

NAC Astrophysics Meeting Minutes, February 16-17, 2011

NASA ADVISORY COUNCIL

ASTROPHYSICS SUBCOMMITTEE

February 16-17, 2011

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MEETING REPORT

Alan Boss, Chair

Rita Sambruna, Executive Secretary

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Introduction

Dr. Alan Boss, Chair of the Astrophysics Subcommittee (APS) welcomed members to the meeting and queried each one for any possible conflicts of interest: Arjun Dey, Sarah Heap, James Kasting, Vicky Kalogera, Mary Elizabeth Kaiser, and Lou Allamandola reported no specific conflicts. Others with potential conflicts identified themselves: Jack Hughes (Astro-H); Shaul Hanany (Cosmic Microwave Background); Chris Martin (GALEX, JWST, WFIRST, Euclid); Ronald Polidan (JWST, Explorers, Chandra); Leisa Townsley (Chandra), Ritz (LAT on Fermi), and Dr. Boss (Kepler).

Executive Secretary Rita Sambruna requested an approval for the nomination of Guido Mueller to the Physics of the Cosmos Program Analysis Group (PhysPAG) Executive Committee, which the APS provided.

Members rotating off the subcommittee were also noted: these were James Rhoads, James Manning, Leisa Townsley, and Ronald Polidan. Individuals selected as new APS members, starting on March 1, 2011, were nominated for the subcommittee's approval: Gary Bernstein (University of Pennsylvania), Edna DeVore (SETI), Gabriela Gonzalez (Louisiana State University), Terry Oswalt (Florida Technology University), and Paul Ray (Naval Research Laboratory). Four of these nominees (Bernstein, DeVore, Gonzalez, and Ray) replace the APS members rotating off, while the fifth (Terry Oswalt) replaces former APS member John Huchra, who passed away in Fall 2010. The APS subcommittee concurred with all five nominations.

Astrophysics Division (APD) Update

Dr. Jon Morse, Director of the APD, provided a status of the Astrophysics Division (APD). He noted numerous science highlights resulting from the high productivity of the space observatories, including many press releases from the Wide-Field Infrared Survey Explorer (WISE), Chandra, Fermi, Planck, Spitzer, and the Stratospheric Observatory for Infrared Astronomy (SOFIA). These missions also enjoyed much representation at the Seattle AAS meeting in the form of dedicated splinter meetings reporting recent or early results. Among the science highlights, Kepler recently discovered an Earth-sized planet candidate, Kepler10b, with an iron-like density of 8.8 g/cc. In multi-wavelength observations of the Crab Nebula, gamma-ray flux variability was detected with Fermi LAT, interpreted as plasma acceleration events in the nebula. A 511 keV line was detected with Fermi from thunderstorms produced above Earth, suggesting presence of antimatter produced in short gamma-ray bursts during lightning. A deep-field Hubble Space Telescope/Chandra/Spitzer image has uncovered the most distant yet protocluster ($z \sim 2$), while an unprecedentedly deep HST image in the IR discovered the most distant protogalaxy yet observed, 13.2 billion light years away. Two Fermi LAT Team members, P. Michelson and W. Atwood, won the 2011 Rossi Prize, the most prestigious award bestowed by the HEAD Division.

The Kepler mission has released data on over 155,000 stars, and is hoping to engage the community as much as possible to further analyze data. At present, Kepler has catalogued 68 roughly Earth-size planets, 288 Super-Earths, 662 Neptune-sized planets, 165 Jupiter-sized planets, and 19 bodies larger than Jupiter. Fifty-four bodies were planets found to be in the habitable zone of their stars, where liquid water might exist.

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Programmatic update.

Dr. Morse moved on to a review of the status of the missions currently in the APD portfolio. He showed a chart with timelines for missions in formulation (GEMS), development (JWST, ST-7, Astro-H, NuSTAR, and SOFIA), and in operation phases. The James Webb Space Telescope (JWST) Launch Readiness Date (LRD) is under review, to be discussed later in the presentations. The Gravity and Extreme Magnetism (GEMS) mission will be going to confirmation shortly, while Astro-H is coming up on its Critical Design Review. Meanwhile, the number of operating missions is declining, with the Wilkinson Microwave Anisotropy Probe (WMAP) decommissioned in late 2010, WISE being decommissioned this month, and INternational Gamma-Ray Astrophysics Laboratory (INTEGRAL) support being discontinued. The Hubble Cosmic Origins Spectrograph (COS) had lost some sensitivity at the rate ~ 5% per year dependent on wavelength; however, the instrument seems to be stabilizing and still functions as a sensitive spectrograph. The cause for this loss could be coatings, cosmic radiance, or atomic oxygen, but is unknown at this time. Planck is operating as expected and the team released its first point source catalog, announced at the AAS meeting.

Next, Dr. Morse showed a color-coded programmatic status chart for the operating APD missions, illustrating that all are functioning on plan (green). The Kepler Observatory spent some time in safe-hold related to maneuvering around a sun avoidance angle, but is now fully operational in science mode.

A Mission Timelines Event chart followed. NuStar is the next APD launch, which will occur about one year from now, aboard a Pegasus vehicle launched from Kwajalein Island. Within the Sounding Rockets program, a small project called FIRE launched successfully from Poker Flats and acquired data on primary and serendipitous targets. APD is working hard to keep a robust rocket program, and is fully addressing recently occurred launch-abort systems issues. The Balloon program is returning to Australia to recertify a balloon launch site and associated procedures that resulted from a mishap in Alice Springs in April 2010. The payload has been recovered and rebuilding of the experiment is under way. The SOFIA instrument Announcement of Opportunity (AO) was drafted, for targeted release in Spring 2011; future AOs will depend upon the Agency's response to the Decadal survey report. The GREAT (German) instrument flights have been planned for a start in early April.

Dr. Morse reviewed the programmatic status of the upcoming missions in detail. Work with ESA continues for the LISA/Pathfinder to enable launch in 2013. ST-7's micro-colloidal thrusters are undergoing additional life testing; ESA is having difficulty with procurement of micro-newton thrusters and is performing a technical feasibility study that will be discussed at the March bilateral meeting. The Astro-H project office at Goddard asked NASA for an additional \$7.2M of cost reserves over FY11-12 to maintain the instrument delivery schedule and a launch of Astro-H in 2014. The additional funding was approved by Science Mission Directorate (SMD).

The GEMS mission, now in phase-B, is scheduled for launch no earlier than 2014; an independent cost estimate (ICE) of the current payload configuration established the need for a rescope. The GEMS Project Office will present to APD the results of its trade studies for rescoping within the provided cost-cap environment in mid-March.

Moving on to NuSTAR, Dr. Morse informed the subcommittee that the project would deliver two optics modules in about two weeks; the Instrument I&T is progressing at JPL, to be complete in mid-April. He noted that, due to logistics issues concerning the thermal vacuum tests at JPL, keeping NuSTAR on schedule has proven to be challenging; nevertheless, the Team still anticipates integrating and testing the payload by November 2011, for a launch in February 2012.

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Next Dr. Morse reviewed the Balloon program. The CREAM (Cosmic Ray Energetics And Mass) VI mission was successfully launched on 12/20/2010, acquiring 5 days of science data. While an unplanned termination occurred 5 days after launch, whose cause is being investigated by an Anomaly Review Board, the mission achieved minimum science requirements and the payload was fully recovered. Launched on 12/26/2010 with the same balloon, BLAST flew 9 days with nominal operations, and was recovered on the Ross Ice Shelf. A 14 million cubic feet (MCF) Super-pressure balloon development flight, launched 01/09/2011, flew 22 days with nominal operation and its payload was also recovered.

