Minutes of the Meeting of the Astronomy and Astrophysics Advisory Committee

11–12 October 2007
National Science Foundation, Arlington, VA

Members attending:	Garth Illingworth (Chair)	Daniel Lester
	Bruce Balick	E. Sterl Phinney
	Bruce Carney	Marcia Rieke
	Scott Dodelson	Keivan Stassun
	Wendy Freedman	Christopher Stubbs
	Katherine Freese	Alycia Weinberger
Agency personnel:	Tony Chan, NSF-MPS	Zlatan Tsvetanov, NASA-HQ
	G. Wayne Van Citters, NSF-AST	Michael Toberman, NASA-HQ
	Eileen Friel, NSF-AST	Eric Smith, NASA-HQ
	Dana Lehr, NSF-AST	Ray Taylor, NASA-HQ
	Nigel Sharp, NSF-AST	Zlatan Tsvetanov, NASA-HQ
	Philip Puxley, NSF-AST	Wilton Sanders, NASA-HQ
	Craig Foltz, NSF-AST	Stephen Ridgway, NASA-HQ
	Jon Morse, NASA-HQ	Glen Crawford, DOE-HEP
	Michael Salamon, NASA-HQ	Kathleen Turner, DOE-HEP
	Yvonne Pendleton, NASA-HQ	Michael Procario, DOE-HEP
Invited participants:	Jonathan Lunine, U. Arizona	Brian Dewhurst, NAS/NRC
	Charles Kennel, UCSD	Chuck Bennett, Johns Hopkins U.
	Fiona Harrison, Caltech	Megan Urry, Yale U.
	Robert Gehrz, U. Minnesota	Kate Beers, OSTP
	Amy Kaminski, OMB	Jean Cottam, OSTP
	Joel Parriott, OMB	
Other participants:	Dennis Socker, NRL	Robin Stebbins, NASA-GSFC
	Michael Ledford, Lewis-Burke Assoc.	Henry Ferguson, STScI
	Jay Frogel, AURA	Matt DeRosier, General Dynamics
	Lamont DiBiasi, SwRI	Dom Conte, General Dynamics
	Jennifer Wiseman, NASA-GSFC	Randall Correll, Ball
	Joan Centrella, NASA-GSFC	Michael Devirian, NASA-JPL
	Ann Hornschemeier, NASA-GSFC	Jon Malary, Lockheed Martin

MEETING CONVENED AT 8:30 AM EST, 11 OCTOBER 2007

The Chair called the meeting to order. He thanked all attendees for their participation and welcomed new members of the Committee. The Chair continued with introductions around the room and asked for comments from the agency representatives. The Chair provided an overview of Committee activities and described the timing of meetings in February, March, May and October relative to the Federal budget development and appropriations. He noted that NSF Program Examiner Joel Parriott from the Office of Management and Budget (OMB) would join the Committee for a discussion via teleconference later that morning. He explained that the

current embargo on the FY 2009 budget would limit the ability to discuss the budget in detail but that the conversation could address broad issues. He reviewed the remainder of the agenda items and their associated issues.

Bruce Balick identified various community meetings scheduled for the fall and asked how the AAAC was connected to them. The Chair explained that no formal connection existed and that the identified meetings were driven by various community segments aimed at providing input to the decadal survey. He continued, "We want to be cognizant of those, but we don't want to get too far out in front of those. We think of ourselves as a tactical group that works within the strategic framework developed by the community consensus." Balick noted that he would like to have input from those meetings in order to understand community thinking in those areas.

NSF Director of the Division of Astronomical Sciences (AST), Wayne Van Citters, next provided an overview of NSF programs. He noted that the Division was embroiled in the aftermath of the Senior Review (SR) and reported that things were going well. He outlined his report, which would describe progress on implementation of the SR recommendations, particularly in the near and intermediate term, review interagency and AST news, and provide an overview of the FY08 and beyond budget outlook (excluding FY09 as currently embargoed).

Van Citters reviewed the first finding from the Senior Review, which NSF had identified as the most important conclusion of the 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 the new initiatives."

Van Citters noted other findings and recommendations from the Senior Review. He reviewed the recommendations for the National Radio Astronomy Observatory (NRAO) transition program. He reported that NRAO had pursued other funding sources for the Very Large Baseline Array (VLBA) and seemed confident for continued operations for VLBA with AST support limited to $3M, as recommended by the SR.

Van Citters next reviewed the SR recommendations for the National Astronomy and Ionosphere Center (NAIC). He noted that, based upon the SR recommendations, the NAIC management organization, Cornell University, took immediate action to eliminate 30 positions to meet the recommended taper to $8M per year. He reported that Cornell planned to close the planetary radar in October 2008 and noted that, although Cornell had slated to close the radar in October 2007, they had identified an alternate operational model to maintain limited operations. Van Citters reported on his June visit to Puerto Rico and Arecibo Observatory to meet with government officials, Arecibo staff, and local universities to kick off planning and development for the future of Arecibo Observatory. He stated that he expects Cornell to submit a plan no later than spring of 2008 to forecast their base of support after 2010. He reported optimism for a vibrant, viable plan to maintain operations based on the SR-recommended $4M AST investment. Stated Van Citters, "I hope that we're looking at an extremely heartening success story coming out of the Senior Review."

Bruce Balick asked if there existed a process to review and evaluate the limited science that would be planned for the facilities that were recommended for reduced investment. Van Citters noted that the SR had delineated that science broadly and replied that the agency would review each facility plan to evaluate its viability. AST Executive Officer Eileen Friel added that the facilities must submit annual operations and management plans that go through merit review. The

Chair noted that the upcoming decadal survey would look at all of the facilities in the context of the next decade. He also reported that the House Science Committee would be holding a hearing on Near Earth Objects (NEOs) and, while the focus of the hearing would be on NASA, there could be a role for Arecibo in that context. The Chair asked about previous NASA support for the Arecibo planetary radar. Van Citters replied that NASA had previously supported the radar capability but phased out its support over 3 years starting in 2001; in response, NSF took up support for the radar. The Chair asked if NASA had indicated any ability to return their support for the radar. Van Citters said no.

Van Citters reviewed the SR recommendations for the National Solar Observatory (NSO), which were all predicated on a start for the Advanced Technology Solar Telescope (ATST). He said that an immediate concern was the recommendation for the Global Oscillation Network Group (GONG++), which was recommended to cease operations one year after the successful deployment of the Solar Dynamics Observatory (SDO) unless a majority of operations support was found from other sources. He noted that this and other SR recommendations for NSO were complicated by the ATST timeline.

Van Citters reviewed the SR recommendations for optical and infrared astronomy, which identified the need to ensure a healthy scientific enterprise going into the Giant Segmented Mirror Telescope (GSMT) era. The SR report stated that we must define a "system" of aperture and access with necessary instrumentation, maintained and supported, and assurance that the system would be robust against delays and uncertainty along the GSMT path. Van Citters noted that the GSMT path was complex from development through construction and into operations, including successful partnership formation, and would require an unprecedented level of leadership and planning at NSF.

Van Citters reported that NSF had asked the National Optical Astronomy Observatory (NOAO), under the management of the Association of Universities for Research in Astronomy (AURA), to act as NSF's "Program Manager" for GSMT development, a role he identified as similar to a NASA Center in the development of major space missions. NOAO would lead in defining the "system" and assuring its long-term health. In this capacity NOAO must understand and champion the national needs for a GSMT, including the formation of a National Science Working Group (which would meet on November 8–9) and a National "Design Reference Mission" to set scientific performance expectations and operational models. Consequent to this redefined role, NOAO must also establish symmetric working relationships with the two GSMT project teams, the Thirty Meter Telescope (TMT) and the Giant Magellan Telescope (GMT).

