



EOS SPHERES

Institute for the Study of Earth, Oceans, and Space • A University of New Hampshire Research Institute • Morse Hall, Durham, NH

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Science on the Edge

IN LATE JANUARY, Eberhard Möbius was giving a colloquium talk at Rensselaer Polytechnic Institute about the importance of making observations of the interstellar medium—the “space between the stars” or the region where the solar system mingles with the stuff that fills our galaxy. He had just mentioned that to carry out this work NASA’s impending Interstellar Boundary Explorer or IBEX mission was one of the next logical steps to take. Said Möbius to the audience, “This is hopefully what we will do, if and when NASA decides about IBEX.”

“We,” in this case, did not mean humankind or the space science community at large but, rather, Möbius himself who, along with SSC’s Marty Lee, in a multi-institution team led by Dave McComas of Southwest Research Institute in San Antonio, Texas, made the final cut from an original field of 36 proposals submitted in response to NASA’s most



The bow shock (center) around a very young star in the intense, star-forming region known as the Great Nebula in Orion resembles what our Sun’s heliosphere would look like if we could see it from the outside of our solar system. Photo courtesy of NASA’s Hubble Space Telescope.

recent call for Small Explorer (SMEX) concepts.

Says Möbius, “I then checked my e-mail during a break, and there was the message from Dave McComas saying that IBEX had been selected. I was so excited that I talked about this at the beginning of a meeting with undergraduate students that followed, and everybody clapped.”

Not long after, at home in Morse Hall, folks from EOS and UNH clapped again and raised a toast of sparkling cider to celebrate the success of IBEX and to cheer on the UNH team of engineers, scientists, and students

that will be put through the paces in order to meet a launch date in 2008. (Being celebrated, too, was the recent installation of a supercomputer cluster in Morse Hall. See story on page 7.)

Said EOS director Berrien Moore III as he kicked off the celebration, “This is really quite a challenge. We have a rendezvous with the Voyager 1 spacecraft as it leaves the solar system, and that rendezvous is very exciting.”

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Winter 2005

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Andy Rosenberg: Taking on Oceans of Trouble

ONE OF THE MEMENTOS Andy Rosenberg collected during years of work in ocean fisheries is a hat emblazoned with the words, “Feared and Reviled.” It was a farewell gift—along with a two-foot wooden sculpture of a right whale that now hangs on his Morse Hall office wall—from colleagues at NOAA’s National Marine Fisheries Service where Rosenberg worked as deputy director for two years. Prior to that, Rosenberg served as Northeast Regional Administrator for NMFS, which meant that, for four years, he was in the hot seat as science and the government tackled the collapse of Atlantic Ocean fishing stocks. In various capacities,

Rosenberg worked at NOAA for 10 years before returning to academia.

“They gave me the whale, the hat, and a newspaper clipping that said I was ‘feared and reviled from Canada to Cape Hatteras.’ I called up the reporter and said I didn’t mind the feared part but reviled seemed a little over the top,” Rosenberg says with a quick, subdued grin. Being Northeast Regional Administrator was the hardest and best job he’s ever had because, he says, the challenges brought results. The fisheries are turning around.

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Prof. Andrew Rosenberg
Photo: Perry Smith, UNH Instr. Services



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Science on the Edge

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Indeed. Voyager 1, launched nearly 30 years ago, is anticipated to punch through the region in space called the “termination shock” (or the supersonic boom of the solar wind) where the limit of the Sun’s magnetic bubble or heliosphere edges into the interstellar medium and the solar wind slows down to below supersonic speed. When Voyager 1 crosses over and nails down the approximate distance to the ever-shifting termination shock at the edge of the galactic frontier, it is hoped that two, high-sensitivity cameras or “neutral atom imagers” on board IBEX will take an image of this boundary, including the location of the Voyager passage.

The mercurial nature of this boundary has, in fact, given rise to disagreement within the space plasma physics community about whether Voyager 1 has already exited the solar system and is boldly going where none have gone before.

Says principal investigator McComas, “The controversy over the Voyager 1 results, and the strong disagreement in our community about whether it has crossed the termination shock or not, highlight the absolutely critical need for the global observations that IBEX will supply.”

