# Minutes of the Meeting of the Astronomy and Astrophysics Advisory Committee

## 10–11 May 2007
## National Science Foundation, Arlington, VA

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| **Members attending:** | Garth Illingworth (Chair) | Daniel Lester |
| | John Carlstrom (Vice-Chair) | Rene Ong |
| | Neta Bahcall | E. Sterl Phinney |
| | Scott Dodelson | Marcia Rieke |
| | Wendy Freedman | Keivan Stassun |
| | Katherine Freese | Alycia Weinberger |
| **Agency personnel:** | Arden Bement, NSF | Michael Salamon, NASA-HQ |
| | G. Wayne Van Citters, NSF-AST | F. Rick Harnden, NASA-HQ |
| | Eileen Friel, NSF-AST | Rick Howard, NASA-HQ |
| | Dana Lehr, NSF-AST | Eric Smith, NASA-HQ |
| | Nigel Sharp, NSF-AST | Ray Taylor, NASA-HQ |
| | Tom Barnes, NSF-AST | Zlatan Tsvetanov, NASA-HQ |
| | Wei Zheng, NSF-AST | Wilton Sanders, NASA-HQ |
| | Philip Puxley, NSF-AST | Stephen Ridgway, NASA-HQ |
| | Craig Foltz, NSF-AST | Robin Staffin, DOE-HEP |
| | Elizabeth Pentecost, NSF-AST | Kathleen Turner, DOE-HEP |
| | Alan Stern, NASA-HQ | Randy Johnson, DOE |
| | Jon Morse, NASA-HQ | |
| **Invited participants:** | Eric Becklin, UCLA | Chuck Bennett, Johns Hopkins U. |
| | Hank Sobel, UC-Irvine | Megan Urry, Yale U. |
| | Jonathan Lunine, U. Arizona | Kate Beers, OSTP |
| **Other participants:** | Brian Dewhurst, NRC-BPA | Nick White, NASA-GSFC |
| | Dennis Socker, NRL | Ethan Schrier, AUI |
| | Michael Ledford, Lewis-Burke Assoc. | Antonella Nota, STScI/ESA |
| | Jay Frogel, AURA | Henry Ferguson, STScI |

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**MEETING CONVENED AT 8:30 AM EST, 10 MAY 2007**

The Chair called the meeting to order. Alan Stern, NASA Associate Administrator for Science, joined the meeting via teleconference. Stern began the discussion with a few brief comments. He stated that NASA is really working hard to make some substantial changes in the Science Mission Directorate (SMD), both in the pace of flight missions and in improving research and analysis (R&A) and data analysis programs. He noted that addressing these areas must be done by "doing more with the budget that we have" since the SMD budget projections increase only with inflation. Stern added that SMD already has recommendations from the Divisions that would allow improvements in both flights and R&A. Stern also identified the importance of controlling costs. He recognized that several missions have had substantive cost increases, which come directly out of the ability to fly more missions and to do R&A. Stern identified controlling costs to be of greater importance than increasing the budget and stated that NASA "must better control the missions that we start."

The Chair asked Stern for an overview of recent personnel changes at NASA Headquarters. Stern reported that he had created the Office of the Chief Scientist (filled by John Mather), a position intended to provide peer and science advice for the four scientific Divisions and to provide balance across the Divisions. Mather also has two deputies, one for Earth Science (Randy Friedl, coming in August) and one for Space Science (Andy Cheng). Stern also created a new position in front office, the Senior Advisor for R&A (SARA), which was filled by Yvonne Pendleton.

Dan Lester asked if Stern could speak to the issue of cost realism. Stern replied that we have to do two things: (1) control costs once we start something and (2) decide what to start by knowing how much they'll cost (within 70% confidence and with 30% contingency). He added that cost estimates are an "engineering art" and that NASA is prepared to help the decadal surveys develop and utilize accurate cost estimates.

The Chair asked Stern how he sees exercising greater cost control. Stern replied, "It's the kind of thing that you have to work on every day in every way." He explained that cost control issues split into two categories: (1) principle-investigator-led (PI-led) missions and (2) strategic missions that are not PI-led. For PI-led missions Stern suggested two mechanisms for cost control. First, if a mission is coming back again for cost increases, Stern is prepared to change the PI. Said Stern, "The PI must lead to cost and schedule, not just scientifically." Second, Stern stated that he wants to reduce the level of oversight, which adds cost, in the lower rungs of the ladder. For strategic missions Stern noted a different set of problems. He described a "vicious cycle" in which "we add personnel to reduce risk, then the risk increases because the cost increases, and so we add more people to reduce risk." Stern stated, "There will be some significant examples of us turning this around. I'm not going to hesitate to change out prominent personnel if needed."

Keivan Stassun asked Stern to estimate the timescale over which cost increases on existing missions have mortgaged the future. Stern replied that he has undertaken steps to address this issue. He has taken some money out of discretionary funds to soften the blow of cuts made to the astrobiology center. He reiterated that he is also trying to make scientists more efficient by "getting out of your hair." He continued, "I've been on the receiving end of that burden; with too much oversight we get less, not more, out of the budget that we have." He said, "we are trying to make substantive changes"—e.g. informing PIs of grant status within weeks of a panel meeting, unless their proposal falls in the "gray zone," and trying to simplify reporting by combining PI activities across programs into one grant with one reporting requirement.

Sterl Phinney asked Stern if he sees some hope of providing funding for technology development before missions are approved. Stern replied that he could provide ideas but no firm plans. He noted that the technology program for the James Webb Space Telescope (JWST) was embedded in the project and said, "I'm becoming enamored of missions doing their own technology development within the mission. We're trying to bring it closer to home so we develop what the missions need but don't develop technologies that we don't need." The Chair noted that it would be very interesting to use JWST for lessons learned.

Rene Ong asked about a possible new wedge in FY09 to support a Beyond Einstein (BE) mission. Stern replied, "We really want to see BE get under way and stop receding into the future." He added that he could not be more specific because the FY09 budget was embargoed.

The Chair asked about costs and specifically, "if there were ways that we could do things more cheaply." He said, "We never seem to be successful in finding a way to make missions cheaper.

Is there a way for us to explore that more deeply?" Stern identified the question as important and replied, "Certainly it is our ambition to get our arms around that." He identified the Astrophysics program as "currently top heavy" and noted that a draft announcement of opportunity (AO) was expected soon for Small Explorers (SMEX). Stern anticipated the ability to do three SMEX missions and to remove some oversight responsibly to control costs. He continued, "It's a harder problem than that for large missions," and added that, after only six weeks on the job, he did not yet have an answer to the question. Stern also identified Astrophysics Division Director Jon Morse as "a brother in arms in this with you."

The Chair asked if Stern had any comments on launch vehicles. Stern replied, "We need them, and they're too expensive." He stated that the Delta II is going away and that, while we still have Pegasus and Taurus, there's still a gap between that and the Evolved Expendable Launch Vehicles (EELVs). He said, "We're looking at alternatives for certification in the domestic market," and added that the problem affects not only SMD but also the whole agency.

The Chair asked if SMD had an operations plan yet for FY07. Stern said no.

The Chair asked about SMEX. Stern replied, "PIs had better read the AO. They are not just the chief scientist on the project; they are in charge of all aspects of the project, and they will be held accountable. I will remove PIs who are not accountable for the entire project." He continued, "We also want to provide the onramps for people to provide the experience and learn the skills," and added, "We want to raise the suborbital flight rate by a good amount of an order of magnitude."