WISE completed a very successful flight in Low Earth Orbit, mapping the entire sky every 6 months. The cryogenic survey ended on 30 September 2010; the spacecraft continued in the so-called warm phase, supported by the Planetary Science Division from October 2010 to January 2011 to perform a survey of near-Earth objects (NEOs). The spacecraft is now decommissioned as of 02/01/2011. The first WISE data release is scheduled for April 2011, with further final release in 2012.

Dr. Morse gave next a review of the upcoming event calendar. He noted that today (02/16/2011) was the deadline for receiving Explorer and Mission of Opportunity (MoO) proposals. Based on the previously received Notices of Intent (NOIs), a couple of dozen proposals are anticipated for each program.

During the Q&A session, Dr. Hanany noted that subsequent to the Alice Springs launch mishap, safety regulations for the balloon program have become very onerous and suggested that NASA review these regulations to simplify them. Dr. Morse agreed that APD could discuss this with the Balloon project office and NASA's Office of Safety and Mission Assurance (OSMA), which has the final decision on the matter, but that he expected that suborbital payload PIs should get used to the new rules. Dr. Vernon Jones added that NASA is also doing a return-to-flight (RTF) review for all balloon launch sites.

Budget Update

The Presidential Budget was released on 02/14/2011, two days prior to the APS meeting. Dr. Morse reported that the FY12 budget has a flat profile of about \$5B total for the SMD, and that beyond FY12, any budget estimates are highly notional. The allocated FY12 money is below last year's projection, reflecting austere fiscal times, but still maintaining support for major APD missions (e.g., JWST, SOFIA). The Earth Science Division received large cuts which will cause significant delay for some of their missions (CLARREO, DESDyNY); the same holds for the Planetary Division, which is awaiting the outcome of its Decadal Survey to prioritize funding for its programs. In the Heliophysics Division (HPD), launch vehicle cost increases (such as those in the Atlas V class) may require a de-scope of the Solar Orbiter mission. Launch vehicle costs are not as big an issue for APD as yet because the only large mission this decade (JWST) is being launched by a foreign partner. Civil servant salaries will be covered by ~6% of the allocated \$5B and managed in a separate SMD account. Since NASA is still operating under the Continuing Resolution, expected to end March 4, for the time being NASA's funding continues to reflect the FY10 level. Given that most of the resources had been already committed, the CR and related FY11 budget delay may imply significant (up to 10%) budget reductions in SMD for the rest of this fiscal year; the main impact for APD could be a reduction of support or termination of all or some of the extended missions.

The allocated budget for APD during FY12 is \$76M less than previously projected. Despite this reduction, APD is still able to implement almost all of the Decadal Survey recommendations, including augmentations of funds for the Explorers, suborbital, and R&A programs. A separate budget line for APD, separate from Heliophysics, has been set up for the Explorer program. The SOFIA budget will be increased to continue its science flights and to preserve second-generation instrumentation.

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An office separate from APD has been established for JWST to increase its visibility to the Agency; the Program Director, Rick Howard, reports directly to the Associate Administrator. The JWST program also had a cut of \$5M. At present, its budget allows \$375M per year, including labor.

While there is no wedge for the development and launch of a large mission within the decade, support for large missions (WFIRST, LISA, IXO) will be carried out through the programs for concept planning and technology development. The funding will also continue for the extended missions that were highly ranked by the Senior Review (Chandra, HST, and Swift), although at a reduced rate, which will impact their operation and GO programs. The lowest-ranked missions - RXTE, GALEX - will be terminated by the end of FY11, and support will end for the Guest Observer (GO) program for INTEGRAL and Suzaku, while the recommended modest (\$1.7M) support for the XMM-Newton GO program will be maintained. The projected increase of 6-7% to Research and Analysis (R&A) in FY12, and substantial increases in the outyears, will allow RXTE and Suzaku proposers to seek funding through the ADAP program. The JDEM and SIM projects have been ended.

Asked about the Fermi LAT Team, Dr. Morse noted that any support for the LAT Team would need to be justified through the proposal to the Senior Review in 2012. Asked if there were a U.S. phase A budget line for participation in the selected ESA's M3 mission concepts, Dr. Morse replied that none was provided. NASA participation with ESA in any of the M3 missions could be carried out possibly through an Explorer MoO or Stand Alone Mission of Opportunity (SALMON) and peer review. NASA has been interacting with ESA, but for exchange of information only at this time. Dr. Hanany noted that NASA could lose the ability to participate in future ESA missions (e.g., Euclid) if a timely start is not provided. Dr. Morse reiterated that the constrained budget allows at this time only for a competed NASA contribution.

Astro2010 Decadal Survey summary

While the Decadal Survey recommendations were developed using the FY10 and FY11 budget projections that are more optimistic than current projections, the Astrophysics Division is implementing most of its priorities. Specifically, APD is planning to support mission concept planning and technology development for the highest-rated large space mission, a Wide- Field Infrared Survey Telescope (WFIRST), and is exploring a partnership with ESA on a merged dark-energy mission consistent with option B of the NRC Decadal Implementation report. The Astrophysics Explorers mission budget was significantly increased to meet the recommended guidelines of achieving a flight rate of 4 new missions and 4 new MoOs over the next decade. Funding for core research and technology programs are also being augmented, including suborbital, theory, data analysis, and laboratory Astrophysics.

Dr. Townsley requested more details on the decision to seek with a merged mission with ESA; Dr. Morse replied that NASA would have more insight after ESA's down selection in the Fall. Dr. Kaiser asked if the science scope of the Euclid mission could increase with U.S. participation. Dr. Morse noted that option B of the NRC report stipulated that any merged mission should retain all elements of the WFIRST science program and have the US play a leading role. Option A of the NRC report requires a launch of the WFIRST mission led entirely by the US within the decade.

Dr. Ritz pointed out that the NRC December report stated in option A that the possibility of launching the WFIRST mission by the end of the decade was not viable due to fiscal constraints. He inquired about the work of the WFIRST Science Definition Team (SDT), adding that it would be more effective if some target cost caps were provided to them. Dr. Morse replied that the SDT was already instructed to design a

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concept mission design that satisfies option A at the lowest possible cost, taking into account that there is no wedge in the budget to realize a large mission on a ~\$1B scale before JWST is launched.

Dr. Morse discussed augmentation breakdowns in more detail: Explorers will ramp up from \$9M in FY12 to \$151M in FY16. APD plans to have an annual SALMON call to enable the US proposer community to take advantage of international opportunities. Asked how many Explorers might be selected, Dr. Paul Hertz, SMD Chief Scientist, commented that at least one Astrophysics or Heliophysics Explorers mission will be selected, following the AO wording. Dr. Hanany asked if a rebudgeting will have to be done in the case of a merger of Euclid and WFIRST. Dr. Morse replied that such a re-budget could be proposed in future budget cycles.

Dr. Heap commented that researchers were counting on Supporting Research and Technology (SR&T) for Exoplanets (early development and instruments for a Terrestrial Planet Finder), in preparation for a downselect in 2015. Dr. Morse noted that APD is meeting the recommended New Worlds technology augmentation in several ways, over a 5-year period, under a notional plan, which will provide a conduit for a possible Exoplanet mission. Dr. Kalogera asked if an Astrobiology budget line had been decided. Dr. Morse confirmed that APD is leveraging an already large Planetary investment in Astrobiology.

