Quantum

Department of Physics and Astronomy

Alumni Newsletter Summer '08

College of Liberal Arts and Sciences

Quantum

Departments

On the cover

Photo by

Features

College of Liberal Arts and Sciences
LAS
IOWA STATE UNIVERSITY

Joseph Shinar, chair
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Physics faculty honored for research, teaching and service

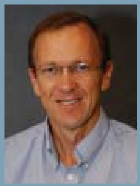
Several faculty members in the Department of Physics and Astronomy will be recognized by Iowa State University and the College of Liberal Arts and Sciences (LAS) this September.

The faculty members will be honored with awards based on their research, teaching and service to Iowa State and LAS.

The recipients include:

Iowa State Awards

J.H. Ellis Award for Excellence in Undergraduate Introductory Teaching - Recognizes outstanding performance in teaching undergraduate introductory classes (defined as entry-level courses in the discipline).



Craig Ogilvie, associate professor of physics and astronomy. Ogilvie's main teaching activities have been in "Introduction to Classical Physics" with an enrollment of between 300-500 students per semester. He has been highly innovative in his approach to this course, for example by introducing the use of clickers for rapid feedback to the lecturer and students, and introducing computer-based feedback in recitation sections. Ogilvie has won several awards for his teaching and teaching innovations and has given many lecturers on- and off-campus on his teaching methods and results.

College of Liberal Arts and Sciences Awards

Mid-Career Achievement in Research Award - Recognizes faculty members who have a national or international reputation for outstanding contributions in research and/or artistic creativity at the mid-career stage.

Marzia Rosati, associate professor of physics and astronomy. Rosati has made significant contributions to the PHENIX experiment at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory, Long Island, N.Y. Her research has led to 128 publications and many more citations by other researchers.

Ruth W. Swenson Award for Outstanding Advising Award - Recognizes outstanding performance as an undergraduate academic adviser over an extended period of time.

Kerry Whisnant, professor of physics and astronomy. Whisnant has been the Department of Physics and Astronomy's undergraduate advising coordinator since 2000 and has been an undergraduate adviser since 1997. At the time of his nomination, he personally advised 53 of the 80 undergrads in the department, including all 10 double majors, five teacher education students and half the freshmen.

Outstanding Achievement in Departmental Leadership Award - Recognizes a department chair who has demonstrated exceptional leadership qualities in advancing the faculty, staff, students and programs in his or her department.

Eli Rosenberg, professor and chair, physics and astronomy. Rosenberg joined ISU in 1979 and became department chair in 2002. He has introduced many innovations in departmental policy and activities that have greatly benefited students, faculty and staff. He also has taken leadership roles in a number of campus-wide activities.

Shinar named chair of the Department of Physics and Astronomy

Joseph Shinar, professor of physics, has been named chair of the Department of Physics and Astronomy effective July 1, 2008.

He replaces Eli Rosenberg, professor of physics, who has accepted a position with the United States Department of Energy in Washington, D.C. Rosenberg will remain on the Iowa State faculty.

A senior physicist with the U.S. Department of Energy's Ames Laboratory, Shinar has been a faculty member at Iowa State since 1985. He has also served as a research fellow at Israel Institute of Technology and a research associate at the University of California, Santa Barbara.

In 2005, Shinar was elected as a fellow of the American Physical Society (APS), an honor granted to no more than one-half of one percent of the current membership of the Society. He was selected for "pioneering contributions to studies of H motion in metal hydrides and amorphous Si, and optically detected magnetic resonance studies of luminescent pi-conjugated polymers, fullerenes, and organic devices."

Shinar's research group works on the science and technology of organic light-emitting devices (OLEDs). OLED-based displays have been incorporated into commercial products such as stereos, cell phones and televisions. Shinar's group works to improve the efficiency, brightness and life of OLEDs.

He is also working with industrial physics to develop luminescent chemical and biological sensors structurally integrated with the OLEDs, which are used as the light source for the luminescent sensor. He has worked to develop OLED-based glucose and hydrazine sensors for NASA and in conjunction with the National Animal Disease Center to develop an anthrax sensor.

Shinar has received three U.S. patents and in 2004 was the recipient of the ISU Foundation Award for Outstanding Achievement in Research.

Costas Soukoulis named Craig Chair

Costas Soukoulis, Distinguished Professor of liberal arts and sciences and professor of physics and astronomy, can add another title to his name.

Earlier this year, Soukoulis was named the Frances M. Craig Chair at Iowa State. He is the third individual appointed to this position on campus.

The Craig Chair was established from portions of proceeds of a $12 million gift made by late Iowa State alumna Frances Craig, a 1949 home economics graduate. Earnings on the endowment are directed to strategic priorities at the university president's discretion. The fund will allow the president to put special emphasis on faculty support.

A world leader in four different fields of theoretical condensed matter physics, Soukoulis' group's interest focuses on the development of a theoretical understanding of the properties of disordered systems, photonic crystals, left-handed materials, random lasers, random magnetic systems, nonlinear systems, and amorphous semiconductors. The theoretical models developed are often quite sophisticated to accurately reflect the complexity of real materials.

