

# *Astronomy and Astrophysics Advisory Committee*

L'Enfant Plaza Hotel  
480 L'Enfant Plaza, SW  
Washington, DC 20024

8–9 February 2007

## AGENDA

*Thursday, February 8, 2007:*

8:00 – 8:30	<i>Coffee and Conversation</i>	
8:30 – 8:35	Welcome and Announcements	<i>Wayne Van Citters Garth Illingworth</i>
8:55 – 9:00	Approval of Minutes	<i>Garth Illingworth</i>
9:00 – 10:00	NSF Programs/Senior Review Update	<i>Wayne Van Citters</i>
10:00 – 11:00	NASA Programs	<i>Richard Howard</i>
11:00 – 11:15	<i>Break</i>	
11:15 – 12:15	DOE Programs	<i>Robin Staffin</i>
12:15 – 1:00	Working Lunch	
1:00 – 2:30	GSMT Project Updates:	<i>Wayne Van Citters; Patrick McCarthy; Edward Stone; William Smith</i>
2:30 – 3:00	Interagency Implications of NSF/AST Senior Review Recommendations	<i>Wayne Van Citters</i>
3:00 – 3:15	Beyond Einstein NRC Committee Update	<i>Brian Dewhurst</i>
3:15 – 3:30	<i>Break</i>	
3:30 – 4:15	OSTP Update	<i>Rob Dimeo; Jon Morse</i>
4:15 – 5:00	Discussion with OMB Program Examiners	<i>Amy Kaminski; Joel Parriott; David Trinkle</i>
5:00 – 5:30	Committee Discussion	
5:30	<i>Adjourn for the Day</i>	

*Agenda, continued:*

*Friday, February 9, 2007:*

8:00 – 8:30	<i>Coffee and Conversation</i>	
8:30 – 9:30	Discussion with NASA Administrator	<i>Michael Griffin</i>
9:30 – 10:00	Committee Discussion	<i>Garth Illingworth</i>
10:00 – 10:30	JWST Update	<i>Eric Smith</i>
	<i>Break</i>	
10:45 -- 11:00	ExoPlanet Task Force Update	<i>Stephen Ridgeway; Jonathan Lunine</i>
11:00 – 11:45	Dark Matter Assessment Group Report	<i>Hank Sobel</i>
11:45 – 12:15	Decadal Survey Planning	<i>Brian Dewhurst</i>
12:15 – 1:00	<i>Working Lunch</i>	
1:00 – 3:00	Committee Discussion	<i>Garth Illingworth</i>
3:00	<i>Adjourn</i>	

Meeting Report:  
Mark Bernstein  
Infonetic  
Submitted February 22, 2007

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*Thursday, February 8:*

*Welcome and Announcements:*

Wayne Van Citters welcomed those present and thanked NASA for hosting the session. He noted this meeting would be the Committee's final face-to-face session for the remainder of the fiscal year due to lack of FY07 travel funds for NSF advisory committees.

Garth Illingworth said one goal of the meeting was to consider what issues the Committee wished to address in its annual report due March 15. He reported briefly on the FY07 and FY08 budgets, saying that the National Science Foundation [NSF] and the science activities of the Department of Energy [DOE] had fared fairly well; he noted that the NASA budget was flat—actually, a decrease if inflation were considered. Illingworth previewed the meeting's agenda, noting the scheduled Friday morning discussion with NASA Administrator Michael Griffin. He urged those present to be straightforward with their questions and concerns.

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*NSF Update and Senior Review*  
Wayne Van Citters

Wayne Van Citters presented a review of the FY07 budget, the FY08 budget request and the status of the Senior Review. Van Citters noted that the FY07 budget request had been framed by the American Competitiveness Initiative [ACI]; next, that facilities base operations budgets were being held level pending the outcome of the Senior Review; and, further, that funding increases had been obtained for the Giant Segmented Mirror Telescope [GSMT], the Telescope System Instrumentation Program [TSIP], the Adaptive Optics Development Program [AODP], Physics of the Universe activities and elementary particle physics. He noted the current FY budget was under Continuing Resolution until February 15; this required funding to remain at FY06 levels with no new starts. He believed the overall 7.7 percent increase for NSF as a whole was extremely good news; he expected Senate approval of this. Garth Illingworth asked if NSF would have flexibility on new starts in FY08. Van Citters said there were various interpretations of this: while no explicit language might forbid new starts, that was the impression. In general, he said budget matters looked much better than several months ago.

Van Citters discussed the development of ACI, which was motivated in part by the "Rising Above the Gathering Storm" report. ACI emphasized the effort to turn fundamental discoveries into marketable technologies and supported facilities, instrumentation and workforce. This called for increased funding for NSF, DOE science activities and National Institute of Standards and Technology [NIST] combined; it was the largest federal science response since Sputnik.

Wayne Van Citters presented data on MPS by division; then, he presented the FY08 budget requests for facilities in development and under construction. Garth Illingworth requested a total budget figure for the Deep Underground Science and Engineering Laboratory [DUSEL]; an estimate of \$500 million was suggested. [*Note:* \$250M is estimated for the lab and \$250 for the first experiments.] Van Citters reported that the MREFC budget request reflects the new baseline for the Atacama Large Millimeter Array [ALMA].

Van Citters reported on interagency efforts, including the Very Energetic Radiation Imaging Telescope Array System [VERITAS], for which termination of the National Historic Preservation Act [NHPA] Section 106 consultation with the Tohono

O'dham Nation was in progress. Van Citters also reported that the Advanced Technology Solar Telescope [ATST] had recently completed a very successful Preliminary Design Review [PDR]. Rene Ong asked when the VERITAS NHPA process would reach closure. Craig Foltz said this was not yet knowable; the public comment period had closed and comments were being incorporated. It was noted that VERITAS was the first project to go through the new NHPA process, which was proving challenging; Van Citters said no fixed deadline existed for the completion of this process.

Wayne Van Citters presented photos of ice drilling operations at the South Pole; work there, he said, was going extremely well. The target to increase the data rate from the South Pole to 60 gigabytes a day had been exceeded; further increases may follow possible antenna upgrades at White Sands.

Wayne Van Citters discussed the Senior Review status. He noted he had discussed this in the recent AAAC teleconference in December 2006. Further, the implementation plan would be presented to the community to keep it informed and to seek feedback. Two town meetings had been held to date; five more were planned. He believed the community fully supported the process.

Wayne Van Citters noted that NSF Division of Astronomical Sciences [AST] was undertaking cost reviews of each observatory to understand operating costs and to see if and where savings might be obtained. Estimates were needed on the costs of closing any facility; no significant budget changes would be reflected prior to FY09. Garth Illingworth suggested that, given the issues involved, a longer period may be required. Wayne Van Citters said that, in many areas, there was no firm basis for determining costs of services delivered; the review might conclude that services provided were out-of-line with costs. That is, NSF was prepared to learn that it wasn't clear how the observatories had managed to provide all the services they had within their available budgets. In that case, costs would be changed or activities phased out.

Wayne Van Citters described community input as essential and provided the following points of contact:

- AST website for the Senior Review: [http://www.nsf.gov/mps/ast/ast\\_senior\\_review.jsp](http://www.nsf.gov/mps/ast/ast_senior_review.jsp)
- Senior Review email input [astsenior-review@nsf.gov](mailto:astsenior-review@nsf.gov)
- Decade Survey planning input: [astro2010@nas.edu](mailto:astro2010@nas.edu)

There was discussion on the relationship between planning in high energy physics and astronomy. Wayne Van Citters said that while parallels existed, one difference stood out. In high energy physics few remaining problems could be usefully tackled with a small cyclotron; in astronomy, however, a four-meter telescope could still do considerable work. Van Citters suggested that if the model of high energy physics was applied too directly to astronomy, people and science would be disenfranchised.

Garth Illingworth asked what steps were required to move the National Virtual Observatory [NVO] forward. Wayne Van Citters said the next step would be to solicit proposals to carry NVO into implementation: he said the FY07/08 budgets had money for this, but a solicitation must be issued first. Van Citters said assembling an interagency solicitation was difficult. Eileen Friel said discussion of this was underway with NASA colleagues. Nigel Sharp said things were moving as fast as possible; multiple iterations had been completed, but the process was inherently slow. Sharp said the important point was that NSF and NASA were committed to making the project happen; if a joint solicitation proved unworkable, a parallel approach would be attempted. Van Citters said the first step was to get a solicitation cleared for release; normally that would take three months. Eileen Friel said, given the multiple agencies, a longer time was likely. Once released, Van Citters said, the solicitation

needed to be 'on the street' for 90 days: given this, there was no possibility of 2007 funding. Van Citters said the involvement of two sets of lawyers complicated the process. Neta Bahcall asked if either NASA or NSF might decide not to support the venture. Speaking for NSF, Van Citters said that an NVO solicitation would be issued somehow—possibly not jointly, though that was preferred. He added that NSF and NASA are continuing to support development activities to keep the existing project productive.

Garth Illingworth asked about inter-agency implications relative to the Large Synoptic Survey Telescope [LSST] given that both dark energy and Near-Earth Objects [NEO] were involved. Wayne Van Citters said the respective agencies were actively discussing this: NASA's position was that LSST was an NSF project, which was fine with NSF. Illingworth noted that NEO detection was a mandated NASA activity; while NASA had no direct tie to LSST, LSST would likely tie into NEO somehow. Van Citters said he expected a proposal from LSST within 30 days, though review would take some time. Kathy Turner noted that DOE did not have the same proposal structure. DOE would coordinate with the other agencies as things went forward; neither DOE nor NSF wished to go forward, she added, unless the other was going forward. Van Citters said some sort of joint review would occur. Illingworth asked if the same proposal would go to each agency; Turner responded that DOE was not prepared to make a decision this year. Wayne Van Citters said any proposal could take several years to consider. Nigel Sharp said the committee should understand that a different process was involved: there needed to be a formal process whereby multiple agencies cooperated while still meeting each agency's legal requirements.

Garth Illingworth asked, relative to NEO activity, how this proposal tied to the others. Rick Howard said that, from NASA's perspective, Exploration Systems Mission Directorate [ESMD] was responsible for tracking and identification; the science fell within Science Mission Directorate [SMD]. Illingworth said it was unclear how this would play out and what the committee might wish to say about it. Wayne Van Citters said any proposal submitted to NSF would have an NEO component; NSF was not a part of the mandate that had been given to NASA and could proceed as an independent undertaking.

Garth Illingworth commented that the AAAC was tasked with reviewing the cost effectiveness: if LSST went forward in a way that met some NASA requirements, that effort should not be duplicated. Illingworth suggested flagging the matter as something with broad implications. Neta Bahcall asked if Van Citters had discussed this with NASA; Van Citters said such conversations had occurred early on: NASA's view was that LSST was an NSF undertaking. Craig Foltz commented that if the requirements of agency coordination changed the way LSST worked, this had implications on the dark energy search; if this occurred, all concerned should be made aware of how their own interests might be impacted. Rick Howard said this was a good point; he added that a similar discussion was occurring on the Widefield Infrared Survey Explorer [WISE]: he was anxious not to disturb the associated science. Neta Bahcall said inter-agency cooperation was an issue the committee needed to address. Garth Illingworth noted that LSST benefited from having a clear lead agency. Wayne Van Citters said the circumstance to avoid was to have LSST proceed with restrictions on its mandate, but without the extra resources this would require. Garth Illingworth expressed agreement.

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*NASA Program Update*  
Rick Howard, Acting Director  
NASA Astrophysics Division

Rick Howard presented [slide 2] an overview of pending missions. Stratospheric Observatory for Infrared Astronomy [SOFIA] had been changed from Red to Yellow status; Howard believed it may go Green in April 2007. At present, the project was engaged in contract restructuring, with the aircraft being transferred from its current contractor. The first functional test flight may occur in March 2007. He noted the Hubble Servicing Mission [SM4] current launch date of September 11, 2008. Kepler continued to experience technical and management issues; project reserves were being expended to maintain schedule.

