

## Astronomy in the FY 2006 Budget

*Kevin B. Marvel, American Astronomical Society;  
K. E. Saavik Ford, Carnegie Institution of Washington, DTM*

### HIGHLIGHTS

- The National Aeronautics and Space Administration<sup>1</sup> (NASA) is reorganized under the FY 2006 budget. The former Office of Space Science is combined with other offices to form the new Science Mission Directorate. Quoting the NASA SMD<sup>2</sup> web page: “The Science Mission Directorate will carry out the scientific exploration of the Earth, Moon, Mars and beyond; chart the best route of discovery; and reap the benefits of Earth and space exploration for society. A combined organization is best able to establish an understanding of the Earth, other planets and their evolution, bring the lessons of our study of Earth to the exploration of the Solar System, and to assure the discoveries made here will enhance our work there.” The directorate has three divisions, Earth-Sun System, Solar System (*e.g.* non Earth-Sun research) and the Universe, which encompasses the bulk of the research carried out by the former Office of Space Science. The impact of this reorganization on support for science is still being assessed.

- The National Science Foundation’s (NSF<sup>3</sup>) division of Astronomical Sciences (AST<sup>4</sup>) budget is proposed to increase by about 1.8 percent from a level of \$195.1 million to \$198.6 million. AST provides funding directly to astronomical researchers, mainly at universities. Arguably one of the most important discoveries of our age was made with support from NSF. Dr. Geoff Marcy and colleagues<sup>5</sup> used NSF support (as well as from NASA and other institutions) to perfect a new observational technique and use it to detect numerous planets around other stars<sup>6</sup>.

---

<sup>1</sup> <http://www.nasa.gov>

<sup>2</sup> <http://science.hq.nasa.gov/>

<sup>3</sup> <http://www.nsf.gov>

<sup>4</sup> <http://www.nsf.gov/mps/ast>

<sup>5</sup> <http://exoplanets.org/teamframe.html>

<sup>6</sup> <http://exoplanets.org/>

- The President's Vision for Space Exploration continues to be implemented at NASA. Many programs directly related to the vision (e.g. Mars and Moon exploration) receive increases, while others not so closely aligned (e.g. solar research) receive decreases. However, the budget is a mixed bag in that some programs not directly focused on the Moon or Mars do receive increases. For example, the Beyond Einstein<sup>7</sup> initiative (an effort to understand the Big Bang, black holes and the mysterious Dark Energy) receives an increase in FY 2006 compared to FY 2005 from \$41.8 million to \$55.5 million.

- 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*<sup>8</sup>. 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*<sup>9</sup>) and the second that covers the Solar and Space Physics community (*Solar and Space Physics: A Community Assessment and Strategy for the Future*<sup>10</sup>). Policy makers take note: 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 (AAS) has endorsed all three reports and an interim report addressing progress toward implementation of the Decadal Survey priority projects<sup>11</sup>.

## 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 it hosts have been observed, debated and analyzed. Only in modern times have we truly

---

<sup>7</sup> <http://universe.nasa.gov/>

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

<sup>9</sup> <http://www.nationalacademies.org/ssb/ssefrontpage.html>

<sup>10</sup> <http://www4.nationalacademies.org/cpsma/SSBDisc.nsf>

<sup>11</sup> <http://www.nap.edu/books/NI000580/html/>

#### ASTRONOMY IN THE FY 2006 BUDGET

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 in an accelerating Universe.

Only in 1957<sup>12</sup> did astronomers determine how the chemical elements that make up our Earth (and us!) formed in supernova explosions and through stellar evolution. Since then, astronomers have traced 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.

Only in the past decade have astronomers discovered planets around other stars, confirming that our solar system is not unique. Even more recently, astronomers discovered that the Universe is not just expanding, but that it is expanding faster and faster – a find that was declared the scientific discovery of 1998<sup>13</sup>. 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. With so much promising work, yet so much still to learn, each discovery creates new questions and new technological needs. It is this dynamic that makes astronomy an exciting and vibrant science which adds meaning to human existence.

NASA provides an increasing amount of the federal funding (roughly 75 percent in a recent study<sup>14</sup>) for astronomical research in the United States. When the budget for the Science Mission Directorate at NASA is changed, many American astronomers can be affected and policy decisions made by the NASA Administrator or the White House can have unforeseen consequences for astronomy.

While NASA provides observing opportunities for astronomers beyond the hindering absorption of the atmosphere, the NSF provides approximately two-thirds of the federal support for ground-based astronomy, including nearly all support for radio astronomy.<sup>15</sup> The NSF

---

<sup>12</sup> [http://prola.aps.org/abstract/RMP/v29/i4/p547\\_1](http://prola.aps.org/abstract/RMP/v29/i4/p547_1) (Note that the first author on this paper is E. Margaret Burbidge, one of the very few women astronomers of the early part of the last century. She continues her research efforts today from a faculty position at the University of California, San Diego.)