Among other initiatives, APD is implementing a technology fellows program, separate from those planned by the Office of the Chief Technologist's (OCT), in response to APS past recommendations. Within the suborbital program, APD is aiming to fly larger payloads, but is budgeting for payloads only. The division is working with Heliophysics to see what is feasible, to buy Black Brants, perhaps, or commercial vehicles, or piggybacking on International Space Station (ISS) cargo missions or commercial satellite launches. Dr. Hertz encouraged researchers to explore alternative access to space.

Issues and concerns

Addressing the Decadal Survey Implementation Advisory Committee (DSIAC) formation, Dr. Morse mentioned that NASA is working with the NRC, NSF and DoE to define an appropriate advisory infrastructure that fulfills the functions described by NWNH while avoiding duplication of existing advisory bodies (e.g., AAAC) and remaining consistent with multiagency funding mechanisms and charters. Another issue that the Division is concerned about is how to optimize strategic cooperation and collaboration among the international agencies. Part of the problem is the different timelines for each Agency to receive the input from the community (e.g., NASA's NWNH vs. ESA's Cosmic Visions) and the variability of the budgets on a relatively short timescale. To discuss approaches to international collaborations (strongly recommended by the Decadal Survey) APD intends to hold a public conference in 2012.

In closing, Dr. Morse reminded the Committee of the remaining issues. This included the end of the CR and remainder of the FY11 budget, the JWST re-baseline, usage of advisory structures in general, future implementation of large missions, resolution of Space Infrared Telescope for Cosmology and Astrophysics (SPICA), ST-7 technical difficulties and timeliness, and ramifications of FY12 budget reductions.

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SOFIA Update

Dr. Paul Hertz gave an update on the SOFIA aircraft, which is now taking science data. He started by reviewing the aircraft's structure and on-board location of the science instruments, and noted that this configuration represents the largest modification to commercial aircrafts to-date. He reviewed the SOFIA's science themes, which span a wide range from studies of the planets and stars to galaxies, and the reason why stratospheric observations are warranted. The operational wavelength range for SOFIA is 1 to 1000 microns; because it operates at 41,000 ft above 99% of the atmosphere water vapor, its sensitivity exceeds that of ground-based telescopes, e.g., the Keck on Mauna Kea. SOFIA can observe objects close to the Sun, enabling their monitoring and other unexpected events (e.g., occultations) during its expected 20-year operational life. Another main advantage of SOFIA is that its payload can be serviced and updated with the most recent technologies available. .

SOFIA was established as a partnership between NASA and Germany's DLR with a contribution ratio of 80/20, for all levels of the program, including development, operation costs, and science time allocation. The NASA time will be competed separately from DLR time. The SOFIA platform project office and program management are located at Dryden, while the science project office is at Ames Research Center. SOFIA met its imaging requirements at first light, with the goal of achieving 1.6 arcseconds within 3 years. During an average flight of 11.9 hours, science operations can be performed up to 10.5 hours. First light was achieved in May 25, 2010. SOFIA has seven first generation instruments including capabilities from infrared (IR) to visible to ultraviolet (UV), spectrometers, a camera to which grisms will be added in the future, and HIPO, a photometry instrument that can be used to monitor occultations. Generally, one instrument at a time is flown on the aircraft. The FORCAST (faint object infrared camera) instrument is ready to support basic science in 2011, and the German Receiver for Astronomy at Terahertz Frequencies (GREAT) will fly 3 science flights in April 2011. FLITECAM and HIPO will come on later in the year. The EXES instrument is due in 2012, FIFI-LS in late 2012, and HAWC in 2013.

The second-generation science instruments will be competed by NASA through an AO and will consist of three categories: general-purpose instruments (facility science instruments); upgrades and modifications to existing instruments; and technology demonstration instruments for both SOFIA and future NASA missions. The first GO early-science proposal AO has been released in Fall 2010, and awards have been completed in November 2010; a total of 21 proposals for FORCAST and 6 for GREAT were selected.

SOFIA has met or exceeded several schedule milestones; the mission achieved first science results 6 months ahead of time, and others are 3 months ahead of schedule. Its full operational capability (FOC) milestone may well be accomplished 16 months ahead of schedule. In the near term, the program will perform various system upgrades, aerodynamics testing, and GO basic science flights, while working to improve image quality through engineering flights in mid 2011. A maintenance period will be initiated in August 2011, followed by an avionics upgrade from October 2011 to April 2012. SOFIA will return to science operations in May 2012. Dr. Hertz detailed recent flight operations and targets. At present the aircraft cavity can cool down to only 0°C. After the insulation and pre-cooling system upgrade, the aircraft cavity will be able to cool to -40°C while still on the ground.

Dr. Hertz presented some of the results obtained during first science flight, including images of Jupiter, M42, and the Orion nebula. The quality of the data is very high, allowing previously unknown details to be revealed. Asked when SOFIA would undergo Senior Review, Dr. Hertz surmised that this would occur after 5 years of performing science. Dr. Morse concurred that SOFIA would more likely be included in the 2018 Senior Review. SOFIA funding in instrument development is at about the \$7-10M level per year in the out years; the average cost is about \$750,000 per night for a 10-hour flight.

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R&A Update

Dr. Linda Sparke presented an update of the R&A 2010 ROSES competition statistics. An average of 119 days from proposal due date to selection was reported, well below the required 150-day metric. The latest Astrophysics R&A selection rate is about 27%, slightly lower than the previous year. Research awards through ROSES are at roughly \$74M per year.

On Friday, 18 February, ROSES 2011 will be released. The Fermi Guest Investigator program will have explicit budget caps removed, and 2-year proposals will be allowed. APRA is now termed APRET (for Astrophysics Research and Enabling Technology). There is a new cross-division element for conference proposals, but Astrophysics will not participate this year. Astrophysics Theory will have no significant changes, but the FY2012 budget anticipates more funding as compared to the previous year. Dr. Boss was concerned that the Astrophysics Theory Program does not support research on extrasolar planet formation theory, which means that a major portion the Astrophysics Division's portfolio, exoplanets, is not currently being fully supported by APD.

Asked about funding to work on XMM data, Dr. Sparke noted that any researcher could use the Astrophysics Data Analysis Program (ADAP), as per existing policy. Dr. Heap asked if adding money to AP Theory (ATP) would be enough to prompt an improvement in the acceptance rate. Dr. Sparke doubted that the acceptance rate would rise dramatically. Dr. Heap endorsed any increase in ATP.

Dr. Sparke detailed how APD was responding to the Astro2010 Decadal Survey recommendations for medium and small initiatives, including Enabling Technologies for both a New Worlds and an Inflation Probe mission beyond 2020, and for future UV/optical ability from space. The survey had requested 25% more suborbital flights, and a 25% increase in ATP in addition to cross-agency development of networks for theory and computation. This call will necessitate cross-agency collaboration. The budget numbers for R&A show a response to these requests, and in addition include provisions for a new program for early-career technology fellows. The ADAP was essentially unchanged from the FY11 budget request. APS expressed some concern that a future solicitation for technology fellows would be oversubscribed. Dr. Morse advised that if any budget shortfalls occurred, there would be a community mechanism for feedback.

Dr. Jay Gallagher continued the presentation, as Chair of a Research Program Review Panel in response to the NRC/Fisk report on SMD's Mission-Enabling Activities, which called for metrics, and to the emphasis given to the area by Astro2010. The panel is charged with assisting NASA in increasing the effectiveness of its Research & Analysis and Enabling Technology programs. It consists of 14 individuals with broad representation of the community, and plans to present a final report in May 2011. There is a web site for public comments at www.science.nasa.gov/astrophysics/working-groups/ApResRev2010.