Rick Howard said the James Webb Space Telescope [JWST] was on schedule; the Yellow ranking involved an issue with the Technical Assistance Agreement. The State Department interpreted the European Space Agency [ESA] as consisting only of the two host countries, France and the Netherlands; ESA personnel from other countries required individual clearance to attend meetings. In consequences, these ESA personnel were sometimes being communicated with through intermediaries, a circumstance that raised the likelihood of something going wrong. Howard reported that the Space Interferometry Mission [SIM], Laser Interferometer Space Antenna [LISA] and Constellation-X [Con-X] were Green because they tracked to program requirements. SIM was experiencing a major personnel reassignment, from 250 to 70 by the end of 2007.

Rick Howard presented [slide 4] NASA budget information: he observed that in 2012, the NASA budget would resume growth at the inflation rate. Garth Illingworth asked if \$600-700 million would be spent on SOFIA by 2010 to create initial capacity; Howard said that was case. Howard said 2006 changes in SOFIA, the Navigator program, Kepler, the Gamma Ray Large Area Space Telescope [GLAST] and WISE had not yet received Congressional approval; therefore, these changes were not reflected in budget data. Howard expressed concern that these steps were not final until Congress approved. Howard said a new 'wedge' for a future mission had been created to accommodate the highest priority identified in the next Decadal Survey. Howard said the Beyond Einstein budget was consistent with previous figures; it could accommodate which of the five potential missions was selected to go first.

Rick Howard presented [slide 8] the President's budget figures for FY08. He said the budget figures were for actual program content; other costs had been placed in 'general institutional,' allowing program comparisons to be made. Howard was asked if SIM science teams could be kept together given its reduced support; Bruce Carney said the central issue for the science teams was the absence of a firm launch date.

Garth Illingworth asked the cost of a four-month slip on SM4; Rick Howard estimated this at \$10-12 million a month.

On SOFIA, Rick Howard noted pending reviews at Ames Research Center and, a month later, at Dryden. He had directed those reviews to determine what mix of science flight hours, new instrument development, and support for the community provided 'the biggest science bang for the buck.' He expected that report by May 2007, in time for the FY08 budget cycle.

Garth Illingworth said the community believed nothing had been done to restore the earlier 15 percent cut in R&A; Howard affirmed this. He noted considerable concern about how this cut would effect the 'pipeline' of students and research; the possibility of restoring that cut by making reductions elsewhere had been discussed, but without agreement on what should be cut.

On JWST, Rick Howard noted that with re-baselining, \$49 million had been added for reserves; the other apparently additional money for JWST in his figures reflected correction of an earlier error. The \$49 million had been added to produce a 70 percent 'S' curve reading; he felt certain a new 'S' curve would be calculated next year, but did not know what it would say. Responding to Daniel Lester, Rick Howard said institutional funds had been separated so that program numbers were first-order transparent; it was, he said, never quite possible to achieve this.

Alycia Weinberger asked about Discovery funding; Rick Howard said that a Discovery line was carried outside astrophysics. Garth Illingworth asked why funding for astrophysics research jumped from FY10 to FY11; Howard said the change in the institutional funding formula represented about \$15 million of this. Howard said many apparent changes in budget figures reflected funds being moved within the budget; attention should focus on the dollars going into project budgets.

Rick Howard identified [slide 9] the following budget issues:

- Any launch slip to GLAST (schedule tight and range conflicts)
- Additional cost growth in Kepler
- Any adjustments in balance within Navigator Program
- Resolving impacts of 2007 budget (full year CR).
- Direction of Balloon Program (ULDB future)
- Additional funding to support Sept 2008 HST SM4 (four-month slip)
- Strategy for Astrophysics Future Missions line

Howard said the GLAST schedule was tight because of backup in launch availability; the launch could either move forward a month -- which he said would be very tight, or some slip would occur. Garth Illingworth noted that GLAST was a joint mission; did the possible change of launch date have cost implications for DOE? Howard said that cost issues had been collaboratively resolved in the past; he believed this would occur again.

Rick Howard said the balloon program needed a strategy; a budget wedge, he noted, was a target: the better its mission was defined, the harder it was for funds to be claimed. Garth Illingworth termed this an important point.

Rick Howard noted that the Astrophysics Division did not sponsor a competed line; this has been regularly discussed but not resolved.

Rick Howard called attention [slide 11] to the launch chart, noting that it reflected the removal of \$3 billion from science budgets, stretch-outs in competed programs, and cost increases elsewhere. He noted other divisions were similarly affected. Marcia Rieke asked about the 'firewall' between various budgets; Rick Howard said this firewall had been 'a gentlemen's agreement;' as it was now reflected in legislative language, it would be difficult to change.

Keivan Stassun sought clarification on R&A expenditures. Rick Howard said R&A was basically a grants line; responding to further questions, he said that on missions, R&A fell within the operations line. Stassun suggested that all R&A funding be aggregated. Howard said the same suggestion had been made at a recent NAC meeting; he noted that an aggregate figure would be useful.

Garth Illingworth expressed the committee's appreciation to Rick Howard for his efforts after becoming acting director of the NASA Astrophysics Division.

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*High Energy Physics Briefing*  
Robin Staffin

Robin Staffin described research priorities within High Energy Physics [HEP] and noted two large domestic facilities at Fermilab and SLAC. The main large one, Tevatron, sends counter-circulating protons and anti-protons to detect signs of the new physics that might be seen at the Terascale. The B-Factory – like its partner/competitor in Japan – looks for clues as to why there is matter/anti-matter asymmetry in the universe. Everything done thus far, Staffin commented, was consistent with the standard model, though it was not obvious this would continue to be the case; two years of data was in hand. Staffin said ‘hard effort’ was being directed at improving machine luminosity, the sensitivity of the detector and analysis; he commented that this was producing ‘a sweet smell of physics’ and that those engaged were greatly excited. There was, he said, something of a healthy competition going on between Fermilab and CERN; the outcome depended on what nature had in store on the subject.

Staffin reported that Tevatron had funding to run through FY09; B-Factory through FY08. It had been possible from FY07 to FY08 to increase funds for both university core research and laboratory core research. He noted that the FY07 request for the International Linear Collider [ILC] had been \$60 million, a sizeable increase over the \$30 million of FY06. The FY07 request was being repeated for FY08.

Staffin reported that the NuMI Off-axis neutrino Appearance experiment [NOVA] would be initiated; this above-ground facility in Minnesota would look for the appearance of electron neutrinos from a muon neutrino beam produced at Fermilab. Further, the U.S. will be partnering with China in the reactor neutrino detector at Daya Bay in southern China.

On dark energy, Staffin reported that support for the Supernova Acceleration Probe [SNAP] continued at close to its FY06 level. Further, the FY08 request again had funds for generic R&D—about \$5-6M for FY08—which would be competed and would take into account the recommendations of the Dark Energy Task Force [DETF]. Garth Illingworth asked if this was ‘on the street.’ Staffin said it was. This, Illingworth commented, meant the proposals would still be received but might not be funded this year. Staffin said it had been made clear that this funding was dependent on scientific and technical reviews from various funding agencies.

Rene Ong commented that considerable funds had for good reason been invested in LSST. Wayne Van Citters said the LSST proposal would take several years to process. Kathy Turner said differing agency procedures were involved. For DOE to approve a project, a placeholder must be put in the budget two years in advance and then the necessary reviews are held, while NSF needed to have the proposal first. Clarifying, Rene Ong asked whether money was being put into the budget now for the Dark Energy Survey [DES]. Turner said it was; the President’s request for R&D in FY07 was about \$5 million and slightly more for FY08. Additionally, DES was in the budget for FY08 for a construction start, contingent on successful review and support from other agencies.

Neta Bahcall asked how this budget information tied into Beyond Einstein funding. Michael Salamon said that even if the Beyond Einstein Program Assessment Committee [BEPAC] announced in September that JDEM was its choice, no serious money could be put into the project until 2009 – the AO must first be written and implemented. Bahcall asked if Staffin anticipated selection of a single joint NASA/DOE dark energy mission. Robin Staffin said that he believed administration policy was that if JDEM went forward, it would be a joint NASA/DOE undertaking.

Michael Salamon said NASA was currently supporting three concept studies, including SNAP. Neta Bahcall urged that all work to determine the best unified approach.

Robin Staffin presented [slide 3] budgets for High Energy Physics. The FY06 actual figure of \$716 million was accurate; the FY07 figure of \$775 was unlikely to be received. While the FY08 figure of \$782 million appeared to be a one-percent increase, there was also an additional \$20-million contribution from another office, so the actual increase was closer to three percent. The reported decline in Tevatron and B-Factory funding reflected completion of upgrades. Staffin noted the importance of 'feeding the pipeline' for future research; he noted that funding for accelerator science would go from \$33 million in FY07 to \$41 million in FY08. Garth Illingworth noted that House Joint Resolution 20 included a seven percent increase for DOE science: was high energy physics receiving this money? Staffin commented that 'the spigot was open,' but as yet no money had been received.

Neta Bahcall asked when results of the 'competition' between the laboratories were likely to be known. Staffin said that if Tevatron had not produced results by late 2008, the LHC would likely overtake it. However, if the Tevatron was 'hot on an answer,' its run might be extended, even beyond FY09.

Garth Illingworth asked if the High Energy Physics program was positioned to respond in 2008 to the 2006 recommendations of EPP2010 [the National Research Council's report on long-term priorities in high energy physics.] Robin Staffin said that as planning had not begun until March, some recommendations had not been incorporated; this did not mean they had been rejected: they would be part of the budget process for FY09.

Garth Illingworth said many interesting activities were underway in dark energy, though perhaps not coherently: there were several proposed Stage III and Stage IV activities. DOE was doing concept studies, but these remained general. Was Staffin considering issuing a solicitation in this area? Illingworth noted that the committee had been established to create an overview but that coordination may be difficult in the absence of a formal solicitation. Wayne Van Citters said it would take at least a year to get a solicitation cleared. Further, issuing a solicitation required identifying a funding level; the budget process made that difficult. However, an excellent task force had been created and had issued its report. Illingworth identified a risk: while one could pick the best proposal of those submitted, it might not be as good as something that a solicitation might have prompted. Nigel Sharp said Stage III projects were listed in the report, but these were at varying levels of preparedness: did the committee wish to say: no proposals should be submitted until a solicitation is issued? Garth Illingworth said techniques had been identified, but not the best approach to implementation. He believed that if a solicitation was issued, 90 percent of the proposals would come in previously identified areas. Wendy Freedman asked for what fraction of the projects listed in the task force report had proposals actually been received. Nigel Sharp said he could not answer that: Stage III projects were complex; a solicitation might not generate 20 proposals, but two or three.

Keivan Stassun asked if the National Virtual Observatory [NVO] was an analogy. Wayne Van Citters said it was; he added that if a joint solicitation was required related to the Dark Energy Task Force report, it could take three years to sort out. Robin Staffin urged that the two relevant advisory panels discuss this specific investigation and, more generally, whether it was better to solicit proposals or to survey the field. Garth Illingworth said the question on dark energy was: how would maximum community involvement be obtained: perhaps an announcement should be made that proposals were being accepted. Neta Bahcall said, otherwise, a very un-level playing field was created: decisions might be based on who had submitted a proposal several years ago. Rene Ong expressed agreement with Neta;

but, he thought the difficulties of issuing a joint solicitation was a serious problem. Dana Lehr noted that proposals were accepted all the time in the absence of a solicitation; the question was how to make the community aware of this.

Robin Staffin noted that his group was advised by multiple bodies, and that if a consensus could be achieved, the advice given would be much more readily executed.

Wendy Freedman said the main complicating factor was that, historically, each agency had different ways of operating: NSF dealt with proposals as they came in, reviewing and deciding whether to fund them. Scott Dodelson noted that engagement of multiple agencies created complications and asked what the Committee might do to help. Wayne Van Citters said the Committee should urge the agencies to continue to work together; he said the Committee should be aware that agencies tended to be set in their ways. Rene Ong said he believed evolutionary changes had occurred at NSF and thanked Van Citters for his efforts in that direction.