The Committee discussed both the role of the National Science Working Group in the development of the science case and the process managing its development and community buy-in. Christopher Stubbs asked about Federal support for annual operations costs for projects at the level of GSMT and specifically if there had been any headway within NSF for examining how these projects would be supported. Van Citters noted that leadership within the NSF Directorate for Mathematical and Physical Sciences (MPS) understood this very well and that it was an active topic for discussion. MPS Assistant Director Tony Chan noted that this was a good question to ask OMB Program Examiner Joel Parriott. Said Chan, "We're having internal discussions, but there's a larger structure at the [NSF] Director's level and within OMB. We're doing what we can internal to MPS, but this affects all Directorates at NSF."

Van Citters identified current activities to implement the SR recommendations. He reported that AST was undertaking detailed cost reviews of each of its facilities, which he described as necessary to understand both vulnerabilities and potential cost reductions. He reported that a

Request for Proposals (RFP) had been issued and that they expected to receive three bids. He stated that AST must also explore the costs and legal issues associated with the SR recommendations, including environmental, deconstruction, divestiture and termination costs. He reported that AST was engaging outside studies in these areas over the next year. The first such study would be undertaken for Arecibo Observatory, for which the first site visit was completed just the day before and for which the final report was expected around February 1.

Van Citters discussed the challenge of operating facilities: "We have a 50-year tradition of operations that we must examine, both for now and for future facilities." He said that we must examine if the current level of service could be delivered for less, for which the answer may well be no. He added that we must also ask if there were a need to look at different service models.

Van Citters identified concerns related to the Senior Review, including lapses in community attention and increasing political pressure and interference with the science community-based process and plan. He reported that AST had recently met with astronomical community leaders in Chicago to address these concerns. In response, the group jointly crafted a "Dear Colleague" letter that was recently circulated by the American Astronomical Society (AAS) to address rumors and statements, many of which indicated that the SR report had not been read or assimilated. He noted with concern both significant misunderstandings among the astronomical community and attention from Congress intended to overrule implementation of the SR recommendations.

Van Citters continued with a report on interagency news. He stated that a Memorandum of Understanding (MOU) between NASA and NSF in support of the Virtual Observatory was now signed and that the agencies were moving forward with a joint solicitation. He also reported excellent interactions with both NASA and DOE regarding the proposal from the National Academies to conduct the next decadal survey; he stated that the agencies were conducting joint decisions, reviews and oversight in this regard.

Van Citters reported that AST would hold its tri-annual Committee of Visitors (COV) review on 6-8 February 2008 to evaluate Divisional programs, management, balance and process. He reported that John Carlstrom would chair the committee and encouraged Committee members to consider serving if asked. He stated that FY07 closeout was completed with a 24% average success rate. He also reported that the National Science Board (NSB) had declared ATST to be ready for inclusion in a future budget as a New Start.

Van Citters reviewed the President's FY 2008 Budget Request for AST programs. He reported that grant support for facility users was under study and that AST was developing a new program intended to help early-career investigators, including graduate students, postdocs and beginning faculty, in initiating instrumentation careers. He identified increases in the Advanced Technologies and Instrumentation Program (ATI, up 30%), the Telescope System Instrumentation Program (TSIP, up 25%) and the University Radio Observatories Program (UROs). He also noted: NOAO would see a $2.3M increase to refurbish and modernize Kitt Peak National Observatory (KPNO) and Cerro Tololo Inter-American Observatory (CTIO); NRAO was up $2M for early operations of the Atacama Large Millimeter Array (ALMA); and technology development programs were identified for both GSMT at $5M and the Square Kilometer Array (SKA) at $3M per year. Van Citters concluded with a comparison of the projected growth in AST budget needs for ongoing and future projects relative to a potential budget doubling and other growth models.

NSF Program Examiner Joel Parriott joined the meeting via teleconference. Parriott noted his understanding that the AAAC focuses on interagency coordination and cooperation. He said that he had been spending most of his time in taking a hard look at how NSF plans for construction and operation of its large facilities. Said Parriott, "I don't think that surprises anyone; it's been a hot button issue for a long time." Parriott continued to say that NSF Director Arden Bement understands that "he's on the hot seat" if projects go over budget and added that he supports the new Large Facilities Office at NSF. He added that so far he's not spending as much time as he would like on the "nitty gritty" of the individual research divisions. He said that it was interesting to come back to an agency that does astronomy and that it was "good and bad to see that some things never change." Parriott elaborated that the public-private issue "hasn't changed at all," and that "we still have issues with time-sharing on public telescopes." Wendy Freedman disagreed. She said that things have changed quite a bit, offered the example of TSIP as a substantial step forward and noted that relationships were very positive. Parriott asked if that model would work at the largest scale.

Parriott mused over the appropriate Federal role in large telescope projects and asked if the role could be in operations or second-generation instrumentation. He said that he did not see a clear path forward in which NSF could support "everyone at the same time." The Chair said that, as Freedman commented, the situation for public involvement in private facilities had improved, but that coming together to do it with a big telescope was both more involved and an open question. He noted that the AAAC had grappled with the issue over the past few years. He also noted for Parriott the two parts to the Committee's charge, the first of which is interagency coordination and the second is overseeing progression of the decadal survey recommendations.

Freedman noted that despite the challenges, there were real positive aspects of public-private relationships. Said Freedman, "If we're creative about this, there's a tremendous amount of leveraging that could occur. It's never been done, but that doesn't mean that it can't be done." She said that it would be important to have these kinds of discussions and that discussions were already taking place among those involved in the projects. She continued, "There's a recognition that these do need to be partnerships between Federal and private."

Parriott described a model of "cooperative stewardship" for interagency collaboration in which a single agency must take responsibility as the steward of the observatory so operations from year to year were not dependent on each agency providing their share. In this model, non-lead agencies would provide in-kind contributions or other deliverables.

The Chair asked Parriott how one couples the different stages of large projects within the NSF Major Research Equipment and Facilities Construction (MREFC) account to incorporate project lifecycle costs. Parriott replied that just the existence of the MREFC "different color of money" creates projects that wouldn't otherwise exist. He said, "There are a lot of strange things that occur because of this incentive to get 'free money' that sits outside of the directorates. For astronomy, where we have natural projects of that scale, we see an incentive to rush projects into the MREFC process prematurely to access that money sooner." Parriott said that, while NSF has a new process to manage the MREFC account, he would like to see NSF move closer to what DOE does for large projects. He stated, "It's not a perfect process, but it includes project management ideals in the decision stages." He offered potential models for the MREFC process to address lifecycle costs.

Parriott added that NSF management seems to like the model in which the directorates pay for operations costs as a form of "appetite control." He continued, "I don't know what the right answer is going forward, but I think that NSF at the current time isn't credible when it comes

forward to present cost and schedule." He suggested that every model has unintended consequences and potentially negative incentives built in.

The Chair suggested trying to minimize the current problems with MREFC rather than radically changing the process. Parriott said that he was sympathetic to the desire to address these needs and to find some way to deal with the "big chunks of money" that need to be distributed over several years for large projects. He noted again the DOE model of Critical Decision 0 (CD0), which provides a top-down indication of the science need for a particular project so large projects "don't just bubble up" unconstrained. The Chair noted that the astronomy decadal survey provides a long-range plan to help manage the inception of large projects. Parriott noted that the previous decadal survey overreached in response both to expectations of budget growth and to the previous decade in which recommended projects were completed relatively quickly during the decade.

