NASA ADVISORY COUNCIL

ASTROPHYSICS SUBCOMMITTEE

October 8-9, 2009

NASA Headquarters
Washington, D.C.

MEETING REPORT

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Craig Hogan, Chair

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Hashima Hasan, Executive Secretary

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October 8, 2009

Announcements
Dr. Craig Hogan, Chair of the Astrophysics Subcommittee (APS) opened the meeting and members made introductions around the table. Dr. Hashima Hasan, Executive Secretary of the APS reviewed logistics for the day.

Astrophysics Division (APD) Update
Dr. Jon Morse, Director of the Astrophysics Division (APD) of the Science Mission Directorate (SMD) provided an update on Division activities. He highlighted a 7 October White House star-gazing event, which NASA supported by providing telescopes, astronaut appearances, and a variety of astronomy-related activities. The event was well-attended and included President Obama and the first family. One-hundred-fifty middle school students and their science teachers participated in this Education and Public Outreach E/PO effort.

Major Division accomplishments
Kepler held an initial science press conference on 6 August, Chandra marked its ten-year anniversary, the Fermi Gamma Ray Space Telescope released first year science results, and the Wide-field Infrared Survey Explorer (WISE) mission is set for a 7 December launch. Dr. Morse noted also the upcoming Women in Astronomy and Space Science conference. The critical design review (CDR) for the James Webb Space Telescope (JWST) mission is due to be held in Spring 2010, and NASA is gearing up for the Hubble Space Telescope (HST) 20-year anniversary in April 2010.

HST early release observations, coming after a successful SM4 repair mission, reveal excellent performance for Wide Field Camera 3 (WFC3). The Cosmic Origins Spectrograph (COS) has demonstrated good sensitivity, somewhat better than pre-launch estimates. The Herschel mission is evaluating first light measurements, with diffraction limited work at 100 microns providing great comparative analyses. Planck is processing first light data as well.

Kepler released its first light image in April 2009, and early science results on Kepler commissioning data were announced on 6 August, showing one-hundred-fold-improved resolution data for a known transit system. This observation proved that Kepler can make the observations it was designed to make. Many ground-based (GB) observatories are following up on targets. Kepler is searching for smaller planets with short periods, with the goal of attaining data in the habitable zone. New results are expected in the first quarter of 2010. It has been estimated that an earth-like planet in a one-astronomical-unit (AU) orbit will probably require three years of data before detection. Asked about proprietary data provided by Kepler, Dr. Morse explained that NASA's data utilization policy and plan for archiving reflects wariness about false positives and scooping. He reported having suggested that NASA publish the candidates to combat this potential problem. Asked if NASA were supporting radial velocity follow-up measurements, Dr. Morse answered in the affirmative, adding that many telescopes have been assigned to this effort.

The Stratospheric Observatory for Infrared Astronomy (SOFIA) mission, in addition to open door testing, will be carrying out initial science measurements in 2010. A Goddard Space Flight Center-led mission called Gravity and Extreme Magnetism SMEX (GEMS) has just been selected as a Small Explorer (SMEX) mission. The Spitzer Space Telescope still has some limited capability despite the depletion of its cryogen supply. The far-ultraviolet (FUV) channel on Galaxy Evolution Explorer (GALEX) has not functioned since May 2009.

Looking forward, Dr. Morse expected the current mission portfolio to be reduced by half by roughly mid-decade, to a total of 8-10 operating missions that are expected to bring great discoveries.

Astro2010 questions posed to APD
Dr. Morse presented a description of some questions that had been asked of NASA by the Astro2010 Decadal Survey committee, and answers provided. In response to Astro2010's inquiry about baseline budget numbers, Dr. Morse presented data that emphasized the importance of prioritizing and sequencing initiatives/missions because budget profiles matter due to limited available resources in any given fiscal year. Budget assumptions include the expectation that no significant wedge of funding will be available until JWST is about to launch. A notional scenario for the rest of the decade assumes $200M per year to continue operating HST, Chandra, and Fermi, and the Division must plan to expend funds in the 2020's to de-orbit HST. Overall, the amount of future mission funding available for moderate and large strategic initiatives between 2013 and 2020 may be in the range of ~$2.3B. The intended message is that if one wants to do several missions, it would be best to carefully phase missions in a temporal fashion to take best advantage of varying fiscal year budget profiles.

A question regarding international collaboration and subsequently introduced uncertainties, Dr. Morse informed Astro2010 that international collaboration is part of almost every mission in the astrophysics portfolio, and that such collaboration is expected to continue to enhance the capabilities of each mission as well as accelerate the pace of discovery.

Astro2010's question regarding NASA response to the Augustine Human Space Flight Plans Committee report was necessarily deflected due to the fact that a final report has to date not been released. Some proposed options illustrated in the Executive Summary (flexible path using L1 and L2 as stepping stones) may have implications for science. Dr. Hogan expressed a concern about launch capability in this context. Dr. Morse felt that this would not have an impact on the next decade of execution, however a heavy launch vehicle is a separate issue that remains to be determined.

On the question of NASA's obligation to meet national needs, APD responded by reiterating its mission statement of increasing understanding of the universe, and elaborating how basic Research and Development (R&D) on fundamental laws of nature can eventually drive the national economy. In addition, APD provides cutting-edge technology that is synergistic with national security, imaging, data processing, etc., and Nobel-Prize winning research.

Asked about the size and scope of a Joint Dark Energy Mission (JDEM), APD presented Astro2010 with 2 JDEM concepts (IDECS, Omega), and have asked the project offices to define a cost-constrained option that is consistent with the original concept of a Dark Energy Probe involving both NASA and the Department of Energy (DOE). NASA has requested that an Interim Science Working Group be created before any competition takes place. Also presented in response was the notion of a competed Probe-class mission line, creating a cost category in the New Frontiers line to do significant ancillary science in focused fields for about $600-800M (including launch vehicle). Dr. Morse felt it would be advantageous to have a recommendation from the Decadal Survey on this latter concept, noting that the Office of Management and Budget is seeking community input on the importance of a balanced mission portfolio.

Kepler would the best example of such a compromise- it is not a Flagship, and APD could accomplish two Kepler-size missions per decade within the projected budget. Competed science investigations and mission concepts could be solicited in three-year intervals, starting in 2011. In addition, Dr. Morse noted that Dark Energy concepts are being submitted to the SMEX program, indicating high interest.

Discussion

The subcommittee engaged in general discussion, beginning with a question about JWST budget and schedule assumptions. Dr. Morse indicated that the FY2010 budget request illustrates the best guidance on the issue, adding that mirror production and flight hardware testing and validation are well under way, and the Integrated Science Instrument Module (ISIM) is under construction.

Queried about the project status of SOFIA, Dr. Morse responded that the first functional test flight is scheduled to be carried out in October 2009 and open door flight tests will follow. In Winter 2010, SOFIA will start flight testing and early science operations as previously described. An Instrument Announcement of Opportunity (AO) for new/upgraded instruments is planned for early 2011. Instrument technology development will be supported under Cosmic Origins Supporting Research and Technology (SR&T).