Soukoulis and his team have received numerous awards over the past few years including:

- The Descartes Prize for Excellence in Scientific Collaborative Research, the European Union's highest honor in the field of science in 2005. Soukoulis was recognized for creating a novel class of artificial metamaterials called left-handed materials, which exhibit fascinating properties that cannot be found in naturally occurring materials.
- An Energy 100 Award and Science 100 Award from the U.S. Department of Energy (DOE) for the photonic bandgap structure that he developed along with Ames Lab senior physicist Kai-Ming Ho and physicist Che-Ting Chan. These awards recognize the 100 most important scientific and technological discoveries funded by the DOE during the previous 25 years since the department's inception.
- In 2002, Soukoulis was elected a Fellow of the Optical Society of America "for outstanding and pioneering contributions to the understanding of disordered and periodic systems, particularly the physics of photonic bandgap materials and random lasers."
- That same year, he was elected a Fellow of the American Association for the Advancement of Science (AAAS). Soukoulis was honored for notable pioneering contributions to the understanding of the localization of light, of random lasers, and of photonic crystals.
- Soukoulis was also named a recipient of an Alexander von Humboldt Foundation Research Award. These awards are given annually to foreign scholars with internationally recognized academic qualifications. The recipients also are invited to carry out research in Germany in collaboration with German scholars for periods of between six months and one year.

Physics faculty recognized

Another faculty member in the Department of Physics and Astronomy has been elected as a fellow of the American Physical Society (APS).

Marshall Luban, professor of physics, was recommended by the

APS' Division of Condensed Matter Physics.

Luban was cited "for long-term significant contributions to condensed matter theory, including pioneering work on the Lifshitz multicritical point, on Bloch oscillations of electrons in semiconductor superlattices, and the modeling of magnetic molecules."

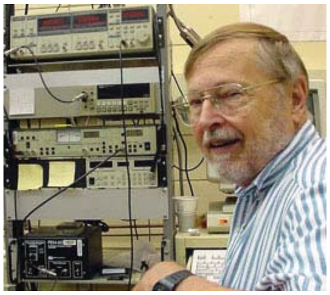
The honor is granted to no more than one-half of one percent of the current membership of the Society. The election of the Luban by his peers brings the number of APS fellows in Iowa State's Department of Physics and Astronomy to 15.

Two other members of the department, Douglas Finnemore and Bruce Harmon, both holding the rank of Distinguished Professor, have also been recognized by the APS. The pair has been named as a member of the inaugural group of "Outstanding Referees."

This lifetime award is given for Finnemore and Harmon's "help to advance and diffuse the knowledge of physics while creating a resource that is invaluable to authors, researchers, students and readers."

Lynch named AAAS Fellow

David Lynch, Distinguished Professor emeritus of liberal arts and sciences and professor of physics and astronomy, was among five Iowa State University faculty members who were



awarded the distinction of being named fellows by the American Association for the Advancement of Science.

Lynch was recognized for using synchrotron radiation sources to elucidate materials and for service in charting the future of synchrotron facilities in the United States.

Election as a fellow is an honor bestowed upon AAAS members by their peers.

This year, 471 members were awarded this honor by AAAS because of their scientifically or socially distinguished efforts to advance science or its applications. New fellows were presented with an official certificate and a gold and blue (representing science and engineering, respectively) rosette pin at the Fellows Forum during the 2008 AAAS Annual Meeting in Boston in February.

The AAAS is the world's largest general scientific society, and publisher of the journal, Science (www.sciencemag.org). AAAS was founded in 1848, and includes some 262 affiliated societies and academies of science, serving 10 million individuals.

Rosenberg to Washington, D.C.

After successfully chairing both the Department of Physics and Astronomy and the High-Energy Physics group at the U.S. Department of Energy's (DOE) Ames Laboratory, Eli Rosenberg wanted a change.

Even with all he had accomplished, the decision to make the change wasn't made lightly.

"It was a difficult decision to make," he says, "but at some point you realize that you aren't going to win a Nobel Prize."

Rosenberg will spend at least the next two years, and possibly up to four, at the DOE's national headquarters in the Washington, D.C. area. There he will review grant applications in the DOE's high-energy physics program.

This is an area where Rosenberg has extensive experience. He serves as the principal investigator on the DOE grant that funds all research in high-energy physic at Iowa State, including accelerator-based experimental work, theoretical work and particle astrophysics. The program annually receives more than $1 million in DOE funding.

He has also served as a consultant to the DOE in reviewing the high-energy physics programs at Argonne National Laboratory and the Lawrence Berkeley National Laboratory.

"I think I bring an unique perspective to help make these type of decisions," Rosenberg said. "While I will miss the active research component of my work, it becomes a question of where I think I can make the most contributions at this stage of my career.

"And because of the recent slashes to the federal budget, I think it is more important than ever that I take this job."

Rosenberg, who will remain a member of the Iowa State faculty, says a majority of his time will now be spent reviewing grant applications and making site visits to universities and DOE national laboratories.

"It gives you a new perspective to find out what is happening in the field," he said. "I hope to be able to advise others on what it will take to put them in a stronger position to receive federal funding."

A Fellow of the American Physical Society, Rosenberg was both an Enrico Fermi Postdoctoral Fellow and a DOE Outstanding Junior Investigator. He has collaborated on major experiments at the Fermi National Accelerator Laboratory in Batavia, Ill., the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, and the Stanford Linear Accelerator Laboratory (SLAC) in Menlo Park, Calif.

He is the author or co-author of over 500 refereed scientific journal articles and is currently working on the BaBar experiment at SLAC's PEP-II Asymmetric B-faculty and preparing for the ATLAS experiment, which will take data at CERN's Large Hadron Collider.

Joseph Shinar, professor of physics and astronomy, will assume the chair of the Department of Physics and Astronomy effective July 1, 2008. DG

Magnetic nanoparticles

Interdisciplinary Ames Laboratory team uses bioinspired approach.

When it comes to designing something, it's hard to find a better source of inspiration than Mother Nature. Using that principle, a diverse, interdisciplinary group of researchers at the U.S. Department of Energy's Ames Laboratory is mimicking bacteria to synthesize magnetic nanoparticles that could be used for drug targeting and delivery, in magnetic inks and high-density memory devices, or as magnetic seals in motors.