<sup>13</sup> <http://msnbc.msn.com/id/3077857/>

<sup>14</sup> <http://www.nap.edu/books/0309071399/html/>

<sup>15</sup> [http://www.nsf.gov/bfa/bud/fy2004/pdf/fy2004\\_11.pdf](http://www.nsf.gov/bfa/bud/fy2004/pdf/fy2004_11.pdf)

funds the construction and operation of the U.S. National Observatories<sup>16</sup>, which play a critical role for researchers from smaller institutions for whom large telescopes are too expensive to construct and operate. The National Observatories also provide American access to the Southern hemisphere sky (which cannot be observed from Northern hemisphere locations). Many important astronomical objects, including the Magellanic Clouds, our nearest galactic neighbors, reside in the southern sky.

Lately, the Department of Energy 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.

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<sup>17</sup> and both agencies are pursuing collaborative efforts such as the National Virtual Observatory<sup>18</sup> 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 celestial objects. The Astronomy and Astrophysics Advisory Committee<sup>19</sup>, a federal advisory 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 \$16.1 billion in FY 2005 to \$16.5 billion in FY 2006, an increase of 2.4 percent (which does not include an emergency hurricane supplemental appropriation of \$126 million to repair damage to NASA's Florida-based

---

<sup>16</sup> [http://www.nsf.gov/mps/divisions/ast/about/c\\_facilities.htm](http://www.nsf.gov/mps/divisions/ast/about/c_facilities.htm)

<sup>17</sup> <http://huey.jpl.nasa.gov/keck/index.html>

<sup>18</sup> <http://www.srl.caltech.edu/nvo/>

<sup>19</sup> <http://www.aas.org/naaac/>

#### ASTRONOMY IN THE FY 2006 BUDGET

facilities). The FY 2006 budget is a mixed bag for NASA, with a number of programs seeing increases, while others decline. Within the Science account, the new Universe and Earth-Sun System divisions decline slightly while Solar System Exploration increases to \$1.9 billion. Looking at the top level, the Science Directorate, which hosts these three divisions, would fall slightly to \$5.5 billion (see Table II-12).

NASA Administrator Sean O’Keefe announced in January 2004 that future servicing missions to the Hubble Space Telescope (HST)<sup>20</sup> would not take place due to an integrated safety assessment. Senator Barbara Mikulski (D-MD), whose state hosts the Space Telescope Science Institute, called for an independent review of the decision. A NRC committee was ultimately formed<sup>21</sup> to assess the options for extending the life of the HST and concluded that the incremental risk in servicing the HST with astronauts in the space shuttle versus visiting the International Space Station in the space shuttle was not substantial and that a robotic servicing mission was more likely to fail to succeed in servicing the HST than a human-based mission from the space shuttle.

The FY 2006 budget includes only funding to develop an ultimate de-orbit mission for the HST (it must be de-orbited carefully as not all of the telescope will burn up upon reentry) and to continue ongoing operations in a way that optimizes the useful scientific life of the telescope.

Congress has had hearings on this topic and is considering what course of action to take. Tradeoffs with other missions, should the servicing mission require support from within existing programs, may require the astronomy community to revisit their priority setting process. The HST is a household name across the nation and the public have strongly supported saving the telescope. Though all astronomers value HST discoveries past and future, community opinion on servicing is split; if it can be accomplished without undue impact to other high priority scientific missions, most astronomers would be supportive of servicing.

Under the proposed FY 2006 budget, the newly formed Science Mission Directorate would decline by \$51 million to \$5.5 billion. Of direct concern to the astronomy community, the Universe Research program, which directly funds astronomy and space science researchers, would decline from \$332 million to \$316 million. This program supports

---

<sup>20</sup> <http://www.stsci.edu/>

<sup>21</sup> <http://www.nap.edu/books/0309095301/html/>

fundamental research that has led to both technology development as well as new ideas for large-scale NASA missions. Declines in this budget line are of great concern to US astronomers. Other key programs facing declines include the Navigator program, which seeks to discover and understand planets beyond our solar system (decline of \$34.3 million to \$199.4 million), the Stratospheric Observatory for Infrared Astronomy (SOFIA; from \$50.9 million to \$48.3 million), HST (from \$215.7 million to \$190.7 million), the Gamma Ray Large Area Space Telescope (GLAST; from \$107 million to \$99.4 million) and the important Discovery program, which supports innovative proposals from researchers for major NASA missions (from \$125.5 million to \$117.9 million). A few programs receive increases under the proposed budget, including the James Webb Space Telescope<sup>22</sup> (from \$311.8 million to \$371.6 million). (For more on the NASA budget, please see Chapter 10.)

#### **ASTRONOMY IN THE NSF BUDGET**

NSF funds astronomy through its Division of Astronomical Sciences<sup>23</sup>. 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<sup>24</sup>) and Facilities (which supports the National Astronomy facilities such as the National Radio Astronomy Observatory<sup>25</sup>, National Optical Astronomy Observatories (NOAO)<sup>26</sup>, National Solar Observatory (NSO)<sup>27</sup>, Gemini Observatories<sup>28</sup> and the National Astronomy and Ionosphere Center<sup>29</sup>).

