Minutes of the Meeting of the Astronomy and Astrophysics Advisory Committee

13–14 February 2006
NASA Headquarters, Washington, DC

Members attending:	Garth Illingworth (Chair)	Daniel Lester
	John Carlstrom (Vice-Chair)	Angela Olinto
	Neta Bahcall	Rene Ong
	Bruce Carney	Catherine Pilachowski
	Wendy Freedman	E. Sterl Phinney
	Katherine Freese	Abhijit Saha
	Robert Kirshner	
Agency personnel:	G. Wayne Van Citters, NSF-AST	Rick Howard, NASA-HQ
	Eileen Friel, NSF-AST	Eric Smith, NASA-HQ
	Dana Lehr, NSF-AST	Jennifer Wiseman, NASA-HQ
	Randy Phelps, NSF-AST	Ed Weiler, NASA-GSFC
	Wei Zheng, NSF-AST	Steve Ritz, NASA-GSFC
	Mary Cleave, NASA-HQ	Nick White, NASA-GSFC
	Colleen Hartman, NASA-HQ	Robin Staffin, DOE-HEP
	Paul Hertz, NASA-HQ	Kathleen Turner, DOE-HEP
	Michael Salamon, NASA-HQ	
Invited participants:	Rocky Kolb, U. Chicago	David Trinkle, OMB
	Andreas Albrecht, U. California-Davis	Megan Urry, Yale U.
	Gary Bernstein, U. Pennsylvania	Roger Blandford, Stanford U.
	Amy Kaminski, OMB	Robert Dimeo, OSTP
	Joel Parriott, OMB	
Other participants:	Brian Dewhurst, NRC-BPA	Jon Morse, OSTP
	Dennis Socker, NRL	Robie Samanta Roy, OSTP
	Michael Ledford, Lewis-Burke Assoc.	Jon Bagger, Johns Hopkins U.
	Jay Frogel, AURA	Don Kniffen, GSFC/USRA
	John Peoples, FNAL	Kathleen Beres, Orbital Sciences
	Brenna Flaugher, FNAL	Kevin Marvel, AAS

MEETING CONVENED AT 8:30 AM EST, 13 FEBRUARY 2006

The Chair called the meeting to order. All participants introduced themselves, and the Chair noted anticipated changes to the published agenda that resulted from inclement weather in the area. The Chair reviewed major items from the President's FY 2007 Budget Request and noted important items for discussion during the meeting.

Dr. Wayne Van Citters, Director of the NSF Division of Astronomical Sciences (AST), provided an update of NSF programs in astronomy and astrophysics. He first provided news about major AST initiatives. On 26 January the cost changes resulting from the decision of European Southern Observatory (ESO) to procure a second antenna design for the Atacama Large Millimeter Array (ALMA) were reviewed at the request of the ALMA Board. The review panel consisted of a

subset of the same committee that in October reviewed the new international project baseline. A separate NSF-appointed panel carried out a second review in Charlottesville, Virginia, on 30 January through 1 February. NSF asked this panel to examine in depth the project cost, schedule and management of the North American (NA) component of the project. The NA panel report would inform the NSF Director's review of ALMA planned for early March. Dr. Van Citters anticipated a recommendation on ALMA from the National Science Board (NSB) during their 9-10 May 2006 meeting.

Dr. Kirshner asked what events led to the selection of two different antenna designs for ALMA. Dr. Van Citters replied that international processes required two separate procurements and that the vendor providing the lowest bid differed during the separate selections. ESO was required to accept the lowest bid despite the outcome of the earlier NA antenna selection.

Dr. Van Citters reported that the NSF Director had moved the Advanced Technology Solar Telescope (ATST) to the “readiness” phase in the Major Research Equipment and Facilities Construction (MREFC) review process. An Environmental Impact study was underway for the project, and partnerships with the U.S. Air Force and international communities were under discussion. Meanwhile, AST continued to provide funding to the National Solar Observatory (NSO) in support of ATST. Dr. Van Citters noted that the earliest likely entry of ATST into the MREFC account queue would occur in FY 2009.

Dr. Van Citters also reported that the Environmental Assessment was completed in November 2005 for the Very Energetic Radiation Imaging Telescope Array System (VERITAS) and that environmental monitoring would continue until June 2006 while progress on the project continued at the Whipple Observatory Basecamp. He stated that the earliest possible resumption of construction on Kitt Peak would be in July 2006.

Dr. Van Citters anticipated an FY 2006 competition for the management and operation of the Virtual Observatory (VO) following the final circulation and signature of the NSF-NASA Memorandum of Understanding (MOU). He noted that the joint NSF-NASA solicitation was ready for clearance upon signature of the MOU and that funds were available to ensure a smooth transition from the National Virtual Observatory (NVO) development project to the VO implementation and operation.

Dr. Van Citters next reviewed the FY 2006 AST budget Request and current operating plan. He noted that the FY 2006 appropriation included a recommended $4M increase over the Request level (to $51.4M) for the National Radio Astronomy Observatory (NRAO), which had to be redistributed from existing program budgets. He compared the FY 2006 Request level for AST facilities ($119.5M) to the current operating plan ($122.0M) and identified funding levels for individual facilities and programs. He also noted that the current FY 2006 operating plan in Astronomy Research and Instrumentation includes $4M for the Large Synoptic Survey Telescope (LSST) and $2M for the Giant Segmented Mirror Telescope (GSMT) Technology Development Program.