John Carlstrom commented, "You mention that you want to lower costs and to reduce hassle for the PIs and scientists. I worry that less oversight may lead to cost overruns." Stern responded, "This is the art in it. The trick is for us to stay out of people's hair, especially for smaller missions. Right now we're approving every resistor, every capacitor, every chip. We want to reduce that paperwork. We acknowledge that missions are expensive, but we don't need to approve every box on these smaller missions." Marcia Rieke suggested allowing designation of a deputy PI on the mission in order to acknowledge his or her role in project management and to develop the necessary skills. Stern agreed that it was an excellent suggestion for the AO that he would provide to Paul Hertz for consideration. Stern added, "We want to bring people into the art of space flight so we can get better results."

Stern noted that Yvonne Pendleton had set up an email address for input into the R&A program and asked that meeting attendees help advertise it: sara@nasa.gov. He added that problems, compliments and issues were all very welcomed. He noted that the mailbox was receiving about 20 emails a day since rollout and concluded, "We plan to be more responsive."

The Chair thanked Stern for joining the discussion and making changes in SMD and added, "We understand the constraints under which you're operating." Stern thanked the Chair and Committee members for their efforts and their "rich and detailed" annual reports. Stern signed off from the teleconference.

The Chair continued with introductions around the room. NSF Division of Astronomical Sciences (AST) Director Wayne Van Citters thanked NASA for their contribution to this meeting of travel support for AAAC members. He described a positive budget outlook for NSF and the need for both vigilance and input to keep NSF on its budget-doubling trajectory. Van Citters also reported that the agencies were starting discussions with the National Research Council (NRC) regarding the next decadal survey and noted that the agencies welcomed input.

The Chair reviewed the meeting agenda. He noted "a general feeling that NASA has major budget challenges" and reported that interest was developing in Congress for a bipartisan "space summit" to review the situation.

The Chair stated that, because the February 2007 meeting minutes provided by the NASA contractor would require substantive edits, the Committee would approve the minutes via email after comments and edits were collated by Executive Secretary Dana Lehr.

The Chair reviewed his recent Congressional testimony for the House Committee on Science and Technology Subcommittee on Space and Aeronautics. He noted interest in Congress for including NASA in the American Competitiveness Initiative (ACI) but added that interest was not yet mirrored in the Administration. The Chair identified the need to reconcile NASA's budget with the agency's mandate—the agency was "asked to do too much with too little." The Chair reported that the second major issue discussed during the hearing was cost growth. He said, "We need to do better, where 'we' includes the community and NASA together," and added, "We have to be absolutely serious about this." Scott Dodelson asked if the attention to cost growth was new or if "this was something that we also heard ten years ago." The Chair replied that, while there was some concern previously, "I don't think there was a willingness within the agency to provide realistic [cost] estimates." Wendy Freedman noted that the suggestion from NASA that they would bring their technology people into the decadal survey process to provide realistic cost estimates was "new and very welcome."

Van Citters next reviewed the FY07 NSF budget request and current plan as approved by Congress. He noted that the FY07 AST budget was up 7.7% ($15.5 million) over FY06, and he itemized increases in the FY07 plan. He also noted that the Major Research Equipment and Facilities Construction (MREFC) account was appropriated at the FY06 continuing resolution (CR) levels but that a $16 million increase for the Atacama Large Millimeter Array (ALMA) was accommodated by NSF in FY07 by reducing funding for new MREFC starts that were not expected to ramp up quickly enough for their budget line. Van Citters also reported that success rates in the Astronomy and Astrophysics Research Grants (AAG) program were likely to be around 20% because of a ~10% increase in proposal pressure. Increases were seen across all divisions within the Directorate for Mathematical and Physical Sciences (MPS).

Van Citters reviewed the FY08 MPS focus areas. He noted a clear emphasis in the FY08 budget request on the Divisions of Chemistry (CHE) and Materials Research (DMR) in response to ACI, although all divisional budgets within MPS were increased significantly. He reviewed the MREFC budget request for FY08 and showed the 10-year historical trend in MPS budgets. He also showed evolution in AAG program statistics for FY1995–2007, including program budget, average award size, number of proposals and success rate.

Van Citters discussed FY09 budget planning. He itemized topics relevant to AST, including ACI priority areas, cyber-related activities and transformational research.

Freedman noted that an AAG success rate less than 20% would be alarming. Van Citters replied, "We already see 20% as alarming," and added, "We consider the program our highest priority. The only answer is to put more money into the program. Our projected budget growth provides good prospects if we can continue to participate in that growth." The Committee continued with extensive discussion about both the "market forces" that influence proposal pressure and the response from the community to low success rates.

Van Citters identified a list of questions and needs that must be addressed by the community and the agencies in planning the next decadal survey. Carlstrom asked how the astronomy community could make their survey "stand out from the crowd," as suggested by Van Citters. Van Citters responded that the Senior Review had provided the context to do that, but that one must also ask the question about the survey's structure and content. The Committee continued with extensive discussion on the decadal survey process. Van Citters provided email addresses for community input regarding the implementation of Senior Review recommendations (astsenior-review@nsf.gov) and decadal survey planning (astro2010@nas.edu).

Phinney noted considerable concern from the planetary science community regarding the Senior Review recommendations for the National Astronomy and Ionosphere Center (NAIC) and recalled a previous discussion of potential cost sharing with NASA. Van Citters stated that AST had explored the issue with NASA at the program level but not yet with Stern.

Freedman asked Van Citters to review the major decadal survey projects and their anticipated progress during this decade. Van Citters reported that the ALMA rebaselining activity was completed with NSF support for the rebaselined cost and schedule. The Advance Technology Solar Telescope (ATST) was still in the Readiness phase and pursuing a site with the National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) processes still underway. Van Citters stated that he planned to continue with restructuring support for a national Giant Segmented Mirror Telescope (GSMT) program through the National Optical Astronomy Observatory (NOAO) and that he did not anticipate any downselect or major funding action in this decade. He added that the community must first frame a preferred process for a national GSMT program before thinking about a downselect or approaching the Office of Science and Technology Policy (OSTP) or the Office of Management and Budget (OMB). Van Citters reported that the Large Synoptic Survey Telescope (LSST) proposal was under review and that NSF was discussing considerations for LSST with DOE. The Chair asked about the typical timescale for that scale of review. Van Citters responded that the full MREFC review process could take several years. Said Van Citters, "The earliest I can see getting money out of the MREFC account for LSST construction is 2012. Backing up from that, 2010 is the earliest that we anticipate LSST could move into Readiness."

The Committee continued with discussion of how ongoing projects should be considered in the upcoming decadal survey.

**MEETING ADJOURNED AT 11:00 AM – RECONVENED AT 11:20 AM**

NASA Astrophysics Division Director Jon Morse began his overview of NASA Astrophysics programs with news items, including the recent press release of brightest supernova ever seen and the occurrence of the Stratospheric Observatory for Infrared Astronomy (SOFIA) first flight on 26 April 2007.

