate clocks and distance-measuring devices and use in superfast quantum computers. Colleagues have praised Ho as "a great teacher and an outstanding mentor" and "a world-class theoretical physicist."

2002 Distinguished Staff Award

Shirley R. Royer
Office Staff Coordinator, Physics

To members of the physics department, Shirley Royer is indispensable. "We just can't imagine our undergraduate operation chugging along without her, let alone her ability to make us fly!" wrote a nominator. Royer rolls up her sleeves every year and handles the myriad details of two annual social events for hundreds of faculty, staff and students: the annual physics open house, which she helped pioneer, and the summer Research Experience for Undergraduates.



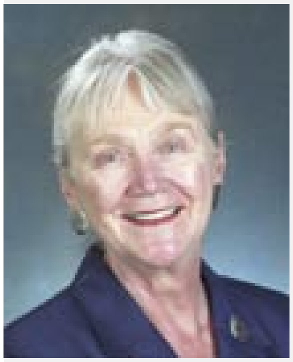
In addition, Royer manages the department's teaching evaluation program; she is an expert in database management; and she is an invaluable resource to students with scheduling questions. Nominators praised Royer's intelligence, organizational skills and warm personality. "Not surprisingly, Shirley is also the official 'mother hen' for over 150 undergraduate physics majors," wrote one nominator. "Not only does she know all the students' names, but she also takes a genuine interest in who we are and what we do," wrote a student who was looking forward to Royer wishing her and her classmates well on graduation day.

At a regular staff meeting, John Whitcomb presented a surprised and delighted Shirley with the Distinguished Staff Award. Also on hand for the event was Ned Cullom from the Ohio State Office of Human Resources, as well as Shirley's husband. "You knew!" she exclaimed to him. "And I believed you when you suggested I dress up so we could go out for dinner!"

After 32 years of service, Shirley retired in December of 2002. She said she will miss all of the undergraduates along with the faculty and staff of the Department of Physics. "I have enjoyed working with all the folks in the Department of Physics, the College of Mathematical and Physical Sciences and The Ohio State University."

Shirley thanked everyone who nominated her for the Distinguished Staff Award for 2002. "It is truly an honor and one I will never forget."

Bunny C. Clark wins OSAPS Howard Maxwell Award



On October 19, 2002, Distinguished University Professor Bunny C. Clark gained the honor of being the only recipient of both the Howard Maxwell Award for Distinguished Service and the William Fowler Award for Distinguished Research in Physics from the Ohio Section of the American Physics Society (OSAPS).

Had it not been for the encouragement of Emeritus Professor Leonard Jossem, Clark may never have joined OSAPS.

"He urged me to get involved with the Ohio Section, and it has been a blast!" Clark said enthusiastically as she accepted the Maxwell Award.

In 1969, Jossem, then chair of he Department of Physics at Ohio State, hired Clark and urged her to become involved with OSAPS, feeling that she'd fit perfectly into the organization. He couldn't have been more correct. Since joining OSAPS, Clark was elected as chair. In 1997 she was elected as vice-chair of the APS Division of Nuclear Physics (DNP) and as chair in 1999. She was elected to be the DNS representative of APS Council in 2001 for a four-year term ending in 2005.

Clark has served on many APS committees including a three-year term as chair of the Committee of the Status of Women in Physics, the Committee on Minorities, the Committee on Education and the Fellowship Committee. She currently serves on the Prize and Awards Committee.

Clark's extensive service to the Ohio Section of the APS earned her the Howard Maxwell Award in 2002.

"I have known and admired [the previous winners] for years," said Clark. "Now just think, the name 'Bunny' will be on this list!"

The OSAPS William Fowler Award was awarded to Clark in 1999 for her research in nuclear physics. Initially met with skepticism, Clark's pioneering research into the relativistic treatment of atomic nuclei is now given enthusiastic endorsement. Originally, theories held that since the binding energies of atomic nuclei are much smaller than nuclear masses, Einstein's special theory of relativity did not need to be taken into account when describing these systems. Clark's relativistic treatment, however, has repeatedly shown success where non-relativistic systems have failed, and is now considered to be the superior method of treatment.

Ohio State University Department of Physics faculty who have previously won the Fowler Award include Emeritus Clifford Heer and K. Narahari Rao. Leonard Jossem received the Maxwell Award.

Jim Burns Graduates with a B.S. in Physics

Jim Burns, a research assistant in the electronics lab in the Department of Physics, graduated with a B.S. in June 2002—22 years after he began pursuing a degree in physics.

"I've been interested in physics since high school," said Burns. "I guess I just enjoy solving problems and puzzles."

Following high school, Burns enrolled at Case Western Reserve University and majored in physics. Before completing his degree, however, Burns accepted a job offer to join the electronics lab at Ohio State.

"I love it here," said Burns enthusiastically. "There is always something going on. Everyone in the shop—the engineers, technicians and students—are all great people to work with."

In the electronics lab, Burns and his colleagues design and build specialized electronics for various physics experiments—the type of instruments you can't just buy off the shelf. Currently, Burns is working on fiber optic communication parts for the ATLAS detector that is being built at CERN. This system communicates through light pulses instead of electronics. The lab offers the Department of Physics the ability to design specialized chips to drive and interpret the light pulses of detectors and senders. Tests of this system could prove to be very useful to future experiments.

Although Burns considered other fields, including computer science and education, he decided to complete his degree in physics. After receiving his degree last spring, Burns has continued to take quantum mechanics courses.

"Quantum mechanics is my favorite subject," Burns explains, "It always made my head swim—that mind-blowing effect is why I'm in physics to begin with."

Epstein was recognized for "leadership in the fundamental and applied interdisciplinary science of conducting, semiconducting and magnetic polymers, particularly for the co-discovery and studies of organic-based magnets."

The AAAS recognized Saam, also a Fellow of the American Physical Society, for "innovative research on interfacial phenomena,especially wetting transitions, and for academic leadership."

Arthur Epstein and William Saam Selected as Fellows of the American Association for the Advancement of Science

Two faculty in the department were selected last year as Fellows of the American Association for the Advancement of Science (AAAS): Arthur J. Epstein, Distinguished University Professor, Departments of Physics and Chemistry, and William F. Saam, professor and chair, Department of Physics.

According to material distributed by the AAAS, Epstein was recognized for "leadership in the fundamental and applied interdisciplinary science of conducting, semiconducting and magnetic polymers, particularly for the co-discovery and studies of organic-based magnets."

