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2 December 2015

Dr. Bradley Peterson
Chair, NASA Advisory Council Science Committee
The Ohio State University

Dear Brad,

The NASA Advisory Council's Astrophysics Subcommittee (APS) met at Goddard Space Flight Center (GSFC) on October 22 and 23, 2015. The following members of the APS were present: Natalie Batalha, Marshall (Mark) Bautz, James (Jamie) J. Bock, Alan Boss, Patricia Boyd, Joel Bregman (APS Vice-Chair), Neil Cornish, Giovanni Fazio, Scott Gaudi (APS Chair), Jason Kalirai, Paul Scowen, Kenneth Sembach, Rachel Somerville, and Yun Wang. Paul Hertz (Director, NASA Astrophysics Division) and Hashima Hasan (APS Executive Secretary) were also in attendance. APS member Beth Willman attended remotely.

The GSFC Deputy Director for Science, Operations and Program Performance, Colleen Hartman, kicked off the meeting by welcoming the APS.

Dr. Hertz then presented an update on the Astrophysics Division (APD) activities. He first shared a few recent science highlights. He then summarized the APD budget situation. Dr. Hertz reported that the FY16 budget request provides funding for NASA astrophysics to continue its programs, missions, and projects as planned. He reported that all of APD's currently operating missions are going well, and continue to generate important and compelling science results. He summarized the progress toward confirmed missions either led by NASA, or with NASA contributions, including LISA Pathfinder, ASTRO-H, ISS-CREAM, NICER, TESS, JWST, and Euclid. All of these missions are on track for launch on schedule. Dr. Hertz reported on NASA activities with regards to missions in pre-formulation, including WFIRST, Athena, ESA's L3 gravitational wave observatory, and the Explorer line, which includes a SMEX mission to be selected in 2016, and a MIDEX mission in 2017. Dr. Hertz reported that there was "huge progress on WFIRST over the past two years." Three potential SMEX missions are currently being studied: SPHEREx, PRAXyS, and IXPE, with a downselect expected late next year. The APS heard reports from all three missions (see below). The APD released an update to the Astrophysics Implementation Plan in December 2014, and the NRC Mid Decade Review (with NSF, DOE) is underway, with Dr. Jacqueline (Jackie) Hewitt (MIT) as chair. The report from the Mid Decade Review is expected in May 2016. The 2016 Senior Review of ongoing missions is in progress. Dr. Hertz summarized the fraction of proposals selected from various solicitations over the past year, with selection fractions ranging from 7%-39%. On average, the selection rates in APD were 23% for R&A programs and 26% for GO programs. This is higher than in previous years, but it is unclear whether this is a statistical anomaly or the beginning of the reversal of the downward trend in selection rates over the past roughly five years. Dr. Hertz also noted that the turnaround time for all proposal selections was less than 155 days. **The APS would like to thank Paul Hertz and the members of the APD for their efforts leading to this quick turnaround time**. Finally, in response to the reports from the Program Analysis Groups (PAGs) described below, the APD is initiating large mission concept studies as input for the 2020 Decadal Survey.

Drs. James Bock (Caltech), Scott Gaudi (Ohio State University), and Ken Sembach (STScI) presented summaries of the PAGs' reports responding to Paul Hertz's charge regarding large missions for study in advance of the next decadal survey.

- Dr. Gaudi summarized the joint findings of all three PAGs. He first summarized Dr. Hertz's charge, which was "to solicit community input for the purpose of commenting on the small set [of large mission concepts to study], including adding or subtracting large

mission concepts." Dr. Hertz initially suggested four missions for consideration, namely the Far-IR Surveyor, the Habitable-Exoplanet Imaging Mission (HabEx), the UV/Optical/IR Surveyor (LUVOIR), and the X-ray Surveyor. Dr. Gaudi noted that all three PAGs agreed upon a joint executive summary for their reports. The main points of this summary are as follows. (1) All three PAGs concurred that all large four of these mission concepts be studied with no additional missions included. (2) The PAGs note that this recommendation is predicated on the assumptions outlined in the white paper and subsequent charge, in particular that major development of future large flagship missions under consideration are to follow the implementation phases of the James Webb Space Telescope (JWST) and the Wide-Field InfraRed Survey Telescope (WFIRST), and NASA will partner with the European Space Agency on its L3 Gravitational Wave Surveyor. (3) There is strong support for developing these missions via Science and Technology Definition Teams (STDTs), and that there be strong coordination between these STDTs. (4) There is support for a line of probe-class missions within the Astrophysics Division mission portfolio, and the PAGs would be willing to collect further input on probe missions from the community.