Morse presented a draft SMD organizational chart and noted substantive personnel changes intended to give attention to science advice and to the R&A program. He next identified three SMD guiding principles: to advance the priorities of all four decadal surveys; to get more from budgets through better management and investments in R&A; and to help the Vision for Space Exploration succeed (e.g. by fostering a lunar science community). The Chair asked if the last guiding principle ensures that we're doing the best science rather than "doing science on the moon because we're going to the moon." Morse replied, "I think that's compatible with our intent. This will be community-driven, set by our established science priorities."

Morse identified improvements to the R&A program, including strategic improvements across SMD to R&A and data analysis as well as outreach activities to centers, universities and affiliates and to the community through science conferences, newsletters, websites and email contact at sara@nasa.gov.

Morse identified new SMD strategic investments in R&A, data analysis and suborbital opportunities. He reported that the next Small Explorer (SMEX) AO was announced on April 24; targets for the draft and final AO were June and October 2007, respectively, with proposals due 90 days after the AO release. Morse expected a mission cost cap of $105 million (in FY08 dollars), excluding the launch vehicle. He also anticipated a Mission of Opportunity (MO) allocation of $70 million (also in FY08 dollars), possibly in addition to three SMEX flights or instead of a third flight. Selections could be expected within four months of the proposal deadline date for approximately 6-8 Phase A studies leading to up to three flights. Morse stated that the community should note the new experience standards required for the mission PI.

Morse described the SMD Science Plan, which fulfills a Congressional requirement from the NASA Authorization Act of 2005. The Science Plan is SMD's implementation plan, per the new NASA Strategic Management and Governance Handbook under the 2006 NASA Strategic Plan. The plan articulates science questions to be pursued in the context of national priorities, especially the Vision for Space Exploration; defines and prioritizes missions; and describes the associated R&A, technology and related programs. The plan is available online at http://science.hq.nasa.gov/strategy/.

Morse presented an overview of NASA Science mission launches for calendar year (CY) 2006–2014 and noted a dip in the launch rate post-2010. The next scheduled Astrophysics launch after the Wide-field Infrared Survey Explorer (WISE) in 2009 was JWST in 2013. New SMEX launches were anticipated for 2012-2013-2014, although a MO might go sooner.

Morse showed the FY08 NASA budget request and the budget run-out through FY12. He noted that Astrophysics funding dips from FY08 to FY09, remains flat until FY11, then rises with the NASA total budget after FY11. He also noted changes in the FY08 budget request relative to the FY07 request.

Morse presented the status of all Astrophysics missions and noted that he wants to "change the discussion" to focus on development times and new starts rather than slips of launch dates for missions that don't exist. He said, "I know that launch date matters for when we get the data, but for planning it's about when we start things."

Morse followed with a detailed line-item budget chart and delta chart. He noted that funding decreases in the Space Interferometry Mission (SIM) came as a result of reinstating SOFIA. He noted particular budget problems and issues in the Astrophysics Division, including potential additional cost growth in Kepler, the direction of the Balloon Program, adjustments in balance in the Navigator Program, and the strategy for the Astrophysics Future Missions budget line. For the latter, a competed line (e.g. a Probes line) was under consideration. He provided a detailed overview of Astrophysics R&A programs, including budgets, number of proposals received and success rates.

Henry Ferguson asked if the Long Term Space Astrophysics (LTSA) program was gone for good. Morse said that he wasn't sure. He added, "I'd like to make sure that we consolidate the funding opportunities so PIs don't need to write too many proposals." He noted the importance of increasing award duration and award amount to decrease the overhead of writing proposals and

stated that he wanted to create a system in which awards were managed through a single grant per PI to reduce the reporting burden.

The Chair commented that it might be useful to integrate award data among NSF and NASA programs to think in common terms among the agencies. He suggested that the American Astronomical Society (AAS) could assist in assembling and reporting of the "big picture." Stassun added that it would be interesting to synthesize what is driving the changes in proposal pressure and success rate. Carlstrom noted that the NSF Faculty Early Career Development (CAREER) Program was comparable to LTSA and that it would be beneficial to return that parallel construct for early-career investigators.

The Chair inquired about the status of the joint NSF-NASA National Virtual Observatory (NVO) solicitation. NSF Program Director Nigel Sharp responded that the agencies were working on it but that "it needs more attention from the folks who need to sign off."

**MEETING ADJOURNED AT 12:20 PM – RECONVENED AT 1:00 PM**

DOE Office of High Energy Physics (HEP) Associate Director Robin Staffin identified the advisory committees and recent studies that have provided advice to DOE HEP. He specified the charge from HEP and NSF to the NRC Committee on Elementary Particle Physics in the 21st Century (EPP 2010): to identify, articulate and prioritize the scientific questions and opportunities that define elementary particle physics; and to recommend a 15-year implementation plan with realistic, ordered priorities to realize these opportunities. The review came back with very clear priorities: (1) to fully exploit opportunities afforded by the Large Hadron Collider (LHC), (2) do what is necessary to mount a compelling bid for the International Linear Collider (ILC) on U.S. soil, (3) expand particle astrophysics and unification, (4) neutrinos and proton decay through an internationally coordinated, staged program, and (5) precision measurements (e.g., future B factory, lepton flavor violation and rare decays).

Staffin showed the HEP budget top line ($782.2 million in the FY08 request, which is up 4% over the FY07 actual) and identified major items and changes in FY08 budget request. He reported that several new HEP construction projects would be ramping up: the NUMI Off-Axis Neutrino Appearance Experiment (NOvA), the Main Injector Experiment for ν-A (MINERνA) neutrino cross-section experiment, the Daya Bay neutrino experiment with China, and a potential Dark Energy Survey (DES) with NSF. He also noted that the Tevatron, B-Factory and NUMI are going full steam while power and consumables costs are increasing.

Staffin stated that the LHC was scheduled to start up in 2008 and noted that approximately half of the U.S. experimental HEP community is working on building detectors for the LHC. He also noted that direct Tevatron searches were gaining on the Standard Model (SM) Higgs particle: individual experiments ruled out a signal at 5-10 times the expected cross section with one inverse femtobarn of luminosity.

Staffin reported that the ILC schedule was under considerable discussion, with technical milestones only a piece of the issue. At the February 2007 High Energy Physics Advisory Panel (HEPAP) meeting, while restating the priority to achieve the ILC based on its scientific promise, DOE Undersecretary for Science Ray Orbach stated that, based on experience, the time to reach international agreements (e.g. on site, shares and organization) plus the time for R&D and construction would stretch out the timeline to mid-2020.

Staffin reported that the Booster Neutrino Experiment (MiniBooNE) had ruled out the possibility of a fourth neutrino.

Staffin reviewed planning and investments for dark-energy science. He reported that the NRC Beyond Einstein Program Assessment Committee (BEPAC) was currently selecting the first-priority Beyond Einstein mission and that DOE and NASA would propose to proceed with the Joint Dark Energy Mission (JDEM) if the project were selected. He also reported that dark-energy R&D proposals were undergoing review at the end of May.

Staffin reported that the Very Energetic Radiation Imaging Telescope Array System (VERITAS) experiment was taking data at the Whipple Base Camp and that the Gamma-ray Large Area Space Telescope (GLAST) launch was scheduled for December 2007.

Staffin compared the HEP Particle Physics Project Prioritization Panel (P5) Roadmap against the FY08 budget request to demonstrate implementation of the panel recommendations.

Wayne Van Citters next reviewed the background and motivation for the AST Senior Review process. He compared the total cost of decadal survey initiatives against the projected AST budget and stated that the Senior Review was made imperative by the budget outlook, the ambitions of the community and the recent budget growth for AST. He identified the boundary conditions and goals for the review and reviewed the committee's activities and recommendations.