Asked if any changes were foreseen for the Astrophysics Theory Program (ATP) and Long Term Astrophysics (LTSA), or general funds for Data Analysis (DA), laboratory Astrophysics and Theory, Dr. Morse indicated that APD would defer to Astro2010, which would provide specific guidance on the importance of R&A, technology development, and the relative balance of operating missions with missions in development. Content has been largely incorporated in the Astrophysics Data Program (ADP), ATP and other ROSES opportunities. APD is also considering larger "consortium grants" as a new funding model, similar to that found within Astrobiology; i.e. a Principal Investigator (PI) institution with many partners. APD is also awaiting inputs from the community, including the National Research Council (NRC)-Fisk R&A study, which examines R&D across SMD. Dr. Morse indicated that he would prefer to take new money and apply it differently, leaving the infrastructure as is, and subsequently has requested that the Decadal Survey weigh in on whether this is a good approach.

In discussing plans for the SMEX and Medium Class Explorer (MIDEX) mission lines, APD has requested that Astro2010 state in explicit terms the relative importance of the Explorer Program to overall space Astrophysics priorities, while noting that the budget for the program, maintained in the Heliophysics Division (HPD), is now half its previous value. The status of next Explorer AO is not evident, but should be determined in the passback from the Office of Management and Budget (OMB). The release of this AO is contingent on funding and launch vehicle availability. Asked about the cost and status to SMD of the Alpha Magnetic Spectrometer (AMS) Space Shuttle mission, Dr. Morse reported that AMS, for which SMD bears no cost, is manifested for late summer 2010.

In response to APS concerns about containing growth and avoiding schedule slips in future missions, Dr. Morse contended that the program is balanced, and that NASA has requested that Astro2010 recommend an optimum level of mission-enabling investments within the APD portfolio, including a target percentage of the budget considered appropriate for mission-enabling expenditures. APD has also requested a recommendation on how investments in Research Opportunities in Space and Earth Sciences (ROSES) and the SR&T line might be increased, as well as balance between near-term and far-term or basic R&D for mid-technology readiness level (TRL) technology investments. Dr. Morse agreed that APD has been underinvesting in these areas.

Asked if he anticipated changes to APS and NASA Advisory Council (NAC) structures, Dr. Morse responded that the enlargement of the NAC Science Committee to 15-18 members means that there will

be more astronomers the next level up, while APS itself will remain unchanged. NASA will also receive advice from the Astronomy and Astrophysics Advisory Committee (AAAC).

The subcommittee discussed field center input weighed against the broader research "user" community as part of the Decadal Survey purview. Dr. Morse felt that the Survey should confine itself to weighing science priorities, which the Agency would then address within project implementation plans, recognizing that field centers would be involved in executing Astro2010 priorities and initiatives. There is a definite push at NASA to having government scientists fully integrated into their relevant science communities. Programmatic information from projects, however, should be considered "NASA input" that has been vetted by Headquarters.

Dr. Morse sought APS feedback on the revision of APD science research goals and objectives as NASA begins its 2010 Strategic Planning under the new Administrator, with the goal to have the Astrophysics Strategic Plan revised by Spring 2010. This activity may coincide with a new roadmapping task.

Dr. Hogan inquired whether Physics of the Cosmos (PCOS) science would be included in Keck Observatory time solicitations. Dr. Morse responded that, yes, it would but explained that oversubscription to Keck has been problematic, and that APD would like to avoid overwhelming the current process. Devoting Keck as a strategic asset towards Kepler follow-up observations also exacerbates the situation. PCOS science will be included in the next call for proposals for Semester 2010B. Everyone understands the issue.

Decadal Survey Update

Dr. John Huchra delivered an update on progress in the compilation of the Astro2010 Decadal Survey. The committee has finished its fourth face-to-face meeting of committee. There are five science panels and four program panels. Science panels are essentially finished and have begun drafting reports which will be reviewed in the NRC in December/early January 2010. Program panel reports should be finalized by June 2010. Dr Huchra reported that the Decadal Survey commitee received significant input from the community and from the Aerospace Corporation (costing exercise). He emphasized that the major difference in this decade's process is that the committee had been specifically charged with looking at the operating costs of existing programs and of future missions, and also with understanding lifecycle costs. The science panel reports will consist of unprioritized science questions.

Exoplanet Analysis Group (ExoPAG) Update

Dr. James Kasting, ExoPAG Chair, reported on the activities of the recently formed Exoplanet Analysis Group (ExoPAG), which has been chartered by the APS to analyze problems related to NASA extrasolar planet studies. A steering committee letter of invitation has attracted 44 high-quality applicants representing a wide range of membership spanning academia, industry, and NASA centers. Of these, 12 candidates were proposed by Dr. Kasting and NASA Headquarters for ExoPAG membership.. Both ground- and space-based techniques for discovery are included in candidates' areas of expertise, as well as astrobiology and exoplanet technology, with one representative each from the Jet Propulsion Laboratory (JPL), GSFC, and Ames Research Center (ARC). PIs from large proposed missions were not included, nor for the most part were ExoPlanet Task Force members. The usual considerations of gender and age balance were entertained. Current planning includes the issuance of letters of invitation once the committee is approved, invitation for topics for initial discussions. The first meeting is scheduled for 7-8 January, 2010. Asked to elaborate on tasking, Dr. Kasting explained that APS or Dr. Morse could directly task the group with questions, and ideas from the steering committee could also be a source of tasking. Cited as one example was the issue of exozodii brightness and the as-yet-to-be-determined background signal that obscures planets. After some discussion, the APS decided that the membership of the ExoPAG should be limited to 9 members. Dr. Kasting was tasked to select these from the list of 12

candidates he had presented, in consultation with NASA Headquarters, for final selection and appointment by Dr. Jon Morse.

Dr. Kasting stressed that the ExoPAG reports information back to the subcommittee and Dr. Morse and does not function as an advisory group. Actions resulting from ExoPAG findings are to be taken by APS and APD. Meetings will be open for community input, after which the ExoPAG would form subgroups in the community and produce a report, to which APS would respond. Dr. Morse added that analysis would be performed within the meeting periods, and the nature of these tasks could result in short- or long-term, scientific, technical or programmatic responses.

PhysPAG Discussion

Dr. Michael Salamon (via teleconference) reviewed the terms of reference for standing up a Physics of the Cosmos Program Analysis Group (PhysPAG), identical to those of the ExoPAG and the CORPAG. Similar to ExoPAG in construction, the rationale for the PhysPAG is to have a community-based forum for analysis in support of Physics of the Cosmos objectives, planning and activity prioritization. A major point is being able to form *ad hoc* study groups comprised of community members to articulate key science drivers for research; evaluate goals, objectives, investigations, and measurements; evaluate missions; articulate goals for technology; and identify activities that enhance mission portfolio. The PhysPAG will transmit findings and analyses to NASA via the NAC. The PhysPAG Chair is to be appointed by the SMD Associate Administrator. Executive committee members will be solicited by "Dear Colleague" letter, and will be balanced over expertise and disciplines, in staggered terms of 1-3 years. PhysPAG Executive Secretary will be a NASA civil servant appointed by the Astrophysics DD, and acts as the single POC within NASA. The main body of the PhysPAG will be the attending community, meeting twice a year or more frequently as needed. Dr. Salamon requested that APS endorse the terms of reference. APS briefly discussed the structure of the PhysPAG, noting a one-year term was perhaps too short. Other members requested clarification on the flow of information, the conduit for which was determined to be the APS itself.

