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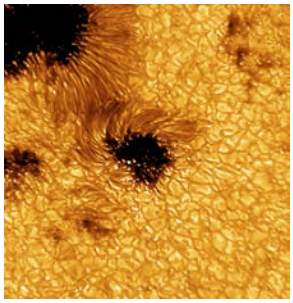
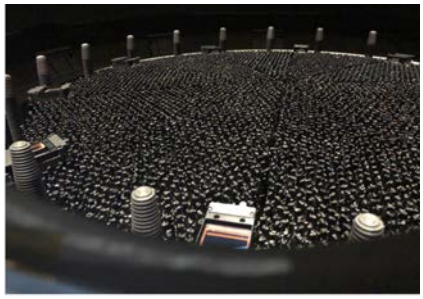
AAAC ANNUAL REPORT 2022

The Astronomy and Astrophysics Advisory Committee (AAAC) advises the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the U.S. Department of Energy (DOE) on selected issues within the fields of astronomy and astrophysics that are of mutual interest and concern to the agencies. This report represents the annual summary of findings and recommendations from the current committee. In particular, this report provides an examination of interagency coordination and appropriate recommendations as it pertains to the recently released Astronomy & Astrophysics 2020 Decadal Survey report from the National Academy of Sciences: “Pathways to Discovery in Astronomy and Astrophysics for the 2020s.”

Executive Summary

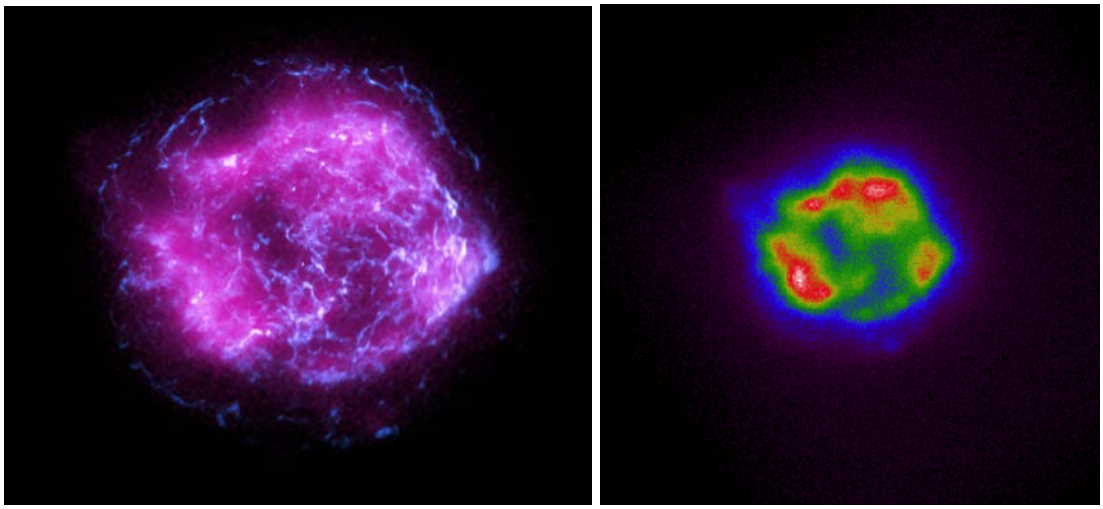
The recently released Astrophysics 2020 Decadal Survey report provides a clear set of priorities to foster further scientific advances and breakthroughs leveraging fruitful cooperation and collaboration between NASA, NSF, and DOE. In addition to providing strategies for catalyzing new scientific discoveries, the 2020 Decadal report provides several critical new recommendations relevant to strengthening the astronomy workforce; continued investment in research and environment; operations and construction of facilities; and new technology development. The findings and recommendations reported and elaborated here include a roadmap for cross-agency cooperation for implementation from each of these four key categories. We highlight specific actions relevant to three issues that the AAAC identified as mission critical and of highest priority:

- collection of demographic data on the scientific community to track progress on our goal to build an equitable, diverse and inclusive community;
- studying actions that we can take as a community to mitigate climate change and conduct our activities sustainably going forward; and
- building a better infrastructure for laboratory astrophysics that is urgently needed to best exploit the upcoming data deluge from multiple science missions.

