NASA Astrophysics

ASTROPHYSICS ADVISORY COMMITTEE

March 30-31, 2022
Virtual Meeting

MEETING MINUTES

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Hashima Hasan, Executive Secretary

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Wednesday, March 30

Introduction and Announcements

Dr. Hashima Hasan, Executive Secretary of the Astrophysics Advisory Committee (APAC), opened the virtual meeting. As this was a Federal Advisory Committee Act (FACA) meeting, it was open to the public and all statements would become part of the public record. This meeting was being recorded on WebEx. By attending the meeting, participants consented to their voice and likeness being recorded and shared on the APAC website and in any media in existence now or in the future. Participants released NASA from any claims and demands that may arise from such use, including claims for compensation. While discussions during the meeting were for APAC members only, the public would have opportunities to ask questions via the WebEx chat feature and a web portal linked in the Federal Register Notice (FRN). There were two public comment sessions on the agenda. All APAC members must have on-the-record conversations during the meeting.

The NASA Science Mission Directorate (SMD) Associate Administrator (AA) had appointed the Committee members on the basis of their subject matter expertise; they must comply with Federal ethics laws applying to Special Government Employees (SGEs). Committee members were required to recuse themselves from discussion of any topics for which they had personal or institutional financial conflicts of interest (COIs). The following members were known to have COIs: Dr. Jessica Gaskin – Imaging X-ray Polarimetry Explorer (IXPE); Dr. Margaret Meixner –Stratospheric Observatory for Infrared Astronomy (SOFIA); Dr. Louis-Gregory Strolger – James Webb Space Telescope (JWST or Webb), Nancy Grace Roman Space Telescope (Roman); Dr. Michael Meyer – JWST. Any members finding additional COIs were obliged to tell Dr. Hasan and recuse themselves during the discussion. Members should address any ethics questions to Dr. Hasan as well. She then introduced Dr. Charles Woodward, APAC Chair.

Dr. Woodward reminded APAC members to be aware of COIs. There was to be an adjustment in the agenda, as Dr. Thomas Zurbuchen, SMD AA, was unable to attend a scheduled discussion session. Instead, the Astrophysics Division (APD) update would be extended. Dr. Kelly Holley-Bockelmann, Dr. Woodward's co-chair, would be assisting. Dr. Woodward then introduced Dr. Paul Hertz, APD Director.

Astrophysics Division Update

Dr. Hertz began his presentation by showing the astrophysics missions across the electromagnetic spectrum, further broken out by operating missions, missions in development, and very small and suborbital missions. This portfolio is strong and precedes implementation of the recently released Decadal Survey (DS), Astro 2020. It is the starting point for implementing the DS, which is the program of record. He next listed APD personnel. Drs. Sandra Cauffman, Rachele Cocks, Terri Brandt, Sangeeta Malhotra, and Sanaz Vahidinia, as well as Ms. Lina Carrington, have recently joined the Division, and Drs. Valerie Connaughton and Hannah Jang-Condell have become civil servants after previously serving on detail.

The DS was blunt about the need for Inclusion, Diversity, Equity, and Accessibility (IDEA), which leads to better science. NASA is committed to IDEA as a core element, and therefore it would be discussed throughout many of the presentations at this meeting.

Science Highlights

There have been numerous suborbital launches in the past year, including 7 balloon launches plus 34 student payloads in the Fall 2021 campaign from Ft. Sumner, NM. Dr. Thomas Hams was on the agenda to speak about this further.

The Colorado Ultraviolet Transit Experiment (CUTE) cubesat launched in late September, 2021, is now returning science data. IXPE launched in early December, with a boom deployment in mid-December and

science observations beginning in January. JWST launched on Christmas; there was to be a separate presentation on that mission.

The Neutron Star Interior Composition Explorer (NICER) team won the 2022 Rossi Prize for work on pulsar mass and radius. The Chandra mission found an extremely long beam of matter and antimatter extending from a tiny pulsar, which may explain the numbers of positrons detected throughout the Milky Way. In a final science highlight, Dr. Hertz explained that NASA has confirmed the existence of more than 5,000 exoplanets, which is remarkable considering the first exoplanet was discovered 30 years ago.

APAC Recommendations
Dr. Hertz next turned to APAC recommendations from the prior meeting, in October, 2021. First, APAC sought complete documentation in a written report from the NASA Historian, Dr. Brian Odom, on all aspects of research culminating in the NASA Administrator's decision to keep the name of James Webb on JWST. NASA acknowledges the shameful past of discrimination against LGBTQ Americans, but the existing historical research does not support renaming JWST. Dr. Odom planned to return to the archives to look further and share information about his research once this work has been done.

Dr. Woodward asked if APAC would receive an outbrief after this trip to the archives and if there will be a written formal document. Dr. Odom confirmed those points, adding that he was aware of the Lavender Scare and was familiar with the issues. He had looked at Mr. Webb's time at the State Department (State) but wanted more information from the archives to identify his role during the Lavender Scare to determine if it was leadership, association, or something else. Covid protocols delayed some of this work, but the archives have now reopened. A contractor is already diving into the records at State with that research question in mind, while Dr. Odom will soon be going to the Truman Library, where he has been talking to librarians about this. He may also double-check some of the contractor's work at State. History is never closed, but once they have done what is possible now, he will present the evidence to APAC and share the decision-making process. Dr. Michael Meyer asked if there is a context for the levels of roles in this space, and if there are members of the gender studies community on the research team. Dr. Odom said that in viewing the historical context, he will be thinking about when Mr. Webb arrived at State, the situation at that time, the activity that had started, what if any reaction he had, and the evidence. Did Mr. Webb want reports, and did he amplify or diminish the reaction in any way? How did he interact with key players on this topic? Written evidence cannot be the only thing, as there are also silences. Dr. Meyer said that it was not evident to him what carried the greatest weight here. Dr. Odom replied that the report will provide the context and evidence, including anything that conflicts with how we currently view Mr. Webb's role. APAC will see the evidence, though NASA Administrator Bill Nelson and Dr. Hertz will have it first. He hoped to substantiate a position or conclude there is too much conflicting evidence by the end of April but will extend that timeline if the research team uncovers new evidence.

Dr. Hertz added that Dr. Odom reports to Sen. Nelson, who makes the decision. Dr. Odom will make the information available publicly by presenting it to APAC. Dr. Hertz will follow APAC's advice, but Sen. Nelson decides, and he can ask for more information if he wants. But while this is not an APD decision, APAC should speak up and the community should let the members know where it differs with the Agency. Dr. Ryan Hickox said there is community concern about NASA leadership's initial reaction and people want to know what evidence was available at that time. It is important for transparency. Dr. Odom said that although the archives were closed due to Covid, there was much information available online due to similar research conducted previously. Historians have looked at these archives with similar questions and have established a clear context for the Lavender Scare. That documentation is available and will be part of the outbrief. Dr. Woodward thanked him and said that it would be helpful for APAC to see the written documentation in advance of the next meeting. Related to this topic, APAC had also made a recommendation about the way APD memorializes individuals via flagship missions. Dr. Hertz said that APD accepts the recommendation to review the way it names missions. While there is no written

convention, other SMD divisions do not normally name missions after people, though the Heliophysics Division (HPD) Parker Solar Probe (PSP) was an exception. APD is the only division with a tradition of naming missions after scientists.

He then moved on to note other recommendations that had been accepted. Regarding the increase in Guest Observer (GO) funding for JWST, proposals came in and were reviewed, and the total came to about 65 percent of what was requested, which was standard for the Hubble Space Telescope (HST). The Space Telescope Science Institution (STScI) recommended this level and APD increased the budget to reflect it. Cycle 1 is the only cycle thus far. Individuals with questions about future cycles should contact STScI. Dr. Woodward asked if the support process for investigators might need to be re-evaluated. Dr. Hertz said that NASA will use a different paradigm on Roman, but HST and JWST are pointed instruments. He could consider rethinking the model.

For other recommendations from APAC, there will be a special APAC meeting upon completion of the Senior Review, and much other requested information was to be covered in the current meeting, though the update on SPD-41 policies will occur at the summer meeting. Also, at the summer meeting will be discussion of reviews stemming from APAC recommendations related to the European Space Agency (ESA) activities. These reviews will address misgivings Committee members have about ESA's ability to meet key science objectives for the Athena mission.

Dr. Hertz said that a recommendation to develop a database on flight spares is not practical, but the Division can alert Pioneers proposers to the existence of hardware and technologies. There were several recommendations regarding the Keck Observatory (Keck). NASA is currently reviewing a proposal from Keck after having made the specific requests that APAC advised.

Dr. Louis Strolger told Dr. Odom that the Webb naming is not a good look and there should be continued dialogue on how to do better. Dr. Odom agreed, noting that IDEA is a priority for both the Agency and him personally. In a clarification, Dr. Hertz explained that Sen. Nelson said that at the time he made the initial decision, there was not sufficient evidence to lead to NASA to change the name. However, the historical research was not complete and Sen. Nelson will react to the new research. This decision was painful to some and seems wrong to many, so the information and process will be shared. Dr. Hertz hoped they can be transparent. Dr. Woodward said that APAC wants as much transparency as possible and will invite Dr. Odom back. Dr. Odom said he appreciated their thoughts and input, which he is taking incredibly seriously. He said he understands the importance of transparency.

Budget/Inclusion initiatives

Dr. Hertz next discussed the budget. Earlier that month, APD received its Fiscal Year 2022 (FY22) appropriation, which was almost exactly what they sought. JWST and Roman received the full amount and SOFIA was appropriated despite being zeroed out in the President's Budget Request (PBR). SMD science activation received almost all requested funds. A Congressional explanatory statement should be taken as binding; it states that appropriators were aware of the DS and that NASA should include technology maturation funding in the FY23 PBR. SOFIA has leftover FY21 funds that it can use toward the FY22 amount, which ameliorates the impact on some of the unfunded activities. However, the operating budget has yet to be approved.

Dr. Hertz reviewed the FY23 budget priorities for SMD, including:

- Promote U.S. leadership in Earth system science and addressing the climate crisis;
- Lead Artemis science;
- Champion IDEA;

- Build a balanced and innovative program driven by the highest national priorities, including DSes;
- Advance open science for all by leveraging cutting-edge data science techniques.

APD is leading some of this, specifically the inclusion plans in solicitations and other IDEA initiatives. The Division is expanding dual-anonymous proposal reviews (dual anon), engaging under-represented communities, changing internal processes, and planning to have codes of conduct for both internal and external science teams. Dr. Woodward asked about metrics for dual anon, which Dr. Daniel Evans answered in the WebEx chat. He stated: "SMD has established four success criteria for dual-anonymous peer review: (1) >99% of submitted are compliant; (2) post-panel surveys of reviewers are positive; (3) our external consultants agree that the focus of the discussion is on the science, not the identities of the proposers; and (4) we see a significant reduction/elimination of gaps in the success rate of different groups of researchers."

Dr. Jessica Gaskin asked about activities related to the codes of conduct. Dr. Hertz explained that the Planetary Science Division (PSD) already does this. APD will make it a proposal requirement that teams produce their own codes and will offer a template. This will probably not include how programs and missions are structured, but Research and Analysis (R&A) requires inclusion plans along these lines and APD will add analogous requirements to Announcements of Opportunity (AOs).

