



April 2013

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## Waves Generated by Meteor Are Recorded Crossing the U.S.

A network of seismographic stations **recorded** a series of signals from the blast waves of the meteor that landed in Russia as the waves crossed the United States. The NSF-supported stations are normally used to study earthquakes and Earth's deep interior.

Thousands of earthquakes around the globe are recorded annually by seismometers at these stations, which are part of the permanent Global Seismographic Network and the temporary EarthScope Transportable Array. Signals from large meteor impacts are far less common.

The meteor explosion near Chelyabinsk on Feb. 15, 2013, generated both ground motions and air pressure waves. Seismic waves, which travel through the ground at about 3.4 kilometers per second, were recorded by both networks. Pressure waves in the atmosphere travel much more slowly--at about 0.3 kilometers per second--and were detected by special sensors in the EarthScope array.

The atmospheric waves were recorded at the Canadian border 8.5 hours after the blast and in Florida three hours after that. The Chelyabinsk meteor is the largest signal recorded to date by the EarthScope instruments.

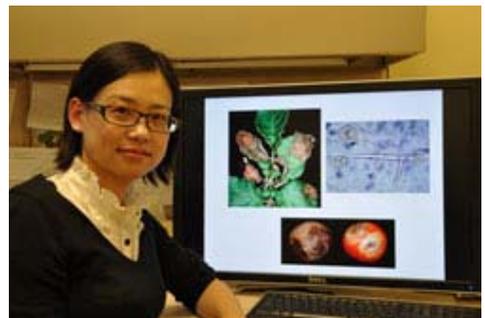


Meteor trail over eastern Russia.  
Credit: Russian Emergency Ministry

## Scientists Uncover Genetic Clues to Irish Famine

Plant pathologists at the University of California-Riverside studying the pathogen that triggered the Irish Famine of the 19th century have deciphered how the microorganism succeeded in crippling the potato plant's immune system.

Today, fungus-like pathogens of the genus *Phytophthora* cause worldwide crop losses in the billions of dollars annually. *Phytophthora infestans* destroys more than \$6 billion in



Wenbo Ma, who studied the potato pathogen. Credit: UCR Strategic

potatoes each year and *Phytophthora sojae* about \$2 billion in soybeans. An NSF-supported team of researchers, led by Wenbo Ma, found that certain proteins produced by these pathogens, called "effectors," block the RNA silencing pathways in their host plants. RNA silencing helps regulate plant growth and development. When the pathways are shut off, the host plant's immunities are suppressed and the plant is more susceptible to disease.

According to Ma, **the research** shows that RNA silencing suppression like that used by *Phytophthora* is a common strategy used by a variety of pathogens, including viruses and bacteria. The work opens up a path for researchers to develop strategies for managing the resulting diseases.

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## Graphene Is Gaining a Foothold in the Marketplace

Nanotechnologies exist in the realm of billionths of a meter and require tolerances that push the limits of manufacturing--so it can be hard to imagine a factory that can turn out such products on a commercial scale. However, one material engineered at the nanoscale--**graphene**--is advancing in the manufacturing sector.

Graphene, composed of tiny sheets of carbon only one atom thick, is a material prized for its exceptional durability, strength and ability to conduct electricity. Graphene has been a focus of research laboratories since the 1980s. Researchers have demonstrated the material's promise as a candidate to **replace silicon** in applications ranging from high-speed computer chips to biochemical sensors.

Vorbeck Materials of Jessup, Md., with the help of an NSF Small Business Innovation Research grant, is at the forefront of efforts to bring graphene technology to the marketplace. The company sells a graphene-based, conductive ink that allows electronic circuits to be drawn on a variety of base materials in a more economical process than current methods of producing printed circuit boards. Vorbeck demonstrated its technology at the 2013 International Consumer Electronics Show in Las Vegas, Nev., in January.

Vorbeck recently **announced plans** to expand its Jessup, Md., production plant and to open a second graphene factory in Pocomoke City on Maryland's Eastern Shore.