Commercial room-temperature synthesis of ferromagnetic nanoparticles is difficult because the particles form rapidly, resulting in agglomerated clusters of particles with less than ideal crystalline and magnetic properties. Size also matters. As particles get smaller, their magnetic properties, particularly with regard to temperature, also diminish.

However, several strains of bacteria produce magnetite (Fe3O4) – fine, uniform nanoparticles that have desirable magnetic properties. These magnetotactic bacteria use a protein to form crystalline particles about 50 nanometers in size. These crystals are bound by membranes to form chains of particles that the bacteria use like a compass needle to orient themselves with the Earth's magnetic field.

To see if researchers could learn from the bacteria, Surya Mallapragada, Ames Laboratory Materials Chemistry and Biomolecular Materials program director, pulled together a team that included microbiologists, biochemists, material chemists, chemical engineers, materials scientists and physicists from Ames Laboratory and Iowa State University.

As a starting point, former ISU microbiologist Dennis Bazylinski, now at the University of Nevada-Las Vegas, isolated several strains of magnetotactic bacteria for use in the study.

Based on earlier work by a Japanese research team, Ames Laboratory biochemist Marit Nilsen-Hamilton looked at several proteins known to bind iron, including Mms6 found in magnetotactic bacteria, which she cloned from the bacteria. "This protein is associated with the membranes that surround the magnetite crystals," Nilsen-Hamilton said, "and each bacterium appears to make particles with their own unique crystal structure."

Ames Lab chemist Tanya Prozorov tried synthesizing crystals, using the proteins with various concentrations of reagents in an aqueous solution, but the particles formed quickly, were small and lacked specific crystal morphology. At the suggestion of Ames Lab senior physicist and crystal growth expert Paul Canfield, the team used polymer gels developed by Mallapragada and Balaji Narasimhan, who are both Ames Lab scientists as well as ISU chemical engineers, to slow down the reaction and help control formation of the nanocrystals and minimize aggregation.

"It's simple chemistry," Prozorov said, "and you can judge the reaction by the color, watching it go from yellow to green to black as the crystals form. Once the crystals precipitate out, we use a magnet to concentrate the particles at the bottom of the flask, then separate them out to study them further."

Prozorov also conducted electron microscopy analysis of the synthetic nanoparticles, which showed that Mms6 produced well-

formed, faceted crystals resembling those produced naturally by the bacteria. Powder X-ray diffraction studies verified the crystal structure of the particles.

Ames Lab physicist Ruslan Prozorov, tested the magnetic properties of the synthetic crystals, which also showed striking similarities to the bacteria-produced crystals and bulk magnetite. The magnetic studies also showed that the "chains" of particles formed by the bacteria had a much sharper magnetic transition definition at a higher temperature than single crystals.

"Nature found a way to beat the thermodynamics (of crystalline magnetite) by arranging the nanoparticles in such a way that they aren't affected by temperature the way individual crystals are," Ruslan Prozorov said.

With this basic understanding of magnetotatic bacteria and the ability to synthesize magnetite nanoparticles, the team proceeded to find out if the bioinspired approach could be used to produce cobalt-ferrite nanoparticles. Cobalt-ferrite, which doesn't occur in living organisms, has more desirable magnetic properties than magnetite, yet presents the same problems for commercially producing nano-scale particles.

In addition to their previous method, the team took the added step of covalently attaching the Mms6 to a strand of functionalized polymer known to self-assemble and form thermoreversible gels. Because the polymer strands come together in a particular way, the attached proteins had a specific alignment that the researchers hoped would serve as a template for the formation of cobalt-ferrite crystals. And the way in which the gel formed would help control the speed of the reaction.

"It worked rather well," Tanya Prozorov said, "and we ended up with very nice hexagonal cobalt ferrite crystals" and added that she is studying whether the protein will also work for the other neodymium, gadolinium and holmium ferrites.

The project is funded by the Department of Energy's Office of Basic Energy Sciences, the National Science Foundation, and the Alfred P. Sloan Foundation. The research has generated fodder for a number of journal articles, including published works in *ACSNano*, *Physical Review B,* and *Advanced Functional Materials*.

New materials

Ames Laboratory physicist makes a case for pursuing new materials research.

What do Sophocles, the Rolling Stones, and Linus Pauling have in common and what do they have to do with fishing? Well, the unlikely trinity is quoted in a perspective piece on new materials in the March issue of *Nature Physics* by Paul Canfield, a senior physicist at the U.S. Department of Energy's Ames Laboratory. In it, Canfield argues that more effort and funding needs to go toward the design, discovery and growth of materials that exhibit new or exotic properties.

The article, "Fishing the Fermi Sea," includes the following intro which gives a hint at the connection: "Sophocles had it right, the Rolling Stones made a friendly amendment and Linus Pauling detailed the conceptual mechanism for finding novel materials that will define and revolutionize the future."

"The design of new materials … is an exercise in trying to improve the odds of finding something interesting," Canfield, who is also an Iowa State University Distinguished Professor, explains in the article. "This requires some ideas of how to improve the odds, and some method of checking whether you have succeeded or not."

He draws a parallel by turning to Pauling's reply when the Nobel-prize-winning chemist was asked how he came up with so many great ideas – "The way to get good ideas is to get lots of ideas, and throw the bad ones away." Canfield then compliments Pauling's statement with a line from the 1969 Rolling Stones hit which laments, "You can't always get what you want, but if you try sometimes, you just might find, you get what you need."

