Minutes of the Meeting of the
Astronomy and Astrophysics Advisory Committee
27-28 October 2016
National Science Foundation, Arlington, VA

Members attending:	Rachel Bean	Brian Keating
	Dieter Hartmann	Shane Larson
	Klaus Honscheid	Rachel Mandelbaum (Vice Chair)
	Kelsey Johnson	William Smith
	Buell Jannuzi (Chair)	Jean Turner
	Lisa Kaltenegger	Martin White
Agency personnel:	James Ulvestad, NSF-AST	Jean Cottam, NSF-PHY
	Chris Davis, NSF-AST	Vladimir Papatashvilli, NSF-Polar
	Elizabeth Pentecost, NSF-AST	Paul Hertz, NASA
	Ed Ajhar, NSF-AST	Hashima Hasan, NASA
	Nigel Sharp, NSF-AST	Rita Sambruna, NASA
	Diana Phan, NSF-AST	Dan Evans, NASA
	Richard Barvainis, NSF-AST	Kartik Sheth, NASA
	Joan Wrobel, NSF-AST	Dominic Benford, NASA
	Ralph Gaume, NSF-AST	Martin Still, NASA
	Peter Kurczynski, NSF-AST	Linda Sparke, NASA
	Jim Neff, NSF-AST	Kathy Turner, DOE
	Harshal Gupta, NSF-AST	Allison Eckhardt, DOE
	Randy Phelps, NSF-OIA	Meredith Drosback, OSTP
Others:	Dan Clery, Science	Tricia Crumley, DOE
	James Murday, USC	Scot Dodelson, Fermi Lab
	Whitney Wen, IISL	Sarah Peacock, Space Studies Board
	Katie Daud, NAS	Ben Kallen, Lewis-Burke
	Amaya Moro Martin, STSci	Heather Bloemhard, AAS
	Jacqueline Hewitt, MIT	James Lochner, USRA
	Nick Saab, Lewis-Burke	Tony Spadafora, Berkeley Labs
	Joel Parriott, AAS	John Carlstrom, U Chicago
	Mitch Ambrose, AIP	

MEETING CONVENED 9:00 AM, 27-28 OCTOBER 2016

The Chair called the meeting to order and welcomed all new Committee members. Introductions were made.

The minutes from the June 6, 2016 meeting were approved by the Committee.

Elizabeth Pentecost, the AAAC Recording Secretary, reviewed the list of identified Conflicts of Interest (COIs) for the AAAC and asked that members send their conflicts to her.

The Committee selected June 22, 2017 as the next teleconference date.

James Ulvestad reviewed the rules, membership, and duties of the AAAC, especially since there were new members of the Committee attending the meeting.

Jim Ulvestad provided an update on NSF activities. Outstanding opportunities are being offered and developed including ALMA, the Dark Energy Camera on the Blanco telescope, the Gemini Planet Imager, and the EVLA. NSF is building the Daniel K. Inouye Solar Telescope (DKIST) and the Large Synoptic Survey Telescope (LSST). The individual investigator grants program is now stable at a success rate is now reaching of approximately 20%. NSF requested ~$87M for AST facility construction in FY 2017 and the second round of MSIP awards were made. Partnerships with NASA and DOE have strengthened and there are new collaborations with DoD (LBO) and NOAA (GONG). The mid-decadal review and Kavli Workshop reports were released. While prospects for budget increases this decade are unknown, it is clear that the next 1.5 years will be critical for divestment activities.

Ulvestad presented some science and facilities highlights. The Dark Energy Camera on the Blanco Telescope is doing a whole host of astrophysics science which has been scientifically interesting. Using ALMA, FU Ori (a flare star) was imaged at 12 AU resolution; when it outburst and went to higher luminosity, it moved out to 42 AU which was attributed to condensation of water at the water-snow line. A bulge globular cluster was imaged in multiple near-IR colors using the Gemini Multi-Conjugate Adaptive Optics system, giving 0.08-arcsec imaging over a 93-arcsec field (comparable to HST resolution in the optical). NSF and NASA have a joint program for exoplanet science. NASA has solicited a facility-class instrument for the WIYN telescope (precision radio velocities); the instrument will be open for community access. DKIST is under construction and is scheduled for completion in FY2020. Construction on LSST is progressing, with a late 2022 start day for the 10-year survey. There is a study of NEO detection capabilities for LSST in progress.

