15

Astronomy in the FY 2007 Budget

Kevin B. Marvel, American Astronomical Society;
James H. Ovelmen, Vanderbilt University

HIGHLIGHTS

- Shortly before publication of this report, the National Aeronautics and Space Administration's[1] (NASA) Science Mission Directorate was reorganized into four divisions, namely Planetary Science, Earth Science, Astrophysics and Heliophysics, reversing an organizational structure that lumped Earth science together with solar physics. Astronomy, defined broadly, is funded through the Planetary Science, Astrophysics and Heliophysics divisions. Web pages for the various divisions have not yet been established and this reorganization is ongoing.

- The budget proposed for the National Science Foundation's (NSF[2]) division of Astronomical Sciences (AST[3]) would increase by 7.7 percent from a FY 2006 estimate of $199.65 million to $215.11 million for FY 2007 (see Table II-7). AST provides funding directly to astronomical researchers. Of the many important projects funded by the NSF, one of the most exciting is the discovery of evidence for how our Universe came to have its current shape. Data from the Sloan Digital Sky Survey was used by Dr. Daniel Eisenstein of the University of Arizona and colleagues from elsewhere to discover a "bump" in the otherwise smooth curve representing the separation between galaxies. This bump can be explained by what may be considered the equivalent of cosmic sound waves traversing through the early Universe. This finding also strengthens the evidence for an expanding and accelerating universe in which roughly 95 percent of its content is "Dark Matter" and "Dark Energy."

- The strong growth of NASA's Science Mission Directorate of the past few years is reined in under the President's budget request, with the

[1] http://www.nasa.gov
[2] http://www.nsf.gov
[3] http://www.nsf.gov/mps/ast

overall directorate seeing only a 1.5 percent growth from FY 2006 funding levels (compared to last year's budget projections, the FY 2007 projections represent a $3.1 billion decrease in total planned expenditure). However, this slight positive increase hides the fact that the funds are preferentially proposed to fund a few large missions, while basic research and smaller missions see significant cuts. The magnitude of the proposed cuts are further obscured by the inclusion of the FY 2006 operating plan into budget documents, which included reductions in numerous programs and activities from their initially planned FY 2006 levels.

- Astronomy is unique in the science community in the production of prioritized lists of projects requiring federal support. These so-called "Decadal Surveys" represent community consensus on the relative importance of scientific research projects. The surveys are carried out under the auspices of the National Academy of Sciences/National Research Council and sponsored by the funding agencies. The most recent astronomy and astrophysics survey is entitled *Astronomy and Astrophysics in the New Millennium.*[4] Two new reports were released in 2002, one that prioritizes the needs of the Planetary Science community (*A New Science Strategy for Solar System Exploration)*[5] and the second that covers the Solar and Space Physics community (*Solar and Space Physics: A Community Assessment and Strategy for the Future.)*[6] Projects requiring federal funding that are not included in these studies (or follow-up letters from the authoring committees) do not necessarily represent a community consensus priority. The American Astronomical Society has endorsed all three reports.

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 observed, debated 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 this century, astronomers have determined how the chemical elements that make up our Earth (and us!) were formed in supernova

[4] http://books.nap.edu/catalog/9839.html
[5] http://www.nationalacademies.org/ssb/ssefrontpage.html
[6] http://www4.nationalacademies.org/cpsma/SSBDisc.nsf

explosions and aging giant stars. 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 also discovered that the Universe is not just expanding, but that it is expanding faster and faster in a kind of "runaway" situation. Amazingly, the newest results indicate that the nature of roughly 96 percent of the matter and energy content of the Universe is completely unknown to us. Each new discovery creates 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 federal funding[7] for astronomical research in the United States. When the budget for the Science Mission Directorate of NASA is changed, many American astronomers can be affected, not to mention the workers in the aerospace industry who build the spacecraft that make these missions possible. NASA continues to provide observing opportunities for astronomers beyond the hindering absorption of the atmosphere.

However, approximately two-thirds of the federal support for ground-based astronomy, including nearly all support for radio astronomy, is provided by the NSF.[8] NSF funds the construction and operation of the U.S. National Observatories.[9] 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).

Lately, the Department of Energy (DOE) has undertaken new astronomical research projects and the Smithsonian Institution and the Department of Defense also fund astronomical research, though on a smaller scale than both NASA and NSF.

