

Astronomy in the FY 2002 Budget

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HIGHLIGHTS

- The National Aeronautics and Space Administration's (NASA) exploration of Mars (Mars Exploration Program¹) would continue under a slightly increased budget of \$431 million in FY 2002 (up 0.8 percent; see Table II-12). Compared to FY 2000, this budget item is up 73 percent. In response to recent discoveries that strongly suggest the presence of water on Mars, a series of Mars Exploration Rovers² would grow quickly under the budget proposal.
- The National Science Foundation's (NSF) division of Astronomical Sciences (AST) is proposed to receive an increase of 5.1 percent to a level of \$156.3 million for FY 2002, but this does not represent an overall increase for astronomy funding at the agency (see Table II-7). The transfer of funding for the fifth year of Design and Development of the Atacama Large Millimeter Array (ALMA) from the Major Research Equipment account to AST artificially inflates the proposed increase.
- NASA plans to continue to expand its Discovery³ program (which provides frequent access to space for small planetary science missions) to begin funding for two new missions, MESSENGER⁴ and Deep Impact⁵. MESSENGER would be the

¹ <http://mars.jpl.nasa.gov/index.html>

² <http://mars.jpl.nasa.gov/missions/future/2003.html>

³ <http://discovery.nasa.gov>

⁴ <http://sd-www.jhuapl.edu/MESSENGER/>

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first mission to Mercury since Mariner 10 in 1974 and Deep Impact will follow on NASA's successful, but not originally planned, landing of a probe on an asteroid (the NEAR⁶ mission) by actually plunging a probe into the surface of a comet. The Discovery program would receive \$217.1 million (up 2 percent).

- The Office of Space Science would also expand a technology development program dubbed New Millennium⁷. This program's main goal is to develop and flight-test revolutionary technologies.
- The astronomy research community has produced a prioritized program for research investments in the coming decade. This National Research Council report (*Astronomy and Astrophysics in the New Millennium*⁸) presents a community consensus of the projects and programs that should be carried out over the coming decade and is unique among all the sciences.

INTRODUCTION

The sky belongs to all of humanity and astronomy has a special role to play in bringing knowledge of the cosmos to us all. Beginning with the earliest recorded history, the sky and the objects to be seen there have been described, studied and analyzed. Only in modern times have we truly found our place in the Universe. Just in this century, astronomers have determined how the chemical elements that make up our Earth (and us!) were formed in supernova explosions. Astronomers have managed to trace the history of the Universe back to the Big Bang, when all matter and light were compressed into a dense energetic state that rapidly expanded (for as yet unknown reasons) to form our Universe. In the past decade, astronomers have finally discovered planets around other stars, confirming that our solar system is not unique.

NASA provides roughly 75 percent of the funding⁹ for astronomical research for individuals in the U.S. NASA continues to provide observing

⁵ <http://deepimpact.jpl.nasa.gov/>

⁶ <http://near.jhuapl.edu/>

⁷ http://nmp.jpl.nasa.gov/index_flash.html

⁸ <http://books.nap.edu/catalog/9839.html>

⁹ <http://www.nap.edu/books/0309071399/html/>

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opportunities for astronomers beyond the hindering absorption of the atmosphere. NSF also funds a significant amount of the astronomical research that takes place in the United States, including constructing and operating the U.S. National Observatories¹⁰. These observatories play a critical role for researchers from smaller institutions for whom large observing facilities are too expensive to construct and operate. They also provide access for American astronomers to the sky in the Southern Hemisphere, where many important astronomical objects are located.

A traditional, but arbitrary, split in funding exists between NASA and NSF, with NASA funding space-based observing and NSF funding ground-based. This line is often blurred, since both agencies support balloon-based observing. NASA does support ground-based observing when these activities have a direct role in its space missions. A recent example is the Keck Interferometer¹¹, and both agencies are pursuing collaborative efforts such as the National Virtual Observatory¹² program, which will interconnect databases, telescopic observations, space mission archives and research tools for astronomy and astrophysics. These collaborations reflect the way astronomers pursue their research, using any means necessary to study the objects that interest them.

A reform provision in the President's budget calls for the formation of a blue ribbon panel to review the implications of moving NSF-funded astronomy research under NASA's control. The panel, now called the Committee on the Organization and Management of Research in Astronomy and Astrophysics, or COMRAA, was formed in late April 2001 and will present its recommendations to the President by September 1, 2001. The recommendations from this panel could have a sweeping impact on the way astronomy is carried out and funded in the United States. The astronomical community is watching this process closely.

ASTRONOMY IN THE NASA BUDGET

Once again, the NASA budget will be increasing, though modestly. From a level of \$14.3 billion in FY 2001, NASA would receive an increase of

¹⁰ http://www.nsf.gov/mps/divisions/ast/about/c_facilities.htm

¹¹ <http://huey.jpl.nasa.gov/keck/index.html>

¹² <http://www.srl.caltech.edu/nvo/>

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1.8 percent to a level of just over \$14.5 billion for FY 2002 (see Table II-12). The bulk of this increase would go to the Science, Aeronautics and Technology (SAT) portion of the agency's budget, which would also see an overall increase of 1.8 percent or \$125 million to \$7.2 billion.