NSF works with other federal agencies through the National Telecommunications and Information Administration (NTIA) to protect the radio spectrum for scientific users. NSF spectrum management for NSF historically (e.g. radio astronomy) has been housed in AST. The landscape is rapidly changing, and a diverse NSF research community now is making use of the spectrum in various ways. An internal NSF group, chaired by Ulvestad is developing recommendations regarding NSF spectrum management needs in the future.

The FY2017 PBR for NSF includes a total increase of 6.5% in the Research and Related Activities account ($6.425 billion vs. $6.034 billion for FY 2016) and 6.4% for AST ($262.61 million vs. $246.73 million for FY2016). The FY 2017 budget fully funds the two AST construction projects, DKIST and LSST.

Major construction projects are funded from an NSF-wide budget line (MREFC), and do not have to be funded from the budget of an individual directorate or division. This makes it feasible to construct projects in the cost range of a half billion dollars or more. However, Operations funds for major facilities must come from the R&RA funds in a proposing directorate/division, so can use a significant fraction of a research division's budget. Assumptions about availability of operations funds must be made a decade before a facility comes into operation; overly optimistic assumptions can have serious consequences.

The Arecibo Environmental Impact Statement (EIS) process has started. In May 2016, NSF initiated the EIS process and consultation under National Historic Preservation Act (NHPA) Section 106 for Arecibo. In July, the process began for Sacramento Peak Observatory. In October, the EIS and NHPA process began for Green Bank Observatory. In FY 2017, NSF will consider an EIS and NHPA process for the Long Baseline Observatory (formerly VLBA) and McMath-Pierce Solar Telescope. In the June 2017 – early 2018 timeframe, NSF plans to conclude the formal environmental reviews and consideration of alternatives, select preferred alternatives in the Record of Decision, which incorporates environmental reviews and many other considerations, and begin implementation. No decisions have been made, or will be made until issuing a Record Of Decision has been issued for a facility or telescope under formal consideration

The *NWNH* Mid-term Assessment Mid-decade Review made several recommendations for NSF: (1) reiterated that "National Science Foundation (NSF) should proceed with divestment from ground-based facilities which have a lower scientific impact, implementing the recommendations of the NSF [AST] Portfolio Review, that is essential to sustaining the scientific vitality of the U.S. ground-based astronomy program as new facilities come into operation"; and (2) "the NSF and the National Science Board should consider actions that would preserve the ability of the astronomical community to fully exploit the Foundation's capital investments in ALMA, DKIST, LSST, and other facilities. Without such action, the community will be unable to do so because at current budget levels the anticipated facilities operations costs are not consistent with the program balance that ensures scientific productivity."

For FY 2017, AST will run a pilot program with "No Proposal Deadline" for the Solar and Planetary (SPG) portions of the Astronomy and Astrophysics Research Grants (AAG) program. The purpose of this is to understand and resolve issues with proposal handling and merit review; to alleviate the impact of life events for proposers; to investigate impact on proposal load over the year; and to enable proposal file updates for minor errors. The rest of AAG will run as before, with a November 15, 2016 proposal deadline. Budget breakdowns between AAG and SPG will remain similar to FY 2016.

