Minutes of the Meeting of the Astronomy and Astrophysics Advisory Committee

15–16 February 2005
National Science Foundation, Arlington, VA

Members attending:	Garth Illingworth (Chair)	Barry LaBonte
	Neta Bahcall	Angela Olinto
	John Carlstrom	Rene Ong
	Alan Dressler	Bradley Peterson
	Robert Gehrz	Catherine Pilachowski
	Robert Kirshner	Abhijit Saha
Agency personnel:	Wayne Van Citters, NSF-AST	Richard Boyd, NSF-PHY
	Eileen Friel, NSF-AST	Kathleen Flint, NSF-OPP
	Dana Lehr, NSF-AST	Paul Hertz, NASA-HQ
	Richard Barvainis, NSF-AST	Philippe Crane, NASA-HQ
	Robert Dickman, NSF-AST	Michael Salamon, NASA-HQ
	Vernon Pankonin, NSF-AST	F. Rick Harnden, NASA-HQ
	Elizabeth Pentecost, NSF-AST	Jeffrey Hayes, NASA-HQ
	Randy Phelps, NSF-AST	Jonathan Gardner, NASA-GSFC
	Nigel Sharp, NSF-AST	Alan Smale, NASA-HQ
	Mark Coles, NSF	Kathleen Turner, DOE-HEP
	Joseph Dehmer, NSF-PHY	Winston Roberts, DOE-NP
	Beverly Berger, NSF-PHY	Francis Thio, DOE-FES
Invited participants:	Martha Haynes, Cornell U.	
	James Graham, U. California-Berkeley	
	Rolf Kudritzki, U. Hawaii	
	Alex Szalay, Johns Hopkins U.	
	Megan Urry, Yale U.	
	Rainier Weiss, MIT	
	Amy Kaminski, OMB	
	David Trinkle, OMB	
Other participants:	Brian Dewhurst, NRC-BPA	
	Don Shapero, NRC-BPA	
	Dennis Socker, NRL	
	Michael Ledford, Lewis-Burke Assoc.	
	Daniel Herman, Brashear	
	John Malay, Lockheed Martin	
	Jay Frogel, AURA	

MEETING CONVENED AT 8:40 AM EST, 15 FEBRUARY 2005

The Chair opened the meeting, and all participants introduced themselves. Dr. Wayne Van Citters, Director of the NSF Division of Astronomical Sciences (AST), welcomed the committee and noted that this meeting will be the last before the amended AAAC charter (see P.L. 108-423) includes the U.S. Department of Energy (DOE) as a formal recipient of the Committee's

recommendations. Mr. Pat Olmert from the NSF Office of Legislative and Public Affairs was present to take some photographs of the Committee's activities for use on the NSF web site.

The Chair noted that the focus of the meeting is to identify issues for inclusion and comment in the Committee's upcoming annual report. The Chair reviewed events occurring since the Committee's November meeting, including the passing of the FY 2005 omnibus appropriations bill and the submission of the President's FY 2006 budget request to Congress. Both budgets contain significant impacts for science. The Chair also pointed to a memorandum[1] from Office of Science and Technology Policy (OSTP) Director John Marburger and Office of Management and Budget Director Joshua Bolton that updates guidance on research and development (R&D) priorities and standards for program evaluation based on the Administration's R&D Investment Criteria[2]. The memo lists interagency R&D efforts that should receive special focus in agency budget requests and notes that priority will be given to activities that are well coordinated across agencies.

Dr. Paul Hertz, NASA Assistant Associate Administrator for Science, next provided an update on NASA astronomy and astrophysics programs. Dr. Hertz first showed the organization chart for the Science Mission Directorate. He noted that NASA is striving for a transparent organizational transformation and wants to hear if any problems exist with the way that NASA is interfacing with the community. He reminded the Committee that NASA is currently undertaking a complete roadmapping exercise with 13 strategic roadmaps, all of which are concurrently under development.

Dr. Hertz reviewed the 2004 Science Mission Highlights, including the launches of MESSENGER, Deep Impact, Swift and Gravity Probe B (GP-B); the return of the Genesis samples (which despite a hard landing are producing science); the successful landing of the Huygens probe on Titan; and a record-breaking balloon flight in three circumnavigations of the South Pole. Dr. Hertz congratulated NASA Goddard Space Flight Center employee Chuck Bennett on his receipt of the Henry Draper Medal for significant contributions to astronomical physics.

Dr. Hertz also noted recent downselections and other significant events and listed the 2005 launch schedule. The Beyond Einstein program and the Laser Interferometer Space Antenna (LISA) mission have begun Phase A formulation, and Kepler has been confirmed for Phase C/D implementation. Constellation-X is not yet in Phase A.

Dr. Hertz next reviewed the President's FY 2006 budget request for NASA, which he deemed "good for NASA and good for NASA science." He showed the budget run-out until 2010 and noted that in the current budget environment NASA's budget is solid. Dr. Hertz noted that the FY 2006 budget request invests 37-38% of NASA funds in science, well above the 20% called for in the 1990 Augustine Report[3].

Dr. Dressler asked if by any measure NASA is withdrawing from astronomy. Dr. Hertz replied no, and noted that while some major construction projects are rolling off, other big projects are not yet at their peak spending.

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[1] http://www.whitehouse.gov/omb/memoranda/fy04/m04-23.pdf
[2] http://www.whitehouse.gov/omb/memoranda/m03-15.pdf
[3] Report of the Advisory Committee on the Future of the U.S. Space Program; http://www.hq.nasa.gov/office/pao/History/augustine/racfup1.htm

Dr. Hertz reviewed the FY 2006 budget impacts on major missions in the Universe Division. In particular, Dr. Hertz noted that the Hubble Space Telescope (HST) budget continues to support additional life-extending measures and robotic de-orbiting mission development but discontinues the effort on robotic servicing. Additionally, NASA will not proceed with a Shuttle servicing mission to HST. The budget will allow continued analysis of archived HST data and a grants program that will bridge until the launch of the James Webb Space Telescope (JWST). Dr. Hertz noted that NASA would examine options for addressing some of the planned HST science, such as rehosting new or modified HST instruments on new space platforms.

The Chair noted that the latter prospect would require extensive discussion within the community since such efforts could significantly impact the priorities outlined in the 2001 Decadal Survey[4]. Dr. Hertz agreed that new money is not likely to be forthcoming in the current budget environment unless such projects appear near the top of the agency's strategic plan.

