14

Astronomy in the FY 2003 Budget

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HIGHLIGHTS

- The National Aeronautics and Space Administration's[1] (NASA) Office of Space Science[2] (OSS) would cancel two outer planet missions that were funded in the final FY 2002 budget, a mission to Jupiter's moon Europa and a congressionally mandated mission to Pluto[3]. A new planetary exploration program modeled on the successful Discovery program would use peer review to select large planetary exploration missions that would be cost capped at $650 million in FY 2003 dollars. The program would be funded initially at a level of $15 million in FY 2003.

- The National Science Foundation's (NSF[4]) division of Astronomical Sciences (AST[5]) budget is proposed to decrease by about 3 percent from a level of just under $165.9 million to $161.3 million. This will likely delay the implementation of ground-based astronomy and astrophysics decadal survey projects (see last bullet item) and decrease the amount of funding available for research grants.

- NASA would initiate a new research program in cooperation with the Department of Energy called the Nuclear Systems Initiative. This program would expand current nuclear-electric power-generation systems and develop new nuclear-electric

[1] http://www.nasa.gov
[2] http://spacescience.nasa.gov
[3] http://pluto.jhuapl.edu
[4] http://www.nsf.gov
[5] http://www.nsf.gov/mps/ast

propulsion technologies to enable expanded exploration missions and decrease travel times to solar system mission targets. The program would be funded at a level of $46.5 million for nuclear-electric propulsion and $79 million for the nuclear-electric propulsion technologies.

- NASA's OSS would also continue its successful Mars Exploration Program[6] with an increased budget request for FY 2003 of just under $454 million. Two Mars Exploration Rovers[7] are being prepared for launch in the summer of 2003 and will arrive in early 2004. These rovers will search for water-affected materials on the surface and will, in a sense, serve as robotic field geologists.

- The astronomy research community is augmenting the successful National Research Council Decadal Survey of Astronomy and Astrophysics (the most recent version is *Astronomy and Astrophysics in the New Millennium*[8]). Two new reports will be released during the lifecycle of this AAAS book, one that prioritizes the needs of the Planetary Science community (*A New Science Strategy for Solar System Exploration*[9]) and the second that covers the Solar and Space Physics community (*Solar and Space Physics: A Community Assessment and Strategy for the Future*[10]). The planetary science report is slated for release in June 2002 and the solar report in early 2003.

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 are described, studied and analyzed. Only in modern times have we truly found our place in the Universe. We live out our lives on a relatively small planet orbiting a rather normal star in an average galaxy. Just in

[6] http://mars.jpl.nasa.gov
[7] http://mars.jpl.nasa.gov/missions/future/2003.html
[8] http://books.nap.edu/catalog/9839.html
[9] http://www.nationalacademies.org/ssb/ssefrontpage.html
[10] http://www4.nationalacademies.org/cpsma/SSBDisc.nsf

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 its very first moments when all matter and light were compressed into a dense energetic state that rapidly expanded (for as yet unknown reasons) forming our Universe. This cosmic explosion is now known as the Big Bang. In the past decade, astronomers have finally discovered planets around other stars, confirming that our solar system is not unique and discovered that the Universe is not just expanding, but that it is expanding faster and faster in a kind of "runaway" situation. Each new discovery brings up new questions and new technological needs. Astronomy is truly an exciting, vibrant science that adds meaning to our human existence.

NASA provides roughly 75 percent of the funding[11] for astronomical research for individuals in the United States. When the budget for the Office of Space Science is changed, many American astronomers can be affected. NASA continues to provide observing 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 Observatories[12]. These observatories play a critical role for researchers from smaller institutions for which 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 and cannot be observed from Northern Hemisphere locations (*e.g.*, the Magellanic Clouds, our nearest galactic neighbors).

A traditional, but arbitrary, split in funding exists between NASA and NSF, with NASA funding *mostly* space-based observing and NSF funding *mostly* ground-based. This line is often blurred, since both agencies support balloon-based observing and other cross-cutting research. NASA does support ground-based observing when these activities have a direct supporting role for their space missions. A recent example is the Keck Interferometer[13] and both agencies are pursuing

[11] http://www.nap.edu/books/0309071399/html/
[12] http://www.nsf.gov/mps/divisions/ast/about/c_facilities.htm
[13] http://huey.jpl.nasa.gov/keck/index.html

collaborative efforts such as the National Virtual Observatory[14] 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 FY 2002 budget called for the formation of a blue-ribbon panel to review the implications of moving NSF-funded astronomy research under NASA's control. The panel, named the Committee on the Organization and Management of Research in Astronomy and Astrophysics[15], or COMRAA, was formed in late April 2001 and presented its recommendations to the President in September 2001. Among other recommendations, the panel recommended the formation of a dual-agency advisory panel that would provide guidance on projects and science that would benefit from agency collaboration. The full text of the report, entitled *U.S. Astronomy and Astrophysics: Managing an Integrated Program*, is now available online and in print[16].

ASTRONOMY IN THE NASA BUDGET

Once again, the overall NASA budget will be increasing only slightly. From a level of just under $14.8 billion in FY 2002, NASA would receive an increase of 1.4 percent to a level of just over $15.0 billion for FY 2003. 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 10.3 percent, or $836 million to $8.9 billion. (These figures exclude adjustments made in Table II-12 to fully fund federal retiree costs, as proposed by the Bush Administration. For information on the overall NASA budget, see Chapter 10 and Table II-12.)