Vladimir Papatashvilli provided an update of astronomy and astrophysics activities in Antarctica. There are several projects including IceCube and the South Pole Telescope being funded by the Division of Polar Programs. IceCube was built to search for very high-energy neutrinos created in the most extreme cosmic environments, opening a window to search for cosmogenic neutrinos. After analyzing three years of data, the Observatory established the world's best limit on an extragalactic flux of cosmogenic neutrinos with significance at 5.7 sigma. The Arianna project explores energy windows beyond the reach of IceCube. It exploits the novel radio-based emission and Antarctic ice to lower costs. The South Pole Telescope (SPT) completed a five-year SZE survey discovering over 500 massive galaxy clusters in the distant Universe; through the fine scale CMB survey, the SPT tested cosmological models of the origin and early history of the universe. The telescope is opening a new window on transient astronomy. By 2018/2019, the South Pole CMB telescopes will have ~50,000 detectors, representing a first step to a CMB-S4 program. BICEP is doing CMB polarization and gravitational lensing experiments. The 0.6m aperture High Elevation Antarctic Terahertz (HEAT) telescope is operated robotically at the Ridge A summit and is delivering spectroscopic data from 150 to 500 microns; it is a joint project between the U.S. and Australia. There are also long–duration balloon projects between NSF and NASA flown from McMurdo Station.

Kathy Turner gave an update on DOE activities. DOE obtains program guidance from various FACA panels and subpanels. Official advice comes from HEPAP and the AAAC. The U.S. High Energy Physics (HEP) program is following the strategic plan laid out by HEPAP/P5 (Particle Physics Project Prioritization Panel) studies in developing and executing its program. HEP will use the P5 criteria to develop the program and determine which projects to invest in and at what level. Advice is also provided by various National Academy of Sciences (NAS) reports, along with community science studies. DOE is advancing the P5 vision by implementing high priority major projects such as LHC, LBNF, dark matter and dark energy projects such as LSST, WFIRST, and ACTA.

The FY 2017 PBR for HEP is $818M, an increase of ~3% over the FY 2016 enacted budget of $795M. The research budget for FY 2017 is expected to be flat. The FY 2017 HEP budget aims to continue the successful P5 implementation. The FY 2017 PBR is $130.1M for the Cosmic Frontier.

Through ground-based telescopes, space missions, and deep underground detectors, research at the cosmic frontier aims to explore dark energy and dark matter. Program thrusts include the study of the nature of dark energy, direct detection searches for dark matter particles, cosmic-ray and gamma-ray

studies, CMB, and computational cosmology. Related efforts funded by other programs in HEP include theory, and detector development. Currently the Dark Energy program consists of the Dark Energy Survey (DES), LSST (camera), and DESI. For dark matter detection, there are several third-generation experiments. CMB experiments are supported as part of the core particle physics program. The multidisciplinary nature of the science warrants continued multi-agency support; the CMB-S4 project is in the P5 plan.

HEP supports teams and collaborations of scientists with the necessary expertise and responsibilities to take experiments through all phases, from R&D, fabrication, operations, and data analysis. Science planning is expected throughout all phases to culminate with coordinated data analysis by a collaboration. Funding for theory, simulations, and computational efforts are in direct support of the experiments.

HEP has started Cosmic Visions groups to allow interactions with small HEP community groups. There are groups for CMB, dark energy, and dark matter direct detection.

In response to the AAAC Report, a Tri-Agency/Tri-Project Group meets monthly to discuss DOE/NASA/NSF cooperation on Euclid/LSST/WFIRST, in particular Joint Data Processing and Joint Simulations. NSF, NASA, and DOE talk regularly about program planning, overlaps, and any issues that might arise in any interagency projects. There is agency coordination and oversight for many joint projects such as DES, LSST, DESI, Veritas, HAWC, SuperCDMS, etc. Depending on science, project, contribution, and agency considerations, sometimes DOE partners on fabrication or provide facilities. DOE makes country-level agreements to allow science partnerships to move forward.

Construction projects and fabrication of large pieces of experimental equipment costing over ~$10M are managed through a series of "Critical Decision (CD)" milestones. The CD process ensures successful project execution and scientific return on agency investments, but funding must still be appropriated. Successful delivery of construction projects and facilities is a central part of the DOE science mission.