Dr. Hertz reported that the Terrestrial Planet Finder mission has been divided into two missions: a visible light coronagraph (TPF-C) followed by a formation flying interferometer (TPF-I). He also reported that the Space Interferometry Mission (SIM) launch date has slipped by two years and that a mission rescope activity is currently underway in response to cost increases that have accompanied design maturity.

Dr. Hertz stated that the FY 2006 budget provides JWST the necessary funds to proceed as rapidly as the technology development allows. He also reported that the Gamma-ray Large Area Space Telescope (GLAST) has experienced a great deal of cost and schedule growth and that the FY 2006 budget builds in the portion of the cost growth that was known at the time the budget was prepared.

Dr. Hertz reported that the Stratospheric Observatory for Infrared Astronomy (SOFIA) has undergone two independent reviews for science and management. As a result, the Operational Readiness review and first science flight have been delayed by approximately 12 months. Because of safety reasons, NASA has decided to take over management of aircraft maintenance and operations from Universities Space Research Association (USRA).

Dr. Hertz reported that reductions to the future Explorers Program will result in fewer missions in the current budget horizon and will delay the next Explorers Program solicitation. The next Discovery Program solicitation will be released no earlier than March 2006.

Dr. Hertz provided more details on the GLAST cost and schedule overruns associated with the Large Area Telescope (LAT), a joint NASA-DOE instrument. The President's FY 2006 budget request caps DOE's contribution to LAT and limits their operations costs to less than previously planned and agreed upon; thus, NASA must fund the remainder of the cost overruns. In addition, the Italian Space Agency (ASI) did not sign the LAT construction contract until February 11 at a cost of $1 million per week for 5 weeks of delay. The GLAST cost growth thus approaches $45-60 million. NASA is currently considering LAT and GLAST descoping as well as ways of reducing further cost and schedule risks. Dr. Hertz noted that these events would have implications for future NASA-DOE partnerships.

[4] *Astronomy and Astrophysics in the New Millennium*; http://www.nap.edu/books/0309070317/html/

Dr. Hertz concluded with a summary of the Scientific Ballooning Roadmap, which was reported to the Structure and Evolution of the Universe Subcommittee/Origins Subcommittee (SEUS/OS) meeting in November.

Dr. Michael Salamon, NASA Program Scientist, followed with an overview of NASA roadmapping activities that are underway. He described two simultaneous roadmapping processes within the Universe Division. The traditional "legacy" roadmap, now called the Universe Division Planning Document (UDPD), is a bottom-up document produced by a community process feeding up through NASA. The second process solicits community input on how to achieve agency goals and objectives, which have been identified in a top-down process, and then generates the NASA Strategic Roadmap.

Dr. Salamon reported that in the past each Theme within the Office of Science produced its own roadmap, which then fed in to higher-level roadmaps. Congress mandates that this process occur every three years; thus, according to schedule, Chairs were selected last year for separate Origins and Structure and Evolution of the Universe (SEU) roadmaps. After the transformation and dissolution of individual Themes, Universe Division Director Anne Kinney decided to produce a single Universe Roadmap with two Co-Chairs. All members of the SEUS and OS are considered members of the UDPD committee, and future OS and SEUS meetings will be held jointly until a single Universe advisory committee is formed. Previous priorities are not expected to change in the UDPD, so the science goals of the document will be familiar, and near-term missions have not changed.

The NASA Strategic Roadmap is lead by the Advanced Planning and Integration Office (APIO), headed by Jet Propulsion Laboratory (JPL) Director Charles Elachi. This planning process will produce an integrated plan for NASA spanning the next 30 years and incorporates 13 Strategic Roadmaps that correspond to the agency-defined Strategic Objectives. Dr. Salamon reviewed the NASA Strategic Goals and Objectives and noted that 15 Capability Roadmap Committees are simultaneously producing a document that articulates technical and programmatic solutions for provision of each required major capability. The 13 Strategic Roadmaps and 15 Capability Roadmaps will be integrated into a single agency planning document—known as the Integrated Strategic Architecture (ISA)—through a complex process under development.

Dr. Salamon noted that the Strategic Roadmap committees are Federal Advisory Committee Act (FACA) committees while the Capability Roadmap committees are not. As a result, the Capability Roadmap teams are approximately 5 months ahead of the Strategic Roadmap schedule since the former were not required to respond to FACA regulations.

For each roadmap committee, Dr. Salamon listed the membership, charter and essential roadmap elements. He explained that the purpose of the roadmapping activities is to support the creation of the ISA, which will serve as the benchmark for agency budget requests and resource allocations. He identified the challenges of integrating the Strategic and Capability Roadmaps into a coordinated, single document and noted that the structure and content of the roadmaps are being planned to permit integration.

Dr. Salamon added that the National Research Council (NRC) would be given two months to review individually each of the 13 Strategic Roadmaps. In addition, NASA will ask the NRC and/or the NASA Advisory Council to review the ISA when completed. The draft Strategic Roadmaps are due April 15 for internal review and will be submitted to the NRC by June 15. The ISA is planned for completion by October 1.

The Chair asked if two months would be sufficient time for the NRC to review the Strategic Roadmaps. Dr. Hertz replied that the time allotment would be sufficient if the roadmaps are familiar from previous planning documents. Dr. Hertz noted that he is the lead for the Science Mission Directorate integration process.

MEETING ADJOURNED AT 10:20 AM – RECONVENED AT 10:45 AM

Dr. Kathy Turner, DOE Office of High Energy Physics (HEP) Program Manager, next provided an update on DOE-HEP programs and activities. She first reviewed the FY 2004-06 HEP budgets and noted that funds for non-accelerator physics have remained constant at approximately 6%. Dr. Turner reported the funding profiles and status of major construction and R&D projects, including the Very Energetic Radiation Imaging Telescope Array System (VERITAS), the Pierre Auger high energy cosmic ray detector array, the Alpha Magnetic Magnetic Spectrometer (AMS), the Cryogenic Dark Matter Search (CDMS), GLAST/LAT and the Supernovae Acceleration Probe (SNAP).