- Dr. Gaudi then summarized the findings specific to the ExoPAG report. (1) There was general support for WFIRST with a coronagraph and a starshade. (2) There was a general consensus that a broad range of apertures and architectures for direct imaging missions should be studied, encompassing both the nominal concepts of the HabEx and LUVOIR missions. (3) The ExoPAG provided several considerations regarding the makeup and structure of the STDTs. In particular, the ExoPAG suggested that there should be significant representation from exoplanetary scientists on both the HabEx and LUVOIR STDTs, that NASA consider providing some financial support for "soft money" members of the STDTs, that NASA consider international participation on the STDTs, and that NASA should appoint a small, independent and unbiased team that is tasked to evaluate the science yield and technical readiness of both mission designs in a consistent and transparent manner. The ExoPAG also emphasized the importance of fair, realistic, and consistent cost analysis of the flagship missions.
- Drs. Gaudi and Sembach noted specifically the COPAG and ExoPAG concurred that, in order to ensure broad support for the HabEx and LUVOIR missions within both the exoplanet and cosmic origins communities, significant science capabilities in both topical areas must be baselined for these missions.
- Dr. Sembach reported that the COPAG submitted its flagship mission report in response to the charge issued by Paul Hertz in January 2015. He presented an overview of the input, analysis, and findings of the study. In addition to the conclusions given in the joint-PAG executive summary that appears at the beginning of the report, a number of specific findings related to the individual mission concepts, synergies between science and the human space flight program, and the work of the STDTs are included in the report. Also included are several additional suggestions related to cross-PAG coordination, involvement of industry and the international science community in such studies, and the availability of material collected throughout the study process.
- Dr. Bock reported that the PhysPAG submitted its report to the charge regarding planning for flagship missions. The PhysPAG reached consensus with the COPAG and EXOPAG on the joint findings on large missions found in the three reports. In addition, the PhysPAG issued five findings of its own, specifically 1) the PhysPAG looks forward to NASA developing the L3 gravitational wave mission with ESA and making the necessary preparations for the US 2020 Decadal review; 2) the PhysPAG agrees with the assumption in the charge that the Inflation Probe mission should be developed as a probe class mission in preparation for the 2020 review; 3) the PhysPAG assumes NASA participation in the ESA L2 Athena mission will not be reviewed by the 2020 decadal; 4) the PhysPAG notes the PCOS science themes in the flagship missions, as described in the report, for consideration by the STDTs in the mission designs; and 5) the PhysPAG notes PCOS community interest in developing probe missions for the 2020 decadal review, and the historical success of the smaller competed line of explorer missions.
- Drs. Bock, Gaudi, and Sembach would like to thank Dr. Hertz for providing the community with the opportunity to provide input to community a chance to prepare for the next decadal survey in a fair, structured manner.

APS accepts the reports from the three PAGs as input to Paul's change, and commends them for their extensive efforts in responding to this charge. **The APS concurs with the recommendation of the three PAGs that all four large mission concepts be studied (Far-IR Surveyor, the Habitable-Exoplanet Imaging Mission, the UV/Optical/IR Surveyor, and the X-ray Surveyor), with no additional missions included. The APS recognizes that this recommendation is predicated on the assumptions outlined in the white paper and subsequent charge, in particular that major development of future large flagship missions under consideration are to follow the implementation phases of the James Webb Space Telescope (JWST) and the Wide-Field InfraRed Survey Telescope (WFIRST), and NASA will partner with the European Space Agency on its L3 Gravitational Wave Surveyor. The APS concurs with the strong support for developing these four missions via Science and Technology Definition Teams (STDTs), and that there be strong coordination between the STDTs.**