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### *Giant Segmented Mirror Telescope [GSMT] Project Updates* Wayne Van Citters

Wendy Freedman recused herself from the GSMT discussion.

Garth Illingworth said there was more uncertainty now than last year about what GSMT would require. Given that GSMT was the first-ranked large ground-based project in the Decadal Survey, Illingworth thought discussion was essential so the Committee could decide what to say in its March report; he thought the Committee should be guiding but not constraining. For context, Wayne Van Citters discussed the Senior Review recommendations related to GSMT. Van Citters presented [slide 3] what NSF regarded as the report's most important conclusion: that '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.' Van Citters quoted further: '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.'

On the Optical-Infrared Program, Wayne Van Citters presented the recommendations [slides 5-6] that National Optical Astronomy Observatory [NOAO] should lead the program: among other things, NOAO should deliver community access to an optimized suite of high-performance telescopes of all apertures in both hemispheres; and, further, moderate-aperture facilities and instrumentation should be regularly assessed by competitive review based on scientific merit.

Next, Van Citters presented [slides 7-8] essential steps for developing a national GSMT program. These noted that moving from development through construction and into operations was complex. No one, he said, could assure when the telescopes would enter use; further, possible international involvement raised complexity. GSMT, he noted, was not a project, but a large-scale program; with this, he noted the recommendation that 'a healthy scientific enterprise' going into the GSMT era 'must be assured.' In consequence, he said, NSF had asked AURA/NOAO to act as NSF's 'Program Manager' for GSMT development. This 'program manager' would [slide 8], first, take the lead in defining the system and assuring its long-term health; second, understand and champion the national needs for a GSMT; third, define a national science working group and a national design reference mission; fourth, set the performance expectations, and other matters. He said coordinating

federal and private timescales was important, as was the need to establish appropriate, symmetrical interfaces with TMT and GMT.

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### *Giant Magellan Telescope [GMT] Update*

Patrick McCarthy  
[via speakerphone]

Patrick McCarthy provided a brief project overview [slide 2]. GMT, he said, was an extremely large telescope [ELT] built on the heritage of the Magellan and MMT 6.5-meter telescopes; its primary mirror is to be composed of seven 8.4-meter spun-cast borosilicate mirrors, the outer six of which were off-axis. McCarthy presented the GMT partnership [slide 3] and the project's governance and standing committees [slide 4]; he noted NOAO, NSF and AURA representatives were routinely invited to activities. McCarthy outlined project milestones [slide 5]: the project began in July 2003 with a Memorandum of Understanding signed by the original partners. The first primary mirror segment had been cast in July 2005; a successful Conceptual Design Review occurred in February 2006; this review had prompted the Australian National University to join and help fund the undertaking. The first two instrumentation reviews [on survey spectrographs AO and instruments AO] were held October and December 2006, respectively. The third review, on high dispersion spectrographs, was set for March 2007. Selection of the first-generation instruments was scheduled for this summer.

Patrick McCarthy said the major technical hurdle was casting the off-axis mirror segments. Given this, and given that mirror production would be pace-setting, the first casting had been undertaken in 2005. He anticipated that the first mirror would be completed by mid-2008, demonstrating the feasibility of the technology. McCarthy presented [slide 7] on site layout for the telescope and [slide 8], the 'new discovery space' that GMT would open. He described [slide 9] seven of the instrument concepts under development. McCarthy outlined the broad goals for relations between NSF and AURA: these include efforts to maximize private support for ground-based astronomy. McCarthy said incentives for large private giving must be maintained while public participants are assured they had a 'seat at the table' commensurate with their support. He noted that developing a partnership model that met both public and private user needs would be a challenge.

Patrick McCarthy identified, as a project goal, the integration of the U.S. user community into ELT design and operations. He saw it as beneficial if the GMT project were integrated more closely with the GSMT Science Working Group; he suggested that – as there were now two well-defined telescope projects – it might be appropriate to reexamine the committee's charter so it could focus more on specifics.

Patrick McCarthy identified [slide 11] various 'realities', including: that funding for construction was unlikely before 2013; that private funds to support construction were contingent on successful design/development phase; and that operation costs are a serious concern for private and state institutions and private donors. He believed early financial support from NSF might make a critical difference to the project's success.

Patrick McCarthy [slide 12] identified as near-term goals: enhancing support for technology development through the GSMT program, and, second, exploring alternate models for federal support of ELTs. On long-term goals [slide 13], he stressed developing an operations model in the ELT area: he believed a general dialog on operations would move the project forward. Commenting further [slide 14],

McCarthy urged development of a long-range plan to support both telescope programs; he said a 'premature down-select' might jeopardize private funding.

Patrick McCarthy presented GMT's view of relations with NSF and AURA, noting that: a closer relationship was desired; additional federal funding for the design effort would speed the project; and, that the broader community was welcomed to participate through committees and outreach activities. He noted that GMT was now, and increasingly would be, an international project.

*Discussion:*

Garth Illingworth asked, if no Federal support materialized, what the timing might be on moving forward with private funding for construction. Patrick McCarthy noted, as a problem, that several university partners were selecting new presidents; he hoped that design work would be completed this year, with construction done by 2016. Illingworth asked if the mirror segments were on GMT's critical path. Patrick McCarthy said that, if production slipped significantly, the mirrors would become the pacing item. Clarifying, Wendy Freedman said this was the reason for deciding to do the first mirror early.

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*Thirty-Meter Telescope [TMT]*

Edward C. Stone

Edward Stone identified [slide 2] the three precursor studies that led to the TMT public/private partnership in June 2003 and gave [slide 3] the project's reference design for the 30-meter telescope, including the work done by the project's Canadian partner. Stone presented [slide 4] an overview of the telescope mount systems and [slide 5] the primary mirror segments: he noted there were 492 segments of 1.4 meter each; he noted that, as Keck segments were 1.8 meters, those for TMT were not 'pushing the state of the art.' He noted that in the next three months contracts would be written to three companies on mirror polishing; he added that the number of segments involved constituted a production issue. He described the value of adaptive optics for TMT and described the design of the deformable mirror. Stone presented [slide 8] an image of Uranus taken with adaptive optics – this, he said, demonstrated the essential role adaptive optics played in TMT. Stone noted [slide 12] that feasibility studies had been undertaken for twelve instruments. Stone described the site testing [Slide 13] in Chile, Mexico and Hawaii as the most comprehensive ever undertaken. Stone described [slide 14] the TMT design-and-development phase [DDP], leading to a restructured DDP in January 2007.

Edward Stone quoted from [slide 16] the cost review report, which stated: 'The Panel was extremely impressed by the quantity and quality of work that has been accomplished since the CDR in May... In general, the cost estimating methodology is credible, and the risks appear to be well addressed in developing the contingency fund.' Looking to the future, Stone said TMT was to complete design and development by 2009; construction would continue until 2016; first light with the full mirror was set for 2016. Stone stressed the importance of timely implementation of GSMT [slide 18]; he pointed to the need to justify GSMT readiness and costs for the next Decadal Survey. Stone identified [slide 19] a way forward he described as somewhat different from Patrick McCarthy's: he urged a decision be made by mid-2009 on selection of the GSMT design approach; and, further, that the current AURA grant be robustly funded for design development of both TMT and GMT.

*Discussion:*

Garth Illingworth asked when construction might begin. Ed Stone said 2009, with first light with the full mirror in 2016. Stone said there was potential NSF funding in construction during the final three years. Stone said the way forward should be consistent with both funding constraints and timely implementation. Dan Lester noted that Stone was proposing a down-select. Stone said this was to address the issue of how the Decadal Survey was to be approached; it was required for timely GSMT implementation. Illingworth said it was unclear how the Review would handle two separate projects; the committee would discuss this over the next two years. Illingworth sought comments from Patrick McCarthy. McCarthy commented that ground-based astronomy was unique in that, historically, it had received large private donations; he believed the value of bringing in private donations outweighed the value of an early selection. Illingworth said he was sensitive to the role of private capital.

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*New GSMT Role for Association of Universities for Research in Astronomy [AURA]*  
William Smith

William Smith said he would expand on Wayne Van Citters's presentation on AURA's role. Smith noted [slide 2] this role had changed, as 'NSF has asked that AURA/National Optical Astronomy Observatory [NOAO] act as NSF's "Program Manager" for the GSMT Technology development effort at a national level in a manner similar to the role played by NASA's major centers for the development and operations of various space missions.' Smith said AURA welcomed this role; it had interpreted its top-level mission as trying to provide access to the telescope and develop resources to support the broad community. As part of this, AURA would establish and maintain the national Design Reference Mission (DRM) to set scientific performance expectations for candidate designs. He noted that AURA would not undertake independent reviews of the two projects; rather, it saw its role as taking on a community viewpoint. The community, he said, would need to learn how to use a GSMT within a public-private partnership. In pursuit of this, AURA would need to assure that national needs were understood and subscribed to. He noted that both GMT and TMT had international partners. Further, AURA/NOAO would advise NSF on options for international collaboration at a governmental level; and NOAO will be the NSF national presence in any eventual partnership operating the GSMT.

William Smith reported that, with this new role, AURA/NOAO would withdraw from direct partnership with either project; he noted that AURA, NSF, TMT, and GMT were discussing how to address earlier imbalances in support for the two projects. Smith noted [slide 7] 'Two Paths Forward on GSMT.' The first involved construction under the MREFC process. The theoretically quickest time that the MREFC process could be completed, he said, was three years; the MREFC process, he said, was a rigid one: it established a high bar. He questioned whether this process could be pursued by relying on statements made in the previous Decadal Survey; awaiting the next Decadal Survey, he added, would cause delay. The second approach was to provide operational support to both projects; this led to the possibility of there being more than one telescope.

William Smith discussed [slide 8] the GSMT Reference Mission. In this, AURA would work with the GSMT Science Working Group to develop a national Design Reference Mission [DRM] to do such things as quantify performance vs. aperture; set scientific expectations for candidate designs traceable to Decadal Survey science

goals; and look at how the science case had evolved since then. He stated that by mid-2009, he hoped a structure would be created to determine how many nights were needed by the community and, from this, how many telescopes might be required.

*Discussion:*

Garth Illingworth stressed the importance of getting a clear reading on the community's wishes prior to the next Decadal Survey. Illingworth noted that the survey was highly competitive: a program was in jeopardy if it was unclear what was wanted. Neta Bahcall asked whether the two projects might be combined; this, she suggested, could make it a higher Decadal Survey priority. Ed Stone said this was possible. Discussion ensued on the likelihood of there being two ELTs, as well as a European ELT. Illingworth commented that, by the baseline model, each project felt it had the chance to go forward: there was a need to look at the roles of NSF and the Federal government relative to different approaches. MREFC, he said, might enter at some mid-point in construction, rather than from the beginning, as traditional; further, the private-public partnership needed further thought.

Neta Bahcall said she welcomed a private-public partnership but still believed the two projects could combine in some way. Patrick McCarthy commented that, characteristically, donors wished to donate to institutions, not to a telescope: combining projects could eliminate major donors. Marcia Rieke said the hardest thing to raise private money for was instrumentation. Responding to a question from Bruce Carney, instrumentation costs were estimated at 20 percent of overall budget, though that covered only the first generation of instruments. Ed Stone said not only was there a question of constructing two telescopes, but also of creating two operating facilities: even constructing and operating one facility might be a 'stretch.'

Neta Bahcall said, given the number of competing projects, she doubted the Decadal Survey would fund two ELT projects. Garth Illingworth suggested the pair could be packaged as a scientific capability being implemented by two telescopes. This, he noted, represented a change from last year's thinking, when an early down-select was anticipated, with the selected option receiving funding from MREFC. Garth Illingworth asked Patrick McCarthy when the down-select would occur on the path forward he had presented; McCarthy said he believed success or failure should be decided at the end of the three-year design period. Illingworth said it was unclear how that would be carried forward into Decadal Survey. Wendy Freedman said the challenge before the committee was to put together a package: private funders would not proceed if the facility would not be operated. Keivan Stassun said a Federal role more in operations than in construction needed to be fully considered; further, he said if NSF assumed significant operating costs, some other NSF activity would have to be 'ramped down.'