Cosmic Origins Program Analysis Group (CORPAG) Discussion

Dr. Eric Smith noted that the mechanics of how the CORPAG would function are to be identical to those of the PhysPAG. He reported briefly on the goals of CORPAG, which will be very broad, covering essentially what has been thought of as "space astronomy" but largely exclude the physics of black holes (considered to be more the domain of the PhysPAG), and exoplanet detection and characterization, and asked that the APS consider CORPAG's purpose, given that large or strategic missions within its purview are likely15-20 years in the future. Dr. Heap suggested, given that black hole and galaxy co-evolution are intermixed, that CORPAG consider the effects of black holes on galaxies and vice versa. Dr. Morse felt that CORPAG could appropriately consider galaxy formation and evolution; how black holes work would be outside a deliberately fuzzy border. There will be overlap. Asked if CORPAG and PhysPAG could cooperate on a topic, Dr. Smith replied in the affirmative. The subcommittee briefly discussed the support mechanisms for the PAGs, and Dr. Morse reported that NASA would be supporting travel for the PAG executive/steering committees.

****APS took an action to bring a recommendation to the NAC Science Committee to establish both PhysPAG and CORPAG.

GEMS Mission Update

Dr. Jean Swank presented an overview of the Gravity and Extreme Magnetism Small Explorer mission (SMEX), proposed for launch in 2014, that will use x-ray polarimetry to examine black holes, neutron stars, and supernova remnants. Dr. Morse interjected that this mission had hit the "sweet spot" in

providing compelling science for a reasonable cost cap. GEMS will also include a student experiment, a Bragg reflection polarimeter, which will help to further constrain inclination and spin measurements.

GEMS will take advantage of the distinct class sources offered by x-ray observations, and its polarimetric measurements will provide geometrical and emission microphysics information. Polarization will allow study of scattering, magnetic fields and strong gravity fields in x-ray sources. GEMS observations can help to constrain black hole spin to probe the mechanisms of black hole growth, and increase knowledge about supermassive black holes, which are challenging but important targets. The mission will coincide with a multi-wavelength effort to make parallel measurements, with details yet to be worked out. GEMS will also study x-ray flux in neutron stars and magnetars. GEMS will be able to measure the polarization signals from magnetars, which carry information about geometry, bounds on field strength, weak dependence on M/R and manifestation of quantum electrodynamic effects. The mission will answer questions about the geometry of emission regions in accreting pulsars, as well as about how cosmic ray acceleration occurs in supernova remnants. The observing program would survey x-ray polarization for 8 classes of sources (plus the supermassive black hole located within the molecular cloud, Sagittarius B2).

The GEMS x-ray polarimeter instrument (XPI) will function in the 2-10 keV range and will carry three independent telescopes. A time projection chamber (TPC) will be used to track photoelectron paths. The XPI has a useful field of view of approximately 14 arc minutes. The spacecraft and instrument will rotate together at 0.1 revolutions per minute and each observation will include 100 revolutions.
GEMS has a planned lifetime of two years, enabling 15 months of General Observer program activities, based on a goal of 35 sources. Thus far, several components of the polarimeter have been tested and demonstrated, and tracks have been obtained and data read for energies across the GEMS range. Possible future results of GEMS observations include the detection of 15 black holes, 11 pulsars and neutron stars, and 6 supernova remnants, at a 100-fold greater sensitivity than previous missions, helping to open the frontier on the essentially unexplored area of x-ray polarization. In response to questions, Dr. Swank answered that the mission will time-stamp photons, and that it has not yet been decided whether to have the instrument continuously on. A participant commented that the number of targets and number of slews is relatively small, reducing serendipitous discoveries of transient events. Dr. Swank also noted that GEMS has budgeted for 50 extra contacts for downlinks, which can respond to targets of opportunity within a day, or a week. The battery and orbit lifetime for GEMS has been sized for two years.

Technology Fellowship Update

Dr. Kathryn Flanagan provided an update on the APS working group that has been analyzing the possibility of establishing a new NASA fellowship to support technology development. Dr. Flanagan provided background information, noting that postdoctoral fellowships already available include the NASA Postdoctoral Program (NPP) as well as a number of graduate student fellowships, the latter of which are open to all full-time students. There are also named fellowships (Hubble, Einstein and Sagan) that are highly competitive and prestigious. Recognizing that the technology infrastructure is in crisis, the working group agrees that existing university centers must be strengthened. To accomplish this, it is felt that a new NASA technology fellowship is necessary to disconnect technology development from NASA centers, and to allow the “blue-sky” type of thinking that is available at universities. The working group is therefore recommending a multi-year (4-5 year) postdoctoral fellowship with at least a 61K per annum stipend, with the expectation that the host institution will demonstrate a commitment to technology R&D, and will also provide program management expertise. The recommendation is ten new fellowships per year. High-risk programs would be encouraged, as would moderate capital investment and partnerships with NASA centers and industry. Applicants and their sponsoring institutes should present a joint proposal to a U.S. university, educational institution or Federally Funded Research and Development Center (FFRDC).

Dr. Morse and the APS discussed some technicalities influencing proposal pathways to a typical NASA fellowship. Dr. Hasan regarded the NPP as a gap-filling program, which enabled post doctoral researchers to work at NASA Centers. Dr. Heap felt that cutting out centers would hurt NASA's technology effort. Dr. Morse suggested examining Astrophysics participation in NPP to see if it might be modified to address such concerns. Dr. Flanagan suggested that there are many ways in which the host institution can contribute to the fellowship; e.g., waive overhead, provide telescope time, or leverage funds.

A new technology fellowship has the strategic advantages of being able to train technologists, and increase the Science, Technology, Engineering and Mathematics (STEM)-educated workforce. Furthermore, a new fellowship can provide advanced technology that will trickle into the economy over time, strengthen the university environment by rewarding creativity, sustain and revitalize existing centers of technology, and provide prestigious support for hardware developers.

The working group recommended that technology graduate fellowships be 3 or more years in length at a level of about 20 fellowships per year, that would be open to industrial partnerships, and to engineering contributions from NASA centers. To sustain the workforce in Astrophysics, the working group felt it would be necessary to devote a total of $15M/year to new postdoctoral and graduate fellowships, postulating 50 postdoctoral fellows in a steady state, introducing one new postdoctoral candidate to each focus area (gamma rays, far IR, etc.) every 3 years. These fellowships would be devoted to breakthrough technologies, suborbital instruments, and other technology advances. A meeting participant commented that cost-sharing would turn into bidding wars (selling fellowships), and marginalizing universities that don't have infrastructure. Dr. Shaul Hanany expressed reservations about the expense and its potential for diverting funds from R&A.

Meeting with SMD Associate Administrator (AA)

Dr. Edward Weiler, Associate Administrator for SMD, engaged the subcommittee in an informal discussion. He first recognized the important efforts of Stephanie Stockman of E/PO, who had been instrumental in supporting the White House star-gazing event, which provided publicity for science and for promulgating science education.

Dr. Hogan asked for a comment on the new advisory structure of the NAC. Dr. Weiler reported having argued strongly to represent a better breadth of science on the NAC Science Committee, specifically including the Chairs of all the subcommittees and adding roughly two new members for each division. The NAC will have 10-15 members. There will be some new subcommittees. He felt happy to have a Science Committee that is broader and more flexible.