Parriott noted that NSF staff were "spread thin" and that salaries and expenses (the account that supports, e.g., staff travel, supplies, and equipment) don't tend to be part of the pitch when the community goes to the Hill to lobby. Said Parriott, "I hope that the research community starts to ask for the resources that NSF needs to do their job."

Keivan Stassun asked what role past performance plays in decision making at OMB and specifically what metrics were used to evaluate past performance. Parriott replied that NSF has a well-tuned system for moving funds out the door. He added that NSF is not as good in post-award monitoring, but part of that was likely to be a result of inadequate resources. Said Parriott, "Past performance there would suggest that the NSF grant-making machine is a decent place to spend money and that universities are a pretty good place to spend money." He continued, "Where past performance really comes in, especially in my mind coming from the [DOE] Office of Science account, is large projects." Parriott said that he knows of past astronomy projects that have performed well but that ALMA has not. He added, "I don't think a lot about proposal success rates because I think you can make your success rate what you want it to be. You can't just fix success rate with increasing the budget in a nonlinear system."

Balick asked if OMB tracks the overruns in MREFC projects. Parriott replied that he does and that NSF had released a report on that issue. Balick asked Parriott if he could estimate the average size of MREFC overruns. Parriott considered for a moment and offered an estimate of 33%, which he compared to a project management guideline of 10%. The Chair noted that NASA was currently using a 30% contingency. Parriott replied that 50% was acceptable on high-risk areas and noted, "that's the problem with locking in a baseline too early."

Weinberger noted that the American Competitiveness Initiative (ACI) contains guidance and goals that are both very specific and very general. She noted that astronomy fits well with the general goals and asked how much OMB was looking at how NSF divisions meet the specific goals versus the general ones. Parriott described his understanding that ACI was intended to increase budgets at non-biomedical agencies and that the initiative focuses on such things as nanotechnology, supercomputing and energy technologies. He noted, "I'm pretty sure that galaxy formation wasn't mentioned." He commented that "everybody can claim to be contributing to getting people interested in science and science careers," but added, "over here that's a little too squishy." He said that OMB was looking for more specific things and noted that the Administration has other priorities in addition to ACI.

Freedman asked Parriott for any further thoughts on the decadal survey process. Parriott replied, given that "every survey by its very nature is going to be a snapshot in time," it would be very

helpful to identify the means to respond to changing circumstances. He added that it would be helpful to provide some guidance on the "science-per-dollar" calculation. He also noted that it was unclear how to include lifecycle costs for projects on the ground and that the decadal committee would have a difficult time drawing the boundaries for astronomy and astrophysics.

The Chair thanked Parriott for joining the Committee, especially during a busy time of year for OMB.

MEETING ADJOURNED AT 10:50 AM – RECONVENED AT 11:10 AM

Glen Crawford, Acting Senior Program Officer for DOE High Energy Physics (HEP) Programs, Plans and Budgets, provided an overview of HEP, including science questions and prioritization for the field. He reported that HEP had structured its program to align with the priorities identified by the elementary particle physics decadal survey (EPP2010) and that the HEP program for the next 10–15 years would focus on: Large Hadron Collider (LHC) discoveries at the terascale; International Linear Collider (ILC) and Superconducting Radio Frequency (SCRF) R&D leading to a construction decision with an international agreement for a U.S.-based ILC and, if not ILC, and alternate world-leading U.S. facility; and dark energy, dark-matter detection, neutrinos and particle astrophysics. He provided a timeline for scenarios and decision points of the HEP program.

Crawford provided an overview of the HEP budget in the President's FY08 Budget Request, House markup and Senate markup. He stated that the bottom line was ~$780M and noted the addition of $7M in the Senate markup for the Joint Dark Energy Mission (JDEM). He identified current Major Items of Equipment (MIE) projects, budgets and completion dates. Crawford noted that MIE includes everything greater than $2M that's not civil construction and does not include operational costs.

Crawford reviewed the "big picture" for HEP FY08: operating current facilities and preparing for the next decade's activities; new (M&S-intensive) HEP construction projects would be ramping up; ILC R&D was ramping up to a $60M request for FY08, up from $42M in FY07; the Tevatron, B-Factory and Neutrinos at the Main Injector (NuMI) projects were all running "full steam." He described the role of the Particle Physics Project Prioritization Panel (P5) in setting priorities.

Daniel Lester said that he was interested in the difference in approaches between DOE and NSF in creating a funding "wedge." Van Citters replied, "I'm not so sure they're all that different. They are both community-based, are given some ground rules to set priorities, and are advisory to the agency." He added that NSF does not have a standing committee such as P5, but otherwise the processes were very similar. Crawford clarified that P5 is actually a "renewable, non-standing" committee and elaborated that the agency writes a different charge and selects a different membership each time around.

Crawford noted that the terascale is where the electromagnetic and weak forces unify. He showed where the Tevatron experiments were at the moment in seeking the Higgs particle and noted that they were getting close to ruling out to 95% confidence a large portion of the expected mass range. He reported on LHC status, which was currently on schedule for the first injected TeV beam before June 2008. He noted an excellent record of recovery at LHC from past technical problems with the accelerator and in the readying of detectors. He articulated the run plan, which currently scheduled the first beam by 21 May 2008 and full physics runs in fall of 2008.

Stubbs said that he was interested in contrasting cost implications for NSF and DOE of schedule slip in LHC. Crawford stated that the project relies on scope contingency given the cost caps from Congress for both agencies. He added that the agencies have modified scope as needed to fit within the caps but that the project was still delivering more scope than what was promised to the European Organization for Nuclear Research (CERN). Joseph Dehmer, NSF Division Director for Physics, noted two big differences in Europe: one may use time/schedule as a contingency because member states provide additional contributions as needed; also, CERN borrowed a lot of money from banks "to keep their cash flow going," which they would pay back through ongoing costs including debt service.

Crawford reported on the first ILC Reference Design Report (RDR) from the international effort. The report had been reviewed by an international review team and was subject to a great deal of discussion of the interpretation of the ILC "value estimate."

Crawford showed a cartoon of the possible neutrino mass hierarchies and noted that oscillations between eigenstates provide measurements of mass differences but not of the overall mass scale. He described the goals of the next phases of the worldwide experimental program in neutrino oscillations and reported on the status of upcoming neutrino experiments. He noted that the Enriched Xenon Observatory-200kg (EXO-200) neutrinoless double-beta decay experiment would allow direct measurement of the neutrino mass. He elaborated that, if the neutrino is its own antiparticle, neutrinoless double-beta decay is allowed but rare; hence, one requires a large detector mass and ultra-low background.

Crawford reviewed current dark matter searches, including the Cryogenic Dark Matter Search II (CDMS-II) and the Axion Dark Matter Search (ADMX), as well as future dark-matter detectors. He noted that HEP was currently evaluating technologies as recommended by the Dark Matter Scientific Assessment Group (DMSAG).

Crawford reviewed planning and recommendations for dark-energy studies as provided by the Dark Energy Task Force (DETF) and P5. He described the Dark Energy Survey (DES) project (in coordination with NSF) and other HEP support for dark energy. He noted that in 2008 HEP again plans to provide "generic" dark energy support—the solicitation was posted online[1] on October 3—and was providing R&D funds for the Large Synoptic Survey Telescope (LSST) and JDEM. He also reported that HEP would continue R&D for the Supernova Acceleration Probe (SNAP) and had started R&D funding in FY07 for both Destiny and the Advanced Dark Energy Physics Telescope (ADEPT) with the latter at ~$200K.