Regarding engagement with Historically Black Colleges and Universities (HBCUs), conversations are ongoing and there is nothing to share yet. As for the SMD Bridge Program, funding was not available until very recently. Dr. Patricia Boyd of NASA's Goddard Space Flight Center (GSFC) is on detail at Headquarters to lead this effort for a year. APAC might ask her to address a future meeting. Dr. Shirley Ho asked about the range of under-represented communities NASA is reaching, and if there was more on data workshops. Dr. Hertz said that the data workshops are run by SMD. NASA is talking to HBCUs and other institutions with at least one astronomer on staff. Dr. Kartik Sheth added that they are also engaging with organizations representing minority groups, as astronomers from under-represented groups come from a range of schools. Dr. Manuel Bautista asked about joint programs that do not embrace these principles the same way. Dr. Hertz replied that when NASA leads, its rules prevail. When NASA is not the lead, the Agency negotiates and insists. This is comparable to the NASA open data policy, which most partners do not have and which the Agency negotiates to have when it is a junior partner. In the data science area, SMD is establishing Transform to OPen Science (TOPS), a 5-year activity to change how SMD-wide core data and computing services are managed, laying the foundation for advance data analysis techniques. The Earth Science Division (ESD) leads this for all of SMD.

SMD is doing a good job of managing its portfolio, especially since implementing the 70 percent confidence level requirement. JWST threw it off, but not dramatically so. A graphic showed the SMD-wide impacts of Covid on missions. IXPE was below cost but beyond schedule, for example. For Roman, the cost cap is the commitment, and APD is intent on demonstrating that it has learned from JWST in management of large missions within budget. Roman is still within cost except for Covid adjustments. Supply chain issues and Covid-related impacts effecting many contractors have created a ripple effect that is challenging, but NASA accepted the challenge and it is being managed. Dr. Ho said that in regard to open science and TOPS, her concern is working closely with the broader science community, allowing science to be done by a larger fraction of that community. Another concern is developing data science and software priorities that do not compromise national security. The Agency needs to be careful about such things. Dr. Hertz said he would welcome a request for a presentation on TOPS from the people involved in the project.

The FY23 PBR sand chart reflects the JWST launch and the extension of the Roman schedule due to Covid and supply chain issues. However, the "out-year" notional planning budget has not increased as

much as it did last year. Dr. Hertz then summarized the planned milestones for FY22-23, which include starting JWST science, conducting a Senior Review of operating missions, Explorer selections, the balloon campaigns, selection of JWST Cycle 2 science observations, Integration and Test (I&T) of the Roman coronagraph demonstration instrument, initiating a precursor science program reflecting DS priorities, and participating in launches with international partner missions.

In discussing which budget features have changed and which have remained the same since last year, Dr. Hertz noted the selection of four Pioneer missions. These had made it through the first round of selection and the decision was made to move all four ahead, though this was not a down-selection as such. The budget will reflect this, budgeting for two Pioneers each year instead of one. In order to support DS recommendations for great observatory precursor science and time domain astrophysics infrastructure systems, APD managed to reprogram some money starting in FY23. The FY24 budget will be fully informed by the DS. There is also additional funding for IDEA initiatives. The DS recommends closing out SOFIA, which the FY23 PBR does. The lower total means an extended Phase B for the Compton Spectrometer and Imager (COSI), delayed development for the next Medium-class Explorer (MidEX), and delays in the DS recommended probe AO. The healthy R&A program and continuation of other missions in operation or development are the same. There is not yet a closeout plan for SOFIA, but that plan will include delivery of data to the archives. Some of the feedback about the probe AO schedule was that it was too aggressive, including technology maturation. A delay will address those concerns. The Division was still discussing some of these things.

Decadal Survey
Dr. Hertz is delighted with the DS, which he characterized as "excellent." It sets a lot of hard challenges. The FY24 budget request will be fully reflective of it and APD is working on that now. In the preliminary response, APD has already incorporated the spirit of the recommendation to match elements of the Great Observatory mission and technology maturation plan. NASA already initiated a three-stage plan leading to formulation of an InfraRed Optical UltraViolet (IROUV) mission, but it is not yet time to formulate. Dr. Hertz presented the classification of recommendations from the Large Mission Study report, along with the SMD Large Mission Study implementation plan. APD will go beyond the DS recommendations, and many of the recommendations have already been done on Roman. The path forward requires more spending before Key Decision Point A (KDP-A). There had been rules about technology readiness levels (TRLs) and KDPs, and the DS recommends less of that. For some missions, like JWST, I&T can be more complex than anticipated and that needs to be included in the planning.

There are three stages in NASA's multi-stage planning and strategy approach to the next large observatory mission. The three stages include Stage 1, focus on enabling science and technology; Stage 2, maturation, analysis of alternatives, and trade studies; and Stage 3, preformulation and the decision to start the next great observatory. Dr. Hertz described Stage 1 activities in the areas of science, science evaluation, and technology, noting that they overlap and do not constitute a timeline. Stage 1 relies on teams for science strategy, science evaluation, science development management, technology strategy, and technology development management. This format will apply to all great observatories but not to other missions. Existing NASA technology programs will cover precursor science. Dr. Margaret Meixner noted that each large mission study had technology development plans. Dr. Hertz said that these are being used to formulate a gap list, technology report, concept studies, and long-lead technologies. He expects that in 2 years, APD will do architecture trades and identification of alternatives.

Among other DS recommendations, Dr. Hertz noted one on postdoc fellowships. In 2021, NASA reviewed the NASA Hubble Fellowship Program (NHFP) and is now working on an implementation plan that is responsive to the 32 recommendations of the report. Regarding a research misconduct recommendation, this is outside of APD's purview but the Division is engaged in finding ways to address serious violations. As advised by the DS, APD will analyze and possibly revisit the cadence for the

Astrophysics Theory Program (ATP) calls in order to address the selection rate. The DS recommends ending the SOFIA mission at the end of its current extension, and NASA is working with the German Space Agency (DLR) to develop a joint response. APD is also developing actions to address the DS recommendations about Time Domain Astrophysics and Multi Messenger (TDAMM) astronomy. There will be a workshop in August with extensive participation from international partners and the National Science Foundation (NSF). At this time, Dr. Hertz does not anticipate having dedicated AOs for TDAMM, as there is no budget for it. This is already a second-order criterion, and there are current proposals that include time domain missions. What this might call for is a specific Program Analysis Group (PAG), which was something for APAC to discuss. The DS recommended that there be a science group to help lay out the priorities for capabilities. This should include not just new missions, but also capabilities in existing missions that might be declining and in need of replacement. This will be an area to discuss with both the community and international partners.

Program updates
Dr. Hertz emphasized that IDEA is not a program, it is part of the way NASA does science. He then listed the ways in which IDEA builds an excellent workforce. SMD is also committed to supporting work-life balance. SMD's IDEA initiatives include bridge programs with Minority Serving Institutions (MSIs), IDEA requirements in AOs, and student programs designed to improve access to underserved populations. SMD has asked the National Academy of Sciences (NAS) to examine increasing diversity in leadership of space missions. A graph illustrated the impact of dual anon reviews – these double-blind peer reviews have increased the percentage of new investigators in the Hubble GO program from around 7 percent to over 30 percent.

While expanding dual anon reviews, APD is phasing in the requirement for inclusion plans in R&A proposals. ROSES-22 requires such plans for ~13 program elements, up from two program elements in ROSES-21. For ROSES-21, inclusion plans were evaluated for adequacy and completeness, and feedback was provided to the proposers. However, this feedback was not incorporated into the adjectival ratings or selection recommendations. ROSES-22 has similar evaluation and feedback elements. While feedback is not folded into the adjectival ratings or selection recommendations, selected proposals will not be funded until unacceptable inclusion plans are remedied. The plan for ROSES-23 is that the evaluation and feedback to proposers will continue, with the feedback not included in the adjectival ratings. Starting with this call, however, proposals with unacceptable inclusion plans will not be selected. The goal is to have an acceptable inclusion plan as a steady state for funding.

Dr. Sheth said that he is coordinating the roll-out but is currently dealing with NASA attorneys on some points. Dr. Hertz explained that the criteria were in ROSES-21 and are being refined. Dr. Sheth added that the principles are the same as for dual anon, and APD is pushing on this as hard as possible. Dr. Hertz said that the Division will work to remain legal while striving for excellence. Some of this is the result of APAC input, which is important. Dr. Strolger pointed out that astrophysicists are not experts in what constitutes meaningful inclusion. Dr. Hertz replied that the panels include specialists in IDEA and astrophysicists with expertise in that area. Dr. Sheth is developing a cadre of experts to work on these reviews; he said he welcomes nominations. Dr. Hickox emphasized the importance of ensuring that these experts are appropriately compensated. He asked if other agencies have tried these things. Dr. Sheth explained that NASA is far ahead of most other federal agencies. The solutions have to be implementable and sustainable. Compensation is an ongoing concern.

Dr. Hertz next presented R&A programs by number of proposals, selection rates, and PI notification time. Another slide showed PI proposal submission and selection rates by identified race from 2014 to 2019. Although some in the community believe otherwise, NASA selects High-Risk/High-Impact (HR/HI) proposals in excess of the rate at which they are received. The Senior Review is ongoing and scheduled to produce its report in early May. Soon after that, there will be an APAC teleconference to discuss it.

The Spectro-Photometer for the History of the Universe, Epoch of Re-ionization, and Ices Explorer (SPHEREx) mission recently completed its Critical Design Review (CDR) and has a launch readiness date (LRD) in spring of 2025. Although the total costs remain unchanged, the cost cap has been increased to incorporate cost impacts due to Covid. The mission is making good technical progress. The Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory (GUSTO) mission, a high-altitude balloon effort, is having problems and its future is uncertain. It has fallen well behind and a termination review is scheduled for May.

The NHFP report was made public in January. Of the 32 total recommendations, some are already being implemented. APD is putting together a plan and timeline for discussing and implementing additional recommendations. There have been some outreach efforts, especially to under-represented groups, in order to obtain community input. Past that, there is nothing to share at this time.

Dr. Holley-Bockelmann asked if Dr. Hertz expected Congress to add SOFIA back to the budget again, as has been done each previous year that the PBRs have zeroed it out. Dr. Hertz said that this time the DS recommends termination, which is significant. The FY23 budget funds an orderly close-out. However, he does not want to guess what Congress will do.

Webb Update

Dr. Eric Smith JWST Program Scientist and APD Chief Scientist, provided an update on the mission. JWST launched from Kourou in French Guiana on Christmas 2021, and it became clear immediately that the mission was going well. People were especially worried about the many deployment elements, but they were all successful. Among these are 29 spacecraft elements, including the sunshield, and 24 optical telescope elements. JWST is just over halfway through commissioning, which determines whether things work and have the appropriate calibrations for the science instruments and science modes.

A graphic showed the Mid-Infrared Instrument (MIRI) cooling that drives eventual instrument commissioning. Outgassing should go to non-optical surfaces, which is why MIRI was kept warm. The team was finally able to turn the MIRI heater off and the cooling is proceeding. Another graphic showed temperature by mirror segment. Almost all are at their operating temperatures. An alignment evaluation image of a single star, the “15 minutes of fame,” gave proof that the 18 mirrors can operate as a single unit. Dr. Smith next discussed preliminary performance measures, which match prelaunch predictions and measurements. The commissioning timeline includes thousands of steps. Dr. Smith gave the Near Infrared Camera (NIRCam) as an example in a chart.

So far, the mission is on schedule. Although things are going well, any schedule gains would be negligible, with the possibility of a day or two from a hypothetical removal of extra steps on focusing. Meanwhile, the science cycle timeline now includes some Cycle 2 activities, starting with a call for proposals in late summer of 2022. Media events have gone quite well, generating a great level of interest. Dr. Smith’s presentation included links for social media accounts and other sites, including the popular “Where is Webb” site (https://jwst.nasa.gov/content/webbLaunch/whereIsWebb.html). Finally, there have been activities at various institutions nationwide. In summary, commissioning continues on schedule, all indications are that the observatory is healthy and meeting performance goals, and Cycle 1 science will begin in July.

