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Dr. Paul Hertz
Astrophysics Director
Science Missions Directorate
National Aeronautics and Space Administration (NASA)

Dear Paul,

The NASA Astrophysics Advisory Committee (APAC) had its Spring meeting on 2022 March 30 and 31st. Due to the continuing Covid-19 environment and related NASA operational and travel restrictions, the entire two-day meeting was conducted virtually using WebEx™ video conferencing technology accompanied by a digital portal and a chat-window to assist in exchanging APAC and community comments. The following members of the APAC attended the meeting: Manuel Batista, Kelly Holley-Bockelmann (APAC Vice Chair), Jessica Gaskin, Hashima Hasan (APAC Executive Secretary), Erika Hamden, Ryan Hickox, Shirley Ho, Margaret Meixner, Michael Meyer, Mark Mozena, Lou Strolger, and Chick Woodward (APAC Chair).

Each day, Dr. Hasan began the meeting by welcoming all the APAC members, and explaining the committee's purpose. Dr. Hasan reminded the APAC members who had conflicts of interest with specific topics on the agenda that they were allowed to listen to the presentation but could not participate in the committee's discussion as they are conflicted. Dr. Hasan then read aloud the Federal Advisory Committee Act (FACA) rules. Dr. Woodward then welcomed the members to the meeting, outlined the agenda, and reiterated some of the FACA and conflict of interest rules. APAC members proceeded to introduce themselves.

The APAC thanks all of the presenters for their time and efforts to provide crisp and informative presentations. In addition to the agenda, the presentations for the meeting are posted at https://science.nasa.gov/researchers/nac/science-advisory-committees/apac

The APAC has the following specific findings and recommendations in response to the presentations and subsequent discussions.

ASTROPHYSICS DIVISION (APD) UPDATE

APD Director Paul Hertz gave an extensive and wide-ranging summary of the State of the APD covering an exceptionally active 6 months. Among the major events, APD successfully launched missions ranging from flagship-sized (the James Webb Space Telescope in particular) to

balloons and received a new Astro2020 Decadal Survey report and a just-released FY2022 budget that included a cost-cap increase for Roman and language specifically instructing NASA to continue to operate the Stratospheric Observatory for Infrared Astronomy (SOFIA) in FY2022[1]. The launch of JWST also involved a large and very successful suite of outreach activities.

The APD Director remarked to the committee that the FY2022 budget was a great budget for the division and any shortfalls introduced by the appropriation language could be managed and balanced without major impacts to the portfolio. Highlights of the FY2023 budget runouts include additional resources to fulfill all four selected Pioneers mission development, and wedges to initiate investment in Time Domain Astrophysics infrastructure systems and the Great Observatory precursor studies in direct response to the Astro2020 Decadal Survey recommendation.

The APD Director's report to the committee also included an extensive debrief of its attention to developing initiatives to respond to principles associated with NASA's new 5th pillar of Inclusion, Diversity, Equity, and Accessibility (IDEA). However, APD is still receiving strong expressions of community concern over the lack of transparency and rationale for the decision not to re-name JWST. The APAC, the NASA historian, and the APD Director had a lengthy discussion of the JWST issue and the current actions to seek additional insight from the Truman Library Archives and those at State, recently re-opened after Covid-19 restrictions.

Findings

APD has successfully launched the flagship great observatory JWST, the International X-Ray Polarimetric Explorer (IXPE), the Colorado Ultra Transit Experiment (CUTE) and conducted a successful suborbital launch campaign of 7 balloon launches that will enable scientific advancement in many fields.

The mission lifecycle costs of the Roman Observatory have increased over original mission commitments and careful management strategies are ensuring success.

APD has thus far responded effectively to implement some of the recommendations contained within the Astro2020 Decadal Survey.

APD is trying to formulate ways to enhance the Astrophysics Theory Program (ATP), as recommended in the Astro2020 Decadal Survey.

APD is taking steps to build a strong portfolio for time domain and multi-messenger science.

APD evaluated the results of the ROSES Inclusion Plans Initiative as a pilot in the context of the ATP program; the initiative is being extended to other programs over three years.