Wayne Van Citters said the general agenda was to define what was going to be done, secure community backing, and develop realistic cost estimates: the next Decadal Survey would have to address those issues. Garth Illingworth called the committee's attention to the significance of the MREFC contribution, noting it was an additive support to astronomy. Neta Bahcall commented that both telescopes would need operating funds. Ed Stone said the level of operational support would depend on the particular model. Van Citters noted considerable talk about the 'lure' of private partnerships; the discussion was of a private-public partnership for the GSMT program – though not yet a GSMT project – among AURA, GMT, TMT and NSF. He believed discussing these issues openly was a big step forward.

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*Interagency Implications of NSF-AST Senior Review Recommendations*  
Wayne Van Citters

Wayne Van Citters opened [slide 2] by reemphasizing the Senior Review finding on the scientific challenge:

“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.”

Wayne Van Citters presented [slide 3] a second Senior Review finding:

“It should be emphasized that, in none of the proposed actions can the facilities targeted be seen as redundant to the scientific enterprise. Instead, the SR is recommending reduced AST funding or closure of some telescopes that could be unique and productive for 20 years.”

Van Citters stressed that the recommended closing of a given facility did not constitute judgment that it was not usefully contributing to science. He noted two facilities in the radio millimeter/sub-millimeter area:

On National Radio Astronomy Observatory [NRAO] [slide 5] the recommendation was to limit AST support of the Very Long Baseline Array [VLBA] to \$3 million annually beginning in FY11 and to seek partners who would contribute personnel or financial support to the operations. If a reasonable scientific program could not be assembled at the recommended level of NSF investment, then the VLBA should be closed.

On National Astronomy and Ionosphere Center [NAIC] (Arecibo) [slide 6] the recommendation was to reduce annual support from \$10.5 million to \$8 million over three years and that the facility should concentrate on the Alpha surveys, with some time reserved for individual investigators. Support from the NSF Division of Atmospheric Sciences [ATM] was expected to continue at \$2 million annually. By 2011, NSF support should be reduced to \$4 million; other sources of support will be sought: if such support and a viable enterprise are not achieved by 2011, the facility should be closed.

*Discussion*

Neta Bahcall asked about the current status of the ramp-down. Wayne Van Citters replied that 25 individuals had received notice; this left a base of support for the Alpha surveys. An audience member suggested a possible NASA role in sustaining Arecibo operations; Van Citters said NSF would consider alternatives to closing if other funding emerged.

Wayne Van Citters presented [slide 7] recommendations for the solar program from the Senior Review. That recommendation was to cease operation of the Global Oscillations Network Group [GONG] project one year after operations of the Solar Dynamics Observatory [SDO] were successfully initiated, unless major alternate sources of support for GONG were identified.

Van Citters said NSF was aware that closure of the planetary radar at Arecibo might impact the planetary science community; NSF was investigating whether other agencies or international partners were interested in providing support. Neta Bahcall

asked if any of those facilities Van Citters had discussed were currently receiving international support; Van Citters said no. Garth Illingworth said reactions would be received from the major parties; he asked the audience for other comments on Arecibo. A NASA audience participant said that nothing down the road would replace the radar capability at Arecibo. Van Citters repeated that NSF Astronomy did not wish to close Arecibo, VLBA and GONG, but the agency had to move forward with its scientific priorities. He urged the recommendations be taken seriously; work should be done to mitigate the impacts.

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*NRC Beyond Einstein Program Assessment Committee (BEPAC)*

Brian Dewhurst

Brian Dewhurst noted that the Beyond Einstein study was a joint 50-50 project of NASA and DOE. Beyond Einstein referred to a suite of five missions: Con-X, LISA and the three Einstein Probes. He said the NRC assessment grew out of the circumstance that during 2006 various Congressional committees had given conflicting instructions on the program; specifically, whether NASA was to remain a joint partner with DOE on JDEM. The study's charge, he said, was to assess the five Beyond Einstein missions and recommend which should be developed first in the funding wedge expected to open in 2009. The assessment criteria, he said, were to determine what impact each mission would have on other scientific activities, and, second, the realism of plans and cost estimates. Dewhurst noted that the second criterion was new to NRC activity; consequently, it made this review something of a 'trailblazer.' Dewhurst presented the BEPAC membership, noting that it included people from astronomy, fundamental particle physics and people experienced in building and costing space missions.

Brian Dewhurst presented the 'Ground Rules' for assessing Beyond Einstein missions. He said the five mission types would be assessed for their science; the eleven proposed missions would receive a technical review. He reported that NRC had contracted with Science Applications International Corporation [SAIC] to provide cost estimates; BEPAC was committed to providing fair and uniform comparisons, a difficult task given the variety of potential missions involved. He noted that BEPAC first met in November 2006; it was currently engaged in data gathering: town meetings and independent cost-estimate work were in progress. BEPAC would be submitting its report by September 8, 2007. He stressed that BEPAC believed that its decisions needed to be supported by the community.

Neta Bahcall asked whether BEPAC would recommend one of the eleven candidate missions; Dewhurst said no, the recommendation would be of one of the five mission categories. If the mission category contained multiple candidates, NASA would undertake a competition. An audience member asked how SAIC would cost estimate the less-well-defined missions; Dewhurst said SAIC understood the challenges involved. Daniel Lester asked what would happen to the other four other mission categories following selection; Michael Salamon said continuing technology development would occur. Dewhurst emphasized that BEPAC was not selecting a mission, but starting a program: there was general agreement that all five missions categories should be done; the question was how to best achieve the total science.

Scott Dodelson asked how project cost would be weighed against science value. Brian Dewhurst said the committee had chosen not to set rules at this point, but would weigh broad considerations. Paul Hertz said that, if one mission had truly excellent science, but no firm idea of how to realize that science, that should be taken into account. Michael Salamon said the operative consideration was cost

realism, not absolute cost. He added that the budget wedge could accommodate either a flagship mission or a Probe being selected to go first. Alycia Weinberger said that, once the report was out, the Committee would be interested in learning how the SAIC cost estimation worked. Garth Illingworth said this costing process represented a very important test case.

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*Office of Science and Technology Policy [OSTP] Update*  
First Presenter: Rob Dimeo

Rob Dimeo said he would present information on budgets and interagency activity; then, Jon Morse would discuss the Decadal Survey. Dimeo described [slide 2] the budget cycle and [slide 3] information showing that the largest influence on research and development funding was continued support for the American Competitiveness Initiative [ACI], now in its second year. Dimeo presented [slide 4] budget information on the NSF, DOE Office of Science and core research at the National Institute of Science and Technology. Dimeo said the funding levels identified in the House 2007 Continuing Resolution were not 'completely devastating,' still, the amounts were less than the President had requested and had been hoped for. Dimeo then presented [slide 5] parallel information on funding for NASA science.

Rob Dimeo discussed the Interagency Working Group on the Physics of the Universe [slide 7], originally established to formulate an implementation plan for the opportunities identified in the NRC report, 'Connecting Quarks with the Cosmos.' Dimeo noted, first, that the group had been meeting to identify what progress had been made on the February 2004 report. He noted that the Interagency Task Force on High Energy Physics had involvement from NASA, NSF and DOE; its report was expected in 30 days. This group's discussions had had an impact on a budget gap that the group had identified in the area of high-energy density laboratory plasma physics; in consequence, DOE was planning a joint program to bridge that gap. Next, he discussed the work of the Interagency Lessons-Learned Task Force, an ad hoc group operating under the auspices of the Physics of the Universe group, which is now working on its draft report. Dimeo noted [slide 9] that OSTP had formally endorsed the process of the NSF Astronomy Senior Review, though it was not endorsing the conclusions of that process.

Second Presenter: Jon Morse

Jon Morse presented [slide 10] identified benefits of the Decadal Survey process:

- Community-based documents that provide consensus views of frontier science opportunities for maintaining the Nation's scientific leadership
- Provides for each field a single, well-respected source for community priorities and the scientific motivations to the agencies, OMB, OSTP, and the Congress
- Limits the range of activities to consider for funding
- Cost estimates, technical risk assessments, and technology roadmaps aid in budget planning

Jon Morse noted that while the Decadal Survey was accepted as valuable, issues remained [slide 11], including: prioritizing may become inflexible, ambiguity about technical risks, cost estimates, and others. He then raised the question of what was most useful to making decisions, identifying [slide 12] the following: that discussion be framed by key science questions; that what was needed to answer each question be identified; and that awareness be maintained of the complementary basis of

initiatives. He added that reporting by capabilities was not useful in budget or program planning.

Jon Morse presented [slide 13] a series of suggested improvements in the Decadal Survey. He emphasized the need to remove ambiguities on the relative start and end dates of projects: specifically, that uncertainty should be removed as to whether a given project should be completed before another is initiated. Next, he said better definition was needed of what was meant by a balanced program; e.g., 'balance' among all current projects, or 'balance' within a decadal context. Third, he suggested that all large [over the \$1 billion] projects be international. Morse emphasized the importance of providing timeline/phasing charts and diagrams for project portfolios under various budget scenarios.

Jon Morse presented [slide 14] discussion on managing expectations, calling particular attention to emphasizing the 'stewardship' of the taxpayer investment. In connection with this, he urged that non-specialists be brought in to support the case for public expenditures. Next, he suggested that budget figures be based on 'order of magnitude lifecycle costs' – this would acknowledge that costing early in the development of a project was very difficult. Marcia Rieke said she understood Morse's logic; nonetheless, a large difference existed between what \$2 billion and \$5 billion could produce. She questioned whether order-of-magnitude statements would work at that level. Amy Kaminski said 'order of magnitude' need not be taken literally; estimates could be in ranges. Morse warned the committee that 'macro-budgetary pressures' were likely to increase in the next decade; if so, he said, then projections of even flat budgets might prove optimistic. Finally, Morse said attention should be paid to the view that some projects must be terminated to allow new initiatives to proceed: OSTP believed that discussions of what might be 'turned off' were a good process.

*Discussion:*

Marcia Rieke suggested the second bullet on the improvements slide implied that the Decadal Survey should review every project; did this mean, for example, that a program half-way through its mission would be reviewed. Amy Kaminski said the broader point was that the more comparative statements that could be made, the better. Rieke responded that doing that sort of comparison might take so long that the Decadal Survey would become ineffective.

Garth Illingworth asked Dimeo and Morse how AAAC's efforts with OSTP could be more effective. Ron Dimeo said OSTP viewed AAAC's reports as extremely important. He thought it was important for the committee to continue to listen to the Office of Management and Budget [OMB] on how priorities are implemented within the budget.

Garth Illingworth suggested general discussion ensue with the representatives of both OSTP and OMB.

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*Discussion with OMB Examiners and OSTP Staff*

Rob Dimeo and Jon Morse were joined by Office of Management and Budget [OMB] examiners: Amy Kaminski, who has been at OMB for four years and works with NASA space and earth science programs; David Trinkle, who after seven years at OMB working with NSF will be leaving in two weeks; and Joel Parriott, who works with the DOE Office of Science budget.

On budget matters, Amy Kaminski commented that NASA had fared better this year than most non-defense discretionary agencies; the FY08 request was once again focused on the President's Vision for Space Exploration. She noted that a Congressional decision was awaited on FY07; the currently expected reduction was \$500 million relative to the President's request. Congress had specified expenditures on a directorate-by-directorate basis, though it remained to be seen if that would stand. She anticipated a likely FY07 appropriation for NASA of \$5.2 billion, about equal to FY06, and a \$79 million decrease from the FY07 request. She reported the President had, during 2006, committed to 1-percent growth for the agency through the end of the five-year budget horizon. She noted application of the 1-percent growth had been complicated by NASA's new procedure for how overhead was assessed. The commitment was maintained for FY08 by putting that amount into the program budget for science, the part of the budget the community was most interested in. The consequence was to increase the five-year budget horizon by \$115 million.