He co-discovered the first magnet based on organic materials in 1985, and is recognized as the world's leading expert in how polymers conduct electricity. Discovering the strange electrical and optical properties of plastics is only one part of Epstein's research—he is also interested in new concepts with magnets, including light-induced magnetism, and spintronics, which uses electron spin to store information. Read more about his most recent discoveries on page 16.

He is a fellow of the American Physical Society and a recipient of the Distinguished Scholar Award and the Distinguished Lecturer Award at Ohio State. He is an author of more than 600 publications and has been granted more than 25 patents. Two of his patents have been licensed through Ohio State to Mitsubishi Corporation in Australia, Japan and the United States for production of the first known water-soluble plastic that conducts electricity. Its applicability ranges from an antistatic additive to eliminate static cling, to enabling finer detail in state-of-the-art computer chips. Ohio State has licensed Epstein's portfolio of patents on polymer-based light-emitting display technology to BTG, International, for further development and commercialization.

Professor Epstein has mentored more then 30 students to completion of their Ph.D. degrees. In 2000, he assumed the post of editor-in-chief of the *Journal of Synthetic Metals.* He received his Ph.D. degree in physics from the University of Pennsylvania in 1971, following a B.S. degree in physics from the Polytechnic Institute of Brooklyn in 1966. He was a principal scientist at Xerox Corporation's Webster Research Center prior to joining The Ohio State University in 1985.

The AAAS recognized Saam, also a Fellow of the American Physical Society, for "innovative research on interfacial phenomena, especially wetting transitions, and for academic leadership."

"We perceive the world through interfaces, or surfaces separating two distinct objects," explained Professor Saam. As a condensed matter theorist, Saam's lab is in his office; his work employs calculations and computers. A major focus of his research concerns universal features associated with phase transitions at interfaces. Universality arises with continuous phase transition characterized by fluctuations at large-length scales. The details at the shorter length are "washed out," so that what remains is a universal view independent of these details.

The other part of his research is wetting transitions. "An unfortunate name," said Professor Saam, "but it's easily understandable. If a droplet spreads, it wets. If it beads, it's not wet."

Until the early 1990s, liquid helium was thought to be a universal wetting agent. Work by Saam and collaborators predicted this to be false for helium adsorbed on cesium at low temperatures, with a transition to wetting behavior occurring at higher temperatures. Experiments verified these predictions, leading to a burst of activity in the field and the development of a broad understanding of wetting phenomena.

Helium is an ideal material for the study of diverse phenomena in physics. Easily available, it forms crystals at low temperatures under pressure, presenting the opportunity for study of important features of liquid-crystal interfaces. At about 1 degree Kelvin, solid helium looks like a droplet, but as the temperature lowers, facets appear. This "roughening" phase transition has some remarkable properties.

"The most remarkable property is that the curvature of the droplet at the point where the facet appears is universal," said Professor Saam. "Prediction of the subsequently observed universality was most satisfying."

In addition to Professor Saam's work with the phase transitions at surfaces, he also has served as Chair of the Department of Physics since 1998. Prior to that, he served as Vice Chair from 1994-1997, and from 1987 to 1989, he served the College of Mathematical and Physical Sciences as Associate Dean.

Professor Saam completed his Ph.D. at the University of Illinois at Urbana-Champaign, after receiving his bachelor's degree from Caltech. He did post-doctoral work at the Institute Laue-Langevin in Munich, Germany, and in Grenoble, France. He joined The Ohio State University in 1970.

A sample of holography art developed by students in Professor Kagan's holography class.

Harris Kagan Named APS Fellow

When Harris Kagan, professor of physics at Ohio State, began his career in the field of high energy physics, his first experiment included just three or four researchers. Today, what was once a small community of scientists has grown into collaborations of thousands from over 150 universities in 34 countries. These scientists are all working to test the validity of the Standard Model of particles, the key to understanding the forces of nature and the fundamental structure of matter.

"You need higher and higher energy to probe more and more deeply," explained Kagan. "With higher levels of energy, the detectors get larger in order to observe what's going on. Think of it as a huge microscope, probing for the tiniest particles known."

Professor Kagan was recently named a Fellow in the American Physical Society (APS) for his work in high energy physics, especially in the development of better particle detectors. Election to Fellowship in the APS is limited to no more than one-half of one percent of the membership.

Professor Kagan began his work with high energy physics in 1978 as a postdoctoral researcher with the University of Rochester's CLEO group, a collaboration of about 60 scientists working with the CLEO detector to study the decay of B and Tau particles. He joined Ohio State's Department of Physics in 1981, starting the research group that studies electron-positron interactions. Thanks to his work, Ohio State became an institutional participant in CLEO, later joining the BaBar and ATLAS collaborations as well. These experiments may someday prove, or disprove, the Standard Model.

These experiments may also enable scientists to investigate the possible matter-antimatter asymmetry in nature. "The idea that symmetries of nature can be violated is very interesting," said Kagan. "It teaches us something about the fundamentals of the world."

Recently, Professor Kagan has been working with the ATLAS and BaBar groups to develop and test various detectors for the experiments, including detectors utilizing diamond, as opposed to the standard silicon. By using diamond, Kagan and other researchers at Ohio State hope to develop better and more radiation hard detectors capable of operating in the extreme conditions very close to the colliding beams of present and future experiments.

"As we reach higher and higher energies, we will be able to resolve smaller and smaller distance scales," said Kagan. The hope is that as higher energies are reached and smaller distance scales are obtained, much of the decays that indicate the fundamental relationships will appear. This will allow the ATLAS team to use its detector to search for physics beyond the Standard Model, perhaps taking scientists closer to a Unified Theory.

The nature of Professor Kagan's research has caused him to branch into other areas, as well. The move to electronics and the development of diamond detectors were natural offshoots. A little more obscure is Professor Kagan's interest in holography.

"I believe art and science are the same thing," explained Kagan. "They're linked in the way you do them, the way you think and reason through a project."

Professor Kagan teaches holography classes at Ohio State's Departments of Art and Physics. Students use quantum mechanics, interference principles and modern physical concepts to produce 3-D works of art. "My goal in teaching a class is to have the students learn how to learn. That's what science is about, teaching people to think, reason and communicate."

Gordon J. Aubrecht Awarded John B. Hart Award for Distinguished Service

Gordon J. Aubrecht, professor of physics at The Ohio State University at Marion and a member of the Physics Education Research Group, was not expecting to receive the prestigious John B. Hart Award for Distinguished Service from the Southern Ohio Section of the American Association of Physics Teachers (SOS/AAPT).

"I don't know how they managed to keep it from me," said Aubrecht. "It came as a surprise!"

The award is named after John B. Hart, who made the Southern Ohio Section possible through a personal donation and is given to honor members who have contributed significantly to the SOS/AAPT.