Van Citters noted that NSF identified Finding 1 to be the most important conclusion of the Senior Review report: "Proper maintenance of current facilities while simultaneously developing and beginning operation of the proposed new facilities is infeasible under any reasonable expectations for federal budget support based on past funding levels. The cuts that are proposed to the existing program are as deep as possible without causing irreparable damage and will only allow a start to be made on new initiatives."

Van Citters described steps taken towards a national GSMT program. He said that the first part of that was the need to assure a healthy scientific enterprise going into the GSMT era; one must define a "system" with an appropriate range of aperture and access, with necessary instrumentation that is maintained and supported, and that is robust against delays and uncertainty along the GSMT path. He noted that this complex path requires leadership and planning at an unprecedented level at NSF and reported that NSF has asked AURA/NOAO to act as NSF's "Program Manager" for GSMT development. He noted that this role would be similar to a NASA center in the development of major space missions. The Program Manager must understand and champion national needs for a GSMT, including formation of a National Science Working Group (SWG) and a National "Design Reference Mission" to set scientific performance expectations and operational models. In addition, one must also promote GSMT development at a pace that recognizes both private and federal timescales. As a result of this new role in GSMT development, NOAO has withdrawn from previous project partnerships in order to establish appropriate, symmetrical interfaces with the Thirty Meter Telescope (TMT) and Giant Magellan Telescope (GMT) projects.

Phinney asked if the options for a GSMT were limited to these two projects. Van Citters said no. He reiterated that there would be no downselect any time soon and that one must first solidify the science case and operational models.

Van Citters reviewed the current status of Senior Review activities in general. AST has begun developing its implementation plan with the consultation of facilities managers, agency partners and advisory bodies such as the Committee on Astronomy and Astrophysics (CAA) and the AAAC. AST has been taking the implementation plan to the community at each stage; in this vein the agency began another town meeting series at the AAS annual winter meeting in Seattle. Van Citters reported that AST was working closely with the facilities to understand the implications of the report recommendations as they consider possible implementation. He added that NSF was active in encouraging and engaging in discussion with other possible partners in facility operations, including international partners and other funding agencies.

Van Citters reported that AST was undertaking detailed cost reviews of its facilities, a necessary step to understand where cost reductions could be made. He said that one needs to understand operational costs, appropriate staffing levels and to consider other operational and business models. AST hopes to complete the reviews within the next 6-8 months, perhaps seeking outside advice. Van Citters stated that AST was also exploring costs and legal issues associated with the Senior Review recommendations (e.g. environmental, deconstruction, divestiture and termination costs). He said that many changes would take several years to implement and that we would begin to see budget implications in FY09. He added that, while the cost reviews would consider if the current level of service could be delivered for less, we also would need to look at different service models. Changes similar to those undertaken recently at NAIC may be necessary at all AST facilities.

Van Citters concluded with the statement that community input is essential and reiterated the email addresses for input to the Senior Review process (astsenior-review@nsf.gov) and to the decadal survey (astro2010@nas.edu).

Neta Bahcall asked Van Citters to characterize the responses at the town meetings. Van Citters replied that overall the response has been very positive. Concern has been expressed, of course, about some of the recommendations, but he has perceived positive interaction about the possibilities. Lester noted that the Senior Review was predicated on a level budget and asked if the Senior Review gave any guidance on what to do if the budget grows more quickly. Van Citters said yes and added, "Keep in mind that you're looking at a scientific prioritization that allows us to adapt to the budget reality." Alycia Weinberger asked for Van Citters' thinking on how to tie grants to new facilities. Van Citters replied, "That hasn't changed. One need only to look at NASA for success in that area. The question is only how to do that here at NSF." He explained that only 4 out of 40 divisions at NSF support substantive facilities programs. As a result, there exists much resistance to tying increases in grants programs to operation of new facilities since the other divisions could not benefit from such a model for increasing budgets.

Ethan Schreier noted the complexity in developing cost sharing for facilities recommended for closure (e.g. the VLBA). Jay Frogel asked for any thoughts on combining a mid-decadal review with another senior review. Van Citters replied that we need to develop that process. He continued, "We'll just be seeing the results of recommendations from this Senior Review in five years, but we need to have that in our thinking." Carlstrom noted that AST programs are only a portion of the issues covered by the decadal survey, so the processes are somewhat separate. The Committee discussed potential models for review of NASA and AST programs and mid-decade reassessments.

Jon Morse and SOFIA Program Executive Ray Taylor next provided an update on the SOFIA program. Morse noted that Hashima Hasan was scheduled to give this presentation but was

unable to attend because of a family emergency. He added that Eric Becklin, SOFIA Observatory Director, expects to join via teleconference.

Morse provided an overview of SOFIA, which consists of a 2.5-m telescope in a (heavily) modified B747-SP aircraft. He noted that the obscured IR (at 30-300 microns) is the most important band of SOFIA's optical-mm performance. The observatory operates at an altitude of 39,000-45,000 feet, above greater than 99% of obscuring water vapor. He reviewed a brief history of the mission.

Eric Becklin and Thomas Roellig joined the meeting via teleconference.

Taylor reviewed the aircraft layout for personnel and accommodations. He noted the pressure bulkhead so the telescope is able to remain at atmospheric pressure throughout flight. He also noted the cavity environmental control system to cool optics prior to flight and to dry out telescope cavity on descent.

Taylor reported that first flight completed in Waco, Texas, in April 2007, and that the aircraft would soon be flown to Dryden Flight Research Center (DFRC) for continuation of flight testing. He noted that NASA-Dryden would hold project responsibility, while L3 would continue as the primary contractor for aircraft modifications.

Taylor showed the tracking achieved in centroid inertial tracking mode during first flight and noted that jitter of <0.8 arcsecond was achieved.

Becklin reviewed SOFIA science capabilities. The telescope is not as sensitive as Spitzer but comes close at longer wavelengths. Science drivers include astrochemistry, occultation astronomy, star formation, the black hole at the center of Galaxy and deuterium abundance measurements. He compared operations of SOFIA, Spitzer and Herschel and noted both that SOFIA would become operational near the time that Spitzer runs out of cryogens and that Herschel and SOFIA would now start at about the same time. He stated that joint SOFIA/Herschel calibration work was ongoing and noted that SOFIA was also very complementary to JWST.

Taylor continued to discuss SOFIA operations plans. He said that flights would ramp up to 960 science hours/year and that flights would be primarily out of Dryden (Edwards AFB) with occasional deployments to the southern hemisphere and other sites as needed. The SOFIA science center would be at NASA-Ames, including management of the telescope time peer review, observing time schedule, flight planning, management of instruments, science data archive and observing support.

Taylor presented an overview of major milestones in the SOFIA schedule leading to first science in 2009. He reported that aircraft structural modifications are complete. The telescope has been installed, several instruments have been tested on ground observatories, and several subsystems were scheduled to be installed (e.g. door drive). First flight has been completed, leading to the ferry flight in June 2007 to DFRC. Full envelope flight testing (closed door) was scheduled to start in fall 2008. Taylor concluded with the statement that SOFIA would be one of the primary facilities for far-infrared and sub-millimeter astronomy for many years.