The research budget supports scientists on in all phases of an experiment. In practice, HEP traditionally supports teams/collaborations of scientists with the necessary expertise and responsibilities to take experiments through all phases, from R&D, fabrication, operations, and data analysis. The priority areas are dark matter, dark energy, CMB, and cosmic/gamma ray research. Not funded in the program is gravity wave, planet searches, or heavy ions.

Rachel Bean asked how the early career awards are selected. Kathy Turner replied that the program is Office of Science-wide and everyone applies to the Office of Science first, then they are sorted and distributed to the various offices such as HEP, and then sorted again for the Cosmic Frontier. Sometimes there may be overlap, i.e., detector development and working on an experiment. If thee proposals are Cosmic frontier-related, the program managers make sure there are adequate reviewers for the proposals (one big panel, separate panels, or mail reviewers).

Kelsey Johnson asked about the general and open solicitations. How are they similar or different to what the NSF is envisioning doing with lessons learned? Turner replied that DOE in the past used a single solicitation for the grants program but there have been problems since there may be large proposals and since there has been a history of continuing resolutions, it has been hard to get to a place where HEP can do the funding adequately. It made more sense to review the grants in October-December and do the funding in April.

Paul Hertz provided an update on NASA activities. There has been a leadership change in the Science Mission Directorate (SMD). The new Associate Administrator (AA) for the Science Mission Directorate

is Dr. Thomas Zurbuchen (University of Michigan). Mr. Geoffrey Yoder remains as Deputy AA until his retirement at the end of 2016.

The FY2016 appropriation and FY2017 President's Budget Request provide funding for NASA astrophysics to continue its programs, missions, projects, and support research technology. The total funding for the Astrophysics Division (including JWST, but excluding STEM) remains at ~$1.35B. This fully funds JWST to remain on plan for an October 2018 launch, funds WFIRST formulation (new start) and increases funding for R&A and new suborbital capabilities. The operating missions continue to generate important and compelling science results, and new missions are under development for the future.

The Senior Review in Spring 2016 recommended continued operation of all missions. SOFIA is adding new instruments, while NASA missions under development (ISS-NICER, ISS-CREAM, TESS, JWST, and WFIRST) are making progress toward launches. Partnerships with ESA and JAXA on their future missions have created additional science opportunities. Explorer AOs are being released every 2-3 years, soliciting a mission and a mission of opportunity each time. The JWST Project is concluding the manufacturing phase and is transitioning into integration and test; community engagement is less than one year away

Progress is being made toward the recommendations in the 2010 Decadal Survey. The National Academies Midterm Assessment Report validates the progress NASA has made on these recommendations. It will take NASA a while to formulate a complete response to the Report, and it will take NASA an entire budget cycle to make any substantive changes in its program.

The FY 2017 President's Budget Request (PBR) for NASA Astrophysics submitted to Congress on February 9, included $757 million for Astrophysics and $569 million for JWST. Both the House and Senate appropriations committees have marked up the FY 2017 NASA budget request. All NASA astrophysics projects and activities continue as planned under the current continuing resolution.

NASA is initiating large and medium mission concept studies as input for the 2020 Decadal Survey. NASA has appointed Science and Technology Development Teams and initiated four large mission concept studies. The teams are planning for quarterly face-to-face meetings in FY2017. NASA is also soliciting mission concept ideas for medium-sized missions as part of community preparations for the 2020 Decadal. A solicitation for mission concept proposals was issued as an amendment to ROSES-16. Proposals are due in November with a selection targeted for February 2017. NASA will submit final reports and the results of the NASA cost assessment to the 2020 Decadal Survey Committee.