Crawford noted that NASA and DOE had jointly sponsored the National Research Council (NRC) Beyond Einstein Program Assessment Committee (BEPAC) study to identify the highest priority among the five proposed NASA Beyond Einstein missions. The report was released on 6 September 2007 and recommended JDEM as the top priority. Crawford stated that DOE and NASA had started meeting regularly to lay out a path forward and have also been meeting with the Office of Science and Technology Policy (OSTP). He added that he could not discuss any details or issues at this time but offered that the agencies were targeting an announcement of opportunity (AO) in 2008, selection in 2009, and launch in the middle of the next decade.

Crawford reviewed the status of other HEP projects in astronomy and astrophysics, including the Sloan Digital Sky Survey II (SDSS-II), the Very Energetic Radiation Imaging Telescope Array System (VERITAS), the Gamma-ray Large Area Space Telescope (GLAST) and the Pierre Auger

[1] http://www.science.doe.gov/grants

Observatory. He noted that proposals were starting to come in or were expected soon for next-generation tools for high-energy and particle-astrophysics experiments. He said that an important part of the DOE-HEP evaluation process would be asking how various proposals impact the HEP mission to "understand how our universe works at its most fundamental level." He added that HEP would ask both the High Energy Physics Advisory Panel (HEPAP) and the AAAC for advice in evaluating and prioritizing.

The Chair asked Committee members to defer BEPAC questions until the scheduled discussion later in the day and asked for other questions. Scott Dodelson asked Crawford to identify the level of DOE involvement in the astronomy decadal survey. Crawford responded that DOE had not yet seen the survey proposal but would cooperate and contribute support to the next decadal survey.

The Chair asked how DOE would be responding broadly to the DMSAG recommendations. Dehmer replied that he thought that the DMSAG recommendations were coincident with where NSF and DOE were going. Crawford added, "We're activity working with NSF on all of these issues." Dehmer continued, "We really are hand-in-glove on all of particle astrophysics." He said that NSF and DOE collaborate half the time or probably more and that the cooperation was excellent.

Balick asked how activity in the U.S. relates to the efforts in Europe and Asia. Dehmer replied that the recent AStroParticle ERAnet[2] (ASPERA) meeting showed that the U.S. was doing very well in particle astrophysics. He said that Europe and China were now beginning to fund planning exercises for a large, deep underground lab and that the U.S. was about 3–4 years ahead of that. He noted that, because everyone expects that there will be a 1 Megaton detector, the U.S. was looking at what would be complimentary to that. He concluded, "The international cooperation in particle astro[physics] will be extremely strong."

MEETING ADJOURNED AT 12:35 PM – RECONVENED AT 1:10 PM

Director of the NASA Astrophysics Division, Jon Morse, reviewed the "guiding principles" of the Science Mission Directorate (SMD): to advance the priorities of all four of the SMD-relevant decadal surveys; to get more from budgets through better management and investments in research and analysis (R&A); and to help the Vision for Space Exploration succeed (e.g. by fostering a lunar science community). He noted that "getting more from the budgets we have" included both interagency and international coordination and collaboration.

Morse reviewed the current SMD organization chart and identified the roles of senior management and the arrival of new personnel. He noted that Paul Hertz was serving as Program Scientist for the Stratospheric Observatory for Infrared Astronomy (SOFIA).

Morse described current directions for NASA Astrophysics in response to recommendations from community reports, including a "hard look" at balance among mission sizes, and reviewed news items in the Astrophyscis Division. He identified exciting new capabilities that would launch within two years, including GLAST, the Hubble Space Telescope Servicing Mission 4 (HST-SM4), Kepler, Herschel/Planck, and the Wide-field Infrared Survey Explorer (WISE). Morse described three new SMD foci: Strategic Investments in Research and Analysis (R&A), Data Analysis, and Suborbital Opportunities.

[2] http://www.aspera-eu.org/

Morse reported reinstatement of the Nuclear Spectroscopic Telescope Array (NuSTAR) mission and noted that the next Small Explorer (SMEX) AO was on the street. He said that a pre-proposal conference would be held on November 6 in Washington, DC, and that Notices of Intent (NOI) to propose were due November 16. Full proposals would be due on 15 January 2008. The AO includes a mission cost cap of $105M (in FY08 dollars), excluding the launch vehicle, as well as a Mission-of-Opportunity allocation of $70M (also in FY08 dollars). Selections were anticipated 4 months after the proposal submission deadline for approximately 6–8 Phase-A concept studies leading to selection of up to 3 for flight. Morse noted that the AO includes new experience standards for the principal investigator (PI), but only for the PI. Morse also reported that proposals were due November 20 in response to the 2007 Strategic Mission Concept Studies NASA Research Announcement (NRA).

The Chair expressed concern over the timing of the downselect of strategic mission concept studies before the decadal survey because of the potential for influence on panel decisions. His comment was followed by extensive discussion of mission planning and input to the next decadal survey. The discussion highlighted the risk that the selected studies might effectively limit the range of missions under consideration by the decadal survey panels. An offsetting view was that the studies would bring greater insights into the selected subset of missions. The downside was noted as not being large, provided that the selected mission set was broad, but differences of opinion remained at the end of the discussion.

Morse showed timelines for missions in the stages of operations, development and formulation and identified items of note: the Far Ultraviolet Spectroscopic Explorer (FUSE) would be terminated after losing its last reaction wheel; NASA would conduct an independent assessment of the potential warm phase for Spitzer; and the onset of science results for SOFIA had been accelerated.

Morse showed the President's FY08 Budget Request for SMD by division and noted that he expects stability in the budget projections. He noted that the Astrophysics (full cost) budget would decrease from FY08 to FY09, stay flat through FY11, then rise with inflation. He showed the SMD mission launch chart and noted: Kepler had moved to 2009; fewer missions would launch in 2010–11; three SMEX flight opportunities were slated for 2012–2013–2014. He also showed a version of the mission launch chart that identified both the SMD division and the size of the investment.

Morse provided a look forward to implementation of the BEPAC and ExoPlanet Task Force (ExoPTF) report recommendations. He identified several assumptions for future planning: the Astrophysics Division budget would remain approximately flat; currently planned facilities would operate at least as long as planned (but most would likely last longer); current missions in development would be completed; basic R&A funding would increase or at worst remain the same; mission funding profile shapes would resemble those in the past. He then provided a rough calculation of the funding available above fixed costs for the next five years, which would allow ~$300M per year (in FY08 dollars) for other things (including medium-class missions and Explorers) by the end of the five-year period. He noted that a balanced portfolio would include: reinvigorating R&A, suborbital, and missions of opportunity; medium class missions with cost envelopes of ~$600–700M at a ~$150–200M/year peak requirement; and the next >$1B mission after the James Webb Space Telescope (JWST). He added that a significant goal is to improve early cost estimations for strategic missions.

Morse concluded that next two years would be rich in new observational capabilities as missions in development launch. While constrained, the NASA Astrophysics budgets were capable of

supporting the initiation of several new missions in the next decade. He reiterated the emphasis on increased R&A, suborbital and small launch opportunities. Said Morse, "Future creativity and hard work of the community, working with government and industry, will produce equally stunning results during the next decade and beyond in a program that is affordable and executable."

Sterl Phinney asked how much of the NASA budget was going to universities at the moment. Morse showed that the Astrophysics research budget was approximately $213M, or 20% of the budget. Stassun noted that Morse showed a figure of $11B in reference to the BEPAC report and asked if that was the entire BE portfolio. Morse replied yes. The Committee continued to discuss the NASA budget in the context of the overall Federal budget. The concern was noted that the NASA budget for Astrophysics was decreasing and did not ramp up after the 2010 decadal survey release date.