Amy Kaminski commented on changes in the Astrophysics budget: SOFIA was back into the budget; SIM was reduced to a minimal technical development effort, at least until the ExoPlanet Task Force report was issued. Further, Beyond Einstein was funded at \$225 million over five years. She noted that a new wedge for an astronomy/astrophysics program began in 2010. She expressed her thanks to the Committee for its work, adding that the astronomy and astrophysics reports issued in the past year had been greatly helpful to providing direction. She felt communication between AAAC and OMB was very good.

Scott Dodelson asked if any metrics – e.g. winning a Nobel Prize -- were used in determining budgets. Amy Kaminski said metrics existed, such as: how well is an agency performing; how solid are its plans; does it deliver results? She said specific results, such as prizes won, were not generally considered.

David Trinkle commented that NSF, NIST and the DOE science office budgets were part of ACI, but that NSF had received a smaller increase than the others. Within NSF, a large share of the increase went to Research and Related Activities; individual directorates received varying amounts: the 8.3 percent increase requested in FY08 for Physics and Astronomy was above the NSF average.

Neta Bahcall asked what the examiners might urge AAAC to look at more carefully in its report. Amy Kaminski said that the level of recommendations had been good; they had become more specific.

Joel Parriott noted it might be necessary to re-baseline projects that had planned starts in FY07 because the Continuing Resolution had been in effect. Parriott added that within DOE Office of Science, Bioenergy Research Centers were a higher priority; High Energy Physics had not done as well, but better than general discretionary non-defense spending. Parriott said he thought it important to engage non-specialists in communications to members of Congress and their staffs, as this tended to add credibility to the report.

Garth Illingworth asked, relative to ACI during FY08, why ATP had not shared in the overall increase. This brought the response that this year's funding included some ventures that end this year; the following year's budget would be more telling. Dan Lester noted that OMB examiners made certain that 'the numbers add up,' that good performance was rewarded. How closely, he asked, were community priorities mapped against administration priorities; should reports more closely reflect administration priorities? Joel Parriott said political priorities existed and OMB was in the position of balancing these; the agencies should be aware of the issues that OMB needed to address. Neta Bahcall asked if communication between OMB and the agencies was good. Trinkle said communication with NSF and NASA was good.

Keivan Stassun asked about workforce development: he called attention to the importance of national investment in the production of scientific and related talent and asked how OMB weighed this as a priority. Would a recommendation from this committee be of value? Joel Parriott said many statements were made that the workforce was inadequate, but it was hard to define what the term meant. Amy Kaminski said she was receptive to hearing about workforce issues. She noted that NASA stressed that the Explorer program helped to support students and new investigators. She thought it difficult to 'draw the line' between education-specific outreach programs and science research dollars. Rob Dimeo said OSTP was generally skeptical about there being a workforce crisis; for example, estimates made by the Bureau of Labor Statistics on nuclear engineering differed significantly from estimates from the field.

Wendy Freedman commented that while collaboration made sense from a scientific perspective, in practical terms, it was difficult to collaborate across programs. Joel Parriott responded that NASA and DOE could work more readily with NSF than they could with each other; this reflected the different selection approaches NASA and DOE employed. Neta Bahcall referred to Joel Parriott's comment that DOE labs were running ahead of NSF on LST and ahead of NASA on JDEM; how did OMB respond to this? Parriott said these matters were under discussion within OMB; he added that OMB attempted to get the pertinent agencies to talk together. He believed it would be useful if AAAC would identify any area in which coordination was working better than in the past.

Garth Illingworth asked why NASA was not included in ACI. Robert Dimeo said ACI was an investment package aimed at those agencies with the broadest possible impact on American competitiveness. Alycia Weinberger asked what would be required to change this. Dimeo said other agencies had ranked lower in the perceived impact of the investments they made.

#### *Committee Discussion:*

Garth Illingworth reminded the group the Friday discussion with NASA Administrator Michael Griffin had been re-scheduled for 8:30 a.m. He noted that Committee discussion of the content and issues of the annual report would begin during Friday's lunch.

Neta Bahcall commented that the AAAC annual report would be read by OMB, OSTP and other agencies. The Committee should strive to provide clear, specific advice. Alycia Weinberger said there appeared to be little interest in Congress in the Committee's reports; were there individuals equivalent to the OMB staff in the Congressional Budget Office who would be interested? Garth Illingworth said that communication with Congress tended to be diffuse; however, he presented a briefing each year and attention was paid. Science Committee staff members have been interested. He would do a briefing again this year once the report was issued.

Daniel Lester asked for comments on how the report should be structured. Neta Bahcall responded that she believed it was good to be specific. Scott Dodelson asked if just interagency issues were to be addressed, or agency-specific ones, as well. Garth Illingworth noted the Committee charge included both interagency issues and implementation of Decadal Surveys; the report would, therefore, have two parts. The committee should use its judgment on what to include on individual agencies.

Neta Bahcall asked what major items the Committee would wish to bring to NASA Administrator Griffin's attention the following morning. Several persons had queries related to the NASA science budgets. Keivan Stassun asked what Griffin's managerial philosophy might be in responding to comments on budget decisions. Alycia

Weinberger said that, in the past, Griffin had held that the balance of large vs. small missions was below his level of management; she suggested he be asked what level of science he thought was critical to NASA. Bahcall commented that Griffin had said he had a specific job to do at NASA; that is, finish the Space Shuttle and the Space Station, and get a new vehicle ready to go to the Moon. She suggested Griffin might be queried on what he had meant in saying he wished to leave NASA in a stronger position than he had found it.

Session of Thursday, February 8 adjourned at 5:45 p.m.

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Session of Friday, February 9, 2007:

[*Note:* The following is NOT a transcript, but a summary of remarks.]

Discussion:

Michael Griffin

NASA Administrator

Garth Illingworth welcomed NASA Administrator Michael Griffin. Griffin had no opening comments.

Illingworth welcomed the announcement that the Hubble Servicing Mission [HST SM4] would go forward. Griffin said he had wanted to do this mission. He noted that his predecessor had had reasons for having declared the mission too risky. Eighteen months of effort had gone into proving the mission could be done under the new rules for shuttle operation.

Daniel Lester noted that Griffin would soon be appointing an Associate Administrator for the NASA Science Mission Directorate [SMD]: What priorities or guidance would Griffin give this person?

Griffin said NASA was guided in its program execution by three major constraints. First: executive direction from the President, which reached the agency through the Office of Management and Budget [OMB]. Second: public law; specifically, the NASA authorization, and others. Third: the priorities of the National Academy. Within astrophysics, he added, he tried to follow the astrophysics Decadal Survey.

His guidance to the new Associate Administrator would be to stay within those boundaries and pay attention to the concerns of the community. Administrator Griffin added that he tried not to micromanage; he noted that if any particular programmatic change was urged, a series of hard questions had to be answered before A could be changed to B. Such questions included matters of budget, staffing, timing, physical locations and others. Griffin concluded that he expected the new Associate Administrator to have a living program; that is, not one carved in stone.

Scott Dodelson commented that many thought this was the 'golden age of cosmology.' Was there a way to ramp up support for that activity?

Administrator Griffin said a place existed, but that place was outside NASA. If the Astrophysics Division wanted more money, then it could either create a rising tide that lifted all boats [i.e. a larger appropriation from Congress] or else seek a larger share of the money NASA was already getting. He said it was 'hugely difficult' to change the broad allocations between NASA divisions. He added that, as good as

astronomers thought they were, all the other science portfolios thought they were as good. Astrophysics needed to understand that. More generally, he thought fighting over budget share was a distraction from the science.

Garth Illingworth noted a concern that, under the previous NASA administrator, funding projections were changed in several areas, i.e. earth science.

Griffin said this had been the case; further, that earth science funding had gotten unbalanced had created subsequent problems for him. When his tenure began, Griffin said, planetary science had received a 40 percent boost for the Mars budget; the Mars budget, he added, was not an entitlement. He believed funding levels needed to be consistent so that each constituency could know what to expect in the long term, so that it could conduct planning accordingly. He did not believe there should be an expectation that a division that was doing well at present should get a bump in funding.

Alycia Weinberger commented that the delay in HST SM4 had presented the Division with rising costs that were outside its control. Did Administrator Griffin see a solution to this?

Griffin replied that he did not. He asked if the science divisions intended to contribute to the pot when others were in trouble.

Alycia Weinberger said that had indeed happened.

Griffin said that had happened only when a Presidential policy decision was made; for example, to re-launch the Shuttle. That money had to come from somewhere. Griffin added that SM4 was, and always was going to be, fairly expensive. It had not been technically possible to undertake the mission as early as some of its proponents had claimed; a December 2007 launch date was just not feasible. The earliest date was April 2008; likely, there would be some slip from this. Further, the launch date must line up with a Launch on Need [LON] flight in the event a rescue was required. The most practicable date was September 2008. From the Committee's standpoint those may be externalities, but they were part of managing NASA.

Neta Bahcall asked how the long-term stability of space-science research could be guaranteed.

Administrator Griffin said there was no guarantee. The best way to maximize the likelihood of continued support, he said, was to continue support of a balanced and robust space program generally. He commented that specialists in each individual discipline commonly believed that their discipline was the most important, and that if only Michael Griffin could get them more money everything would be okay. Broad balances relating to resource allocation within the agency had been worked out over decades and were not likely to change. He noted that the space-science community tended to circle the wagons and shoot inward. Without a healthy overall space program, he said, there would not be a healthy space-science program. He believed that, generally, people who came across as self-serving were treated accordingly.

Michael Griffin stressed that NASA, the space community and the defense space community had been under fire for more than a decade because of the gap between stated intention and performance: 'We say we'll do Hubble for \$1.5 billion; we spend \$2.5 billion, and the mirror doesn't work.' He cited other instances of this. He noted that early in his tenure he had received a bill for the James Webb Space Telescope [JWST] that was \$1.4 billion higher than the project's entire budget, at a time when the project was only 15 percent completed. Administrator Griffin stressed that until the agency's statements on what would be done, when it would be

completed and what it would cost were more reliable, NASA would have a problem with policy makers who, at present, placed little credence on what NASA said. He said he could remember that, during the Apollo era, when NASA said it would do something, that was 'the gold standard.' Griffin said that restoring agency credibility was the biggest thing it needed to do.

Neta Bahcall said she believed the scientific community must be 'getting some very good points' because of recent scientific successes.

Administrator Griffin noted that the lead story in that morning's Washington Post concerned the death of Anna Nicole Smith; he thought the committee might be over-estimating how much attention people generally paid to what they were doing.

Neta Bahcall commented that such topics as Hubble and Black Holes created significant interest when she made presentations. Alycia Weinberger noted that in social settings, people responded more attentively to her, as an astronomer, than to, say, a bank examiner.

Michael Griffin said it depended on how one set the bar. If the bar was 'astronomy vs. bank examiner,' then astronomers were winning; if the bar was astronomer vs. the Super Bowl, then astronomers were not winning.

Neta Bahcall asked how important did Griffin believe NASA science was to Congress.

Administrator Griffin said NASA science was important to Congress, depending on the member. He noted that NASA represented 0.6 percent of the federal budget; NASA science represented 0.2 percent. He believed that whatever politicians said was not policy; the budget was policy. If one looked at the full Federal budget, it was hard to say that space science was a priority in the general budget. NASA was not something most members of Congress spent much of their day thinking about. It was better, he added, that when members thought about NASA that they thought about something NASA had done well rather than to hold hearings on why the Genesis probe had crashed into the desert.

Garth Illingworth noted the next Decadal Survey would look seriously at better costing of missions; he asked Griffin what he thought might be the best way to estimate during conceptual design.