Jim Ulvestad, Paul Hertz, and Kathy Turner provided feedback on the 2016 AAAC Annual Report. There were several recommendations from the report. NASA, NSF, and DOE have formed a Tri-Agency group to discuss the possible implementation – and cost – of joint pixel analysis of data from LSST, Euclid, and WFIRST; this group meets regularly with project leadership. In response to the recommendation to continue working toward a plan for future ground based CMB experiments, NSF and DOE are actively coordinating and working with the science community; the current plan is to form an AAAC subcommittee to develop a strawman project concept that can be used for agencies' planning purposes. Environmental Impact Statements are being prepared for three AST facilities, Arecibo Observatory, Sacramento Peak Observatory, and Green Bank Observatory. International partners remain critical for LSST operations; the principle of "reciprocity" from the Principles for Access is key in these conversations. New partnerships incorporate the Principles in discussion; for example, they are called out explicitly in the NN-EXPLORE agreement between NASA and NSF. Building further international cooperation and partnerships was an important theme of the P5 strategic plan and most of the projects and experiments for HEP are international collaborations. Agencies have had discussions with the AAS and

NAS regarding the 2020 decadal survey and whether an updated study of federal funding should be completed before Astro2020. NASA has begun discussions with ESA about a larger role for the US in their L3 mission; ESA is open to this possibility subject to their established constraints on international partnerships. NASA is reviewing options for reduced funding of exoplanet technology development beyond the WFIRST coronagraph. NASA has discussed with their Astrophysics Subcommittee ways of combating low proposal success rate such as alternate year solicitations for the Astrophysics Theory Program and rebalancing the funding levels between postdoctoral programs and core R&A.

Jim Ulvestad and Kathy Turner gave a presentation on the formation of a CMB S4 Subcommittee. Ground-based CMB generally falls under the purview of NSF and DOE, while NASA supports CMB projects within its long-duration balloon program and space missions. In its 2016 report, the interagency AAAC recommended the following: "We encourage DOE, NSF, and the university community to continue working toward a plan for a future (Stage 4) ground based CMB experiment." NSF and DOE have asked the AAAC to establish a CMB Stage 4 Concept Definition Task Force (CMB-S4 CDT) to develop a concept for a CMB-S4 experiment. The CMB-S4 CDT is asked to develop a concept for implementing a ground-based CMB-S4 experiment. The CDT will take as input the community CMB-S4 Science Book and any further community information as appropriate, and will consider the global landscape of CMB experiments (including ground, balloons, and space. The CDT should provide a progress report to the AAAC by May 2017 and a final report to AAAC by August 2017 for consideration and approval. In accordance with Federal Advisory Committee Act (FACA) rules, this report will be discussed and approved by the AAAC before formal transmittal to the agencies.

Buell Jannuzi commented that this activity is important and is glad that the AAAC is enabling this Task Force to happen. The Task Force report will be delivered to the AAAC for acceptance. Charles Lawrence (JPL) will chair the Task Force; Brian Keating has agreed to be the liaison between the AAAC and the subcommittee and both Jannuzi and Keating will keep the AAAC informed on all the activities of the Task Force. The AAAC Chair asked that the Committee members provide names of potential CDT members to the Agencies. The agencies have been working with the various groups involved in CMB research to make sure that they are somehow involved in the process. The role of the AAAC in this process will to be able to look at the report and understand the rationale for the report and whether the process taken by the Task Force makes sense.

Scott Dodelson (Fermilab) gave an update on the Cosmic Visions Dark Energy Group activities. The Cosmic Visions Dark Energy group was formed by HEP in August 2015 as a 2-way communication group between HEP and the community. Two other CV groups (CMB and Dark Matter) coordinate with DOE. The CMB -S4 community-based collaboration released a first version of their Science Book. The HEP CV-CMB group has since built up a collaboration and is concentrating on coordinating the HEP community activities. The group is now starting the same process as the CMB-S4 group (building broad community and developing a strong science case) and is about 1-2 years away from a Science Book. Between formation and the end of January 2016, the group of eight members held weekly telecons. Representatives of the group met with leaders of DESI at their November collaboration meeting and with leaders of the LSST Dark Energy Science Collaboration at their October collaboration meeting. There were three workshops held to gather input for the three white papers. The group would like to the AAAC to encourage the DOE, NSF, and the university community to continue working toward a plan for a future ground-based CMB experiment.