Aubrecht has been an active member of the section since he helped to found it in 1983. In addition to serving as the section's initial vice president for Colleges and Universities, president-elect, president and past president, he has run several of its semiannual meetings and has been on the executive committee throughout its existence.

The SOS/AAPT is dedicated to the exchange of information about physics with physics teachers and prospective teachers of physics from the college level to the grade-school level. The organization also seeks to generate an interest in physics among junior high and high school students through several outreach programs, including the State Science Day Physics Awards Program. Aubrecht initiated and has served as coordinator of this program for 14 years. It provides awards for the three best physics projects in two divisions: grades 7, 8 and 9 and grades 10, 11 and 12. With over 100 entrants every year, it is one of the biggest judging groups for special awards at the State Science Day.

Throughout his years with the SOS/AAPT, Aubrecht has gone beyond the definition of "distinguished service," according to members of the executive committee. "When a job has had to be done, Aubrecht has been there," said James F. Sullivan, AAPT member and past Hart Award recipient. "This award is long overdue."

Aubrecht has also been active in the Ohio Section of the American Physical Society, having recently served as vice chair, chair and past chair. He is currently chair of the Contemporary Physics Education Project, secretary of the InterAmerican Council on Physics Education and secretary of the Standards Coordinating Committee 14 of the Institute for Electrical and Electronic Engineering. He received the national AAPT Distinguished Service Award in 1996 and was recently named a Fellow of the American Physical Society.

Women in Physics Lunch

Department of Physics professor Bunny Clark sponsors a Women in Physics luncheon several times a year. All women (and many men!) in Smith Lab are invited to enjoy delicious food and physics fellowship. Undergraduate students and graduate students, administrators and faculty, staff support and college personnel renew acquaintances and spend valuable time reconnecting.

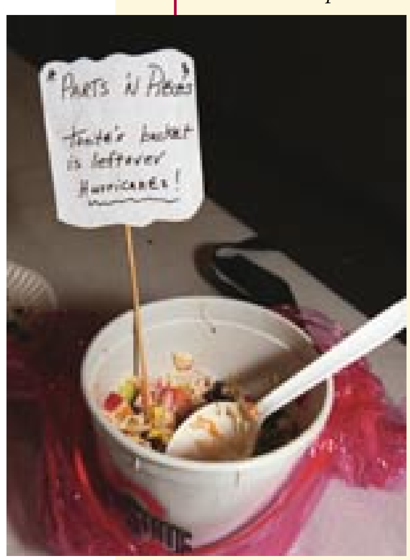
Dr. Clark (middle) poses with students Sheryl Derolph and Melanie Frey at the Women in Physics Lunch.

Winter Party 2003

The theme of the 2003 Winter Party was "Name That… Game!" Trivia questions reminiscent of *Name That Tune* added to a fun evening that included a band, dancing and bubbles to blow at every table. Guests brought a dessert or appetizer, and prizes were given for the best title of the food item.

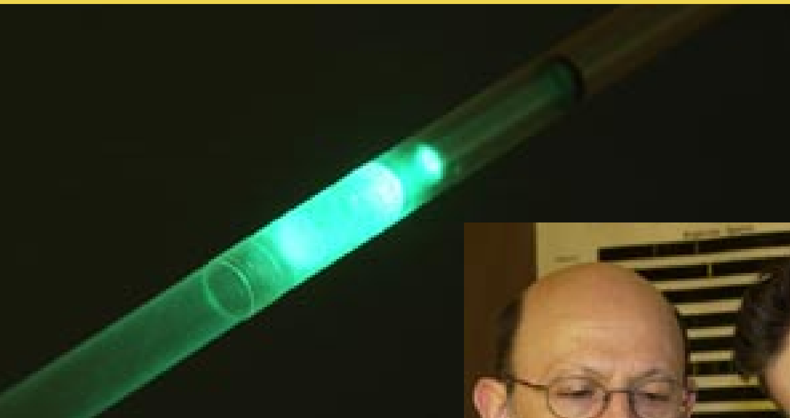
A serious ceremony was also presented in the form of the renewal of the Sigma Pi Sigma honorary, presided over by Department of Physics alumnus David Price, College of Mathematical and Physical Sciences representative to the Alumni Advisory Council of The Ohio State University Alumni Association. (See page 19 for more details.)

The saxophone player on the left is also physicist and Ohio State alumna, Dr. Kathi Harper.



Dorothy Whitcomb created Parts 'N Pieces, a rice dish that won her honors as most creative potluck dish. At right, guests enjoy the various activities offered at the Winter Party.

The next two articles feature research by Arthur J. Epstein, Distinguished University Professor in the Departments of Physics and Chemistry and director of Ohio State's Center for Materials Research.



Researchers at The Ohio State University, in collaboration with the University of Utah, developed the world's first light-tunable plastic magnet. Green laser light, as shown here, makes the plastic less magnetic, while blue laser light makes it more magnetic. Photo by Jo McCulty.

Arthur J. Epstein (left), professor of physics and director of Ohio State University's Center for Materials research, and Dusan Pejakovic, a doctoral student, demonstrate their use of laser light to "tune" the strength of a plastic magnet. Epstein and Pejakovic worked with chemists at the University of Utah to produce the plastic, which grows more magnetic in blue light and less magnetic in green light. One day, this work could lead to a magneto-optical system for writing and erasing data from computer hard drives. Photo by Jo McCulty.

Researchers Develop World's First Light-Tunable 'Plastic' Magnet

Low-cost, flexible electronics and better computer data storage might result from the world's first light-tunable plastic magnet, just developed at Ohio State.

With colleagues at the University of Utah, researchers at Ohio State developed a plastic material that becomes 1.5 times more magnetic when blue light shines on it. Green light partially reverses that effect.

Although possible applications are years away, this technology could one day lead to a magneto-optical system for writing and erasing data from computer hard drives.

While other scientists have developed plastic magnets, and yet others have developed light-responsive magnets, this is the first material to marry both technologies into one—and at record-high temperatures, explained Arthur J. Epstein, Distinguished University Professor in the Departments of Physics and Chemistry and director of Ohio State's Center for Materials Research.

The magnet resulted from a 30-year collaboration between Epstein and Joel S. Miller, professor of chemistry at the University of Utah. They describe the magnet in the current issue of the journal *Physical Review Letters*, in a paper coauthored with Dusan Pejakovic, a doctoral student in physics at Ohio State, and Miller's former graduate student Chitoshi Kitamura, now at the Himeji Institute of Technology in Japan.