Dr. Woodward asked about the data downlink. Dr. Smith replied that the communications links have worked as expected, and the pipelines and downlinks are working as expected. He does not it to be a bottleneck. Dr. Meixner asked if anything has not gone as expected. Dr. Smith said that there are always little glitches where a command does not go through as expected the first time. But that is normal in operating a satellite. No one has been stumped by the JWST behavior. Once commissioning is complete,

the plan is to scale back from having a full staff at all times. As for a date on first images, that will occur in July and the team is talking to the NASA Office of Communications. A few milestones need to be met first, but they will have a better sense of this in a few weeks. Once commissioning is done, it will be possible to do science instantly, though there will be preliminary calibration. The data become public when they hit the archive. He has not heard of plans for a bulk release of papers.

Roman Update

Dr. Julie McEnery, Roman Senior Project Scientist, gave the current status of the Roman mission. The main priority is the Wide Field Infrared (WFI) survey. While other objectives incorporate the WFI survey, it is on its own the first priority. Along with the 2.4-meter telescope, there will be a wide field instrument and a coronagraph. The primary mission will last for 5 years, with the goal of extending the mission to at least 10 years. Dr. McEnery reviewed the project status. All items are going well, and the team is doing a lot of flight hardware characterization.

There has been confusion about the budget and schedule, which Dr. McEnery sought to clarify. The Agency Baseline Commitment (ABC) is intended to provide high confidence, usually at the 70 percent joint confidence level. At the same time, the Management Agreement (MA) is controlled by the project, which has different dates. This is essentially the scope, budget, and schedule agreement between NASA and the Roman project, to include the schedule and funding reserves held or controlled by the project to execute within acceptable risk. Unfortunately, Covid impacts on Roman were significant, hitting during the peak funding years and affecting labor. The global supply chain issues created additional problems, and the net effect was a loss of efficiency at every level, from parts suppliers through major contractors. New requirements to address the myriad issues slowed things down further. A schedule replan became necessary, as the critical path had suffered too much diminution.

Roman passed KDP-C and set its baseline schedule in February 2020, right before the pandemic impacts began. The ABC LRD was to have been October 2026, and the MA LRD was set as December, 2025. The covid replan established in May, 2021, increased the lifecycle cost by $382 million and slipped the launch by 7 months, so that the ABC LRD became May 2027, and the MA date was July 2026. These adjustments minimized changes to the risk posture approved at KDP-C. In September 2021, Roman passed CDR. There was a finding that the mission is achievable within ABC cost and schedule with high confidence, but there could be inadequate project reserves within MA cost and schedule. The ABC LRD remains May, 2027, while the MA LRD is now October 2026. In a nutshell, there is more of a buffer, and the risk posture is still green. While it is reasonable to ask if there is cause for concern in I&T, the quick answer is no, though Dr. McEnery does expect to use some of the schedule margin there. As things pop up, this project has been on top of the things that matter. She has complete confidence in how the project is managed. While supply chain issues have been a concern, much of the hardware is in hand and these issues are largely past.

Dr. McEnery next discussed Roman observations and community engagement. Three Core Community (CC) Surveys will address the 2010 DS science goals while providing broad scientific power. These surveys are for everyone. At least 25 percent of the time will be allocated to General Astrophysics Surveys, and this percentage could rise. In addition, there will be 90 days for the coronagraph technology demonstration within the first 18 months of the mission. The team is still developing the CC survey goals with the science centers. Community engagement will involve workshops on Roman's capabilities, among other things. A call will go out for white papers detailing science that can be done with the survey. The mission team wants this to be an inclusive process so that the entire community has a voice in the survey definition process, and therefore will reach out as broadly as possible, with special attention paid to early career scientists and researchers at MSIs and undergraduate-serving institutions.

In the area of evaluation and recommendations, the team hopes to charter a committee to recommend survey definitions based on community input. There will be individual survey committees for each of the CC surveys. A steering committee will include representatives from the individual survey committees and advocates for the general astrophysics surveys. Finally, the team could increase the time for CC surveys. NAS is looking at the balance among the surveys and will weigh in on the degree of flexibility to the community process, possibly in time for APAC's July meeting.

Roman science investigation team contracts ended in 2021 and the draft ROSES solicitation for new teams will go out soon. The intent is to have a range of award sizes and durations. There will be multiple funding opportunities between now and the launch for those at U.S. institutions to work independently or with existing science teams. "Long-ish" stable support of teams will allow development of software, pipelines, etc. Among the opportunities will be WFI science, which will have most of the calls and will entertain proposals of up to several million dollars. There will also be infrastructure teams and a Coronagraph Community Participation (CPP) program. Some activities have already taken place, such as a Science Team Community Briefing in November 2021 and a workshop on exploring the transient universe with Roman in February 2022.

Dr. McEnery concluded by showing the overall timeline, which indicated that the project is about at the halfway point.

Dr. Ho asked about what the community should pitch for in regard to building consensus. Dr. McEnery replied that the team hopes for ideas for surveys that address multiple questions simultaneously. When describing the mission lifetime in terms of survey time, she noted that nomenclature has been an issue, but depending on how one uses it, Roman can be equal to or 1,000 times more efficient than HST. It is intended to maximize the instrument via surveys. The 25 percent for general astrophysics is much higher than what is available for HST; it is not a small amount of time. Eventually, there will be a need to discuss the right way to use the observatory. Dr. Holley-Bockelmann said that the data volume strikes her as a challenge, and she would like more on that in the next presentation. Dr. McEnery agreed but said it is also an opportunity. Roman will have catalogue generation from the science centers and the goal is to make data accessible at a variety of levels.

Balloon Task Force Update

Dr. Thomas Hams, program scientist in NASA's Balloon Program Office (BPO), explained that Astro 2020 made a recommendation for external review that is leading the Agency to establish a Balloon Program Independent Review (BPIR). In reviewing this DS advice, Dr. Hams pointed out the interest in having balloon flights of about 100 days. There was also DS discussion of funding balance. The plan is for the BPIR to be a subcommittee of APAC. It will include science users of the balloon program, a member of the 2020 DS and the PAG 2020 Balloon Roadmap Team, plus costing and project management subject matter experts (SMEs).

Dr. Hams reviewed some of the deliverables. BPIR will prepare a report with findings and recommendations that will assist APD in making the BPO more effective. Among the items listed were a ranked list of the technologies and capabilities needed to enable science investigations and technology maturation in future missions; requirements for launch sites and the characteristics of a healthy campaign cadence, including the number of launches per campaign; the optimal number of R&A balloon investigations with notional funding profiles; the capabilities of commercial suborbital flight providers; and strategies to reduce barriers to entry, particularly for PIs and organizations that are new to the program, including under-represented groups.

Tentatively, the panel chair and members will be selected soon, and a review schedule will be established in partnership with the BPO by the beginning of June. The review team will begin the process by the end

of July, probably starting with a visit to the Wallops Flight Facility (WFF) and the Columbia Scientific Balloon Facility (CSBF) in Palestine, TX. Additional meetings will take place at WFF and/or NASA Headquarters, with draft recommendations presented to APAC in February, 2023, and a final report issued soon after that. The schedule is intended to be in sync with the BPO campaigns. The risk here is that the individuals participating in the review would be SGEs or civil servants, which could present a delay. If that is the case, the initial site visit might have to occur months later. An aggressive approach would affect FY25 activities, otherwise the results will go into effect in FY26. Dr. Hams asked APAC to provide input and to concur with the Review Plan and Terms of Reference (TOR) for the BPIR.

Dr. Gaskin asked for more information on the TOR for the BPIR. She wondered about the BPIR in relation to the existing Balloon Working Group (BWG). Dr. Hams explained that BWG advises the BPO chief. It is possible there could be overlap in membership. Dr. Gaskin thought the BWG would have a lot of insight and ideas, and she was concerned about the BPIR ignoring their work. She asked if there would be any synergy between the two groups. Dr. Hams replied that the BPO is loathe to overprescribe what the review team should do. They can establish their data sources and can talk to the BWG. Dr. Hertz added that the BWG cannot give advice, just technical analysis. The BPIR can advise. Dr. Hams agreed. In answer to a question about data archiving, he explained that there is an SMD requirement to archive data for broader analysis, so if this review panel wants to provide input, they are welcome to do so. Dr. Erika Hamden asked if they will consider the level of support to do all of these activities. Dr. Hams replied that the committee should identify characteristics of a healthy program and advise NASA on a direction to proceed to have those capabilities. Dr. Hickox noted that the DS calls for the BPO to develop technologies for future missions. He wanted to know if there is explicit treatment of that aspect as part of this review, and if the effort will look at how well prior missions have done in that regard. Dr. Hams reiterated that it is important to not overprescribe. Balloon programs are meant to advance technologies readiness, but not primarily to develop technology. BPO wants to address excellent science, have technology maturation, grow the next generation of scientists, and make the science available to the public. The panel could look back at lessons learned. Dr. Woodward asked APAC to review the TOR that evening.

Covid affected the balloon program, especially in Antarctica, and other launches were delayed as well. However, the BPO had a significant number of achievements, which Dr. Hams listed on the slides to conclude his presentation.

Sounding Rockets Program Update

HPD manages NASA's Sounding Rockets Program for SMD; Dr. Hams is APD's point of contact. He observed that there have been some changes long in the making. NASA hopes to make commercial suborbital platforms available to SMD-sponsored investigators alongside NASA-provided platforms. Currently, there are several NASA-provided avenues for suborbital launch vehicle platforms. These include sounding rockets provided by the NASA Sounding Rockets Program Office (SRPO), which operates out of GSFC and WFF. New for ROSES-22 will be commercial rocket-powered vehicles and high-altitude balloons procured through NASA's Space Technology Mission Directorate's (STMD) Flight Opportunities Program (FOP). Proposers have the option of providing their own commercial suborbital launch vehicles, though NASA retains final authority regarding which vehicles can be used. Such proposals may end up being two steps. Dr. Hams provided the language from ROSES-22 addressing this change, noting that there are some exciting commercial options at lower weights and altitudes.

Suborbital payloads serve as microcosms of larger missions. While the risk is greater than for most other types of missions, NASA accepts this risk because the cost is comparatively low. These efforts are PI-led, with the PI specifically controlling the mission from proposal through to publication, though NASA controls the platform and launch operations. Engagement of students in all aspects is key, and mission lifecycles are meant to encompass graduate school tenure. The value of these missions lies in building the

instrument and carrying out the mission, with defined new science and TRLs at flight level (TRL-7). Although the risk of failure is more acceptable and emphasis is on lessons learned, more advanced missions may call for systems being tested prior to deployment.

Dr. Hams showed NASA's 16 sounding rocket vehicles and a graph comparing their performance by altitude and payload weight. He also presented a map of worldwide launch locations that APD sounding rocket investigations can use. Of particular interest to astrophysics is Australia, which will host a sounding rocket campaign in 2022. While NASA had previously launched from Woomera, then quit Australia altogether for a while, for several years now SRPO has been working on plans to use Equatorial Launch Australia (ELA) in the northern part of the country. Australia implemented strict entry requirements during the height of the Covid pandemic, which slowed this effort. However, in fall of 2021, a team of 27 from WFF deployed to ELA to install the mobile NASA launch support equipment. At that time, Australia required a 14-day managed self-isolation to enter, and SPRO has additional requirements of its own. However, soon the various restrictions are likely to become lighter or removed altogether. Dr. Hams described the infrastructure set-up process, adding that some of these things were subject to the International Traffic in Arms Regulations (ITAR). He gave the campaign schedule, with payloads ready to ship. The plan is to launch three payloads from ELA during a 3-week window in June and July of 2022. Assuming this goes well, SRPO hopes to launch from ELA more than once a decade. Additional launch sites are coming online, including others in Australia. Dr. Hams closed by showing the astrophysics sounding rocket manifest.