"There can be a certain amount of luck involved in discovering new materials," Canfield says, pointing out that rare-earth neodymium-iron-boron magnets resulted from an attempt to melt neodymium and iron in a boron-nitride crucible and some of the boron leached out to form the new compound.

"Sadly, many classically trained physicists disdain such efforts and refer to them as 'fishing trips,' akin to throwing darts at the periodic table while blindfolded," he continues. "That couldn't be further from the truth and, as in the case of a real fisherman, you go where the 'fish' are known to congregate and reap an abundant harvest."

Besides the title, the article is accompanied by two graphics that depict this type of educated, purposeful fishing. The first is a photo of an ancient mosaic on display at the Archaeological Museum at Sousse, Tunisia, that honors fishermen skilled at finding the "right place" to fish. The second is an illustration by Canfield's son Jacob, a high school senior, that depicts a scientist (that looks remarkably similar to the elder Canfield) fishing in a "sea" populated by superconductors, non-traditional and traditional Kondo systems, quasicrystals, Stoner systems and local-moment magnets.

"Searches for interesting compounds are obviously more successful when the definition of success is allowed to be as broad as possible," Canfield says. "This breadth is one of the reasons that groups engaged in such searches often have fairly wide research interests and even wider networks of collaborators."

This collaboration also helps advance the discovery process. "Sometimes realizing that a material is of great interest to somebody other than yourself is almost as important a step as growing the material in the first place," Canfield adds.

He closes the article with perhaps the simplest, yet most appropriate argument for actively seeking out new materials by quoting Sophocles from his play Oedipus Rex: "Seek and ye shall find. Unsought goes undetected."

Canfield wrote the article at the request of the editors of *Nature Physics* who approached him in late 2007 about writing a "thought piece" on new materials. He has long been an advocate for new materials research and last year testified in Washington D.C., before the National Academy of Science's Materials Synthesis and Crystal Growth committee that has been charged to study and assess the status of new materials development and crystal growth in the United States.

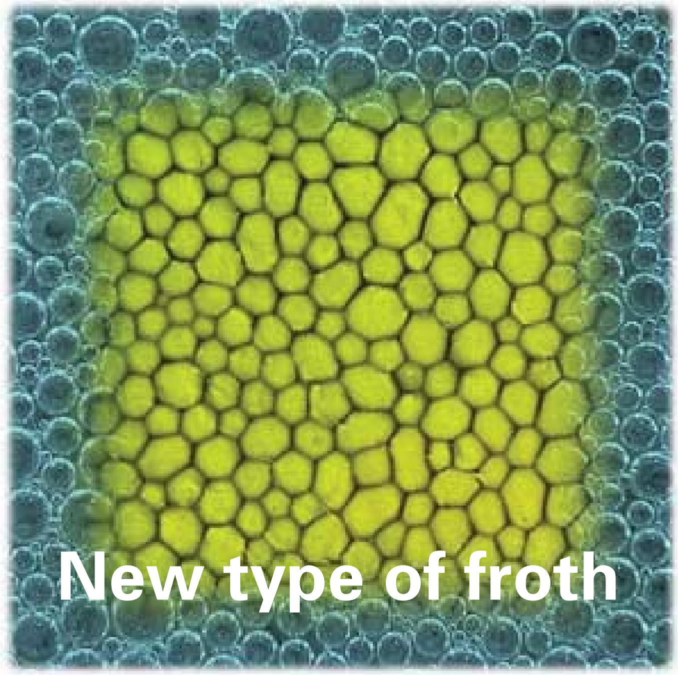
"I've gotten positive feedback," Canfield said, "with many people stating that 'this needed to be said.' Some were also amazed at working Pauling and the Stones into the same sentence."

As for the illustrations, Canfield said the editors wanted something "eye catching." He first came across the photo of the fishermen mosaic from Tunisia and then turned to his son who has developed into a skilled illustrator.

"Jacob's a good illustrator and was willing to draw a physicist fishing from a boat," he said. "It seems that became me in a boat, though that wasn't part of the request. One colleague said it was clearly a poor drawing since my back is never that straight."

Canfield said that he enjoyed preparing the piece and hopes it helps draw attention to the need for more newmaterials research.

"It's out of these types of broad, collaborative searches that the materials that will be used to address the challenges of the next century will be discovered," he said. "On the other hand, if research groups are discouraged from this activity, then it becomes a self-fulfilling prophecy and they will not discover anything."



New type of froth

Physics team propose model froth system

To see the latest science of type-I superconductors, look no further than the froth on a morning cup of cappuccino. A team of U.S. Department of Energy's Ames Laboratory physicists and collaborating students have found that the bubble-like arrangement of magnetic domains in superconducting lead exhibits patterns that are very similar to everyday froths like soap foam or frothed milk on a fancy coffee.

The similarities between the polygonal-shaped patterns in conventional foams and "suprafroths," the patterns created by a magnetic field in a superconductor, establish suprafroths as a model system for the study of froths.

"There are certain statistical laws that govern the behavior of froths, and we found that suprafroths satisfy these laws," said Ruslan Prozorov, Ames Laboratory physicist and primary investigator. "We can now apply what we know of suprafroths to all other froths and complex froth-like systems."

Prozorov discovered the suprafroth pattern last year, seeing an unexpected foam-like design when he applied a magnetic field to a lead sample in a magneto-optics system. Since the term "superfroth" was already in use for an unrelated product, Prozorov coined "suprafroths" in a nod to history: in the 1930s, superconductors were called "supraconductors."

To help characterize suprafroths, Prozorov pulled together a team including Ames Lab senior physicist Paul Canfield, summer laboratory assistant Andrew Fidler and graduate student Jacob Hoberg.