The panel has found that the readily available data may be inadequate to develop good metrics to evaluate "effectiveness", and is attempting to develop a better set by consulting with various communities, such as those overseeing Guest Observer (GO) programs. The panel aims at being enabled to provide an anecdotal evaluation of program performance, and to describe the deliveries of each program in a

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quantitative way. Dr. Gallagher stressed the challenge of the task given to the panel, stating that there is no sanctioned or easy way to compare the GO programs in detail with each other, or with research award programs such as ADAP. However, the review panel will compile a collection of best practices.

This large effort has prompted the formation within the panel of working groups (WGs) on each of the various research award programs, on the Fisk report metrics and on Workforce issues. Each WG will produce a report, and the collection will be surmounted by one summary, written by Dr. Gallagher. Asked about the types of metrics likely to be developed, Dr. Gallagher commented that he would like to hear about the GO programs of different operating missions, and how they collect data on supporting students and post-docs, EPO efforts and published papers.

Dr. Boss questioned the utility of the panel, since it was not required to produce a consensus report. Dr. Hertz noted that after receiving the findings NASA would then decide how to proceed. Dr. Ritz suggested a review of panel results, beyond that of APS, before they went public. Dr. Gallagher assured APS that this was not necessary, as one of the panel charges was to ensure quality-control of its findings.

Dr. Boss asked if the Panel would consider proposal pressure as a metric. Dr. Gallagher's reply was that proposal pressure should be considered in relation to the size of the community, which meant that the metric was not necessarily one of science merit. The Panel would prefer to develop a menu of metrics that could be applied in different cases. Dr. Morse noted that putting more money into a proposal call could also drive up the number of proposals. Dr. Morse reminded that GO programs of individual missions such as Fermi, Chandra, and HST currently allow requests for both small-size, one-year grants and larger, multi-year ones, and that this structure could also benefit the R&A programs. Dr. Gallagher agreed that such an approach might be useful for an oversubscribed program like ATP.

JWST update

Because of conflicts of interest, Dr. Polidan recused himself from the discussion on JWST.

Mr. Rick Howard, Director of the new JWST program office, presented an update on JWST. This separate program office has recently been created for JWST as its own theme within the SMD budget. The program now reports directly to NASA Associate Administrator Chris Scolese as a element of Ed Weiler's SMD. While the technical performance on the JWST project has been recognized as commendable, it has been made at the expense of cost and schedule, exacerbated by problems in program management, budgeting and communication. The program's visibility has been elevated to the level of the NASA Administrator's office to address the issues; JWST is now an SMD and Agency priority. At Goddard Space Flight Center (GSFC), the program reports directly to the Center Director.

The launch of JWST in 2014 or even 2015 is no longer feasible due to budgeting uncertainty, as NASA is unlikely to have additional funds in 2011. Thus NASA is re-planning the JWST launch schedule, with results expected by Summer 2011 that are suitable for a budget submission for FY13. A Joint cost and schedule Confidence Level (JCL) exercise will begin in March 2011.

Mr. Howard briefly reviewed various aspects of flight hardware progress. Flight mirrors have all meet their specifications of 17 nm RMS figure roughness; the reflectivity of the gold coatings exceeds requirements. Flight fabrication, including final polishing and testing of mirrors, will be complete this year.

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Concerns

NIRCam and NIRSpec are both having issues with long wavelength near infrared detectors (out to 5 microns), related to hot (saturated) pixels, that are nonetheless still within the specification of 5% inoperable pixels (roughly 2% at present). Requirement is for 95% of pixels to be operable at end of life. The Failure Review Board has been working on this problem for a month. Dr. Eric Smith commented that discussions are also in progress with the HST Team as to whether these effects are seen in WFC3 detectors. Mr. Howard pointed APS to several opportunities through which the community can communicate with the JWST office and welcomed feedback. Dr. Boss cautioned that the program ensure that relevant JWST science conferences be well publicized.

Mr. Howard noted that JWST is very challenging, but is making progress in its technical accomplishments. Spacecraft Critical Design Review (CDR), under the previous schedule, was May 2011; this date will change under the re-plan. This CDR is the only major element remaining for the mission. Asked how this might impact SMD, such as planning for WFIRST, Dr. Morse said that the two large missions were not necessarily decoupled 100%; but that SMD must still pursue a balanced program. JWST impacts outside SMD will also be considered; however, the re-plan assumes only the President's budget values for FY11 and FY12. Beyond that the budget figures are notional.

JWST Science

Dr. Hashima Hasan, JWST program scientist (acting), provided the science rationale of the mission by summarizing its main driving topics. JWST will provide information on re-ionization events in the early universe, allow us to learn how the first stars were born; it will study the earliest supernovae and quasars, find the remnants of the earliest super-massive stars; study the assembly of galaxies, protoplanetary disks, accretion of planets, and atmospheres of planetary systems. JWST will address the nature of dark energy by improving the precision on the estimate of supernovae (SN) distances, constraining the Hubble constant to 1.5%; it will also allow investigations on dark matter. JWST can look far deeper into the universe than HST, producing images about 100 times faster than HST, on a timescale of minutes. JWST will also provide transit spectroscopy to deepen the observations of exoplanets, by observing both primary and secondary transits. For instance, a transit of a nearby M dwarf (magnitude 6) might enable the analysis of an atmosphere of an Earth-like planet residing in the habitable zone. More distant candidate planets will be obtained from Kepler observations.

The JWST instruments NIR Cam, NIRSpec, MIRI (Mid-infrared Instrument), and the FGS/TFI (Fine Guidance Sensor/Tunable Filter Imager) are shared amongst NASA, ESA, and the Canadian Space Agency (CSA). By the time JWST launches, HST and Spitzer will have been terminated, but the potential for great discoveries will continue to exist. Senior Project Scientist, Dr. John Mather, is reportedly happy with mirror performance, and is monitoring the progress of test program architecture and planning, optical performance and stray light prediction, detector issues, possible glow of black plastic excited by electrons (the latter is not likely but it is necessary to know if it is possible). In response to the TAT and ICRP reports, the program has strengthened its science team with addition of Randy Kimble, Mal Niedner, and Jane Rigby. Dr. Hasan reported that a Frontier Science Opportunities conference will be held in Baltimore in June 2011; registration and information on the conference can be found at the www.stsci.edu website.

Dr. Kaiser commented that the science working group appears to contain few members with a perspective external to NASA. Dr. Hasan responded that the team was selected competitively through an AO solicitation, and many selectees were scientists who were not based at STScI at the time they were

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selected. Dr. Morse assured APS that there is a wide array of community-based groups supporting JWST. Dr. Rhoads asked if the GOs programs would be established before launch. Dr. Hasan replied that GO observing programs will be solicited in the same way as HST through competitive peer reviews, about a year and a half before the anticipated launch date.

Discussion

The APS discussed how the reallocation of the JWST program outside APD might protect the Division programs from budget reductions. Dr. Eric Smith, JWST Deputy Program Director, commented that the SMD budget would be vulnerable, but that it wouldn't necessarily be the only area of NASA to be affected. Dr. Morse pointed to the caveat inherent in the notional budget that has been prepared for the out years, where the issue of offsets will be a difficult one. JWST is still an Astrophysics mission, first and foremost, and APD must be prepared to contribute to its cost, as there are no extra funds in the Agency from other Divisions. Dr. Morse pointed out that the JWST Program does not have its own "future mission line" from which to take funds, and funds would have to come from somewhere in the agency.. Dr. Ritz wondered about whether the WFIRST Science Definition Team could make progress in light of the JWST uncertainties, and asked if APS recommendations in this regard were warranted. Dr. Morse recommended waiting for the SDT's interim report in Summer 2011, which will then inform ESA discussions and the next budget process.

