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Astronomy in the FY 2008 Budget

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HIGHLIGHTS

- The Science Mission Directorate (SMD) of the National Aeronautics and Space Administration[1] (NASA) would see a modest 0.9 percent increase for FY 2008 to $5.5 billion, compared with the President's FY 2007 request. However, the year-long joint funding resolution, which became Public Law 110-5 in February 2007, provided $78.8 million less for SMD than the President's FY 2007 request of $5.3 billion, a decline of 1.5 percent. The NASA Science budget picture is particularly complicated by 1) a change in the agency's full-cost accounting method and 2) the as yet unknown FY 2007 operating plan, which will reveal the full impact of the joint funding resolution.

- The National Science Foundation[2] (NSF) top-line budget authority grows by 8.7 percent to $6.4 billion for FY 2008, compared to the final FY 2007 level (see Table II-7). The proposed FY 2008 budget provides $233 million for the Astronomical Sciences Division[3] (AST), an increase of 8.3 percent over the final FY 2007 level.

- The Department of Energy's (DOE) Office of Science[4] receives an R&D budget of $4.1 billion for FY 2008, an increase of 15.4 percent over the final FY 2007 level (see Table II-11). DOE Science, along with NSF and the National Institute of Standards and Technology (NIST), benefits from the President's American Competitiveness Initiative (ACI), which seeks to double the total funding for these three agencies by 2016.

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

INTRODUCTION

Astronomy is one of the most exciting and dynamic fields of science, and astronomical research in the past few decades has literally changed our understanding of the Universe. The most ancient of the sciences, astronomy began with the earliest recorded history, when the sky was first observed and debated. Only in modern times have we truly discovered our place in the Universe—we live 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 life on it) were formed in supernova 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.

Some of the most cutting-edge scientific discoveries in recent years have come from astronomy. In the past decade, astronomers have discovered that the Universe is expanding faster and faster in a kind of "runaway" situation, identified and characterized planets around other stars (raising interest in detecting Earth-like planets around other stars), and found that roughly 96 percent of the matter and energy content of the Universe is completely unknown to us.

Each new discovery raises more questions and creates new technological needs, thus spawning creativity and innovation. Astronomy is truly an exciting, vibrant science that adds meaning to our human existence, captures the public's imagination, and inspires young people to pursue careers in science and technology.

NASA provides roughly 75 percent of the federal funding[5] 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 Earth's atmosphere.

[5] http://www.nap.edu/books/0309071399/html/

NSF provides approximately two-thirds of all federal support for ground-based astronomy, including nearly all support for radio astronomy.[6] NSF funds the construction and operation of the U.S. National Observatories.[7] 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 Southern hemisphere sky, 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 has undertaken new astronomical research projects, and the Smithsonian Institution and the Department of Defense (DOD) also fund astronomical research, though on a much 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.[8] Additionally, DOE has begun collaborations with both NSF and NASA on astronomy-related projects, such as the Supernova Acceleration Probe[9] (SNAP). The Astronomy and Astrophysics Advisory Committee[10] (AAAC) 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 $16.2 billion in the FY 2007 final estimate to $17.3 billion for FY 2008. (All figures for the NASA budget can be found in Table II-12.)

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[6] http://www.nsf.gov/bfa/bud/fy2004/pdf/fy2004_11.pdf
[7] http://www.nsf.gov/mps/divisions/ast/about/c_facilities.htm
[8] http://huey.jpl.nasa.gov/keck/index.html
[9] http://snap.lbl.gov/
[10] http://www.nsf.gov/mps/ast/aaac.jsp

The agency is focused on implementing the priorities set out by the NASA Authorization Act of 2005 and the Vision for Space Exploration.[11] Major priorities include the completing the International Space Station, retiring the Space Shuttle by 2010, and transitioning to the Orion Crew Exploration Vehicle and Ares Crew Launch Vehicle. Cuts made by Congress to the President's FY 2007 budget request for NASA threaten to push the launch date for Orion into early 2015.

The agency's task to implement 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. In addition to an ambitious program of exploration, NASA is also charged with continuing its mission of scientific discovery. Currently, NASA manages 58 spacecraft conducting scientific research.