For the cameras on board IBEX, Möbius, Lee, and their team will build the equivalent of the iris—a device that “collimates” or lines up incoming radiation. In the case of IBEX, the “radiation” is in the form of incoming neutral atoms. The collimator, an elaborately engineered ring of magnesium and titanium, will “focus” incoming atoms from the boundary region and thereby provide an image of the edge of our solar system. The UNH team will also supply the time-of-flight sensor system, which determines the mass of captured atoms, for one of the cameras.

From the Director

Of Past, Present, and Future

AT THE MEETING of the UNH Foundation in late January, I had the exciting privilege to announce the selection of the Interstellar Boundary Experiment (IBEX) by NASA as well as the decision by the National Science Foundation to fund our supercomputer proposal. In sharing with the UNH Foundation these and other wonderful successes of the Institute, I remembered my expression of thanks to Peter Paul when the University announced in December of 2001 the creation of the Peter T. Paul Chair in Space Science. It began, “The poet T. S. Elliot said, ‘Time present and time past are both perhaps in time future.’¹” Today we realize and celebrate time future.

The establishment of the Peter T. Paul Chair in Space Science is a substantial force in the future of the Institute for the Study of Earth, Oceans, and Space and the University of New Hampshire. It also becomes part of the future of our planet.

The study of the universe and the Earth’s place in it is, almost by definition, an eternal process in the study of eternity. It is a process that naturally and fundamentally spills into the future.

This long-term character is consistent with the role of a university.

Universities are part of the past and the present, but even more importantly, they are of and for the future.

The winning of a space mission, with its well-defined launch date, forces reflection on the challenges of the future. But such successes have their roots in the accomplishments of the past. This duality of past and future is even more apparent as we enter the year of the 20th anniversary of EOS.

Over the past 20 years, the Institute has faced a wide array of economic and political conditions. Therefore, while the budgetary trials of the present are significant for the Earth and space sciences (as well as many other areas), we have strong roots that allow a weathering of difficult environments. We should also recognize that with change and challenge there is opportunity. As a seasoned vintager, Peter Paul knows that seemingly unfavorable conditions often combine to produce the best wine.

— Berrien Moore III 

¹ *Four Quartets: Burnt Norton, 1935*




The mission logo cleverly uses the image of an ibex, a wild mountain goat from Eurasia and North Africa, with large, distinctive horns.

Notes Möbius, “We need to understand the environment where space weather is happening and, in particular, the first of three shields against high-energy cosmic rays.” Along with the heliosphere, the other shields are the Earth’s magnetosphere and atmosphere.

IBEX will make its observations from a highly elliptical orbit that takes it beyond the interference of the Earth’s magnetosphere, which can extend in excess of 60,000 kilometers from Earth. Achieving this orbit, according to McComas, represents the most

technically challenging aspect of the mission. However, McComas notes, “The IBEX team has been drawn together to combine the best capabilities from across the country and around the world to build our spacecraft and sensors and to analyze the data.” He adds, “And this mission is critical to determine how our Sun and solar system interact with the local interstellar medium and thereby understand our home in the galaxy.”

In addition to taking the first image of the termination shock, IBEX will also directly capture interstellar gas, which flows through our solar system from beyond the boundary between the constellations of Scorpio and Sagittarius.

Says Möbius, “Fifty years after the beginning of the space age we are about to stick our head out of our solar system.” —DS 

A Shrimp's Life

FOR A CRUSTACEAN so recognizable and so important to the commercial fisheries, the life history of the northern shrimp is surprisingly mysterious. Jeff Runge hopes to change that.

Runge, a research professor in the Ocean Process Analysis Laboratory (OPAL), is collaborating with scientists in Maine and Canada to determine what factors influence whether juvenile northern shrimp, *Pandalus borealis*, survive long enough to be recruited into the fishery.

After mating offshore, egg-bearing females move into coastal waters to spawn during winter. It's at this point, when the adult females have moved inshore, that the commercial fishery kicks into gear. But what happens to the newly hatched larvae—and thus to future harvests—is not well understood.

Annual abundance of northern shrimp varies dramatically. In 2002, the value of New England's shrimp fishery was around \$1 million. Yet during the peak years of 1995-1997, shrimp landings had a value of \$12 to \$15 million. Understanding what factors influence survival of juvenile northern shrimp will have big implications for this variable and tightly managed fishery.