NASA Roadmapping

Mr. Michael Moore presented an update on NASA Technology Roadmapping activities, as driven partly by the OCT. Drafts for these new roadmaps were developed based on the extensive roadmap development previously accomplished in 2005, as well as an extensive NASA review. Updates were done internally, but NASA has asked NRC to review and comment on its effort. These roadmaps can be seen at www.nasa.gov/offices/oct/home/index.htm. The key Astrophysics roadmap draft is the Technology Area 8 Roadmap draft, which was released by OCT in late 2010. OCT oversees Space Technology Research Grants, a particular area that may be of interest to Astrophysics. There is also a Space Technology Grand Challenges open call, one theme of which is "enabling transformational space exploration and scientific discovery." The next review will be held at the Beckman Center in Irvine, CA in late March 2011. Despite the government's CR, OCT is still making plans, and has some funding in FY12 in areas such as the Small Business Innovative Research/Small Business Technology Transfer (SBIR/STTR) programs. SMD is also funding OCT activities in Laser Communications and Entry Descent and Landing (EDL) technologies.

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Morning introduction

Dr. Morse prefaced the Program Analysis Group (PAG) discussions with the request to consider whether APD should enable space-based experiments purely motivated by technology demonstrations, not necessarily addressing specific science questions, based on the model of the Office of Chief Technologist. Presentations of the work and findings of the Program Analysis Groups (PAGs) for Exoplanets, Cosmic Origins, and Physics of the Cosmos followed.

ExoPAG

Dr. James Kasting provided an update on the Exoplanet Exploration PAG (ExoPAG), which held its third meeting in January 2011 in Seattle. The meeting was well attended by 60-70 researchers, and contained much discussion on why certain missions were selected in Astro2010. The ExoPAG also received a briefing from ESA's exoplanet program, focusing on technology. The bulk of the discussion centered on a large flagship mission for next decade, and considered such questions as whether ground-based radial velocity measurements can detect Earth mass-candidates. Points of scientific agreement included:

- The community should work together to support the goal of finding Earth-sized planets in the habitable zone of FGKM stars.
- The next flagship mission should include a large optical telescope, perhaps with UV and NIR capabilities
- The size of the aperture should be at least 4 meters. Some individuals argued for larger, 8-16 meter apertures, to excite the interest of the general astronomical community in competing with 30-meter ground-based telescopes.

APS speculated that an 8-meter telescope would cost about \$7B (not counting the cost of an possible external occulter). Dr. Kasting noted that he would also argue that such a flagship mission should be a long-term (20-year), serviceable mission. The concept could be considered as Terrestrial Planet Finder (TPF)-like, with an internal coronagraph, or a New Worlds Observer, which could couple a segmented mirror with an external occulter. Internal coronagraphs need an aperture of at least 4 meters to achieve the require 60 mas angular resolution; if an occulter is employed, the size of the telescope depends on other factors, especially the necessity of separating the planet signal from the exozodi background. A "cheap" version of TPF is probably \$5-6B, using a 4-meter telescope plus plus starshade. (No actual costing estimates have been performed for this concept.)

ExoPAG agreed that more high-precision RV measurements are needed, and this could be accomplished by either using more Keck time, or acquiring an RV-dedicated, appropriately equipped, 3-5 meter telescope. The Keck facility is limited to 1 m/s measurements. Harvard University is now building a spectrograph based on a superior European design, which will be used for Kepler follow-up. Dr. Kasting stated that the Decadal Survey mistakenly assumed that nearby stars were "quiet" enough so that Earth-mass planets can potentially be detected. RV is good, but there may be limits to what it can achieve, even with essentially perfect, laser-comb, wavelength calibration. The most interesting Kepler planet candidates are the small, Earth-sized ones that are hard to follow up. In order to fully characterize a planet, actual mass, orbit, and spectrum are necessary. A future mission of note to exoplanet researchers is NEAT (Nearby Exo Earth Astrometric Telescope), which has been proposed to ESA (and subsequently rejected).

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Proposed ExoPAG resolutions:

- NASA should not continue to invest in IR interferometry as the basis for a New Worlds Flagship mission. The most viable mission architecture would be a UV/optical telescope with either an internal coronagraph or an external occulter.
- A mission downselect should choose the mission architecture around 2015.
- In a proposed timeline, ExoPAG SAGs will define the minimum science requirements, fund studies of occulters and coronagraphs, and hold a Senior Review-style evaluation in 2014 to allow for a 2015 downselect.

A key concern is whether TPF technology will be sufficiently advanced by 2015 to allow a sound choice of mission architecture. A TPF technology effort would benefit from additional funding support. In response to a question, Dr. Kasting explained that a 95% chance of detecting an Earth-like planet would be a necessary feature of a Flagship mission; Kepler will determine Eta_Earth by 2013, in time for the downselect. Asked why the mission should include UV/NIR, Dr. Kasting noted that the inclusion of UV capability is aimed at procuring broader astrophysics support, but in part could be useful for measuring ozone in planetary atmospheres. Near-IR capability allows one to look for gases such as CO₂ and CH₄. Mr. Geoff Yoder, APD Deputy Director, asked if ExoPAG had considered a TPF precursor. Dr. Kasting replied that it would be ideal to have a coronagraph precursor mission, but the science could really benefit from an occulter precursor because it is difficult to test on the ground. However, failure of an external occulter would not jeopardize other functions of a large telescope in space, mitigating the risk of not flying a precursor.

COPAG (Cosmic Origins Program Analysis Group)

Dr. Martin reported on the newly formed Cosmic Origins PAG (COPAG). The COPAG is charged with various tasks, including: identify a focused set of mission-enabling technologies for CO future missions, provide input to the Strategic Astrophysics Technology selections, provide input to APRA, provide input to NASA and NRC Technology Roadmapping activities, help make tough choices for high-value projects given limited resources, and provide a voice for the community in technology prioritization. COPAG has assembled a five member Executive Committee and hopes to expand by 2-3 more individuals.

COPAG 2011 tasks

Task 1- determine technology focus areas for a stand-alone Large Aperture UV-Optical mission, such as detectors, optical coatings, gratings, multiplexing elements, and lightweight mirrors. Develop a strawman reference mission concept, assess the technology readiness levels (TRL) of various required technologies, determine the time and money needed to reach necessary TRL, and develop a portfolio based on one or more figures of merit (FOMs).

Task 2- determine technology focus areas which would make possible a joint UV-Optical/exoplanet mission, such as optical coatings, wavefront sensing and control, and lightweight mirrors.

Task 3- determine technology focus areas for future far-IR instruments (i.e. third generation SOFIA instruments, or SPICA) such as detectors, spectrometers, transient capabilities, and polarimetry.

Technologies being considered in task 3 include a multi-object extragalactic spectrometer with reconfigurable pixels.