The top line NASA/SMD budget would increase from $5.4 billion in FY 2007 to $5.5 billion in FY 2008, a modest increase of 2.4 percent.

The outlook for Science remains somewhat unclear. With Public Law 110-5, Congress funded SMD at $78.8 million below the President's FY 2007 request. The situation is worse for Exploration Capabilities (the Station and the Shuttle), which suffered a more than $500 million shortfall compared to the FY 2007 request. These shortfalls, in addition to changes in NASA's accounting structure, could be partially offset by shuffling around overhead costs, which would be evenly distributed throughout the four directorates. This suggests that SMD could bear part of the burden for the shortfalls in manned exploration. NASA's FY 2007 Operating Plan, which is not yet publicly available, will specify the details; the ultimate effect on science funding for FY 2007 is therefore not well understood.

A key question remains about what will be the new baseline for science funding levels. If the final FY 2007 amount is adopted as the new baseline (as opposed to the President's original FY 2007 request), this could mean a loss to science in the outyears (through 2012) of more than $1 billion.

SMD has also shuffled its Theme structure, creating four new divisions from the original three. The former Earth-Sun System Division has been

[11] http://www.nasa.gov/mission_pages/exploration/main/index.html

split into the Earth Science and Heliophysics Divisions; the former Universe Division has been renamed the Astrophysics Division; and the former Solar System Exploration Division is now called the Planetary Science Division.

Earth Science sees an increase of 3.7 percent over the FY 2007 level to $1.5 billion, mostly representing cost growth and schedule changes. Additional funds are added to the Global Precipitation Mission (GPM) for schedule assurance and to the Glory Mission for cost growth. The Landsat Data Continuity Mission (LDCM) also shows an increase, reflecting the decision to change from an instruments-only mission to a free-flyer, meaning the cost of a launch vehicle is added.

Heliophysics increases by 4.3 percent over the FY 2007 level, to $1.1 billion.

Planetary Science increases by 0.4 percent to $1.4 billion, essentially flat compared to the FY 2007 level. No projects are cancelled in Planetary Science.

Astrophysics increases by 1.6 percent over the FY 2007 level, to $1.6 billion. The astrophysics portfolio is dominated by development of the James Webb Space Telescope (JWST) and the Hubble Space Telescope (HST) servicing mission. The Space Interferometry Mission (SIM) is changed to a technology-only mission. The Stratospheric Observatory for Infrared Astronomy (SOFIA) is reinstated after completing a thorough senior review.

Although each of the four directorates shows a positive change in the budget from FY 2007, the effect of inflation reduces the budget request to barely increasing or slightly decreasing for FY 2008. The budget request therefore effectively represents a loss in real dollars available for scientific research. (For more on the NASA budget, see Chapter 9.)

ASTRONOMY IN THE NSF BUDGET

The total NSF budget is slated to increase from a final amount of $5.9 billion in FY 2007 to $6.4 billion in FY 2008, an increase of 8.7 percent. NSF is one of three agencies singled out for increased funding as part of the President's American Competitiveness Initiative (ACI). (All figures for the NSF budget can be found in Table II-7.)

NSF funds astronomy through its Astronomical Sciences Division (AST).[12] This funding is split into two main units: 1) Astronomy Research and Instrumentation, which funds individual researchers, infrastructure and instrument development projects, as well as some research facilities such as the Science and Technology Center for Adaptive Optics[13]; and 2) Facilities, which supports the International Gemini Observatory[14] and the four national astronomy R&D centers, the National Radio Astronomy Observatory[15] (NRAO), the National Optical Astronomy Observatories[16] (NOAO), the National Solar Observatory[17] (NSO), and the National Astronomy and Ionosphere Center[18] (NAIC).

AST would grow in the President's FY 2008 budget by 8.3 percent to $233 million over the final FY 2007 amount of $215 million. From FY 2006 to FY 2007, AST increased by 7.5 percent. This trend reflects the President's commitment to the ACI. About 20 percent of the AST portfolio will be available for new grants in FY 2008, with the remainder supporting previous commitments to research grants, facilities, instrumentation, educational outreach, and centers.