We conclude with a series of recommendations not addressed by the Decadal Survey report that we feel are still pertinent.

Agency and Science Highlights

NASA: This past year has seen the fulfillment of a major prior Decadal recommendation for NASA - the successful launch of the James Webb Space Telescope (JWST) on December 25, 2021. JWST is now in orbit around the sun, one million miles away from the Earth at the second Lagrange point. The facility has a large primary mirror, 6.5 meters across, and a five-layer sunshield the size of a tennis court, giving it its iconic shape. The telescope deployed its gold-coated primary mirror successfully on January 8, 2022, and the rest of the commissioning sequence is following schedule. JWST will allow scientists to explore cosmic history, observing space and time as never seen before – seeking light from the first galaxies and black holes, tracing the evolution of galaxies over cosmic time and exploring our solar system and other exoplanetary systems. JWST is an international collaboration between NASA, ESA and the Canadian Space Agency, including engineers and scientists from 14 countries. Other significant space science milestones include the successful launch and first light from the Imaging X-ray Polarimetry Explorer (IXPE) and the return to construction and development of the Nancy Grace Roman Space Telescope (NGRST) after Covid-related delays.



First press release image from IPXE of the supernova remnant Cassiopeia A overlaid with X-ray data from the Chandra Observatory (left panel); the IPXE X-ray image (right panel).

NSF: The world's largest solar observatory, the NSF's 4-meter Daniel K. Inouye Solar Telescope (DKIST), near the summit of Haleakala on Maui was completed in November 2021 after experiencing a 14-month delay caused by the COVID-19 pandemic. DKIST's first-light campaign has revealed the unprecedented capabilities of capturing the highest resolution images of the solar atmosphere. The year-long operations commissioning phase began in December 2021, with three state-of-the-art instruments available for the initial phase of science observations. The first science observations commenced on February 23, 2022, aiming to study the electric field associated with magnetic reconnection driving jets in the chromosphere. The DKIST Data Center in Boulder, CO has started receiving and calibrating data of its first science observations. The observing

times are now oversubscribed by the global solar community. The facility will begin its regular operations in 2023. Other highlights from NSF include the return to the construction schedule of the LSST Vera Rubin observatory and several new programs to address the impact of satellite constellations.

DOE: The Dark Energy Spectroscopic Instrument (DESI) started its five-year survey in May 2021. DESI is the world's premier multi-object spectrograph with 5,000 robotically-controlled fiber optics installed in the focal plane of the 4-meter Mayall Telescope at Kitt Peak National Observatory. DESI will measure the spectra of more than 40 million galaxies to study the nature of dark energy and cosmological physics. Since beginning science operations, DESI has recorded ten million redshifts of galaxies and quasars, more than all prior surveys combined. The project is managed by Lawrence Berkeley National Laboratory, with DOE responsible for the instrumentation, data management system, and upgrades to the telescope. Other highlights from DOE include the completion of the camera project for the Vera Rubin Observatory in September 2021 and several new programs to foster mentoring and diversity in the profession such as student fellowships and additional proposal review criteria.

Science: We outline a few notable science results that have shifted our understanding of the cosmos this past year. It has been an exciting year for exoplanet searches with the detection of multiple new exoplanetary systems. This last year witnessed several firsts in exoplanet science ranging from the discovery of the first exoplanet outside our galaxy in M51, the discovery of a hot Jupiter with the shortest period, and the potential detection of 27 additional free-floating exoplanet candidates detected via gravitational microlensing. Meanwhile in cosmology, evidence now stands in support of tension at the 5-sigma level between the values of the Hubble constant measured from the near Universe from nearby Cepheid variables and standard candle supernovae and the far Universe from the distant cosmic microwave background radiation, baryonic acoustic oscillations in the distribution of galaxies, and standard candle supernovae. This tension hints at new physics beyond the standard cosmological framework; its resolution requires new observational techniques for further investigation. In the newly burgeoning field of multi-messenger astronomy, the LIGO-VIRGO collaboration publicly released their third catalog GWTC-3 comprising 35 newly detected gravitational wave events, bringing the total detected GW source counts to data to 90 events.