Bahcall inquired about the expectation for science selections. Becklin replied that an annual call for observing proposals was anticipated. Stassun said that he found it a bit difficult to follow the discussion of complementarity and uniqueness of SOFIA compared to other missions. Taylor

showed a final slide of wavelength vs. time of infrared space observatories, including Spitzer, Herschel, SOFIA, the Single Aperture Far-Infrared Observatory (SAFIR) and JWST.

**MEETING ADJOURNED AT 3:10 PM – RECONVENED AT 3:40 PM**

OSTP Assistant Director for Physical Sciences and Engineering Kathryn Beers joined the meeting. She identified a major theme of budgets and noted a general lack of discretionary funds. She said that ACI remains a primary Administration priority. She noted shortfalls in appropriations relative to the FY07 budget request and stated that this would remain a challenge for the future.

Beers reported that the Physics of the Universe (POU) Working Group had put together a Lessons Learned report and noted that the report was not available to the public. She stated that the major findings from the report include the need for increased communication among the agencies, OSTP, and OMB. She said, "We do realize that we have a special role to play for POU projects; we will make a bigger effort to pay attention to that portfolio." She said that the report identified the value of a solid Memorandum of Understanding (MOU) to provide well-defined budget, scope and project responsibilities as well as clear documentation of agreements. She reported that joint oversight was also found to be important and that an interagency group could provide coordination. The report found that one must define a single (not necessarily small) community to serve through each project; that is, interagency projects cannot be "all things to all people." Stassun asked Beers to provide example of latter. Beers replied that she could not say since her recent arrival at OSTP does not allow her all of the details. AST Executive Officer and POU Working Group member Eileen Friel offered LHC as example of common community between DOE and NSF. The Committee discussed other communities, such as dark energy, that may be "newer marriages" among agencies.

Beers discussed the MREFC account at NSF. She noted a few comments in the AAAC annual report that addressed the need for OSTP to get involved in aspects of this. She said that OMB Program Examiner Joel Parriott and others have used the phrase "appetite control" to identify the need for divisions and communities to plan carefully for their new facilities and capabilities. She stated that design and development were also necessary to plan within Division budgets. The Chair clarified that the AAAC report identifies MREFC projects as agency-wide activities that would benefit from agency accountability and support of pre- and post-MREFC stages immediately prior and after construction. Beers noted that one could also make the same argument for operations. She also noted that only three directorates use up the majority of MREFC funds and added, "We need a mechanism for prioritization among and within those directorates." The Chair replied, "The option should be there to add funds for very large projects that are clearly demanded scientifically. Otherwise, one simply cannot provide transformational tools." Beers replied, "Sure, if there were just one thing. But there are many decadal surveys prioritizing many large projects." She noted that NSF had taken steps recently to improve the MREFC process.

The Chair noted the opportunity for private-public partnerships that could have a federal role that isn't clearly met by the MREFC process. Beers identified that question as referring to GSMT and asked, "When do we pick one?" The Chair replied, "What we're thinking about is the federal role in one or both. What's the optimum approach for a national component? We don't know, but we need to think about the process that would accommodate the private-public relationship. If this is highly ranked at the national level by the entire community, what is the federal role? It's addressed to OSTP because of the national policy issues." Beers asked to clarify the policy issues. The Chair responded, "Being able to make the agreements that allow the projects to plan for a

federal role. How does the federal government generate agreements to partner in operations in ten years?" Phinney noted that the question may be likened to a "chicken and egg" argument…private funds won't come without a federal commitment, but the federal commitment would be made for ten years hence. Beers noted that LSST is also very expensive and said, "Other things may be better for private foundations to invest in." The Chair noted that GSMT was the number one priority in the decadal survey and said, "That's presumably the project that one most wants to fund." Beers asked, "Would two GSMTs be better than one GSMT and one LSST?" The Chair said that the federal investment may not be different in those two cases. He continued, "The issue is being able to do the science for a reasonable federal investment, and how is that investment made? The issue of two projects is a complication, but it may not be the relevant issue." Beers said that she was also referring to the resources available to the community as a whole, not just the federal investment. Carlstrom noted that this might play out within the next decadal survey. The Chair reiterated that the policy question is how people should come together among private and federal. The Chair asked Van Citters for any comments. Van Citters replied, "I don't see how the current process can accommodate the agreements that we're talking about." Beers said, "We have to think about good governance and accountability for the agency. We need to ask what best serves the taxpayers."

Rieke noted that Beers alluded to NASA budget problems and shared that the community was thinking about a "space summit" to think about what kind of portfolio we can accommodate. Beers said that she was aware of a letter from Congress regarding this issue and added, "I'm sure that Alan Stern communicated these challenges to you." She said that a lot of NASA problems are also internal, and they are finding ways to deal with that. She continued, "They have a lot to be excited about, too, and Stern has a lot of good ideas about how to manage the resources they have now," and added that it was unclear how a summit would be different from the actions that they were taking now. Rieke provided the example that it was unclear how the NASA budget could possibly accommodate human space flight goals without "robbing" science. She continued, "I'm worried about placing dates and constraints on a program without providing the needed resources. Maybe we need to relax those dates so we're not trying to achieve something that looks impossible." Beers replied, "That may not require a summit." She noted that NASA's budget is "very, very big" and that it was not unreasonable for the agency to have an ambitious mission. She added, "Part of this is expectations, part of this is cost growth. More conservative restrictions on cost estimates will help their bottom line. While we can help formulate budgets and be supportive of their initiatives, I'm not sure where the higher role is for policy." The Chair responded that, while the agency's budget may be large, "they either need to do less, or their budget needs to increase." Beers replied, "With 90 missions in operations or development, NASA doing less is not a terrifying option. Comparing historically, there is still a very high number of missions." The Chair stated that one would have to go back "a long way" to see the low number of missions coming in the next few years. He added that he would like to see Congress and the Administration spend more money on it. Beers replied, "We can't spend more money on everything."

Lester asked Beers for what else she sees as problems internal to NASA. Beers identified cost estimates and a very top-heavy mission list.

Dodelson asked what the Committee could do in their annual reports to help OSTP advocate. Beers replied, "The argument that more funding needs to be provided is not the most constructive for us. Looking for prioritization is constructive…helping your communities to weigh the expensive options they have…incorporating cost and having realistic expectations for what the government can support." She added that it was also constructive to point out problems consistently over time (e.g. MREFC).

Stassun asked Beers to compare the effectiveness of the various decadal surveys that she encounters. Beers replied, "How much you weigh realistic options for future budgets is important and will become more important."

Dodelson returned to the issue of private-public partnerships. He commented that the Chair was identifying a large pot of private money that could be lost because the agency processes cannot provide the commitments necessary to access those funds. Beers responded that she could not imagine providing a 10-year out-year commitment while also being accountable for government resources that may not be available." Freedman reiterated the "chicken-and-egg" situation that currently impedes collaboration among private-public sectors. She noted that the matching of available resources (and other processes) requires careful thought, so one would like to set up a structure just to begin discussions of a way forward. Beers agreed and asked if there were any overriding body that oversees that process. Carlstrom said, "No, that's what we're seeking." Beers relied, "It seems to me that you would need some kind of body that both groups would recognize as an authority." Carlstrom added that international partners were also involved.