NRC Committee on Astronomy and Astrophysics (CAA) Co-Chair Charles Bennett and BEPAC Co-Chair Charles Kennel joined the meeting via teleconference to summarize the results of the BEPAC study. Kennel reviewed the charge to the BEPAC committee. He noted that two of the five proposed Beyond Einstein (BE) missions were defined projects, while three others were areas with several proposed projects that could fill the mission slot. He identified the committee membership and noted that co-Chair Joseph Rothenberg worked on technical side while Kennel drove consensus on the science side. He identified "essential tensions" in the dialogue among astronomers and physicists and among engineers and scientists that proved to be very creative.

Kennel stated that BE science includes challenges at the intersection of physics and astrophysics and has the potential to extend our basic physical laws beyond where 20th-century research left them. He said that new physical understanding may be required to explain cosmological observations and that the challenge of investigating the laws of physics using astronomical techniques promises to bring higher precision, clarity and completeness to many astrophysical investigations relating to galaxies, black holes and the large-scale structure of the universe, among other areas.

Kennel identified the five BE mission areas and the eleven individual mission candidates. He reviewed the science goals of each BE mission. He described the committee's data gathering process and meeting schedule, which included four committee meetings and a series of town hall meetings for community input. Following the first committee meeting in November, the committee distributed a request for information (RFI) to the 11 mission candidate teams, which was in turn followed by detailed presentations from the teams at the second committee meeting. The NRC also established an email inbox for community input and posted the input received on the committee's website[3]. The committee also heard from the European Space Agency (ESA) on plans for BE science as well as a presentation on the ability of ground-based telescopes to investigate dark energy.

Kennel reviewed the BEPAC report's table of contents and the five evaluation criteria used: advancement of BE research goals, broader science contributions, potential for revolutionary discovery, science risk and readiness, and uniqueness of the mission candidate for addressing its scientific question. Kennel also reviewed BE science objectives: to find out what powered the Big Bang; to observe how black holes manipulate space, time and matter; and to identify the mysterious dark energy pulling the Universe apart.

[3] http://www7.nationalacademies.org/ssb/comments.html

Kennel described the evaluation of technical readiness, which consisted of two parts: (1) technical readiness, including the instrument, spacecraft, operations and technical margins and (2) management readiness, including team organization, schedule and other special challenges. He noted that the committee, supported by Science Applications International Corporation (SAIC), developed independent cost estimates for each mission candidate using three different models derived from historical databases. He noted that the committee saw this job as developing methodologies that would be useful in comparing costs with a commensurate basis across missions at various stages of development and that the committee used three different models to try to make early estimates of cost (QuickCost, NAFCOM and CoBRA).

Kennel also noted policy issues that could influence future implementation of the BEPAC report recommendations. As directed in the statement of task, the committee made its recommendations based on assessments of scientific impact and technical and management realism of the proposed missions. Kennel added that "the only rigorous thing to do" was to stick to the budget wedge that was provided to the committee.

Kennel then reviewed the report findings and recommendations. He said that two mission areas stood out for the directness with which they address BE goals and their potential for broader scientific impact: the Laser Interferometer Space Antenna (LISA) and JDEM. The committee found that LISA science was extraordinarily compelling as a long-term flagship mission for BE but that the mission was not ready technically for an FY09 start.

Katie Freese asked Kennel to identify the BE science that LISA would address. Kennel replied that there are most certainly sources in the universe—including coalescing black holes—that radiate at the detection frequency of LISA. He explained that LISA science includs tests in the strong-field limit of general relativity, as well as searching for remnant gravitational waves from the early universe. In addition, an optical identification of the gravitational wave source would provide a precise determination of the distance scale of the universe.

Kennel reported that the committee found that the JDEM mission candidates identified thus far were based on instrument and spacecraft technologies that have either been flown in space or have been extensively developed in other programs. Thus, a JDEM mission selected in 2009 could proceed smoothly to a timely and successful launch. The committee also found that the present NASA BE funding wedge alone was inadequate to develop any candidate BE mission on its nominal schedule; however, both JDEM and LISA could be carried out with the currently forecasted NASA contribution if the DOE contribution that benefits JDEM is taken into account and if LISA's development schedule was extended and funding from ESA was assumed.

The committee recommended that NASA and DOE proceed immediately with a competition to select a JDEM mission for a 2009 new start. The broad mission goals in the Request for Proposal should be (1) to determine the properties of dark energy with high precision and (2) to enable a broad range of astronomical investigations. The committee encouraged the agencies to seek as wide a variety of mission concepts and partnerships as possible.

The committee also recommended that NASA invest additional BE funds in LISA technology development and risk reduction to help ensure that the agency is in a position to proceed in partnership with ESA to a new start after the LISA Pathfinder results are understood.

The committee recommended that NASA move forward with appropriate measures to increase the readiness of the three remaining mission areas—Black Hole Finder Probe, Constellation-X,

and Inflation Probe—for consideration by NASA and the NRC Decadal Survey of Astronomy and Astrophysics.

DOE-HEP Program Officer Kathy Turner joined the meeting via teleconference.

Kennel summarized the committee's final selection: JDEM is the mission providing the measurements most likely to determine the nature of dark energy, and LISA provides the most direct and cleanest probe of spacetime near a black hole. Constellation-X, in contrast, provides measurements promising progress on at least two of the three questions, but does not provide the most direct, cleanest measurement on any of them. It was the committee's judgment that for a focused program like Beyond Einstein, it is most important to provide the definitive measurement against at least one of the questions. The committee concluded that JDEM is technologically mature enough to succeed on the timescale specified in the charge. LISA requires additional technology development and a successful pathfinder mission before it is ready for development.

The Chair thanked Kennel for his excellent summary and an outstanding report.

The Chair broadened the discussion and asked Jon Morse and Glen Crawford to join the Committee at the table. Marcia Rieke asked if the committee's costing methodology could be applied to large, ground-based projects. Kennel identified this as an excellent question. He said that he only knows that the folks who run NASA projects are highly disciplined; he would suggest inviting one of them to come to a review of a big, ground-based project to see if there was something valuable to come from that interaction. NRC/BEPAC staff member Brian Dewhurst acknowledged the extensive database of comparables available for space missions, but added that he did not know if that kind of database were available for the ground. Kennel noted that one could collect that kind of data for the ground, particularly for optical telescopes.

Morse noted that a JDEM new start delayed into FY11 and a LISA new start in FY14 would fill the Astrophysics wedge. He said that with no additional funding for another large mission, the community would have to come to NASA with a decision that this is the science to be done in the available space. Kennel said that it was important for NASA and DOE to get together to decide how they would work on this and also for communities to get together to explore if excitement exists in the high-energy physics communities to co-fund more of these missions.

Lester noted that, aside from JDEM and LISA, the committee recommended that NASA should move forward with "best judgment." He asked Morse for his thoughts on how to move forward. Morse replied that LISA and Con-X have budget lines in the FY08 Budget Request that support minimal technology development funding. He added that no change from that was expected in the next year as the decadal survey panels start chewing on it. He said simply, "It's as much as we can afford."

Phinney noted that the term "new start" seems to have at least two meanings in the report and even more at NASA and asked what the term was intended to mean. Kennel replied that most of the time the committee meant entry into formal Phase A. Phinney elaborated, "So the recommendation is to 'de-new-start' LISA and to 're-new start' JDEM?" Morse replied, "Practically speaking, yes." Phinney asked if the recommendations could be overturned by the decadal survey. The Chair replied yes, formally, but he sensed that the expectation would be for JDEM to move ahead.