Dr. Van Citters then turned to the President’s FY 2007 Budget Request, which provides $215.11M ($7.7% or $15.5M over the FY 2006 Request) to AST and includes increases for: GSMT (up $3M to $5M); the Telescope System Instrumentation Program (TSIP, up $2M to $4M); the Adaptive Optics Development Program (AODP, restored to $1.5M); enhanced activities in both Physics of the Universe (POU) and Elementary Particle Physics (EPP, with the Division of Physics); AST research grants programs; and Gemini Observatory future instrumentation. He compared the AST budget to the other divisions in the Directorate for

Mathematical and Physical Sciences (MPS) and noted that AST fared as well as NSF as a whole and that the percentage increase in the AST budget was equivalent to the percentage increase in NSF Research and Related Activities (R&RA).

Dr. Van Citters presented the 10-year program history for the Astronomy and Astrophysics Research Grants (AAG) program and noted significant growth in the number of proposals, program budget, success rate and typical award size. He drew attention to considerable increases in AST proposal pressure that likely have resulted from NASA program changes; in particular, the number of research grant proposals submitted to AST had increased 20% in FY 2006 following a 15% increase in FY 2005. As a result, the Division anticipates decreased success rates in FY 2006.

Dr. Van Citters identified the new personnel that have joined AST, including Dr. Phil Puxley, Dr. Wei Zheng and Dr. Thomas Barnes.

Dr. Van Citters provided a brief overview of the motivation for the AST Senior Review (SR), identified the committee membership, and reviewed their activities-to-date. He noted that the committee's report had been requested with a target deadline of 31 March with instructions to take the time needed to respond fully to their charge. The SR committee would next meet at the end of February. Dr. Van Citters described the next steps for the activity. Following the submission of the committee's report to the MPS Advisory Committee for acceptance and transmittal to the Assistant Director for MPS, AST would formulate an implementation plan and bring that plan to the astronomical community at the spring meeting of the American Astronomical Society (AAS) and at regional town meetings. Dr. Van Citters added that AST plans to consult with the Committee on Astronomy and Astrophysics (CAA) as AST acts on the SR recommendations. The results of the SR process, at the earliest, would inform the FY 2008 budget development.

The Chair asked Dr. Van Citters to provide a summary of the feedback received from the regional town meetings that had preceded and accompanied the SR committee activities. Dr. Van Citters replied that 70% of the time had been spent grappling with the need for and concept of a Senior Review. The town meeting participants emphasized the importance of access to telescopes for research and training and strongly voiced that a large portion of the community feels disenfranchised by the Decadal Survey process. Dr. Friel added that the meetings produced substantive recommendations for consideration in carrying out the next Decadal Survey.

Dr. Phinney inquired about the status of the Square Kilometer Array (SKA). Dr. Van Citters stated that he is well aware of the activity in Europe and that the Decadal Survey currently prioritizes SKA below GSMT and the LSST. Dr. Carlstrom noted that SKA was not ranked against GSMT and LSST; rather, SKA was prioritized in another category.

Dr. Lester asked Dr. Van Citters to comment on the FY 2007 budget increases and asked, "What worked?" Dr. Van Citters replied that the 2006 National Research Council report, *Rising Above The Gathering Storm*[1], generated a lot of interest. Dr. Kirshner asked Dr. Van Citters how he would articulate the need for the Senior Review in light of comments that the AST budget increase negates the need for the Senior Review or at least allows its postponement. Dr. Van Citters replied that the Senior Review activity is "part and parcel" of both growing the AST program and demonstrating a strategic plan. He noted that growth is not guaranteed; that is,

[1] *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*; http://fermat.nap.edu/books/0309100399/html

requests and authorizations are not appropriations. The Chair added that even with reasonable budget increases, a problem still exists. In addition, the Chair noted that NSF Deputy Director Kathie Olsen had identified the Senior Review as an exemplar activity at NSF. Dr. Phinney added, "The budget isn't growing yet."

Dr. Robin Staffin, Associate Director of the DOE Office of High Energy Physics (HEP), provided an update on astrophysics activities at DOE. He started by reviewing the organization of HEP into four sectors: accelerator-based physics, non-accelerator physics, theory, and research and development (R&D) for accelerator and detector technologies. He noted that non-accelerator physics is a growing and important sector and identified current projects in Atmospheric and Solar Neutrinos and in Particle Physics and Cosmology.

Dr. Staffin reviewed the overall HEP budget and priorities in FY 2007: the Tevatron and B-Factory are supported for their full scheduled operations; support of the Large Hadron Collider (LHC) is up 8% as construction completes; and the core research programs at universities (up 6%) and laboratories (up 2%) have been increased. Future HEP initiatives include: the doubling of R&D support for the International Linear Collider (ILC); two new neutrino experiments known as the Electron Neutrino Appearance Experiment (EvA) and the Reactor Neutrino Detector; an increase in the investment in long-term accelerator R&D (up $5M); and dark energy R&D, including an additional $5M for the Supernovae Acceleration Probe (SNAP) and $5M for R&D for other ground and/or space concepts that will be selected by open competition and peer review.

Dr. Urry asked if HEP has an implementation plan for the increase in university support. She questioned if the increased support will go to existing HEP principal investigators (PIs) or if room will be made for new PIs. Dr. Staffin replied that the funds would be distributed "without prejudice."

Dr. Staffin continued to report that the requested doubling of ILC R&D (from $30M to $60M) would: enable significant progress on all major subsystems; begin the industrialization of key components so U.S. industry can "get up to speed" and successfully compete for contracts if the ILC is built; include detector R&D funding; and include U.S. contributions to the Global Design Effort (GDE) management and support. He noted that the funding increase was a major step forward but that progress on the ILC does not yet include approval of either construction or an engineering design. He said, "The goal of the R&D program at this stage is to provide solid technical, cost and schedule information to governments to enable a decision on ILC construction at the turn of the decade."