Dr. Woodward asked how, in light of its impact, the SRPO tracks science impact and the progress of the participants. Dr. Hams replied that his extensive backup slides include all of this, but there is no formal process. Dr. Woodward then asked if the Biological and Physical Sciences (BPS) Division will have sounding rocket opportunities now that it is part of SMD. Dr. Hertz explained that the BPS science niche is the microgravity environment, so all of its research is aimed at the International Space Station (ISS) and other flight opportunities that provide microgravity. Dr. Hams noted that they also study radiation effects, and balloons do provide that capability. Some BPS payloads have gone up on balloons. Regarding commercial providers, some, like Blue Origins, allow investigations to piggyback on a launch, especially investigator-tended payloads.

Public Comment Period

The public had an opportunity for comment. Dr. Holley-Bockelmann read the top-ranked question from the public portal. It stated that in 2021, an outside expert found that not all of Mr. Webb's decisions and actions during his government service align well with current societal and NASA expectations and values today. Thus, it is appropriate to rename JWST at this juncture. The question was why this name remains. Dr. Hertz responded that that input was used by the NASA Administrator in his decision. People can reference the earlier discussion.

The next comment stated that the handling of the situation has severely undermined community confidence in the NASA and APD commitment to diversity and asked what will be done to fix this erosion of community confidence. Dr. Hertz said that there will be more information after the historians complete their work. There may be a need to further revisit this. The third question was "Does NASA not realize the continuing and increasing damage their position on the naming on JWST continues to have to the LGBTQ+ astronomy community?" Dr. Hertz explained that he personally recognizes the damage, and many at NASA also recognize it, but he could not speak for the Agency.

Another question asked if there will be a larger survey with members of the astronomical community (including LGBTQ members) on the JWST name change. Dr. Hertz replied that that is a reference to an email he wrote. He spoke to many members of the LGBTQ community. The question was, what did other parts of the community think? Dr. Hamden observed that is seemed like this decision was made by Mr.

Nelson and wanted to know if he would be speaking to APAC or others about it. Dr. Hertz said that Mr. Nelson has not spoken to the press about this decision and Dr. Hertz does not expect him to speak in public about it or address APAC.

Ms. Joy Wilson Skipper said that it feels like there is a lack of information on what has been looked at, and she wanted to know if there will be a release about the sources, etc. Dr. Hertz said that Dr. Odom said there would be, but he himself cannot speak for Dr. Odom.

Ms. Marufa Bhuiyan asked about opportunities for engagement, specifically for international consultants and other individuals. Dr. Hamden asked Ms. Bhuiyan to email her. Dr. Sheth added a link in the WebEx chat: intern.nasa.gov.

Dr. Holley-Bockelmann read another question, asking about plans to improve interagency coordination given that the budget might not fit the ambitious DS. Are there plans for reducing overall costs to achieve a whole-government approach? Dr. Hertz explained that many of the DS recommendations were aimed at a single agency. Those agencies will respond to those recommendations. If all the agencies are U.S. federal government agencies, spreading the work among them does not reduce the U.S. federal budget costs. Generally, single agencies pay for the expensive projects. Where the common community is affected, as with data archives, for example, the agencies do coordinate extensively. The Astronomy and Astrophysics Advisory Committee advises the federal agencies involved in astrophysics research, and specifically focuses on coordination among those agencies. Dr. Holley-Bockelmann added that Multi-Messenger Astronomy (MMA) has come to the fore and will probably require inter-agency cooperation. Dr. Hertz agreed. The DS made a recommendation about MMA to NASA only to address TDAMM follow-up. MMA is intrinsically multi-agency and multi-national.

Dr. Woodward closed the session by noting that there would be more opportunities for public comment the next day.

Discussion

Dr. Woodward asked what other communities are doing in TDAMM. Dr. Hertz said that it is early, and a workshop is planned for August. Dr. Hickox said that there has to be some kind of interagency cooperation. Dr. Hertz explained that there is not yet a group to set priorities on capabilities. However, when capabilities are launched into space on the assumption of alignment with ground-based facilities, coordination will be needed to ensure that everything works together. Those conversations have not yet occurred. He will need community input on priorities. The Explorers program is a great place to propose new capabilities and generates innovative science proposals. Dr. Holley-Bockelmann noted the need for common standards among the agencies to combine data that are quite different. Dr. Hertz agreed, pointing out that the DS made recommendations about interoperable data.

Dr. Gaskin observed that there are currently TDAMM-type missions throughout the portfolio. There could be a mission that coordinates among missions rather than providing its own data, and having the community look at this would be valuable. Dr. Strolger said that the time domain astronomy capability encompasses a wide spread of factors, and he was not sure if a working group would be best. Dr. Hertz replied that that is what NASA wants to learn from the August workshop. There are so many ways to look at the landscape. The workshop will help identify the path forward. While there is a need to set priorities, he wants the community to do that. There will be a workshop report. Dr. Valerie Connaughton added that there will be a white paper from the workshop; NASA wants the workshop to precede the formation of the group. Dr. Ho pointed out that this will include capabilities beyond engineering, such as software. The next great observatories will need to coordinate. Dr. Hertz said that this will work with Roman and the Rubin observatory. Dr. Meixner said that IR is less developed on time domain, so it would be good to get that perspective.

Dr. Woodward said that there are great scientific opportunities for the future. APAC might want more Roman discussions and will look forward to JWST images. NASA needs to ensure the community can benefit from all of these assets, and he thought NASA needs to address how to best work on these missions. Dr. Hickox added that their field has a huge variety of team sizes and coordination styles, which gets to the question of how to fund all of this to be most effective scientifically. A full accounting would probably be a useful conversation. Dr. Hertz said that APD wants to be responsive, but the community needs to inform the Division about which groups call for support.

Wrap up for Day 1

Dr. Woodward asked the APAC members to spend the evening thinking about recommendations or findings and forward them to him and Dr. Holley-Bockelmann. He asked that they also review the TOR for the balloon task force.

The meeting adjourned for the day at 4:59 p.m.

Thursday, March 31

Opening Remarks

Dr. Hasan opened the second day of this virtual APAC meeting by reviewing the FACA rules and explaining that the meeting was being recorded. There was to be a public comment period in the afternoon. Dr. Woodward added that an electronic dashboard was open for those wishing to comment.

Archives Modernization

Dr. Linda Sparke discussed archives modernization efforts. The DS cited the importance of sophisticated archives, and in its October 2021, meeting, APAC advised APD to identify appropriate cloud-based infrastructure options that will facilitate analysis and theoretical modeling of large data volumes from upcoming large missions. The astrophysics data landscape is growing increasingly complex and the priority on multi-wavelength observations will only expand that complexity moving forward.

As the field generates more and better data, astrophysics archiving capabilities will come under strain. While data volumes double roughly every 2 years, and ability to manipulate the data on a standard laptop does not keep pace. Dr. Sparke reviewed upcoming large data set scenarios from Euclid, Roman, Rubin, and MMA. She noted that Rubin will release a final data set that is about three times what is currently in the archives. Science often requires analyzing data along with simulations, especially for cosmology. Artificial Intelligence and Machine Learning (AI/ML) will call for computing resources close to large data sets.

The Astrophysics Science Platform includes three components: a cloud-based interface and system rooted in open-source software; notebooks and pre-configured software containers for multi-wavelength and big-data science so each scientist does not have to reinvent these things from scratch; and advanced data services that allow investigators to find the data that they need, which are not all in the NASA archives. The community needing access will include those requiring server-side analysis for large amounts of data; those needing computational facilities for big data analytics, ML, etc.; collaborators at different institutions wishing to share a computational environment; scientists who cannot easily build the software locally that they want to use; and others. Many of these individuals are in academia.

Dr. Sparke then reviewed user requirements for the cloud-based interface, as well as notebooks and software containers. Dr. Woodward asked how NASA requirements for cloud service providers and data might apply to external teams wanting to use this or wanting to supply a notebook. Dr. Sparke said that these discussions are occurring now with the Agency's cloud experts. It is not yet clear how astrophysics

will do enable non-NASA users, but it is being done for some science users already. Three groups currently run the NASA cloud environments. One of those supports users with high-end computing (HEC) allocation: once a user has an HEC allocation, they can use a cloud allocation. NASA has to know something about users in order to give them HEC accounts, which now requires a NASA-funded research or project award. Dr. Woodward said that the research award seems to be the key entry point. Dr. Gaskin asked if these resources will be accessible internationally. Dr. Sparke replied that international investigators would have to be part of a NASA-supported team in order to have access to HEC. ESD is the most advanced on this, on two fronts. First, they simply serve data to users, including commercial entities, in a fairly unrestricted sign-up that encompasses international researchers. Members of NASA-funded teams are eligible to receive HEC accounts. Dr. Ho asked about missions like Rubin, which is worldwide. Dr. Sparke said that that is still being discussed. The data have always been open. APD expects to have two classes of users: most that are allocated relatively few resources, but if an entity wants to use significant NASA resources, someone will need to decide whether the work has value to NASA. The Agency cannot let anyone do everything.

Dr. Meixner asked about the ability to explore before writing a grant proposal. Dr. Sparke explained that other than excluding bots, NASA should not have to know much more about those who want minimal resources, to explore. On the other hand, getting data out costs money and so cannot be unlimited. Dr. Bautista pointed out that a lot of responsibility comes with providing users with basic code and notebooks. There will also be needs for support, mechanisms for addressing mistakes, etc. Dr. Sparke compared this to reduction tools for mission data. The notebooks will have to be curated for sustainability. Dr. Hickox observed that there is a cultural difference within astrophysics for end-stage analysis versus mission-reduction data. It is important to recognize what differs from the user tools that are offered now, which may require an investment. Dr. Sparke said that for user-contributed tools, NASA would need to be clear about what is and is not curated. She then described the user requirements for advanced data services.

The near-term goals, for FY22-23, include making some high-priority NASA datasets available in Amazon Web Services (AWS) Simple Storage System (S3) buckets. S3 offers fast access to data needed for computations. Other near-term goals include development of a Python software layer for cloud-based data access, integrated with standard tools; prototyping of a public user interface based on JupyterHub on the NASA AWS cloud; and development of an initial set of Jupyter notebooks (a web-based interactive computing platform) for both data in the cloud and data held on-premises. A 5-year plan is under development; Dr. Sparke listed some preliminary goals.

APD initially thought they would be following work done in ESD, but in fact much of APD's work requires starting from scratch. APD is funding the data archives to bring on more staff for this effort. Dr. Woodward asked if commercial providers might supplant the mission archives. Dr. Sparke explained that data must still be curated, else they will become unusable regardless of where they are held. The team for this effort is drawn from the three archives. Putting data on the cloud calls for a lot of decisions. There are needs for records of catalogue files, for example, to ensure data can be moved in and out and not lost.

Dr. Woodward said that the output from large simulations would have to be served through the cloud and asked about the thinking around that. Dr. Sparke called up slide 12 in her presentation, showing results of a pilot project. It is now possible to go to the InfraRed Science Archive (IRSA) to look at the mock catalogue (https://irsa.ipac.caltech.edu/Missions/cosmodc2.html) from a large simulation run for the Rubin Dark Energy Science Collaboration. Dr. Ho was concerned about NASA having the right people with knowledge of ML, AI, and notebooks. She also had concerns about the Agency having the right tools. Dr. Sparke said that NASA wants the science community to decide what science problems should be attacked in this way so that the Agency can provide the capabilities. In answer to another question, she

explained that the cloud contracts are held by NASA as a whole. The initial level of resources for each user is controlled via allocations of use.

COPAG/PhysPAG/ExoPAG Updates
The PAGs provided updates.