The Astronomy Research and Education portion would increase from $89.9 million in FY 2007 to $102.8 million in FY 2008 (14.4 percent increase), 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. AST continues to support a wide range of investigations, ranging from the detection of extrasolar planets to the origin of the Universe, as well as continued emphasis on education and outreach activities. The FY 2008 budget also maintains support for technology development for the Large-Aperture Synoptic Survey Telescope (LSST).

Astronomy Facilities would see an increase of $5.6 million over FY 2007 to $126.9 million. Funding for base operations for all facilities remains roughly the same as the FY 2007 level, pending a full implementation

[12] http://www.nsf.gov/mps/ast
[13] http://cfao.ucolick.org/
[14] http://www.gemini.edu/
[15] http://www.nrao.edu/
[16] http://www.noao.edu/
[17] http://www.nso.edu/
[18] http://www.naic.edu/

plan for the Senior Review[19] of AST facilities. AST 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 National Research Council (NRC) Decadal Survey (*Astronomy and Astrophysics in the New Millennium*[20]) while maintaining core programs.

Specific changes to the facilities budget include 1) an increase of $0.5 million (2.5 percent) for the Gemini Observatory to enhance support for operations and visiting researchers, as well as to fund new advanced instrumentation; 2) design and development costs for the Advanced Technology Solar Telescope; 3) an increase of $2 million (3.9 percent) for NRAO to $52.7 million, which includes $8.2 million for early operations of the Atacama Large Millimeter Array[21] (ALMA); and 4) a decrease of $4.8 million (14.5 percent) in the Laser Interferometer Gravitational Wave Observatory (LIGO), but this represents a shift in funds to Advanced LIGO.[22]

Research Grants Programs are the highest priority for maintaining the AST portfolio, emphasizing the scientific priorities outlined in the Decadal Survey. Other areas of emphasis include cyberinfrastructure and cyberscience, including creating the National Virtual Observatory in partnership with NASA, and ensuring a healthy balance within the research portfolio.

Physics of the Universe (POU) is the highest scientific priority, as spelled out by the NRC report *Connecting Quarks with the Cosmos*. A multidisciplinary effort at the interface of physics and astronomy, POU is a partnership between the Astronomy and Physics Divisions at NSF, DOE, and NASA. Strategic public-private partnerships are a key priority for AST, with renewed investments in the Giant Segmented Mirror Telescope (GSMT) and the Telescope System Instrumentation Program (TSIP) in FY 2008.

Astronomy is also supported within the NSF budget through the Office of Polar Programs[23] (OPP), Major Research Equipment and Facilities

[19] http://www.nsf.gov/mps/ast/ast_senior_review.jsp
[20] http://www.nap.edu/books/0309070317/html/
[21] http://www.alma.nrao.edu/
[22] http://www.ligo.caltech.edu/advLIGO/
[23] http://www.nsf.gov/od/opp

Construction (MREFC) and Multidisciplinary Activities budget lines. The request for the IceCube Neutrino Observatory,[24] an extension of the successful AMANDA project, would receive $1.5 million in operating funds. (For more on NSF, see Chapter 6.)

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 also funds astrophysical research under its Office of Science. One example is the Supernova Acceleration Probe[25] (SNAP). Support for R&D within High Energy Physics increases from $752 million to $782 million (4.1 percent). (All figures for the DOE budget can be found in Table II-11.)

The proposed budget for the Smithsonian Institution's R&D activities increases by 4.6 percent, from $175 million in FY 2007 to $183 million in FY 2008 (see Table II-1). The Smithsonian supports a wide array of astronomical research through its Center for Astrophysics,[26] including telescopes in Hawaii and Arizona. The Submillimeter Array,[27] an innovative high-frequency radio telescope, is nearing operational completion on the summit of Mauna Kea in Hawaii.

[24] http://icecube.wisc.edu/
[25] http://snap.lbl.gov/
[26] http://cfa-www.harvard.edu/
[27] http://sma-www.harvard.edu/