CURRENT
NATIONAL SCIENCE FOUNDATION

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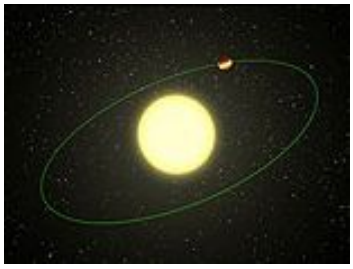
NSF AT WORK

Mapping an Alien Planet

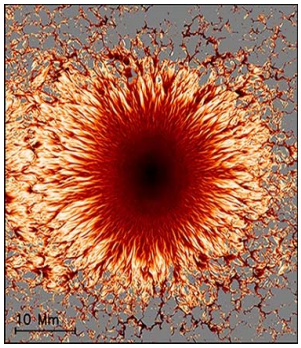


Artist's rendition of exoplanet. Credit: NASA/JPL

In a paper published on July 7, 2009 in *Astrophysical Journal*, scientists report on the development of a new technique for analyzing light from Earth-like planets in distant solar systems, known as exoplanets, that may reveal whether these worlds have liquid water in the form of oceans. The new technique, developed with joint funding from the National Science Foundation (NSF), NASA and the Natural Sciences and Engineering Research Council of Canada, used data beamed back to earth from NASA's Deep Impact spacecraft.

The researchers developed their method using observations of our own planet, since the location of oceans on the Earth's surface is known. The scientists were then able to use a "backward modeling" technique to fit the data to Earth's known features. The result is a method that can distinguish land masses, which show up as red areas in the light signal, from oceans, which appear as blue patches.

The investigators caution that the appearance of blue light in signals from distant planets does not imply that liquid water is present, since this can also result from gaseous planets like Neptune and can indicate the presence of methane as well as water vapor. As Nicolas Cowan, graduate student with NSF CAREER-awardee Eric Agol, explains: "It looks blue from every angle, the same blue all the way around...For Earth, the blue varies from one place to another." Telescopes capable of making similar observations for Earth-sized exoplanets will not be available for several more years, but devising this technique now could guide the construction of those instruments, he said. Read more here.



Complex structure of a sunspot. Credit: Matthias Rempel, NCAR

First Comprehensive Model of Sunspots Created

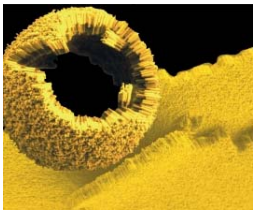
In a breakthrough that will help scientists unlock mysteries of the sun, NSF-funded scientists have created the first comprehensive computer model of sunspots. The work was published in the July 10, 2009, issue of *Science*.

Sunspots are associated with massive ejections of charged plasma that can cause geomagnetic storms and disrupt communications and navigational systems. The resulting damage to power grids, satellites and other technological systems takes an economic toll on a rising number of industries. Sunspots are also linked to variations in solar output that can subtly affect Earth's weather and climate.

The new computer models capture pairs of sunspots with opposite polarity. The simulations reveal the dark central region, or umbra, with brighter umbral dots, as well as webs of elongated narrow filaments with flows of mass streaming away from the spots in the outer penumbral regions. They also capture the convective flow and movement of energy that underlie the sunspots, and which are not directly detectable by instruments.

To create the simulations, a research team at the National Center for Atmospheric Research (NCAR) designed a virtual, three-dimensional domain that simulated fundamental physical processes such as energy transfer, fluid dynamics, magnetic induction, and other phenomena. "With this breakthrough simulation, an overall comprehensive physical picture is emerging for everything that observers have associated with the appearance, formation, dynamics, and the decay of sunspots on the sun's surface," says Michael Knölker, director of NCAR's High Altitude Observatory and a co-author of the paper. Read more about the research here.

Nanoscience Center Educates Community, Produces Jobs



Gold nanoparticle. Credit: Chad Mirkin

The NSF-funded Northwestern University-Nanoscale Science and Engineering Center (NU-NSEC), directed by professor Chad Mirkin, is one of 19 NSF-funded NSECs around the country dedicated to providing coherence and direction for U.S. nanotechnology research and education.