The Office of Space Science would experience a very healthy budgetary growth of 19 percent from a level of just under $2.9 billion to a FY 2003 total of $3.4 billion (see Table II-12). The bulk of this increase ($547 million) is from increases in the technology program ($264 million) and the remainder ($210 million) due to an increase in the mission

[14] http://www.srl.caltech.edu/nvo/
[15] http://www.srl.caltech.edu/nvo/
[16] http://www.nap.edu/catalog/10190.html

operations budget line, including the transfer of the Deep Space Network[17] (DSN), an extensive ground-based space communications system, from another portion of the NASA budget into the Space Science budget. Space Science missions were by far the dominant user of the DSN, so the transfer makes a great deal of sense.

The OSS 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 missions[18] 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 the Highlights section above).

Chandra X-ray Observatory[19]: Deployed in July of 1999, the Chandra telescope (one of the four "great observatories", which include 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. This observatory will continue to produce exciting science results throughout the next several years and is expected to remain operational until 2009.

Space Infrared Telescope Facility (SIRTF[20]): The fourth and final great observatory, this telescope is now slated for launch no earlier than December 2002. The launch was delayed to resolve software and technical problems. The President's budget proposes a continued development expenditure of $47.4 million in FY 2003. This instrument is sensitive to the infrared portion of the electromagnetic radiation and in

[17] http://deepspace.jpl.nasa.gov/dsn
[18] http://spacescience.nasa.gov/missions/index.htm
[19] http://chandra.harvard.edu/index.html
[20] http://sirtf.jpl.nasa.gov/

its high orbit above Earth will observe the earliest era of galaxy formation as well as sub-stellar mass objects in our own galaxy.

Stratospheric Observatory for Infrared Astronomy[21]: This airborne observatory replaces the Kuiper Airborne Observatory, which was retired in October of 1995. A Boeing 747SP aircraft will carry a 2.5-meter telescope that will be used to study infrared light from a variety of celestial objects. This challenging and collaborative project with the German Aerospace Center (DLR[22]) has met with some delays during the development process. First light is now planned for October 2004.

Research program: This core NASA-OSS program, part of the wider supporting research and technology line item, supports researchers through peer-reviewed proposal selection. This program would receive an overall increase of about 9.7 percent in FY 2003 to a level of $709.6 million. The line item consists of both Research and Analysis (mainly direct funding to researchers) and Data Analysis (funding for reduction of mission data).

ASTRONOMY IN THE NSF BUDGET

NSF funds astronomy through its Division of Astronomical Sciences[23]. This funding is split into two basic units, Astronomy Research and Instrumentation (which funds individual researchers, instrument development projects and some research centers such as the center for adaptive optics[24]) and Facilities (which supports the National Astronomy facilities such as the National Radio Astronomy Observatory[25], National Optical Astronomy Observatories[26], Gemini 8 meter telescopes[27] and the National Astronomy and Ionosphere Center[28]).

The Astronomy Division budget would decrease in the President's FY 2003 budget by 2.8 percent (see Table II-7; for information on the

[21] http://sofia.arc.nasa.gov/
[22] http://www.dlr.de/
[23] http://www.nsf.gov/mps/ast
[24] http://cfao.ucolick.org/
[25] http://www.nrao.edu/
[26] http://www.noao.edu/
[27] http://www.gemini.edu/
[28] http://www.naic.edu/

overall NSF budget, see Chapter 7). The Astronomy Research and Instrumentation portion would decrease by $2.75 million to $64.3 million. This would decrease the amount of funds available for grants to researchers as well as potentially hinder instrumentation development.

The Astronomy Facilities would also receive a decrease of $1.86 million to a FY 2003 proposed funding level of $96.9 million. This reduction would slow down the implementation of various decadal survey[29] initiatives. Reductions would also cut into the operations budgets of these important research tools, reducing the level of service to the community.

Astronomy is also supported within the NSF budget both through the Office of Polar Programs[30] (OPP) and the Major Research Equipment and Facilities Construction (MREFC) budget line. The exact amounts expended by OPP for astronomy research were not available, but several telescopes reside at the South Pole station[31], including a unique instrument (AMANDA[32]) that uses photodetectors buried more than a kilometer deep in the Antarctic ice sheet to detect high energy neutrinos from celestial objects. The long-awaited construction start for the Atacama Large Millimeter Array[33] (ALMA) telescope is supported in the FY 2003 budget at a level of $30.0 million. ALMA construction is funded within the MREFC budget line. This telescope, an international collaboration, will be built in the high altiplano[34] of Chile where the absorption of celestial millimeter and sub-millimeter radiation by water vapor is significantly less than at other locations on Earth.

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 under its Office of Science. Again, detailed

[29] http://books.nap.edu/catalog/9839.html
[30] http://www.nsf.gov/opp
[31] http://www.nsf.gov/od/opp/antarct/aeroastro.htm
[32] http://alizarin.physics.wisc.edu/
[33] http://www.alma.nrao.edu/
[34] http://www.raingod.com/angus/Gallery/Photos/SouthAmerica/Bolivia/Altiplano.html

funding levels are not easily determined. The Smithsonian Institution also supports a wide array of astronomical research through its Center for Astrophysics[35], including telescopes in Hawaii and Arizona. The Submillimeter Array[36], an innovative high-frequency radio telescope is nearing operational completion on the summit of Mauna Kea in Hawaii.

[35] http://cfa-www.harvard.edu/
[36] http://sma-www.harvard.edu/