Van Citters added, "We have to have a much better idea of what the community needs and wants to do, as well as what risk the private community is willing to undertake, before we can have the conversation we're having. The role of NOAO here is exactly the role we are identifying for negotiating the federal role. We need to enunciate how to move forward from our own point of view before we involve OSTP at the broader policy level." Beers agreed and said, "There's little role for OSTP to play here as yet." Freedman noted that the various partners need to stay close to continue the conversation.

Phinney noted Beers' comment on the need for solid MOUs. He said, "The more MOU's you have, the more restrictions you have on the agencies." Beers agreed that there is a lot of resistance to having more and more MOUs.

The Chair thanked Beers for attendance and added, "Dialogue is good for clarifying one's thoughts."

The Chair suggested that AAAC members selected by each agency could act proactively to solicit concerns and feedback from the community regarding their respective agency for sharing during each meeting. He asked Committee members for their response to the idea. Ong noted that each member would need to talk to enough people to get an accurate reading on input. He added a concern that one could also perceive the input as serving only a particular community. Phinney noted that the interagency aspect was key for this Committee, so that approach could narrow the view somewhat. The Chair clarified that he was seeking a means to bring more input into the committee. The Committee reached agreement that this objective was appropriate but that a general call for topics may not be reasonable. The Committee discussed potential processes for soliciting input within the structure of agenda development.

The Committee discussed the election of the Chair and Vice-Chair. The members identified the need to elect a Chair-Elect in October (or at the latest in February) prior to the end of term of the current Chair. The members noted the original intent of the position of Vice Chair to fill this role but agreed that a Chair-Elect chosen from among the membership of the next term may be more appropriate.

The Committee discussed potential questions for their discussion with NSF Director Arden Bement.

**MEETING ADJOURNED AT 6:00 PM, 10 MAY 2007**

**MEETING RECONVENED AT 8:30 AM EST, 11 MAY 2007**

For the first hour the Committee defined questions and issues for their subsequent discussion with NSF Director Arden Bement.

The Committee returned to their discussion of issues involving the election of AAAC Chair, Vice-Chair and Chair-Elect. The current Chair expressed his willingness to serve for another year if the Chair-Elect process were well defined. The Committee outlined other options and decided that selection of another member for a one-year term as Chair would be too discontinuous. Therefore, the Committee would either choose a new Chair for two years or continue the current Chair's tenure for one additional year with determination of a Chair-Elect. The Committee unanimously elected to continue the current Chair's term for another year. The Committee also designated Daniel Lester to serve as Vice-Chair to enable the transition to a Chair-Elect, which would be selected at the October 2007 meeting. The Committee advised that the sponsoring agencies should pay particular attention to potential Chairs and balance when selecting new members for this term.

Bement joined the meeting, and introductions were made around the room. Bement thanked the Committee for their annual reports and letters, which keep him abreast of current thinking and developments in other agencies. Bement commented that this was very important "as we think forward in our budget development." Bement discussed the current budget process and noted that so far this year the hearings with the authorizers and appropriators had all been "good hearings—constructive, positive and generally supportive." He added that NSF is looking forward to the process for developing the reauthorization, which is structurally different in the Senate and the House. He reported that initial markups on FY08 budgets would likely start in mid-June and commented that he was very hopeful that the President's request would be given serious consideration. The Chair agreed that the FY07 appropriation showed great confidence in the agencies and in science.

The Chair thanked Bement for his support for ALMA last year. Bement noted that ALMA must be very well managed; one must be cautious about the use of contingency at this early stage in the project. He added that, optimistically, there may be contingency left to buy another antenna or two. The Chair asked for questions from the Committee.

The Chair asked Bement for his sense of the role and importance of the Senior Review. Bement replied that it had been well received in most quarters, although of course some community members were concerned about specific recommendations. He noted that there may be some political hurdles ahead in implementing its recommendations. He stated that NSF is taking it very seriously and that "we'll take it as far as we can." He added, "As we look forward, there are many very important projects on astronomy's horizon. NSF can't step up to those unless we can handle the recurring costs of maintenance and operations. We also have to keep in mind what is most transformative and what is the right balance, not only in size but also in spectrum. We're not going to become Fermi degenerate so we can no longer support the accompanying research. We don't need a large facility with only 400 users left that we can fund." Bement commented that NSF could not step up to a facility of $0.5 billion or more without strong interagency and/or international participation.

The Chair brought attention to the upcoming decadal survey and noted that the community had realized that some projects in the previous survey did not have accurate cost estimates. He identified concern within the community to do a much better job this time around to develop a program that is better matched to likely available resources. He noted that LSST and GSMT each have a large private component that could provide a shared endeavor for these projects. Bement commented that NSF retains the flexibility to re-scope projects continually as long as they remain transformative.

Carlstrom asked how Bement envisioned managing substantial operating costs. Bement replied, "We are looking at the process so that we consider lifecycle costs, cyberinfrastructure and planned improvements over the lifetime of the project. You've advised us to pay attention to this. Going from conceptual design review to preliminary design review, we need to make sure that we have the tools in place and the organization in place, and to make sure that we can accommodate the budget." He noted that all MREFC projects must also go to the National Science Board (NSB) to prioritize projects across disciplines, which he described as "very difficult." He continued, "Everything up to that point is highly speculative, and after that one must go through the final design review, including environmental and cultural impacts, permits and other requirements before one can put a shovel in the ground. That's a pacing factor." He stated that all of these steps were incorporated in the large facilities manual, which was close to ready for issuance and presentation to the NSB. The Chair noted his understanding that operations would not be funded by MREFC but that the operations requirements were part of the process. Bement commented that the issue of operations and maintenance costs, as well as R&D needs, was what led to the Senior Review.

Rieke noted the "buzz" about ACI and asked what astronomers could do to help realize the goals of that initiative. Bement replied, "Your advocacy is always appreciated. This is a hard question to answer because physical science and engineering are the focus of ACI, but it's also linked to competitiveness, but competitiveness is also linked to economics and education. We try to keep in mind also quality of life. We're a society that likes to explore and likes to understand. If we only focus on economic activity, we would lose that exploration and our quality of life in a highly advanced society. We want to know how the universe works."

Carlstrom noted that students are very attracted to astronomy and engineering because they like to build things. Bement concurred and identified scientific advances that may apply to other applications (e.g. interferometry from LIGO to measure very small distances). He also noted the work at Fermilab to couple high energy physics and cosmology through studies of dark matter and dark energy.

Lester noted Bement's reference to interagency and international components to large projects and asked Bement to identify the challenges that NSF faces. Bement stated that this applies not just to NSF but rather includes all the agencies that the Committee represents. He noted that the annual report breaks out recommendations by agencies and suggested breaking out the recommendations by science "so one could see the interlacing among agencies." He stated that he finds the AAAC annual reports to be very helpful and useful and added that the AAAC ought to be proud of its task force activities.

Freedman asked Bement how he envisions achieving the balance between the grants programs and facilities Foundation-wide. She asked, "How can we support the many fields of science that have individual investigators who also need to build large facilities?" Bement replied that there were many dimensions and balances: between young and more senior researches, between discovery and tools, and education at every level. He noted that the grants success rate was a

major issue at this time, but there also needs to be a balance between small and large projects and higher risk projects. He said, "Panelists tell us that they turn down just as many projects that aren't risky enough as those that are too risky. Program officers would go the extra mile to fund a truly transformative project. With NSF down to a 25% success rate this brings a perception that we may be too conservative. We need to overcome that to the extent that we can." He added that NSF was trying to understand why proposal pressure is going up and had identified 8-10 interconnected drivers. He continued, "We are beginning to see a turnaround with the increase in our budget, but it won't be solved for many budget cycles. We have to sell our program year after year; we can't assume that ACI is just going to raise the bar. OMB is very cautious; they want to see the very best program that we can put forward."