Griffin said he thought two steps were involved. First, one needed to have the right concept; he noted that the initial mission concept advanced for doing SIM [Space Interferometry Mission] was no longer the mission concept. In effect, he said, NASA had jacked up the license plate and slid in a new car. He did not necessarily object to this: if it was realized that an initial concept no longer met the need, it needed to be changed. But that change does push costs up. What was important, he said, was to maintain intellectual honesty and change the budget baseline for the project. He noted that the human space programs had been as vulnerable to this as any other program aspect.

Griffin suggested that when project content was firm, NASA did have good cost estimators. The difficulty, he said, was that the estimators would bring in estimates the project people did not like; the estimators were told their numbers were wrong. He urged people to 'swallow hard' and accept the number. If the concept needed to be adjusted to reduce costs, fine. Options existed, but simply not believing the numbers was not one of the better strategies.

Garth noted that cost estimates were included when projects were presented to panels for review. There had been discussion that the Decadal Survey should obtain independent estimates. Did Griffin agree?

Griffin said he thought such estimates could be useful. He thought a more important aspect was that when projects were reviewed for the Decadal Survey, many were still in the concept stage; serious cost studies were not done until a mission was placed on the Decadal priority list. He noted that no feedback loop existed within the overall survey. If, he said, it was known that a technology improvement would reduce the cost of one mission by twenty-five percent, and that something else would raise the cost of another mission by fifty percent, priorities might change given that information.

Garth Illingworth asked if Administrator Griffin could suggest a mechanism for adjusting priorities if significant cost changes occurred.

Griffin called attention to HST SM4. He thought that, broadly, the final Hubble Servicing Mission was the right thing to do. He noted that the astrophysics community had lobbied quite hard to have the mission restored; Congress had restored it. He said he wondered whether the broader astronomy community would have felt the same if it had known what the mission's final cost would be and what it would have to give up to do it. Griffin stressed he meant that as a question.

Sterl Phinney [by speakerphone] said little technology money existed for determining how to do missions; a mission did not get 'traction' until it had been prioritized. This made cost estimating difficult.

Administrator Griffin said this was not a question for him to decide.

Sterl Phinney asked what alternative Griffin might suggest.

Griffin noted he had pointed out the need for a feedback loop. More broadly, he thought it was a matter of community discipline. The community, he said, needed to free itself from the idea that once a mission was put on the list it would be done, whatever the cost. Griffin said he had no means of making money available for technology studies.

Sterl Phinney commented that if a mission were judged too expensive and cancelled, nothing was in the pipeline behind it.

Griffin said the question might be: what mission was the astrophysics community prepared to give up to be able to pay for in-depth technology studies of three or four others? NASA, he noted, lived in a constant-dollars world.

Sterl Phinney said technology money tended to be withdrawn when a near-launch mission got into trouble.

Griffin responded that when a given mission was relatively far along, it had a fully fledged constituency of employees, international partners, Senators, contractors, etc. If, he said, he made a move to cancel an international mission, he would get into trouble with the State Department.

Sterl Phinney asked if it were possible to 'firewall' technology money.

Griffin said this could not be done until a higher confidence level was established that missions could do their desired work within their given budget. If, he added, all missions were budgeted at the lowest possible cost for which they could conceivably be completed, then budget over-runs would continue to occur. Over time, he said, the average program produced overruns of thirty percent.

Garth Illingworth said the science community needed to be willing to consider what it would sacrifice to continue technology development.

Griffin commented that if he knew the community's priorities, he could attempt to manage the enterprise with those priorities in mind. He felt the scientific community – not just astrophysics – needed to understand more than how to return bits of data to be stored on a computer; it also needed to understand elements of program management 101. The communities needed to know that, over decades, the program management community had come to understand that there were three major causes of cost over-runs. These were: beginning with an immature technology; changing program requirements subsequent to program approval; and funding instability. The third, Griffin said, was largely the consequence of Congress. The science community, however, was the normal source for the first two. Major causes of cost over-runs were within NASA's control.

Keivan Stassun presented a slide showing the low number of African-Americans and Hispanics receiving PhDs in astrophysics and the high proportion being awarded to foreign nationals. He expressed concern about training the next generation of space scientists.

Griffin said he was aware that America was under-educating itself.

Keivan Stassun asked what Griffin saw as NASA's role in sustaining the pipeline.

Griffin said he did not know that he had a good answer. NASA was not the Department of Education; it did, however, undertake exciting missions that prompted some number of young people to undertake study of fairly difficult subjects so they could become part of the effort. He noted that most NASA programs had R&A money to support graduate students. He added that, given the average rates of pay in the broader aerospace community, the NASA budget could support about 75,000 human beings. He said that unless some national debate decided to allocate it more money, all arguments were really about what names would be on the badges of the 75,000 people who would be supported by this money. He said that during the Apollo era, which many recollected as a 'golden age,' NASA was supporting about 500,000 people; that was a big difference. Griffin commented that he felt he was saying things that he regarded as very basic and that the Committee was not happy to hear.

Daniel Lester asked whether Griffin saw the role of astrophysics in the lunar exploration to be limited to the lunar surface.

Griffin said no; the community did not need to limit itself to the lunar surface. The agency was producing an architecture for astronautics; he believed it had embarked on a better program in that area than the country had had in 35 years. He believed the President and the Congress had got it right. He urged the Committee to take the broadest possible look at what use it could make of space.

Neta Bahcall asked if Griffin thought Congressional support for lunar initiatives would be sustained.

Griffin said he believed it would be, unless the NASA authorization was changed. He said the agency had fairly good bipartisan support. Historically, it had not encountered partisan issues; it did run into geographic ones.

Neta Bahcall asked if there was bipartisan support for Moon/Mars.

Griffin said the broad spectrum in Congress supported the initiative. He did not see partisanship in the continuing resolution that had been passed; he believed the agency had been treated evenhandedly.

Neta Bahcall asked if Griffin believed Moon/Mars would continue indefinitely.

Griffin said he believed so. He suggested considering certain questions. First, was the nation going to have a space program? He believed a huge majority in Congress would say 'yes.' He noted that the conflicting pressures to raise or lower the appropriation were about equal; he believed eliminating NASA would cause a cataclysm. Second, if NASA existed, will there be a manned space program? As there has been such a program for 45 years, Griffin said he believed it would continue; changing would represent a huge policy shift. Third, if there is a NASA and a manned space program, where will that program go? He noted that sending astronauts back and forth to the Space Station had been judged an insufficient goal; if so, then the moon was next. Following that logic, he said, it was difficult to conclude there would not be a Moon/Mars program. To date, he said, humans had spent only one man-month on a surface the size of Africa; much remained to be learned.

Garth Illingworth asked about the FY07 budget.

Griffin said he thought the FY07 budget had been good news for science. The House had acted and the Senate was likely to concur; the 'hit' NASA science would take relative to the President's request would be \$75 million out of a \$5.3 billion budget. He said the budget question for the Committee was FY08 and beyond. If, he noted, the FY07 budget figure became the new baseline, then the community would lose \$3 billion over the budget run-out; if FY07 was a blip, then everybody was okay. If the general NASA budget split is 2/3 human; 1/3 science, then science would lose \$1 billion. If Astrophysics was one-fourth of science, it could lose \$250 million. He believed the energies of the space community needed to be focused on supporting the President's budget request.

NASA Administrator Michael Griffin departed at 9:40 a.m.

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A brief discussion on international efforts ensued:

Marcia Rieke raised the issue of cost vs. benefits on international efforts. Paul Hertz said that on small projects, the increased costs of complexity and management overhead often outweighed the value of the contribution; at the same time, he added, international efforts broadened the intellectual mix on the project, and, second, both the current Administration and Congress encouraged NASA to work internationally. Sterl Phinney commented that the European expenditure of \$300 million on the LISA Pathfinder had posed no problem, as there had been no difficulty in importing it. Hertz said one issue was the complexity of the project: on GLAST, he said, the interfaces were highly complex and considerable project management overhead was added. When, he said, the international component was an instrument that could be strapped on, the risks related largely to scheduling.

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*James Webb Space Telescope [JWST]:*

Eric Smith

Eric Smith presented a JWST status report. He noted that primary mirror segments had passed their critical design audit; a review team established in April 2006 by NASA Headquarters and the Program Management Council [PMC] had confirmed the current project baseline; the Near Infrared Camera (NIRCam) passed its critical design review in May 2006; the Integrated Science Instrument Module (ISIM) had a

preliminary design review; mid-infrared instrument critical design review began in December 2006, and the Canadian Fine Guidance sensor is scheduled for review this year. Smith said 2006 was an important year for JWST technology development; the general strategy was to retire technological risk early. He noted mirror production was in progress at the two major production facilities; all 18 primary mirrors were now at Tinsley, which he termed a major project milestone. Garth Illingworth asked if any mirror segments had yet been polished to completion; Smith said that was several years off.

Smith detailed the effects of the JWST re-plan, including the scheduling of the Non-Advocate Review [NAR] and the Preliminary Design Review [PDR]. He described ten technologies [slide 5] that had been independently reviewed; nine had achieved Technology Readiness Level 6 [TRL6]. His comments included:

The actuator mechanism had passed review, Smith said; the review team acknowledged that risk was associated with any large optic that is yet to launch. Smith noted that the risk of inventing a beryllium primary mirror segments had been retired.

Mirror Phasing Algorithm: passed with flying marks.

On the backplane: it had been demonstrated that this could be built of composites and that changes of shape at very low temperatures could be controlled.

On near-infrared detector: factories could make these to the appropriate standard; questions remained about producing them in quantity.

Sunshield membrane material: this had passed tests of its ability to withstand meteorite impacts; further, it was established the material was well enough understood to permit understanding of temperature and radiation effects. He noted that the ability to deploy the entire unit had not been deemed a new technology, as Northrop Grumman had developed many previous deployable systems.

Cryocooler was the only technology not to pass at the TRL6 level. Smith said this was because it had required additional power to reach the target temperatures; teams were currently working to reduce its power requirements. The JWST project reserves were sufficient to pay for this. Smith felt that while the cryocooler goal had not been reached, a clear path had been established. Marcia Rieke commented that reducing the power requirements was largely a matter of tuning. Daniel Lester asked how great a reduction was needed; Rieke said 20-30 percent.

The review, Smith commented, acknowledged that manufacturing challenges remained before launch; the reviewers' prime concern was to complete the 'invention' phase of the project so that manufacturing could proceed. The question was asked if the shutters faced 'lifetime' issues; Eric Smith said that as shutters had almost no mass, there was no real issue. He noted that, when manufactured, some shutters were 'stuck open' – this had occurred to 12 shutters in an array of 364 x 171.

Eric Smith repeated the review team's comment that JWST was completing its technology work early so the budget did not 'blow up' at CDR. Smith noted that major elements of JWST would be tested in cryogenic settings separately; because no cryogenic facility was large enough, models would be used. Smith said considerable time and testing would be involved.

On budget [slide 7], Eric Smith called attention to the \$49 million added to the FY08/FY09 budgets for contingencies. Alycia Weinberger asked if FY06/FY07 contingency funds had been spent; Smith said they had. Daniel Lester asked the budget impact if it proved necessary to hire back people who had been let go; Smith said no one had been let go until it was established that their work had been completed correctly. Garth Illingworth asked where project reserves were held; Smith said they were held by the project. Illingworth asked if the ten technologies on

which Smith had reported were the outstanding ones: Smith said: yes; the cryogenic actuators had reached TRL6 in 2000.

Garth Illingworth said Committee discussion had been prompted by concern last year over JWST's potential impact on other activities. He believed JWST was now in an obviously more stable position. Smith said two years of stable funding had helped considerably; still, the project was not a 'slam dunk.'

Steve Harrison, Northrop Grumman, noted that a full-sized model of JWST, created at the corporation's expense, would be displayed near the National Air & Space Museum in Washington D.C. in May 2007.