[1] See https://docs.house.gov/billsthisweek/20220307/BILLS-117RCP35-JES-DIVISION-B.pdf, p129ff, https://www.appropriations.senate.gov/imo/media/doc/Division%20B%20-%20CJS%20Statement%20FY21.pdf , p117ff.

APD has shown leadership in building excellence in the NASA workforce by initiating efforts to support work-life balance.

The APAC endorses the initial APD plan to implement enforceable Codes of Conduct requirements for science teams.

Recommendations

The APAC requests regular updates on the cost and schedule of the Roman Observatory.

The APAC requests an update regarding the next MIDEX opportunity now delayed.

The APAC requests a presentation on the status of GUSTO at its next meeting.

The APAC requests a presentation on the SOFIA close out process plans, including mission data archive completion at the NASA/IPAC Infrared Science Archive (IRSA) and aircraft asset preservation. The APAC recommends that NASA extend the SOFIA mission close-our process to FY2023 to carry out the Cycle 10-selected peer reviewed proposals.

The APAC requests APD initiate a review of whether the community research and analysis funding profiles and formulae used in pointed GO mission models (e.g., Hubble, Webb) is applicable to survey missions (e.g., Roman, Euclid) to maximize the scientific return.

The APAC requests a presentation on the evolution of the NASA Science Mission Directorate (SMD) Bridge program and a broad strategic overview of the implementation of IDEA initiatives at the committee's next meeting.

The APAC advises APD to communicate effectively and in a timely fashion with the astrophysics community and other stakeholders with regard to release of a Probe Announcement of Opportunity (AO), envisaged in the Astro2020 Decadal Survey.

The APAC requests APD to provide frequent updates on action related to time-domain and multi-messenger science.

The APAC advises APD to continue close evaluation of the ROSES Inclusion Plans Initiative, as it extends to different programs.

The APAC requests Kevin Murphy, Transform to Open Science (TOPs) lead, to discuss with the committee at a future meeting the developments in this area, with a particular focus on the national needs and sensitivities to national security awareness of widely accessible and distributed scientific software codes.

JAMES WEBB SPACE TELESCOPE MEMORIALIZATION CONVERSATION

APD Director Paul Hertz introduced the discussion with a statement on Astrophysics SMD inclusivity objectives, policies, and scope. Dr. Brian Odom, NASA Acting Chief Historian, then provided the committee with further details of the planned visit to the State Department historical archives and the Truman Library, which were to occur within the next few weeks. They also outlined the plans for the study and the rough timeline for reporting findings. The APAC pressed both the Historian and the APD regarding the need for transparency, a thorough and objective investigation, and a well-documented public report stating the finding of facts. APD espouses to be data-driven in its decision-making processes. The APAC and the broader astrophysics community, therefore, expects an honest, evidentiary-based record of the decision.

Public comments on the naming issue received through the APAC portal were substantial. Rebuilding confidence in the APD and the Agency's decision-making process as transparent, equitable, and balanced will require both a short-term response as well as a long-term commitment.

Findings

Information contained within the Agency Freedom of Information Act (FOIA) document tranche suggests a new urgency for the NASA historian to assess carefully documents in the historical archives of the State Department and the Truman Library.

The APAC was dismayed to receive no formal record decisions and associated findings, despite the committee's specific request, that summarized the decision-making process that resulted in the Observatory's name remaining as is.

The APAC notes that NASA is committed to complete the additional investigation promptly, in the next few months, and to report publicly on the results.

Recommendations

The APAC requests the APD strongly encourage the NASA historian and their team to document fully and completely in a written report the current status of the ongoing investigation of archival materials, conversations, and other sources by the committee's 2022 July meeting.

The APAC advises that advancing the resolution of the Webb investigation may require additional future work and requests a schedule for timely and crisp completion of these activities.

The APAC requests the NASA historian be invited to provide a thorough debrief to the committee for the record at the committee's 2022 summer meeting.

The APAC advises APD to consider development of written policies and guidelines-of-practice of naming flagship missions that could build community trust and endorsement.

The APAC suggests that the findings of the NASA historian, the issue of James Webb memorialization, and the naming of future observatories be discussed by the NASA Advisory Council (NAC).