Stubbs commented that by construction this exercise evaluated these missions with fundamental physics as the primary metric and that, as the decadal survey is assembled, we'll have to consider

how to involve that community. He also noted that the cost estimates used were done as carefully as possible but were also uncertain: “It makes it of paramount importance that we understand the validity of these cost estimates.” Kennel said that he could support both of those points. Stubbs continued, “So why would NASA decide to spend its costing resources ahead of time on two particular missions rather than keep it available for any creative idea off of the street?” Morse replied, “We’re going to do both. We’ve stated that we’re going to make NASA resources available to the costing exercises necessary for the decadal survey. We certainly can’t afford a rigorous process for every creative idea off the street, but we are willing to augment the costing efforts of the decadal survey with our own resources once the survey undertakes its first steps of science prioritization.” The Chair reiterated that there would need to be a science downselect first.

The Chair asked Morse and Crawford to describe what is happening on JDEM. Morse replied that NASA plans to talk with DOE as well as with its domestic and international partners about the possibilities and mechanisms for putting together a mission that’s built around the science. He said, “We still have some work to do.” He said that a timeline for reaching Phase A was to be determined, but that the agencies could start a process for the acquisition in a year or so. He noted that plans would depend on appropriations and on how the partnership is structured, particularly if there were international components. Said Morse, “We have to find a balance between just putting a budget number out there and making sure that we’re doing the most exciting science we can that we can afford.” The Chair asked if there would be a solicitation. Morse replied that the agencies were discussing it. He added that JDEM would be a strategic mission with a competed aspect and a field center to manage the project. The Chair asked if discussions were ongoing on identifying a lead agency for JDEM. Morse replied that he would not frame it that way and offered, “We’re looking at how to scope the whole program for meaningful science.”

Crawford added, “Clearly both agencies want to play a major role in the project. The challenge is to define what role each agency takes on and how they work together. It won’t fit exactly into our culture in either one, but we certainly hope that it will be successful.” Crawford said that the agencies were currently holding weekly meetings at the program level. He continued, “We know some of the ground rules from smaller efforts like GLAST, but this is new territory.” Turner added that the agencies were also working with OSTP. She said that there were quite a number of things to work out and that the agencies “need the time to do it right.” She added, “We’re excited, and we’re actively working on it.” Crawford said that DOE realizes that JDEM is going to be a lot of work, so Turner would be doing JDEM as her “more-than-a-full-time job” and DOE was also looking for help.

Stubbs stated, “I think this BEPAC report is a very crisp answer to the wrong question,” and offered that the right question to ask was, “What is the optimal combination of ground-based and space-based investments that would most effectively address dark energy?” He continued, “We’re in a position to fold in the third agency that has the ground-based side to offer,” and asked if the AO would include a ground-based component that would complement the space-based piece. Morse replied, “That question is dead on,” and added, “We’re looking at what resources will be available.” Morse noted that the DETF looked at how ground and space would work together to improve their figure of merit. Stubbs countered that the DETF report did not address his question specifically. The Chair identified this as “a prime example of what happens when Congress gets into the act” and added, “the stage is not amenable to that anymore.” He noted that a rational process would have been to complete the DETF report, plan for ground and space concurrently, and then move forward. Instead, he said, “We now have to recover and make the best of it and look at the activities that would best complement a JDEM activity.” Stubbs added, “And so I would suggest that people in this room could look at that and serve science well.”

The Committee discussed the cost of JDEM and methods for addressing cost growth. The Committee expressed that a clear focus was needed on constraining JDEM cost growth.

The Chair thanked Kennel for his time today and the committee's incredible effort and clear recommendations. Kennel said that he appreciated the time spent on the issue and requested that the Chair keep him informed of the Committee's thinking. The Chair thanked Turner for joining the discussion.

MEETING ADJOURNED AT 4:15 PM – RECONVENED AT 4:35 PM

OSTP Assistant Director for Physical Sciences and Engineering Kathryn Beers and Senior Policy Advisor Jean Cottam joined the meeting. Beers provided an overview of OSTP and asked to make two points based on the day's previous discussion. She drew attention to both the recent NRC report on plasma physics[4], which included the recommendation that the AAAC look at plasma science, and the National Science and Technology Council (NSTC) Report of the Interagency Task Force on High Energy Density Physics[5]. She also noted a large emphasis on climate and earth science right now and reminded the Committee that those areas also have attention at NASA.

Beers identified the Committee's earlier discussion with Parriott regarding the NSF MREFC account as salient. She said that OSTP sees in parallel the processes at DOE, NASA and NSF and noted that OSTP Director John Marburger has remarked that a comparison among the agencies could be of considerable benefit. Beers emphasized that the MREFC process could particularly benefit from such a comparison. She recalled that Parriott had mentioned various options for addressing lifecycle costs at NSF and added, "I think he's asking all the right questions." She continued, "Of those options, we think it's scary to eliminate MREFC and push everything down into the directorates." She noted in such a scenario that MPS would become huge compared to every other part of NSF and that one must then consider how MPS would compete with the rest of the Foundation.

The Chair commented that a critical step in the near term could be strengthening the initial costing activities for MREFC projects. Beers responded, "There may be times when NSF should be building large facilities, and there are other times when other agencies may be better placed with the skill and experience to undertake that project." She added that the rest of NSF has a lot to learn from AST "for the hard choices that they've made and the process that they've undertaken" with the Senior Review.

Stubbs asked how OSTP perceives the way that the different agencies treat contingency. Beers replied that different mechanisms and types of projects promote healthy differences in how the agencies can apply contingency. She offered examples of NASA space-based missions in comparison with DOE large projects.

Lester asked if there were lessons for public-private partnerships outside of astronomy and the physical sciences that Beers could bring to the Committee's attention. Beers suggested that the best place to look right now was the Smithsonian, which "has been doing this for a very long time." She added, "I don't have a lot of insight for you for how to solve the problem." Freedman

[4] "Plasma Science: Advancing Knowledge in the National Interest;" http://www.nap.edu/catalog.php?record_id=11960

[5] http://www.sc.doe.gov/News_Information/Report%20of%20the%20Interagency%20Task%20Force%20on%20High%20Energy%20Density%20Physics.pdf

noted that, as OSTP Assistant Director for Physical Sciences and Engineering, Patrick Looney once characterized this problem as "an orphan left on your doorstep." Beers agreed, "I don't think there are examples of this magnitude or complexity." The Chair stated that moving forward on this may best be done with a very clear plan, and the community does not have that yet. Beers offered, "The more you can do to convince the Federal government that this is the best investment for the community and is advocated for by the community broadly, the better it will be." The Chair stated that the astronomical community had a start on that consensus with the last decadal survey, but not a lot on a public level has been done since then. He continued, "We'll need to be more specific on how we want to proceed."

Beers, Cottam and the Committee discussed and compared processes in Europe for science program planning and investment.

Freedman asked for the OSTP perspective on LSST as a different sort of example of coordination between NSF and DOE. Beers said that OSTP hasn't yet been asked to weigh in on that except on how other priorities may impact the wedge for LSST.

The Chair inquired about ACI and asked specifically how OSTP sees ACI at the moment and for the rest of this Administration. Beers replied that she agreed with Parriott's earlier comments on ACI and that not much change was anticipated from this Administration's perspective. She said, "Our office is still committed very much to meeting those obligations." She also stressed the difference and importance of the appropriations process and its impact: "Last year we were successful, but that process would have to be started from scratch again if we didn't get an appropriation." Stubbs asked if that meant that the augmentation wouldn't follow through under a continuing resolution. Beers replied that no, formally one would go back to the last passed appropriation, which was FY06. She added, "That would be particularly bad for DOE."