The Chair asked how an increase of $5M for SNAP would influence the open competition for the Joint Dark Energy Mission (JDEM) in coordination with NASA. Dr. Staffin replied by noting that the identification of an additional $5M for open competition is a new approach for DOE. The Chair agreed but questioned whether the funds directed to SNAP presented a disconnect. Dr. Staffin answered, "DOE continues to affirm that it sees NASA as its partner in JDEM," and noted that budget discussions are necessarily separate among the agencies. The Chair identified his question as relevant to the Committee's panel discussion with Office of Management and Budget (OMB) program examiners later in the day.

Dr. Staffin identified the active HEP advisory panels and noted that a Dark Matter Science Assessment Group was under development in coordination with NSF.

Dr. Carney asked what role Dr. Staffin foresaw for China over the next five years. Dr. Staffin replied, “I hope a growing one.” He noted that the Reactor Neutrino Experiment is something that China has pushed and that China would send a delegate to the ILC meetings.

MEETING ADJOURNED AT 10:30 AM – RECONVENED AT 10:45 AM

Dr. Rocky Kolb joined the Committee to provide an update on the activities of the Dark Energy Task Force (DETF). He reviewed the DETF charge and membership and outlined their draft report, which had been divided into four sections: Context, Goals and Methodology, Findings and Recommendations. Dr. Kolb noted that he would present the core of the first three sections; the Recommendations were still under consideration and were expected to be complete within a few weeks.

The Context section of the DETF report affirms the observational evidence for an increasing expansion rate of the universe and identifies understanding the nature of dark energy as requiring revolutionary new physics. In describing the Goals and Methodology section, Dr. Kolb stated that the DETF had made extensive use of statistical (Fisher-matrix) techniques incorporating Cosmic Microwave Background (CMB) and Hubble constant (H_0) information to predict the future performance of various approaches to study dark energy. The committee’s considerations follow the development of dark-energy experiments in four Stages that incorporate both ongoing and proposed near- and intermediate-term dark energy projects. Dr. Kolb emphasized that the DETF had evaluated observational techniques for studying dark energy but had not prioritized or assessed individual project proposals. Dr. Kolb also noted that dark-energy science has far-reaching implications for other fields of physics and that discoveries in other fields may point the way to understanding the nature of dark energy, such as providing evidence for a modification of the theory of general relativity.

Dr. Kolb next described the committee’s fifteen Findings. He stated that four observational techniques dominated the white papers that were submitted to the DETF: baryon acoustic oscillations (BAO), cluster (CL) surveys, supernovae (SN) surveys, and weak lensing (WL) surveys. He noted that the different techniques have different strengths and weaknesses and are sensitive in different ways to dark energy and to other cosmological parameters. For each technique Dr. Kolb identified its respective sensitivity, level of maturity, importance of systematic uncertainties and potential power for measuring dark energy parameters.

Dr. Kolb defined the committee’s “figure of merit” and noted that their modeling does not assume a spatially flat Universe. He indicated that the inability to forecast reliable systematic error levels was the biggest impediment to judging the future capabilities of the observational techniques, and he identified the needs per each technique to better determine the systematic errors levels. The committee determined that a program that includes multiple techniques at their Stage-IV level of development could provide an order-of-magnitude increase in the figure of merit, which would constitute “a major advance in our understanding of dark energy.” Dr. Kolb continued, “No single technique is sufficiently powerful and well established that it is guaranteed to address the order-of-magnitude increase in our figure-of-merit alone. Combinations of the principal techniques have substantially more statistical power, much more ability to discriminate among dark energy models, and more robustness to systematic errors than any single technique. Also, the case for multiple techniques is supported by the critical need for confirmation of results from any single method.” The Chair commented that this result might suggest—particularly in a cost-limited environment—that a mix of cheaper, less accurate experiments may surpass a single, expensive, highly accurate experiment that utilizes only one observational technique.

Dr. Kolb identified four types of next-generation (Stage-IV) projects that had been considered: a ground-based Large Survey Telescope (LST), a space-based optical/near-infrared JDEM, an X-ray JDEM CL survey and a 21-cm emission hemisphere-scale survey using BAO and/or WL with SKA. He described the profiles of each of the Stage-IV experiments and reiterated that a mix of techniques would be essential for a fully effective Stage-IV program.

DETF member Dr. Andreas Albrecht next described the modeling methodology used by the committee to compare constraints from different simulated data sets on dark energy. He identified the 8-dimensional parameter space in which the models were compared, described the Fisher-matrix technique, and reviewed a case study of a supernovae survey to demonstrate the statistical approach.

Dr. Ong asked how the modeling would be impacted if the systematic errors of the techniques were correlated. Dr. Albrecht replied that the committee had done their best to consider and include those effects but that the community would need to take the analysis to the next level. Dr. Albrecht noted that the simplifications due to the Fisher-matrix approach were not likely to reduce the usefulness of the committee's chosen figure of merit and stated his confidence that the committee's methodology allowed a fair comparison among the techniques.

Dr. Kolb stated that the DETF report would be completed before the May AAAC meeting and that the report deserves scrutiny and careful debate and consideration by the AAAC. Dr. Kolb proposed that the AAAC, in coordination with HEPAP, should appoint a group of ad hoc reviewers to consider the report and provide their feedback and recommendation. Dr. Carlstrom asked if the DETF was asking for feedback from the ad hoc group to the DETF. Dr. Kolb replied that of course the DETF would accept that feedback, particularly on issues of clarification rather than, for example, the need to include an additional nuisance parameter in their modeling. Dr. Carlstrom asked if the committee thinks that it has uniformity in its optimistic and pessimistic systematic error assumptions or if input was needed from other experts. Dr. Kolb replied, "I think we have that in hand. We have provided a snapshot of the field and a framework for fair comparison."