NU-NSEC collaborates with local laboratories to develop chemical and biological detection tools. The center's research has already led to 600 publications, 125 invention disclosures, and over 30 patents, according to Kathleen Cook of Northwestern's International Institute for Nanotechnology. One notable success was the development of a selective detection system that senses a protein linked to Alzheimer's disease. This has the potential to be a tool for early diagnosis of Alzheimer's, improving the lives of patients and lowering health care costs.

In addition to developing cutting-edge technologies, the center is devoted to educating students, researchers, and the general public on issues and practices in nanotechnology. Along with graduate fellowships and undergraduate research opportunities, partnerships have been developed with local museums and high schools to promote informal science education. Furthermore, NU-NSEC has launched 14 start-up companies, stimulating research and creating jobs. NU-NSEC hosts a multitude of educational programs for the general public, including an interactive Web site and numerous seminars and meetings on nanotechnology. A listing of the center's seminars is available here.

Caroline Moore. Credit: Robert E. Moore

New Class of Supernovae Discovered by Young Scientist

Carl Sagan was fond of saying, "We are star-stuff," which refers to the astrophysical theory that all of the atoms in our bodies were created inside stars. When those stars go supernova, they explode and spew their material into space. The clouds of atoms, attracted by gravity, swirl to form solar systems and planets, such as our own earth.

Now, a 14-year-old amateur astronomer has discovered a new type of supernova that appears to be different from all previously known classes of supernovae. Caroline Moore of Warwick, N.Y., found the supernova in November 2008 while analyzing data sets in her home observatory. Later analysis by Alexei Filippenko, an NSF-funded researcher at the University of California-Berkeley, showed that Moore's discovery was intermediate in size between a supernova and a smaller nova. "It's really a strange supernova," said Moore. "A supernova is a huge explosion deep in the core of a star, whereas a nova is an explosion on the outside surface of a star."

When a white dwarf star is gravitationally bound to another star, the white dwarf can steal material from its companion, leading to a potentially unstable situation and an explosion which involves only the surface material of the star. This is called a nova. In a supernova explosion, on the other hand, the star either completely explodes or its core collapses in on itself.

Moore's discovery, now known as Supernova 2008ha, was approximately a thousand times brighter than a nova, yet a thousand times less luminous than a supernova, something which had never been seen before. Filippenko says that Moore's discovery has sent astronomers in a new direction as they seek to understand supernovae and also shows "that ordinary people, who have ordinary jobs not in the sciences, can also contribute to actual research." Read more about the research here.

Did You Know?

As part of President Obama's "New Energy for America" plan, the administration will provide opportunities for thousands of American students to pursue careers in science, engineering, and entrepreneurship related to clean energy. NSF is joining the Department of Energy in sponsoring programs intended to inspire students to pursue energy-related careers in science and engineering. NSF programs include Graduate Fellowships, Research Experiences for Undergraduates in clean energy, research in K-12 science education, informal outreach using television programs and museum exhibits, specialized energy centers within America's colleges and universities, and many other initiatives.

Faces of NSF Research

Researcher Investigates Pollution and Climate Change


Barbara Finlayson-Pitts. Credit: UC-Irvine

Dr. Barbara Finlayson-Pitts's researchers at the AirUCI Environmental Molecular Science Institute at the University of California (UC) in Irvine are used to seeing their boss rushing around the building, whirling from lab to lab, to and from meetings, and back to her lab again. Finlayson-Pitts has a good reason to rush: her team is investigating the causes and effects of air pollution, in Los Angeles and on a global scale, and in such a sensitive area, there is no time to waste.

Finlayson-Pitts is a professor of chemistry in the School of Physical Sciences at UC-Irvine, as well as the Director of AirUCI. Her deep concern for environmental issues has led her to study the unique chemical reactions that occur in the air above coastal urban areas. This year, her research was recognized with the Coalition for Clean Air's 2009 Carl Moyer Award for Scientific Leadership and Technical Excellence.

The AirUCI team is studying chemical reactions at the air-water interface, an aspect of atmospheric chemistry about which little is known. Most research in atmospheric science has been in either the gas phase, since the atmosphere is mostly a continuous gas phase, or in the liquid phase, such as the bulk of water droplets in the air. But Finlayson-Pitts has found that, when these two phases meet, something that resembles neither happens. "We don't know that the same chemistry applies on the surface. In fact, we have pretty good evidence that it does not," says Finlayson-Pitts. Her team at AirUCI is studying chemical reactions at the air-water interface in order to further our understanding of the full scope of the effect of man-made emissions.