Printed graphene electronics before incorporation into electronic devices.  
*Credit: Vorbeck Materials Corp.*

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## Learning Science While Building a Moon

The formation of a moon, or any planet or planetary satellite, can be a violent process. In the online, interactive game "Selene: A Lunar Construction Game," geared to players age 9 and above, players "create" their own moon with raw space materials, then pummel it with asteroids and flood it with lava.

**The game** is designed as a research platform to measure learning as it occurs. Players can adjust the rate of accretion--new material glomming onto the moon--and generate differentiation, in which materials of varying densities settle into the planet's core, mantle and crust. The game, written in Flash animation software, allows players to simulate the creation of lunar surface features such as lava flows and impact craters.

Players creating different kinds of moons discover and apply fundamental science concepts, such

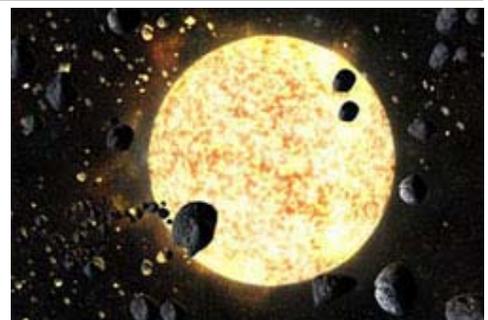


Image from the Selene video game.  
*Credit: Debbie Denise Reese et al, Wheeling Jesuit University; Barbara Tabachnick, California State University-Northridge*

as the physics of collisions and geologic processes, according to Debbie Denise Reese of Wheeling Jesuit University in West Virginia. Reese is the lead researcher for the NSF-funded Cyber-Enabled Teaching and Learning through Game-based, Metaphor Enhanced Learning Objects (**CyGaMEs**) project. CyGaMEs is a research environment for studying instructional game design, learning and embedded assessment.

Selene was the name of a goddess in Greek mythology with dominion over the moon. A version of the game was awarded an Honorable Mention in the 2012 **International Science and Engineering Visualization** competition sponsored by NSF and the journal *Science*.

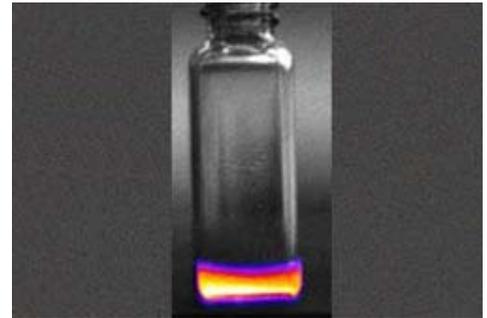
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## Tiny Glow Sticks for Cancer Detection

A research group at the University of Notre Dame in Indiana has developed a suite of self-illuminating molecules that act as tiny flashlights when warmed to body temperature. By changing the molecular structure, the color of the emitted light can be changed from visible colors, such as red and green, to invisible, near-infrared light that can be detected by a special night-vision camera.

The self-illuminating molecules could be useful in biomedical imaging, by improving the detection of disease markers in blood and biological samples. According to the NSF-supported **researchers**, it may even be possible to convert the molecules into cancer-targeting beacons that identify the location of tumors in the body and help surgeons more accurately define the margins of tumors.

The molecules' self-illuminating process is known as chemiluminescence, and is similar to the chemistry that occurs in common glow sticks. The molecules can be stored in a kitchen freezer and, when warmed to body temperature of 37 degrees Celsius (98.6 degrees Fahrenheit), they begin to glow.

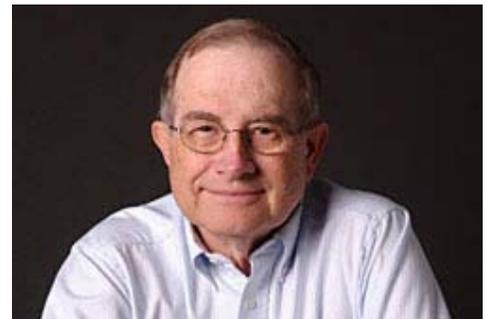


Warmed molecules emit near-infrared light. *Credit: Bradley Smith, University of Notre Dame*

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## Former NSF Director Neal Lane To Receive Vannevar Bush Award

Physicist Neal Lane, former NSF director from 1993 to 1998, has been **selected** by the National Science Board to receive the 2013 Vannevar Bush Award. The award recognizes leaders who have made substantial contributions to the nation through public service in science, technology and public policy.



