



April 20, 2023

Dr. Mark Clampin
Astrophysics Director
Science Missions Directorate
National Aeronautics and Space Administration (NASA)

Dear Mark,

The NASA Astrophysics Advisory Committee (APAC) had its Spring meeting on March 29-30, 2023. The entire two-day meeting was conducted in a hybrid mode, with the majority of APAC members being present with Senior Division management at NASA HQ, aided using WebEx™ video conferencing technology accompanied by a digital portal and a chat-window to assist in exchanging APAC, invited speaker, and community comments. The following members of the APAC attended the meeting in person: Daniela Calzetti, Jessica Gaskin, Erika Hamden, Ryan Hickox (deputy chair) Kelly Holley-Bockelmann (chair), Alina Kiessling, and Mark Mozena, while the following attended virtually: Regina Caputo, Shardha Jogee, and Ilaria Pascucci, and Grant Tremblay.

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

The APAC thanks all of the presenters for their time and efforts to provide detailed and informative presentations, especially the PAG chairs who provided video updates in advance of the meeting. In addition to the agenda, the meeting presentations are posted at <https://science.nasa.gov/researchers/nac/science-advisory-committees/apac>

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

Astrophysics Division (APD) Update

Dr. Mark Clampin gave a detailed summary of the state of the APD and outlined the responses to the APAC's October 2022 recommendations.

The APAC is pleased to see that the SMEX balloon mission, GUSTO, is back on track for a December 2023 launch. The 2 other major APD launches in 2023, XRISM and Euclid, are international partner-led missions, and the APAC would like to underline the importance of international partnership to continue the pace of discovery.

The APAC was apprised of a new policy for naming NASA projects and facilities (NPD 7620.1J), in which an ad hoc name selection team will be assembled from NASA members, including a NASA historian.

Regarding the APD budget, the FY23 appropriation of \$1.51B is \$79M less than the FY22 appropriation. As a result, the Explorer program is delayed by up to 1 year and the SMEX call will be delayed until 2025, as well. Changes to the expected 2026 MDEX call are not planned at this time. In addition, there is only a modest wedge in the budget for technology maturation in the GOMAP program, with the current plan to focus on a UVOIR mission, and delay in focused funding technology development for X-ray and Far-IR Great Observatories.

The APD Director discussed with the committee the change in US involvement with the ESA-led NewAthena mission. APD plans an overall reduction in its investment in the mission pending the ESA re-formulation; NASA will contribute a 50 Kelvin to 4 Kelvin cryocooler, and will withdraw support for testing the XRCF element.

The APD Director briefed the APAC on the status of the Astro2020 recommendation for the next flagship mission, nominally called the Habitable Worlds Observatory (HWO). As part of a strategy to contain cost, APD aims to adopt a Planetary Division approach to make *Maintaining Schedule* a Mission Level 1 requirement. The APD Director expects further cost-savings by building on prior successful technology demonstrations, such as the JWST segmented optics and the Roman coronagraph.

The APAC was apprised that APD continues to meet internal performance metrics of delivering selection decisions within an approximately 150-day window to investigators. The APAC recognizes the effort of APD personnel in achieving this goal and commends their commitment. Recent outcomes from the latest aggregate announcement of opportunities indicate that the selection rates are improving for research and analysis proposals (24%), with APRA and SAT achieving a 35% selection rate.

The APD Director outlined the changes in the NASA Hubble Fellowship Program in response to a 2022 report of 32 recommendations to improve the efficacy and equity of the program. The APAC commends the rapid implementation of 15 of these recommendations, and looks forward to a more timely adoption of the remaining 17.

SPD-41a was also discussed, including the SMD-wide Open Science Guidelines, the APD policy on implementation, and the forward-looking Transform to Open Science program. The APAC applauds the ethos of the TOPS program and appreciates that APD is participating.

Findings

The APD science highlights from Fermi, Swift, and JWST, including the brightest gamma-ray burst ever detected, the farthest known galaxy, and the first evidence of photochemistry in an exoplanet atmosphere. The APAC commends the APD for enabling astronomers to continue to push the boundaries of our knowledge of the Universe.

The APAC notes that Fermi (launched in 2008) and Swift (launched in 2004) have been operating longer than their mission lifetime

The APAC appreciates learning the strategy for the preliminary HWO design to detect potentially-habitable planets around Sun-like stars.

The APAC lauds the development of a team-based process associated with naming Flagship and Great Observatories.

The APAC commends the attention given to bolstering infrastructure and space communications in general and to enable TDAMM. However, the APAC found the APD working interpretation of TDAMM to be at once too broad (a mission detecting transients) and too narrow (a mission for prompt electromagnetic followup of ground-based gravitational wave alerts). The lack of TDAMM prioritization and strategy puts the rich discovery space of this emerging field at risk.