Dr. Turner reviewed the overall HEP budget and priorities in FY06: the Tevatron, B-factory and Large Hadron Collider (LHC) preparations will be fully supported; a reasonable level of support has to be maintained for the core research program in the universities and labs; and investment for near- and long-term new initiatives (including R&D for the International Linear Collider) should grow. She reported that any new initiatives would have to come from redirection of current funds. She also reported that DOE has decided not to proceed with the B Physics at the Tevatron (BTeV) project.

Dr. Turner reiterated the status of the GLAST LAT instrument development, which includes contributions from NASA, DOE, France, Italy, Japan and Sweden. A team at the Stanford Linear Accelerator Center (SLAC) manages the project. Dr. Turner reported that DOE's contribution to the LAT will increase by $3 million and has been capped at $45 million. She noted that the descoping activity will identify a well defined deliverable (e.g. data acquisition electronics and systems engineering) for DOE to provide within the budget cap. She agreed that the budget cap has changed the NASA-DOE relationship and noted that the reduction in project reporting would be a positive benefit once DOE no longer has a management role. Dr. Turner reported that the LAT operating budget has also been capped at $5 million per year for FY 2006-07. Former budget plans included $7 million per year for the commissioning and operating phases.

Dr. Hertz added that NASA has not yet determined a long-range budget plan for GLAST/LAT. Options include maintaining the same NASA funding level (and thus reducing the overall GLAST/LAT budget) or finding more money for the project in FY 2005 from the rest of the Universe Division budget. The timeline for the funding decision is weeks in order to provide FY 2005 guidance to the project.

Dr. Turner noted that while the DOE GLAST/LAT construction funds are fixed, the operating funds might be more flexible. Dr. Hertz agreed that this offered NASA and DOE additional flexibility in solving the cost overrun problems. The Chair noted that the AAAC should address the issue of the DOE budget cap since such measures take away needed flexibility in interagency collaborations. Dr. Turner reported that the GLAST launch is currently scheduled for 2007 pending the re-planning process.

Dr. Turner noted that the AMS launch and deployment is currently planned for 2008 but will likely slip if the Shuttle does not return to flight in 2005.

Dr. Turner concluded with a discussion of DOE HEP future planning, which includes the development of Level 1 Requirements of a space-based dark energy mission by the Joint Dark Energy Mission (JDEM) Science Definition Team as well as requested R&D efforts for SNAP, the Dark Energy Survey (DES), and the Large Synoptic Survey Telescope (LSST).

Dr. Van Citters next provided an update on NSF astronomy and astrophysics programs. He announced that Dr. Arden Bement has been confirmed as NSF Director. He also reminded the Committee that the Department of Energy would formally join the AAAC charter as of 15 March 2005, after which date the AAAC membership will rotate to include DOE-selected members.

Dr. Van Citters reviewed the FY 2005 budget and the outlook for later fiscal years. The final AST budget for FY05 was estimated at $195.1M (pending Congressional approval of the AST spending plan), which falls below both the FY05 Request level of $204.35M (4% over FY04) and the FY04 operating budget of $196.6M. The FY06 Request level is $198.64M (1.81% over FY05). Dr. Van Citters noted that AST is planning for level budgets in the foreseeable future. He also noted that changes might occur in the structure and jurisdictional boundaries of the Congressional Appropriations Committees.

Dr. Van Citters next reviewed the status of progress on the NRC Decadal Survey recommendations. Starting with the smaller initiatives, Dr. Van Citters described the current status of the National Virtual Observatory (NVO) and NSF support for theory and laboratory astrophysics. He noted that the recently held Theory Workshop in the Directorate for Mathematical and Physical Sciences (MPS) found no need for a separate theory program in AST, and that laboratory astrophysics projects were strongly represented in FY04 proposals and awards, including many with co-funding from the Divisions of Physics (PHY) and Chemistry (CHE). Dr. Olinto requested a future briefing on the MPS Theory Workshop when the final report is completed.

Dr. Van Citters provided an update on planning for the Giant Segmented Mirror Telescope (GSMT). The GSMT Science Working Group (SWG), led by the National Optical Astronomy Observatory (NOAO), has formulated a detailed science case for GSMT, and a consortium has formed to undertake an extensive technology development and site characterization effort. The project is planned to result in a private-public partnership with private funds supporting approximately 50% of the $70M estimated cost of design and development; a proposal to NSF would request the remaining 50%. The FY05 AST budget provides limited funds for GSMT, and a similar level of support is anticipated in FY06. Dr. Van Citters explained that the planned growth of support for GSMT activities awaits the outcome of the AST Senior Review.

Dr. Van Citters reported that a similar NOAO-led SWG has constructed a detailed science case for the Large Synoptic Survey Telescope (LSST), and the LSST Corporation has been established to oversee the project. The Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) project, the second significant design for a Large Survey Telescope (LST), is underway in Hawaii with funding from the Department of Defense (DOD). Dr. Van Citters noted that current funding for LSST includes $1.3M from NSF in FY03 in support of LSST detector development, as well as $1.7M/year from NOAO in support of the telescope design. In addition, DOE has demonstrated strong interest in participating in the project through procurement of the camera. NSF and NASA have discussed LSST data handling as part of the overall NVO effort. A technology development project and possible architecture studies are planned in FY05-06.

Dr. Van Citters next reviewed recent and upcoming milestones for the Advanced Technology Solar Telescope (ATST). The ATST team had planned aggressively for an FY06 construction

start, but the current schedule allows construction to begin no sooner than fall 2006. AST will fund the project to produce the final design and until the Major Research Equipment and Facilities Construction (MREFC) account provides support for construction. AST will bring the project to the MREFC panel in March 2005; AST considers the project ready for consideration for promotion to "ready" status by the MREFC panel and the National Science Board (NSB). Dr. Van Citters also noted that the ATST project has completed site selection (Haleakala, Hawaii) and that an environmental impact study is underway.

Dr. Van Citters next identified AST long-range planning activities currently underway by independent committees, for which separate reports will be provided at this meeting.

Dr. Van Citters provided a detailed overview of the AST FY04 budget, which totaled $196.55M exclusive of MREFC support for the Atacama Large Millimeter Array (ALMA). $124.75M provided support to AST facilities; $71.8M supported research and instrumentation. Dr. Van Citters showed the FY 1992-2004 budget history, which demonstrated a $60M increase over five years. Some of the increases were appropriated as earmarks, which did not allow advance planning.