Canfield, who has an interest in pattern formation in nature, supplied the original idea to compare suprafroths' patterns to conventional froths.

"Last year, we were standing by Ruslan's poster on equilibrium patterns in Pb (lead), and I was discussing one of his figures during a break," said Canfield. "I recognized that the patterns he was showing for his Pb sample were exceptionally similar to that of a classical picture of bubbles.

"At first Ruslan was skeptical, but over the next few weeks we both realized just how profound the similarity between suprafroths and conventional froths was," Canfield continued.

The team's analysis revealed that suprafroths behave similarly to other commonplace froths, despite their very different microscopic origins: traditional froths' cell walls consist of material like detergent, water or plastic, while suprafroths' cell boundaries consist of superconducting phase lead.

One similarity between suprafroths and conventional froths is the process of coarsening, or when froth cells grow or shrink and eventually disappear. In everyday froths, this process is evident in a sink full of dish soap bubbles that pop and disappear over time. The process is similar in suprafroths when magnetic field is increased, illustrating that suprafroths adhere to John von Neumann's law, the widely accepted concept in froth physics that specifies the rate at which froth cells grow or shrink.

"Seeing von Neumann's law at work in suprafroths shows that the froth state is really an intrinsic property of this superconductor," said Prozorov.

"Suprafroths, like regular foams, adhere to the concept of area tiling that says that if you want to cover a plane with polygons with each having three vertices, the most probable polygon is a hexagon," he continued.

Physicists have long believed in a connection between the two statistical rules of froths. Common understanding has been that the most probable polygon—the hexagon—was related to the number of sides—six—that determines whether a froth cell shrinks or grows during coarsening. But the Ames Lab team's analysis has decoupled these two concepts in suprafroths.

"In our suprafroths, we found that the association between these two ideas is a coincidence, said Prozorov. "There is no strict correspondence between the most stable type of froth cell and the most common number of sides in a froth cell."

In suprafroths, cells of all observed numbers of sides grow with an increase in magnetic field, a discovery marking an important contribution to the general study of froths.

But the most significant contribution suprafroths make to the general physics of froth is as a model system that can be used to study all froths. Suprafroths offer reversibility, a significant benefit over conventional froths.

"In everyday froths, like soap foam, the agent of change is time," said Prozorov. "You have to wait for bubbles to simply dry out, and that takes days. And it's not reversible. You cannot reverse time."

"Once the bubbles pop, the problem is that the physical and chemical properties of the cells get modified, so that doesn't make for a clean experiment," Prozorov continued. "In an ideal situation, you want to only study the properties of the froth patterns and their complexity. You want to easily be able to change some parameter and change the structure of the froth."

Achieving an ideal froth experiment is possible in suprafroths because the agents that create the superconducting phase cells are magnetic field and temperature, both reversible parameters.

"Magnetic field and temperature can be tuned in the lab," said Prozorov. "They can be increased or decreased, and therefore we are able to study the pure statistical properties of froth without problems associated with the irreversibility of time or with chemical property changes."

High-energy physics

In this decade alone, almost $10 million has come to Iowa State's Department of Physics and Astronomy and the U.S. Department of Energy's (DOE) Ames Laboratory for funding high-energy physics research.

"Historically the department had three individual goals," said Eli Rosenberg, professor and past chair of the Department of Physics and Astronomy. "A few years ago we decided to combine the grants into one application.

"It was not only a trend in our area but also helped reduce paperwork once the grant was combined."

Rosenberg, who has served as the principle investigator on the DOE grant, says the funding includes accelerator-based experimental work, theoretical work and particle astrophysics. The program annually receives more than $1 million in DOE funding.

"Our large funding levels are a reflection of the fact that we are doing research that is important to the scientific community as a whole in high-energy physics and other areas," Rosenberg said. "Our faculty are playing important roles, many times lead roles, in important projects throughout the world."

There are four distinct research programs within the high-energy physics program. Rosenberg says that research done by Iowa State physics faculty members in these areas not only coincides with activities within the Ames Laboratory, but also coincides with activities at similar DOE and other government facilities in the U.S. and the world.

Each research program is actively engaged in the study of high-energy gamma rays in both the VERITAS and GLAST collaborations and include:

- Professor John Hauptman leads an experimental program working on the DZero detector at the Fermilab Tevatron Collider, on the Hadronic Forward (HF) calorimeters of CMS (including simulations and some instrumentation), and on the 4th Concept detector for the ILC.
- Professors James Cochran, H. Bert Crawley, W. Thomas Meyer, Soeren Prell and Rosenberg form the Ames High-Energy Physics Group. Past activities include the DELPHI detector at the CERN LEP site. The group's current projects include the PEP-II BaBar detector at SLAC, and the ATLAS detector at the CERN LHC site.
- Phenomenological research in particle theory is done by Professors David Atwood, German Valencia and Kerry Whisnant. Studies of Quantum Chromodynamics also form part of the research in theoretical nuclear physics carried out by Professors Jianwei Qiu, Kirill Tuchin and James Vary.
- Professors David Carter-Lewis, Frank Krennrich and Martin Pohl do research in particle astrophysics.