Bahcall asked if OMB sees the increased demand from science and scientists as positive. Bement replied that there is always a discount factor when scientists advocate for science. He noted that "our favorable situation now" followed from *Rising Above the Gathering Storm*[1], which had a huge impact on Congress as coming from industry leaders. He stated, "The framework already existed in the Administration, but that report put science policy back on the radar screen. Priorities being what they are, we could be flying under the radar screen very quickly. Clearly the support we're getting on the Hill is bipartisan and bicameral. There will be a change in Administration, of course, but the hope is that the momentum will be carried forward."

Lester noted the recent cut in R&A programs at NASA and asked if that may have influenced proposal pressure at NSF. Bement replied, "We've observed that in some of the mission agencies there's been a decline in support for basic research. That could be one factor. Another could be an increase in the total number of research-capable institutions (e.g. small colleges). We have noticed that the diversity of basic research support has closed in a bit. We're probably getting multiples of proposals from investigators. That's problematic for several reasons: the time burden on the investigator, the burden on the Foundation in administration and management of proposals, and the burden on review community."

Dodelson noted both that the *Rising Above the Gathering Storm* report came from industry leaders and that the EPP2010 group was chaired by an economist from outside the field of elementary particle physics. He asked if Bement would recommend that approach for major efforts such as the decadal survey. Bement replied, "Absolutely. Members of Congress take notice."

The Chair asked if the apparent increase in proposal pressure fell across NSF divisions. Bement replied that MPS and the Directorate for Geosciences (GEO) had the highest success rates and noted that these are also the directorates that had the major facilities, tools, operations and maintenance costs. He called this "a good sign." He identified the two most problematic directorates for success rates as the Directorate for Biological Sciences (BIO), in which success rates were still going down, and the Directorate for Engineering (ENG), in which success rates seemed to be going up. He reported that the Directorate for Computer and Information Science and Engineering (CISE) "has really had a turnaround in success rate" that now lies very close to the agency average. He said that ENG had "turned themselves around with good, solid management." The Chair asked how so. Bement replied, "They've cut back on the number of solicitations, stretched out the duration between solicitations, and narrowed the language." The Chair noted that narrowing the language may exclude some segments of a broad community. Bement responded, "Part of that is natural; part is intended. The question is where you draw the boundary. Maybe the program doesn't require proposals from everyone." Carlstrom also noted

[1] http://www.nap.edu/catalog.php?record_id=11463

that investigators often submit to several programs. Bement explained that several people in the Foundation were trying to quantify these factors "to manage our success rate and manage our growth." He added, "The worst thing we could do is to get out in front of our budget and to get overextended."

The Chair noted the attention given in the AAAC annual report to mid-scale instrumentation. Bement identified the question as timely given the previous discussion. He stated that NSF had lifted the cap in the Major Research Instrumentation Program (MRI) from $2 to $4 million. He added, "We have to experience how that affects the overall balance in the portfolio, especially for institutions that are at the lower end of the mid-scale. If it goes up too high, you could squeeze out a number of very important proposals. We're looking at where we would be at the end of the doubling period. We're ramping up budget cycle by budget cycle." The Chair commented that it would be hard to fit into the current program projects in the $10-20 million range. Bement replied, "It's a question of what is an instrument and what is a facility. MREFC is more focused on major facilities than on instruments. We have to take it year by year to determine how the balance is working." The Chair asked how the authorization language fits with that plan. Bement replied that the authorization language had scaled back the cap increase but also gave NSF some flexibility "to increase the cap as we go." He stated that $10-20 million projects might have to be done along with other agencies and other resources. He concluded, "It's a question of how much we can do with our own resources."

The Chair asked about potential increases in the MREFC account. Bement replied, "It looks like it's going up, but only because we're at peak spending in some current projects. As we provide more margin, we can potentially start other projects." Bement added that NSF is very committed to ALMA and ATST and that "we want those projects to go forward as quickly as possible…to be available as soon as possible."

Bahcall asked for anything that the Committee should focus on with interagency activities. Bement reiterated his suggestion to mesh the three agencies along science lines. Bahcall asked if Bement saw any particular challenges or problems in interagency activities. Bement said no and added, "We are all very competitive and resource-limited. We all try to cooperate. We try to keep open to opportunities for leveraging—intellectual, operational and financial. I see no showstoppers there except resources. We do what we can do. Having some coordination and some phasing of our activities—and anticipating what the potential budget impacts are going to be—is very important." Bahcall asked the same question for international collaborations. Bement stated, "For those we budget differently and we manage differently. We're a year by year process, while other nations want to pay up front. The better we do—the more credible we are in following up on our commitments—the easier it becomes to develop international collaborations." He noted the European Union facilities plan and the ramping up of the European Research Council (ERC). He commented, "There is competition there, but also opportunities for collaboration."

Bement added, "If we build too much capacity, we won't have enough of a community to ensure a level of competitiveness. The cost of doing research is going to go up." He also noted the development of virtual and remote access to facilitate research. The Chair commented, "That's interesting for its relation to our thoughts on some projects for international collaboration where we may not share money but rather provide access and coordinate collaboration on individual projects."

The Chair thanked Bement for visiting with the Committee. Bement stated that he enjoyed the interaction and added, "Don't take the end of this time as the end of our communication."

**MEETING ADJOURNED AT 10:55 AM – RECONVENED AT 11:25 AM**

NRC Committee on Astronomy and Astrophysics (CAA) Co-Chair Chuck Bennett joined the meeting to discuss decadal survey planning and to provide an update on CAA activities. NRC staff member Brian Dewhurst and CAA Co-Chair Meg Urry also joined via teleconference.

Bennett noted the value added to the astronomy community of coordination among the AAAC and CAA. He identified the CAA charge to assess the health of the field and the progress of decadal survey recommendations and noted that the current major issue was how to optimize the next decadal survey. The CAA had received ideas from astronomers, committees, agencies, OMB and OSTP and had identified issues to resolve. He noted that the NRC wants broad input, ideas, comments and suggestions. He reported that two town meetings were held in January and April 2007 and provided an email address for input to the decadal survey process: astro2010@nas.edu. He noted that the CAA had received considerable input thus far and commented that it was useful to hear about issues as well as broad consensus. Bennett identified the CAA membership.

Bennett then itemized issues for the upcoming decadal survey, including: how to get effective input from the entire community; how to structure the committees and panels, e.g. science vs. technique; whether to include members from outside the astronomy community on panels; how to provide cost estimates; how to address uncompleted recommendations from previous surveys; international coordination; defining the boundaries of astronomy and astrophysics (e.g. biology, geology, particle physics, plasma physics, gravitational physics); how to accommodate variation in the state of project readiness; how to manage prioritization intra-decade; and how to structure the recommendations, particularly in their prioritization across categories (e.g. space vs. ground, major vs. moderate). He noted that, while some of these topics present nearly community-wide agreement, others need more work. He said, "The whole process is consensus-building."