Last year, with support from NH Sea Grant, Runge and his students towed for larval shrimp to determine, for the first time, where the juveniles dwell within the Gulf of Maine. "We found that the larvae live in offshore waters 30 to 90 meters deep," Runge says. Now he hopes to determine what environmental factors cause their abundance to ebb and

flow. "We believe their recruitment has a strong connection to the timing of the winter-spring phytoplankton bloom," Runge explains.

Runge and his students are testing the hypothesis that planktonic early larval stages consume phytoplankton, while later stages feed upon microzooplankton. They've installed a cold room in their OPAL lab to house adult and larval shrimp, and a culture room in which their first phytoplankton cultures took up residence in January. Unfortunately for hungry larvae, the timing of the phytoplankton bloom can vary dramatically. Clarifying how that timing affects each larval stage will be a step toward understanding how shrimp survive to adulthood.

Runge is also working with physical oceanographers, creating computer models to learn how winds and currents affect the larvae's survival at sea. "If they end up inshore, there's great recruitment," Runge says. "If they're not careful, they'll find themselves off Nantucket, and lost to the Gulf of Maine." — Kirsten Weir



Jeff Runge checks phytoplankton cultures in the newly constructed culture room. Below, left: Northern shrimp are housed in a cold room kept at 6 degrees C.

Oceans of Trouble continued from page 1

"Scallops are booming, haddock populations and most of the other species of groundfish are increasing," Rosenberg says. He adds that while cod are not responding as well, and there are still severe restrictions in place, "the populations are becoming much healthier at the fisheries level." The recovery is "unequivocally" the result of imposing severe restrictions. Technically, it was Rosenberg who made the call to close down tens of thousands of square miles to fishing in the Georges Bank and Western Gulf of Maine, which made him a popular fellow.

"That was a time of going to meetings every week and having people screaming at you and threatening you. But there were also a lot of other folks—fishermen, scientists, environmentalists—working to figure out how to make something happen. As difficult as that was, it worked," says Rosenberg, who is now enjoying the somewhat less volatile position of professor of natural resources within OPAL. Prior to his EOS position Rosenberg served as dean of the UNH College of Life Sciences and Agriculture.

Like the hard-won successes of ocean fisheries, Rosenberg is hoping that the challenges of protecting the oceans themselves, as recently laid out by U.S. Commission on Ocean Policy, will be met in the years ahead. Rosenberg

served as one of 16 commissioners on the Presidentially appointed commission, which spent more than three years assessing the state of the world's oceans. Last September the commission presented its recommendations to President Bush and members of Congress in its final report, "An Ocean Blueprint for the 21st Century." In the report, the commissioners characterized the oceans as being in a state of crisis.

Says Rosenberg, "The report clearly stated, by universal agreement of all commissioners—from oil executives and admirals to me—that the oceans are in trouble and we need to change the way we manage them in order to get out of that trouble. And that means not tinkering around the edges—we need a fundamental change."

The biggest component of that fundamental change is the recommendation for an "ecosystem-based management approach" to the oceans, where fisheries, coastal development, pollution abatement, transportation, etc. are all part of the same equation. Says Rosenberg, "We need to put all the separate pieces together so we can manage them in concert and not in opposition."



Andy Rosenberg talks with an attendee of last September's U.S. Senate field hearing on the Ocean Commission report at UNH's Dimond Library. Photo: Perry Smith, UNH Instr. Services

Although the idea of ecosystem-based management is not new, Rosenberg points out that applying it to the ocean is, and this is fraught with difficulties because the ocean is a system of such size and complexity. Still, there are signs that the much-needed shift in policy is underway.

"People are seriously trying to figure out how you do this. It's taken hold as a real task. But the devil's in the details—how do you actually do this? The ecosystem is complex enough, once you add humans, it gets really complex." Nevertheless Rosenberg adds, "The idea of ecosystem-based management is an idea whose time has come, and we've got to get there." —DS



Liz MacDonald's doctoral work was based on data collected by the fifteen-minute flight of a 60-foot, four-stage sounding rocket flying at 1,000 meters per second above the aurora borealis.

Recalling the launch from Poker Flat, Alaska, MacDonald says, "Our instruments were in the top six feet or so. The nose cone ejected and this exposed our instruments to the plasma. We get above the altitude where the actual auroral light is produced, so we measure the spectrum of particles that are causing that light."

The sounding rocket research MacDonald did with former SSC faculty member Kristina Lynch (now at Dartmouth) gives a very detailed look at the microphysics involved in the majestic northern lights, and is a small but integral part of understanding the whole ionosphere-magnetosphere system.