The Subcommittee also asked the three Program Analysis Groups to discuss the subject of a future probe-class mission line with the astronomical community. **Although the APS notes that all three PAGs found that there is community support for a line of probe-class missions within the Astrophysics Division mission portfolio,** there was no consensus on which and/or how many probe-class mission concepts should be studied in advance of the next decadal survey, or the detail and completeness with which any mission concept study should be carried out. The PAGs will discuss this subject with their constituents and will hold a discussion at the upcoming AAS meeting in January 2016 as part of the joint-PAG activities scheduled for that meeting. The PAGs will consider how input for probe-class missions should be introduced into the 2020 Decadal Survey process, the science cases for such missions, and what type of mission concept studies, if any, should be conducted prior to the Decadal Survey. The results of this activity will be documented in a joint white paper by the PAG Executive Committees if sufficient community consensus on these topics is achieved.

The APS also heard updates from all three PAGs regarding activities not related to Paul Hertz's charge.

- Dr. Ken Sembach (STScI) presented the status of various COPAG activities. The COPAG Executive Committee is in the process of recruiting two, or perhaps three, new members to fill an existing vacancy and replace Dr. Sembach when his term expires in early 2016. The COPAG was actively working on the report for the flagship mission charge since the last Astrophysics Subcommittee meeting. At this meeting, brief descriptions of Science Interest Group activities at the upcoming AAS meeting in January 2016 were presented for each of the three active COPAG SIGs (Far-IR Science and Technology, UV/Optical Science and Technology, Cosmic Dawn). **A request to accept the final report of Science Analysis Group #8 (Science Enabled by the WFIRST-AFTA Data Archive) and to formally close the SAG activity was made and approved.**
- Dr. Alan Boss (Carnegie DTM) updated the status of the ExoPAG. The ExoPAG accepted a plan for its explicit involvement in the annual Technology Gap List evaluation, managed by the Exoplanet Exploration Program (ExEP) at JPL. **The ExoPAG requested and received APS approval for actions regarding three SAGs, namely dropping one unresponsive SAG (#4: Planetary Measurements Needed for Exoplanet Characterization), and adding two new SAGs (#14: Characterization of Stars Targeted for NASA Exoplanet Missions, and #15: Exploring Other Worlds: Observational Constraints and Science Questions for Direct Imaging Exoplanet Missions).** The next ExoPAG meeting will be held prior to the AAS winter meeting on January 3-4, 2016 in Kissimmee, Florida. The ExoPAG will hold a joint session with COPAG and PhysPAG on January 4 to hear Paul Hertz's update on the APD and Large Missions planning for the Astro2020 Decadal Survey, and to discuss input to NASA with regards to probe-class missions as mentioned above.
- Dr. James Bock (Caltech) reported on the activities of the PhysPAG. The large mission charge occupied much of the PhysPAGs activity since the last APS meeting. In other business, the PhysPAG is currently in the process of identifying new members to replace current members on the PhysPAG EC. The PhysPAG participated in the gathering and organizing PCOS gap technologies for the annual PATR process. Finally the PhysPAG is now organizing an EC and SIG splinter meetings for the 2016 AAS, AAS/HEAD and APS conferences.

Dr. Eric Smith (NASA HQ), the JWST Program Director, summarized the progress on JWST. Dr. Smith reviewed the high-level milestones and the requirements verification progress, a major element of the current activity. The most important conclusion of Dr. Smith's report is that the JWST development remains on schedule, and maintains significant schedule reserves. Dr. Smith noted that the primary risk to the progress of JWST is another government shutdown, which could affect testing.

Dr. Smith reminded the APS that there had been discussion about moving the Guest Observer (GO) exclusive use period from 12 to 6 months. This was originally a recommendation made by Space Telescope Science Institute (STScI) director, based on advice from the JWST Space Telescope Advisory Committee (JSTAC), and the APS had previous concurred with this recommendation. However, ESA is opposed to this change for several reasons, and NASA has pulled back for now. Therefore, the default will be 12 months in keeping with a Memorandum of Understanding (MOU) that NASA signed with ESA and the Canadian Space Agency (CSA).

On the morning of second day of the meeting, the APS was provided a tour of the JWST integration and testing facilities at Goddard by Dr. Jonathan Gardner. The APS would like to thank Dr. Smith for his presentation and Dr. Gardner for his guided tour of the JWST development facilities.

