National Science Foundation
WHERE DISCOVERIES BEGIN

NSF Current
National Science Foundation

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NSF FY 2014 Budget Request Sustains Momentum

NSF headquarters in Arlington, Va. *Credit: NSF*

The NSF budget request for fiscal year (FY) 2014 is for $7.626 billion, an 8.4-percent increase over the budget enacted for FY 2012, the agency announced on April 10.

In addition to continuing support for fundamental research in all fields of science and engineering, the NSF **request** includes proposed investments in:

- Completion of the Atacama Large Millimeter Array, located in Chile and operated by an international partnership.
- Development of the National Ecological Observatory Network, Ocean Observatories Initiative, Large Synoptic Survey Telescope, Advanced Technology Solar Telescope and Advanced Laser Interferometer Gravitational-Wave Observatory.
- An emphasis on research in novel materials, advanced manufacturing processes and smart systems.
- Cyberinfrastructure for the research community, government and consumers.
- Sustainability science and engineering.
- The interagency BRAIN initiative (see article below) to understand the brain and nervous system.

The budget request emphasizes science, technology, engineering and mathematics (STEM) education, particularly at the graduate and undergraduate levels, with a request for nearly $1.3 billion for FY 2014. Investments in STEM education will include expanding NSF's Graduate Research Fellowships, gathering existing undergraduate programs into a new Catalyzing Advances program, and launching a new Research Traineeships program.

Peat Bogs: An Underestimated Source of Greenhouse Gases


Peat bogs in Canada. *Credit:*

New research is increasing scientists' understanding of the behavior of methane in northern peat bogs. The release of methane and carbon dioxide from underground spaces represents an important source of greenhouse gas emissions from peatlands--wetland areas formed by the natural accumulation of layers of decaying plant material. Peatlands

are present at both high and tropical latitudes. *©UCAR/Lee Klinger*

Until recently, scientists have had limited knowledge of the distribution of subsurface greenhouse gases in peat soils, as well as the effects of environmental variables (for example, atmospheric pressure, water table elevation and temperature) on greenhouse gas releases.

Using modeling and sensing technologies, **NSF-funded researchers** from Rutgers University-Newark in New Jersey, the University of Maine, and Florida Atlantic University concluded that free-phase gas (gas trapped in underground spaces) behaves differently at different depths. The researchers used ground-penetrating radar to measure the vertical distribution of free-phase gas below the ground and found that changes in atmospheric pressure affect this distribution. Increases in atmospheric pressure resulted in gas being released from shallow peat soils into the atmosphere, and decreases in atmospheric pressure resulted in upward gas movement from deeper to shallow layers.

Improved knowledge of how environmental conditions influence the production and release of greenhouse gases is expected to allow better prediction of how peatlands affect climate change, and vice versa.

Mars' Formation Explains Its Small Size

The relative size of Earth and Mars. *Credit: Lunar and Planetary Institute*

The red planet developed much more rapidly than our blue planet, accounting for Mars' small size in relation to Earth, according to an NSF-funded study.

The research suggests that Mars is not a terrestrial planet like Earth, which grew to its full size over 50 to 100 million years via collisions with other small bodies in the solar system. Instead, Mars formed much more quickly, in as little as 2 to 4 million years after the birth of the solar system.

Previous estimates of how long Mars' formation took ranged as high as 15 million years, because the chemical composition of the martian mantle, the rock layer that underlies the crust, was largely unknown. In **their study**, Nicolas Dauphas of the University of Chicago and Ali Pourmand of the University of Miami used radioactive decay to solve some lingering unknowns about the composition of chondrites, a common type of meteorites. A computer simulation based on the data showed that Mars must have reached half its present size only 2 million years after the formation of the solar system.

The rapid formation helps explain why Mars is so small. According to Dauphas, Earth was made of many planetary embryos like Mars, but Mars is a “stranded” embryo that never collided with others to increase its bulk.

Researchers Identify Genetics of van Gogh’s Sunflower

When Vincent van Gogh painted sunflowers, he probably focused on light, color and the overall beauty of these garden staples. A team of NSF-funded plant biologists took a slightly more analytical perspective. In 2012, **the scientists** at Indiana University identified the gene underlying the double-flowered mutation shown in van Gogh's series of paintings.

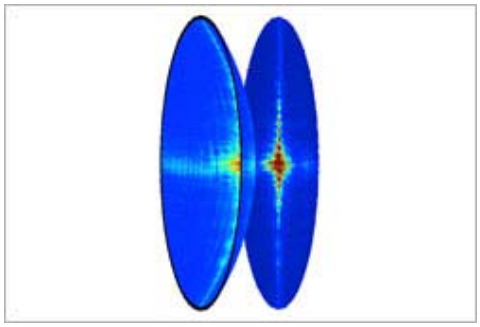
Sunflowers have been an important crop for centuries, both as a source of nutrition and as an ornamental. In addition to the historical importance of van Gogh's work, the double-flowered sunflower is a popular ornamental with a significant market. From a biological perspective, understanding the genetic basis of the flower provides insight into the remarkable success of the sunflower family as well as traits that may be useful for crop improvement or for the control of weeds or pests.