Mr. Manning requested any insights into the Augustine panel summary. Dr. Weiler replied that he had participated in many high-level meetings over the last few weeks, and the Agency has some preliminary ideas on how to respond, but stressed that the ultimate decision lies with the President. He considered the panel recommendations as constituting an opportunity for science, which had previously been constrained by the lunar program. It may be possible, with a new direction, to broaden the ability of science to participate more in the human space flight program. In addition, SMD will be able to take advantage of a future Ares V vehicle. One of the options mentioned has been the flexible path option, which would make use of the Lagrange points as possible sites for creating large structures in space. Dr. Weiler declined to comment on an assertion that science has been made subservient to the Moon. He did comment however that human space flight exists for many reasons other than science, adding that science considerations did not drive the original Vision for Space Exploration. Therefore, he continued to express optimism that science can now play a larger role in shaping the future direction of NASA.

Dr. Rhoads asked about the extent of SMD investment in technology development. Dr. Weiler contended that over 10% of the SMD budget is devoted to technology development throughout, but conceded that SMD does lack a separate arm for low-TRL, open-ended technology, with the exception of some limited low-TRL work in R&A. He felt the new Presidential budget would offer some relief in this area. Asked about Administrator Bolden's attitude toward E/PO, Dr. Weiler replied that Mr. Bolden overwhelmingly supports education and outreach, and like himself, expected 1% of each project to go to E/PO. Currently SMD is spending $50-60M per year on E/PO, a figure he considered inadequate.

Dr. Kasting noted that NASA needs some overarching goal and asked what it would be if not "back to the Moon." Dr. Weiler agreed that a goal must be exciting and preferably have some scientific implications, but deferred comment on a precise suggestion. Dr. Suntzeff expressed concern about training the next generation of scientists and engineers, and advocated NASA programs that build instruments, such as the Balloon and Sounding Rockets programs, and aircraft programs in Earth Science. In response, Dr. Weiler charged APS with helping the Division Director work within the available budget and finding a balance to provide funds to these programs

Dr. Rhoads asked for insight into European Space Agency (ESA)/NASA efforts to construct a Dark Energy mission. Dr. Weiler felt that while NASA and Europe are going in their own directions, neither side can develop a solo Flagship mission. SMD is waiting for the Decadal Survey to weigh in on the matter, but Dr. Weiler averred that international collaboration will be key. Dr. Hogan felt there was a mismatch with schedules. Dr. Weiler felt that schedule concerns were merely an excuse, and that the community could work together if it truly wanted a program. If the Decadal Survey supports an expensive JDEM mission, the only option is to work with ESA. Dr. Morse added that ESA has already adjusted their path toward Dark Energy, allowing more opportunities for collaboration with NASA. Dr. Heap commented that JDEM is very directed, whereas the ESA Euclid mission has other components; would NASA consider broadening in the same way? Dr. Weiler replied that the Decadal Survey would determine this direction. The same constraints covered DOE involvement in the mission; if there are other science objectives desired, NASA would have to support them. Dr. Weiler added that in the meantime, OMB has directed NASA to maintain stability in Dark Energy programs pending the Astro2010 recommendations.

Dr. Hogan inquired about fundamental physics in space and where this topic is covered in NASA. Dr. Morse commented that there is a another Decadal Survey which covers microgravity and biological science in space, as well as the International Space Station, adding that Paul Hertz would be a good source of information on the issue. Dr. Hanany asked how APS might be advised to deal with the tension between science return and public image. Dr. Weiler averred that HST has probably helped increase the space science budget because of public interest through visual representation. The Mars program offers similar value. In tougher times, relevance to the public is going to be more important. Dr. Weiler suggested that APS think about relevance in terms of what is the best way to support science at NASA; this will include reaching out to the public and influencing family attitudes toward engineering and science.

Balloon Program Update

Dr. W. Vernon Jones presented an overview of NASA's Balloon Program, reporting that FY 2009 has been an exciting year with considerable press and science journal coverage. The flight program has flown 13 of 16 scheduled missions, with 2 domestic and 2 foreign campaigns. The other 3 scheduled missions will be flown early in the new fiscal year, soon after October 1.Three long duration flights were carried out in Antarctica, The Cosmic Ray Energetics and Mass (CREAM-IV) mission carried the first instrument to exceed 100 days of exposure. NASA is also making plans to celebrate the 100th anniversary of the discovery of cosmic rays in 1912 (discovered on an instrument in a balloon gondola), and is

considering a 100-day balloon flight as an appropriate way to mark the occasion. The Antarctic Impulsive Transient Antenna (ANITA-II) mission, carrying a balloon-borne radiotelescope to search for $>10^{17}$ eV cosmic neutrinos using the Askaryan effect in Antarctic ice, has completed its second successful flight. The result for neutrino candidates from these ultrahigh energy cosmic ray radio impulses is embargoed pending completion of the double-blind data analysis.

NASA's 7-million cubic foot (MCF) superpressure balloon test flight, launched in January 2009, was very successful, achieving 54 days of flight with no apparent gas loss. It is postulated that the balloon could have stayed aloft indefinitely. This flight represented the longest large NASA balloon flight ever undertaken, with altitude fluctuating only with atmospheric parameters. A larger 14-MCF superpressure balloon test, carried out in Sweden in June 2009, met minimum success criteria, but tears were subsequently found near the base plate of the balloon. An error traced to conversion of the balloon design parameters to the balloon fabrication accounted for the tears, as confirmed by an Anomaly Review Board. A duplicate balloon has been fabricated and shipped to Antarctica for an expected launch in late November or early December 2009. These ongoing flight tests are stepping stones for developing an ultra long duration superpressure balloon that can carry 1000-kg of science above 110,000 ft for 100 days, or smaller payloads above 120,000 ft.

For FY10, the balloon program has 17 missions and 21 flights scheduled, including the Balloon Array for Radiation-belt Relativistic Electron Losses (BARREL) mission, which is comprised of 5 separate hand-held launches. A total of 16 science flights plus 2 flights leftover from FY09 are on the slate for 2010. Among them, CREAM will make its fifth flight. While the superpressure balloon project is not fully funded, a 25-MCF balloon test flight is currently scheduled for Summer 2010 in Australia. The long-term plan is to fly 9 ultralong duration balloons (ULDBs) per year, which will require additional resources for payloads as well as balloons. For the future, the program will need fine pointing and trajectory control systems to support superpressure ballooning.

Educational efforts include internships, piggyback flights for undergraduate and graduate payloads, and collaborations with students on science missions. The balloon program provides hands-on training for students to be leaders in science. Dr. Jones noted that both Nobel Laureate John Mather and astronaut John Grunsfeld were products of the balloon program.

Dr. Rhoads asked for clarification of balloon types. Dr. Jones explained that long-duration balloons are zero-pressure balloons, while ultralong duration balloons are based on the first new balloon patented since 1950- a pumpkin-shaped balloon with no vents. It will also be used for long duration flights at mid-latitudes that remain at the same altitude. A ULDB flight is typically longer than 60 days. In response to questions about funding, Dr. Jones reported a shortage of payloads as well as budget reductions, while noting that the payloads themselves are expensive and are funded at an insufficient level; roughly 25% of the science payloads are paid for by internationals. By contrast, more than U.S. 200 scientists are involved in balloon missions. Dr. Hanany confirmed that there has been a substantial reduction in the number of flights per year. Asked about scientific impact on a per-dollar basis, Dr. Jones felt that the balloon program was excellent, and one of the best programs in NASA in this respect. However, more funding is highly desired. Dr. Jones estimated that the flight program could function optimally at $40M/year, but balloon payloads are now underfunded by a factor of 2 or 3. The program is oversubscribed only in Antarctica, and undersubscribed elsewhere. Mid-latitude superpressure balloons will open up a lot of opportunities for disciplines that can't do their science in the Polar Regions, and NASA hopes to have this capability for 2012. Obtaining flights over Russia also remains a major obstacle.