Says MacDonald, "One of the advantages of the rockets is that they are at a lower altitude than most satellites, so we can see, in some cases, the beginnings of phenomena that propagate outward from the ionosphere into the magnetosphere." What's more, she adds, rockets are much cheaper than satellites and the turn-around time between proposal and launch is typically much shorter. "The sounding rocket community is pretty small, but it provides valuable training for graduate students to work on experiments and hardware."

Now with a newly minted Ph.D. in hand, MacDonald will settle into a post-doc position at Los Alamos National Laboratory working on satellite instrumentation—the next step up from rockets. —DS 🌍

JEANNE ANDERSON'S career has gone from the ground up. Way up.

A Ph.D. candidate in CSRC with a long career in conservation biology, Anderson calls her doctoral work involving lidar remote sensing "an extension" of what she did before as Director of Ecological Management for the Massachusetts Audubon Society and as Director of Science and Stewardship at the NH chapter of The Nature Conservancy.

"I love natural history and have studied everything from rare plant communities to butterflies and mosses. But as I monitored and planned for conservation lands, I became increasingly interested in working at larger scales," Anderson says.

The airborne-based, remote sensing work she now does with Mary Martin allows her to look at the structural complexity of a forest. This is very difficult, time-consuming information to collect on the ground and not something easily obtained from other forms of remote sensing such as multispectral or hyperspectral imagery. Using lidar or laser altimetry—a remote-sensing technique that uses a laser sensor to probe the physical characteristics of a target surface—Anderson is able to directly gauge the height of the forest and relate this and other lidar metrics to standard forest measures such as biomass. These relationships can then be applied to larger data sets covering thousands of acres at a time.



"Being able to locate tracts of older forests where complex structures persist may have important implications for conserving biological diversity and maintaining the variation in structure of a natural forest," Anderson says.

As for being able to pursue her doctoral work as a mother of two, Anderson credits fellowships through Space Grant, the NASA Earth System Science Fellowship program and the Switzer Foundation for making it possible. "These have been crucial in being able to balance life at home while pursuing my research." —DS 🌍




The Blizzard of 1978 was something of a wake-up call to the young **JEN HEGARTY**.

“It basically shut down parts of the Northeastern U.S. for weeks,” says the CCRC doctoral candidate. Massachusetts, where Hegarty was living, Connecticut, and Rhode Island were all declared federal disaster areas. For all intents and purposes, little Rhode Island was closed for a week.

“The blizzard helped spawn an interest in meteorology,” she says. Her interest was further piqued over the following years when there were very few snowstorms, let alone any monsters like that of ‘78. “That got me to wondering and I started paying more and more attention to the weather.”

Years later, as a graduate student at Penn State, Hegarty worked with numerical weather prediction models studying atmospheric phenomena. She then went on to work for ten years at a firm that developed models and algorithms used for satellites measuring climatic or meteorological parameters. Then came a period of lean times and layoffs and, for Hegarty, reflection.

“Getting laid off is always a motivator and helps you reevaluate what you’re doing and where you want to go with your career. At that point I wanted to be more involved in the research side of things as opposed to just developing algorithms that would support engineers. I saw coming here as an opportunity to do that,” she says. She has not been disappointed.


“What I liked about this interdisciplinary program is that not only do we look at the atmosphere but the people in this building or even on the third floor involved in AIRMAP look at geochemistry, paleoclimatology, and oceanography. So it even mixes in more things and I get to interact with a wide array of disciplines. And that’s very exciting.” Hegarty is working with Huiting Mao on atmospheric dynamics. —DS 

DOUG VANDEMARK’S first research project met an unfortunate fate. The NASA Goddard radar engineer and OPAL Ph.D. student had developed a project with NOAA to directly measure the exchange of carbon dioxide between the air and sea using a special research aircraft.

“The plane was a single-seater, flying just 15 meters above the ocean surface. Using radar instruments I had developed, we were combining measurements for ocean color, sea surface temperature, wind, waves, and carbon dioxide. It would have been a first,” Vandemark recalls. But it was not to be. “Just as we started the measurement project, the pilot had a fatal stroke and we lost him, the plane, and all the equipment. It was a nightmare, and the end of that particular project. It switched things around for me a lot.”