COPAG is currently planning to provide inputs to the roadmapping process, and hold Spring/Summer workshops to try to agree on target mission concepts, FOMs, candidate technologies, forward planning, and UV technology. COPAG will meet at the AAS in Boston in June, and plan to present findings at the Fall APS meeting (www.cor.gsfc.nasa.gov). COPAG is also planning to coordinate with ExoPAG, with perhaps an overlapping meeting, and is just beginning to coordinate with PhysPAG, while also focusing

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on the next Decadal Survey. Dr. Hanany suggested that COPAG identify specific target science goals that might help formulating a compelling case for a combined mission. Dr. Kasting commented that it would be helpful to coordinate on telescope design, as the use of a coronagraph could be found in general astrophysics. Dr. Sambruna considered that another overlap could be with WFIRST. Dr. Heap asked about the feasibility of lifting a very large telescope into space and whether coronagraphs could tolerate a segmented mirror- is this an area of study for a joint exoplanet mission? Dr. Kasting responded that a visible nuller can be used with a segmented mirror. Dr. Martin stressed that COPAG is open to all ideas. Dr. Polidan remarked that a 9-m option would resemble a JWST launched on a Delta IV-heavy vehicle; the real question is whether a segmented or monolithic mirror is really necessary.

PhysPAG (Physics of the Cosmos PAG)

Dr. Steve Ritz reported on the recently created Physics of the Cosmos Program Analysis Group (PhysPAG), which held its first in-person meeting in January 2011 at the AAS in Seattle, WA. The PAG is addressing issues under a constrained budget scenario, and vis-à-vis the Decadal prioritizations, e.g., first priority the WFIRST mission, Explorer and Core research augmentations; second-priority LISA/IXO technology development, and third-priority Inflation Probe Technology Development. PhysPAG has defined its Science Analysis groups (SAGs), including the Technology SAG which aims at providing input in response to the NRC Roadmapping workshops. An additional task of the Technology SAG is developing technology priorities for PCOS-related science with the Explorer. A second and third SAG will work on defining the technological requirements for an Inflation Probe (IPSAG), and on how to engage the PCOS community (Community Interactions SAG), respectively. PhysPAG is requesting the APS subcommittee to review the proposed SAGs, for which NASA will provide one point of contact each.

Dr. Ritz gave more details on the individual tasks of the proposed SAGs. The Technology SAG aims to understand the NRC process, review technology roadmaps relevant to PCOS science, and provide input to NRC studies within official channels. It will consider how to identify and support technology development needs for Explorers, to identify Explorer-class opportunities to address PCOS science, and targeted technology development on a scale relevant to Explorers (identifying needs that would not be otherwise sufficiently supported). Dr. Kaiser commented that this raised the risk of proprietary information for Explorer proposals. Dr. Morse cautioned against conflicts, with peer review remaining key to selection; strategic documents should be a source of capabilities only, without recommending specific missions. Dr. Martin commented that one should simply rate the science, then identify necessary technologies. Dr. Allamandola noted that the Explorers program is very competitive, and usually uses mature technologies.

Dr. Ritz turned to the IPSAG. The Inflation Probe SAG will provide quantitative metrics and assessments of an Inflation Probe, building upon work carried out by the pre-New Worlds/New Horizons community, agency investments in NASA's 2009 Strategic Mission Concept Study, and papers submitted to New Worlds/New Horizons. Next steps, if the IPSAG is approved, are to set up the first teleconference and discuss international participation. Dr. Sambruna took an action to investigate whether international partners could participate in the SAGs.

The Community Interfaces SAG will work with the PCOS Program Office at GSFC and NASA Headquarters to ensure that there is a clear set of web pages, provide an email news sign-up, and brainstorm additional ways to reach out to the scientists and technologists, such as community e-mail exploders. Issues for additional discussion include how to recruit international participation in SAGs; how to best position PCOS for DSIAC and next Decadal Survey; LISA and IXO Technology Development;

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Dark Energy; tests of General Relativity beyond gravitational waves; and other technology development (e.g. SAT, formation flying).

APS approved the formulation of the three SAGs. Dr. Kasting warned against prejudicing mission concepts and to speak generically about the science. APS encouraged all the PAGs to remain aware of each others' activities.

EPO Overview and Update

Dr. Hasan introduced Stephanie Stockman, representing the Education Design Team of NASA's Education and Public Outreach (EPO) program. Ms. Stockman briefly described the Education Design Team as chartered by the Agency to produce an innovative Science, Technology, Engineering and Mathematics (STEM) Education program. Beginning in May 2010, the team conducted meetings, held a web survey, and conducted an extensive final review of recommendations on how to improve student participation in STEM activities. Ms. Stockman commented that middle school is often a key decision point for deciding on STEM careers. Middle school teachers often don't have the resources to guide such decisions to fruition. Thus one approach of STEM enhancement is to focus on middle school materials. The Education Coordination Committee (ECC) will become a Program Management Council (PMC), so that projects at a certain funding level will undergo reviews just as major NASA missions do. EPO already routinely develops materials for after-school programs, museums, etc. The Astronomy Picture of the Day, for example, is funded through NASA EPO.

Dr. Hasan gave an overview of the Astrophysics EPO portfolio. Every flight mission is required to have an EPO plan, signed by the SMD EPO lead. Another avenue for development is through the Education and Public Outreach for Earth And Space (EPOESS) call, which is competed through ROSES and funded by SMD. ROSES supplements offer an opportunity for funded research programs to propose for a supplemental grant to perform EPO activities. In addition, division funds are used for "programs of opportunity" e.g. partially or fully supporting meritorious EPOESS proposals; participation in the Space Science Student Ambassador Program. The PCOS and COR Program Offices are developing a coordinated approach to EPO, and Exoplanet Exploration has an established EPO program which has been recently updated. The intention is to have these programs provide infrastructure for smaller EPO efforts. Several APS members complained that the grant size (\$15K) was simply insufficient for these efforts, as each one required a professional expensive evaluation plan. Dr. Kasting commented that similar grant work well in Astrobiology because they fund consortium groups.

Dr. Hasan conclude the presentation, and detailed several examples of EPO, including a WISE Teacher Professional Development activity associated with the mission, and identifying Science Education and Public Outreach Forums (SEPOF) for each SMD division.

Kepler Update

Dr. Thomas Gautier presented the latest results of Kepler science. The one-meter space telescope, which possesses a 95-Mpixel focal plane array, has been doing a transit survey of about 150,000 stars, taking samples every 30 minutes during a 3.5-year baseline mission, with a precision of about 2 thousandths of a percent. Kepler's field of view lies between the constellations Cygnus and Lyra. The mission recently detected the first rocky planet, dubbed Kepler 10b, located near star Kepler 10, a G4 star, that is approximately 560 light years distant. Kepler 10b has been measured to be 4.6 Earth masses, with a radius of $1.4R_E$ and a 1833°K bright-side equilibrium temperature. It is the smallest exoplanet found to date that is unquestionably a rocky planet. RV measurements were used to derive 10b's mass and density. The light curve for Kepler 10 also shows clear, multiple transiting planets. The mission's latest data release reveal 1200 new candidates, with 170 multiply transiting systems. There has been some crowding seen in

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the images near the galactic plane, showing more noisy stars in this area; the reason for this observation has not yet been determined.

Overall, there has been a uniform distribution of new candidates across the range of planetary types. Of Kepler planets in the habitable zone, one seems to be smaller than Earth, but more data is forthcoming to refine this measurement. Kepler 11 is the largest multiply transiting system with 6 planets; all 6 planets are in an orbit comparable to that of Venus around the Sun, and all are water/gas planets. A paper has been written on this system (<http://arxiv.org/pdf/1102.0291v1.pdf>). Overall, the latest discoveries show a surprising number of multiply transiting systems, and also seem to support the conclusion that there is a uniform distribution of planets, generally, across the F to M spectrum of stars.