Rocket Program Update

Dr. Wilt Sanders presented an update on the Sounding Rocket program. Like balloons, rockets carry out science experiments, advance TRLs, and train students. A recent Astrophysics science project was an x-ray microcalorimeter experiment by McCammon et al., which helped to qualify instrumentation for the Suzaku mission.

The Sounding Rocket program is run out of the Heliophysics Division (HPD). In addition to NASA payloads, it also flies payloads for the Department of Defense (DoD) and industry, at a wide range of altitudes. A typical Astrophysics payload is 1000 pounds. Many payloads run in the few-hundreds of seconds observing time. The program maintains a stable of 8 vehicles including the Terrier and Black Brant-IX vehicles, and launches primarily from the White Sands Missile Range for Astrophysics projects. The program is hoping to expand to flights from the Kwajalein atoll in order to reach either hemisphere. The target program flight rate is 20-24 flights per year. Astrophysics payloads currently run at 1-2 per year but are anticipated to be at 3-5 per year in FY2010 and beyond. The rocket program has about a $45M budget; by comparison the balloon program has about half that amount. Each launch costs about $2M, whereas new payload costs may be $5-10M. The rocket program is developing technologies such as thrust termination systems, high data transmission rates, attitude control systems, etc.

Dr. Sanders pointed out that both balloon and rocket program budgets are essentially flat from FY07-10. Dr. Morse commented that the APD R&A line pays for Astrophysics payloads, and can't ramp up funding despite Congressional requests to do more with the program. He added that these monies come from R&A based on how it is rolled up in ROSES- a solution might be to relabel R&A, however Dr. Morse felt that APD needed to talk to Congress about content. In response to a question, Dr. Morse explained that when R&A is cut, money goes to programs of Congressional interest. As it stands, Congressional budget threats are $60-80M across SMD. Dr. Polidan noted past successes in contributing engineers to suborbital missions to obtain hands-on experience. Dr. Morse agreed that industry involvement would be welcome on a systematic basis.

Discussion and Public Comment Period

The subcommittee reviewed the issues of the day: Strategic Plan questions and objectives, PAGs, and Technology Fellowships.

Dr. Morse asked that the APS at least prepare for ExoPAG items at the next meeting such that the APS would have tasks to allot to the group; a sample task may be to determine who is submitting white papers to Astro2010. A further action for PhysPAG would be to clarify its charter statements in writing.

October 9, 2009

Subcommittee Discussion

Dr. Rhoads briefly summarized the previous evening's dinner conversation regarding a NASA new technology fellowship, highlighting some issues, such as discomfort with the idea of having an inexperienced student put in charge of a large budget. On the other hand, support had been expressed for a prestigious named fellowship, with funding provided for both a fellow and the proposed host institution. Such proposals would include a request for HST-level stipend/support money for a specific project. Dr. Hanany felt that in the current budget climate, this fellowship would potentially take money away from existing programs, and suggested that named fellowship funds be redistributed more broadly to allow the technology fellowship to go forward. There was also a fear that few named fellowships would be awarded disproportionately to already well-funded institutions. Dr. Hanany reported the sense that experimentalist colleagues who are devoted to technology development are already underfunded by NASA, and that a better tactic would be to fund those who are lacking. Dr. Rhoads suggested that in trying to build human resources, the fellowship funding could be run as a small tax on mission budgets, or existing funds could

be distributed among fewer fellowships. Dr. Kasting recommended utilizing a funded technology project at an institution, with the purpose of bringing students into the technology field. Dr. Hanany suggested NASA adopt a high-risk NSF-type MRI program that is not necessarily tied to a fellowship, recognizing that $20-30K grant could help to train a new technologist/instrumentalist.

E/PO Overview

Ms. Stephanie Stockman presented an overview of SMD education and outreach activities, noting first that she anticipated yet more science events for children at the White House.

SMD maintains an education portfolio for higher education (primarily focusing on undergraduates), elementary and secondary K-12 students and teachers, and also supports efforts to create a scientifically literate public. Informal education efforts include work with museums, citizen scientists, etc. SMD also has a specific outreach goal to stimulate interest in science, engineering and technology. The E/PO vision is to share the story of science and the adventure of NASA's scientific exploration. SMD E/PO attempts to highlight individual missions highlighted in the context of science themes. Sponsored and unique activities include the previously described "Star Party" at the White House and the 40th anniversary of the Apollo 11 lunar landing. Mid-size activities in E/PO are PI-led and competed in ROSES. SMD has recently restored small E/PO research supplements through ROSES as well.

Due to budgetary changes, existing space science forums in SMD E/PO will be replaced by competitively selected Science Education and Public Outreach Forums (SEPOF) as of October 2009. The major responsibilities of these forums are E/PO community engagement and development, division E/PO product and project activity analysis, and SEPOF coordination committee service. The goal is to identify gaps and duplications in educational materials, develop content for after-school activities, and other education materials. In about 8 months, a Working Group for various education communities will be formed, and strategic planning is under way. PIs for each NASA SMD directorate have been selected, and they will interact with their E/PO point of contact. Opportunities in Education and Public Outreach for Earth and Space Science (EPOESS), a mid-range program, had $2M available in 2009. The Heliophysics Division has added $1.25M to this amount. EPOESS received 103 proposals in 2009 and is currently in the selection process.

Two proposal opportunities in September and March of each year will be available for research supplements: $10k/yr outreach or $15k/yr education supplements. Sixty-seven proposals were received in the 2008 ROSES announcement, and 11 education and 17 outreach research supplements were selected. 2009 ROSES has received 10 education and 9 outreach proposals.

Ms. Stockman recounted details of the White House event. Committee members discussed the importance of teaching young parents, perhaps through intervention at PTA meetings. Ms. Stockman responded that E/PO is in fact looking at a broader plan for outreach, citing Family Science Nights at GSFC, which require the presence of a parent, and which feature high school students guiding younger students in separate activities. E/PO is also working with state science supervisors to have a presence in the states. NASA is also taking advantage of social media such as Facebook, Twitter, podcasting, blogging and comment utilities on NASA mission websites. NASA also has a Flickr page and other photo sites.

NASA International Year of Astronomy (IYA) Update

Dr. Denise Smith updated APS on NASA's International Year of Astronomy (IYA) activities. IYA's purpose is to spark interest in science education through personal observing experiences as well as activities for educators and communities. NASA carried out IYA activities through missions and the Research Opportunity for Space and Earth Science (ROSES) program and coordinated activities through Education Forums. Personal observations help provide a hook for the subject of astronomy, through such

Web activities as "object of the month." Articles relating to IYA activities can be found at astronomy2009.nasa.gov. The site includes a suite of observing tools, a monthly podcast, and links to "microobservatory" online telescopes that can be controlled over the Internet. Professional development activities have included National Science Teacher Association journal articles and columns, and workshops for educators.

Community activities such as From Earth to the Universe (FETTU) have brought images of the cosmos to more than 250 nontraditional venues such as airports and parks. "Visions of the Universe," a traveling exhibit on astronomy, is reaching new audiences through libraries, particularly rural libraries, and by providing downloadable materials for educators and speaker's bureaus. Preliminary evaluation of "Visions of the Universe" activities has revealed creation of new collaborations within the community, and has encouraged visiting students to use computer resources, as well as expanded the range of library patrons.