Bennett reported that the Board on Physics and Astronomy (BPA) and the Space Studies Board (SSB) had convened a planning meeting on 28 April 2007. The goal was to provide NRC staff with general outlines, suitable for the internal NRC proposal process. The NRC Governing Board would consider the plan on June 14. If approved, the NRC would then prepare proposals for NASA, NSF and DOE. NASA Program Officer Michael Salamon asked if the NRC would have the issues that were raised above answered by the time the proposals came into the agencies. Dewhurst said no. Bennett agreed and added, "I think the agencies will be involved in making some of those determinations." Dewhurst said that he expects an iterative process with agencies that allows input from the survey leads.

Bennett provided an overview of other NRC astronomy and astrophysics studies. He reported that the NASA Astrophysics Performance Assessment (NAPA) report was released on 7 February 2007 and that a study on NASA Astronomy Science Centers was in publication, scheduled for release in June 2007. He reported that the Beyond Einstein Program Assessment Committee (BEPAC) was underway with a report due date to the agencies of 8 Sep 2007. He added that the NRC would be required to make something public within 10 working days of the report release to the sponsor. Dewhurst provided details for the NASA Astronomy Science Centers study, which he described as looking at efficiencies and best practices.

Bennett listed related studies published and underway in BPA and SSB. He noted that the decadal survey statement of work must be well defined so the work would be finite. Bennett and several Committee members noted the importance of the workshop on Space Science Activities and International Traffic in Arms Regulations (ITAR). All agreed that ITAR had created considerable

difficulties for space science missions. The workshop[2] would be held in Washington, DC, in September 2007.

Bahcall asked about the schedule for the decadal survey. Dewhurst stated that the most optimistic start would be March 2008 and that he expects to request funds for a two-year activity. Dodelson suggested that a letter from the AAAC could provide input to the development of the survey process. The Committee agreed and tabled the discussion for later in the meeting. Urry noted that the survey was led by the BPA in cooperation with the SSB and that the CAA stands down at that time. She felt that the input to CAA was there, and now it was largely in the hands of the BPA. Her sense was that input had been provided and was being used.

Carlstrom asked if Bennett or Urry saw a role for the CAA during the process. Bennett said that he anticipated no particular role except providing input.

Hank Sobel next provided an overview of the Dark Matter Scientific Assessment Group (DMSAG) Report. He identified changes to the report following his previous presentation to the Committee, which were motivated by the Committee's comments and feedback from a group of external readers. The report was sent to 11 people selected from nominations from both the AAAC and HEPAP; of those, 8 accepted the request to read the report and 7 returned comments. Sobel reported several major improvements to the report as a result, including a new executive summary, glossary and many wording changes. The Committee complimented Sobel on the addition of a glossary as very helpful. Sobel continued to identify and justify particular changes in the report's findings and recommendations.

The Chair asked for the Committee's general thoughts on the changes. Ong stated that the document had improved greatly and thanked committee for their service in managing the process of external readers. The Chair complimented the report structure. Phinney noted that the connection to dark matter did not appear until page 46 and commented that the astrophysical justification of dark matter searches was not made very clearly. The Committee discussed potential edits to the document, and the Chair suggested that Committee members should send additional comments to Sobel via email. Sobel noted that HEPAP would consider the final DMSAG report at its July meeting, so suggested changes would be incorporated by then.

NSF Physics Division Director Joseph Dehmer agreed that a final round of minor changes would be helpful. He stated that the quality of the DMSAG committee's work had been excellent and thanked Sobel for his outstanding leadership.

Ong noted that Sobel had articulated justifications for certain aspects of the report that negated some of Ong's previous comments (e.g. regarding SuperCDMS). The Committee discussed the conservatism of the recommendations and noted, for example, that it may not be necessary to provide the "if funds allow" caveat repeatedly. Dehmer agreed that the tone could be stronger. The discussion continued to clarify some aspects of the report, including prioritization.

The Chair noted that the recommendation for the Deep Underground Science and Engineering Laboratory (DUSEL) was stronger than the justification. He suggested that some of the text should be added to the recommendation to provide the justification up front. He also suggested that the DMSAG strengthen wording in the report to recommend moving forward on R&D leading up to another major review in 2009.

[2] http://www7.nationalacademies.org/ssb/ITAR2007Wkshp.html

The Chair thanked the DMSAG committee again for their tremendous work. He suggested that the AAAC accept the report for transmittal to the agencies, contingent on the suggested minor changes. The Committee unanimously agreed.

ExoPlanet Task Force (ExoPTF) Chair Jonathan Lunine joined the meeting via teleconference. NASA liaison Stephen Ridgway identified the task force membership. Lunine summarized the three ExoPTF meetings held so far (March 20–21 at NSF and NASA, April 10–11 at MIT, and May 2–3 at the University of Arizona) and identified all invited speakers and presentations provided to the committee. Lunine characterized the white papers that were submitted to the committee in response to their general call; he reported that the ExoPTF had received 84 contributed white papers from 48 institutions, 308 distinct authors, 23 states and 13 countries. The white papers had been assigned to committee members for thorough reading and summary to full committee.

Lunine reported that at the most recent meeting the committee had discussed their "attack strategy" at length to outline the report and to select writing subgroups. The next meeting would be held on August 14–15 at San Francisco State University. Lunine stated that the committee expected to write their draft report after that meeting in time for consideration at the October AAAC meeting. Ridgway noted that Jon Morse had asked to aim for public availability of the report at the January AAS meeting to keep decadal survey planning on track.

Carlstrom inquired if the options to use an external occulter on a space-based mission had been included in the submitted white papers and subsequent committee discussions. Lunine said yes and added that the committee had heard from the Navigator program in particular about that kind of thinking. Weinberger asked how many of the 84 white papers were deemed to be irrelevant. Lunine stated that on the order of 15% of the white papers were of "marginal utility." Bahcall asked if the committee perceived any consensus emerging from the white papers or if they were broadly distributed. Lunine replied that the white papers had been broadly distributed. He reported that no single paper had attempted to provide a cohesive strategy, which he felt "reflects the vigor of this field." He continued, "We need a lot of approaches, even if we somewhat narrow the range in our report."

Bahcall asked if the committee would prioritize its recommendations. Lunine replied, "Certainly. We've been cautioned several times now by Jon Morse that our final report is not useful as merely a list of acronyms. We're aiming to identify techniques and forecast which may be most crucial for taking steps forward. We expect to present at least one, if not more than one, timeline to present the development of techniques needed."

The Chair noted that he had attended the second day of the May ExoPTF meeting and was impressed with both the breadth and depth of the committee's considerations. He expressed appreciation for the time commitment from the committee members.

**MEETING ADJOURNED AT 1:35 AM – RECONVENED AT 1:50 AM**

The Committee reconvened for general discussion and identified items of interest for each of the agencies.

The Chair thanked Rene Ong, John Carlstrom and Neta Bahcall for their efforts on the Committee. Ong and the Committee thanked Dana Lehr for her ongoing efforts on behalf of the Committee. Ong departed the meeting.

The Committee identified action items and assigned Committee members to follow up with the agencies to identify issues for their October program updates.

Friel and Van Citters requested the Committee's thoughts on the upcoming decadal survey to inform iterations between NSF and NRC. Dodelson agreed to send around a list of topics to identify the recommended boundaries of the survey.

The Chair thanked the Committee members for their time and attention.

**MEETING ADJOURNED AT 3:00 PM, 11 MAY 2007**