JAMES WEBB SPACE TELESCOPE UPDATE

The APAC congratulates the JWST team for the successful launch and exemplary progress on preparing the Observatory to undertake transformational science driven by a world-wide community of investigators.

Dr. Eric Smith gave an interesting and informative discussion of progress on JWST during and after its launch on 2021 December 25. This successful launch captured the imagination of the scientific community and the broader public across the world. Dr. Smith noted the exceptional performance of the Ariane 5 launch vehicle that placed the telescope into a near perfect trajectory, saving substantial amounts of fuel and extending mission lifetime. Dr. Smith described the deployment, cooling, and alignment processes and noted the excellent performance of the optical system and instruments so far, with only the Mid Infrared Instrument (MIRI) still to reach operating temperature. Dr. Smith spelled out the detailed plans for continued commissioning of the telescope and public outreach in the coming months, leading up to the start of Cycle 1 science in July 2022.

Findings

The successful JWST launch, deployment, and initial commissioning progress demonstrates the nation's ability to press the frontiers of achievement.

Recommendations

The APAC strongly advises the APD to work aggressively to sustain full funding of investigators' research and analysis requirements to ensure a sustained scientific return from the observatory, its archives, and the theoretical and laboratory endeavors that JWST will engender.

The APAC requests an update on the on-orbit JWST mission status and early release science at the committee's next meeting.

The APAC requests additional information regarding the JWST project's initial science release and publication plans, following precedents established by prior flagship missions, to assure that there is a coherent strategy to disseminate science results within the astrophysics community.

ROMAN UPDATE

The APAC appreciates the overview and status presentation on Roman by Dr. Julie McEnery. The Roman telescope promises to deliver transformational science with mission objectives that

include a wide-field infrared (IR) survey, expansion history of the universe, growth and structure of the universe, exoplanet census, general astrophysics surveys, and a coronographic technology demonstration. Good progress is being made regarding the project, including launch vehicle selection, telescope, spacecraft, wave-front interferometer (WFI), and the coronograph, though with overall decrease in project execution efficiency, primarily due to Covid-19 impacts. The APAC also discussed with project the balance between a survey driven science mission operations model verses one that also enables a substantive community guest observer science component.

The APAC congratulates the Roman team on passing their Critical Design Review (CDR).

Findings

The Roman team's proactive project management has attempted to reduce risk of further cost-overrun and schedule slip related to Covid-19 and associated reductions in supply-chain efficiencies.

High data volumes will drive the astrophysics community and its requisite work-force requirements in new directions related to data science, data mining, cloud-computing techniques, and data engineering technologies that may have unanticipated cost consequences.

Reframing Roman as a community survey instrument may enable acquisition of additional valuable datasets that enhance the mission's science return.

Recommendations

The APAC requests an update on Covid-19 and other supply chain issues that could further impact schedule and cost at the committee's next meeting.

The APAC requests an update on the status of the Committee on Astrophysics and Astronomy (CAA) non-advocate review of Roman's capacity for large ambitious community driven surveys at a future meeting.

The APAC requests Roman return to the committee to discuss specifically details of managing the enormous data volumes and data utilization and distribution schemes to maximize the science return of the mission commensurate with the opportunities and constraints in the NASA TOPS initiatives.

BALLOON TASK FORCE UPDATE

The APAC received a thorough update from Dr. Thomas Hams, APD Project Scientist for the Balloon program. The Balloon program itself had a successful return to flight after a pause due to Covid-19. The previous year's campaigns resulted in multiple flights, including scientific, training, and student payloads. The Astro2020 Decadal Survey recommendation for NASA to

review the program has been accepted and APD provided a plan and terms of reference (TOR) for such a review.

Findings

The APAC endorses stand-up of a Balloon Program Independent Review (BPIR) Subcommittee of the Astrophysics Advisory Committee.

The draft Terms of Reference (TOR) for this subcommittee, submitted to the APAC for review, is endorsed after consideration of various APAC recommendations highlighted below.