Dr. Freese asked which DETF members provided expertise in cluster surveys. Dr. Kolb stated that Dr. Wayne Hu and Dr. Lloyd Knox had provided the primary input for clusters from within the committee. Dr. Staffin asked if the committee anticipated providing a background piece on why particle physicists should be interested in the report. Dr. Kolb stated that the appropriate background would be provided in the expanded text of the Context section. He added that the report would discuss possible explanations for dark energy but could not point to one or two as the most promising. Dr. Albrecht added, "Any result would be a stunning result for particle physics. An iterative approach just doesn't seem to work." Dr. Kolb concluded, "We have a lot of theory. We need action."

Dr. Jon Morse cautioned the committee not to put the credibility of the report at risk by mentioning costs. Dr. Kolb noted only one cost range in the report, which Dr. Morse labeled as problematic because the upper limit was too low pending a vetting of the proposed costs. Dr. Kolb replied that the DETF did not do a cost analysis. The Chair noted that the report should provide a sense of scale for the evaluated activities, particularly for readers on Capitol Hill.

Dr. Kirshner asked why SKA was included in the evaluation since the charge letter did not identify SKA for consideration. Dr. Kolb responded that, because the committee received white papers about SKA and because the community has discussed its potential for dark energy measurements, the committee chose to include SKA in its analysis.

MEETING ADJOURNED AT 12:15 PM – RECONVENED AT 1:00 PM

The Committee identified issues for later discussion and for preparing their annual report due 15 March, including: the funding profile for ALMA and the NSF MREFC account; the identification of ad hoc reviewers for the DETF report and interagency coordination on dark energy research; and concern regarding the additional FY 2007 funding for SNAP versus the available funds to be competed among all JDEM concepts.

Dr. Richard Howard joined the Committee to provide an update on NASA programs and activities in the Universe (Astrophysics) Division. Dr. Howard first presented the status of the Universe Division's operating missions, all of which were green for October through December. He noted that the one of the charge-coupled devices (CCDs) on the Hubble Space Telescope (HST) Wide Field and Planetary Camera (WFPC2) had been showing anomalous, temperature-dependent bias behavior caused by on-orbit aging. The workaround would be to restrict temperature variations in the WFPC2 electronics bays. He also noted that the Swift Gamma-Ray Burst (GRB) Mission detected its 100th GRB on 8 January 2006. Dr. Howard followed with the status of each of the Division's developmental missions.

Dr. Howard next reviewed the major changes in the Universe Division in the FY 2007 budget Request. The Keck Outrigger telescopes would not be supported. In addition, given the cost constraints and growing out-year cost estimates of the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Division planned to reassess SOFIA before committing any future funds. The FY 2007 budget Request included no support for SOFIA. A critical review of SOFIA would be held in 2006 in partnership with the German Aerospace Center (DLR) in order to determine the best course of action. Dr. Howard noted that any reinstatement of SOFIA funding would have to be carved from other missions.

Dr. Howard reported that the Space Interferometry Mission (SIM) Launch Readiness Date (LRD) was delayed to no earlier than (NET) 2015/2016. The Terrestrial Planet Finder (TPF), Laser Interferometry Space Antenna (LISA) and Constellation-X (Con-X) missions have been delayed indefinitely but not cancelled. Dr. Howard also told the Committee that the decision to undertake HST Servicing Mission 4 (SM-4) is awaiting the second Space Shuttle Return to Flight (RTF) and that planning continues for a December 2007 (FY 2008) mission.

The Chair asked if enough money remained in the SOFIA FY 2006 budget to get to first flight. Dr. Howard said no. He added that it was unlikely for SOFIA to ever have overlap with the Spitzer Space Telescope mission. Dr. Carlstrom asked if a fallback to the Kuiper Airborne Observatory (KAO) model was an option. Dr. Howard replied that, although that option existed, the funds were still unavailable.

Dr. Howard reported that the Gamma-Ray Large Area Space Telescope (GLAST) had completed a schedule and cost re-baseline required mainly by development problems with the Large Area Telescope (LAT). The LAT was now good to go, however, and current issues were all spacecraft-related. The anticipated GLAST LRD was NET September 2007.

Dr. Howard continued to describe changes reflected in the FY 2007 budget Request: the Kepler mission confirmation baseline had been established; the Wide-Field Infrared Survey Explorer (WISE) confirmation review had been conducted; and the Herschel and Planck budgets had been adjusted to reflect schedule changes. Research and Analysis (R&A) funding had been reduced approximately 15%. In addition, the Division would conduct a re-plan of the Beyond Einstein

(BE) program, including LISA, Con-X and JDEM, to determine which one mission would be selected to proceed first.

The Chair asked if a decision had been made that JDEM will be the first Einstein Probe. Dr. Howard replied that, given the involvement of DOE, JDEM would be "the first one out of the gate" and now would compete with LISA and Con-X for limited dollars. Dr. Kirshner asked how scientific input would be provided to inform that decision. Dr. Howard replied that the next Decadal Survey was approaching. Dr. Colleen Hartman added that a comparison of the BE program and the current budget outlook would acknowledge that the Division has plenty of time to get scientific advice. She said, "That's a long-term input."

Dr. Howard presented the line-item content of the FY 2007 budget Request. Dr. Paul Hertz noted that the Explorer program would probably support an Announcement of Opportunity (AO) for a Medium-class Explorer (MIDEX) mission in FY 2008. He also noted that the BE wedge had been moved to FY 2009.

The Chair asked what would have been done in BE in the next couple of years if the budget had not been reduced. Dr. Howard responded that such a scenario would provide an accelerated path for technology development and system engineering design. He added that the best path for the available funds had not yet been determined.

The Chair asked if the budget showed a cost before launch for SIM that exceeded $1B. Dr. Howard replied that the numbers supported a 2015 launch and stretched out Phase B, especially for risk reduction. He did not have the cost through launch available but noted that the later launch would definitely increase costs. Dr. Phinney asked how much had already been spent on SIM to date. Dr. Howard estimated several hundred million dollars but could not provide an exact figure.