Dr. Jason Kalirai presented a summary of the science capabilities of and timeline for JWST, and the community engagement efforts to prepare for Cycle 1. The recent "Exploring the Universe with JWST" science conference at the European Space Agency's Technical Centre (ESTEC) brought together leading scientists in most areas of modern astrophysics. The tremendous sensitivity of JWST combined with its vast array of technical capabilities will be foundational tools to address many of the forefront research themes in astrophysics today. Dr. Kalirai also described a wide range of activities aimed at keeping the community up to speed on JWST.

The timing of JWST cycles implies that very little non-proprietary data may be available to the community to prepare and plan Cycle 2 observations in late 2019. As a result, STScI is planning to execute an "Early Release Science (ERS) Program" in the first months of Cycle 1. The program would be shaped by the science community through a Call for Proposals in the spring of 2017, before the nominal Cycle 1 Call for Proposals later in 2017. The ERS would execute scientifically compelling programs using the major JWST instrument modes, and the data would have no proprietary time. The teams that are competitively selected to lead the ERS will work with STScI to address key technical challenges related to JWST. The program is expected to have a scale of several hundred hours, and would be supported by Director's Discretionary Time. The APS felt that this program was a great way to engage the science community early on JWST, to build community expertise on the data products and data analysis that will be required to get science out, and to ultimately seed better proposals for the Cycle 2 call in late 2019. **The APS commends STScI for protecting the community's interests with the ERS program.** More information on the ERS program will be presented at the January 2016 American Astronomical Society Meeting, in the JWST Town Hall on Wednesday January 6th at 6:30 pm.

The APS also heard reports from the three SMEX mission selected for further study: IXPE, PRAXyS, and SPHEREx.

- Dr. Martin Weisskopf (NASA MSFC) presented the mission design and science capabilities of the Imaging X-ray Polarimetry Explorer (IXPE).
- Dr. Keith Jahoda (NASA GSFC) presented the mission design and science capabilities of the Polarimeter for Relativistic X-ray Sources (PRAXyS).
- Dr. James Bock (Caltech/JPL) presented the mission design and science capabilities of SPHEREx.

The APS would like to thank Drs. Weisskopf, Jahoda, and Bock for their presentations.

Dr. Priscilla Cushman (U Minnesota), past Chair of the Astronomy and Astrophysics Advisory Committee (AAAC), presented the results of the interim report of the Proposal Pressure Study Group. Their analysis and conclusions also appear in "Impact of Declining Proposal Success Rates on Scientific Productivity" (arXiv:1510.01647v2). This AAAC study group was established to discover the cause of decreasing proposal success rates, identify impacts, and propose solutions

and potential impacts of those solutions. Their interim document is provided to inform the mid-decadal study.

As in other science areas, proposal success rates in astronomy and related fields have declined significantly in the last decade, including proposals funded by NASA and NSF. The report finds that the cause does not appear to be due to a decline in proposal merit (as measured by proposal rating), changes in proposer demographics (such as seniority, gender, or institutional affiliation), inflation-adjusted increases in requested funding per proposal, or a rise in the number of proposals per investigator per year. During this period the number of people in the field has grown; this is likely at least partially responsible for the contemporaneous increase in the number of proposers. However, the agency research budgets have not grown in proportion to the increase in the number of proposers, and thus the overall funding rates have dropped. A rising fraction of proposers also resubmit previously unfunded proposals, presumably rising as the success rate declines. The report also looked at the opportunity cost of scientists writing a significant number of unsuccessful proposals and found that a funding rate of ~6% was the tipping point below which proposal writing prevents more papers than the resulting grants produce. The report claims that the success rate experienced by new investigators is quite close to this tipping point, (the overall average funding rate was 20%). They also report a rating bias against PIs without recent funding. At 20% selection rate, the opportunity cost is 2-3 papers per successful proposal. Currently, a proposal rated "very good" has a ~58% chance of funding after 3 attempts. The report concludes that the current 20% overall funding rate is unhealthy for astrophysics, since stable, long-term support for students, postdocs, or researchers on soft money is at risk, and young researchers are particularly discouraged from staying the field. They recommend aiming for a 30-35% success rate, claiming this would simultaneously relieve the burden on proposers, who would thus submit fewer proposals per year, and on the funding agencies, who currently have to manage a steadily rising number of submissions.