Neal Lane. *Credit: Tommy LaVergne, Rice University*

Lane is the Malcolm Gillis University Professor at Rice University in Houston, Tex. He also is a senior fellow at the James A. Baker III Institute for Public Policy and professor in the department of physics and astronomy. After leaving NSF, he served as assistant to President Clinton for science and technology and director of the White House Office of Science and Technology Policy.

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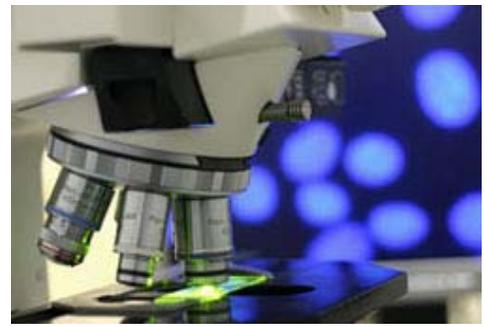
## U.S. Academic Research Spending Hits New High

U.S. universities reported their highest level of spending on research and development (R&D) in fiscal year 2011. The \$65.1-billion total is an increase of 6.3 percent (\$3.9 billion) over the previous year.

Funding from the *American Recovery and Reinvestment Act* (ARRA) of 2009 was responsible for much of the boost, with ARRA-funded expenditures totaling \$4.2 billion in fiscal year 2011. ARRA funds represented 10.2 percent of all federally funded R&D expenditures reported by universities that year.

The data are from NSF's annual Higher Education Research and Development Survey. The number of universities participating in the survey rose from 742 in 2010 to 912 in 2011; the new institutions accounted for \$533 million of the fiscal year 2011 expenditures.

Details, including ARRA funding by state, are available in this **InfoBrief** published by NSF's National Center for Science and Engineering Statistics.



*Credit: Thinkstock*

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## World Penguin Day; Antarctic Penguins Celebrate

April 25 is celebrated as World Penguin Day, a designation with obscure origins--but the celebrations continue nonetheless. The occasion offers penguin fans the opportunity to reflect on various species' impressive abilities to **navigate** across vast expanses of ice, **stay underwater** for almost 30 minutes at a time, and cope with the impacts of **climate change**.

NSF-funded scientists, just back from the summer research season in Antarctica, report that some of their research subjects have big plans for the special day.

Late April marks the beginning of the southernmost penguins' migration to traditional nesting sites. The scientists reported a rumor that, as the only migratory birds that don't fly--their wings having evolved into flippers--the penguins will celebrate the beginning of their long journey with a triathlon-style competition. The first stage, as in other triathlons, will feature diving and swimming. The second leg, however, will embrace the novel sport of belly-sliding-on-ice, a penguin specialty. The third, running phase, to the uninitiated observer, is more likely to resemble waddling.

**Learn more** about how some Antarctic penguins evolved into such hardy athletes.



*Adelie penguins prepare to dive.  
Credit: penguinscience.com*

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## National Science Foundation in the News

**U.S. Moves to Provide Quicker Access to Publicly Financed Scientific Research** (*New York Times*)--In response to a White House policy, NSF and other agencies will work to increase the accessibility of published results of taxpayer-funded research.

**Mimicking Nature in Engineering** (*R & D Magazine*)--NSF's Physics of Living program funds research projects at the interface of biology, mathematical modeling, physics and engineering.

**Meet ALMA, the \$1.5 Billion 'Time Machine' in Chile** (*CNBC*)--The 66 interconnected radio telescopes, operating in synchronicity, will serve as the world's most powerful telescope.

**Future Science: Using 3D Worlds to Visualize Data** (*Fox News*)--At the University of Illinois-Chicago, an 8-foot-high screen displays a panorama of images, surrounding the viewer with a wraparound virtual world.

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