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### *ExoPlanet Task Force Update*

Stephen Ridgway [NASA]

Jonathan Lunine [LPL] [by speakerphone]

Stephen Ridgway presented the charge from the Astronomy and Astrophysics Advisory Committee to the ExoPlanet Task Force [slide 5], which stated in part:

"The ExoPlanet Task Force is asked to recommend a 15-year strategy to detect and characterize exo-planets and planetary systems, and their formation and evolution, including specifically the identification of nearby candidate Earth-like planets and study of their habitability. The strategy may include planning and preparation for facilities and missions beyond the 15-year horizon."

Ridgway noted that the Task Force had been urged to develop strategies at various levels of aggressiveness.

Jonathan Lunine presented the Task Force's membership [slide 7], which he said included a very broad range of expertise; he believed its size was consistent with being an effective working group. Garth Illingworth expressed pleasure that people were committing their time to the activity and particularly thanked Jonathan Lunine for taking on the task of chair.

Jonathan Lunine presented the Task Force schedule [slide 8]. He said the Task Force would first meet February 20-21, 2007. Meetings to receive invited briefings and white papers would be held in April and May; the time until September would be used for recommendations and writing, with the formal report to be presented in October 2007. Lunine said the community would receive a 'heads-up' [slide 10] that white papers were welcome; additional information was available at [www.nsf.gov/mps/ast/exoptf.jsp](http://www.nsf.gov/mps/ast/exoptf.jsp). Lunine said he believed the Task Force would be exciting; technologies were changing and new opportunities were opening.

### *Discussion:*

Marcia Rieke said the Task Force composition appeared to have charted a bias-free course between agencies and centers. Garth Illingworth said it was preferable not to include strong proponents on a task force; he suggested that the Task Force, when its report draft was very complete, should select community members to read the draft and provide feedback. Lunine said AAAC should expect a briefing in August; perhaps sooner. Illingworth added that he thought the present was a good time to do

a relatively zero-based assessment of how to move forward on what was an important topic.

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*Dark Matter Assessment Group:*  
Draft Report  
Hank Sobel, chair

Hank Sobel said his presentation would cover:

- Experimental approaches to using particle detectors in underground laboratories
- Relative advantages and disadvantages
- Optimum strategy to operate at the sensitivity frontier while making the investment required to reach the ultimate sensitivity
- Present state of the worldwide dark matter program
- What guidance and constraint can be gained from other approaches to understanding dark matter?

Hank Sobel presented the task force membership, noting that most were not currently focused on the area; the group had met June 29-30; August 14-15; and [in closed door] September 19-20, 2006. Three videoconferences had occurred. The context for the task force, Sobel said, was that breakthroughs in cosmology had altered understanding of the universe: many observations supported the idea that four-fifths of the matter in the universe was Dark Matter. The evidence was that most Dark Matter was not of a known particle, which strongly suggested that current fundamental theory was incomplete.

Garth Illingworth requested comments from Rene Ong [by speakerphone]. Ong said on balance that the task force had done an excellent job; it should be applauded for going somewhat beyond its charge. He described the report as a current snapshot; a new assessment should occur in two years. He said the recommendations on which experiments should go forward might be too specific. Illingworth asked Ong if recommendation #8, on priorities, provided sufficient guidance to the agencies involved. Ong said recommendation #8 was something of a shopping list; he urged it be tightened.

Commenting on priorities, Hank Sobel said the \$2-3 million annual expenditure on Dark Matter was quite small; for \$10 million annually, the entire Dark Matter program could be done comprehensively. That was being recommended, though Sobel understood it would not happen immediately. One question was: what were the priorities until funding levels were built up. He identified two: first, funding the expansion of the noble liquid experiment to its next level; second, continue the CDMS and ADMX experiments. About equal funds should go to each; other items, though very promising, would have to remain lower priorities. Sobel presented a status chart, commenting that the next few years offered great opportunity, as major technology developments would occur by 2009; that development framed the recommendation for a reevaluation in 2009.

Garth Illingworth suggested that the specific R&D techniques to be pursued should be identified in the report's recommendation. Further, Illingworth urged inclusion of a 'flow down' showing how the thinking led to the recommendations; these might be stated first in an executive summary.

Keivan Stassun asked whether funding was 50-50 between DOE and NSF; Sobel said the greater share of R&D money might come from NSF. Scott Dodelson asked if funding remained at the \$2-3 million level, could informed technology

choices be made by 2009. Sobel said not. Alycia Weinberger asked if current funding levels would support making such choices by 2011. Sobel said many factors were involved; he felt, generally, the funds being spent on Dark Matter did not reflect the subject's significance.

Wendy Freedman said the call for a future reassessment made sense; she expressed some concern that if funding remained at its current level, the suggested 2009 review could not be undertaken: still, to call for the review seemed to assume receipt of funding that the effort did not have. Hank Sobel commented that the task force was attempting to produce a report that would maintain U.S. leadership in the area.

Garth Illingworth noted that other task forces had submitted draft reports to a group of community reviewers; had Sobel's group done that. Sobel said no. Illingworth said such feedback had proven to be highly valuable; he suggested delaying the report's issuance until this occurred. Illingworth noted that this report, more than others, was built around experiments: did Joe Dehmer believe the level of detail obscured things? Dehmer said he thought that what existed was excellent.

Randy Johnson thanked Hank Sobel for the report which, he said, would provide a valuable blueprint for the future. Scott Dodelson, noting the presence of interagency issues, asked if the agencies were talking together? Dehmer said they were and had been for years. Keivan Stassun said he learned a great deal from the task force report.

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#### *Decadal Survey Planning/CAA Updates*

Brian Dewhurst

Brian Dewhurst noted the recent release of the NRC report "Performance Assessment of NASA's Astrophysics Program," which had been requested in the NASA 2005 authorization and constituted a mid-decadal report card. Dewhurst presented the membership of the committee, chaired by Ken Keller, former president of the University of Minnesota.

Brian Dewhurst reported the committee had three tasks: first, determine whether NASA's program planning addressed the goals and opportunities in the Decadal Survey and the report "Connecting Quarks with the Cosmos;" second, assess the progress made in achieving those plans; and, third, recommend any actions the committee felt would optimize the program. Dewhurst presented the report's recommendations:

First: 'NASA's 2003 Astrophysics program plan responded effectively to the recommendations made in the National Research Council reports Astronomy and Astrophysics in the New Millennium and Connecting Quarks with the Cosmos...'

Second: 'In a time of extraordinary potential for scientific discovery, the prospects have been substantially reduced for NASA's contributing in the future to astrophysics over a diverse range of enterprises, and with the agility necessary to rapidly respond to opportunity.'

Third: 'NASA's Astrophysics Division does not have the resources to pursue the priorities, goals, and opportunities outlined in the AANM and Q2C reports.'

The report urged that NASA 'optimize the projected science return' from its Astrophysics Program by (a) ensuring a diversified portfolio of large and small missions that reflect the science priorities articulated in the 2001 Decadal Survey and (b) by investing in the work required to bring science missions to their full potential: e.g. technology development, data analysis, data archiving, and theory.'

Beyond this, the report urged that NASA both establish the goal of restoring the Explorer line to the launch rate it had early in this decade and identify structural mechanisms [firewalls, etc.] for protecting its activities. Dewhurst noted that the committee observed that, while all missions tend to cost more than planned, the repercussions were larger when large missions exceeded planned budgets.

*Discussion:*

The point was raised that mission cost overruns were so large a problem that it needed to be addressed in the context of the Decadal Survey. Brian Dewhurst noted an ambiguity in the Decadal Survey: was it, in fact, achievable in the next decade or only a future goal. He believed missions should have passed some milestone to be included in the Decadal Survey process. The larger problem, he said, was that significant science opportunities were being missed by not having a robust Explorer program. He noted that 'top-priority' missions were done; the Explorer class, he noted, had no top-priority mission: if it did, it was likely to be executed. Garth Illingworth said he thought this a wise approach; he added, however, that for the next two years activities were hamstrung by general budget concerns and the JWST cost profile.

Neta Bahcall asked about the structure of the Decadal Survey: would it be a combination of science questions and projects; would it be divided by wavelength? Brian Dewhurst said that, at present, the focus was on looking to the committees and to others to say; there were as yet no answers to those questions. He believed that once a committee was formed and a chairman selected, things would become defined. Eileen Friel asked how those decisions would be made. Dewhurst said the Decadal Survey was the creature of the astronomy section and the broader community; he believed that, in April, members of the Academy and from CAA would meet to decide if a proposal to do the Decadal Survey should be initiated.

Neta Bahcall asked if, to date, the activity was one of securing comments from the community; Dewhurst said it was. He noted the range of topics discussed at the last Town Hall, including: how to gather input from the entire community; committee structure -- science vs technique; how to address uncompleted recommendations from previous surveys; and others. Dewhurst said the community would be surveyed in early 2008; he termed this a large effort. He believed the Survey would be completed in early- or mid-2010. Garth Illingworth emphasized the importance of continuing to move forward; Dewhurst said his strongest impression from the Town Meeting was that the community was ready for this activity.

Brian Dewhurst said it was clear that the astronomy/astrophysics decadal plan was viewed as the best. Wayne van Citters said that quality was positively reflected in funding levels received. Garth Illingworth said the committee should consider innovative approaches to process or content. Dewhurst suggested committee members look at other committee surveys. Wendy Freedman said there was some tendency to over-correct whatever it was thought was not done well the previous time; she cautioned against this. Garth Illingworth suggested the previous effort had been good at programmatic details, less good on science.

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*Solar Survey*  
Alex Pevtsov

Alex Pevtsov presented information on Solar Dynamics Observatory [SDO], scheduled to launch August 2008. Garth Illingworth asked if the mission was on track

for launch; Pevtsov said it was. Pevstov discussed cost savings achievable by closing GONG: the annual program budget of \$2.5 million included \$1 million for telescopes and \$1.5 million for scientists; eliminating the program would remove \$1.5 million from support for scientists. The project involved six instruments in six different countries; he suggested that each country be asked for \$150k annually to sustain the project. Garth Illingworth commented that recommendations for closure included the seeking of alternative funds.

Pevtsov discussed the value of a one-year overlap of GONG and SDO. Data would be collected, but no data analysis done -- the data work was very intense; likely, 'soft money' scientists would depart earlier than otherwise. He believed that, even without support for data collection, scientific personnel needed a year to conclude research; this would provide useful results. Wayne Van Citters noted that closure of GONG was recommended to happen one year after SDO entered operations, not one year after launch.

Pevstov suggested that GONG provided value to, among other places, NSF space weather programs; perhaps the National Oceanographic and Atmospheric Administration [NOAA] or other parts of NSF could provide underwriting. Wayne Van Citters said the Australian weather service was opposed to GONG's going out of service but had not offered financial assistance.

Garth Illingworth said Pevstov's presentation helped inform the Committee of areas of possible overlap. He believed that when NSF identified possible changes, the best response was to see how the 'bottoms-up' activity played out. He expressed interest in receiving updates, adding that the Committee may wish to make a recommendation in the future.

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#### *Committee Discussion:*

Marcia Rieke said that, on budget, the NASA Astrophysics Division was 'between a rock and a hard place' – funding would not match the community's aspirations. Garth Illingworth agreed.

Rick Howard was asked to comment on SOFIA. Howard said the program plan awaited Congressional approval; he anticipated operational costs of about \$75 million annually, continuing to the end of the budget horizon. He anticipated a further review of science output in five years, to see if expenditures were justified. Garth Illingworth said SOFIA was a very expensive program; NASA Headquarters believed \$80 million annually was reasonable for operations. Daniel Lester noted efforts to see if operations costs could be reduced; he added that the 'tragedy' was that SOFIA would happen in 2010 rather than in 2002. Illingworth asked what advice might be given on SOFIA. Marcia Rieke suggested encouraging the program to reduce operations costs; Lester noted – as a cost factor – the doubling or tripling of the price of jet fuel.