Great Observatories image unveilings have been carried out at museums and science centers throughout the U.S. in conjunction with Galileo's birthday in February 2009. Another unveiling is scheduled for November, and will focus on the Galactic Center with images from HST, Spitzer, and Chandra. The NASA IYA Student Ambassador program has allowed undergraduate students to share their projects with communities and with each other through oral presentations and posters.

In supporting the U.S. goal for IYA, NASA has strengthened existing partnerships, has provided a common umbrella for individual science messages, worked across the divisions of SMD, and has developed collaborations beyond NASA. IYA successes will help inform future SMD E/PO plans. Asked to name successes, Dr. Smith felt that community-based imagery and observing activities had been particularly successful.

Fermi Update

Project Scientist Dr. Julie McEnery provided an update on the status of the Fermi Gamma Ray Telescope mission, which launched in June 2008, and has completed one year of science operations. Fermi carries two instruments, a Large Array Telescope (LAT) operating in the 20 MeV to 300 GeV range, and a Gamma-ray Burst Monitor (GBM), which views the entire unocculted sky in the 8 keV to 40 MeV range. Combined, these two instruments provide superb coverage of sky and energies, and have been meeting or exceeding expectations. The mission supports 10 downlinks per day, after which high-level results are sent back to the Fermi Science Support Center at GSFC.

LAT collaboration occurs amongst international partners, and this project is managed at the Stanford Linear Accelerator Center (SLAC). The tracker was developed by the U.S., Italy, and Japan, the calorimeter by the U.S., France, and Sweden, and the instrument was integrated at SLAC. Almost all LAT observations are made in survey modes; LAT observes the entire sky every two orbits (about 3 hours). During the past year, the mission has had 25 autonomous repoint observations in reaction to gamma ray bursts. Calibration needs are modest: only 13 hours of calibration downtime and 5 days of engineering for LAT. Transient detection uses source direction algorithms to find candidate point sources, followed by full likelihood analysis, after which astronomer telegrams (ATels) are issued for proposed targets of opportunity (ToOs). Thus far, 47 ATels have been issued. Multiwavelength observations of LAT transients in the galactic plane remain a mystery; the key will be to obtain rapid follow-up of these events. LAT high level data releases have been modified, lowering the flux threshold to release information on flaring sources by a factor of 2. Fermi started with 23 sources, and there are now more than 40. The mission is also communicating with follow-up scientists informally via fermisky.blogspot.com.

Since July 2008, Fermi's GBM has detected over 260 gamma ray bursts (GRBs), compared to 200

originally expected. Observations have benefited from flexible onboard triggering mechanisms. GBM has also seen 3 soft gamma repeaters (SGRs), >10 terrestrial gamma ray flashes (TGFs), and a solar flare.

Ten long and 2 short gamma-ray bursts have been detected by LAT at GeV energies, and Swift XRT has detected x-ray afterglows from the 7 brightest LAT bursts, enabling some redshift/distance determinations. Both types of burst show similar phenomenology at high energies. The GBM team has also made non-GRB high level results available, as well as data from the GBM Occultation project. One-year Fermi-LAT sky observations have yielded 1000 new high-energy gamma ray sources, including new classes, such as pulsars pulsing only in x-ray, and millisecond radio pulsars. Fermi can also give a more complete census of young nearby pulsars. Milagro ground-based (TeV) observations have found a strong correlation between 3 sigma excesses and pulsars. All previously known Milagro sources are now associated with Fermi pulsars. Fermi has also detected emission from 47 Tucanae; a search for pulsations from individual pulsars is ongoing. Early indications suggest that there are more than 50 pulsars in this cluster. LAT is also resolving the MeV to GeV gamma ray emissions from extended sources, distinguishing between hadronic or electronic emissions. A paper has been submitted to Science on this subject. LAT sensitivity and wide bandpass has also allowed the measurement of many non power-law spectra. The LAT energy range is also providing joint fits between LAT (MeV-GeV) and IACTs (GeV-TeV), with a peak sensitivity at a few GeV for typical spectra, providing a more complete picture of object spectra. Dr. McEnery displayed a movie of an autonomous repoint detecting a GRB.

Fermi-LAT capabilities for detecting electrons are based on 100% acceptance above 20GeV (onboard filtering is disabled), using algorithms to distinguish gamma rays from charged particles, and using shower shape to distinguish electromagnetic from hadron events. Fermi is seeing more electrons at high energy than had been predicted by models, suggesting an as yet unknown local source.

The Fermi mission has generated 30 papers either published or accepted, with another 21 submitted, and many in preparation. The Fermi Science Support Center supports a guest investigator program, provides training workshops, as well as data, software, documentation and workbooks to the community. Data releases include 400 queries on the first day of release, with many requesting an entire data set. In response, the mission has made a link to weekly all-sky files more obvious, thus the overall number of queries has dropped. Community support has been very successful. There is background contamination in LAT data, so selections are provided as defaults on the server. The Cycle-2 program has selected 80 of 199 proposals. The first data analysis workshop was held at GSFC on 1 October, and future workshop venues will be chosen in response to community feedback. Dr. McEnery acknowledged guidance from the Users Committee members, chaired by Alan Marscher. She added that the first LAT GeV catalog will be arriving within weeks. Asked whether Fermi was coordinating with the AMS group, Dr. McEnery replied that there are indirect communications, but the mission does have formal agreements with IceCube, LIGO, and other observatories, with a policy is to be open and collaborative. Asked about mission life, Dr. McEnery reported that the orbit is good to 2050, while the mission itself has a 5-year prime requirement, with a goal of 10 years.

NuSTAR Update

Dr. Fiona Harrison (via teleconference) gave an update on the SMEX mission NuSTAR due to launch in August 2011, the first focusing high-energy x-ray telescopes (6-80 keV), with a smaller field of view (FOV) but 10-100 times more sensitive than non-focusing telescopes. Other performance parameters include an angular resolution of 45 arcsec, timing resolution of 1 ms, and ToO response of less than 24 hours. The three-axis attitude control, single-string spacecraft is to be launched on a Pegasus XL from Kwajalein, containing two hard x-ray telescopes with a 10m focal length and a laser metrology system to remove mast flexure. NuSTAR will carry out long-pointing (week to several weeks) observations of survey fields, specific science targets, and ToOs. Daily downlinks and infrequent uplinks will be carried

out. Mission operations will be conducted at the University of California at Berkeley and science operations at the California Institute of Technology. NuSTAR has a two-year baseline mission, including six months science reserve in the baseline. Key science goals are to locate massive black holes, study the population of compact objects in the Milky Way, study the explosion dynamics and nucleosynthesis in core collapse and 1a supernovae, and relativistic jets in supermassive black holes. To do this, NuSTAR will observe numerous targets, and will spend significant time in coordinating multiwavelength measurements, the goal being to identify redshifts through optical and IR measurements. Sciences objectives include locating the remnants of collapsed stars (white dwarfs, neutron stars, black holes) to learn about the endpoints of stellar evolution, and monitoring GeV and TeV blazars in month-long campaigns coordinated with ground-based observatories to study jets in supermassive black holes. For ToOs, optical telescopes will identify 1a supernovae before the peak of optical emission, after which NuSTAR will try to detect the transition from optically thick to thin in the nickel emission band.