Though the working temperature of the magnet is very cold, it represents an important first step toward future light-based forms of electronics, Epstein said.

"Now that we've proven it's possible to make a light-tunable magnet out of an organic, or 'plastic,' material, we can use what we know about organic chemistry to further improve its properties," Epstein said. "We may someday even be able to improve it to the point that it works at room temperature."

Worldwide, scientists and engineers are working to develop computer data storage based on light and magnetics. Theoretically, such magneto-optical systems would work faster and much more efficiently than traditional electronics. A light-tunable magnet would be a critical component because it would allow computers to write and erase data magnetically.

Because the new magnet works at temperatures up to 75 Kelvin, it could one day be employed in a device that was cooled by a refrigerator or by liquid nitrogen. Today, liquid nitrogen costs less per gallon than milk, roughly $2. Manufacturers that bought it in bulk would pay even less.

But such applications are years away, said Epstein. "We'd like to see the magnet work at higher temperatures before we talk about commercial development," he said.

He and his colleagues are now trying to improve the magnet by exploring different chemical compositions. The Air Force Office of Scientific Research and the U.S. Department of Energy funded this work.

Plastic Shows Promise for Spintronics, Magnetic Computer Memory

Researchers at The Ohio State University and their colleagues have expanded the possibilities for a new kind of electronics, known as spintronics.

Though spintronics technology has yet to be fully developed, it could result in computers that store more data in less space, process data faster and consume less power. It could even lead to computers that boot up instantly, said Arthur J. Epstein, professor of physics and chemistry and director of Ohio State's Center for Materials Research.

Spintronics uses magnetic fields to control the spin of electrons. In a recent issue of the journal *Advanced Materials*, Epstein and his coauthors report using a magnetic field to make nearly all the moving electrons inside a sample of plastic spin in the same direction, an effect called "spin polarization." Achieving spin polarization is the first step in converting the plastic into a device that could read and write spintronic data inside a working computer. What's unique about this work is that the researchers achieved spin polarization in a polymer, which offers several advantages over silicon and gallium arsenide, the traditional materials for electronics.

Epstein and long-time collaborator Joel S. Miller, professor of chemistry at the University of Utah, coauthored the paper with Vladimir N. Prigodin, a research specialist; Nandyala P. Raju, a research associate; and Kostyantyn I. Pokhodnya, a visiting researcher, all of Ohio State.

Since the mid-1980s, Epstein and Miller have been developing plastic electronics, most recently a plastic magnet that conducts electricity. (See story above.) Epstein characterized this latest project as part of a natural progression of their work toward spintronics.

"Electronics and magnetism have transformed modern society," said Epstein. "The advent of plastic electronics opens up many opportunities for new technologies such as flexible displays and inexpensive solar cells.

"With this latest study, we've now shown that we can make all of the components that go into spintronics from plastics," Epstein continued, "so it is timely to bring all these components together to make plastic spintronics."

Why are researchers so

interested in spintronics? Normal electronics encode computer data based on a binary code of ones and zeros, depending on whether an electron is present in a void within the material. In principle, the direction of a spinning electron—either "spin up" or "spin down"—can be used as data, too. Spintronics would effectively let computers store and transfer twice as much data per electron.

Another bonus: once a magnetic field pushes an electron into a direction of spin, it will keep spinning the same way until another magnetic field causes the spin to change. This effect can be used to very quickly access magnetically stored information during computer operation, even if the electrical power to a computer is switched off between uses. Data can be stored permanently and are nearly instantly available anytime, so no lengthy boot up is needed.

Plastic spintronics would weigh less than traditional electronics and cost less to manufacture, Epstein said. Today's inorganic semiconductors are created through multiple steps of vacuum deposition and etching. Theoretically, inexpensive ink-jet technology could one day be used to quickly print entire sheets of plastic semiconductors for spintronics.

Using plastic may solve another problem currently faced by developers: spinning electrons must be able to move smoothly between different components. Traveling from one material to another, though, can sometimes knock an electron off kilter. Data encoded in that electron's spin would be lost.

For this reason, Epstein, Miller and their colleagues are working on transferring spinning electrons through a layered stack of different magnetic and non-magnetic polymers.

Research Could Explain Unusual Behavior in Superconductors

Tom Lemberger and John Skinta in the lab.

Since their discovery in 1986, the crystalline ceramic materials known as cuprates have puzzled scientists for their high-temperature superconductivity.

Efforts to understand cuprates have generated a great deal of debate, in part because the materials seem to demonstrate a split personality. In some experiments, their superconducting electrons exhibit d-wave behavior, meaning they appear to orbit each other in a formation resembling a four-leaf clover; other times they exhibit s-wave behavior, in which the electrons appear to follow spherical paths, but in opposite directions.

In Ohio State's Department of Physics, Professor Thomas Lemberger is confronting this controversy head-on. In tests with thin films of cuprates, he and his colleagues may have found a transition in which the material switches from d-wave behavior to s-wave. This work, which was done in collaboration with NTT Basic Research Laboratories in Japan, might explain the varied research results other teams have found in the past.

"It seems that the mechanisms for d-wave and s-wave behavior are always present in the material," Lemberger said, "so if you could suppress the d-wave behavior, a cuprate would automatically switch to s-wave."

S-wave behavior has some technical advantages over d-wave. Buckyballs, Lemberger pointed out, demonstrate high-temperature s-wave-type superconductivity at 40 Kelvin. Scientists have speculated that cuprates could sustain s-wave superconductivity at a temperature as high as 90 Kelvin.

"The question now is how high can we push s-wave superconductivity?" Lemberger said.

Finding the answer will be a very complex task. Along the way, Lemberger and graduate student John Skinta have discovered something else surprising about cuprates.

Working with physicists at Pennsylvania State University, Lemberger and Skinta measured thermal fluctuations in a thin film cuprate. "The fluctuations are not nearly as strong as they should be," Lemberger said. "It's as if the layers of the material are much more strongly coupled than other measurements have led us to expect."

At the moment, the implications of these findings are unclear, but Lemberger and his collaborators have written two articles detailing their work, both of which have been published in recent editions of *Physical Review Letters*. In addition, further measurements are supporting earlier conclusions.

For the Collider Detector at Fermilab (CDF) group in Ohio State's Department of Physics, this is an exciting time. Not only did Brian Winer and Richard Hughes, both associate professors, lead the effort to design a particle tracker for CDF, but they had the singular joy of seeing the device in action—and reveling in the results.