Species in the sunflower family exhibit composite flower heads, in which hundreds (or more) of tiny flowers combine into what appears to be a single, large flower. These individual flowers can be either radially symmetric, with many identical elements, or bilaterally symmetric, with a single mirror-image element. In the case of the van Gogh sunflowers, both flower types are present in a single flowering head—the result of the anomalous expression of a single gene.

One of the sunflower paintings. *Credit: Steve Dorrington/Flickr; Creative Commons Attribution 2.0 Generic License*

Looking in on the Nanoworld

Views at the nanoscale are extremely difficult to achieve. Objects at this scale are measured in nanometers, or billionths of a meter. To improve analysis of processes at this scale, a team of researchers has dramatically increased the spatial resolution of tabletop microscopes--to about 22 nanometers--and demonstrated 3-D imaging capability.



Reconstructing a nanoscale 3-D image. *Credit: Matthew Seaberg, University of Colorado*

The team achieved **these results** using a short-wavelength, X-ray microscopy technique. The researchers illuminated a sample with laser beams at nanometer wavelengths, causing the sample to emit light in a scatter pattern that was captured by a camera operating at X-ray wavelengths. The image was then reconstructed using a sequence of algorithms.

The imaging advance will lead to substantial increases in the variety of objects that can be imaged on the nanoscale--from cells to tiny magnetic wires. This capability, coupled with improved spatial resolution, essentially creates a super-resolution microscope. Furthermore, the microscope can image samples in three dimensions.

The team is affiliated with the NSF-funded **Engineering Research Center for Extreme Ultraviolet Science and Technology** and includes researchers at the University of Colorado-Boulder, Colorado State University, the University of California (UC)-Los Angeles, UC-Berkeley and the Stanford Linear Accelerator Center.

Unraveling the Fabric of the Brain

Credit: Thinkstock

NSF is joining other government agencies and private institutions in a $100-million **research initiative** to understand the human brain, called Brain Research through Advancing Innovative Neurotechnologies (BRAIN). NSF's $20-million contribution will include development of molecular-scale probes that can sense and record the activity of neural networks; advances in "Big Data" needed to analyze the huge amounts of information that will be generated by the research; and research into how

thoughts, emotions, actions and memories are represented in the brain.

The National Institutes of Health and Defense Advanced Research Projects Agency will also participate in the White House initiative. At NSF, the work will build on the agency's existing neuroscience and cognitive science research portfolios, which range from understanding the operation and functions of the brain and nervous system to developing precise imaging and computational tools for mapping brain activity.

Accomplishments include, for example, the discovery by Massachusetts scientists funded by NSF that **connections** in the brain form a grid-like pattern, unlike the tangled “spaghetti” format previously thought to exist. Another Massachusetts team identified a core brain structure associated with the development of **habits**, which may aid in understanding disorders like Parkinson's and Huntington's diseases.

Other NSF-supported researchers have decoded which areas of the brain are activated by various activities such as playing **music** and **bilingual** speech.

U.S. Academic Research Facilities Have Grown

A large-scale virtual research environment. *Credit: Lance Long/Electronic Visualization Laboratory, University of Illinois-Chicago*

Science and engineering research space at the nation’s research-performing colleges and universities increased 3.5 percent in fiscal years 2009-2011, according to NSF’s Survey of Science and Engineering Research Facilities. The biological and biomedical sciences accounted for the bulk of the growth, increasing by 8 percent. The increase followed a 12.3-percent increase for those sciences in fiscal years 2007-2009. In 2011, the biological and biomedical sciences accounted for 26.8 percent of research space.

All types of academic institutions experienced net growth except non-doctorate-granting institutions, in which research space declined 1.2 percent.

Details are available in this **InfoBrief** from NSF's National Center for Science and Engineering Statistics.

National Science Foundation in the News

National Science Foundation to Stay in Ballston, For Now *(Washington Business Journal)*--NSF will keep its headquarters in Arlington, Va., for five more years while reviewing options for a longer term.

Dark-matter Detector Reports Hints of WIMPs *(Science News)*--NSF-supported scientists searching for elusive dark-matter particles reported three promising signals from underground detectors in Minnesota.

A Hunt for Dark Matter in a Former Gold Mine *(Los Angeles Times)*--Another NSF-supported experiment seeking to detect dark-matter particles recently began in a South Dakota underground lab.

The $300-Million Science Museum of the Future *(Scientific American)*--Begun in 1969 with an NSF grant for a “library of experiments,” San Francisco’s Exploratorium has moved to a new space with new exhibits.

Advanced Placement Engineering May Be on the Horizon *(Education Week)*--An NSF-funded researcher at the University of Virginia has worked with the College Board to explore the possibility of an engineering program.

The National Science Foundation (NSF) is an independent federal agency that supports fundamental research and education across all fields of science and engineering. Its Fiscal Year 2012 budget was $7.0 billion. NSF funds reach all 50 states through grants to nearly 2,000 colleges, universities and other institutions. Each year, NSF receives more than 50,000 competitive requests for funding, and makes about 11,000 new funding awards. Contact NSF's ***Office of Legislative and Public Affairs*** *at 703-292-8070 for more information or for permission to reuse newsletter images. Editor: Amber Jones.*

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