Cosmic Origins Program Analysis Group (COPAG)
Dr. Janice C. Lee explained that she recently took over from Dr. Meixner as Chair of the COPAG Executive Committee (EC). The APD PAGs' organizational structure has altered a bit in the last year. The analyses with the greatest benefit will recognize the shift in the science landscape, and future activities have to adjust. Within COPAG, members should represent the breadth of Cosmic Origins (COR) science and technology. Dr. Lee then reviewed some of the PAG's recent activities and discussed EC membership.

COPAG has had two active Science/Technology Interest Groups (STIGs), for IR and UV, for a number of years. Dr. Meixner's EC initiated some new Science Interest Groups (SIGs) in anticipation of Astro2020. Two SIGs, one for Galaxies and the other for Stars, Sun, and Stellar populations, are now active but still awaiting some approvals. Common activities of all STIGs and SIGs are monthly talks. Dr. Lee then detailed some of the highlights from the IR STIG, which typically has high attendance at its monthly talks. These are also available online.

The UV/Optical Science STIG held a workshop in January to discuss the DS impacts, along with the likely workforce impacts. There was also a Quorum for Ultraviolet Exploration of Science and Technology (QUEST) seminar in February that identified an initial 26 gaps, distilled down to 8; these were forwarded to APD along with a summary of the process. The Stars SIG began developing its distribution list, submitted its TOR, and is hosting a webinar series every 2 weeks. The Galaxies SIG began in late 2021, with monthly presentations and community discussion. This SIG will identify some of the science gaps en route to fulfilling the DS.

Dr. Lee next discussed COPAG's American Astronomical Society (AAS) community engagement efforts. The plan is to have a joint meeting with the other PAGs at the June AAS, followed by a COPAG splinter session. At the COPAG annual meeting, the SIGs and STIGs all held virtual meetings. COPAG is working to broaden participation, including involvement in the Society for Advancing Chicanos/Hispanics & Native Americans in Science (SACNAS), the October 2021 National Diversity in STEM Digital Conference, and the November 2021 meeting of the National Society of Black Physicists.

COPAG seeks to determine how to best support and inform NASA astrophysics leadership in the rapidly changing world and scientific landscape. A schematic illustrated the basic flow, which incorporates inputs from the SIGs and STIGs to identify precursor science. To ensure depth and breadth, COPAG will need to follow this flow while pursuing integration with the other PAGs. The DS gives strong emphasis to foundational elements, including data archives, workforce, and issues in the greater world. To that end, COPAG hopes to do analysis of challenges like recruitment and retention of software engineers, who are better compensated in other professional environments. This particular challenge reflects a delayed uptake on modern data, which is a gap in Astro 2020 as well. Concurrent needs are for greater open access and sharing.

Dr. Woodward agreed that the data scientist/software engineer issue has to be addressed seriously, as there is a large gap. He looks forward to COPAG thoughts on those. Dr. Strolger asked if APAC needs another PAG to deal with these issues or if there should be a subgroup within COPAG. Dr. Lee replied that any effort should be across the PAGs, as it affects them equally. APAC recommended that PAG leaders meet regularly, and they will likely be crafting a draft TOR. The solution must be systemic, with

partnerships from industry and others. Dr. Ho asked if there might be a training solution employing AI/ML tools to help address the software scientist and engineer retention issue. Dr. Lee said that there must be a distinction in people who are hired but understanding how best to use AI/ML is also a big gap within the community, which needs more expertise.

Physics of the Cosmos PAG
Dr. Grant Tremblay, Chair of the Physics of the Cosmos PAG (PhysPAG) EC, began his update by listing activities since APAC's October 2021, meeting. These include SIG meetings, EC review of the Physics of the Cosmos (PCOS) technology gap list, an event at the AAS High Energy Astrophysics Division (HEAD) conference, proposed new Science Analysis Groups (SAGs), and more. The X-Ray SIG held a discussion during AAS HEAD to consider the future of x-ray astronomy in light of Astro 2020.

The DS heavily cited PhysPAG's Great Observatories report, which shows the combined science case for multiple observatories in concert. PhysPAG now sought a new Great Observatories SAG to cut across the PAGs, following on the previous effort. Ideally, this SAG will be open to a broad and diverse swath of the science community. The chairs of the other two PAGs are aligned with this proposal. It would address four key points, to: examine key questions unanswered by current missions; synthesize notional science cases for a future fleet of great observatories; identify science gaps that might be of impact should the future great observatories not fly simultaneously. Astro 2020 also recommended a TDAMM program. Dr. Tremblay noted that all three PAG ECs were interested in starting a cross-PAG TDAMM SAG to provide analysis for this program. Dr. Tremblay noted that Astro 2020 did not recommend mission architectures, possibly by design. PAGs can do some of the analyses of alternatives in order to answer questions about the various proposed flagship missions. The PAG chairs will be meeting with Dr. Hertz soon to get his vision of the PAG role.

Dr. Holley-Bockelmann emphasized that time domain astronomy is part of all astrophysics, so maybe it should not be siloed. Likewise, MMA could be incorporated into the Great Observatories SAG. Dr. Tremblay agreed, stating that the walls between wavelengths are blurry now, and time domain has roots in all three PAGs.

Exoplanet PAG (ExoPAG)
Dr. Meyer, Chair of the ExoPAG EC, listed the committee members, noting that they are striving for diversity and seek members of under-represented groups. His term as chair ends in a few months. He then described ExoPAG activities since the October 2021, APAC meeting. The community and EC gave input on the the technology gap prioritization exercise. It could be that this exercise may need to occur again this year in the context of Astro 2020. He reported to the Planetary Science Advisory Committee (PAC) at their recent meetings. The EC is reviewing reports from existing SAGs and SIGs, while also considering proposals for new SAGs and SIGs. They coordinated with the other PAGs and gave support for precursor science workshops. ExoPAG also had a meeting with the Nexus for Exoplanet System Science (NExSS) research coordination network on Quantitative Habitability; this group mostly draws from planetary, but there are shared interests. Dr. Meyer showed the ExoPAG 25 agenda, noting that the PAG always invites young scientists to present at these meetings.

There are two long-term SIGs, addressing exoplanet demographics and exoplanet solar system synergies. Two SAGs, on stellar contamination on transit spectra (SAG 21) and exoplanet host properties (SAG 22), have submitted their final reports. ExoPAG is proposing to start SAG 23, Exozodi and Debris Disk Properties of Exoplanet Hosts. Dr. Meyer explained the ongoing SIG activities and summarized the two SAG reports, which had many contributors who provided good science questions and valuable analyses.

An area that calls for more careful investigation is that of exozodiacal dust in the context of future flagship imaging missions. While some work has been done in this area, much remains to be done and it

is time to revisit the topic. If approved, SAG 23 will review the current state of knowledge for warm zodiacal dust in the solar system and around nearby stars, to report on the current state of knowledge as obtained from current measurements. The SAG will also determine what knowledge gaps may be pertinent for future work and will identify potential mission methodologies. Findings could address methodological uncertainties, disk systems that might be studied to better understand the phenomenon, and risk retirement.

Therefore, Dr. Meyer was asking APAC to approve the final reports for the two SAGs that have completed their work, and to accept the TOR for the new SAG.

Dr. Woodward said that Dr. Hertz would decide on the disposition of SAGs 21 and 22. He asked if the heliophysics community had had any input to SAG 21. Dr. Meyer confirmed that some individuals had weighed in, and he would like to continue communication with that community. Dr. Meixner asked about the possible involvement of COR people in the proposed SAG. Dr. Meyer said that anyone who would like to be involved will be welcome and there is already some cross-pollination on the existing team.

Expanding Participation in Astrophysics

Dr. Hickox, Chair Emeritus of PhysPAG, explained that a large portion of the DS report is dedicated to the state of the profession. Special attention was paid to the historic barriers of race, gender, class, background, and identity. Astrophysics, like nearly all of the other sciences, still has a long way to go in dealing with systemic inequities. The inordinate pressures within the field are particularly intense for students, early-career scientists, and individuals from marginalized communities. Therefore, astrophysics must attend to the structures of the career pipelines and the workplace environments.

Conversations are ongoing as to how to respond. In the meantime, the PAGs have been actively participating at events sponsored by groups such as SACNAS and the National Society of Black Physicists. In part, these efforts illustrate NASA astrophysics science and provide information on how to get involved. At the same time, it is also important to remove structural barriers, as discussed in the DS. NASA needs to rebalance budget priorities to reflect this. Consistent funding for promising programs has been an issue, making it hard to know how to build on successes.

The cross-PAG group on this topic has taken some time to get traction due to personnel changes and other activity, but the proposal is finally ready for the proposed SAG, which would be called Astrophysics With Equity: Surmounting Obstacles to Membership (AWESOM). The SAG will include scientists from a diverse range of backgrounds, science interests, and institutions. The TOR will focus on optimal practices for funding, supporting, and assessing programs to maximize their impact on expanding participation.

As stated in the DS, NASA has funding issues related to programs that are not consistently measured for success or even continued. The TOR will address this, with the goal of determining how members of under-represented groups engage with NASA and what means of engagement do and do not succeed. A 2021 NASA RFI on racial equity and support for underserved communities generated about 80 responses relevant to NASA's structure.

The PAGs were asking APAC for feedback before moving further with the draft TOR.

A related issue was that NASA had recently discontinued a pilot program encouraging people to provide their pronouns, despite the great enthusiasm the project generated at GSFC. Termination of this project has resulted in a significant amount of criticism, especially since no reason was given for ending the program. The result, along with the Webb naming controversy, has led to decreased trust in NASA.

Moving forward, the PAGs want to continue engaging the community on these concerns. There is a proposed session for the AAS summer meeting, though organizers have indicated that meeting space could be an issue. Based on APAC feedback, the PAGs want to complete the TOR.

Dr. Woodward said he liked the focus on the how and why of program success and discontinuation. A model that came to mind was the NHFP. He asked how the redirection would work in that context. Dr. Hickox said that the first step is fact-finding. While NHFP has been around for a long time, it has been otherwise difficult to understand the landscape while developing the TOR. The PAGs want to know the resources available to those from small institutions or under-represented groups to access NASA resources. The TOR team is learning of other facets they were not aware of, so this would help develop a clear picture in order to direct the path.

Dr. Meyer raised the possibility of doing a survey, which can be difficult. He asked if it would be useful. Dr. Hickox said that at this juncture, the team wanted APAC feedback. They have received different views on the value of gaining more information from scientists versus the programs. Dr. Meyer said he worries that they need to ask those who experience the problems, but maybe the team has that information. While he would opt for a survey, the need is to move sooner rather than later. Dr. Holley-Bockelmann said that she is involved with Fisk University, an HBCU. Fisk has a lot of access issues, and some of that is access to technology resources. It is important to recognize how much basic infrastructure these institutions need in order to participate. Dr. Hickox said that another angle is to identify what they can do without that infrastructure. For example, x-ray astronomy is not resource-intensive. Perhaps it is best to approach from both directions: access to funding, and what they can do with what they have.

Dr. Strolger said that the effort is worthwhile, but he was worried about the proposed SAG having too narrow a focus. He would welcome more ideas. Dr. Gaskin asked about the timeframe and exactly who the target will be: existing scientists, students, or others. Dr. Hickox replied that the charge was to focus on something that is actionable, which seems to be research and training for research. The aim was to see how people come to engage with NASA research. So, the targets will be undergrads, grad students, postdocs, and faculty who want to do research or help students do research.

Dr. Bautista pointed out that APAC had previously discussed how the difficulties of pulling in under-represented communities begins at the family and community levels. He asked how the SAG might work with community science programs. Dr. Hickox acknowledged that this is important. It gets back to the SAG's scope. If it is access to research, that comes later than community programs. People need to be in an academic or scientific setting to do research. However, ommunity programs could be an element.