Denise Caldwell gave an update on astrophysics activities in the NSF Physics Division. The portfolio of awards made through the Physics Division has as primary goal "to promote the progress of science", as expressed in the NSF act. Awards in the portfolio support the research needed to address a scientific question that is at the frontier of knowledge as it is currently known, while at the same time extending and

redefining that frontier. Inherent in the implementation of this portfolio, which includes significant support for students and junior scientists, is the preparation of the next generation of the advanced high tech workforce and the development of innovative new technologies that arise in the quest to answer some of the hardest questions that Nature can pose. There are five perspectives on the Frontier of Physics, with the "Origin and Structure of the Universe (star formation and creation of the elements, dark matter and dark energy, modeling of black holes, gravitational waves)," bringing some overlap with AST.

LIGO is preparing for the second scientific observing run after the Advanced LIGO upgrade. LIGO sensitivity is expected to be 10% to 30% greater than the first run (1.3 to 2.2 increase in event rate). The Virgo operation is planned to overlap with LIGO in spring 2017. Virgo sensitivity is TBD.

Particle Astrophysics supports university research that uses astrophysical sources and particle physics techniques to study fundamental physics. This includes the study of ultra-high energy particles reaching Earth from beyond our atmosphere (cosmic-rays, gamma-rays, and neutrinos with the exception of IceCube); searches for supernova neutrinos; and studies of the Cosmic Microwave Background (CMB) and Dark Energy. This area supports university research that generally locates experiments in low background environments. Currently supported activities include: studies of solar, underground and reactor neutrinos; neutrino mass measurements; and searches for the direct detection of Dark Matter. This area also supports university research that utilizes the facilities of IceCube at the South Pole. Currently supported activities include: searches for ultra-high energy neutrinos and studies of the properties of neutrinos. There is also a strong theoretical program in Theoretical Astrophysics and Cosmology.

In cooperation with NSF/AST, NSF/AGS and DOE, the Physics Division has provided continuous support for synergetic observation, theory, modeling and laboratory experiments in the area of plasma astrophysics. There is also ongoing informal and formal cooperative with various parts of NASA. Partnerships are key to the success of the science. The Physics Division invests in projects where there is significant impact.

Jacqueline Hewitt, Chair of the NRC Mid-Decade Review Committee, provided a review of the findings on the Astro2010 *NWNH* Midterm Assessment, "Review of Progress Toward the Decadal Survey Vision in New Worlds, New Horizons in Astronomy and Astrophysics." The Committee was given four tasks:(1) describe the most significant scientific discoveries, technical advances, and relevant programmatic changes in astronomy and astrophysics over the years since the publication of the decadal survey; (2) assess how well the Agencies' programs address the strategies, goals, and priorities outlined in the 2010 decadal survey and other relevant NRC reports; (3) assess the progress toward realizing these strategies, goals, and priorities; and, (4) in the context of strategic advice provided for the Agencies' programs by Federal Advisory Committees, and in the context of mid-decade contingencies described in the decadal survey, recommend any actions that could be taken to maximize the science return of the Agencies' programs. The review did not revisit or alter the scientific priorities or mission recommendations provided in the decadal survey and related NRC reports but did provide guidance on implementation of the recommended science and activities portfolio and on other potential activities in preparation for the next decadal survey. There have been four Committee meetings with time set aside for public comment; there was a splinter session at the January AAS meeting and an open letter to the community was distributed by the AAS. The three Agencies made presentations to the Committee and presentations were given by OSTP, ESA, JAXA (Japan Space Agency), TMT, GMT, LSST, and CTA.