The APAC is concerned about the level of priority and funding given to TDAMM. The update noted that TDAMM funding, including precursor science, was \$5M in FY23, far below the Astro2020 recommended funding in this decade.

Within the SMD, the APD continues to be an exemplar in IDEA initiatives. The APAC applauds the work done so far and looks forward to deeper integration of NASA's 5th pillar of inclusion within all APD activities.

As the cost of living increases sharply nationally, many R1 and AAU universities are increasing graduate research stipends. The APAC recommends that APD monitor graduate stipends nationally and consider a commensurate increase for graduate fellowships.

Recommendations

The APAC recommends that every APAC presentation describe how IDEA is implemented in their mission and/or program. Examples may include: team demographics, an inclusion plan, description of IDEA initiatives, and/or metrics.

The APAC recommends a mechanism for engaging the public when naming Flagship missions and Great Observatories and reiterates that more caution be used when naming missions after people.

The APAC notes that the HWO key technical requirements, an extremely stable wave-front error (10s of pm) and an ultra-high contrast coronagraph (10^{-10}), are several orders of magnitude better than the current TRL-9 technology. Therefore, the APAC requests information on the current state of the technological challenges, as well as an update on the timeline, technology roadmap, mitigation strategies, and key decision points to determine whether reformulation is needed. In particular, members of the APAC are interested in the tradeoff between on and off axis coronagraphs for HWO. The APAC recommends a standing risk review board to report periodically to APD and the APAC addressing these issues.

Given the funding climate and GOMAP prioritization of HWO, the APAC requests a presentation on how SAT and APRA will be used to maintain the X-ray and Far-IR communities.

The APAC recommends that APD accelerate the implementation of the NHFP report recommendations. As an example, it is puzzling why some of the seemingly straightforward recommendations, such as virtual panels to increase panel diversity, are planned to be implemented by FY30 and not sooner. The APAC would like a thorough update on the evaluation criteria of NHFP candidates based on inclusive leadership requirements.

The APAC recommends that APD investigate consequences and mitigation for aging instruments/missions that support TDAMM, with emphasis on Fermi and Swift.

The APAC recommends higher prioritization of TDAMM. As a first step, APAC recommends a reanalysis of APD's current portfolio to determine how to maximize TDAMM capabilities, such as prioritizing TDAMM in mission selection or enabling TDAMM science through multi-messenger joint analysis tools in TDAMM-specific ADAP opportunities.

JWST Update

The APAC would like to thank Eric Smith for an informative update on JWST performance. Cycle 2 observations are constrained by micrometeoroid avoidance mode that will likely persist in future cycles. Although the mass and number distribution of micrometeoroids are consistent with models, APD expects future L2 missions to feature baffles to mitigate impacts. The MIRI grating is experiencing a restricted range of motion and the Deep Space Network Goldstone station is down for maintenance until December 2023. Demand for the mission is high, with 1600 Cycle 2 proposals, 15% of which were student PIs. JWST has generated 117 TB of data, 56% of which is public, including all commissioning and calibration data; observations are given a 1-year proprietary period by default.

Findings: JWST is performing better than anticipated, and the mission continues to deliver paradigm-shifting science. The APAC commends the JWST team for its nimble response to challenges, its outstanding public outreach, and its rapid release of open data.

Recommendations:

The APAC is cognizant that the shift to open data can disproportionately affect early career and under-resourced scientists. Although there is a mechanism to request additional proprietary time, few proposers are aware of this – indeed, many proposers have expressed concern that a request for any proprietary time be viewed unfavorably by the TAC. The APAC recommends that information on the length of (or lack of) proprietary time requested in proposals be kept confidential from the TAC.

The APAC recommends that APD consider mechanisms to make limited proprietary time models more equitable for early career and under-resources GOs.

Euclid Update

Jason Rhodes gave a clear and concise update on the Euclid mission, set to launch in July, 2023 by SpaceX. The APAC appreciates the discussion of the science ground segment, data release policy, and US support model, as well as the synergies between Roman, Rubin, and Euclid. The APAC also welcomed the acknowledgement that land sacred to the Apache and Hawaiian communities is used by Euclid to achieve its science goals.

Findings:

The synergy between the Roman, Rubin, and Euclid data can provide important constraints on cosmology and time-domain science when combined; taking advantage of these synergies will require joint analysis tools and data curation.

Euclid's model for US participation, in which explicit APD funding for Euclid science is limited to pre-selected consortium members, is incompatible with IDEA. This model is

used for several international partnership missions, and needs to be rethought for future partnerships.

Recommendations:

The APAC recommends funding to jointly analyze Euclid, Roman, and Rubin data to maximize the science impact of the three missions, as well as to build infrastructure to enable time-domain and multi-messenger astronomy.