The Office of Space Science (OSS¹³) would experience a healthy budgetary growth of 6.2 percent from a level of \$2.6 billion to just under \$2.8 billion in FY 2002. The office has four long-term goals, which may be posed as simple, penetrating questions: How did the Universe, galaxies, stars, the Sun and planets form and evolve? How can exploration of the Universe and our solar system revolutionize our understanding of physics, chemistry and biology? Are there Earth-like planets beyond our solar system? Does life in any form, however simple or complex, carbon-based or other, exist elsewhere than on planet Earth?

To attempt to answer these questions, the OSS has undertaken a series of missions¹⁴ that attempt to answer fundamental scientific questions. Although too numerous to mention here, a few of the missions stand out as particularly exciting (in addition to those mentioned in Highlights).

Chandra X-ray Observatory¹⁵: Deployed in July 1999, the Chandra telescope (one of the four great observatories, which includes the Hubble Space Telescope, the Compton Gamma-ray Observatory and the Space Infrared Telescope Facility) has produced dramatic images of supernova remnants, active galactic nuclei and diffuse X-ray emission found in clusters of galaxies. Chandra is expected to remain operational until 2009.

Space Infrared Telescope Facility (SIRTF)¹⁶: The fourth and final great observatory, this telescope is now slated for launch in July 2002. The President's budget proposes a continued development expenditure of \$106 million in FY 2002. This amount is lower (about 10.5 percent) than the FY 2001 amount, as planned. This instrument is sensitive to the infrared portion of the electromagnetic radiation and in its high orbit above Earth will observe the earliest era of galaxy formation as well as sub-

¹³ <http://spacescience.nasa.gov/>

¹⁴ <http://spacescience.nasa.gov/missions/index.htm>

¹⁵ <http://chandra.harvard.edu/index.html>

¹⁶ <http://sirtf.jpl.nasa.gov/>

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stellar mass objects in our own galaxy. The project was completely restructured to fit within a fixed (FY 1994 value) \$400 million cost ceiling (self-imposed by NASA).

Stratospheric Observatory for Infrared Astronomy¹⁷: This airborne observatory replaces the Kuiper Airborne Observatory, which was retired in October 1995. This collaborative project with the German space agency, DARA, has met delays in the development of the German telescope assembly. These delays have pushed the beginning of science operations into FY 2004.

Research Program: This program supports researchers through peer-reviewed proposal selection. This program would receive an overall increase of about 1.6 percent in FY 2002 to a level of \$607 million. The line item consists of both Research and Analysis (mainly direct funding to researchers; up 0.6 percent to \$246.2 million) and Data Analysis (funding for reduction of mission data; up 3 percent to \$319.2 million).

ASTRONOMY IN THE NSF BUDGET

NSF funds astronomy through its Division of Astronomical Sciences¹⁸. The funds are split between Astronomy Research and Instrumentation (individual researchers, instrument development projects and some research centers) and Facilities (the National Astronomy facilities such as the National Radio Astronomy Observatory¹⁹, National Optical Astronomy Observatories²⁰, Gemini 8 meter telescopes²¹ and the National Astronomy and Ionosphere Center²²). (See Table II-7.)

The Astronomy Research and Instrumentation portion would receive an apparent increase of 1.4 percent to \$54.7 million, although this total would include about \$7 million for NSF-wide programs such as the Information Technology Research (ITR²³) program or the Science Technology

¹⁷ <http://sofia.arc.nasa.gov/>

¹⁸ <http://www.nsf.gov/mps/ast>

¹⁹ <http://www.nrao.edu/>

²⁰ <http://www.noao.edu/>

²¹ <http://www.gemini.edu/>

²² <http://www.naic.edu/>

²³ <http://www.itr.nsf.gov/>

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Centers (STC²⁴) program, to which other scientists may also apply. Astronomers should be pleased to know that in FY 2000, an adaptive optics center²⁵ was established under the STC program and in FY 1991 astrophysical research in the Antarctic was established, both of which have had direct benefit to the astronomical community.

The Astronomy Facilities would seemingly receive a large increase of 7.2 percent or \$6.9 million to a FY 2002 proposed funding level of \$101.5 million. This increase is mainly due to the transfer of funds for a fifth year of design and development of the Atacama Large Millimeter Array (ALMA)²⁶ telescope from the Major Research Equipment line to the division budget. This shift could have serious ramifications for the long-term health of this international collaborative project. ALMA was originally slated to move into construction in FY 2000, was delayed beyond FY 2001, and the President's "no new starts" policy prohibited it from beginning construction in FY 2002. Other facilities would receive small increases, roughly inflationary adjustments or less.

Astronomy is also supported within the NSF budget both through the Office of Polar Programs²⁷ (OPP) and the Major Research Equipment (MRE) line. The exact amounts expended by OPP for astronomy research were not available.

ASTRONOMY ELSEWHERE IN THE BUDGET

Both the Navy and Air Force fund fundamental astronomical research for a variety of reasons related to national security. Although exact numbers were not available, the total amount expended is not as large as either NSF or NASA. The Department of Energy also funds astrophysical research in its Office of Science. Again, detailed funding levels are not easily determined. The Smithsonian Institution also supports a wide array of astronomical research through its Center for Astrophysics²⁸, including telescopes in Hawaii and Arizona.

²⁴ <http://www.nsf.gov/od/oia/programs/stc/start.htm>

²⁵ <http://cfao.ucolick.org/>

²⁶ <http://www.alma.nrao.edu/>

²⁷ <http://www.nsf.gov/opp>

²⁸ <http://cfa-www.harvard.edu/>