Public comment period

Mr. Dennis Ebbetts (Ball Aerospace) complimented APS on running an orderly meeting, and was impressed by the optimism regarding the budget, but wondered if any medium-class Probe missions like Einstein were being considered. Dr. Morse responded that there is no future mission line with a Probe-class opportunity; the Explorer mission line is the alternative for future missions. Ms. Bethany Johns (AAS) asked if WFIRST might be in the 2013 budget. Dr. Morse stated this was possible especially if the WFIRST interim report was released in time for budget request. Similarly, any decisions about a potential ESA/NASA joint Euclid mission would be settled after September.

Dr. Dan Lester (UTexas) asked how various SAG technology assessments can be communicated to the NRC. Dr. Boss replied that white papers from the SAGs would suffice. Dr. Ritz recommended circulating these white papers within APS in advance. Dr. Hanany suggested that the PhysPAG respond as well, after which a discussion can take place in the planned April teleconference. Dr. Lester noted that APD should consider synergistic efforts with OCT.

Dr. Paul Ray (NRL) was interested in hearing about the growth of Explorers into MidEX-class missions, perhaps through the use of Falcon 9 launch vehicles. Dr. Morse responded that if you increase the cost cap then the flight rate would decrease. Also, the real year dollar expenditures on any EX mission(s) selected in the current AO, and any similar future AO, are commensurate with the \$300M cost of a MIDEX recommended in the decadal survey. Dr. Paul Ray commented on the breaking out of civil service labor as a separate line, and was concerned that this would lead to proposal bias toward NASA civil servants as free labor. Dr. Dave Leisawitz noted that within Explorers, civil servants are fully costed in the budget, to make for an equitable review, and with respect to APRA, the full cost dollars are not seen by reviewers, but they do see the FTE amounts associated with civil service.

Q&A Session with Dr. Waleed Abdalati, NASA Chief Scientist

Recently hired NASA Chief Scientist Dr. Waleed Abdalati addressed the APS, and asked how he could help the representatives of the Astrophysics community to make the best use of NASA funds, while ensuring that science is integrated into Agency activities. The Chief Scientist position had been eliminated in 2005 and is now being revived to serve as an independent science voice. Funds for implementing flight projects among the various Divisions are limited, and it is the task of the Chief Scientist to provide an independent assessment of the programs from a purely scientific viewpoint. The new position is to be considered as a complementary function to the SMD AA, and other roles. Dr. Abdalati offered his help as a resource in representing Astrophysics science to Administrator Bolden, but added that he should not be viewed as a means of circumventing normal channels. However, he would be happy to express collective concerns on broad science issues, and in how NASA might better serve the science community. Dr. Boss hoped that Dr. Abdalati would attend the NAC Science Committee meetings. Dr. Abdalati agreed that the Advisory Committees have a broader view than the Decadal

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Survey and can provide an added dimension. Other areas addressed by the Chief Scientist position are science programs at NASA that do not have a current official representation within the Agency; examples are the human research program (life and microgravity sciences, which once had its own enterprise and was moved into ESMD), and Aeronautics scientific research.

Dr. Abdalati provided information about his background at GSFC and as a program manager during a time of transformational discoveries in Earth Science. He stated that NASA is serious about this new position and it is highly beneficial to have science advocate on the 9th floor. He also stated his intention to build a Chief Scientist office by hiring a deputy with expertise in space science (leaning toward Planetary), another with life/microgravity sciences experience, plus a senior policy advisor and someone with communication/media expertise. He stressed his role in representing the Agency science perspective and interest by interacting with other agencies, including international parties.

Dr. Boss raised the issue of international coordination especially given the recent experience with the phasing of the Decadal vs. ESA's planning process. The aim is for NASA and ESA to coordinate in advance for planning cycles. Dr. Boss asked specifically about the prospects for NASA to collaborate with ESA's Euclid mission. Dr. Abdalati reported that Administrator Bolden had sent a letter to ESA the day before, exploring the potential of a greater partnership, and he welcomed other recommendations on how to facilitate international and interagency cooperation. An international Decadal Survey, or some synchronicity between the two communities is desirable. Dr. Ritz asked about the Chief Scientist office position about JWST. Dr. Abdalati responded that he would avoid the details of implementation, but saw a responsibility to support the scientific capabilities of the mission.

Dr. Rhoads commented on the favorable synergy between space- and ground-based activities. He remarked that while NASA's default position is that the managing and funding of ground-based facilities pertains to NSF, some ground-based assets such as the Keck Observatory are important for space-based Astrophysics. He urged Dr. Abdalati to keep an open mind for NASA's ground-based needs. Dr. Abdalati agreed, but cautioned that a strong science case is warranted for NASA to support any ground-based facility. Dr. Boss noted that Keck ended up being extraordinarily valuable but not for the reason it was originally proposed. Dr. Kalogera questioned whether the role of basic science vs. applied science was valued. Dr. Abdalati replied that basic science is certainly valued, in addition to the caveat that NASA science should both inspire and serve society. The search for origins is tremendously valuable, and the community must show its own enthusiasm, and speak publicly to support it.

Dr. Abdalati expects to work closely with OCT's Bobby Braun, and to help assure that NASA's science goals are achievable. Dr. Dey commented that it is certainly true that space missions have benefited from support from the ground; researchers have the opportunity to propose to use ground-based assets at the same time they use space assets like Spitzer; he encouraged the continuation of coordinating with other agencies. In response to a question about linkages between scientists at different NASA centers, Dr. Abdalati reported that he was in the planning phase of reestablishing a Science Council to deal with both center-specific issues and also broader science issues.

Discussion

The APS discussed Dr. Kasting's ExoPAG request, to create a science working group within the PAG, an unfunded activity to find requirements for a TPF, then set up for later funded studies, to ideally evaluate a 4-meter and 8-meter concept. Dr. Boss asked Dr. Kasting to remit revised text for the subcommittee letter.

Dr. Ritz noted the termination of support for RXTE and GALEX by the end of 2011 and was interested in the impact of the termination on the science programs. Dr. Yoder noted that RXTE would not have been

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extended into 2012 in any case. GALEX will have lost about 18 months of legacy survey data, and there is a chance there will be no time or resources to create a high-quality archive. Some post-doc positions will also be endangered by the termination of the mission. APS considered that there may be further reductions once the FY11 budget is released.

APS considered how to respond to the loss of science as per the Senior Review. Dr. Sambruna noted a potential agenda item for the next APS meeting are talks by RXTE and GALEX PIs on the impact on science of the mission termination. Another item was suggested on providing the enumeration of and rationale for losses. Dr. Yoder remarked that APS regard the Senior Review as a tool that can be used to deal with budget cuts. Dr. Boss remarked that he was not proposing to chastise the review, but perhaps the Senior Review should have been given other directions, for example notions of the APD expected budget.

Regarding the DSIAC, the subcommittee discussed the issues of conflicting advice arising from disparate sources such as the NRC, Space Studies Board, etc. and agreed that more information would be required on how APS resides within the structure of the advisory bodies. Dr. Hanany was tasked with providing language regarding this matter.