The Chair asked Beers for her impressions of the BEPAC report. Beers responded that OSTP was very impressed with the rigor and process and was pleased that NRC "opened up a new paradigm in how they do business" for incorporating more realistic cost estimates. She added that, now that we have these estimates, she completely empathized with Morse for how difficult it is to fit these projects into the portfolio.

Dodelson asked what OSTP would think about broadening the JDEM discussions to include NSF and ground-based efforts. Beers replied that it would be important scientifically but added, "The committee wanted both fast and flexible, and one can do only one or the other. They seemed to want 'fast' more." NASA BE Program Manager Michael Salamon noted that the agencies specifically called out to the committee that the mission should be considered in the context of ground-based and other space-based activities and stated, "We're now going to follow through on their advice." Stubbs replied that he understood but that it did not make sense to have only two of the agencies at the table when NSF could provide essential science to complement the mission. The Committee discussed at some length the complexity of the interagency planning among ground- and space-based efforts. The broad sense was that closer coupling was needed to ensure that the optimal strategy was followed.

The Chair added that the Dark Energy Survey (DES) was going ahead as a partnership between DOE and NSF and that one could include complementary activities on the ground in consideration of the space-based activities. "But," he said, "we don't want to stall or slow down the space efforts as a result. We've already gone through a lot to get here."

Freedman noted that the AAAC was the right committee to grapple with these things. Phinney offered that the best committee to do this would be the decadal survey. He added that one must accept that other committees with different boundary conditions would have a different perspective. Dodelson commented that it was unclear that the decadal survey was the "end all or perfect process" either. Beers responded, "But it may be the most effective way." The Chair noted that the involvement of DOE in the decadal survey was an excellent development. Freese asked how the agencies were involved in the process. Van Citters replied that the agencies were talking to the NRC about how exactly the survey would work. He described the issue as a "delicate balance between an independent look at the field and intense agency involvement." The Committee continued discussion about the decadal survey process.

The Chair thanked both Beers and Cottam for their participation.

The Committee continued their discussion about decadal survey planning and potential input to the process from the AAAC. Van Citters noted that NSF has a proposal from the NRC requesting funds for the survey that would be sent out to the community for review. He said that NASA and NSF have agreed on a joint review and that the agencies would issue a joint memo to the NRC with their input to process. He added that NASA, NSF, DOE, OMB and OSTP have also met to discuss the survey. The Chair noted that the Committee should ask the NRC what might be the most useful input at this point. Van Citters noted that both NASA and NSF agreed that the cost of the survey was not a problem relative to the magnitude of what is being addressed. Instead, he said, the agencies would be addressing "boundaries and process."

MEETING ADJOURNED AT 5:30 PM, 11 OCTOBER 2007

MEETING RECONVENED AT 8:30 AM EST, 12 OCTOBER 2007

Minutes of the May 2007 AAAC meeting were approved with only minor comments that would be sent to the Executive Secretary.

The Chair reviewed activities on the agenda for the day. He reminded the committee of the background that motivated the formation of the ExoPlanet Task Force (ExoPTF), which should submit its draft report to the readers in several weeks. Today the AAAC would be presented with an interim report to get a sense of how the task force is thinking. The broad structure and themes of the report were expected to be unchanged. The AAAC may want to schedule a teleconference in November or December to discuss the report after input from the readers is included.

The Chair introduced Robert Gehrz, who would later make a presentation on SOFIA science. Megan Urry and Chuck Bennett would be available by teleconference for the discussion on the next decadal survey. Finally, the committee would need to elect a new chair.

The Committee entered into general discussion about the BEPAC recommendations and how ground-based work could be brought into consideration of its recommendations. There was a general sense that decisions made about JDEM should be cognizant of ground-based opportunities, even if there could not be assurance at the time of proposal submission that coordinated ground-based capabilities would exist.

ExoPTF Chair Jonathan Lunine presented an update on the ExoPTF activities and status of its report. He reminded the Committee that the findings presented were preliminary, and he expected that input from the AAAC and the readers would result in changes. He reviewed the history of discoveries of extrasolar planets and the rate of publication in the field, both of which had

increased rapidly in the last six to seven years. He reviewed recent results and the techniques used to obtain them. Currently, over 200 exoplanets are known, most having been discovered by radial velocity techniques. There is a rich variety of extrasolar planetary systems; planet formation is a common, but not universal, feature of star formation. Multiple planet systems are starting to be discovered now that longer time-baselines are available. With the higher accuracy now possible surveys are also reaching lower masses. Potentially Earth-like planets may be common, although there is still the ambiguity of the inclination of the orbit of the planetary system.

He reviewed the charge to the ExoPTF. Its key element was the development of a strategy to identify Earth-like planets in habitable zones. The task force's recommended plan was optimal in maximizing the output with a reasonable cost. He reviewed the specific areas the task force had been asked to address. He reviewed the task force membership, noting its breadth of expertise and perspective, and outlined the schedule of task force meetings and the input they had received from the community.

Two major questions framed their strategy: what are the characteristics of earth-size or earth-mass planets in habitable zones around bright, nearby stars and what are the techniques to determine these?; and what is the architecture of planetary systems?

The draft report made six recommendations: 1) intensify radial velocity studies to reach lower-mass planets by providing more time on larger telescopes and higher precision with extension to the near infrared, 2) search for transiting terrestrial exoplanets around nearby M dwarfs, characterized with the warm Spitzer mission and JWST, 3) prepare for a characterization mission around sun-like stars, which requires technology development in several areas and sensitive exozodiacal measurements around nearby stars, 4) a characterization mission with coronography/occulter first, followed by interferometry, 5) microlensing for large-scale architectures, to augment ground-based systems or a space-borne mission, and 6) flexibility of approach by adjusting the timing and scope of missions.

The task force suggested a two-pronged strategy, with three time horizons, that proposed separate strategies for M dwarfs and for F, G, and K stars. The strategies also differed depending on the fraction of stars with Earth-like planets in the habitable zone, still an unknown. For M dwarfs, a fast track relies on ground-based and existing space missions while the approach for F-K dwarfs requires technology investments and new space-based facilities. The final plan was a balance among different types of techniques, ground- and space-based, and a mixture of existing and new capabilities. The strategy provided an opportunity for early studies and risk reduction and maintains flexibility.

The Committee entered into discussion of the report. Members inquired about how some specific studies fit into the proposed program, and Lunine emphasized that the task force was not reviewing individual efforts. He was asked what budget profile was needed. Lunine noted that the task force had not determined budgets and had only tried to size missions in rough categories. The profile would have a slow ramp-up, however, with early funding being toward ground-based telescopes dedicated to surveys. Freedman noted that the task force had endorsed the warm Spitzer mission and asked what would happen if that did not go ahead. The task force regarded their report as one of the arguments to continue its operation. If Spitzer did not continue, things would wait for JWST. NASA Goddard Space Flight Center ExoPlanets and Stellar Astrophysics Laboratory Chief Jennifer Wiseman asked for clarification on the recommendation that an astrometry mission go before a coronography/occulting mission regardless of the frequency of Earth-like planets. Lunine explained that astrometry provides a target list and would potentially

yield densities, while a coronograph may not be productive if the pollution is too high. He clarified that space-based interferometry is the method of choice for astrometry.

The Chair thanked Lunine and the task force for its efforts. Lunine said he would entertain emails from AAAC members and would send the answers to all members.