The Chair noted the disappearance of the wedge that had been anticipated after 2008 following both HST SM-4 and the peak spending for the James Webb Space Telescope (JWST). Dr. Howard agreed and said that $1.4B had been redirected from the Universe Division to Shuttle RTF and to support the launch dates for existing missions (JWST, Kepler, WISE and GLAST).

The Chair asked if the Europeans had yet reacted to the LISA deferral. Dr. Howard replied that he had immediate discussions with Europe; their biggest concern was that LISA would no longer be first out of the gate. He noted that the LISA pathfinder would still be supported.

Dr. Kirshner asked for the status of the Nuclear Spectroscopic Telescope Array (NuSTAR). Dr. Howard replied that the Explorer program had inadequate funding to move NuSTAR forward and that the rest of the formulation phase would not be continued. Dr. Hertz added that NuSTAR would require funds in FY 2006-7 while an AO would require funds in FY 2009. Dr. Howard continued to explain that it would be unreasonable to stretch out NuSTAR for the additional 3-4 years. The Chair emphasized that the Explorer-class missions were especially important to the university community. Dr. Hertz agreed and added some additional facts. With the exception of NuSTAR, NASA would complete all Explorers that had been fully selected. The only way to increase the Explorer program budget would be to cancel another activity when other activities had already been cut. Dr. Urry noted that the Decadal Survey provided the advice to continue to balance the scale-size of activities. Dr. Hertz said, "You're right; that's missing now."

Dr. Kirshner asked why NASA was not included with NSF, NIST and DOE as part of the national effort to emphasize the importance of science through the American Competitiveness

Initiative (ACI). Dr. Hertz replied that OMB or the Office of Science and Technology Policy (OSTP) would need to address that question. He added that the current budget Request represents a balance to meet the highest priorities for NASA to execute. He relayed that the NASA Advisory Council (NAC) was also very concerned about workforce issues, not just in astronomy but also in aeronautics and other fields. Dr. Hertz also noted that OSTP Director John Marburger had commented that NASA is a mission agency rather than a basic research agency.

Dr. Bahcall noted that the Universe Division seemed to have taken a much larger cut than the other science divisions. Dr. Hertz disagreed and stated that the Universe Division had taken the smallest hit. (N.b. Correction added by Dr. Hertz: This was incorrect. The Earth-Sun System Division had an increase, but the Solar System Division cut for FY 2007-2010 was eight times larger than the cut in the Universe Division.] He also noted that, following extensive discussion, the Universe Division would not be required to pay for the full costs of HST SM-4. He continued to explain that Astrophysics and Space Science had been growing under a flat NASA budget for half a decade while Earth Science and Aeronautics had suffered.

Dr. Bahcall asked what would be a useful mechanism to provide strategic input into the integration of the separate decadal surveys in earth science and astrophysics. Dr. Hertz said that her question was very appropriate for the Committee's discussion with Mary Cleave and added that the Space Studies Board (SSB) would be a good advisory body for that purpose.

MEETING ADJOURNED AT 3:00 PM – RECONVENED AT 3:30 PM

Mr. David Trinkle, NSF Program Examiner for OMB, presented the Administration's broad priorities for the FY 2007 budget and provided budget outlooks through 2015 under the ACI for the NIST Labs, DOE Office of Science and NSF. He noted that the ACI packages also include education initiatives and new immigration policies. In addition, he compared the FY 2006 and FY 2007 budgets for Federal research and development (R&D) and science and technology (S&T) and noted that while the NASA budget is up 7% overall in R&D, the comparative S&T budget for NASA is down 8%.

Ms. Amy Kaminski, NASA Program Examiner for OMB, continued to provide details of the FY 2007 budget Request for NASA. She first noted that the FY 2007 budget Request includes a 3.2% increase for NASA (not including the supplement for Hurricane Katrina damage). She reviewed the FY 2005-2011 budgets for NASA Space Operations, Aeronautics, Exploration Systems and Science and noted the large wedge for Exploration that begins in FY 2010. She stated that the top line for NASA Science went down in FY 2006 in response to the Congressional 1% rescission, better cost estimates for completion of the Space Shuttle program and a focus on the Crew Exploration Vehicle, all of which became constraints for the FY 2007 budget Request.

Ms. Kaminski provided the FY 2005-2011 Universe Division budget profile broken down among missions and R&A. She noted that the Division budget takes a large cut in the out-years beyond FY 2008 and stated that the cut was not a reflection of poor performance. Dr. Bahcall noted that the cut coincides with the completion of HST SM-4 and peak spending in JWST and asked why the ramp-down was not filled in with a wedge in another program. Ms. Kaminski replied that the cut was neither a permanent ramp-down nor a judgment about the Universe Division. Dr. Urry emphasized that the proposed 30% cut in R&A activities would be devastating. Ms. Kaminski replied that all divisions were taking the same R&A cut.

Dr. Joel Parriott, DOE Program Examiner for OMB, joined the Committee via teleconference. Dr. Parriott first noted that, although the total DOE budget is flat from FY 2006 to FY 2007, the

Office of Science budget increases 14%. Dr. Parriott noted that NSF should be the lead agency on LSST. Also, while JDEM is in a holding pattern, the increased FY 2007 funding for SNAP was intended to maintain the SNAP collaboration and to allow the project to develop international collaborations.

The Chair expressed his surprise at the $5M increase for SNAP in FY 2007 and reiterated that JDEM was intended to be a joint NASA-DOE venture and a competitive process. He said that the latter requires a level playing field among concepts before the call for proposals, and he asked if Dr. Parriott and Ms. Kaminski had discussed the $5M increase for SNAP during the budget process. Ms. Kaminski replied that the OMB Examiners do communicate among themselves and with OSTP. She added that, although OMB and OSTP are more than aware of fostering interagency cooperation, the reality of the budget process makes it difficult to compare budgets late in the process. Dr. Parriott continued, "Dark energy is so compelling that we wanted to do what we could to maintain momentum in the near term." He said that DOE agreed with NASA that, if JDEM went forward without SNAP, then the DOE funds would still be on the table; however, it wasn't clear that enough interest exists at DOE without SNAP.