Other findings and recommendations

- Australian balloon failure/new onerous safety rules
- APD is fulfilling Astro2010 to the best given its limited resources
- New line item Technology fellows within APD
- DSIAC status
- International planning
- Issues of concern related to budget
- R&A/SR&T plan; request to increase money for APT; protoplanet issue
- Gallagher plan for upcoming Senior Review
- What is the notional vs. optimal scenario for JWST?
- Approval of tasks for COPAR SAGs
- Approval of PhysPAG subgroup creations and their tasks
- International involvement in PAGs- pending action to look at MEPAG, etc., with international members
- Establish uniform policy on emailing via exploders
- EPO grant sizes vs. cost for professional evaluation
- Synergy of APD with OCT and leveraging with industry's resources
- PhysPAG input to NRC technology review
- Voice support for discussion between agencies on the Decadal Survey- support for Administrator's letter to ESA on future cooperation
- Senior Review issues intersecting with budget decisions

Dr. Dey suggested that rather than relying on busy PIs to carry out an EPO activity, there should be a mechanism to enable teachers to access resources that identify PIs in the area who have grants, and offer to work with them. Dr. Boss asked Dr. Dey to take an action to discover what sort of information was already on the web to locate such PIs. International components of EPO were briefly discussed and seen to be limited. However Dr. Hasan observed that the Earth Science Division has considerable international presence; wherein funds for international opportunity are decided upon on a case-by-case basis. Occasionally NASA can buy node services for limited international outreach.

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Dr. Boss briefed Dr. Morse on APS findings. Dr. Morse suggested a future possible briefing from the chair of AAAC, and noted that a draft proposal could not be previewed by APS. Dr. Morse further commented that the December NRC report was the main rationale for excluding a 20% share of NASA in the Euclid mission, and went on to express appreciation for the efforts of all APS members and the various SAG activities. Dr. Boss adjourned the meeting at 4:43pm.

Appendix A Attendees

Subcommittee members

Alan Boss, Chair Astrophysics Subcommittee

Lou Allamandola, NASA Ames Research Center

Arjun Dey, NOAO (remote)

Shaul Hanany, University of Minnesota

Sara R. Heap, NASA Goddard Space Flight Center

John Hughes, Rutgers University

Mary Beth Kaiser, Johns Hopkins University

James Kasting, Pennsylvania State University

James Manning, Astronomical Society of the Pacific

Chris Martin, California Institute of Technology

James Manning, Astronomical Society of the Pacific

Ronald Polidan, Northrop Grumman Space Technology

James Rhoads, Arizona State University

Steve Ritz, University of California Santa Cruz

Leisa Townsley, Pennsylvania State University

NASA Attendees

Jaya Bajpayee, NASA SMD

Dan Coulter, NASA JPL

Bill Danchi, NASA SMD

Chris Davis, NASA SMD

T. Jens Feeley, NASA HQ

Hashima Hasan, NASA HQ

Paul Hertz, NASA HQ

Vinaram Gardner, NASA/GSFC

Colleen Wilson-Hodge, NASA/MSFC

Ilana Harrus, NASA SMD/AP

Debbie Hollebeck, NASA SMD

W. Vernon Jones, NASA SMD

Lou Kaluzienski, NASA SMD

Chryssa Kouveliotou, NASA MSFC

Lia LaPiana, NASA SMD

Thierry Lanz, NASA SMD

Steven Merkowitz, NASA SMD

Mike Moore, NASA SMD

Jon Morse, NASA SMD/APD

Marian Norris, NASA SMD

Bill Oegerle, NASA GSFC

Arik Posner, NASA SMD

Wilton Sanders, NASA SMD

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Eric Smith, NASA SMD
Linda Sparke, NASA SMD
Stephanie Stockman, NASA SMD
Ray Taylor, NASA SMD
Greg Williams, NASA SMD
Dan Woods, NASA SMD

Other Attendees

Dom Conte, Orbital Sciences
Randall Cowell, Ball Aerospace
Dennis Ebbets, Ball Aerospace
Jay Gallagher, University of Wisconsin
Bethany Johns, AAS
Michael Moloney, NRC-SSB
Saewoo Nam, OSTP
Virginia Neale, Caltech
Jim Ulvestad, NSF
Joan Zimmermann, Zantech IT.

Webex

(separate attachments in PDF)

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Appendix B NAC Astrophysics Subcommittee Membership

Alan P. Boss, Chair

Department of Terrestrial Magnetism
Carnegie Institution for Science

Louis Allamandola
NASA Ames Research Center

Arjun Dey
National Optical Astronomy Observatory

Shaul Hanany
School of Physics and Astronomy
University of Minnesota/Twin Cities

Sara R. Heap
Exoplanets and Stellar Astrophysics Laboratory
Goddard Space Flight Center/NASA

John (Jack) P. Hughes
Department of Physics and Astronomy
Rutgers University

Mary Elizabeth Kaiser
Department of Physics and Astronomy
Johns Hopkins University

Vicky Kalogera
E.O. Haven Professor of Physics and Astronomy
Northwestern University

James F. Kasting
Pennsylvania State University

James G. Manning
Astronomical Society of the Pacific

Chris Martin
California Institute of Technology

Ronald S. Polidan
Northrop Grumman Space Technology
Civil Systems Division

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James E. Rhoads

Physical Sciences F-251

Arizona State University

Steven Ritz

Santa Cruz Institute for Particle Physics

University of California

Leisa Townsley

Department of Astronomy and Astrophysics

Pennsylvania State University

Appendix C Presentations

1. Astrophysics Division and Budget Update, *John Morse*
2. SOFIA Update, *Paul Hertz*
3. Research and Analysis Update, *Linda Sparke*
4. Research and Analysis Review Update, *Jay Gallagher*
5. JWST Office Update, *Rick Howard*
6. JWST Science Update, *Hashima Hasan*
7. NASA Roadmapping Activities, *Michael Moore*
8. ExoPAG Status/Update, *James Kasting*
9. CoPAG Status/Update, *Chris Martin*
10. PhysPAG Status/Update, *Steve Ritz*
11. EPO Overview and Decadal Results, *Hashima Hasan and Stephanie Stockman*
12. Kepler Update, *Nick Gautier*

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**Appendix D
Agenda**

**Astrophysics Subcommittee meeting
February 16-17, 2011 NASA Headquarters
Wednesday, February 16**

Location: Mic 3

8:30–8:45	Welcome and Conflict of interest review	A. Boss
8:45–10:30	APD update and Budget	J. Morse
10:30–10:40	Break	
10:40–12:00	APD update continued/Q&A	J. Morse/A. Boss
12:00–1:00	Lunch	
1:00–1:30	SOFIA update	P. Hertz
1:30–1:40	Q&A	
1:40–2:10	R&A update	L. Sparke
2:10–2:20	Q&A	
2:20–2:50	R&A Review update	L. Sparke/J. Gallagher
2:50–3:00	Q&A	
3:00–3:15	Break	
3:15–3:45	JWST Office update	R. Howard/E. Smith
3:45–4:15	JWST Science update	H. Hasan
4:15–4:30	Q&A	
4:30–4:50	NASA Roadmapping Q&A	M. Moore
4:50–5:00	Summary and Adjourn	A. Boss
5:00		

AGENDA

Thursday, February 17

Location: Mic7

8:30–9:00	ExoPAG status update	J. Kasting
9:00–9:15	Q&A	
9:15–9:45	CoPAG status update	C. Martin
9:45–10:00	Q&A	
10:00–10:30	PhysPAG status update	S. Ritz
10:30–10:45	Q&A	
10:45–11:00	Break	
11:00–11:20	EPO Overview/update & Decadal results	H. Hasan
11:20–11:30	Q&A	
11:30–11:50	Kepler update	N. Gautier
11:50–12:00	Q&A	
12:00–1:00	Lunch	
1:00–1:30	Public comment period	
1:30–2:30	Meet with NASA Chief Scientist Waleed Abdalati	
2:30–4:00	Discussion/Pending Issues/Report writing	

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4:00–4:30 Briefing to APD Division Director
4:30 Adjourn