Dr. Van Citters described the AST Senior Review process and timeline. The Senior Review responds to a Decadal Survey recommendation for an NSF review of facilities support; the Review has been made imperative by the need to respond to the ambitions of the astronomy community within a flat budget outlook. Dr. Van Citters reported the conclusions that resulted from an internal AST retreat (the first ever) that established an understanding of the needs and goals for the Senior Review as well as issues that NSF and the community must address during the process. Primary outcomes from the retreat include: the AST grants program for individual investigator awards will be excluded from the consideration of balance; ~$20M per year of "free energy" must be identified to make significant progress on major Decadal Survey recommendations; implications of the Review for the AST program may be profound. The next steps in the Senior Review process will require AST to explore the implications of issues and conclusions identified at the retreat. AST plans to frame options in the rebalancing of facilities support along with their best understanding of positive and negative consequences of each scenario. In mid-2005 AST will convene a committee of community representatives to advise on the best options or to identify others.

The Chair asked Dr. Van Citters when ALMA operations will begin to ramp up. Dr. Van Citters replied that costs would begin this year, with a notional amount of $5M needed in FY06. The Chair also inquired about the activities of the upcoming MPS Committee of Visitors (COV). Dr. Van Citters described the statutory requirement to convene a COV once every three years to advise on the proposal review process as well as on planning and the overall balance of support within AST programs.

Dr. Bahcall asked about the success rate of the current AST grants program. Dr. Friel responded that the current success rate is 30%. Dr. Van Citters noted that additional grant support would be needed for data produced by future large facilities.

The Chair questioned the narrow focus of the MREFC account on construction costs and noted that the structure of MREFC funding does not address the full project lifecycle costs. Dr. Dressler noted that the Brinkman Report[5] considered but did not recommend expanding MREFC

[5] *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*; http://www.nap.edu/books/0309090849/html

support to include non-construction costs. Dr. Van Citters noted that the scale of future projects is changing; for example, AST could close every current facility and still not recover operating costs for a $700M project.

Dr. Dressler expressed alarm at the "dissipation" of the prioritization process. He stated that while the Decadal Survey panels and survey committee make certain assumptions during the prioritization process, the process does not provide a mechanism to remove projects from the list as these assumptions fail and constraints develop. He asked how the community becomes involved in a decision "to do fewer things because we have less money." Dr. Van Citters replied that AST plans to take what comes out of the Senior Review process. The Chair noted that ATST has moved forward rather quickly relative to its priority in the Decadal Survey. Dr. Van Citters explained that AST decided to go forward because ATST can complete its duration in the MREFC queue before another AST project is ready for consideration in that account.

Dr. Pilachowski described the activities of the OIR Long Range Planning Committee. The committee began its activities in late August 2004 and has met three times prior to a planned meeting this week. The committee has drafted a very preliminary report after hearing from the major projects involved and has distributed the report back to the major projects for comment. The committee hopes to complete its final report by May 2005 for submission to NSF as input to the Senior Review process.

MEETING ADJOURNED AT 12:30 PM – RECONVENED AT 1:40 PM

Dr. Van Citters provided background on the formation of the Dark Energy Task Force (DETF), which will help the agencies to identify actions that will optimize a near- and intermediate-term dark energy program. He described the elements of the finalized committee charge and identified 11 of the 13 committee members that have confirmed participation. Dr. Edward (Rocky) Kolb will serve as DETF Chair. The charge letter identifies a December 2005 reporting date.

Dr. Megan Urry, Co-Chair of the NRC Committee to Assess Progress Toward the Decadal Vision in Astronomy and Astrophysics, next presented the conclusions and recommendations of the committee's 11 February 2005 report[6]. She first reviewed the formal charge to the committee and identified its membership. She described the structure of the report, which addresses whether the science strategy of the Decadal Survey, supplemented by the NRC Report *Connecting Quarks with the Cosmos*[7], is on course or should be re-examined.

Dr. Urry described the science section of the report, which identifies three categories of scientific advances since 2000: dark energy and the structure of the universe, planets and disks around other stars, and the formation and evolution of black holes (i.e. probing strong gravity and high densities).

Dr. Urry continued to describe the technology section of the report, which identifies technological developments that have occurred since early 2000, including adaptive optics, infrared detectors, bolometric arrays and information technology. The report concludes that, while successful implementation of the Decadal Survey requires timely and sustained commitment to technology development, no technological breakthroughs or challenges require further assessment of the Decadal Survey or imperil the Decadal vision. Additionally, the report questions the effect of

[6] http://www.nap.edu/books/NI000580/html
[7] http://www.nap.edu/books/0309074061/html/

ongoing programmatic changes on young investigators and identifies human capital as a significant and pressing concern.

The third section of the report assesses progress towards the Decadal vision and concludes that recent scientific and technological advances do not require that the NRC undertake an in-depth, mid-course review of the Decadal Survey's scientific goals or recommended priorities. To the contrary, progress in the field validates the broad scientific program envisioned by the Survey and implemented thus far by the agencies. The report notes the need for balance and flexibility, particularly as the most exciting scientific discoveries from new instruments are often unanticipated. As a result, serendipity is very important and programs must be flexible enough to explore unforeseen phenomena.

Dr. Urry added that the report identifies the formation of the AAAC and interagency working groups (IWG, e.g. Physics of the Universe) as significant and important for achieving the Decadal vision. Coordination works because of the strong planning process within the field; the astronomy and astrophysics surveys provide the strategic underpinnings for a cohesive interagency program. The report also stresses the importance of strategic planning and provides specific comments for NSF, DOE and NASA.

Dr. Urry noted that the committee did not make an independent assessment of HST but agrees with the conclusions of the Lanzerotti report[8]. The report also states that the Decadal Survey should remain the basis of the nation's astronomy and astrophysics program, even if HST ceases to operate before 2010. If the cost of repairing HST or developing a fast-track HST replacement is large enough to threaten the timely completion of a substantial fraction of the projects recommended in the Decadal Survey, then the scientific community should be involved in assessing the relative value of HST or its replacement vis-à-vis the affected program. Urry stated, "If it comes to 'science vs. science,' then scientists should make the decision."