Candidates for the NuSTAR science program include high-energy emission in clusters to study how particle acceleration occurs. The magnetic field and relativistic electron density of galaxy clusters can be measured using high-energy x-ray emissions (>10 keV); targets are clusters Ophiuchus, Coma and A754. NuSTAR will also study the Sun to determine the source of continuous heating of the solar corona, and direct observations of electron populations- this latter observation might provide first images of emission from reconnection region.

Optics are being developed, and optics assembly techniques have been based on a method developed in the suborbital program. The flight mast has been built and tested, and will go into thermal testing in early December. Data analysis and archiving plans are based on HEASARC FTOOLs and OGIP, which are familiar to high-energy astrophysicists. All data will be made public after a 6-month validation/verification period, to be delivered to HEASARC within two months of observation. The project will apply for a Senior Review in 2012 for funding for community access, and will also provide online simulation tools. The mission recently passed instrument subsystem and spacecraft CDRs. Asked about NuSTAR's ability to verify Suzaku hard tail observations, Dr. Harrison felt that hard detection will be difficult to do with NuSTAR.

Technology fellowship discussion, continued

The subcommittee returned to discussion of the technology fellowship. Dr. Hogan agreed that a consensus existed to support a technology program fellowship to foster young careers, perhaps carved out of the existing fellowship. Dr. Morse reviewed the available budget in this context, noting a flat budget for future missions. A fellowship could be placed as a line item for R&A with a transfer of future mission funds, leading to a call, a year from now, for an initiation of a new fellowship in 2011. This would require a funding profile and justification from APS by February 2010- more details can follow on after this decision is made. There was a brief debate over "social engineering" of fellowship monies versus fears of R&A reduction resulting from the fellowship. Dr. Morse encouraged APS to consider the technology fellowship apart from the funding source, as simply a new initiative that would be considered against future mission lines.

Spitzer Space Telescope

Dr. Michael Werner (via teleconference) reviewed the Spitzer mission as it makes its transition to warm operations. The telescope ran out of cryogens on 21 May, after a lifetime of 5 years 9 months, and an uproariously successful mission, with more than 7000 observations per year. The "warm mission" began 28 July, in the IRAC 3.6 and 4.5 micron bands, and the telescope's performance is essentially changed compared to its cryogenic mission.

Reviewing the cryogenic mission, Dr. Werner noted that Spitzer had observed a previously unknown ring around Saturn, associated with satellite Phoebe, which orbits at about 200 Saturn radii. Dust from this ring is thought to account for the dark face of Iapetus. Spitzer also provided aW5 finding that shows large scale patterns of star formation, including protostars and IR-ex sources. A shallow survey of the Bootes field has produced results predicting the WISE mission will see around 700 cool brown dwarfs. Spitzer has also detected the coolest candidate Y dwarf yet seen.

The telescope has also produced detailed information about the anatomy of an exoplanet system, the three planets of HR8799. Spitzer and IRS observations of dust around the system helped create a notional picture of the system surrounded by a complex dust disk. Spitzer has also vastly increased the number of known galaxy clusters at z>1, with more to be added and at higher redshift; these observations will improve the understanding of structure at intermediate times. Spitzer has also achieved JWST depth in characterizing z>6 galaxies. Many more sources are expected to be found in the Warm Mission Infrared Array Camera (IRAC) Lensing Surveys.

During the warm mission, the IRAC instrument will function continuously, assuring instrument stability. Thus far, imagery looks identical to the eye, with little degradation of resolution. Two years of operations are planned, with an initial call of 6500 hours/year science. Programs include NEO characterization, detailed exoplanet surveys, young stellar object variability, and mapping the Outer Milky Way. The time allocated for Cycle-6 Exoplanet studies is about 2600 hours. Measurements of eclipse and transit depths will provide a wealth of information, including temperature distribution on the surface of planets. A full-orbit survey of atmospheric circulation for five representative planets will be carried out. Spitzer can also help confirm Kepler Super-Earths by weeding out false positives. Among extragalactic projects, Spitzer will attempt to determine the Hubble constant to 2% by providing precise distance measurements for LMC Cepheid variable stars, and will also attempt to verify the Tully-Fisher calibration by decreasing scatter in the Tully-Fisher relation.

As a primary data source, Spitzer data was represented in 38% of selected projects for ADP09 proposals. Commenting on the Hubble constant effort, Dr. Suntzeff highlighted the important of checking the water maser result for a completely independent measurement.

Hubble Status

Dr. Ken Sembach presented a status of the post-SM4 Hubble Space Telescope (HST), highlighting the cornerstone of the repair mission, which was the installation of two new instruments: the Cosmic Origins Spectrograph (COS) and the Wide Field Camera 3 (WFC3). HST is has nearly completed its Servicing Mission Observatory Verification (SMOV) period, during which new instruments are tuned and monitored, and outgassed for about a month. The Near Infrared Camera and Multi-Object Spectrometer (NICMOS) SMOV should be completed in November 2009. COS's far-UV throughput is exceptional (10X better than STIS in the effective area), and the new WFC2 has 50-100 times the capability of NICMOS in terms of IR field-of-view and sensitivity. The Advanced Camera for Surveys (ACS) has been repaired, restoring the wide field channel function, and the repaired WFC performance is at least as good as pre-failure performance; however High-resolution Camera (HRC) functionality was not restored.

The repaired Space Telescope Imaging Spectrograph (STIS) performance is comparable to that expected, but the charge-coupled device (CCD) median dark current is 40% higher than expected at center of chip. This anomaly is being corrected for observers. The dark current in the near-ultraviolet (NUV) multi-anode multichannel array (MAMA) channel is 5 times higher than expected, perhaps due to cosmic ray impacts. The decay time of phenomenon is about 100 days, thus it is being tracked.

COS sensitivity is being described as superb, with its recent measurement of a quasar showing excellent signal-to-noise ratio. COS opens new science possibilities, such as detecting more quasars with fewer orbits in studies of how galaxies acquire their gas. COS also has sensitivity down to the Lyman Limit, useful for detecting low-redshift galaxies.

For WFC3, throughput and sensitivity are above that expected. The UV to visible range performance is 5-20% above pre-launch predictions, and the same is true of IR channel (5-15%). In early release observations (EROs), WFC3 caught an impact of asteroid on Jupiter on 23 July. Omega Cen images are being used for calculating geometric distortions across detectors. Deep field images are already generating debate about new redshift object discoveries, and 60-80 HST papers are expected at the next AAAS meeting. It has been estimated that one billion people have viewed Hubble images. Asked about COS shortwave sensitivity, Dr. Sembach thought it to be a few hundred angstroms, potentially. The resolving power is about 2500 at that grating. Dr. Suntzeff applauded the overwhelming success reflected by the meeting's telescope presentations.

Discussion and wrap-up

APS returned to considering the technology fellowship, having achieved some consensus as to restricting the size of funding, with an eye to filling the future scientist/engineer pipeline and furthering technology capabilities. Concerns were aired about diluting the power of individual awards by taking away capital equipment. Further suggestions including using the fellowship as a bridge to faculty positions, having proposers present a detailed budget as part of the proposal, the establishment of a small number of "genius" fellowships, a focus on launching independent talent, and more direct participation from industry as sponsors for fellows. Dr. Morse suggested that APS consider early career faculty and whether the NASA research apparatus is properly set up to support them, and to consider this as complementary to the structure of the technology fellowship. Dr. Polidan felt that industry had high interest in building technologies at the university level, and APS members felt that a workshop might be necessary to communicate such opportunities to students.