The Astronomy Division budget would increase in the President's FY 2006 budget by 1.8 percent to \$199 million (see Table II-7 for details of the NSF budget). The Astronomy Research and Instrumentation portion of the budget is essentially flat at \$84.8 million, with only a small cut of \$0.04 million in research and education grants. The Astronomy Facilities

---

<sup>22</sup> <http://www.jwst.nasa.gov/>

<sup>23</sup> <http://www.nsf.gov/mps/ast>

<sup>24</sup> <http://cfao.ucolick.org/>

<sup>25</sup> <http://www.nrao.edu/>

<sup>26</sup> <http://www.noao.edu/>

<sup>27</sup> <http://www.nso.edu/>

<sup>28</sup> <http://www.gemini.edu/>

<sup>29</sup> <http://www.naic.edu/>

#### ASTRONOMY IN THE FY 2006 BUDGET

budget would receive a net increase of \$3.6 million to a FY 2006 proposed funding level of \$113.9 million.

The top priority in the Astronomy Facilities budget is the Gemini Observatory and as such it receives the lion's share of the Astronomy Division's budget increase – an additional \$3.7 million is requested to support operations of the Observatory, including development of next-generation instrumentation and a partial buyback of the Chilean share of construction costs, allowing American astronomers greater access to these valuable telescopes. The Gemini increase is partially offset by a cut of \$0.56 million from the NOAO/NSO budget line, mostly achieved by freezing progress on the Adaptive Optics Development Program.

Astronomy is also supported within the NSF budget both through the Office of Polar Programs<sup>30</sup> (OPP) and the Major Research Equipment and Facilities Construction (MREFC) budget line. Cuts in the OPP budget will force a slowing of progress on a 10-meter telescope at the South Pole and will prevent researchers from beginning their work using this telescope to study Dark Energy. However, a new Antarctic instrument, IceCube, is slated to receive a healthy (\$2.8 million) increase through the MREFC budget line to continue construction on schedule. This novel telescope uses photodetectors embedded in the clear Antarctic ice to observe neutrinos from distant high-energy astronomical sources and is an expanded and improved version of the earlier AMANDA observatory. The Atacama Large Millimeter Array<sup>31</sup> (ALMA) telescope construction continues to be supported in the FY 2006 budget from the MREFC line at a level of \$49.3 million. ALMA was ranked as the highest priority project in the MREFC budget. This telescope, an international collaboration, will be the largest and highest resolution telescope in the millimeter and sub-millimeter region of the electromagnetic spectrum, allowing it to provide unprecedented views of the process of star and planet formation, as well as images of some of the earliest galaxies. ALMA continues to proceed on schedule for a full operations start date early in 2012.

This year's budget proposal includes a transfer (at a loss) of the important polar icebreaker program from the Coast Guard to the NSF. This transfer, though appropriate as the breakers spend much of their time supporting research at the poles, is a long-term concern for the

---

<sup>30</sup> <http://www.nsf.gov/od/opp>

<sup>31</sup> <http://www.alma.nrao.edu/>

agency. Both icebreakers are aging, and one is in urgent need of refurbishment. The cost of refurbishing, or more dramatically, replacing these important ships would be a large budgetary burden on the agency. Although cost estimates are hard to come by, rough numbers of several hundred million dollars for refurbishment and much more for construction of a new ship, should raise eyebrows for those who follow the NSF budget. Should NSF have to shoulder these costs without additional funds being added to the budget, all science programs, especially those that rely on the MREFC budget line at one time or another, will be put under significant budgetary threat. (For more on the NSF budget, please see Chapter 7.)

#### **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 are not available, the total amount expended is not as large as either NSF or NASA. The Department of Energy (DOE) also funds astrophysical research under its Office of Science. One example is the Supernova Acceleration Probe<sup>32</sup> (SNAP), which would receive \$2.9 million in the FY 2006 budget under the High Energy Physics budget. DOE also plays a critical role in development and integration of detector technology for NASA's GLAST mission and is continuing the construction of VERITAS, a ground-based gamma ray telescope array south of Tucson, Arizona. The Smithsonian Institution also supports a wide array of astronomical research through its Center for Astrophysics<sup>33</sup>, including telescopes in Hawaii and Arizona. The Submillimeter Array<sup>34</sup>, an innovative high-frequency radio telescope is now operational and producing scientific results on the summit of Mauna Kea in Hawaii and the Smithsonian Institution continues to support other research through its partnership with Harvard in the Harvard-Smithsonian Center for Astrophysics<sup>35</sup>, home in one way or another to a significant fraction of the Nation's astronomical researchers.

---

<sup>32</sup> <http://snap.lbl.gov/>

<sup>33</sup> <http://cfa-www.harvard.edu/>

<sup>34</sup> <http://sma-www.harvard.edu/>

<sup>35</sup> <http://cfa-www.harvard.edu/>