<u>Aerospace Study on Astrophysics Technology Heritage</u>

Mr. Marc Hayhurst of The Aerospace Corporation (Aerospace) described an independent study of APD's technology heritage. The goal was to understand the how APD grants impact astrophysics technology advancement. Mr. Hayhurst acknowledged the participation of the Division's Chief Technologist, Dr. Mario Perez. The study, which began in mid-2021 and issued a midterm report in the fall, looked at the grants database of competed astrophysics technology grants from 2009 to 2020; space and suborbital missions from 2010 onward; and a survey of more than 300 technology grant recipients between 2009 and 2020. Data analyses were conducted in each area separately, then cross-referenced. Non-technology development grants were included only in the general trend analysis. The study did not include directed technology investment.

The study found that astrophysics grants and contracts funding results in a healthy 62 percent infusion rate. About half of these were suborbital missions, which traditionally offer science and technology maturation opportunities. However, the technology development lifecycle typically exceeds 10 years. The study also found that grant awards have numerous benefits beyond the primary purpose, such as student

development and lab/infrastructure funding. Lack of opportunity for space missions was the top reason PIs gave when infusion did not occur. Analysis of which organizations receive grants found that of the 120 grant recipient entities, most have had only 1 grant, while 19 organizations account for 58 percent of all grants. The top two recipients were GSFC and the Jet Propulsion Lab (JPL), which together received almost 20 percent of the grants.

Mr. Hayhurst showed pie charts with breakouts by program from the grants database. Of the 801 grants included, two-thirds went for the Astrophysics Research and Analysis Program (APRA), followed by Strategic Astrophysics Technology (SAT), Future Investigators in NASA Earth and Space Science and Technology (FINESST), Roman Fellowships, and others. The missions database evaluation of 123 missions and 207 instruments included those yet to be flown and international missions to which NASA contributed. The grant infusion analysis found that only 6 percent of the sufficiently matured technologies were not infused. Infused grants were most likely to contribute to flown/past missions (89 of 285 grants, or 31 percent), followed by missions in pre-formulation (72 grants, or 25 percent). Five grants were infused into non-astrophysics missions, and some are in development. Mr. Hayhurst gave the Compton Spectrometer and Imager (COSI) as an example of how infusion might occur. In looking at the types of organizations receiving grants, the study team found that only 6 percent went to MSIs.

Dr. Strolger said that while the study was very thorough, it gave no clear sense of how it meets program officer expectations. He wanted to know if the narrow organizational spread is intended, an area of concern, or a capability factor. Mr. Hayhurst said that it was interesting to see the distribution, which the study team discussed. He pointed out that there were no HBCUs among the MSIs that received grants, which goes back to the access question. Dr. Hickox was interested in what did not get infused as well. The main reason given was lack of an appropriate mission, but he wanted to know if there was anything else. Mr. Hayhurst replied that the team discussed this with Dr. Perez and it is something that warrants a further look. There is the timeline to consider as well. Dr. Holley-Bockelmann asked if there had been analysis of the first-time recipients versus those obtaining multiple grants. That could contain important information, including about demographics. Mr. Hayhurst replied that the team did not have a chance to study this and did not have the demographic data.

ExoExplorer Program

Dr. Tiffany Kataria of JPL discussed the ExoExplorer Program, which is fairly new and came about during the tumult of the pandemic and the protests of 2020. The three core pillars are visibility, inclusion, and science. Inclusion is a NASA core value that seeks to amplify the science of early career scientists, especially those from under-served and under-represented communities. ExoExplorer serves the broader exoplanet community, enabled by the Exoplanet Exploration Program (ExEP) and ExoPAG. The intent is to have an inclusive program enabling early career cohorts to build networks, amplify science, and grow professionally. To that end, the team is having careful discussions about recruitment, advertising, and evaluation and be inclusive of applicants that can develop science-enabling technologies in addition to conducting pure research. Applications were evaluated by three criteria: Science; Diversity, Equity, and Inclusion (DEI) experience and leadership potential; and cohort participation ideas (i.e., what activities/ideas might they bring to the cohort experience). All applicants have the option of a 30-minute debrief on their applications. The Steering Committee (SC) and Organizing Committee (OC) have had weekly meetings since July 2020, to move the program forward. The first call for applications was released in October 2020, with selections made in December and a fully virtual meet-and-greet in January 2021. The virtual environment has allowed activities to occur much faster than they otherwise might have.

The ExoExplorers Program is not only responsive to Astro 2020, it was addressing DS recommendations before the document was released. Dr. Kataria reviewed the pertinent DS recommendations, which overall call for increased funding of training grants for students, along with greater investment in

professional workforce diversity programs. Implementation of bridge programs should seek to address transition junctures throughout the higher-education pipeline and into the professional ranks.

Program components include a speaker series, professional development activities, and internal network building. Dr. Kataria described the speaker series, in which each cohort member gives a 30-minute public virtual talk over the course of 6 months. There are also one-on-one meetings with prominent scientists of the members' choosing, coordinated by the OC. The ExoGuides are prominent exoplanet scientists who speak with the cohort directly. The program averaged 60 applications for each of the 2021 and 2022 cohorts. Because this is done virtually, the program is expanding to international ExoExplorers and ExoGuides, while growing the cohorts to include a maximum of 12 participants. Cohorts are debriefed, the conclusion of the program, providing lessons learned. It is important to have more two-way engagement and to learn from the cohort members. One goal is to eventually add an in-person component.

The next component, professional development, offers workshops based on topics identified by the cohorts. Dr. Kataria gave some examples. There are also panel discussions and meet-and-greets with NASA program officers. Some of the Exoguides were on Astro 2020 panels, including the State of the Profession, and plans are underway to discuss this in a panel format. There are also plans for a panel on career paths. Finally, Dr. Kataria described the elements of building internal networks.

As this is a new program, the SC and OC sent anonymous surveys to cohort members at the beginning and end of the program and provided additional avenues for anonymous feedback. The 2021 cohort closing survey indicated an overall positive response in providing visibility and connections, networking, and resources for a support system. The members sought meetings with IDEA decision-makers at NASA, in-person events, more science talks, guest lecturers on advancements in the exoplanets field, a "state-of-the-field" discussion that addresses technology and career paths, and greater effort to reach broader communities. The organizing team is following up on all of these.

In summary, the ExoExplorers Program created an opportunity for early career scientists to engage at a time when such opportunities were limited. The virtual environment allowed the organizers to rapidly implement a nationwide program. The second cohort is now underway, and plans are being made for the third to start in early 2023. The ideal cohort size appears to be about 10. Students are compensated for their presentations.

Dr. Strolger praised the program but expressed concern about the small size. He wondered if they might expand some of the workshops. Dr. Kataria replied that both the size and possible workshop expansion are being discussed. The team would like to expand where possible, though balance is important. Dr. Gaskin said that expanding to other PAGs would be a great idea, getting this program on multiple fronts. Dr. Holley-Bockelmann asked if the one-on-one discussions with scientists were separate from the Exoguides. Dr. Kataria said that they are separate. The scientists are people from the community who are vetted. There have been some suggestions that did not go forward.

<u>R&A Update</u>

Dr. Stefan Immler, Lead R&A Program Manager, began the R&A program update by crediting the APD program managers. Between March 2021 and March 2022, APD received more than 4,500 proposals, about 1,000 in R&A and the rest related to missions. The overall selection rate is about 25 percent, and 80 percent of PIs receive notification within 150 days. Since the 2010 DS, R&A research funding has grown 47 percent. ROSES-22 was released in February 2022. As a result of Astro 2020, the Astrophysics Decadal Survey Precursor Science (ADSPS) program under Supporting Research and Technology will have an amendment soon. ADSPS is one of seven program elements in which proposals will be required to have a plan to create and sustain a positive and inclusive working environment. Six program elements will be evaluated using Dual Anon peer reviews.

Dr. Immler showed the balance of the various program elements in a series of pie charts. APRA accounts for just under half of the funding; half of APRA funding is invested in suborbital programs, and 70 percent of funding for suborbital programs goes to universities. A sand chart depicted funding over time by wavelength, also breaking out Cubesats. Starting in FY15, APD began launching Cubesats in earnest as a result of dedicated funding. Specific Cubesats of note include HaloSat, the Division's first cubesat under this program. It deployed in 2018 and re-entered in 2021. CUTE is currently in operation and will complete its mission by the end of 2022. Star-Planet Activity Research CubeSat (SPARCS) was halted a few years ago but has been restarted. Maturation of Instruments for Solar System Exploration (MatISSE) could be a good ML tool.

In looking at Astro 2020 recommendations, APD is in agreement and moving ahead with many of them. However, the DS called for NASA to augment and restore the annual proposal calls for ATP. APD sought APAC feedback in this area. There are several options under consideration, including: keeping the biannual solicitation, which has a selection rate above 20 percent; changing the solicitation to annual, which would likely result in a lower selection rate unless there is a funding augmentation; and adding a solicitation targeting early career proposers every other year. APD expects to have two interns soon, one of whom will develop data on the impact the biannual ATP solicitation has had on early career researchers. The plan is to present these data to APAC and seek the Committee's input.

Dr. Strolger said that the selection rate is an issue. Proposers seem to want to hit every opportunity they can, and there are early career people working in theory who could benefit from this. Dr. Immler said that it is too late to implement a change for this year, but the number of proposals has significantly dropped compared to the increased funding. He will dive into the data and discuss it at the next APAC meeting. Dr. Hamden asked if there had been communications with early career theorists about this. Dr. Immler said that APD might be able to add a targeted early career solicitation alternating with an open theory solicitation. Dr. Holley-Bockelmann said that she read the recommendation as referring to an augmentation in order to keep the selection rate the same or make it higher, while also making it annual. Dr. Immler explained that she was correct, the recommendation was to augment the theory program by $2.5 million per year by FY28. NASA is already ramping up the funding, but not at the pace indicated. The current ramp-up of ATP funding should preserve a selection rate of over 20 percent if the solicitations remain biannual. An annual solicitation would require double the funding to keep that rate.

While a recommendation for undergraduate and graduate "traineeship" funding is not specific to R&A, NASA is considering a funding augmentation for FINESST, and SMD is looking at how a training component might work. NASA is already ramping up Laboratory Astrophysics (Lab Astro) funding and believes the level is sufficient in light of stable proposal levels. Also under discussion are faculty diversity and early career faculty awards, and independent postdoc fellowships as part of the response to the NHFP report. The DS recommended augmentation to APRA, which has a healthy selection rate and no cap, but there will be an internal review, nonetheless. Similarly, NASA already modified the SAT call in ROSES-21 and ROSES-22 to include technologies for specific future great observatories and probes. Finally, regarding the use of hybrid and remote conferences, NASA plans to use virtual panels for R&A programs in perpetuity while assessing various impacts.

Dr. Bautista pointed out that Lab Astro is usually part of APRA and accounts for less than 2 percent of R&A, supporting two proposals at most. The success rate means there are few proposals, and this is because the field is not very healthy and needs help. APD should look beyond the data. Dr. Immler agreed and said he would welcome APAC input.

He next addressed the ATP inclusion plan pilot program. ROSES-21 required proposers to submit a two-page inclusion plan to address: plans for creating and sustaining a positive and inclusive working

environment for those carrying out the proposed investigation; and contributions the proposed investigation will make to the training and development of a diverse and inclusive scientific workforce. Evaluation factors included the adequacy and completeness of a number of factors. Among these were: communication of the goal of a positive and inclusive working environment for the investigation team; processes for creating and sustaining this environment; and description of and plan for how the proposed investigation will contribute to the training and development of a diverse and inclusive workforce.