Mr. Trinkle briefly reviewed the FY 2007 budget Request for NSF, which puts NSF up 8%, R&RA up 8%, MPS up 6%, AST up 8% and PHY up 7%. He noted that "a lot of the good news is in the out-years" and would depend on the appropriations process. He reported that ALMA and IceCube were maintaining their planned funding in the MREFC account and that the Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO) project was now first in the MREFC queue with a FY 2008 start.

Mr. Trinkle offered to preempt the question of why NASA was not included in the ACI. He said that he could not provide a definitive answer but offered the rationale that, within a constrained budget, one could ask which agencies and programs could be targeted to effect competitiveness without diffusing dollars too much or focusing on a single agency mission. The Chair noted that much of the ACI is about encouraging interest in science and technology at many levels. He proposed that HST may have met that goal more than any other science program; thus, it seemed like a disconnect to exclude NASA from the physical sciences component of the ACI. Dr. Parriott replied that for DOE there was a real distinction between those programs in which the people in the lab are participating in basic energy sciences and those programs with application to technology.

Dr. Olinto expressed concern about the out-year funding for NASA and, in particular, about a potential lack of X-ray astronomy between 2010 and 2020. She explained, "We're now losing things we used to know because we're losing the workforce capable of passing on that information." Ms. Kaminski replied that the BE wedge was not yet defined. She continued to explain that OMB continuously struggles with the issue of prioritization. She stated, "The Decadal Survey beats me over the head at night, but it has its limitations in terms of its utility during the budget process." Because small, medium and large missions are not intercompared, she said, the recommendations "don't help when you're trying to put it all together." She stated that she needs input with prioritization now before the next Decadal Survey is ready or even started.

Dr. Kirshner asked if the current NASA advisory process was the right one. He noted that some forums for advice have been discontinued and some have been restarted. Ms. Kaminski replied that she did not yet know enough about science in the NAC to comment. She added that community advice is very helpful in working across parameters in performance and prioritization. Dr. Bahcall asked what the Examiners would recommend for the Decadal Survey process. Ms.

Kaminski replied that they had given a full presentation to the CAA, and she outlined major points from that discussion. Mr. Brian Dewhurst offered to distribute the presentation to the Committee and noted that the presentation was available on the CAA website[2]. Dr. Olinto noted the decrease in R&A at NASA and emphasized that the Decadal Survey keeps R&A untouchable.

The Chair asked for the Examiners' thoughts for the AAAC annual report. Ms. Kaminski answered, "Prioritization and cross-comparison." She asked the Committee to order the Decadal Survey missions, particularly because cost growth in many of the missions and other tensions in the overall NASA budget have made prioritization difficult. She said, "Knowing which mission should go first would help."

Dr. Freedman noted that SIM and ALMA were not prioritized within this Decadal Survey but that the list of missions was ranked. She added that JWST had been particularly difficult as a result of a push from the previous NASA Administrator for a larger mission along with a cost cap, and she noted that budgets are not often well understood at the time of prioritization. Ms. Kaminski agreed that budgets are clearly difficult to estimate but that OMB needs greater understanding of the budgets as presented. Ms. Kaminski noted that JWST was now fully funded for launch in 2013 and asked if the project should be descoped, delayed or stopped if more funding was required.

The Chair asked the Examiners if they had any thoughts for the "lessons learned" activity that would be discussed the next day. Ms. Kaminski said that OMB had seen the prepared comments from OSTP and that the comments were consistent with their thoughts. She said that she heavily endorses looking at the projects' aspects of international cooperation. She advised the Committee to ask what premium or priority should be placed on a project that has an international component and how that would impact other projects. The OMB Examiners left the meeting.

The Committee discussed the preparation of their annual report.

The Chair announced that the meeting would reconvene at 8:15 am the next day to accommodate the addition of Mary Cleave to the morning agenda.

MEETING ADJOURNED AT 6:00 PM, 13 FEBRUARY 2006

MEETING RECONVENED AT 8:15 AM EST, 14 FEBRUARY 2006

The Chair reviewed the day's agenda as published. The Committee then discussed topics to raise during their conversation with Mary Cleave. They identified areas of concern such as the FY2006 and 2007 budgets and long-term projections, the NASA advisory committee structure and the role of community input and involvement in decision-making, the process that NASA had followed for making significant programmatic changes, such as that for SOFIA, and the question of programmatic balance, in particular that between support for research and analysis grants, small programs such as Explorers, and large missions.

Dr. Mary Cleave, NASA Associate Administrator for Science, and Dr. Colleen Hartman, NASA Deputy Associate Administrator for Science, joined the Committee. Dr. Cleave noted that she had no additional comments on the budget beyond the presentations that had been made yesterday. In response to questions from the Committee, she explained that the astrophysics community was not alone in being concerned about the budget and that NASA had attempted to deal equitably

[2] http://www7.nationalacademies.org/bpa/CAA_Presentation_Kaminski_Looney.pdf

with all communities in its need to make programmatic decisions that met the requirements of establishing "executable programs" and that could achieve the goals for Exploration in the Administration's Vision. She noted that the Universe program had not been an executable program before the FY 2006 budget allocations. The SOFIA program had exceeded all authorized ceilings that necessitated review. When asked what defined an "executable program," she replied that it was a program that could be done within available resources.