[7] http://www.nap.edu/books/0309071399/html/
[8] http://www.nsf.gov/bfa/bud/fy2004/pdf/fy2004_11.pdf
[9] http://www.nsf.gov/mps/divisions/ast/about/c_facilities.htm

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 (whose planned outrigger telescopes are proposed to be canceled in the FY 2007 budget proposal).[10] Additionally, DOE has begun collaborations with both the NSF and NASA on astronomy-related projects, such as the Supernova Acceleration Probe, or SNAP.[11] These collaborations reflect the way astronomers pursue their research, using any means necessary to study celestial objects. The Astronomy and Astrophysics Advisory Committee (AAAC)[12]—a Federal Advisory Committee Act (FACA) committee—meets regularly to discuss and advise on the best and most efficient ways for agencies to collaborate on astronomy research.

ASTRONOMY IN THE NASA BUDGET

The overall NASA budget would increase from a level of $16.6 billion in FY 2006 to $16.8 billion in FY 2007, an increase of 3.2 percent (excluding emergency supplementals; see Table II-12 for NASA details). This increase is lower than anticipated from prior year budget projections. The agency is focused on implementing the priorities of Congress and the President within the resources requested.

Major plans for the agency overall include continued assembly of the International Space Station (which is scheduled to be completed by 2010), servicing the Hubble Space Telescope (if the Space Shuttle can be flown safely at all) and beginning development of a new manned space flight hardware system (the Crew Exploration Vehicle and Crew Launch Vehicle).

The agency focus on implementing the President's Vision for Space Exploration without incurring a large gap in U.S. capability to place humans in orbit has placed significant pressure on other parts of the agency, given the assumption of nearly flat budgetary growth.

[10] http://huey.jpl.nasa.gov/keck/index.html
[11] http://snap.lbl.gov/
[12] http://www.nsf.gov/mps/ast/aaac.jsp

Science is especially hard hit under the proposed budget for FY 2007. The agency uses the argument that the science portion of NASA's budget has grown from a level of 24 percent in 1992 to nearly 32 percent in the FY 2007 request as a case for reducing its growth. But this statement ignores the fact that NASA modified its accounting structure in the 1990s to a "full-cost" system, which has artificially enhanced the Science budget by distributing support costs previously carried elsewhere in the budget into the Science Misison Directorate's budget. Although a detailed accounting is beyond the scope of this short chapter, it is fairly clear that if the 1992 funding level quoted by the administration was scaled to represent full-cost accounting, it would be at least of the order of the FY 2007 funding level.

The Science Mission Directorate, which was expecting growth in the 5 percent range based on previous budget outyear projections, is reined in under the President's FY 2007 budget proposal to a modest 1.5 percent growth from FY 2006 to FY 2007 and 1 percent in subsequent years. The initial FY 2006 operating plan called for $5.254 billion while the FY 2007 request calls for $5.330 billion. These funding levels should be compared to the planned FY 2006 level of $5.342 billion ($88 million more than was received in FY 2006) and the projected (in the FY 2006 budget) FY 2007 funding level of $5.684 billion ($354 million more than is being requested in the 2007 budget).

Within the Science Mission Directorate, the Solar System Exploration division would receive $1.6 billion (compared to last year's projection of $2.1 billion), the Universe division would receive $1.5 billion and the Earth-Sun System division $2.210 billion (compare to an FY 2006 planned request level for FY 2007 of $2.081 billion). These budget levels would all be only slightly positive increases over the FY 2006 initial operating plan.

Although there are slight increases for the various divisions compared to the FY 2006 initial operating plan, a range of activities are cancelled or delayed in the President's FY 2007 budget, including: cancellation or delay of six Mars missions (including Mars Sample Return[13]), termination of the Dawn[14] mission, cancellation of various power technology development plans (necessary for deep-space exploration

[13] http://mars.jpl.nasa.gov/missions/future/2005-plus.html
[14] http://dawn.jpl.nasa.gov/

missions), reduction in astrobiology research by 50 percent, reduction in solar system exploration research funding by 15 percent, deferment of the Terrestrial Planet Finder[15], cancellation of the Keck outrigger telescopes, an initial termination of the Stratospheric Observatory for Infrared Astronomy (SOFIA)[16] mission with a retrenchment to a 'review to determine best course of action', reduction in astrophysics research funding of 15 percent, replan of the Beyond Einstein program with a delay in starting this new initiative for several years, reduction in Earth-Sun research funding by 15 percent, and launch delays for a number of Earth and Sun missions (including STEREO[17] and SDO.)[18]