Dr. Urry also noted the committee's belief that maintaining the breadth of the astronomy and astrophysics enterprise at NASA is consistent with the new Exploration Vision and that the new vision does not require a "revisit" to the Decadal Survey. The report comments on short-term changes that have already affected astronomy and astrophysics and expresses concern that certain impacts may adversely affect NASA's ability to generate the kind of transformational science that is the hallmark of past decades.

AAAC members inquired whether the report raises the question of the future relationship between the NASA planning process and the Decadal Survey. Dr. Urry responded that the report does not address this issue and added that it will be incumbent upon the community to advocate for the Decadal process. The Committee returned to a discussion of how the Decadal Survey process will respond to the dramatic difference between envisioned and available resources.

MEETING ADJOURNED AT 3:20 PM – RECONVENED AT 3:40 PM

Dr. Martha Haynes, Chair of the Radio, Millimeter and Submillimeter Planning Group (RMSPG), provided an overview of the group's activities. She first identified members of the group, which intentionally replicates the 2000 Astronomy and Astrophysics Survey Panel on Radio and Submillimeter-Wave Astronomy. Dr. Haynes noted that the RMS facilities portfolio provides observing capability over 5 orders of magnitude in wavelength and with angular scales down to

[8] *Assessment of Options for Extending the Life of the Hubble Space Telescope: Final Report*; http://www.nap.edu/books/0309095301/html/

100 microarcseconds. She identified the foremost science questions addressed by RMS astronomy and reviewed the National Center radio facilities, including Arecibo Observatory, the Robert C. Byrd Green Bank Telescope (GBT), the Expanded Very Large Array (EVLA) and the Very Long Baseline Array (VLBA). Dr. Haynes drew attention to the unique characteristics of each facility and noted that national facilities encompass the world's best radio telescopes. She described a radio development program for this decade and noted that several projects are looking at demonstrations and new approaches for the next generation radio telescope, the Square Kilometer Array (SKA).

Dr. Haynes described millimeter and submillimeter (MS) astronomy as rapidly developing fields with new instruments coming online. She described a suite of MS instruments needed to accompany ALMA for survey and spectroscopy capability and outlined developments for MS astronomy in the ALMA era.

Dr. Haynes drew particular attention to the role of the RMS university community, which provides research instruments complementary to national facilities as well as necessary instrument development and training for future generations. Dr. Haynes also identified technology drivers for RMS astronomy as well as synergies with NASA and DOE facilities and missions. She noted that RMS facilities provide a suite of instruments with little overlap in capability. Dr. Haynes concluded with the identification of the principal challenges that impact (but not uniquely) RMS astronomy, particularly within constrained budgets.

Dr. Rolf Kudritzki, GSMT SWG Chair, joined the committee via teleconference to discuss the status of the GSMT SWG's report on GSMT-JWST complementarity. The Chair provided a summary of draft document's status, and Dr. Kudritzki described its structure and primary revisions. The Committee provided comments on the document, and Dr. Kudritzki provided a timeline for moving forward in cooperation with the JWST SWG. Dr. Jonathan Gardner, JWST Deputy Senior Project Scientist, concurred with the timeline for follow-up.

Mr. David Trinkle, NSF Program Examiner for the Office of Management and Budget (OMB), and Dr. Amy Kaminski, NASA Program Examiner, discussed the President's FY06 Budget Request. Mr. Trinkle reminded the Committee of the President's promise to halve the deficit by 2009 and stated that OMB is currently examining economic policies "to get there." He stated that the current focus is on spending restraint and showed a slowdown in non-security discretionary spending from FY02-06. He compared FY05 spending to FY06 Request levels for the Federal R&D budget and for NSF astronomy-related programs and facilities.

Ms. Kaminski followed with a review of the President's FY05 and FY06 Budget Requests for NASA. She provided a brief overview of the transformation of NASA in response to the President's Space Exploration Vision and indicated that NASA is beginning to redefine its objectives in response to the new Vision. She noted that the NASA science budget comprises $5.5B of the $16.5B total FY06 Budget Request and provided details for budget line items in the Universe Division, which is roughly 9% "and holding" of the total NASA budget.

Mr. Trinkle described the Program Assessment Rating Tool (PART) and noted that all NSF programs to date have been rated as "effective." Many NASA programs are also rated as "effective" while others are "moderately effective" or "adequate." No NSF or NASA programs have been rated as "ineffective." Ms. Kaminski noted that PART is a standard tool that is used across government programs; only a few questions are additional to R&D agencies. Mr. Trinkle noted that the PART assessment tool and agency responses are publicly available.

Dr. Olinto inquired about the origin of the GLAST budget cap that was imposed upon DOE and noted that the cap has been detrimental to the collaborative activity between DOE and NASA. Ms. Kaminski and Mr. Trinkle deferred the question to DOE Program Examiner Joel Parriott, who was not present. Dr. Ong asked how OMB views input from the strategic roadmapping activities that are currently ongoing for NASA and asked if the process would continue similarly to the past. Ms. Kaminski noted that her experience at OMB is limited to the past two years and that the collaboration during that time has been very positive. She replied, "We pay attention to the Academy studies and roadmapping activities and try our best to heed what the community and the agency are saying."

Dr. Ong asked if uncertainties in large mission costs are detrimental. Ms. Kaminski replied that OMB is more concerned about running many large and expensive missions at the same time. The Chair expressed concern about the Explorer program. Ms. Kaminski answered that part of the rationale for removing the Explorer missions was that the missions were undefined. She added, "Tough decisions need to be made," so one needs to ask if a better approach would be to reduce funding for another mission such as LISA.

Dr. Bahcall drew attention to the "effective" rating earned by most NSF and NASA programs, to which Ms. Kaminski replied, "That's not lost on the Administration," and added that science programs are faring comparably well in the current budget climate. Dr. Bahcall asked the Examiners if they would like to comment on HST. Ms. Kaminski explained that no one argues that the mission is not a high-performing mission; rather, "it comes down to trade-offs." She noted that the language regarding the proposed robotic servicing mission expressed that the approach would be expensive and risky. NASA also decided that they could not service HST in a timely manner with a Shuttle servicing mission given the requirements of return-to-flight. Dr. Hertz offered that it would be unrealistic to expect OMB Program Examiners to overrule NASA on a safety situation. Ms. Kaminski added that while the Academy report noted that the risks are not as high as the NASA Administrator perceives them to be, OMB must defer to NASA.