Electronics Decipher Fermilab Collisions

Graduate student Chris Neu and postdoc Evelyn Thomson look at one of the 24 XFT LINKER boards that process signals from the detector. Photo courtesy of Fermilab

Fermilab's Tevatron is the most powerful particle accelerator of the world, and Brian Winer and Richard Hughes worked for five years to design the fastest tracker in the world: a mass of circuits and parallel processors capable of charting the paths of up to 5 trillion particles per second, emanating from 7.5 million proton-antiproton collisions each second.

The device, called the eXtremely Fast Tracker (XFT), kept pace with the accelerator, and it worked perfectly its first time out. Its initial results matched the computer simulations that Winer and Hughes ran during its development. Now the physicists are busy analyzing data from Fermilab's Collider Run II, which started in March of 2001 and is expected to continue through 2007.

The XFT is the first and most powerful in a series of tracking devices that sort the data emerging from the collider. When a collision occurs that may be of interest to physicists—for instance, the creation of the theoretical Higgs boson—the XFT pulls that data from the stream and passes them along to other devices for more analysis.

"We're dealing with a huge amount of data," said Winer. "From the trillions of collisions that will take place over the next five years, we may only generate 50 events that will help us find the Higgs boson. We have to make sure we can find those key events and save them to tape."

"Because the collisions happen so fast, we had to design the XFT to attain a balance between gathering enough information and doing it very quickly," Hughes added.

Society of Physics Students

SPS students take a study break and celebrate the second anniversary of the expiration of a carton of milk.

Playing with liquid nitrogen…celebrating the second birthday of a half gallon jug of milk…bobbing for apples while watching Halloween episodes of *The Simpsons*… microwaving stuff that probably shouldn't be microwaved…

Can you think of better ways to relieve stress before finals?

At least once a quarter the Ohio State Society of Physics Students (SPS) hosts a study break where physics students can relieve some of the stress that accumulates just before midterms and finals. These study breaks generally consist of watching a movie and eating pizza, but sometimes things get a little carried away. Like when the "fun with liquid nitrogen" and "bobbing for apples" activities were mixed… You can imagine the outcome.

SPS does much more than just hold stress-relieving study breaks. Every two weeks, SPS holds informal meetings in the Undergraduate Physics Student Lounge (Smith Laboratory, Room 1011). At these meetings, members of the faculty give informative talks on their research. So far this year, some of the highlights have included a discussion by Professor Richard Hughes about the CDF Detector at Fermilab, a presentation on superconductivity using liquid nitrogen by Professor Tom Lemberger, a field trip out to Ohio State's nuclear reactor on West Campus and a joint meeting with Radical π (Ohio State's Mathematics Club) at which Professor Samir Mathur discussed his research in black holes and string theory.

"One of SPS's biggest goals is to encourage social activities among physics students," said SPS president and physics major Becky Weber. "SPS membership allows students to get to know their professors on a more personal basis, meet upper level physics students and get help with their homework, even learn about opportunities for research within the department."

During spring quarter, SPS plans to host discussions with Ohio Eminent Scholar Chris Hammel on the magnetic, electronic and superconducting properties of different materials and Professor Ciriyam Jayaprakash on the philosophical aspects of quantum mechanics. Plus, they're scheduling a field trip to the basement of Dreese Lab—to make lightening bolts!

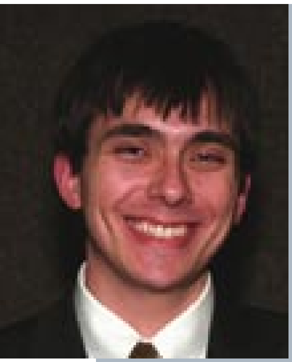
"Being president of SPS and becoming actively involved with the department has taught me that the physics department is a lot more fun if you take an interest in what is going on around you," Becky said. "The professors are really easy to get to know, if you take the time to talk to them outside of class."

This year, SPS has experienced a big increase in attendance at meetings and activities, which Becky attributes to her fellow SPS officers. "We have great officers—everyone has been actively involved and they all have worked really hard to promote the activities," she said.

The increase in attendance has allowed SPS to reinstate the Ohio State chapter of the Sigma Pi Sigma Honor Society (see next page). Sigma Pi Sigma is already off to a great start with 22 members from the sophomore, junior and senior classes.

The SPS meetings are open to anyone, not just physics students, and there are no local dues. Membership in the national chapter is strongly encouraged, but not required, and applications can be picked up in the SPS office or can be downloaded from the national SPS web site at www.spsnational.org.

Michael Tychonievich Wins Goldwater Scholarship



With a double major in physics and mathematics, plus involvement in research projects in both departments, it's a wonder Mike Tychonievich even managed to find time to apply for the highly competitive Barry M. Goldwater Scholarship. But not only did he apply, he won.

Nationally, only 309 scholarships were awarded from a field of 1,155 mathematics, science and engineering students. The one- and two-year scholarships cover the cost of tuition, fees, books and room and board up to $7,500 per year. The academically based scholarship was created in 1986 by Congress to honor Arizona Senator Barry M. Goldwater and is given to students who plan to pursue careers in science, mathematics or engineering. Mike received notification of his award on April 1, 2002. No fooling.

Mike became interested in physics after reading *The God Particle* by Leon Lederman, a book that recounts the evolution of physics through the quest of some of the greatest physicists of all time to discover the origins of the universe. Mike wanted to learn more about physics and Ohio State offered the best physics program in the state.

By his second quarter at Ohio State, Mike was actively engaged in research in Professor Tom Lemberger's lab. Throughout the past three years, he has continued working with the Lemberger group as his class load permitted. They are investigating the changing properties of high-temperature superconductors. The results of research by the Lemberger group seem to indicate that high temperature s-wave-type superconductivity may be sustainable up to temperatures as high as 90 Kelvin, a result that would have many industrial uses (see page 17 for details). Mike also participated in the National Science Foundation (NSF)-funded Research Experience for Undergraduates (REU) program with Professor Lemberger during the summer of 2001.

Last summer Mike also participated in a research program supported through the NSF-funded Vertical Integration of Research and Education (VIGRE) in the Department of Mathematics. This intensive program seeks to introduce students to higher-level mathematical concepts through special courses and research.

Mike hopes to earn a Ph.D. in physics and someday become a theoretical physicist or mathematician and conduct research that integrates both subjects. "To recognize when I don't understand something and then know how to go about finding the answer is the most important thing I've learned at Ohio State," said Mike.

Academic Achievement Scholarship

Mike Starr
Undergraduate Physics Major

Mike Starr was at lunch in his Lexington, Ohio, high school when his father called to tell him, "We're going to Hawaii!" That's when Mike knew he had won the Academic Achievement Scholarship in the Department of Physics at Ohio State.