Recommendations

The APAC requests APD modify the TOR to include a specific charge within the subcommittee's remit to study a comprehensive and appropriate approach to data archiving associated with balloon mission science return.

The APAC suggests APD advise the BPIR Subcommittee to consider in their deliberations the recommendation and findings within the PAG 2020 Balloon Roadmap Report and to consider including members of the Balloon Working Group on the BPIR Subcommittee.

The APAC suggests APD not limit the review to 18 months, but provide an option to extend, while also providing interim updates to the Division to permit a timely response to recommendations and findings.

The APAC recommends not restricting the number of meetings to six, but to allow for additional meetings as budget permits (ideally meetings could be a combination of in-person and virtual gatherings).

SOUNDING ROCKET UPDATE

The APAC received a detailed report on the sounding rocket program by Dr. Thomas Hams. NASA's rocket program provides instrument development opportunities on the timescale appropriate for graduate student thesis projects. Moreover, the acceptance for risk of failure is much higher because the cost is low allowing for lessons to be learned in the projects. The rocket program now allows commercial suborbital platforms to be used. In the proposal process, the principal investigator (PI) can choose a NASA provided rocket, a NASA purchased commercial rocket, or a commercial platform and the cost of the launch is not part of the proposal review. During the pandemic months of September and October 2021, NASA successfully setup a new Australian sounding rocket site in Nhulunbuy, Australia for rockets to be launched in June/July 2022. APD's sounding rocket program expects to return every three years. Not presented but included in the slide deck were slides from all current sounding rocket programs that displayed the breadth of science and student training aspects of the program.

Findings

APD is building a very extensive and versatile array of sounding rocket vehicles and launch platforms by including commercial capabilities. These assets should enable newer science opportunities.

APD's intent to provide information of appropriate and available launch vehicles to level the playing field for commercial providers is endorsed.

Recommendations

The APAC recommends APD implement a strategy to enable more frequent sounding rocket campaigns from Australia if science demands warrant.

The APAC suggests APD develop a coherent process to track metrics of scientific impact across the entire Sounding Rocket portfolio to assess the return on investment, technology readiness level advancement, and work-force development.

ARCHIVE MODERNIZATION

Dr. Linda Sparke presented the committee an overview of the necessities and challenges associated with modernization of the APD mission archives and the need to make these rich scientific repositories dynamically accessible, of value add to a broad community of researchers while minimizing NASA operational infrastructure by adopting commercial cloud-based assets. APD is anticipating the velocity of data volumes to increase markedly with mission such as Euclid delivering upwards of 4.5 peta-bytes (Pb) of science data, while Roman in 2028 will be returning of the order of 1.5 Pb per year through its prime mission. These repositories also demand new tools to extract science. The committee was informed of how archive modernization efforts will deploy data mining and machine learning analytics, coupled with substantial computing resources and other enhanced analysis services, notebooks, and simulations codes to investigators.

The APAC was advised that this activity is a very large and complicated project, involving private and federal actors, and significant poorly understood technological, curation, and user support demands. The committee also had a lengthy discussion on various aspects of this project, including verified access privileges, quality assurance standards and practices, interoperability of archives, and maintenance of simulation repositories. Also discussed were concerns associated with the distribution of advanced machine learning, and/or artificial intelligence tools and algorithms without an assessment of national interests.

Archives modernization is driven by necessity and recognition by the Astro2020 Decadal Survey report of the importance to advancing key strategic science themes using missions across the APD portfolio. However, the Astro2020 Decadal Survey requirement on open science for all should take into account the national interests, the interest of the broader scientific community,

and the national security sector. There should be broad consultation with the relevant stakeholders outside NASA as the archive modernization efforts evolve.

Findings

Broader consultation with the scientific community and other relevant stakeholders outside NASA, including the national security sector, will be required to assure that this project meets the national interest.

The Archive Modernization effort is essential to the success of upcoming large survey missions as well as to comply with the requirement to make all NASA science products available to the public when it is not contrary to national security requirements.

The APAC questions the utility of an "open-skies" approach to the Archives Modernization efforts, in particular in the realm of dual-use applications and running complex simulations.

Recommendations

The APAC requests an update on the Archive Modernization at a future meeting.