The APS thanks Dr. Cushman for a clear and complete presentation of the interim report, which represents a significant effort synthesizing data across agencies over a long timescale. The APS was concerned by the possibility that some NASA funds that go to the community had not been included in this study. A comment from the floor from Dr. Daniel Evans (NASA Headquarters) suggested that the net decline in win rates could potentially be explained by several independent effects that each contribute at about a 10% level.

Based on Dr. Cushman's presentation and the discussion that followed, the APS developed the following suggestions for the AAAC Proposal Pressure Study Group: (1) the group should consider obtaining and including information from NASA about all funding that goes directly to the community (such as Guest Investigator funding through ROSES calls, funding through the Great Observatories, postdoctoral fellowships, etc.) and (2) the group should consider evaluating whether the sum of all of the "10%" effects can, in fact, explain the decline in funding rates.

Dr. Padi Boyd (NASA/GSFC) has agreed to be the liaison between the APS and the AAAC Proposal Pressure Study Group.

Dr. Kristen Erickson (Director for Science Engagement & Partnerships for the SMD) gave a briefing on the SMD Education Restructuring Strategy and Selections. The motivation for restructuring is to allow NASA scientists and engineers to more effectively engage with learners of all ages. The objectives are to enable STEM education, improve US scientific literacy, advance national educational goals, and to leverage these goals through partnerships. A competitive selection process was initiated with the Science Education Cooperative Agreement Notice (CAN). Proposals were submitted May 4, 2015, and selections were announced September 25, 2015. Selections fit within a budget of $42M/yr. The selection rate was 37% (27 out of 73 compliant proposals selected). PIs are now negotiating with Headquarters on their awards. Fifteen selectees are from Legacy institutions, and three proposals support the 2017 Total Solar Eclipse with one academic year of preparation. Awards planned to be completed by the end of the calendar year. Panels were convened with help from the National Academies and approximately one of every four panelists was from "outside NASA". There was a two-step evaluation process.

All existing education efforts will be transitioned into the cooperative agreements that result from this solicitation. Several gaps were identified, that will lead to additional opportunities planned for the future. An example of a significant gap is a relative lack of programs targeting underserved areas. A targeted call will come out in the next 3-5 years to attempt to fill these gaps.

Some attempts are being made to use non-selectees for filling gaps. Non-selectees are encouraged to share their updated Curricula Vitae on Forum websites, so that they can share information with selectees. Dr. Erikson noted that 44% of the selectees are new players in this community. Coming up with the framework to facilitate this collaboration is the biggest challenge. There is now an opportunity for more of a role for the education POCs in the science divisions, with a science-first approach. There was some discussion of insuring that the education done at the SMD level be appropriately highlighted so that it has effective visibility in the NASA Education Office. There was also some discussion of the definition of a scientifically literate population (one of the main objectives of the SMD Education approach). **The APS would like to thank Kristen Erickson, Paul Hertz, and John Grunsfeld for being strong advocates of education and outreach.**

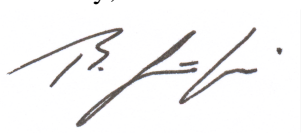
Dr. Erin Smith (NASA HQ) introduced the Big Data Task Force (BDTF) initiative, and requested input from the APS as to the charge of this initiative. The APS found it difficult to make any specific recommendations, as the charge of the BDTF appeared rather vague. Ultimately, the APS suggested that the task force first assess what are the current and future big data needs in each science division, and determine what is being done to meet those needs. This will provide the context with which it can determine what synergies or useful exchange of information may be possible between the science divisions.

Finally, Dr. Hertz welcomed Dr. Beth Willman to the APS. The APS would like to echo Dr. Hertz's welcome to Dr. Willman.

Requests for presentations at the next meeting: The APS requests a presentation on the NESSF-15 program, including statistics on where the fellowships are being awarded, and what would be required to roughly double the number of awards (i.e., from 8 to 20).

Major conclusion: The APS concurs with the recommendation of the three PAGs that all large four mission concepts cited in Paul Hertz's charged be studied by Science and Technology Definition Teams, with no additional missions included, subject to the assumptions outlined in the white paper and subsequent charge as outlined above.

Sincerely,



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