The APAC recommends that APD conduct an analysis on how to broaden participation in Euclid science, particularly for marginalized and early career groups.

The APAC requests discussion of the tangible benefits to the Apache and Hawaiian communities for partnering with APD beyond land acknowledgements.

Roman Update

Julie McEnery, Roman Senior Project Scientist, gave a compelling update on the Roman mission, and the APAC thanks her for her level of detail and candor. Of note is the project's attention to replanning and optimizing the integration and testing of spacecraft components; this exercise increased the schedule margin for the October 2026 launch date. The mission has a large community-survey-driven component, with low-barriers to participation in helping to define the surveys – 113 short pitches have been submitted to propose a community survey (35% of which are early-career scientists), and a tiered committee structure will help evaluate and define the community survey selection. One issue to be considered is how to change the time allocation planning in the event that the Coronagraph performs well enough to be used for science observation, as it is currently a technology demonstration to be tested only during the first 18 months of the mission.

Findings: Roman has adapted well to earlier schedule and budgetary challenges and is on a solid trajectory for a 2026 launch.

The deliberate engagement of the community appears to have been successful so far, and the APAC anticipates continued broad community support.

Recommendations:

The APAC requests an update on the Community Survey progress, as well as that of the Infrastructure teams.

As Roman is being referred to as a TDAMM mission within APD, the APAC would like a conversation on how the project is specifically enabling the aspects of TDAMM that were prioritized by the TDAMM workshop report.

SMD Bridge Program Update

The APAC thanks Padi Boyd for her presentation on the SMD Bridge Program, and especially for being generous with her time to allow the APAC to continue the conversation with her the next day.

Findings: The targeted preparation done to understand the needs of a broad spectrum of stakeholders is laudable and bodes well for success. The APAC looks forward to the workshop report and the imminent ROSES call.

Recommendations: The APAC suggests that APD explore ways to magnify the impact of the SMD Bridge through institutional buy-in. One suggestion is to have MSI institutions support teaching release, and explicitly recognize the value of the bridge program in the components used to evaluate promotion and tenure dossiers: research, teaching, mentoring, advising and service.

We also note the plethora of existing efforts within federal agencies and suggest that partnering with other Inclusion programs, such as the NSF REU, NSF INCLUDES, NSF Louis Stokes Regional Centers for Excellence, DOD ASSURE, DOE FAST, AAAS SEA Change, etc., may be fruitful to share mentoring resources, best practices for evaluation, as well as to avoid duplication of effort.

JWST Naming Investigation Report

The APAC thanks Brian Odom for his detailed report on his research into the actions of James Webb during the Lavender Scare.

Findings: The APAC wishes to convey that the lack of written report for so long, even an interim one describing the progress of the investigation, significantly eroded the trust of the LGBTQIA+ astronomical community. Coupled with the lack of information on the results of the Goddard Space Flight Center pilot to optionally include pronouns in IT identities, it appears that gender, gender identity, and sexual orientation is an afterthought at APD.

Recommendations: The APAC requests an update at the next meeting on APD IDEA efforts specifically for the LGBTQIA+ community.

GUSTO Update

The APAC appreciates the status provided by Dr. Chris Walker, GUSTO PI, on the status of the mission. The science, which includes determining the makeup and life cycle of interstellar gas, understanding gas dynamics in the Galactic Center, and understanding the connection between star formation, stellar winds and radiation, and the structure of the ISM, is compelling. Even a reduced mission meeting Threshold plus margin, provides significant return to the community.

Findings: The project is on-schedule for integration in June, 2023, ship to Antarctica in August, and flight-readiness in December. No additional costs are expected at this time.

Recommendations: The APAC requests a short status on mission progress at the Summer APAC meeting.

Great Observatories Maturation Program (GOMAP)

The APAC thanks Program Executive Julie Crooke and Program Scientist Shawn Domagal-Goldman for their informative GOMAP presentation describing the new approach to flagship missions and the rationale behind and more detail about the Habitable Worlds Observatory.

Findings: APD has taken the lessons learned about cost, schedule, and technology maturation from recent flagship missions to heart in the approach to HWO. As stated above, we have concerns about the degree to which the prior heritage technology can be leveraged, given the much more stringent demands on stability and performance, as well as concern about the health of and commensurate loss of technological heritage in the Far-IR and X-ray communities.

Recommendations: In addition to the other GOMAP-related recommendations elsewhere, the APAC would like more clarification on the connection, synergies, and overlap between the START team and the PAGs at the Fall meeting. The APAC requests a presentation on the programmatic support of NASA for interdisciplinary astrophysics studies.

Time Domain Multi-Messenger Astronomy (TDAMM)

Valerie Connaughton gave an engaging update on APD plans to enable TDAMM in response to the Astro2020 Decadal recommendation to prioritize this emerging science area.