The visiting NASA scientist/OPAL student now works on the coupling between wind and waves – specifically, how waves affect the turbulence in the atmospheric boundary layer, which can in turn affect the ocean’s role in the carbon cycle. Says Vandemark, “Janet Campbell’s group is interested in the ocean-atmosphere exchange of CO₂ and how you can use satellite ocean color and wind data to get at that. And that’s what brought me to UNH.”

Vandemark continues to work on a satellite altimetry project, for which he has been the principle investigator for six years. He’s also working on the coastal carbon time series project at the Martha’s Vineyard Coastal Observatory where wind, carbon dioxide, and ocean color measurement sensors are deployed.

Trained as a microwave remote sensing engineer with a Master’s in electrical engineering, Vandemark’s work with NASA often involves air-sea interaction field experiments where he serves as both engineer and scientist. “So it made sense to get a formal degree in oceanography, which is where I spend most of my time —measuring ocean wind waves,” he says. —DS 



Faculty/Staff News

At the February celebration for the IBEX mission (see cover story) and the Zaphod supercomputer cluster (see page 7), SSC director **Roy Torbert** finished his remarks by thanking all the staff of the SSC for their behind-the-scenes efforts in helping to achieve successes like these. Accounting staff, technical scientists, post-docs, students, and faculty all deserve praise, Torbert said. “When you write one of these proposals, you’re up against a lot of excellent institutions,” and it’s not possible to stand there and say, ‘We can deliver’ something as complex as this without knowing our staff are really dedicated to doing it. So, I really feel strongly that they deserve a great deal of credit,” he said.

Eberhard Möbius notes that 2007-08 is the International Heliospherical Year and that he is on the IHY scientific organizing committee chairing the Outer Heliosphere and Cosmic Ray working group.

The astrophysics group, Jim Ryan and Mark McConnell, report that two new research scientists have come on board. **Peter Bloser** received his Ph.D. from Harvard (2000) and spent two years as a post-doc at the Max Planck Institute before moving to the Goddard Space Flight Center in 2002. He will be focusing his efforts on various projects in X-ray and gamma-ray astronomy.

Ulisse Bravar received his Ph.D. from New Mexico State University in 2001 and has spent time at both the University of Maryland and Oxford University. He will be working on various projects involving neutron and gamma-ray detection. In addition, the group received two new funding awards in December. Ryan is PI on a two-year \$600,000 project to continue the development of Cadmium Zinc Telluride (CZT) gamma-ray detectors. And McConnell is PI on a two-year \$300,000 project to work on the application of new scintillation detectors in high-energy astrophysics.

Toni Galvin reports that the STEREO-PLASTIC team was awarded an additional \$1,739,340, which brings the current value of the contract to \$12,578,271. Also, in December and January, the team calibrated the first flight unit at the University of Bern. Participants included Galvin, Mark Popecki, Katherine Singer, Stan Ellis, John Gaidos, Lynn Kistler, and Lorna Ellis. Galvin also notes that **Frank DiDonna**, who passed away unexpectedly in November, was awarded a NASA Individual Achievement Award by the STEREO Project office in recognition of his work on the PLASTIC solid state detector electronics.

Pam Puhl-Quinn, John Dorelli, and Jimmy Raeder each won a NASA Guest-Investigator program proposal, with Raeder’s being the biggest at \$700K for three years.

Vania Jordanova, together with colleagues Ruth Skoug from the Los Alamos National Lab and Michael Liemohn from the University of Michigan, is organizing a special session SM05 “Solar cycle variations of the magnetosphere—causes and consequences” at the 2005 Joint Assembly Meeting in New Orleans, Louisiana, 23-27 May, 2005.

Faculty Profile

Our Man from Malta: Charlie Farrugia



Charlie Farrugia

A CONVERSATION WITH CHARLIE FARRUGIA, or, rather, listening to *him* talk, is something akin to theater; he repeats key words for emphasis, gestures fluidly with hands and arms, lunges forward wide-eyed in his chair to make a point, and talks of his passion for the creative genius of Wagner, Rossini, and Bob Dylan. The man is animated.

It’s not surprising then that his students—from the high school kids learning physics in Farrugia’s homeland on the Mediterranean Island of Malta to college students grappling with magnetospheres—have commented that the professor has the right stuff.

Farrugia loves teaching. But at age 28, after having taught high school physics for eight years, it was time for a change. “There were parts of me that longed for more creative things, for discovery. I’m curious about our universe. And this is what I like about space science. There is so much discovery, there are so many probes out there exploring and gathering data.”