The ATP peer review had two independent panels evaluate each inclusion plan. Twenty science panels evaluated all 184 inclusion plans, with strengths and weaknesses, and 4 inclusion panels performed more in-depth evaluations of 120 inclusion plans (30 per panel). The inclusion panels were made up of astrophysicists with significant experience in improving DEI, along with DEI experts from a variety of fields. Proposers received the resulting summary evaluations, but the inclusion plan findings were not incorporated into the ratings and did not inform the selection processes. NASA asked proposers for feedback after they received their comments. An internal report on the pilot was provided to the SMD-wide Science Management Council (SMaC) meeting in December 2021. Lessons learned have been incorporated into inclusion plan requirements for six ROSES-22 solicitations in APD and four solicitations in other SMD divisions.

Dr. Gaskin asked about what might have been learned that can further inform researchers. Dr. Immler replied that the PIs had greatly different understandings of what this all meant. Many thought they were to address the nature of the investigation or add a couple of early career investigators. Others were very well informed. This shows that NASA needs to provide good feedback. This is a fundamental change in how researchers are requesting funds from NASA, and it is not a small change. Time is needed as most parties are learning as they go. For example, in the science evaluations, reviewers are told to not tell PIs what they should have written. However, inclusion plan feedback can include that. Dr. Gaskin observed that a lot of PIs don't know what they don't know. That raises the question of how to educate them, possibly by having training sessions at conferences. To avoid wasting the time and effort involved in writing a proposal, it would be best to be proactive. Dr. Immler said that SMD has a working group on this led by Dr. Sheth. There is a need for clear language on solicitations, documents PIs can consult, and workshops. All of this is in the early stages.

Pointing out that the DS recommends including DEI in evaluation of funding awards, Dr. Immler began reviewing feedback given by the inclusion panels after they completed their reviews. The panels agreed that NASA can, and should, include DEI among the criteria. The consensus was that specialized panels of inclusion experts are best for these evaluations, though there were suggestions of cross-pollination of astrophysicists. NASA will have separate panels going forward. SMD hopes to hire an expert to assemble a pool of qualified reviewers and to run the reviews. There was also consensus that DEI should be its own merit criteria for evaluation. Solicitation language should be as targeted as possible, and more explicit than in the pilot. Further, solicitations should push proposers to address the intentionality of their work via a clear description of barriers and plans to address those barriers. For accountability, they need to define success and provide metrics. Other feedback emphasized the importance of communicating that inclusion is not the same as outreach. SMD should state an explicit willingness to fund IDEA work. Accountability, possibly accompanied by positive and/or negative incentives, is crucial, and NASA staff may need additional training.

Dr. Immler listed the six astrophysics ROSES-2022 program elements that will require inclusion plans: APRA, SAT, Theoretical and Computational Astrophysics Networks (TCAN), ADSPS, Astrophysics Pioneers, and Large Interferometer Space Antenna (LISA) Preparatory Science (LPS).

APD does not yet intend to make inclusion plans a funding criterion, but that could change. Government entities have to walk a fine line. Dr. Bautista said that inclusion plans, training, etc., are not new; they

have been tried since 1970s. He applauded the decision not to include this in selections because making it mandatory can backfire. The scientists need to write the plans. Metrics are extremely difficult, and he did not see how to have them, noting that the numbers can be too small to be meaningful.

Dr. Ho said NASA should clarify what groups are to be covered in inclusion plans. She wondered about how to provide training and encouragement. Dr. Hertz explained that traditionally, NASA has relied on universities to provide a pipeline of people to support the Agency. However, one of NASA's responsibilities is the workforce for space, and there are shortages of different types of engineers. It is hard to know how to address this.

Dr. Meyer asked for perspective on the low selection rate for the Exoplanets Research Program (XRP), and whether that was tied to proposal pressure. Dr. Immler said that there is much proposal pressure there, and NASA is significantly ramping up XRP funding. If the pressure continues ramping up, it will be increasingly difficult. Dr. Hertz raised the issue of whether APD is supporting the right areas of R&A.

Detection and Mass Measurement of the First Isolated Stellar-Mass Black Hole Using HST

Dr. Kailash Sahu described a paper on HST's detection of the first isolated stellar-mass black hole (BH). The paper, which has more than 90 authors, was under review at the time of this meeting. To understand the topic, it was important to first discuss BHs and astrometric microlensing. Up to this point, all BHs discovered have been in binaries. However, the data on stars at the end of their lives would indicate that about 30 percent of BHs begin in isolated form. Microlensing is the only technique capable of detecting isolated BHs. Dr. Sahu provided graphs on how to detect the shift and the size of the Einstein ring, which provides measurements of the mass, distance, and velocity. The HST microlensing survey programs find thousands of microlensing events per year. Some of these will be BHs. The deflections are very small, and the observations need to occur over several years. HST provided such observations for 6 years, from 2011 to 2017. These observations showed that the blending in ground-based data is due to a nearby star that is about 20 times brighter than the source. Therefore, to correctly measure the source, the bright star has to be subtracted with accuracy. This was done; Dr. Sahu showed how the lens moved in relation to the source. The evidence, including the lack of blending and non-detection of the lens, indicates that the isolated object is nonluminous and therefore an isolated BH.

Dr. Woodward praised the effort, saying that this was fantastic science that shows the importance of access to long-duration space platforms. He observed that the investigation had the proper motion measurements. If those measurements were run backwards in time, would there be evidence of anything along the lines of supernovae? Dr. Sahu replied that he did not find anything. Dr. Woodward suggested that this might be a great archival data project for someone. Dr. Strolger asked about the initial mass, which Dr. Sahu estimated at 30 solar mass. The mass BHs detected in binaries peak around this mass. The investigators measure the motion of the lens against the motion of the source to subtract the motion of the lens. Dr. Hickox congratulated Dr. Sahu. As this is only one detection, he wondered if it is consistent with an expected number in the galaxy. Dr. Sahu said they did not try to calculate since this is only a single detection, but this fits within expectations.

Priorities in Time Domain Astronomy

Dr. Woodward asked APAC to pivot back to TDAMM. He wanted the members to revisit the priorities and how they are established, and as well as the PAGs' thinking on this. Dr. Meyer said that this is not in his wheelhouse, but there are challenges in standing up a new PAG. There are enough special issues to include a cross-PAG SAG while keeping the current activities. ExoPAG would want to be part of that. Dr. Holley-Bockelmann agreed. The great observatories study should consider this but a new PAG could do something like new missions and opportunities. They could do both. Dr. Meixner said that a new PAG would need to work with the existing PAGs, which are already collaborating. It may be useful to have something longer standing than a SAG. Dr. Strolger agreed. The emphasis should be on what science is

needed. He would like a broader conversation, with wide representation and discussion of the software hurdles and data access. They are facing a deluge.

Dr. Hickox noted that the DS recommends a standing structure, which would be a PAG rather than a SAG. It is important to remember that while many discoveries are made with existing capabilities, some of those capabilities will not be around for much longer; the missions will not live forever. It is critical to think about replacements along with new capabilities. Dr. Meyer said that the current PAG structure has not been around forever, so evolution is expected. He agreed that the DS seems to call for a PAG, though this one might be different. It would include the capabilities and synergies with ground-based work, not just space. There was an MMA SAG in PhysPAG, though, and he wondered if this might be a redefinition. Dr. Woodward thought APAC needed time to think about whether or not there is a need for a PAG specific to TDAMM. He would like to see consensus, possibly at the July meeting.

Dr. Gaskin suggested taking an action to get notional thoughts on what a TDAMM PAG might look like. Dr. Woodward liked that idea and thought some APAC members could join the PAG leads to sketch out a framework. Dr. Hertz reminded APAC that a PAG is the entire community. It does not have members, though the EC manages logistics. Depending on what APAC wants it to do, a PAG may or may not be the right thing. If the charge is to develop priorities, they need to think about whether the community could do that. An alternative would be a subcommittee to APAC, with defined membership. It could be a standing group, as a subcommittee can last in perpetuity. Dr. Strolger asked what Dr. Hertz really wanted from this group and how he would like it to play out. Dr. Hertz asked what APAC thinks APD needs further advice on from the community. The August workshop may be useful. Dr. Woodward advocated further discussion and advised tabling the conversation until the July meeting.

Public Comment Period

The public had another opportunity for comment. Dr. Holley-Bockelmann read a question from the portal, asking about how SOFIA will be funded. Dr. Hertz replied that he was not at liberty to discuss specific numbers until Congress acts. Generally, APD will reduce reserves and carryover. This makes things a bit tighter, and yet it does not have a significant negative effect on the program. Most people in the community will not notice any impact on their work with APD.

Dr. Holley-Bockelmann read another question from the portal, asking about the increasing cadence for Pioneers to two per year. The commenter wondered if that comes at the expense of Explorer Missions of Opportunity (MoOs). Dr. Hertz said that that was not specifically the case. APD's plans were not to reduce the Explorers cadence. The increase in Pioneers will take from something new, as APD does not take from existing programs. The out-year planning numbers have been reduced, however, and the Division will have to determine if that affects the Explorer cadence.

Dr. Stephan McCandliss said that in regard to the time domain PAG, the review of technology gaps uncovered some specific to time domain astronomy, and the COPAG EC lacked the expertise to address them. This is an example of the possible need to stand up a new PAG, in order to provide proper analysis to NASA.

Discussion

Dr. Woodward said that ExoPAG asked to close out a couple of SAGs, but Dr. Hertz needed to read their reports as well as the new TOR once it was ready. Dr. Hertz said it would be helpful for APAC to determine if it would be worth the PAGs developing a TOR on exozodi. Dr. Woodward asked if there were any strong feelings on it. Dr. Meyer said that the program office had the draft TOR and it went up on the website the previous day. Dr. Hertz said that APAC was welcome to weigh in so that he could review it with Committee input. Dr. Meixner said that it would be more helpful for APAC members to receive proposed TORs further in advance of these meetings. Dr. Meyer noted that there were three

notional SAGs without TORs that could be discussed at APAC's next meeting. In discussing the exozodi SAG, Dr. Meixner said that the field has been revolutionized and exozodi could be a major contaminant to the exoplanet mission the DS recommended.

Dr. Hertz said that he could approve the SAG 22 report if APAC agreed. Dr. Woodward heard no objections from the Committee. The same was the case for the SAG 21 report. Therefore, Dr. Hertz could close those out. The other three notional concepts needed to be further fleshed out. However, the survey Dr. Hickox discussed called for input, as it was a DS recommendation.

Dr. Gaskin wondered if there was a need for more research, but Dr. Strolger said that a team of experts would be more helpful than polling the community again. NASA cannot keep starting pilots over and over again due to expired funding. Dr. Hickox agreed, explaining that Dr. Sheth had suggested detailed interviews with individuals. They have the breadth but need the depth. Dr. Hertz pointed out that there are multiple reports that provide actionable advice to NASA. He asked if the need was for more suggestions or for implementation of what exists. Dr. Woodward agreed, noting that this gets back to the question of urgency and sustainability.

Dr. Hickox said that the Astro 2020 recommendation is not prescriptive, and that NASA needs to figure out the implementation. Dr. Bautista raised the issue of where to focus. It should all be approached like the field approaches science and technology, by identifying gaps. There should be all the pieces put together in a cohesive way. Dr. Meyer agreed but said that that is outside the remit of a SAG. He believed that APAC had given Dr. Hickox conflicting advice on expanding or contracting. They should say what they wanted or back away. A TOR from Dr. Hickox would give the Committee something to react to. Personally, he thought obtaining more information from a deep dive would be useful, but he trusted Dr. Hickox's perspective.

Dr. Meixner said that the one SAG cannot do everything, but it can identify where to start. She was not sure another survey would add that much. Dr. Holley-Bockelmann interpreted a survey as a deeper dive into things that worked and things that did not work, which was what she saw being proposed. Figuring out the scope of what they need would be a place to start. Dr. Woodward observed that they were getting to where they could advise Dr. Hickox. He liked the gap identification idea and hoped to see sustainable programs come from this. By July, APAC should crystallize its thinking or pull the issue off the table.