"The science we are doing is exciting, because it illuminates new evidence about both air pollution and climate change," says Finlayson-Pitts. She stresses how much these two hazards are connected. "It starts with fossil fuel emissions, causing air pollution on a regional and global scale," and the presence and chemical composition of the emitted particles has an effect on the climate. As Finlayson-Pitts sees it, "It's not just about carbon dioxide."

More detailed information about Finlayson-Pitts and her research, including recent articles in *Science* and *PNAS,* can be found here.

NSF in the News

Mysterious Tremors Detected on San Andreas Fault (*Associated Press*) A spike in underground rumblings on a section of California's San Andreas Fault has been detected, suggesting underground stress may be building faster than expected. The work was partly funded by NSF.

Tropical Rain Band Is Shifting North (*MSNBC)* Earth's most prominent rain band, near the equator, has been moving north at an average rate of almost a mile a year for three centuries, likely because of a warming world, say scientists whose work is partially funded by NSF.

Food Storage Began Well Before Farming (*ABC News*) People were storing grain long before they learned to domesticate crops, according to research partially funded by NSF. The conclusions are the result of the recent discovery of 11,300-year-old granaries in Jordan.

South Pole Doctor Who Treated Herself for Cancer Dies (*Washington Post)* Jerri Nielsen, the doctor who treated herself for breast cancer while working at NSF's Antarctic research station, died June 23, 2009 after her cancer, which had been in remission, returned.

Bees Sterilize Their Hives (*BBC*) NSF-funded scientists have discovered that honeybees sterilize their hives with an anti-microbial resin, giving the entire colony a type of social immunity and decreasing the need for individual bees to maintain a strong immune system.

Joint Annual Meeting Draws Crowds

The Division of Human Resource Development within the Directorate for Education and Human Resources and the Directorate for Biological Sciences sponsored the 2009 Joint Annual Meeting (JAM) held in Washington, D.C., on June 8-11. The meeting, which was also available by webcast, brought together 1,260 attendees, including principle investigators, administrative staff and students to discuss research and education opportunities.

Forums and informational sessions highlighted programs such as the Tribal Colleges and Universities Program (TCUP), Research Infrastructure for Science and Engineering (RISE), Alliances for Graduate Education in the Professoriate and others. Speakers from industry and NSF presented talks on grantsmanship, innovation, funding opportunities and other topics.

Craig Venter speaks at JAM luncheon. Credit: Eric S. Miller

Left to right: Dr. Arden L. Bement, Jr., Dr. Jeannette Wing and Sen. Harry Reid. Credit: NSF

Robots Invade the Senate

On July 9, NSF hosted a luncheon briefing and open house in the Hart Senate Office Building where over 50 researchers and students presented their work supported by NSF's program on Cyber-Physical Systems (CPS) to members of Congress, academia, and industry.

The event featured special guest Senate Majority Leader Harry Reid, who, along with NSF director Dr. Arden L. Bement, Jr., delivered remarks on the importance of CPS research, noting the "tremendous impact" that the technologies can make on many sectors of the economy.

The basic concept behind CPS is straightforward: combine computing power with existing systems to turn them into "smart" technologies such as airplanes that can detect each other and automatically adjust their flight paths, or bridges that can sense when they are being overloaded and in danger of falling down.

Experts believe that CPS technologies will increasingly affect our well-being, security and competitiveness, in a variety of areas including aerospace, automobiles, civil infrastructure, energy, finance, healthcare and manufacturing.

The luncheon speakers included Dr. Jeannette Wing, NSF's assistant director for Computer and Information Science and Engineering, Don C. Winter, vice president of engineering and information technology at Boeing's Phantom Works, and Julian M. Goldman of Massachusetts General Hospital in Boston and the medical director of Partners HealthCare System Biomedical Engineering. Wing explained NSF's new CPS program while Winter spoke about the importance of CPS in the aerospace industry. Goldman explained how integrating CPS technologies into more areas of healthcare can improve the quality of care patients receive.

The event brought together experts from diverse backgrounds, allowing congressional staff, researchers, and the general public to explore recent breakthroughs and improve their understanding of the potential impacts that cyber-physical systems could make on securing a safer, healthier, and more prosperous future. More information on the luncheon can be found here.