So he quickly learned German and departed Malta for the University of Bern in Switzerland to study astrophysics and, specifically, black hole theory.

At the time, scientists—like Jacob Beckenstein, Stephen Hawking, and James Bardeen—were working on the thermodynamics of black holes. In particular, they were looking at the third law, which says roughly that the three quantities

characterizing a black hole—its mass, charge, and rotation—cannot be related in a certain way. Farrugia, too, was looking into all this. In 1979, while sitting in a church in Tuebingen, Germany listening to his younger brother, Eddie, who was the “Pfarrer” or parish priest, give a sermon, Farrugia scribbled some back-of-the-envelope calculations on the matter. “I suddenly realized that for a certain choice of parameters the black hole develops in such a way that the third law is violated.”

Back in Bern, his master, Petr Hajicek, “jumped off his chair and paced the room” when he saw Farrugia’s numbers. “Within a week we wrote a paper entitled, ‘The Third Law of Black Hole Mechanics; A Counterexample.’ It actually made some news because the third law had to be reformulated in another way to ‘outmaneuver’ our counterexample,” he says with pride.

Farrugia now researches various phenomena involving the Earth’s magnetosphere, ionosphere, and the solar wind—the latter being something he considers a cosmic gift. “Here on Earth we have a star right on our doorstep, and that means we can examine not only its light but everything”—including the interaction of the solar wind with Earth’s magnetic blanket, which can give rise to “strange bedfellows,” Farrugia says. “When one magnetized plasma meets another they tend not to intermix.”

But back in the 1960s, English astrophysicist James Dungey (whom Farrugia knows and refers to as “pipe-smoking Dungey, a giant of the subject”) made the wild proposition that under certain conditions they do intermix and interconnect in a process called reconnection. Says Farrugia, “Forty years of data have only gone to prove him right.”

Farrugia revels in the fact that he lives in a time when there is so much data available to help piece together the puzzle of the universe. “Your ideas are constrained by all the measurements being done today. If you make a statement, you have the experimental truth to confront,” he says. Likewise, he counts himself lucky to be in an environment that fosters creativity and progress.

“At EOS, at UNH, we are in a lucky situation because we have theorists, modelers, people who do simulations and data analysis, people on missions of all types. And if you have an idea, you can go here or there and before you know it you have a panorama of ideas and information. This is what I like. The place is alive.” —DS 🌍

Helping Teachers Teach

SINCE 1991, the New Hampshire Space Grant Consortium (NHSGC) has brought together the state's education and scientific communities in an effort to foster public interest in science education, scholarship, and research. Beginning in 1999, this mission was significantly expanded through the creation of courses for elementary and middle school teachers that provide access to detailed

science content in the areas of the Sun-Earth environment and environmental studies.

The two-credit, Master's in Education courses allow access to authentic research activities or "inquiry-based" NASA educational materials not readily available to the typical classroom teacher. In addition, says CSRC's Barry Rock who has participated in the effort, the coursework provides "support and encouragement leading to a 'comfort level' with science not typical for the average classroom teacher." Often, these teachers have no formal training in physics, chemistry, etc., and this can limit their ability and inclination to delve into these areas with their student.

"Many elementary teachers can be science phobic," says associate professor Eleanor Abrams of the UNH Department of Education. "Their experiences with learning science left them feeling like they can't learn and therefore can't teach science."

Rock, Abrams, and SSC's Toni Galvin have all been instrumental in getting the "Practical Physical Science for the Pre-service Elementary Teacher" and "Teaching Inquiry in the Classroom" courses off the ground. NHSGC member First Place has also provided support for the effort.

The idea behind the workshops and the classes is to provide a curriculum and materials that allow teachers to practice what Galvin calls

"kitchen physics." For example, the first course the teachers take is on physical concepts and the first unit is on electricity and magnetism. Using largely materials that can be bought at Radio Shack, the teachers build a simple, working motor on the first day and, in subsequent lessons, learn the basic concepts behind electricity, magnetism and how certain machines (from a telephone to a satellite) function with respect to these properties.

Says Galvin, "The teachers are very dedicated and we want to lower their anxiety level with respect to the subject matter so they will be able to incorporate it into the classroom in more than a cursory way."