"We had made a deal earlier in the year that if I found a way to pay for school, [my father] would take our family on a trip that summer," said Mike. "I couldn't believe [that I'd won] at first, and it didn't really sink in until later. We ended up going to Cancun, which was a blast!"

The Academic Achievement Scholarship is open to any high school student planning to major in physics or engineering physics at Ohio State. It covers the full cost of in-state tuition for four years as long as the student continues to make good progress toward a degree in physics.

A high school physics teacher sparked Mike's fascination with physics. He is especially intrigued with problems dealing with conservation of momentum and heat capacity. Mike was already considering coming to Ohio State based on its outstanding physics program. Add to that the fact that Mike's entire family (parents, grandparents, aunts, uncles and cousins) have all come through Ohio State, and it becomes clear that his future as a Buckeye was already more or less predetermined when the Academic Achievement Scholarship sealed the deal.

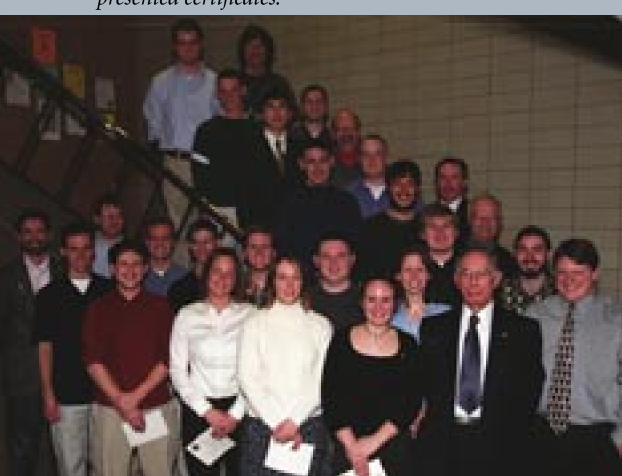
Since arriving at Ohio State in autumn 2002, Mike has become increasingly involved in student organizations. On move-in day, Mike served as an Ohio State Welcome Leader (OWL), helping fellow freshman move into their dorms. He has also become a member of the Student Alumni Council (SAC), Students Active in Involvement and Leadership (SAIL) and has attended several of the Society of Physics Students (SPS) meetings.

In addition to his Academic Achievement Scholarship, Mike has won an Ohio Academic Scholarship, the Robert C. Byrd Scholarship, a Mayer Scholarship and a University Scholarship through Ohio State. He is also a National Merit Scholarship Commended Scholar.

Mike has not yet decided which direction his physics degree will take him.

"Have you ever seen *Van Wilder*?" asked Mike. "The main character talks about living life in the present and not over-thinking the future. I'm having a lot of fun, and I'm working really hard. So I'll just roll with the punches and see where I end up in four years."

New members of Sigma Pi Sigma announced by alumnus David Price. William Saam and Richard Furnstahl presented certificates.



Sigma Pi Sigma at Ohio State

Sigma Pi Sigma Physics Honor Society

The Society of Physics Students (SPS) is pleased to announce that it has reinstated the Ohio State chapter of the Sigma Pi Sigma Honor Society. The Ohio State chapter inducted its first new members since 1982 during winter quarter at the annual Department of Physics Winter Party. These students will have the opportunity to significantly influence the direction of Sigma Pi Sigma for years to come.

The brief induction ceremony featured Emeritus Professor and former Department Chair Leonard Jossem, as well as alumnus David Price, who also serves the department and College of Mathematical and Physical Sciences as the college representative to the Alumni Advisory Board of The Ohio State University Alumni Association. SPS advisor Richard Furnstahl, professor of physics, was also inducted.

Sigma Pi Sigma is a nationally recognized and respected organization dedicated to leadership and service and is associated with SPS and the American Physical Society (APS). It is designed to acknowledge upper-class students who have excelled in physics. Those students eligible for membership maintain a minimum of 3.0 GPA in at least five upper-level physics classes as well as cumulatively, and they must be involved in research, SPS or other activities related to physics.

Sigma Pi Sigma was originally founded at Ohio State in 1936. If you are a former member of the organization and would like to contribute advice regarding the running of Sigma Pi Sigma, or if you'd like more information, please e-mail the SPS officers at sps@mps.ohio-state.edu.

Recognizing Undergraduate Achievement

Each spring, the Department of Physics recognizes the achievements of students in physics classes as well as undergraduate student majors. High-achieving students in the introductory physics courses are presented with the Helen Cowan Book Award. Professor Bunny Clark presents the certificates and bookstore gift certificates with the message that she hopes "non-majors will realize that they should major in physics." Bob Scherrer, professor of physics and vice chair for undergraduate students, presents the remaining certificates and checks in a brief ceremony preceded by great food.

Physics Undergradate Scholarship winners (from left): Tom Weisgarber, Mike Starr, Thomas Scaife.

Smith Junior Award winners.

Helen Cowan Book Award winners with Dr. Bunny Clark (center).

Department of Physics Undergraduate Awards Ceremony, May 29, 2002

Physics Academic Achievement Scholarship:

Michael Starr

National Awards:

Karoline Gilbert, NSF Graduate Fellowship
Michael Tychonievich, Goldwater Scholarship

Alpheus W. and Adah B. Smith Research Scholarships:

Benjamin Auer
Christopher Carey

2001–2002 Undergraduate Prizes

Senior Alumni Award

Karoline Gilbert

Smith Senior Award

Jeffrey Atwell
Robert Coridan
Amy Stutz

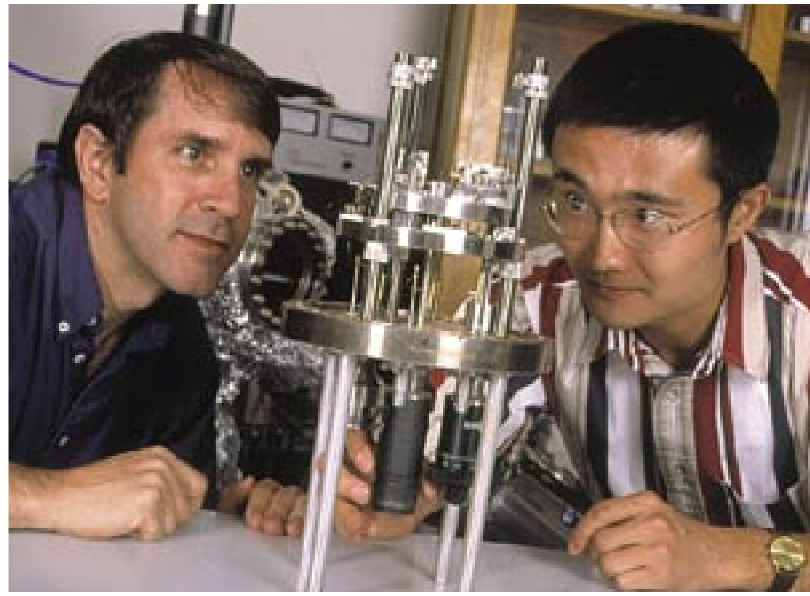
Smith Junior Award

Benjamin Auer
Mark Pitts
William Ruane
Michael Tychonievich
Bret Underwood

Helen Cowan Book Award

Charles Baginski
Scott Batdorf
William Belisle
Brandon Childers
Tim Cowley
Tianman Huang
Andrew Jeanblanc
Lee Mazurek
Eugene Talagrand
Tom Weisgarber
Craig Wiggenhorn