The APAC recommends assembling an advisory group of experts for this work. Such a group should be led by users from the community and have representation from the commercial and national security sectors.

PAG UPDATES

The APAC received an update on the COPAG activities from Dr. Janice Lee. The IRSTIG and UVSTIG have maintained an active rapport with the community with periodic webinars on science or technology and are discussing Astro2020 Decadal Survey matters. The IRSTIG held an in-person meeting in Boulder, CO 2022 March 30-April 1 entitled *"Astro2020 and IR Astrophysics: Planning for the Next Decade".* Two new SIGs, Stars and Galaxies, have started with webinars discussing relevant science, Astro2020 Decadal Survey priorities and science gaps. The COPAG, PhysPAG and ExoPAG groups have joined forces to create sessions for the Society for Advancing Chincanos/Hispanics & Native Americans in Science (SACNAS) and at the National Society of Black Physicists (NSBP) meetings.

The PhysPAG report, delivered by Dr. Grant Tremblay, described community engagement activities at the recent American Astronomical Society, High Energy Astrophysics Division (HEAD) meeting and review of technology gap assessment. PhysPAG proposed two new SAG ideas on the next generation great observatories and time domain techniques relevant to multi-messenger science. This latter suggestion is similar to the APAC discussion of a new subcommittee focused on time domain studies that may include not only science, but archival research and computational methods.

The ExoPAG report, delivered by Dr. Michael Meyer, covered numerous community activities and recent reports including two completed SAG reports and one proposed new SAG. Both science and technology gaps were assessed. ExoPAG 25 was held virtually in January. Two active SIGs, Exoplanet Demographics and Exoplanet Solar Systems Synergies, have been holding monthly telecons/journal clubs and actively recruiting new members.

Dr. Ryan Hickox reported on the status of the TOR for a SAG entitled *Astrophysics With Equity: Surmounting Obstacles to Membership (AWESOM),* that would be cross-PAG. He reports on the COPAG, PhysPAG and ExoPAG joint activities to create future sessions for the Society for Advancing Chincanos/Hispanics & Native Americans in Science (SACNAS) and at the National Society of Black Physicists (NSBP) meetings. Hickox cited references to the Astro2020 Decadal Survey report and commented on the astronomy community disappointment for ending the pronoun project and the poor response to communities concerns about the name of the James Webb Space Telescope.

Findings

The PAGs are taking an active role engaging communities.

The APAC applauds the cross-PAG sessions at SACNAS and NSBP.

Recommendations

The APAC recommends APD accept and close out the ExoPAG SAG21, and SAG22 final reports, posting the documents to the 2022 March APAC document website.

The APAC recommends APD accept the TOR for the Exozodi SAG of the ExoPAG.

The APAC requests a report from the COPAG on the IRSTIG workshop on Astro2020 planning.

The APAC suggests the PhysPAG draft a TOR for the cross-PAG SAG on synergies between the Next Generation Great Observatories noted in the Astro2020 Decadal Survey report. This TOR should be submitted two weeks before the next APAC meeting for review and discussion.

The APAC requests the leads finalize cross-PAG TOR for the AWESOM SAG on removing barriers to participation in the APD research enterprise by the next meeting of the committee, which should have as a focus an examination of APD programs that have led to expanded participation, the sustainability of these initiatives, and new pathways to maximize their impact.

EXOEXPLORER PROGRAM

The Exoplanet Explorers (ExoExplorers) program is now in its second year, having admitted a cohort of 12 new ExoExplorers and 4 new ExoGuides. The program was started in mid-2020 to provide early career scientists with greater visibility during the pandemic. The goals of the

program are responsive to several Astro2020 Decadal Survey recommendations, especially those related to training, workforce development, and diversity/inclusion.

Findings

The ExoExplorer program is serving a community need and the APAC endorses its goals for future cohorts, especially the addition of in-person, live components to the program.

RESEARCH AND ANALYSIS (R&A) UPDATE

The APD Research & Analysis (R&A) Program status was presented by the Lead R&A Program Manager Stefan Immler. The status was comprehensive and included specific and R&A relevant responses to the Astro2020 Decadal Survey recommendations and APD Inclusion Plans.