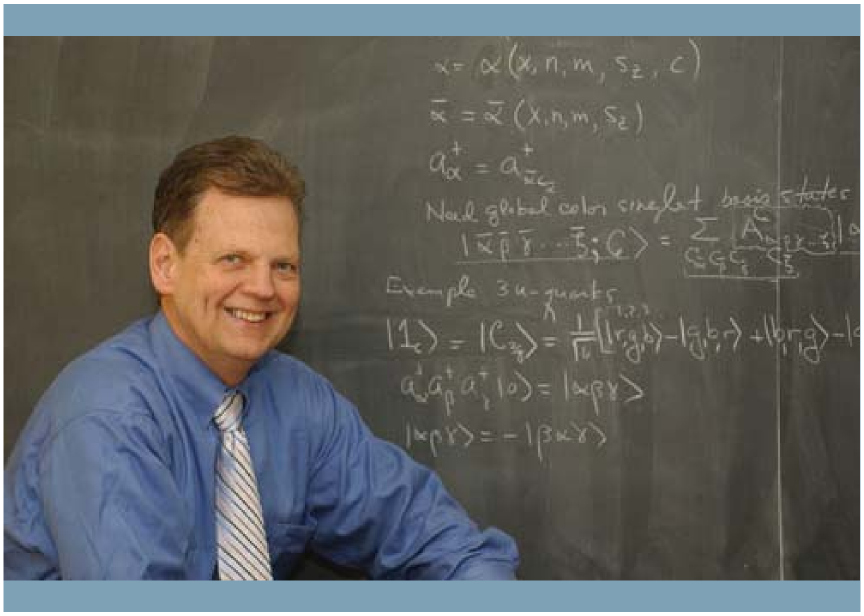
"These are large projects with large time scales attached to them,"

Rosenberg said, "The Department of Energy has faith in us doing front-level research in this area.

"Because we have an excellent track area in this year, the department has had a history of funding as well. We keep on submitting proposals and they keep getting funded so we must be doing something right." DG

Nuclear theory group

Computational advances pushing physics discoveries.



James Vary has spent his career studying the universe. As a member of the physics nuclear theory group at Iowa State, the professor of physics and astronomy is part of a global community of scientists who ask questions like, "What is the universe made of?"

They don't exactly know, but as Vary likes to say, "We know a lot about what we don't know.

"What we do know only makes up four percent of the universe," he said. "So 96 percent of it is out there, we know it's out there, we know a little about it, but we don't know what it all is."

Physicists have been searching for these answers for years. Using gigantic and powerful particle accelerators and high-tech detection devices, they have studied matter at the smallest scale known.

Vary now is confident that particle physics will make astronomical leaps in the coming years through an emerging form of discovery: computational science.

"We're going to find out a lot about this 96 percent in the next few years," he said.

Scientists from all fields are benefiting from the tremendous advances in computers. Computational physics, like computational biology or chemistry, is leading to discoveries, Vary said.

"We're actually getting to the discovery phase using computers," he explained. "We sometimes characterize this as the three-legged stool of current science - theory, experiment and computational simulations."

Vary's lab is working to calculate the mass (the binding energy) of the nucleus in carbon-12, a fundamental element in the universe and the building block of carbon-based life forms.

Physicists believe, Vary said, that "hints of the mysterious 96 percent can be found in high-precision comparisons between theory and experiment on the known four percent." For this reason Vary and his team aim to obtain exact solutions of carbon-12 from existing theory of the four percent to compare with the results of the experiments.

"We'd like to figure the mass of carbon-12 to a fraction of a percent," Vary said. "We're within two percent of the exact mass, and we'd like to get it to one-half percent."

To do so takes great computational power. Vary's research is using the supercomputers at the Department of Energy facilities at Oak Ridge, Tenn., Berkeley, Calif., and Livermore, Calif.

Traditionally scientists came up with a theory and did approximations, which Vary said could be off as much as 50 percent. The massive computers (each can have the power of 12,000 to 25,000 high-end workstations) do away with the gross approximations.

Although Vary has been involved in his research since the late 1960s, it's only been in recent years that computers have come on the scene with their enormous computational capabilities.

Computer simulations allow Vary and his team to explore, for example, the ways in which the nuclei behave during experiments.

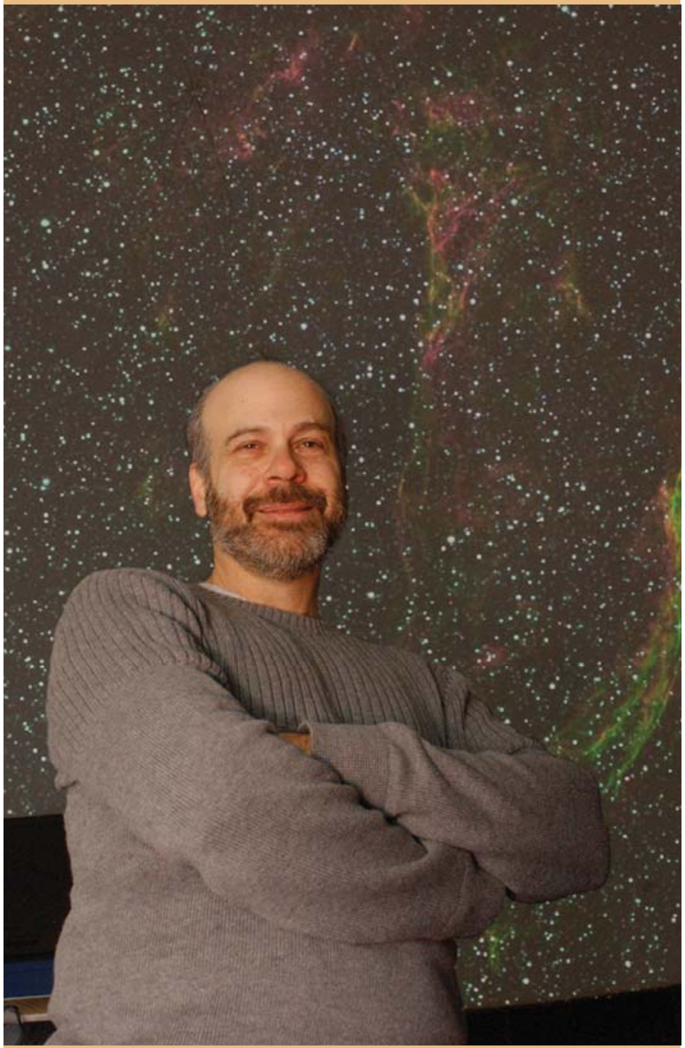
"We can see which simulations give us a particular phenomena we're looking for. Or, if we have no idea what an experiment is telling us, we can alter the simulations until we see a good match-up of the phenomena with the experiment."