She pointed out to the Committee that the Universe Division had been fortunate in that the Space Shuttle launch was not being charged to the program and that other programs had had to absorb even larger costs. She emphasized the need to follow the advisory path from the Decadal Survey to the agencies that interacted directly with OMB and OSTP in establishing budgets. NASA relies on advisory committees to give tactical advice in realizing the recommendations and priorities of the community, but she emphasized that during the process of developing the federal budget, discussions are privileged and information strictly embargoed. During this time, advice from the community to the internal budget process should come through the NASA program scientists. Unfortunately, in this past year, the advisory committees were not in place early enough to have the normal cycle of budget discussions based on the previous year's budget.

Dr. Cleave reviewed the current NASA advisory committee structure. She pointed out that the astrophysics community was very well represented on the NAC and that there would be subcommittees for each Science Division, Astrophysics being one of four. She explained in detail how reports from the community would come to the NAC through the subcommittees, and NASA's plan for concurrent meetings of the subcommittees at the same location were intended to provide opportunity for increased interaction and cross-talk. Subcommittee meetings would be held about 45 days before NAC meetings, and the agency was eager to establish the subcommittees and have them meet before the next NAC meeting scheduled for May. In response to questions from the Committee, she reiterated that NASA saw communication in both directions—from and to the community—as being important, and wanted coordinated, and not conflicting, advice from community groups. The Chair asked Dr. Cleave whether the subcommittees' reports that were sent up through the NAC science committee would be made available in their entirety to her and to SMD or whether the reports would be modified. Dr. Cleave responded that she expected that the reports would be made available in full.

When asked why NASA was not part of the ACI, Dr. Cleave responded that she did not know and had not been part of that aspect of budget development. The Committee expressed frustration with the inability to provide input to the budget process at critical times. Dr. Hartman noted that the 5-year budget may well change and that a cohesive community with well thought-out priorities would be in a strong position to benefit. In response to questions from the Committee about the direction of future budgets, Dr. Cleave stated that Congress's view of the FY 2006 budget was the best indication of the future. Dr. Cleave left the meeting.

Dr. Robert Dimeo, Acting Assistant Director for Physical Sciences and Engineering in OSTP, joined the Committee by telephone. He made several comments on the FY 2007 budget and referred the Committee to the presentations that had been made by OMB representatives at yesterday's meeting. He provided some background on the ACI and noted that the Initiative was aimed at encouraging innovation and competitiveness. He also noted that the substantial budget increases had been directed toward agencies that focus on basic research and can implement the targeted initiatives and that are linked more closely to economic competitiveness. He reviewed some of the budget numbers that had been presented yesterday but noted that, while specific agencies had been selected for the ACI investment, specific programs were not. In response to questions, Dr. Dimeo suggested to the Committee that the community's concern and reaction to

the NASA budget changes should be considered in a broader context of Administration priorities and the R&D budget, where NASA was already a priority and had seen significant growth. He encouraged the community to continue to support the Decadal Survey process and to maintain a coherent and unified approach.

Dr. Dimeo then turned to discussion of the proposed "lessons learned" activity the Committee had discussed with the agencies. He noted that OSTP works closely with OMB and the agencies to lead interagency efforts where coordination has become more important. An assessment of the previous agency collaborative activities, such as GLAST, would be useful in providing future guidance to OSTP, OMB, Congress and the agencies themselves. The outcome of this assessment should provide recommendations that would allow the agencies to plan strategically, to emphasize their own missions and identities, and to maintain commitments without compromising other agency-specific programs. A compilation of best practices and an exploration of common policies and practices across agencies could result in a streamlined process for establishing and maintaining collaborations.

He suggested this activity should be coordinated under the auspices of the National Science and Technology Council (NSTC), which OSTP would facilitate. He proposed that a group of agency officials from NSF, NASA and DOE should form to begin discussions. Agency representatives expressed support for such an activity. Dr. Van Citters, speaking for the NSF Astronomy and Physics Divisions, supported it strongly but noted he could not speak for the agency as a whole. Other divisions and offices within NSF would be affected, and NSF's participation would need to be coordinated out of the Office of the Director and formalized with them. Dr. Hertz noted that NASA is already involved in many interagency activities that went beyond the NSF- and DOE-related activities discussed thus far, and it would be important to have this OSTP-facilitated effort be consistent with the working relationships NASA had established with other federal agencies, such as the National Oceanic and Atmospheric Administration (NOAA). The NASA authority to enter into such activities resided with Dr. Cleave's office.

Dr. Dimeo expressed satisfaction with the response from the agencies and noted that Dr. Jon Morse of OSTP would be working with him to establish an interagency working group. The Chair asked if international collaborations would be considered, and Dr. Dimeo noted that there are already working groups dealing with international issues. He invited the Committee to send him their thoughts on this issue. Dr. Dimeo left the meeting.

Dr. Van Citters reviewed the draft letter from NSF and DOE requesting that the AAAC and HEPAP form a subpanel to provide advice on priorities and strategies for the direct detection and study of dark matter. This Dark Matter Science Assessment Group (DMSAG) is modeled on the DETF and is asked to report on an interagency strategy on a dark matter research program no later than 1 September 2006. He reviewed the charge to the DMSAG given in the letter and noted that the group would focus on the direct detection of dark matter with next-generation experiments, both in the context of international efforts and plans and with its connections to astrophysics and particle physics. Dr. Ong noted that he had reviewed an earlier draft and was happy with this charge, which is broader than originally proposed. He expressed concern over the timeline, which seemed very rapid and not sufficient given the breadth of the charge. He did not see the reason to act so quickly. He suggested that an interim report could be provided in time to give input to the FY 2008 budget cycle and that the group could then continue with the roadmapping in a two-phase approach. Dr. Eric Smith of NASA Headquarters noted that the September 2006 timeframe is too late to affect the FY2008 NASA budget; Dr. Staffin noted that the budget might still be affected through the passback and that DOE would still find the report helpful on this timescale. This report would primarily advise the NSF Physics Division (PHY),

and Dr. Van Citters noted that PHY Division Director Dr. Joe Dehmer would need to comment from his perspective. The Chair invited the Committee members to submit suggestions for membership to Dr. Lehr and himself; these would be shared with the agencies.