Robert Gehrz next spoke on SOFIA science highlights. He leads the SOFIA Community Task Force (SCTF); a group formed to ensure that SOFIA's capabilities are appreciated by the community. He outlined the major science topics that SOFIA could contribute to, such as the question of origins, how stars form in our galaxy and other nearby galaxies, solar system studies, and targets of opportunity, such as variable stars, comets, novae and supernovae. He reviewed the advantages of SOFIA, such as that it flies above 99% of the water vapor in the atmosphere. SOFIA operates from 1 to 800 microns, has a wide variety of instrumentation capabilities, and can observe anywhere at any time. He reviewed its unique science capabilities, which include a large field of view and the ability to track temporal events. He offered a number of examples of how SOFIA could be used, including astrochemistry, occultation astronomy, and studies of extrasolar planetary transits, debris disks, and classical novae. He reviewed SOFIA's instrument complement, which covers the full IR range with imagers and low, moderate, and high resolution spectrographs. He pointed out that SOFIA capabilities fill a large phase space in resolution and wavelength so should provide science opportunities for a wide community of users.

Gehrz reviewed the status of the mission. The aircraft flew in April 2007; early science was expected in 2009 and user science in 2010. The mission has a 20-year design lifetime. A total of 100 to 120 flights were expected in 2013. A call for next-generation instruments would be made in 2010; the operating budget included instrument upgrades. The cost per hour of operation is high, due to SOFIA's lower number of operating hours than for most missions. Gehrz reported that the lifecycle cost of SOFIA was $2.565B in FY2006 dollars, which was comparable to other great observatories, like Chandra, Spitzer, and HST.

The Chair urged the SCTF to inform the community of the broader capabilities of SOFIA and the larger questions it could address. That is the goal of the workshops the group is hosting. The Chair also emphasized the need to develop a broadly based science program consistent with the scale of the SOFIA mission, as the AAAC had encouraged in its 2007 annual report. There were questions and some discussion about "killer aps" that SOFIA would be in a position to make and how far one could look into the future in terms of complementarity to other facilities. Paul Hertz of NASA SMD clarified that there would be a fully funded grants program for SOFIA, like other NASA missions. The Chair thanked Gehrz for coming to the meeting and for leading the community group.

Meg Urry and Chuck Bennett joined the AAAC by phone to talk with the Committee about planning for the next NRC decadal survey. Urry reminded the AAAC that the CAA is inactive while the decadal survey is going on, so she had no news of CAA activities to report. She reviewed the role of the NRC committees involved in planning for the decadal survey and their recent activity. A meeting in April 2007 led to an internal NRC proposal that had been submitted to the agencies. The survey would not start until the agencies' funding begins, which was expected early in 2008. The planning process had been discussed at recent AAS and American Physical Society (APS) meetings and would be the subject of a session at the January 2008 AAS meeting as well.

Urry reported that the guiding principles were largely left open to be decided by the agencies and the NRC. Among those considered were the community involvement which would be extensive

with input at all stages. The organization of the panels was still an open issue, of importance because there was a sense that the last survey was less impactful because of the science presentation. The Chair mentioned the approach that the Europeans had taken, which was to start with defining the science goals and to follow that with distinct activities that looked at the techniques and capabilities needed. Perhaps one could combine these approaches to make an effective process. Urry noted that everyone agreed that cost and technical readiness of projects considered in the survey must be more realistic; the model of independent assessment used in the BEPAC study was identified as one possibility. There was the question of which of the unrealized projects from the last survey would be included in the prioritization. Also still to be determined was how the international community would be included in the process, recognizing that their funding structures are very different from that in the US. The scientific scope of the survey was a topic of active discussion with the agencies, who had provided input on what would be most useful to them. The Committee discussed this issue at some length, with various members expressing the view that topics in the interface of physics and astronomy, such as those treated in the Connecting Quarks with the Cosmos[6] report, be included and that DOE be involved. NRC staff member Brian Dewhurst noted that the proposal was that the survey committee would define the panels and draw the boundaries of the study, but the NRC was now negotiating this.

Also of importance in planning was that the study be robust to changing circumstances, and to build in decisions, rules or mid-term assessments that would apply as projects become better defined or change in cost. Urry also reviewed discussions on the makeup of the survey committee and questions of how diverse it should be with respect to field and expertise covered.

Dewhurst described the process the NAS/NRC would follow in carrying out the survey. The NAS President would formally appoint the committee, based on names that have been suggested. NAS staff would poll sections of the Academy, use the AAS email exploder, and solicit input by email to collect suggested names. They would seek balance across many factors and present a committee membership that must be approved by the Board on Physics and Astronomy (BPA), the Space Science Board (SSB) and other NAS division staff, before formal approval and appointment by the NAS President. The survey committee would meet several times and would hear external presentations and gather community input at town meetings. The committee would collect all this information, then isolate itself and write their report. The report would be reviewed by outside members, NAS staff would respond to all comments, and the report would be approved and released. At no point in the process would the community see a draft report for comment.

Urry reminded the AAAC that the survey was to represent the priorities of the community, but that not all projects may be mentioned. The survey committee would be seeking more communication with the community throughout the process, perhaps with a call for white papers and ideas that are publicly shared for comment. Several members of the AAAC and Van Citters stressed that there must be a mechanism to get as wide an input as possible so that people are part of the process. In response to questions about how existing projects would be weighed against the new, as was done in the AST Senior Review, Van Citters noted that while the survey committee would not be prioritizing individual facilities, they would be asked to look at the entire suite of capabilities that are needed to prosecute the science recommended, and not assume, as in the past, that all existing facilities would always be available.

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

[6] http://www.nap.edu/openbook.php?isbn=0309074061

The Committee discussed ways in which they could provide input to the NRC on the decadal survey process, particularly the survey's scope and relationship to fundamental physics, and concluded that members should send their comments to the NRC directly, as individual views rather than as an AAAC statement. Several members spoke to the importance of involving DOE and the DOE community in the survey process. The Chair suggested that a letter to DOE-HEP Associate Director Robin Staffin from the AAAC might be effective. He proposed to draft one to circulate to the committee.

Lester inquired about the role of the AAAC during the survey and asked for the agencies' perspective. Salamon noted that there were several areas where the agencies could use input. Van Citters reminded the Committee that the business of the agencies continues through the survey process, and that the agendas of future meetings would be structured to include topics where the agencies would continue to seek advice or comment. If AAAC advice appears to be conflicting with the decadal survey, the agencies would let them know.

The Chair turned to discussion of the election of the next AAAC chair. He clarified who would be rotating off the committee in 2008, noting that a possible extension of an appointment for the duration of service as chair would be possible, making it possible to consider all current members. Freedman expressed a willingness to serve as Vice-chair but reluctance to take on the chair. Balick and Stubbs indicated an unwillingness to serve as chair. Lester noted that a number of things may change in the next few years, such as the length and detail of the annual report. There would be no CAA meetings, and NRC activities should be lessened. The Committee held no election, and would continue to consider alternatives.

The agencies were invited to raise any other issues that had not been covered in discussion. Salamon reiterated the importance of the decadal survey boundaries, and was pleased to learn that the committee members were considering it. Van Citters called attention to some issues regarding political involvement or influence by the community, particularly with respect to the recommendations of the AST Senior Review. He stated that letters to the NSF Director were not helpful and that exerting this influence could compromise all the efforts of the Senior Review. He suggested that it would be helpful if the AAAC members also brought this message to the community.

The Committee discussed sending a letter to the NSF Director that would note both strong support for the Senior Review process and concerns that community members were taking steps to undermine the process. The concerns particularly extended to Congressional language directing NSF to support facilities that were recommended for revised support through the community-based peer-assessment process of the Senior Review. The Chair offered to draft a letter for distribution and discussion.

MEETING ADJOURNED AT 2:25 PM, 12 OCTOBER 2007