Wendy Freedman commented that considerable clarity had been achieved in many areas previously undetermined -- HST, SOFIA, SIM and JWST. While she regarded the current circumstance as challenging, the clarity achieved was extremely important to moving forward.

Alycia Weinberger expressed concern over the difficulties inherent in interagency cooperation; e.g. the extended time that was required to issue an NVO solicitation. Dana Lehr said agencies worked well together on the programmatic level; the solicitation was particularly complicated because of the legal involvement from both agencies. Daniel Lester said such issues were likely to increase in importance; they merited the group's attention. Michael Salamon said JDEM had a fairly clear path; if the project were selected, NASA and DOE would collaborate on

the AO. Wayne Van Citters said that, perhaps curiously, it was easier to get cooperation on JDEM than on NVO: JDEM was a larger undertaking and thus received higher-level attention. Garth Illingworth noted that the Committee had several times urged action on NVO; it would repeat that urging.

Neta Bahcall asked how far the DOE/NSF ground-based Dark Energy Survey [DES] project could proceed without an AO having to be issued; minimally, the community should be informed that proposals would be accepted. Wayne Van Citters suggested the Committee formally state the importance of the Dark Energy Task Force report and urge all concerned to streamline their processes. Neta Bahcall asked what the best procedure was when two agencies each wanted to pursue something with the understanding that at some point it would become a joint venture. Kathy Turner said she endorsed the statement just made by Wayne Van Citters; Van Citters said that DES would either go forward as a joint program or not at all. He noted that, if a joint solicitation were required, that would hold up the program for a year or two. Wendy Freedman said the community was already aware of these opportunities; Wayne Van Citters said 30-50 percent of the proposals submitted in the area of extragalactic astronomy and cosmology concerned Dark Energy and/or the Dark Energy Task Force.

Marcia Rieke inquired of efforts to enhance the mid-scale instrumentation program. Eileen Friel said little had happened; however, the \$2 million cap on MRI may be lifted to \$4 million.

Wendy Freedman said the Committee should welcome the stability various reviews had brought to JWST; further, she noted that NASA Administrator Michael Griffin had been very clear about which projects would go forward. Garth Illingworth suggested the community prepare itself for a time period in which they might not get what they wanted. Daniel Lester noted that little was on the launch schedule in the early 2010s. Freedman noted that, while clarity was being achieved, both science and workforce continuity was being disrupted.

Garth Illingworth invited comment on the Decadal Survey process. Marcia Rieke suggested the next survey process should be supported by NASA, DOE and NSF. Illingworth said DOE involvement should be encouraged; since DOE had interests in science outcomes, it should be part of the process. Wendy Freedman alluded to Michael Griffin's comment about the absence of a 'feedback loop'; a decade was a very long time frame; however, nothing else had the stature of the Decadal Survey. Michael Salamon said decision trees could be included in the planning process.

Wendy Freedman urged the Committee to comment on the Senior Review process, which she regarded as very important. Daniel Lester asked if the Senior Review would become a regular activity. Wayne Van Citters said yes, though there was some question about how to do this.

Neta Bahcall said she was puzzled that two large telescope projects [GMT and TMT] were proceeding independently. Wayne Van Citters said the Senior Review had made clear that ample time existed to do things right; he noted plans in Europe to construct a 42-meter telescope, though its funding was very unclear. Perhaps, he suggested, a substantial fraction of each telescope might be privately funded in four or five years. Marcia Rieke said those advocating the telescope projects doubted both would come to fruition.

Garth Illingworth said that, in the interests of continuity, members should review last year's report to identify topics upon which the committee should say something.

Michael Salamon said one 'big question' was how to define the boundary between astronomy and physics. Garth Illingworth reported receiving a communication raising a similar question from someone doing fundamental physics

in space. Daniel Lester said he had spoken with the letter writer, who acknowledged he might be 'stretching things' in requesting support for fundamental physics from astrophysics. Michael Salamon said the unresolved issue was whether NASA and other agencies should further the use of space as a site for fundamental physics.

Neta Bahcall asked if the FY07 budget baseline was a matter of concern; Garth Illingworth said it was.

Neta Bahcall noted that, with SIM, a large team of experts that had been accumulated was now being let go. Michael Salamon noted that NASA Jet Propulsion Laboratory [JPL] was attempting to retain the interferometry talent, but this was proving a struggle; it was hoped that some of these technologists would move to other projects, such as LISA, within JPL. Michael Devirian [audience] said SIM employment would fall from 280 to 50; people were being retained either because, first, they constituted a core team needed to re-launch the project, or, second, they were engaged in an effort to reduce engineering risk, which would reduce future costs. Devirian noted that making large cuts would make it inefficient to turn the project back on; further, the project's most vital people were those receiving the most job offers elsewhere. Devirian added that, at present, priorities were to get the most useful science possible out of SIM, and, second, to position the Navigator Program as well as could be done for the Decadal Survey. He said planning was proceeding at the \$1-billion and \$2-billion level – compared to the \$4-billion level earlier discussed – with a view to seeing how much science each might achieve.

Garth Illingworth thanked all for their efforts and adjourned the meeting at 3:00 p.m.

*Appendix A: membership*

Astronomy and Astrophysics Advisory Committee (AAAC)  
2006-2007 Membership

Dr. Garth D. Illingworth (Chair)  
University of California, Santa Cruz

Dr. Neta A. Bahcall  
Princeton University

Dr. John E. Carlstrom  
University of Chicago

Dr. Bruce Carney  
University of North Carolina at Chapel Hill

Dr. Scott Dodelson  
Fermi National Accelerator Laboratory

Dr. Wendy Freedman  
Carnegie Observatories

Dr. Katherine Freese  
University of Michigan

Dr. Daniel Lester  
University of Texas at Austin

Dr. Rene A. Ong  
University of California, Los Angeles

Dr. E. Sterl Phinney  
California Institute of Technology

Dr. Marcia Rieke  
University of Arizona

Dr. Keivan Stassun  
Vanderbilt University

Dr. Alycia J. Weinberger  
Carnegie Institution of Washington

*Appendix B: Presentations:*

John Dimeo and Jon Morse, Office of Science and Technology Policy, 'OSTP Update,' February 8, 2007

Brian Dewhurst, Board of Physics and Astronomy, 'Beyond Einstein'

Brian Dewhurst, Board of Physics and Astronomy, 'NRC Astrophysics Update,' February 9, 2007

Richard Howard, 'Astronomy and Astrophysics Advisory Committee: Astrophysics Division FY2008 Budget,' February 8, 2007

Jonathan Lunine, LPL, and Steven Ridgway, NASA, 'Exo-Planet Task Force (ExoPTF), February 9, 2007

Patrick McCarthy, Carnegie Observatories, 'Giant Magellan Telescope: Project Status and Relationship with the NSF,' February 8, 2007

Eric P. Smith, Program Scientist, 'JWST Project Status for the Astronomy and Astrophysics Advisory Committee,' February 9, 2007

Robin Staffin, Office of High Energy Physics, DOE Office of Science, 'High Energy Physics Briefing to the Astronomy and Astrophysics Advisory Committee, February 8, 2007

Edward C. Stone, 'Thirty Meter Telescope,' February 6, 2007

Wayne Van Citters, 'From the Ground Up: Balancing the NSF Astronomy Program – Implications for GSMT' [undated]

Wayne Van Citters, 'From the Ground Up: Balancing the NSF Astronomy Program – Interagency Implications' [undated]

Wayne Van Citters, 'NSF Update,' February 8, 2007

*Appendix C: Persons in Attendance*

*Thursday, February 8, 2007:*

Scott Dodelson, FermiLab  
Rene Ong, University of California, Los Angeles  
Alycia Weinberger, Carnegie/DTM  
Wendy Freedman, Carnegie Observatories  
Wayne Van Citters, National Science Foundation/AST  
Eileen Friel, National Science Foundation/AST  
Bruce Carney, University of North Carolina  
Jay Frogel, AURA  
William Smith, AURA  
Daniel Lester, University of Texas, Austin  
Marcia Rieke, University of Arizona  
Tammy Bosler, National Science Foundation/AST  
Henry Ferguson, Space Telescope Science Institute  
Michael Devirian, NASA Jet Propulsion Laboratory  
Craig Foltz, National Science Foundation/AST  
Keith Strong, Lockheed Martin  
Wilton Sanders, NASA headquarters  
Nigel Sharp, National Science Foundation/AST  
Rob Dimeo, Office of Science and Technology Policy  
Jon Morse, Office of Science and Technology Policy  
Jerome Drexler, author  
Ed Stone, California Institute of Technology  
Stephen Unwin, NASA Jet Propulsion Laboratory  
Andrew Voelker, L-3/Brashear  
Wei Zheng, National Science Foundation  
Thomas Barnes, National Science Foundation  
Brian Dewhurst, National Research Council/BPA  
Jeremy Richardson, AAS  
Michael Ledford, Lewis-Burke Associates  
Dana Lehr, National Science Foundation/AST  
Garth Illingworth, University of California/Santa Cruz  
Nicholas White, NASA Goddard Space Flight Center  
Keivan Stassun, Vanderbilt University  
Richard Howard, NASA  
Zlatan Tsvetanov, NASA Headquarters  
Alexei Pevtsov, NASA Headquarters  
Stephen Ridgway, NASA headquarters  
Robin Staffin, Department of Energy/HEP  
Ron Hellings, NASA Headquarters  
John Gantt, Mizrack & Gantt  
Steve Harrison, Northrop-Grumman  
Robert Katt, Infonetic  
T. Jens Feeley, NASA Headquarters  
Julian Christou, National Science Foundation/AST  
Paul Hertz, NASA Headquarters

Victoria Swisher, National Research Council  
Kathleen Beres, Orbital  
Lia LaPiana, NASA  
Jon Malan, Lockheed Martin  
Amy Kaminski, Office of Management and Budget  
Dave Trinkle, Office of Management and Budget  
Joel Parriott, Office and Management and Budget  
Jennifer Wiseman, NASA  
Dennis Socker, NRL  
Hashima Hasan, NASA Headquarters  
Kathleen Turner, Department of Energy/HEP

*Friday, February 9, 2007:*

Keivan Stassun, Vanderbilt University  
Alycia Weinberger, Carnegie/DTM  
Gay Miller, USDA  
Nicholas White, NASA Goddard Space Flight Center  
Wei Zheng, National Science Foundation  
Steve Harrison, Northrop Grumman  
Marc Allen, NASA headquarters  
Zlatan Tsvetanov, NASA Headquarters  
Dan Akerib, Case Western Reserve University  
Scott Dodelson, Fermilab  
Hank Sobel, University of California, Irvine  
Garth Illingworth, University of California, Santa Cruz  
Steven Unwin, NASA Jet Propulsion Laboratory  
Randy Johnson, Department of Energy/HEP  
James Stone, National Science Foundation/PHY  
Matt Mountain, Space Telescope Science Institute  
Brian Dewhurst, National Research Council  
Paul Hertz, NASA Headquarters  
Michael Salamon, NASA Headquarters  
Michael Ledford, Lewis-Burke Associates  
Dan Lester, University of Texas  
Joe Dehmer, National Science Foundation  
Bruce Carney, University of North Carolina  
Dennis Socker, NRL  
Jerome Drexler, author  
Andy Voelker, L3/Brashear  
Ron Hellings, NASA Headquarters  
John Gantt, Mizrack & Gantt  
Wendy Freedman, Carnegie Observatories  
Kathleen Turner, Department of Energy/HEP  
Julian Christou, National Science Foundation/AST  
Nigel Sharp, National Science Foundation/AST  
Michael Devirian, NASA Jet Propulsion Laboratory  
Stephen Ridgway, NASA Headquarters  
Eric Smith, NASA Headquarters  
Lia LaPiana, NASA Headquarters  
Marc Postman, Space Telescope Science Institute  
Jennifer Wiseman, NASA  
Jeremy Richardson, AAS  
Wilton Sanders, NASA Headquarters  
David Lang, National Academy of Sciences  
Jay Frogel, AURA