MEETING ADJOURNED AT 10:15 AM – RECONVENED AT 10:45 AM

Dr. Meg Urry, CAA Co-Chair, discussed with the Committee plans for the next Astronomy and Astrophysics Decadal Survey. Dr. Blandford, CAA Co-Chair, joined the Committee by phone for the discussion.

Dr. Urry noted that the astronomy and astrophysics process is considered the "gold standard" for its breadth, its emphasis on prioritization, and its involvement of the community. However, there is a growing mismatch between the assumptions made when the recommendations are formulated and the reality under which they may be achieved. The CAA has discussed how to modify the process, both in the short-term implementation of the current survey and with the long-term question of how to carry out the next survey. The community also needs a flexible process that can take into account unforeseen circumstances, such as cost increases in projects or a changing scientific landscape. She invited the AAAC to express their views on these issues.

Dr. Freedman suggested that the chair of the next committee should be in a position to champion the survey and must be prepared to do so. If co-chairs are used again, it will be important to understand the division of labor. The challenge of the next survey will be the inheritance of the largely unfinished recommendations of the previous one. The Committee discussed the merits of the alternatives of starting from zero or beginning with the full array of current recommendations in their present state. Committee members raised issues such as the importance of the weighting given to technical readiness and risk as connected to the budget and likely cost growth. How should priorities be viewed—or altered—in the light of later cost increases?

The Committee discussed the need to provide an assessment of the survey recommendations on a timescale intermediate to decades. Dr. Bahcall suggested that there should be a standing "executive committee" that would serve through the decade and address changes and adjustments as necessary. It was noted that the CAA was intended to serve in this role but that perhaps it needed broader representation from the community.

The structure of the decadal report was discussed. Dr. Urry noted that the CAA was receiving a great deal of advice in this area, with the primary suggestion to use science-based panels, not the wavelength-dependent or technique-based panel structure used previously. Beginning with science would focus the development of priorities, and then the required techniques and facilities to achieve these science goals would be integrated across panels. This hybrid approach would provide an effective framework for the definition and articulation of scientific priorities while providing the technical expertise and perspective that result in specific project and mission recommendations. This focus would also remove the rigid divisions by agency and category of funding level. A systems approach that looked at the relatedness of projects would be more helpful.

The Committee discussed the survey committee membership and considered changes from the previous constitution, which had been limited to scientists. Suggestions were made to enlarge the committee to include industrialists, project managers and those outside astronomy and astrophysics. Comparison was made to the EPP2010 activity being carried out in high energy physics, and Committee members familiar with that field noted that there were significant differences in the culture of the communities and the goals of the report. There was some

discussion about whether the chair should be someone outside the field, but the consensus among the AAAC members was that the chair should remain a scientist of stature in astronomy and astrophysics. A broader involvement of the non-scientific community and validation of the report and its recommendations in the broader social context could be accomplished through membership on committees, but not through the chair.

Dr. Urry noted that the CAA has heard comments that much of the community feels disenfranchised in the decadal survey process and in the resulting final recommendations. A number of AAAC members agreed. Some Committee members suggested this might be dealt with by ensuring that representatives of small institutions were on the survey committees. Dr. Van Citters and others pointed out that the issue was much deeper than this and that the feeling of disenfranchisement was much broader. The recommendations of the decadal survey, with its focus on large projects, facilities and missions, have not considered fully the implications this shift to a different kind and scale of science would have for the field as a whole. The community is broader than those working on the projects highlighted in NRC reports and recommendations. Those scientists provide an essential, underlying intellectual infrastructure and must have the ability and resources to continue to explore and sustain "discovery astronomy." The community leaders, and those who put together the decadal survey, must be sensitive to the needs of the entire scientific community. The community must look at the totality of its science program and cannot assume what has always been there will remain unless it is attended to and provided resources. The field needs a sustainable program that the federal agencies, as the stewards of astronomy, can realize.

The Committee discussed the timescale for carrying out the next survey. Starting now would mean largely redoing the present survey, but it was recognized that it was important to begin communicating with the community, perhaps with precursor activities to survey capabilities and the status of development, to build consensus and begin to explore new initiatives that need technical development. Several members expressed the need to begin the process as soon as possible, even if the actual survey was kept to the decadal cycle.

Dr. Blandford raised the issue of the role of international partnerships in the decadal survey activity and what mechanisms existed for phasing international development with U.S. plans. The relative priorities of the international communities should inform the U.S. recommendations. Dr. Van Citters noted that there are many possibilities for interaction with the international communities and that several were underway. For example, a recent meeting convened by the Organization for Economic Cooperation and Development (OECD) to look at planning for next-generation large telescopes generated many suggestions for coordination. Dr. Van Citters has established a group of funding agency representatives with interest in both Extremely Large Telescopes (ELTs) and SKA that has met regularly to exchange information on national activities and to facilitate coordination among national groups. He noted that discussion among agency representatives at these meetings goes beyond the large projects that require collaboration and that agencies find common issues of sustaining the underlying scientific infrastructure.

The Committee turned to discussion of their annual report. The Chair reminded the Committee of the report's audience, which goes beyond the agencies to OMB, OSTP and Congress. The Committee discussed the structure of the report and focused on the definition and development of the main issues they wished to raise. The Chair would produce a draft outline and circulate this to the Committee for writing. Committee members would exchange report drafts by email, and a teleconference would be scheduled for shortly before the report was due to finalize the presentation and wording before submission to the agencies. The Committee would be polled before establishing an exact date and time for the teleconference.

MEETING ADJOURNED AT 2:30 PM, 14 FEBRUARY 2006