There were many findings throughout the report. Among them, (1) The NSF-AST budget through the first half of the decade has been approximately flat in real-year dollars. This budget reality is somewhat lower than that baselined by NSF for *NWNH* (approximately flat in inflation-adjusted dollars) and significantly lower than that assumed by NWNH (doubling in real-year dollars); (2) For NASA-APD, *NWNH* assumed a flat budget in inflation-adjusted dollars. The actual combined budget for NASA-APD

and JWST has roughly tracked this assumption. However, the late-breaking schedule delay and associated budget increase of JWST have delayed the availability of funding for new initiatives by about 4 to 5 years; (3) At the Department of Energy (DOE), support for astrophysics has been strong, and the budget reality has been close to the baseline plan presented in *NWNH*; and, (4) The completion and successful operation of ALMA are a remarkable success and the culmination of significant investment by NSF through the Major Research Equipment and Facilities Construction (MREFC) program. The committee interpreted "balance" to refer to a viable mix of small, medium, and large initiatives on the ground and in space that optimizes the overall scientific return of the entire U.S. astronomy enterprise viewed collectively. It did not refer to a balance of wavelengths, nor of astronomy subtopics.

Even following the divestment recommended by the Portfolio Review, the operations costs of ALMA, DKIST, and LSST will compromise the ability of the U.S. community to reap the scientific return from its premier ground-based facilities. Moderate increases in the NSF-AST budget would have highly leveraged science impact as a consequence of these powerful new facilities. The NSF should proceed with divestment from ground-based facilities that have a lower scientific impact, implementing the recommendations of the NSF Portfolio Review, which is essential to sustaining the scientific vitality of the U.S. ground- based astronomy program as new facilities come into operation. The NSF and the National Science Board should consider actions that would preserve the ability of the astronomical community to fully exploit the Foundation's capital investments in ALMA, DKIST, LSST, and other facilities. Without such action, the community will be unable to do so because at current budget levels the anticipated facilities operations costs are not consistent with the program balance that ensures scientific productivity.

Prior to Key Decision Point B, NASA should commission an independent technical, management, and cost assessment of the Wide-Field Infrared Survey Telescope, including a quantitative assessment of the incremental cost of the coronagraph. If the mission cost estimate exceeds the point at which executing the mission would compromise the scientific priorities and the balanced astrophysics program recommended by the 2010 report, *NWNH*, then NASA should de-scope the mission to restore the scientific priorities and program balance by reducing the mission cost. NASA's Astrophysics Division should execute its current plan, as presented to the committee, of at least four Explorer Announcements of Opportunity during the 2012-2021 decade, each with a Mission of Opportunity call, and each followed by mission selection. NASA should restore support this decade for gravitational wave research that enables the U.S. community to be a strong technical and scientific partner in the European Space Agency (ESA)-led L3 mission, consistent with the Laser Interferometer Space Antenna's high priority in the 2010 report, *NWNH*. One goal of U.S. participation should be the restoration of the full scientific capability of the mission as envisioned by *NWNH*. NASA should proceed with its current plan to participate in Athena, with primary contributions directed toward enhancing the scientific capabilities of the mission.

Cost and Technical Evaluation (CATE) is an important part of the process. Improvements to this process might include: (1) a two-stage approach and (2) better communication between proposers and reviewers while maintaining independence. Facilities life-cycle costs should be considered, including in addition to operations design and development, pipeline data processing, and data curating for a "prime" mission. Decision rules are necessary, and the planning for the decadal survey should include consideration of their implementation.

Rachel Mandelbaum reviewed the process for submitting the annual report on March 15, especially for the benefit of the new members. Topics of concern should be on the agenda for the January meeting; Mandelbaum requested that Committee members send in topics to her. Writing assignments will be given out either at the January meeting or shortly thereafter and an outline of the structure of the report will be provided. First drafts of the report will be sent around to the Committee and will be discussed at the February telecon; the Agencies get a chance to fact check the document.

The Committee discussed topics for the next meeting including the health of the community (e.g. postdoc funding by the Agencies), the Windows on the Universe initiative, Committee desire for a presentation from the NASA Planetary Science Division, Education and Public Outreach at the Agencies, AAS follow-on effort on proposal success rates, and spectrum management (fundamental importance to astronomy).

MEETING ADJOURNED AT 12:00 PM EDT, 28 October 2016