The Chair asked if the Beyond Einstein program still appears as a NASA line item. Ms. Kaminski was uncertain but stated that a 19 January chart shows the line item. Dr. Hertz offered to confirm. Dr. Pilachowski inquired about the looming problem of operations costs for large facilities at NSF. She noted that the operations costs for a large facility could exceed the entire AST budget. Dr. Trinkle responded, "It's on our radar screen."

Dr. Urry noted that the Decadal Survey recommended the inclusion of funding for theory challenges along with each mission in the development stages. She understood that NASA tried to include this kind of funding with JWST, but OMB threw it out. She asked, if NASA tried again, if the theory funding could survive. Ms. Kaminski said that she was unfamiliar with the concept, and that she would like to better understand the question and flesh out the implications before offering a response.

The Chair asked if the Examiners foresee long-range planning at NSF having a significant positive impact and if the proposed approaches meet the goals that OMB had in mind. Mr. Trinkle answered affirmatively and noted that the planning activities have also been well received by Congress. He cautioned that questions always arise of "how to think about these things" and added that NSF provides meaningful out-year budget figures only for facilities; the rest of NSF programs receive a more standard calculation of budget run-outs that are less meaningful. As NSF grows, the agency will need to address these challenges.

The Committee discussed potential issues for inclusion in their upcoming annual report, including the support of science at NASA under the Exploration Vision, the lack of funding for Beyond Einstein, and the long-range planning activities underway at NSF. Dr. Dressler expressed regret at the loss of the previous Theme structure at NASA following the transformation. He described the old Themes as a very productive intellectual structure for science at NASA. Dr. Hertz agreed that the effective aspects of the Theme structure do a great job of advocating for the science and for justifying a long-term program that builds upon itself.

MEETING ADJOURNED AT 6:05 PM, 15 FEBRUARY 2005

MEETING RECONVENED AT 8:35 AM EST, 16 FEBRUARY 2005

The Committee convened to discuss the development of their annual report. Members continued to identify critical issues to address and distributed writing assignments.

Dr. Rainer Weiss, Chair of the Task Force on CMB Research (TFCR), reviewed TFCR activities. He first provided the background and motivation for creating the TFCR, identified its members, and described the formal charter. The TFCR will recommend a program of research of CMB observations with a focus on CMB polarization measurements to understand the properties of the inflationary epoch of cosmology.

Dr. Weiss reviewed the basic questions addressed by CMB research: how did the universe begin, what is the fundamental physics, and how did the universe evolve? He provided an overview of CMB physics and the properties of "standard" inflation measurable with the CMB. He also described the predicted polarization measurements and overlaid their amplitudes with the sensitivities of the Wilkinson Microwave Anisotropy Probe (WMAP), the Planck mission, a space-based Inflation Probe (CMBPOL), and two proposed ground-based experiments.

Dr. Weiss outlined the major components of the TFCR-recommended program: completion of WMAP and the successful launch and operation of Planck; ground-based observations of small-angular-scale temperature variations; and a ground-based and balloon-borne program to measure polarization of the CMB and to develop techniques and technology for a space mission in the next decade. The space mission would be designed to measure the polarization B modes to a level limited by the ability to model foregrounds. The recommendations include a program to measure polarized foregrounds and a program to develop polarization-sensitive receivers incorporating arrays of thousands of detectors operating at the background limit of the CMB. The result is a cooperative interagency program of research supported by DOE, NSF, NASA and the National Institute of Standards and Technology (NIST). Dr. Weiss concluded with a proposed research timeline for major programs and capabilities.

The Chair asked if the TFCR had any sense of the cost of their recommended program. Dr. Weiss answered yes but also that significant controversy still exists among the committee of what should be included in the program. The committee is still deciding the number of efforts that should be supported, particularly because of the difficulty in recommending that particular lines of research should be shut off at this early stage. He added that the report is currently under review by experts external to the committee.

Dr. Mark Coles, NSF Deputy Director for Large Facilities Projects, reported that the NSF has considered the Brinkman report, which provides specific recommendations for the agency's planning, review and ranking of large facilities. Under the direction of the NSF Deputy Director, a committee of individuals from across NSF conducted a detailed analysis of the report's

recommendations, and a formal NSF/NSB report was prepared after broadly canvassing NSF for input.

Dr. Coles reviewed the salient features of the NSF/NSB report: NSF is developing a Facility Plan "roadmap;" NSF embraces the Brinkman recommendations to provide greater clarity and transparency to the project selection and prioritization process; and NSF will take steps to enhance the robustness of the pre-construction project development process to improve cost projections.

Dr. Coles outlined the NSF Facility Plan. The Facility Plan will report a list of all projects under construction and at the various stages of development. The Plan will include a detailed discussion of the development plans and criteria for projects in the advanced stage of pre-construction development, as well as a discussion of the scientific objectives and opportunities that provide context and compel the need for their development. The Plan will provide a discussion of the overarching considerations used for cross-disciplinary prioritization (i.e., the first and second NAS ranking criteria). The first draft of the Facility Plan is expected in April or May 2005 (following the March NSB meeting) and will be posted for public comment. Dr. Coles added that the Facility Plan should become a strategic tool for communicating with NSF research communities and government policy makers. The Facility Plan will be updated annually and made available to the public.

Dr. Coles described the revision of the MREFC process for making decisions about and setting priorities among large facilities projects; the revised process will be reflected in the NSF Facilities Management and Oversight Guide[9]. The Guide will define a new stage in the pre-construction development process called "Readiness," which is expected to begin 1-2 years before a project is considered for NSB approval for inclusion in the pool of new start candidates. Dr. Coles described how the Readiness stage fits into the overall MREFC project lifecycle stages: Horizon Stage, Concept Stage, Development Stage, Readiness Stage, Candidates for New Start, Construction and Operations.

Dr. Coles described the Project Development Plan that is written during the Development Stage by the project developers in consultation with NSF. The Project Development Plan lays out the project's development trajectory for the Readiness Stage, including: the technical and managerial activities needed to bring the project to construction readiness; planning activities that result in mature construction budget estimates and sound projections of expected operations costs; and budget requirements for final development. The NSF will then add oversight decision points for use during the Readiness Stage; the decision points provide criteria for both advancement and "off-ramps" that are approved by the NSB and made public as part of the Facility Plan.