Dr. Hogan appointed Dr. Chris Martin to chair a committee tasked with producing specific and detailed recommendations, rules, funding profiles, etc., for a new technology fellowship.

Strategic Plan revision discussion

The subcommittee briefly discussed revision of Strategic Plan wording, emphasizing science goals and key science questions, with the inclusion of fundamental physics at the top level. Tentative meeting dates were put in the January time frame, with a preference for a post-budget meeting. Dr. Hogan adjourned the meeting.

Appendix A
Attendees

Subcommittee members
Craig Hogan, University of Chicago, *Chair Astrophysics Subcommittee*
Kathyrn Flanagan, STScI
Shaul Hanany, University of Minnesota
John Hughes, Rutgers University
John Huchra, Harvard University
James Kasting, Pennsylvania State University
Fred K.Y. Lo, National Radio Astronomy Observatory
James Manning, Astronomical Society of the Pacific
Chris Martin, California Institute of Technology
Christopher McKee, UC Berkeley (remote)
Ronald Polidan, Northrop Grumman Aerospace Systems
James Rhoads, Arizona State University
Nicholas Suntzeff, Texas A&M University
Leisa Townsley, Pennsylvania State University
Michael Turner, University of Chicago
Hashima Hasan, APS Executive Secretary, NASA Headquarters

NASA Attendees
Jaya Bajpayee, NASA Headquarters
Scott Barber, NASA Headquarters
Holly Degn, NASA Headquarters
T. Jens Feeley, NASA Headquarters
Richard Griffiths, NASA Headquarters
Ilana Harris, NASA Headquarters
Douglas Hudgins, NASA Headquarters
Keith Jahoda, NASA GSFC
W. Vernon Jones, NASA Headquarters
Tim Kallman, NASA GSFC
Lou Kaluzienski, NASA Headquarters
Jennifer Kearns, NASA Headquarters
Lori Kearns, NASA Headquarters
Chryssa Kouveliotou, NASA MSFC
Thierry Lanz, NASA Headquarters
Lia LaPiana, NASA Headquarters
Julie McEnery, NASA GSFC
Jon Morse, NASA Science Mission Directorate, *Director Astrophysics Division*
Marian Norris, NASA Headquarters
Bill Oegerle, NASA GSFC
Mario R. Perez, NASA Headquarters
Michael Salamon, NASA Headquarters (teleconference)
Wilton Sanders, NASA Headquarters
Eric Smith, NASA Headquarters
Stephanie Stockman, NASA Headquarters
Jean Swank, NASA GSFC
Ray Taylor, NASA Headquarters/SMD

Azita Valinia, NASA GSFC
Edward Weiler, NASA Headquarters/SMD AA
Greg Williams, NASA Headquarters
Dan Woods, NASA Headquarters/SMD

Other Attendees
Dom Conte, Self
Randy Cornell, Ball Aerospace
Lamont DiBiasi, DiBiasi Associates
Jed Hancock, Space Dynamics Lab
E. Hand, Nature
Anita Krishnamurthi, AAS
Dan Lester, University of Texas
Miriam Quintal, Lewis-Burke Associates
Ken Sembach, STScI
Denise Smith, STScI
Joan Zimmermann, Harris Corp.

Webex
Jack Burns, NASA Advisory Council, Science Committee Chair
Sandra Cauffman, GSFC
Mike Devirian, NASA/JPL
Fiona Harrison, Caltech
David Leisawitz, NASA GSFC
Marie Levine
Michael Salamon, NASA Headquarters
Stephen Unwin, NASA/JPL
Michael Werner, NASA/JPL

Appendix B
NAC Astrophysics Subcommittee Membership

Craig J. Hogan, Chairman
Fermilab
University of Chicago

Kimberly Ennico
NASA Ames Research Center

Kathryn Flanagan Space
Telescope Science Institute

Shaul Hanany
University of Minnesota/Twin Cities

Hashima Hasan
NASA Headquarters
Science Mission Directorate
Astrophysics Division Exec. Secretary

Sara R. Heap
Goddard Space Flight Center/NASA

John Huchra
Harvard-Smithsonian Center for Astrophysics
Harvard University

John (Jack) P. Hughes
Rutgers University

James F. Kasting
Pennsylvania State University

Fred K.Y. Lo
National Radio Astronomy Observatory

James G. Manning
Astronomical Society of the Pacific

Chris Martin
California Institute of Technology

Ronald S. Polidan
Northrop Grumman Aerospace Systems
Civil Systems Division

James E. Rhoads
Arizona State University
School of Earth and Space Exploration

Nicholas B. Suntzeff
Texas A&M University
Department of Physics

Leisa Townsley
Pennsylvania State University

Appendix C
Presentations

1. *Astrophysics Division Update*, Jon Morse
2. *ExoPAG Update,* James Kasting
3. *GEMS Mission Update,* Jean Swank
4. *Technology Fellowship Update,* Kathryn Flanagan
5. *NASA Balloon Program Update,* W. Vernon Jones
6. *NASA Sounding Rocket Program Update,* Wilton Sanders
7. *Education/Public Outreach at NASA,* Stephanie Stockman
8. *NASA IYA Update,* Denise Smith
9. *Fermi Update,* Julie McEnery
10. *NuSTAR Update,* Fiona Harrison
11. *Spitzer Space Telescope Status,* Michael Werner
12. *Hubble Space Telescope SM4 SMOV Update,* Ken Sembach

Appendix D
Agenda

Agenda		
Astrophysics Subcommittee		
October 8-9, 2009		
NASA Headquarters Room 8R40		
Thursday 8 October		
8:45 a.m.	Introduction and Announcements	Craig Hogan
9:00 a.m.	Astrophysics Division Update	Jon Morse
10:30 a.m.	Break	
10:45 a.m.	Decadal Update	John Huchra
11:00 a.m.	ExoPAG Update	Jim Kasting
11:20 a.m.	PhysPAG Discussion	Michael Salamon
11:40 a.m.	CORPAG Discussion	Eric Smith
12:00 noon	Working Lunch	
12:30 p.m.	GEMS Mission Update	Jean Swank
1:30 p.m.	Fellowship Update	Nicholas Suntzeff
2:00 p.m.	Meeting with AA	Edward Weiler
3:00 p.m.	Break	
3:15 p.m.	Balloon Program Update	Vernon Jones
3:45 p.m.	Rocket Program Update	Wilt Sanders
4:00 p.m.	Discussion and Public Comment Period	
4:45 p.m.	Wrap up of Day 1	Craig Hogan
5:00 p.m.	Adjourn	

Friday 9 October		
9:00 a.m.	Re-cap of Day 1	Craig Hogan
9:15 a.m.	E/PO Update	Stephanie Stockman
9:55 a.m.	NASA IYA Update	Denise Smith
10:15 a.m.	Fermi Update	Julie McEnry
11:15 a.m.	Break	
11:30 a.m.	NuSTAR Update	Fiona Harrison
12:30 p.m.	Working Lunch	
1:00 p.m.	Spitzer Status	Mike Werner
1:30 p.m.	HST SM4 SMOV Update	Ken Sembach
2:30 p.m.	Discussion and Public Comment Period	
3:00 p.m.	Update on recommendation items from June APS meeting	Craig Hogan
3:15 p.m.	Wrap-up, Recommendations, Actions	Craig Hogan
3:45 p.m.	Brief to Morse	Craig Hogan
4:00 p.m.	**Adjourn**	