Findings: The APAC appreciates the current investment in infrastructure to enable easier coordination of TDAMM science, such as a joint General Observer Facility. The APAC has concerns that several currently operating and planned missions are labeled as TDAMM without consideration of the impending critical gaps in capabilities outlined in the workshop in August 2022 that the community requires to continue doing this science.

Recommendations: The APAC would like a summary of the TDAMM workshop report to be presented at a future meeting. In addition, it may be fruitful to engage the NSF in a joint TDAMM discussion at the next APAC meeting.

Science Activation Program Update

The APAC appreciates the update by Kristen Erickson on the Science Activation Program, which has significantly increased its impact over the past year. Preparations

for the upcoming solar eclipse are underway, the program footprint is reaching more Hispanic-serving institutions, and evaluators are now engaged to determine the efficacy of several initiatives.

Findings: The APAC was impressed by the impact of the Science Activation Program, and notes the huge community engagement with JWST as a sign of success.

Recommendations: The APAC is interested in the metrics and evaluation report and requests an update at a future meeting.

Explorer Program Update

The APAC thanks Linda Sparke and Pat Knezek for preparing and presenting an update on the Explorers Program. The current suite of missions includes operating TESS, NICER, and IXPE, with GUSTO, SPHEREx, Ariel, and COSI in various stages of development. Updates on the 2021 MIDEX Downselect timeline were also provided. Finally, the changes in schedule for the next SMEX call were presented. Details on the Probe Announcement of Opportunity were also provided.

Findings: The APAC finds that the Explorers program continues to provide excellent, focused science on short timelines and smaller budgets.

Recommendations: The APAC recommends continued support for the Explorer program, and efforts should be made to shield the 4 calls per decade cadence in addition to the plans for a large explorer/probe. from budget constraints.

Ultraset Update

The APAC appreciates the update from the Ultraset Project Scientist, James Rhoads, presenting an overview of the mission, details of the international agreement between NASA and ISA, and the role for US scientists.

Findings: Ultraset's model for US participation, similar to Euclid in which explicit APD funding for Ultraset science is limited to pre-selected science working group members, is incompatible with IDEA. This model is used for several international partnership missions, and needs to be rethought for future partnerships.

Recommendations: In future international agreements, APD does not limit the funding to perform science to preselected science team members.

SPHEREx Update

The APAC appreciates PI of SPHEREx, Jamie Bock, presenting the goals of the mission, its current integration and hardware status, and brief the APAC on the upcoming milestones and schedule. SPHEREx has nearly all flight hardware in hand, with delivery of remaining parts scheduled throughout the 2023 calendar year. SPHEREx cost and schedule was severely impacted by the COVID-19 pandemic.

Findings: SPHEREx, despite bearing the brunt of the COVID pandemic during critical parts of its development, has made significant progress towards flight. Of note is that their current performance is in line with the best-case 2018 sensitivity estimates. Due to COVID delays, the available funding for comprehensive pipeline development has been limited and will not be continued past the launch.

Recommendations: SPHEREx is scheduled to undergo an SIR review in November 2023. The APAC recommends that the review panel, either at this review or at KDP-D, evaluate funding the pipeline development beyond the launch date. In particular, the cosmology science cases of SPHEREx may not be achieved with continued pipeline development.

COPAG/PhysPAG/ExoPAG Discussion

The APAC sincerely thanks the PAG chairs for pre-recording their talks to allow for a more in-depth conversation. The APAC is aware that this format requires extra work, in particular to provide accurate captions, and appreciates their willingness to engage in this hybrid experiment.

COPAG has two new groups: a science interest group in Diffuse Gas in Cosmic Systems, and a UV Science and Technology Working Group in Support of the Habitable Worlds Observatory. The Executive Committee is also undergoing a strategic planning exercise, and is exploring the concept of a Student Science Interest Group.

PhysPAG requests APAC to approve a TDAMM Communications Science Analysis Group.

ExoPAG continues its suite of interest and analysis activities, including the innovative ExoExplorers program. Of particular note is the directed community discussion by Jason Wright on zero proprietary time.

Findings: The PAGs continue their excellent work engaging the astronomical community, particularly with responding to Astro2020 priorities. With its wider span of science topics and technologies, PhysPAG has the biggest challenge in having a unifying impact.

Recommendations: The APAC would like to see the Terms of Reference for the cross-PAG TDAMM Science Interest Group at the next meeting.

The APAC approves the TDAMM Communications Science Analysis Group and looks forward to hearing the result.

The APAC is concerned that PhysPAG may be missing an opportunity to capitalize on the interest in multi-messenger astronomy through more connected interactions

between the PhysPAG SIGs and suggests a strategic planning exercise to increase its impact and development of the community.

Sincerely,
Kelly Holley-Bockelmann, on behalf of APAC