Over sixty teachers have participated in the courses, many of them before they have entered the classroom—so-called "pre-service" teachers. Says Abrams, "The result at the end of the course is that many of the students feel they have a better understanding of the science that was taught and, more importantly, that they can teach it to their students."

Abrams adds that plans are being laid to incorporate distance learning into the courses this summer using LearnLinc—an online software that allows for real-time audio communication as well as the ability to share computer screens. "With this technology we will be able to reach a larger audience of teachers." —DS



A student uses a rudimentary clinometer to measure tree height, which can be used to determine the biomass of a forest and, in turn, can be an indicator of forest health.

8,000 Pounds of Dedicated "Brains"

EOS joins a select group with supercomputer acquisition

ZAPHOD BEEBLEBROX is a fictional character in the humorous science fiction novel, radio and television series, *The Hitchhiker's Guide to the Galaxy*. Zaphod, according to the books, is "one hell of a guy."

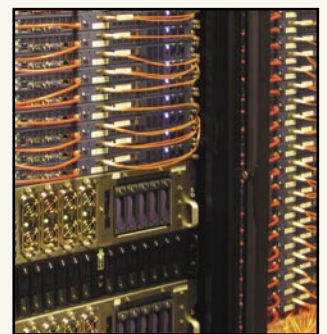
EOS is now home to one hell of a computer, and Jimmy Raeder, who has led the UNH effort to acquire the cluster, dubbed the 8,000 pound, 168-node, \$750,000 collection of 344 Opteron processors "Zaphod."

The purchase of the Linux Beowulf cluster was made possible by grants from the National Science Foundation through its Major Research Instrumentation Program, and NOAA for the joint NOAA-UNH AIRMAP program. EOS provided additional resources.

AIRMAP's primary mission is to develop a detailed understanding of climate variability and the source of persistent air pollutants in New England. AIRMAP director Robert Talbot, whose group will be a major user of the cluster for three-dimensional simulations of atmospheric transport, chemistry, and climate, says, "The cluster will allow us to conduct these studies on time scales of seasons to decades." This capability will spark new insight into the climate-chemistry connection on regional to global scales, and will put AIRMAP on the forefront of research in this area.

Notes Amitava Bhattacharjee, who will use Zaphod in simulations of space plasmas, the

beauty of the cluster is not only its speed but, even more importantly, the fact that it is dedicated, 24 hours per day, to EOS users. This will eliminate the need to "stand in line" remotely at national supercomputer centers at Oak Ridge or Lawrence Livermore, etc., where processing a problem can take weeks as the computer crunches your numbers for, say, half an hour, before turning its attention to the next in line—a process Bhattacharjee characterizes as "agonizing." —DS





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An Accolade From AGU

QINGYUAN ZHANG, a Ph.D. candidate in Natural Resources and Earth System Science (NRESS) program, was recently recognized by the American Geophysical Union for his presentation at its 2004 fall meeting in San Francisco. In the category of Biogeosciences, Zhang was awarded Outstanding Student Paper Award for his research concerning light absorption by leaf chlorophyll.



Qingyuan Zhang is expected to receive his Ph.D. in Natural Resources and Environmental Studies in December 2005.

Plant photosynthesis requires light, water, and CO₂. Zhang's paper evaluated the hypothesis about light absorption at canopy, leaf, and chlorophyll levels, respectively. Says Zhang, "Quantifying light absorption by chlorophyll would substantially reduce uncertainty in estimating gross primary production, the first step of the terrestrial carbon cycle." Adds CSRC's Xiangming Xiao, Zhang's advisor, "This is a very high honor for a student paper. It means that it has very high scientific qualities." 

Interdisciplinary Science and Engineering Symposium: Undergraduate Research Conference 2005

LAST YEAR, Morse Hall hosted its first Undergraduate Research Conference (URC) event—as part of the larger, week-long, university-wide program—and attracted several hundred attendees, including presenters, friends, faculty, staff, university leaders, legislators, and others. This year's event, renamed the Interdisciplinary Science and Engineering Symposium, will take place on Wednesday, April 27, 2005 from 3 to 6 p.m.

Says faculty organizer George Hurtt, "This is a tremendous opportunity for students to present their research in a professional setting, and for both presenters and attendees to experience the tremendous research activity led by students at UNH."

The sixth annual, university-wide URC runs from April 25–30. For more information, visit www.unh.edu/urc. 