Ph.D. Graduates



Autumn '01

Daniel Cociorva
Advisor: John Wilkins
Quasiparticle Calculations for Semiconductor Interfaces and Defects

Hsung Jai Im
Advisor: Jon Pelz
Metal Contacts to Silicon Carbide and Gallium Nitride Studied with Ballistic Electron Emission Microscopy

Dusan Pejakovic
Advisor: Arthur Epstein
Optical Control of Magnetic Order in Molecule-Based Magnets

Latife Sahin
Advisor: Richard Boyd
Measurement of the Cross Section and Reaction Rate of 8Li(d,alpha)6He Reation at the Energies of Astrophysical Interest

Negussie Tirfessa
Advisor: Richard Furnstahl
Effective Field Theory Approach to Nuclear Matter

Spring '02

Eivind Almaas
Advisor: David Stroud
Topics in the Theory of Quantum and Classical Networks

Matthew Fulkerson
Advisor: Bruce Patton
Gas Sensor Array Modeling and Cuprate Superconductivity from Correlated Spin Disorder

John Skinta
Advisor: Thomas Lemberger
Magnetic Penetration Depth Studies of Electron-Doped Cuprate and Ultrathin YBa2Cu307-8 Films

Summer '02

Catalin Ciobanu
Advisor: Richard Hughes
A Neural Networks Search for Single Top Quark Production in CDF Run 1 Data

Luisa Ciobanu
Advisor: Charles Pennington
High Resolution M.R. Microscopy

Arthur Cole
Advisor: Richard Boyd
Search for Supernovae Signatures in an Ice Core

Igor Filippov
Advisor: Steven Pinsky
Nonperfurlative Numerical Analysis of SYM1+1

Glen Gillen
Advisor: Linn Van Woerkom
Multiphoton and Above-Threshold Ionization of Magnesium Using High-Intensity Ti: Sapphire Laser Pulses

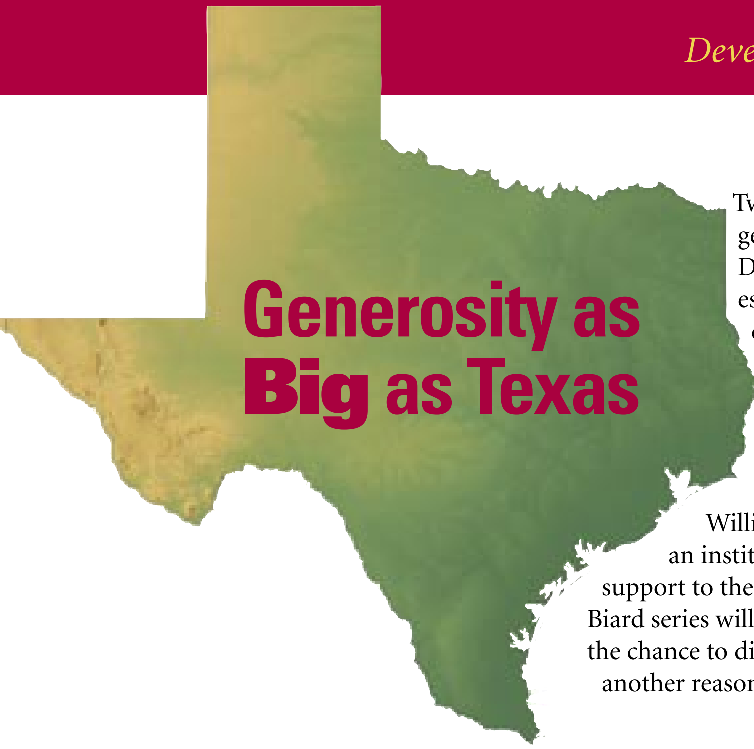
Yu Jia
Advisor: Eric Braaten
Heavy-Quark Recombination Mechanism

Seongwon Lee
Advisor: John Wilkins
Laser Excited and Multiply Charged Semiconductor Quantum Dots Modeled by Empirical Tight Binding

David May
Advisor: Gordon Aubrecht
How Are Learning Physics and Student Beliefs About Learning Physics Connected?

Autumn '02

John Ferguson
Advisor: Arthur Epstein
Transport Studies of Conducting, Semiconducting and Photoconducting Star Polymers



Generosity as Big as Texas

Two Texans, both alumni of the Department of Physics, have given generously in support of excellence in physics at Ohio State. David DeMartini, Houston, and Captain Forrest R. Biard, Dallas, have both established special funds in the department. The DeMartini scholarship is designed to be used at the discretion of the chair of the department for either an undergraduate or graduate student. Captain Biard's gift will establish a new lecture series in the department, which will further excellence through timely discussion with experts in cutting-edge research in physics.

"Truly excellent physics students live here in the state of Ohio," said William Saam, chair. "Often, financial constraints may force them to choose an institution besides Ohio State. With the DeMartini scholarship, we can offer support to the students who may need it and who will excel in physics. Moreover, the Biard series will offer students opportunities to meet with visiting scholars and give them the chance to discuss important issues in the field from a variety of perspectives. This is another reason that the Department of Physics is so strong here at Ohio State."

Search to Fill Endowed Chair Underway

The search to fill the now fully funded Dr. Edward E. and Sylvia Hagenlocker Chair in Physics recently began. The Hagenlocker Chair will provide support for a distinguished senior faculty position in the area of atomic, molecular, and optical physics.

"This is the first endowed chair in the department," said William Saam, chair. "It provides a unique opportunity to enhance our stature in the worldwide research community."

The Department of Physics recently began inviting applications and nominations for the endowed chair. The job description states in part, "The occupant of the chair will have an appointment as Professor of Physics. An extensive, internationally recognized record of research commensurate with a chaired position is expected. Experimental and computational support facilities are exceptional and a new state-of-the-art Physics Research Building is under construction."