Dr. Coles identified the gatekeepers for the Readiness Stage, including entry and exit criteria. He noted the reasons that a project may exit the Readiness Stage: the project has been NSB-approved; the project fails to advance against its Project Development Plan criteria; the project is eclipsed by other projects; reprioritization; or other factors as deemed appropriate by the NSF Director.

Dr. Coles continued to explain that successful projects exiting the Readiness Stage advance to the pool of Candidates for New Start. He noted that the NSB might reprioritize this pool when candidates are added; in that case the reprioritization rationale will be made public. Each year the NSF Director will propose to OMB a subset of the New Start pool for construction funding;

[9] http://www.nsf.gov/pubs/2003/nsf03049/nsf03049.pdf

funding would follow if OMB approves the project's inclusion in the NSF budget request and Congress appropriates the funds.

Dr. Coles stated that NSF's next steps include the revision of NSF's Facilities Management and Oversight Guide to incorporate the new policies. He identified several challenges that remain: to describe specific implementation steps that incorporate these principles; to define steps to develop "sufficiently mature" budget projections prior to construction approval; to develop strategies to minimize the risk of a potential backlog of approved New Starts; and to consider aspects of the new framework that may be used to aid fields (such as astronomy) that have needs for very long lead times during facilities development. Dr. Coles welcomed input from the Committee.

Dr. Coles returned to the definition of "construction ready" and offered a definition that includes the creation of a robust final project baseline in which: enabling technical developments are complete; thorough cost and contingency estimates exist with a high degree of certainty that the project can be completed within scope; project management is in place; and a Project Management Control System (PMCS) is in place. He noted that baseline development can be very expensive (5-15% of the total construction budget), but it must be done eventually. Dr. Coles offered that this definition of "construction ready" may be overly ambitious but also noted that NSF needs to define acceptable levels of risk and uncertainty.

Dr. Coles explained that NSF's internal policies in the Management and Oversight Guide should conform to generally accepted notions of how large projects are managed, including the typically well understood stages of conceptual design, preliminary design, final design, construction, commissioning and operations. He added that the Guide should also define how solicitations for these proposals might be made if required (e.g., in cases where several concepts could address a particular science goal).

The Chair asked if NSF Divisions would need to support efforts to explore opportunities or if NSF would centrally fund these development stages. Dr. Coles replied that the issue is under debate; serious pros and cons have been expressed.

Dr. Coles noted that the Facility Plan and the Facilities Management and Oversight Guide should broadly mesh NSF strategic planning with the activities of other agencies such as NASA and DOE as well as provide a natural place to articulate NSF's intentions for specific international partnerships. He concluded with the identification of the next steps in the revision of the Facilities Management and Oversight Guide.

Dr. Dressler asked Dr. Coles if he thought it appropriate for the MREFC Panel to make a decision between two competing proposals for one science goal. Dr. Coles replied that down-selection would occur prior to the Readiness Stage. Dr. Van Citters added, "We don't want the MREFC Panel making a decision that the community should make." Dr. Ong noted the difficulty of aligning timelines and processes among agencies, particularly at the early stages of project development, and asked if NSF would mesh the MREFC guidelines with other agencies. Dr. Coles deferred to Dr. Van Citters, who noted the desire for a transparent process so potential collaborators could understand NSF's level of commitment. Dr. Pilachowski asked if the Readiness Stage communicates to potential collaborators that the potential for NSF funding is real. Dr. Coles answered yes. Dr. Kirshner inquired about the backlog of existing projects in the pool of Candidates for New Start. Dr. Coles replied, "The new tool that we're bringing to the table is the Facility Plan that communicates our intentions."

Dr. Carlstrom inquired about operations funding. Dr. Van Citters explained that current NSF policy gives the responsibility for operations costs to the proposing Directorate, if not the proposing Division. The Chair commented that NSF as a whole needs to be aware of the impact on the Division and on NSF. He compared the changing scale of projects to the NASA Great Observatories, which impact across the entire agency. Dr. Van Citters noted that the highest priority for the AST Senior Review is to provide the operating costs for ALMA.

MEETING ADJOURNED AT 11:10 AM – RECONVENED AT 11:30 AM

Dr. Alex Szalay provided an overview of the National Virtual Observatory (NVO). He offered a brief history of the NVO and noted that the Decadal Survey identified the NVO as the highest priority among the small (<$100M) initiatives. Recent events include the first NVO science prototypes shown in January 2003 and the first applications released in January 2005. Dr. Szalay described the US NVO Framework development project, which is entering the fourth year of a $10M+, five-year project. The project collaboration includes 17 organizations among the disciplines of astronomy, computer science and information technology. The collaboration and discussions are also being extended to the Gemini Science Archive, LSST, Keck and PanSTARRS.

Dr. Szalay reported that the NVO is also the founder of the International Virtual Observatory alliance, which now includes 15 member projects that strive to ensure common standards and non-duplication of effort. He also described the NVO Summer School, held in Aspen in September 2004, which trained 40 students and software developers in VO tools and technology. A special session at the January 2005 American Astronomical Society (AAS) meeting also provided additional exposure.

Dr. Szalay stated that evolving new technologies drive the standards; the VO works to apply these standards to the astronomy domain and to fit with legacy astronomy data formats. Dr. Szalay described what the Virtual Observatory is and is not. In particular, the NVO is neither a centralized repository for all astronomical data nor a data quality enforcement organization. Dr. Szalay cautioned that the VO cannot "build everything for everybody;" rather, the NVO strives to build the 10% of services that are used by 90%. NVO will provide the tools and documentation, and users will build the custom applications they need.

Dr. Szalay reported that the first real NVO applications were released in January 2005. He described the current tools: NVO Registry Portal, which allows users to find source catalogs, image archives and other astronomical resources registered with the NVO; DataScope, which allows the user to discover and explore data in the VO; OpenSkyQuery, a tool to cross-match data with numerous astronomical catalogs; Spectrum Services, which will search, plot and retrieve spectra from the Sloan Digital Sky Survey (SDSS DR1) and 2-degree Field redshift survey (2dF GRS); and Web Enabled Source Identification with Cross-Matching (WESIX), which provides source extraction and cross-matching for any astrometric FITS image. Dr. Szalay also described potential NVO applications under development for 2005-6 that will be determined in consultation with their Science Steering Committee.