He asked if APAC wanted to confirm the exozodi SAG; the response was that they did. On the balloon task force TOR, he had received some comments from APAC members that the terms were reading well. He thought the TOR should insert a specific reference to dealing with the archives and the data sets. Dr. Gaskin said she was struck by the term of 18 months. She would like the option to extend it, as she was not convinced of the need for a sharp cutoff. She also wondered why it specified six meetings. The rationales behind some of the details were unclear. Dr. Woodward added that the charge was extensive. Dr. Hamden said that there should be reporting deadlines if the time is extended. Dr. Meyer worried about mission creep and timeliness.

Dr. Hertz said that it was not a requirement to have APAC members on the BPIR subcommittee, though that would be helpful. The only requirement was to have the subcommittee report to APAC. Dr. Woodward agreed that this was a good idea. He would want it to be of limited duration for timeliness and impact, possibly with an interim report. It is useful to move quickly after the DS comes out. The recommendation of APAC was approval of the TOR. Dr. Hertz offered to approach APAC members about possible participation on the subcommittee.

Dr. Mark Mozena said he was most interested in seeing Dr. Odom's report. The community continues to bring up the issue of Mr. Webb's actions, and NASA needs to be as thorough and timely as possible.

Formulate Recommendations/Report to Division Director

Dr. Woodward said that APAC would bring back Dr. Odom. The Committee would also endorse the code of conduct and advocate that teams apply them with rigorous adherence. APAC would ask Dr. Boyd to discuss the Bridge Program and possibly ask Dr. Jade Singleton to discuss implementation of the IDEA initiatives. Another topic for July is the TOPS activity and APAC would like Dr. Kevin Murphy to present on developments in this area. The Committee wanted the Roman team to discuss matching enormous data volumes with access. APAC also wanted more on the Roman survey versus the pointed mission. He thanked the JWST team and asked the public outreach side to think about how they stage these releases. The August TDAMM workshop could advise the October meeting of the Committee.

The Committee was not entirely satisfied with the information about the archives, the utility of the open skies approach, and AI applications and development, so they would like more on that in October. When Dr. Hertz characterized that as more of a ground-based issue, Dr. Woodward disagreed, and Dr. Holley-Bockelmann explained that there was a lot of pushback on international use.

Dr. Gaskin said she still had a lot of questions about the technology heritage discussion and felt it was unclear and incomplete. Dr. Hertz said that the purpose would be to gauge technology infusion. When Drs. Gaskin and Holley-Bockelmann said they would like to continue that discussion, Dr. Hertz said there was a full report that he would make available to them.

Dr. Bautista praised the nationwide public outreach activities accompanying the JWST launch and would like to see that kind of activity done more frequently. The archives modernization is something APAC should hear about regularly. Dr. Hertz asked if APAC thought this would benefit from community input, or if APAC is the right community. Dr. Woodward said that the Committee does need outside expertise in some cases and wondered if there might be a broader group called for here, possibly a User's group. Dr. Ho said that it was important to have the scientists involved so that it serves them. APAC will need to revisit this. Dr. Meixner wanted to know more about the JWST science release plan.

Dr. Woodward said that APAC was impressed with the sounding rocket program getting back to Australia and ramping up. Rideshare provides opportunities for science payloads. He thanked the PAG chairs and appreciated their enthusiasm. He also thanked the presenters. He would develop the letter to Dr. Hertz over the next couple of weeks, email it to APAC members, and send a draft to Dr. Hertz.

Dr. Holley-Bockelmann pointed out that they did not discuss the ATP cadence as the DS advised. Dr. Woodward said that that would occur in July. Dr. Hertz added that there was time, as the first opportunity for impact is 2024. The interns' work might provide something sharable by then.

Adjourn

Dr. Hasan thanked everyone and adjourned the meeting at 5:14 p.m.

Appendix A
Participants

Committee members
Charles Woodward, University of Minnesota, *Chair, Astrophysics Advisory Committee*
Kelly Holley-Bockelmann, Vanderbilt University, *Co-Chair*
Manuel Bautista, University of West Michigan
Jessica Gaskin, NASA Marshall Space Flight Center
Erika Hamden, University of Arizona
Ryan Hickox, Dartmouth College
Shirley Ho, Flatiron Institute
Margaret Meixner, USRA
Michael R. Meyer, University of Michigan
Mark Mozena, Planet Labs, Inc.
Louis Strolger, Space Telescope Science Institute

NASA
Paul Hertz, NASA HQ
Director, Astrophysics Division
Megan Ansdell
Lorella Angelini
Giada Arney
Cathy Barclay
Natasha Batalha
Gary Blackwood
Matthew Bolcar
Terri Brandt
Jenna Cann
Mark Clampin
Valerie Connaughton
Brian Corb
Steven Crawford
Brendan Crill
Julie Crooke
Elinor Davis
Shawn Domagal-Goldman
Kristen Erickson
Marc Etkind
Daniel Evans
Debora Fairbrother
John Falker
Ingrid Farrell
Alise Fisher
Christopher Flaherty
Ronald Gamble
Michael Garcia
Jonathan Gardner
Paul Goldsmith
Barbara Grofic
Shahid Habib
Andrew Hamilton
Thomas Hams
Hashima Hasan, NASA HQ
Executive Secretary, APAC
Elizabeth Hays
Douglas Hudgins
Michelle Hui
Stefan Immler
Tess Jaffe
Keith Jahoda
Robert Jameson
Hannah Jang-Condell
Tiffany Kataria
Bernard Kelly
Patricia Knezek
Jeffrey Kruk
Marc Kuchner
Peter Kurczynski
Elizabeth Landau
William Latter
Sangeeta Malhotra
Pamela Marcum
Sean McCarville
Julie McEnery
Stefanie Milam
Rhonda Morgan
Elisabeth Morse
Susan Neff
Michael New

Brian Odom
Mario Perez
David Pierce
Natasha Pinol
Naseem Rangwala
Rachel Rivera
Gregory Robinson
Andrew Rowe
Rita Sambruna
Evan Scannapieco
Joshua Schlieder
Sara Schwartzman
Marta Shelton
Kartik Sheth
Nicholas Siegler
Jacob Slutsky
Alan Smale
Eric Smith
Linda Sparke
H. Philip Stahl
Karl Stapelfeldt
Christine Steeley
Amber Straughn
Pasquale Temi
Eric Tollestrup
Jacqueline Townsend
Neal Turner
Sanaz Vahidinia
Brian Williams

Non-NASA/Unknown

Lynn Allen
Ghassem Asrar
Meghan Bartels
Rachael Beaton
Ruslan Belikov
Marufa Bhuiyan
Francesco Bordi
Uma Bruegman
Eric Burns
Aarynn Carter
Teddy Cheung
Haeun Chung
Jonathan Crass
Miguel Angel Vargas Cruz
Ian Dargin
Anne Dattilo
Etienne Dauvergne
Andrew Davis
Julie Davis
Monty Di Biasi
Tammy Dickinson
Shirin Eftekharzadeh
Mike Fanelli
Jeff Filippini
Justin Finke
Jeff Foust
Adam Goldstein
Abraham Gomez
Josh Grindlay
Steve Groom
Bruce Grossan
Lewis Groswald
Marc Hayhurst
Teresa Jensen
Hussein Jirdeh
Bethany Johns
William Jones
Philip Kaaret
Brandon Lawton
Cathirame Lee
Janice Lee
James Lochner
Andrés A. Plazas Malagón
Adam Mann
Stephan McCandliss
Athina Meli
Gene Mikulka
Drew Miles
Richard Miller
David Millman
Ed Montiel
Mayra Montrose
Rachel O'Connor
Roopesh Ojha
April Olson
Chris Packham
Adam Para
Sang Park
Vincent Picouet
Tereza Pultarova
Richard Rogers
Erin Ryan
Kailash Sahu
Wilton Sanders
Phil Scott
Elizabeth Sheley

David Shoemaker
Harpreet Singh
Wilson Joy Skipper
Denise Smith
Marcia Smith
Harvey Tananbaum
Johanna Teske
Alan Thurgood
David Traore
Grant Tremblay
Alexey Vikhlinin
Ashlee Wilkins
Dan Wilkins
Alexandra Witze
Greg Zengilowski

Appendix B
Astrophysics Advisory Committee Members

Charles Woodward, APAC Chair
University of Minnesota

Hashima Hasan, Executive Secretary
Astrophysics Division
Science Mission Directorate
NASA Headquarters

Manuel Bautista
University of West Michigan

Jessica Gaskin
Marshall Space Flight Center

Erika Hamden
University of Arizona

Ryan Hickox
Dartmouth College

Shirley Ho
Flatiron Institute

Kelly Holley-Bockelmann
Vanderbilt University

Margaret Meixner
USRA/SOFIA

Michael R. Meyer
University of Michigan

Mark Mozena
Planet Labs Inc.

Louis Strolger
Space Telescope Science Institute

Appendix C
Presentations

1. *Astrophysics Division Update*, Paul Hertz
2. *Webb Update*, Eric Smith
3. *Roman Update*, Julie McEnery
4. *Balloon Task Force Update*, Thomas Hams
5. *Sounding Rockets Program Update,* Thomas Hams
6. *Archives Modernization*, Linda Sparke
7. *COPAG/PhysPAG/ExoPAG Updates*, Janice Lee/Grant Tremblay/Michael Meyer
8. *Expanding Participation in Astrophysics,* Ryan Hickox
9. *Aerospace Study on Astrophysics Technology Heritage,* Marc Hayhurst
10. *ExoExplorer Program,* Tiffany Kataria
11. *R&A Update*, Stefan Immler
12. *Detection and Mass Measurement of the First Isolated Stellar-Mass Black Hole Using HST,* Kailash Sahu

Appendix D
Agenda

Astrophysics Advisory Committee
Virtual
March 30 and 31, 2022

Wednesday 30 March

11:00 a.m.	Introduction and Announcements	Hashima Hasan/Chick Woodward
11:10 a.m.	Astrophysics Division Update	Paul Hertz
12:30 p.m.	Meet with SMD AA (canceled)	Thomas Zurbuchen
1:00 p.m.	Astrophysics Division Update (contd.)	Paul Hertz
2:00 p.m.	Break	
2:20 p.m.	Webb Update	Eric Smith
2:50 p.m.	Roman Update	Julie McEnery
3:20 p.m.	Balloon Task Force Update	Thomas Hams
3:50 p.m.	Sounding Rockets Program Update	Thomas Hams
4:20 p.m.	Public Comment Period	
4:30 p.m.	Discussion	APAC members
5:00 p.m.	Wrap up for Day 1	Chick Woodward

Thursday 31 March

11:00 a.m.	Opening Remarks	Hashima Hasan/Chick Woodward
11:10 a.m.	Archives Modernization	Linda Sparke
11:40 a.m.	COPAG/PhysPAG/ExoPAG Updates	Janice Lee/Grant Tremblay/ Michael Meyer
12:40 p.m.	Expanding Participation in Astrophysics	Ryan Hickox
1:00 p.m.	Aerospace Study on Astrophysics Technology Heritage	Marc Hayhurst
1:30 p.m.	ExoExplorer Program	Tiffany Kataria
2:00 p.m.	Break	
2:20 p.m.	R&A Update	Stefan Immler
3:00 p.m.	Detection and Mass Measurement of the First Isolated Stellar-Mass Black Hole Using HST	Kailash Sahu
3:30 p.m.	Priorities in Time Domain Astronomy	APAC members
3:45 p.m.	Public Comment Period	
3:55 p.m.	Discussion	APAC members
4:30 p.m.	Formulate Recommendations	APAC members
4:45 p.m.	Debrief Division Director	APAC members
5:00 p.m.	Adjourn	