A native of Marysville, Ohio, Dr. Hagenlocker is a three-time graduate of Ohio State (B.S. Physics 1962, M.S. Physics, 1962, and Ph.D. Physics, 1964), as well as recipient of an MBA from Michigan State University. He retired as Vice Chairman of the Ford Motor Company in January of 1999 and was awarded the first-ever Distinguished Alumni Award from the Department of Physics in the spring of that year. He received an honorary doctorate in science in 1997 from OSU and gave the Summer 1997 commencement address. He and his wife Sylvia reside in Detroit.

Physics Research Building Naming Opportunities

Building – $7,500,000
Laboratory Wing – Research Facility – $5,000,000
Faculty Wing Collegium – $2,500,000
Atrium – $1,000,000
Clean Room – $500,000
Department Meeting Room – $500,000
Laboratory – $250,000
Patio – $250,000
Conference Room – $50,000
Faculty Office – $25,000

For more information, contact James Azzaro, Development Officer, College of Mathematical and Physical Sciences, (614) 292-6980, azzaro.1@osu.edu.

www.physics.ohio-state.edu

Physics Open House

APS/AAPT Ohio Division Fall 2002 Meeting

The biannual American Physical Society (APS) Ohio Division meeting, held at Ohio State on October 18 and 19, 2002, was the busiest it's ever been. For the first time since the conception of the biannual meeting, both the Ohio and Southern Ohio sections of the American Association of Physics Teachers participated in the meeting. Add to that the fact that Ohio State was also running its annual Physics Open House, and you have the makings of a fun-filled physics weekend!

"Having both together gave the meeting a sense of the full scope of physics," said Steve Pinsky, professor in the Department of Physics and meeting coordinator. "Everyone from high school students who are thinking about becoming physicists to world-class research scientists were there. We had it all. We are all involved in education either as students or teachers, and having the strong presence of the AAPT was a real plus. Everyone loved the [open house] demonstrations."

The demonstrations, presented each year by Associate Professor Linn Van Woerkom, feature the irresistible title, "Things you should never, ever put in a microwave." Van Woerkom delights his audience by showing what happens when a variety of objects—from a hammer to CDs to soap—are placed in a microwave. He also showcases things you should never do with liquid nitrogen.

The meeting was also an opportunity to highlight the Department of Physics' string theory group, a group that originated in the autumn of 1999 with professors Arkady Tseytlin and Samir Mathur. Several of the meeting's talks focused on string theory, with sessions given by world-class researchers Igor Klebanov from Princeton University, Michael Duff and Finn Larson from the University of Michigan, and Sumit Das from the University of Kentucky.

Leonard Jossem and graduate student Christian Raduta show visiting high-school students a "physics of toys" demonstration.

Graduate student Yuh-fen Lin shows high school students physics in action.

Steve Pinsky assists with the demo.

An eager audience fills the Lawrence Lecture Room in McPherson Lab during Linn Van Woerkom's demo.

Alumni—Let Us Hear from You!

Are you (or is someone you know) an alumnus of the Ohio State Department of Physics with an interesting story or news to share? We would like to feature these stories in the new Alumni News section of Ohio State Physics magazine. Contact Melissa Weber, editor, at weber.254@osu.edu, (614) 292-2254, or at the following address:

Physics Magazine
Department of Physics
1012 Smith Lab
174 W. 18th Ave.
Columbus, OH 43210

The following article was published in The Other Paper*, a weekly alternative paper published in Columbus, Ohio. The story was written by Jenny Young and is used here with permission.*

What Inventors Talk About in Private

Tuesday's meeting of the Inventors Network revealed some astonishing facts. For example: Inventors actually look like normal people.

Paul Cover, [1955 graduate from the Department of Physics at The Ohio State University] the group's treasurer and secretary, is a kind, grandfatherly gent who, it just so happens, helped to invent photocopying during his 31 years at Battelle.

The physicist and inventor, who lives in Hilliard, also worked on batteries for pacemakers, deep-sea rescue vehicles and satellites, and his name is on a patent for ultra-fine filters used in airbags.

Although he retired in 1986, Cover still putters around with ideas.

"I keep making stupid things around the house that my wife laughs at," he said.

And, of course, he attends the Inventors Network meetings the second Tuesday of every month at Chemical Abstracts. The group gives fledgling inventors a chance to pick the brains of more experienced ones for tips on idea protection, marketing and the ins and outs of getting a patent.

Tuesday's get-together featured speaker Ron Docie, who looked and sounded more like a polished businessman than a mad scientist.

Docie got lucky in 1975 with his first invention: the still-popular Docie Wedge Blindspot Mirror, which he dreamed up while driving a hearse for Schoedinger Funeral Homes. The DWBM is that little wide-angle mirror you stick to your car's regular rearview mirror.

After that, he founded Docie Development in Athens, Ohio, which handles marketing and contract negotiations for inventor-clients. Most potential inventors get stuck, he said, when it comes to getting paid. They either can't find companies such as Battelle to help fund their projects, or they can't find manufacturers who will license their ideas and pay royalties.

"Usually inventors can't market themselves out of a brown paper bag," he told *The Other Paper* before the meeting.

Such issues are covered in Docie's new book, *The Inventor's Bible*, as is his No. 1 tip: Don't fret about people stealing your invention.

"That is probably the most worried-about thing by inventors, and the least important thing to worry about," he said.

"That doesn't mean you shouldn't be careful, but I think it also means you shouldn't be so anal about the doggone idea."

Despite talk of market research and selling price, there were still signs at the meeting that inventors' minds work in strange and mysterious ways. For instance, an audience member offered advice on doing patent searches at the U.S. Patent and Trade Office's website.

"You might type in 'finger-activated aerial toy,'" he tossed out as an example.

"Or 'Frisbee,'" an audience member muttered.

At another point, Docie began a story about his friend who invented the modem, then paused to make sure the 15 or so people in the audience were keeping up.

"You know what a modem is, right? An acoustic coupler?" he asked.

Ah, yes, an acoustic coupler.

Cover talked about the "joyful, creative skills" of inventing in almost spiritual terms, and he mostly steered clear of "patent-ese." His latest creation is a three-legged stool with an insulated pocket under the seat for holding a beverage—an idea that came to him one day when he was working outside.

"I always had my drink over here," he said, extending his arm to illustrate, "and I was forever knocking it over. But I've never kicked over the bottle when I've been sitting on top of it."

But even though Cover jokes that his creation will "cure your thirst and bad back," he has no plans to capitalize on it.

"I don't have the time or money to market it," he said. "I'm to the point that I'm glad if someone steals my idea."