Dr. Szalay stated that the NVO is clearly recognized as an excellent vehicle for education and public outreach (EPO). The NVO Education and Outreach Coordinator, Dr. Carol Christian, is currently developing partnerships and planning the second EPO workshop for summer 2005. Dr. Szalay concluded by noting that community engagement is underway and that the first research papers utilizing VO are beginning to appear.

Dr. Jeffrey Hayes, NASA Program Scientist, and Dr. Eileen Friel, AST Executive Officer, followed with a report on joint NASA-NSF NVO activities. Dr. Hayes reported that the two agencies are working towards a strategy to allow joint funding of domestic NVO work. He noted that E-Government initiatives and a new online proposal submission system at NASA have complicated the issue. He also noted that NASA now has an identified budget line for the NVO initiative that will continue to the current budget horizon. NSF has a similar budget scenario.

Dr. Hayes reported that queries to NSF and NASA legal and procurement officials have identified a Memorandum of Understanding (MOU) as the most reasonable approach to a joint Announcement of Opportunity (AO) for the operation and management of the NVO. He explained that, although one agency must take the lead in the drafting and issuing of the solicitation, NASA and NSF would share funding roughly 50/50 for the foreseeable funding horizon. NSF will issue the solicitation and manage the joint review. Dr. Hayes provided a timeline for the AO and described the progress-to-date for outlining an agreed-upon framework. He stated that there is clear agreement between the agencies and that no insurmountable issues remain.

Dr. Alan Smale, NASA Program Executive for Mission Operations and Data Analysis, distributed an 18 October 2004 letter from the Science Archive Working Group (SAWG). Dr. Smale described the SAWG charter and identified its structure and membership. He explained that SAWG serves as a standing working group of the (former) Structure and Evolution of the Universe (SEU) and Origins Subcommittees of the Space Science Advisory Committee (SSAC).

Dr. Smale reported that, when asked for an opinion on whether NASA should archive ground-based data, SAWG's general position is that ground-based data should be archived by the ground-based community and funded by NSF and DOE where appropriate. He noted, however, that the division is not clear-cut because of NASA's presence in ground-based observing. Moreover, tremendous synergy exists among space-based and ground-based datasets. In their 18 October letter, SAWG requested a general statement of NASA policy regarding the archiving of ground-based data at NASA-funded archive centers. SAWG would also like to know if the AAAC has formulated (or may in the future formulate) any policies that might be germane and whether a vision exists for the formation of archives from ground-based observatories.

The Chair asked the agencies how to proceed. Dr. Van Citters stated that the ground-based community has clearly been behind on archiving. He noted that ALMA would have an archive and, while NOAO has also been archiving, it's a cost issue. He stated that NSF is very willing to consider proposals to establish archives. He added that the community must talk very clearly about SDSS data and what will happen to the archive when Fermilab no longer supports it. Dr. Hertz commented that NASA is archiving ground-based data from their share of ground-based projects (e.g. Keck interferometer data), but they do not plan to archive data from non-NASA ground-based projects.

The Chair asked the agencies to consider the issue. Dr. Ong noted that the community must consider the costs of a public archive up front. Dr. Szalay added that the costs are not in hardware and tools but rather in curation (e.g. updating platforms). The Chair tabled the issue until the spring meeting and after hearing from the agencies.

Dr. James Graham provided an overview of planet detection with high-contrast imaging and extreme adaptive optics (ExAO) on 30-meter class telescopes. He first demonstrated the ability to detect planets with high-contrast imaging by showing a movie of Venus moving into the field of view of the Solar and Heliospheric Observatory (SOHO) Large Angle and Spectrometric

Coronagraph (LASCO C3) as well as images of a stellar disk and binary brown dwarf detected by stellar coronagraphs. He showed the state-of-the-art accomplishments in high-contrast imaging and described the science issues and drivers. He noted that high-contrast is a fairly unexplored domain for astronomy, yet there is broad potential for scientific application in exoplanet detection, circumstellar disks (protoplanetary and debris disks), fundamental stellar astrophysics (stellar binaries), mass transfer and loss (cataclysmic variables, symbiotic stars and supergiants), and solar system astronomy (icy moons, Titan and asteroids).

Dr. Graham stated that the goal of ExAO is to find self-luminous planets at 4-40 AU. He described the architecture of planetary systems and the relevance for detection techniques. He also provided planetary cooling models to demonstrate the contrast required to detect Sun-like planets at various wavelengths. He noted that the contrast required to detect planets is much lower in the near infrared than at visible wavelengths.

Dr. Graham defined ExAO and addressed the question of how to achieve the necessary contrast to detect planets. He described the need to control both diffraction and wavefront errors, which cause speckles that masquerade as planets. He noted that planet detection requires both AO and a coronagraph because wavefront errors and diffraction couple.

Dr. Graham showed results from a simulation to demonstrate high-precision wavefront and diffraction control. He noted that the errors are caused by optical-surface and calibration errors—not the atmosphere—so similar issues arise for space-based planet detection. He concluded that ExAO plus a coronagraph on 8-meter class telescopes could yield the first detections of self-luminous exoplanets, which are of a different type from those detected by Doppler techniques. As an example, Dr. Graham noted that the objects discovered with ExAO could have water clouds.

Dr. Graham continued with a comparison of ExAO on a 30-meter telescope to that on an 8-meter. The former provides better angular resolution, better contrast (for a given rms wavefront error budget on fixed spatial scales), the ability to explore star-forming regions, and the potential for astrometry and spectroscopy. He noted that the Thirty Meter Telescope (TMT) could not lock on fainter guide stars. He also commented that a case could be made that TMT could detect Doppler planets, which would be redundant with TPF-C and indirect searches. Dr. Graham described the issues and challenges for ExAO on TMT and noted issues with TMT design that could influence the ability to image exoplanets.

MEETING ADJOURNED AT 1:00 PM – RECONVENED AT 1:30 PM

The Committee agreed to provide the draft TFCR report to NASA for use in the agency's roadmapping activities and to assemble their feedback on the report for communication to the TFCR Chair. The Chair will communicate to Dr. Weiss the Committee's suggestion that the TFCR should consider prioritizing their recommendations.

The Committee utilized the remainder of the meeting to draft their annual report.

MEETING ADJOURNED AT 2:35 PM, 16 FEBRUARY 2005