At some point, Vary noted, the "experiment" could be efficiently run on a computer and would be much cheaper than to run it on the big accelerator.

"If your theory is good and you're testing your theory along the way, you should be able to predict the results of that experiment," he said. SJ

Starry afterthought

Steve Kawaler and the Whole Earth Telescope contribute to major planetary discovery.



It was nothing more than an afterthought.

There just happened to be extra observing time during a three-week run of the Whole Earth Telescope, a worldwide network of cooperating observatories that allow astronomers to take uninterrupted measurements of variable stars that change in brightness.

Steve Kawaler, professor of physics and astronomy, was responsible for organizing that observing run. He didn't give much thought to the third-priority target. After all, one of his own graduate students had gotten similar results on a similar star previously. Those findings didn't pan out after the initial excitement generated by the data.

So when WET made their observations during the 2003 run, they concentrated their efforts on their primary target – a supernova progenitor.

Today, Kawaler can't tell you if anything came from the data collected for the primary target. As for the afterthought – well the data that Kawaler helped obtain may well turn out to be one of the most significant astronomical discoveries in recent years.

Kawaler is part of an international team of astronomers that announced recently in *Nature* of the first discovery of a planet orbiting a star near the end of its life. The star, in the constellation of Pegasus, represents the state of our own sun 4-5 billion years into the future. The announcement culminates seven years of research on the planet with the tongue-rolling name of "V 391 Pegasi b."

The discovery is important because it could provide a look into the future of what will happen to the Earth when the sun exhausts its hydrogen fuel, expands enormously as a red giant and expels its outer layers in an explosive helium flash.

Never before has a planet been observed that has survived such an evolution of a red giant.

"The exciting thing about finding a planet around this star is that it indicates that planetary systems can survive the giant phase and the helium flash of their parent star," Kawaler says. "This may indicate that the Earth could survive a similar expansion of the sun."

While "V 391 Pegasi b" is the first planet to be observed surviving a red giant expansion, there are differences between that planet and the Earth. The recently discovered planet is larger than Jupiter and Kawaler warns a smaller planet like Earth could still be vulnerable.

The international research team was led by Roberto Silvotti from the INAF-Osservatorio Astronomico di Capodimonte in Naples, Italy, and a long-time collaborator of Kawaler's.

In addition to the role WET played in obtaining data, Kawaler advanced the project by doing theoretical calculations to make sure irregularities of the star's orbital motion were caused by the orbiting planet and not processes within the star itself.

"I am delighted to have been able to contribute to an extremely exciting discovery," Kawaler said.

The discovery has also got Kawaler dreaming again.

"This has made me think about why I and others got interested in astronomy and space as kids in the first place," he said, "you want to find aliens and this has me thinking again about life on other worlds around other stars." DG

Large-class success

By using breakout sessions and group projects, Craig Ogilvie's physics 222 clicks with students.

Seat a couple hundred students in a large lecture hall, and Craig Ogilvie knows what they dread most.

"Everybody's worst fears are these large classes with the professor up front talking, talking and talking," he said.

The associate professor of physics and astronomy has worked to alleviate those fears in physics 222, which enrolls an average of 400 students a semester in up to three sections.

Ogilvie uses several innovative methods to engage students in the lecture hall and small-group recitation sections. For his efforts he was named a College of Liberal Arts and Sciences Master Teacher earlier this academic year.

Physics 222 is primarily engineering students. Ogilvie uses automated personal response units (aka the clickers) and brief group discussions in the lecture hall to personalize the large classes. In the recitation sessions students engage in midsemester group projects and two group exams.

Ogilvie believes he was the first ISU faculty member to use clickers in a large class. With a grant he purchased a class set a few years ago. Each student grabbed one of the devices from a box upon entering the class and returned it on the way out.

Now ISU students purchase their own devices, which are a large-class staple. Ogilvie uses them in the large lecture class as part of an effort to encourage small-group discussions. He will ask a "conceptual-type" question every 10 minutes or so. Students answer with their clickers then Ogilvie asks them to discuss the question among themselves in brief breakout sessions.

Each group provides its own answer via the clicker.

"Typically what I see is that the percentage of correct answers from the breakout sessions go right up," said Ogilvie, who walks about the room during the breakouts allowing students to ask him questions

Ogilvie's group projects in the recitation sessions challenge the students to choose an item they regularly use and apply physics principles to improve its performance. "It could be a George Foreman grill and the time it takes to cook a steak," Ogilvie explained. "Or it could be to increase the insulative properties of different blanket designs."

With teaching assistants as group mentors, the projects teach students how physics works in a complex system, and then the students use that understanding to build a mathematical model.

The twice-a-semester group exams follow a similar idea. Ogilvie said, "I'm interested in developing the students' skills of how to attack complex problems."

The students are challenged because he purposely gives them little data to use. For example, the assignment could be to calculate the amount of ice needed in an ice chest to keep drinks cold for a certain length of time. He might not indicate, for example, the thickness of the ice chest's walls.