ADP reported the proposal success rate for Laboratory Astrophysics (LabAstro), recommended for augmentation by the Astro2020 Decadal Survey, is comparable to that in other areas of about 25%. However, the APAC points out this statistic is based on less than ten proposals per year. The current funding level for LabAstro can only fund one or two programs per year. The small number of proposals being submitted might be indicative of a field that has stopped growing, and indeed, may be in decline.

Plans for increased funding growth are underway to permit continued, and essential support for the science community were discussed with the committee. The APAC was informed that the APD R&A funding has grown at a pace of about 2% over the last decade. Unfortunately, this growth is at pace or below the national rate of inflation. In addition, the APAC was briefed on APD's consideration of the Astro2020 Decadal Survey recommendation regarding augmentation and restoration of annual proposal calls for the Astrophysics Theory Program (ATP). The current level of funding leads to a very small success rate, which is abnormal and unhealthy. A conversation regarding adjusting the cadence of ATP announcement of opportunities to an annual call was robust.

Findings

The APAC recognizes and appreciates that APD has worked hard to inform the community of selections within 150 days of submission.

The APD R&A Program remains healthy in the number and breadth of research program elements, the balance of R&A elements, and in the overall number of proposals received and selected.

The APAC notes the very low selection rate in the XRP relative to comparable programs.

The APD R&A funding commitments are not adequately addressing inflationary impacts.

The current funding of ATP leads to a very small success rate that may not sustain a robust community.

Recommendations

The APAC requests a complete debrief on the Inclusion Plan Pilot Program findings at its next meeting.

The APAC requests a discussion on how the inclusion plan critiques are being relayed to the proposers and what efforts are being made to educate potential proposers in this area at the committee's next meeting.

The APAC recommends an analysis of the ATP program for either direct augmentation in funding or restructuring in a way for the field to be properly funded.

The APAC requests a status update describing how APD is meeting Astro2020 Decadal Survey recommendations with specific asks regarding how the Division is considering potential responses in the areas of "…*undergraduate and graduate "traineeship" funding*…" and "*...augmentation and improved coordination of Laboratory Astrophysics funding*…" at the committee's next meeting.

The APAC encourages APD to review whether a rebalanced program might more efficiently achieve NASA's strategic 5th pillar goal, in particular increasing the impact of the IDEA objectives.

PRIORITIES IN TIME DOMAIN ASTRONOMY

The APAC had a productive discussion about the future of time domain astronomy and the need for new observing capabilities and coordination between facilities to take advantage of exciting new science. The upcoming facilities, such as the Vera Rubin Observatory and upgraded gravitational wave observatories, will provide a wealth of new transient targets for rapid follow-up in part with APD mission assets. These targets will drive new science and the need for new capabilities, as emphasized by the Astro2020 Decadal Survey report. However, the report also points out that much of NASA's *current* time domain capability, such as the gamma ray burst detection and rapid slew ability of the Neil Gehrels Swift observatory, are aging and may be lost in the relatively near future. Thus, there is a need to balance replacing those capabilities versus investing in new more advanced NASA facilities.

While the Astro2020 Decadal Survey emphasizes the need for a focus on time-domain and multi-messenger astronomy, it leaves open the precise mechanism by which these science goals would be prioritized within mission programs of different scales (i.e., Explorers, Probes, etc.). The APAC discussion also noted the importance of improved alert and communication networks, as well as the wide range of time scales that correspond to time-domain and multi-messenger astronomy (for example coalescing supermassive black hole binaries, for which the relevant timescales can be many years).

Findings

New science frontiers enabled by judicious use of NASA mission assets will transform our understanding of the cosmos in the time-domain.

Time domain astronomy response expectations will involve a reassessment of current NASA astrophysics mission operations models to understand fundamental constraints and to identify novel new modes to effectively respond to this new science direction.

Recommendations

The APAC advises APD to consider the merits of establishing a Time Domain and Multi-Messenger Astrophysics (TDAMM) sub-committee of the APAC and develop a draft TOR for the committee's consideration at its 2022 fall meeting.

Sincerely,

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