ASTRONOMY IN THE NSF BUDGET

NSF funds astronomy through its Division of Astronomical Sciences.[19] This funding is split into two basic units, Astronomy Research and Instrumentation (which funds individual researchers, infrastructure and instrument development projects and some research facilities such as the Science and Technology Center for Adaptive Optics[20]) and Facilities, which supports the four national R&D centers (National Radio Astronomy Observatory[21], National Optical Astronomy Observatories[22], National Solar Observatory[23], and National Astronomy and Ionosphere Center[24]), as well as the International Gemini Observatory.[25]

The Astronomy Division budget would increase in the President's FY 2007 budget by 7.7 percent to $215.1 million (see Table II-7 for NSF budget details). The Astronomy Research and Education portion is proposed to increase from $79.32 million to $89.86 million, representing the bulk of the increase in the division and the portion of the NSF-AST budget that goes to researchers in the form of research grants. Astronomy

[15] http://planetquest.jpl.nasa.gov/TPF/tpf_index.cfm
[16] http://www.sofia.usra.edu/
[17] http://www.nasa.gov/mission_pages/stereo/main/index.html
[18] http://sdo.gsfc.nasa.gov/
[19] http://www.nsf.gov/mps/ast
[20] http://cfao.ucolick.org/
[21] http://www.nrao.edu/
[22] http://www.noao.edu/
[23] http://www.nso.edu/
[24] http://www.naic.edu/
[25] http://www.gemini.edu/

Facilities would see an increase of $4.88 million over FY 2006 to a FY 2007 request for $121.25 million.

The increased funding for the division will go to a variety of programs including enhancing the Physics of the Universe (POU) partnership between the Astronomy Division, Physics Division, DOE, and NASA; cyberscience and cyberinfrastructure (including the National Virtual Observatory); the capabilities of Gemini Observatory; and strategic private-public partnerships (including development of the Giant Segmented Mirror Telescope). The Elementary Particle Physics Investment has maintained its FY 2006 funding level of $15 million and has provided discoveries in a range of fields. $3 million of the investment has been for investigations into a study of "Dark Matter" and "Dark Energy."

Funding for the Gemini telescopes would increase by $1.74 million to $20 million overall in FY 2007. The proposed increase would pay for the development of the instrumentation that will expand the Gemini telescopes' capabilities in adaptive optics. The new instrumentation will remove much of the atmospheric distortion and allow the Gemini telescopes to search for planets around nearby stars. The Laser Interferometer Gravitational Wave Observatory (LIGO) would receive an additional $4.6 million, increasing from $31.7 million for FY 2006 to $33.0 million for FY 2007.

NOAO would also receive an increase in its share of the Facilities budget, increasing by $3.14 million to $40.05 million. NAIC and NRAO would see no change in their budgets between FY 2006 and FY 2007, although ALMA, which falls under NRAO, would receive a $2.0 million increase to its early operations budget, increasing its total to $6.0 million. The increase would currently have to be funded through reallocation of funds within the overall NRAO budget.

Overall, the facilities budgets would be maintained at nearly the FY 2006 levels due to the "Senior Review," a process new to NSF that is similar to NASA's Senior Review. The NSF AST division is employing this process to evaluate the cost effectiveness of its facilities and to determine how to manage its current portfolio of facilities in order to achieve the priorities outlined in the last Decadal Survey, while maintaining core programs.[26]

[26] http://www.nsf.gov/mps/ast/ast_senior_review.jsp

Astronomy is also supported within the NSF budget through the Office of Polar Programs[27] (OPP), Major Research Equipment and Facilities Construction (MREFC) and Multidisciplinary Activities budget lines. Request for the IceCube Neutrino Observatory, an extension of the successful AMANDA project, would receive $28.65 million in its continued construction phase. Funding for the Atacama Large Millimeter Array[28] (ALMA) telescope construction in FY 2007 is slated to be $47.89 million.

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, but is important as it often represents multidisciplinary involvement in astrophysical research. The Department of Energy (DOE) also funds astrophysical research under its Office of Science. One example is the Supernova Acceleration Probe (SNAP).[29] The Smithsonian Institution supports a wide array of astronomical research as well through its Center for Astrophysics[30], including telescopes in Hawaii and Arizona. The Submillimeter Array[31], an innovative high-frequency radio telescope is nearing operational completion on the summit of Mauna Kea in Hawaii.

[27] http://www.nsf.gov/od/opp
[28] http://www.alma.nrao.edu/
[29] http://snap.lbl.gov/
[30] http://cfa-www.harvard.edu/
[31] http://sma-www.harvard.edu/