"It assesses how students can attack complex problems, how they can work in a group in a finite time." Ogilvie explained. "The whole theme is to encourage students how to attack ill-structured, less-well-defined problems because that is what they will be doing when they graduate."

Ogilvie is dedicated to his teaching, and he also is an active researcher in ISU's experimental nuclear physics group. The research often pulls him away from campus to places such as the Department of Energy's Brookhaven National Laboratory on Long Island, N.Y.

Ogilvie is one of many physicists worldwide who use Brookhaven's RHIC (Relativistic Heavy Ion Collider) to study collisions of subatomic particles that might shed light on what the universe may have looked like in the first few moments after its creation.

But his travels curtail in the spring. That's when he teaches the scores of students in physics 222. SJ

Iowa State alum designates $200,000 for hobby, not career field

It may be difficult to believe that Doug Troxel, founder of the highly successful SERENA software company, would choose to designate a gift to his alma mater's physics and astronomy department over his career field of computer science.

But that's what he did. His recent unrestricted gift of $200,000 was allotted to the Department of Physics and Astronomy, an area related more to his hobby than his career.

"Ever since I was a kid, I've had this fascination with physics and astronomy," says Troxel, Iowa State alumnus and past CEO/ chairman of SERENA Software, Inc. "That's always been my real love."

In the beginning, Troxel's relationship with Iowa State was bittersweet. In fact, the well-known software entrepreneur really didn't want to go to college in the first place. Growing up on a farm in the small town of Yetter, Iowa, he didn't know what he wanted to do after high school, but he was certain he didn't want to be a farmer.

"I wasn't too keen about college. But my father insisted I go, so I enrolled at Iowa State," he said. "I knew more about what I didn't want to do than what I wanted to do. I knew I was good in math and science, but that was about it."

It wasn't until his senior year that Troxel stumbled upon a new course offering. It was called FOR-TRAN, short for formula translation, and was offered in the College of Engineering. It was unique, technical and after the first class, he was hooked.

"It was a new engineering language. It was so new that the teachers were learning about it as they taught us; we were all learning together," Troxel said. "I ate it up. I instantly knew that this is what I wanted to do."

The timing was perfect. Just as he graduated with a bachelor's degree in mathematics in 1967, Troxel found a surge of businesses recruiting fresh graduates for computer programming careers. With diploma in hand, he went to Jackson, Mich., and took his first job with Consumer's Power Company. There, he was able to dive into his new career writing computer software. He became fluent with complicated, but commonly used computer languages like COBOL and Assembler, but was eager to learn more.

"During my second year with the company, I didn't have enough seniority to be trained for a new up-and-coming IBM product Customer Information Control System or CICS," he said. "So at night, I would dig through waste baskets for compiled listings and study it on my own. It wasn't long after that I helped the team solve a problem and I became the resident expert in CICS and Assembler. Problem solving is what I'm really good at."

His career kept him moving and was filled with new opportunities. Troxel's intuitive understanding, expertise and vision in the industry made him a leader in his field which quickly led him to Silicon Valley. In 1980, he founded SERENA Software Inc., where he created a product that assisted large corporations struggling to keep up with the changing technology.

"When I worked for a large bank, every time they updated one software application, it would blow up another application because of invalid data passed to it. These programs tracked important information linking bank and trust accounts, so this was a big problem for them," Troxel said. "I wrote a produced call Comparax that ran tests on computers with new software to identify and eliminate possible software malfunctions."

The product's success was a launching pad for Troxel and SERENA Software Company, Inc. SERENA is now recognized as the world's largest company solely focused on managing change in the IT environment. "It was a way for me to do something larger and I knew I could make an impact," he said.

With many successful years under his belt, Troxel now splits his time between the SERENA headquarters in San Francisco, Calif., and his home in Kaon, Hawaii. He recently reconnected with his alma mater and often his more time to spend exploring his interests in physics and astronomy.

"I've always been very interested in science related to the cosmos, black holes and all of that. I read magazines, books, watch TV shows on the subject as much as I can," he explained. "I can't get enough of it and I'd study that all of the time if I could. That's where my passion is."

When Troxel thought about making a gift to his alma mater, he immediately thought about a contribution to the physics and astronomy department. He left his $200,00 gift unrestricted to provide maximum flexibility.

"We are deeply indebted to Mr. Troxel. We plan to use a large fraction of the gift for research equipment enabling the faculty to move quickly on research programs and exposing our students to the latest techniques," said Eli Rosenberg, past chair of the Department of Physics and Astronomy. "To launch new projects and keep our teaching labs up to date, we need additional resources of funds that only private donors can provide."

"I'm not an educator," Troxel adds. "I want them to know that I appreciate what they're doing and I want them to decide the best way to use the funds. I was very happy to make the gift to Iowa State. I will always have a sympathetic feeling about my alma mater."

Making a Difference

The Department of Physics and Astronomy at Iowa State University is committed to providing outstanding opportunities for the university community. In order to have the resources necessary to take these programs into the future, support for the department is essential. Funding is required to aid the program in developing new opportunities in technology, continuing and advancing outreach activities, maintaining and expanding current performance and educational opportunities, and supporting students and faculty. These services are crucial as the Department of Physics and Astronomy strives to keep up with the student demand for these experiences. To help make a difference, simply fill out the form, drop it in the mail (ISU Foundation, 2505 University Blvd, Ames, Iowa 50010-8644) and check our next newsletter.

For more information about making a gift to the Department of Physics and Astronomy or including ISU in your estate plans, please contact the College of Liberal Arts and Sciences Development Office at 515-294-3607 or Erin Steinkamp at estein@iastate.edu. www.foundation.iastate.edu/las_gift

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