Findings and Recommendations

In what follows, we focus on the key recommendations from the Decadal that are salient to inter-agency cooperation. These are divided by programmatic themes as outlined in the 2020 Decadal Report. Delving into the specific findings and recommendations to offer guidance to the agencies for the next year, we draw particular attention to several action items that we have already identified and in some instances set in motion along with a road-map on how to pursue, customize and implement. We conclude with a series of additional recommendations from the AAAC that were not addressed by the Decadal Survey report, but remain pertinent.

A. Assessment of the Status of Decadal Programs and Recommendations

The release of the 2020 Decadal Survey report represents the most comprehensive and ambitious roadmap for agency priorities for the upcoming decade. Agency progress in the fields of Astronomy and Astrophysics in the next ten years will be evaluated relative to the specific recommendations from the Decadal Survey. For this purpose, it is critical to maintain a public record of agency progress with updates at intervals comparable to the AAAC meeting times. Therefore, our first recommendation relates to transparency in sharing agency effort toward decadal recommendations.

1. **The three agencies should develop a living document linking the 2020 Decadal recommendations to each agency's effort, emphasizing connections and consistencies between the three agencies.**

   This updated document will be most useful to the AAAC if provided before the 2022-2023 committee convenes in September. Concise summaries of progress toward specific recommendations and, when relevant, a prioritization of recommendations within individual agencies would help the AAAC review how the Decadal recommendations are being addressed. The living document can also serve as the repository of material for agency presentations to the AAAC, including how the Decadal Survey recommendations align with the strategic vision, points of synergy and coordination between the agencies, risks, challenges, and impediments to implementing recommendations. Including specific examples where advocacy from the AAAC or others within the community would be most useful would enhance the advisory role of the AAAC.

B. Strengthening the Astronomy Workforce

The astronomy and astrophysics community is strongest when it is accessible to a population with diverse backgrounds and supportive of early-career researchers. The AAAC reiterates the importance of the programs presented in the 2020 Decadal Survey report with the following specific guidance to their recommendations:

1. **NASA, NSF, and DOE should implement a cross-agency committee or working group tasked with establishing a consistent format and policy for regularly collecting, evaluating, and publicly reporting demographic data and indicators pertaining at a minimum to outcomes of proposal competitions.**

   To ensure that the astrophysics research ecosystem in the nation is inclusive and reflects the diversity of our nation, it is imperative that we gather and maintain demographic data on who proposes and who is awarded federal dollars. Currently all three agencies collect some demographic data that is voluntarily provided. The data collected are not-uniform. Moreover, agency policies differ in how the data may be publicly released. Aligned with these recommendations from the State of the Profession Panel of the 2020 Decadal Survey, in order to facilitate the collection of uniform data, the AAAC has requested coordination and information sharing amongst the agencies.

   As a first step toward addressing the 2020 Decadal Report recommendation, the AAAC requests NASA, NSF and DOE to identify current internal policies, procedures, and practices regarding collection, evaluation, and sharing of demographic information. The AAAC requests a definition of what changes each agency is considering or intends to make to these policies, procedures, and practices in order to collect, evaluate, and publicly report (at the appropriate level) on success rates of proposals for request for resources in solicitations related to astronomy and astrophysics. We also advise the agencies to outline their near-term and long-term actions to address these changes. To facilitate digestion and dissemination of this information, we advise collation in a single spreadsheet.

   The AAAC requests information from all three agencies on internal and external/government barriers to their gathering information. In particular, we invite study and comparison with the NIH model as suggested in the 2020 Decadal Report. WIth many efforts currently underway such as the White House Equitable Data Working Group and the studies commissioned by the National Academies[1], we advise alignment with identified best practices. In outlining the scope of the information to be included on the spreadsheet, the AAAC requests the following: (i) information on the mechanisms (processes and business systems) the agencies use to collect demographic information from applicants. (e.g., Grants.gov/OMB standard form; agency-specific awards management system, etc.); (ii) tables of all the research project related personnel on whom demographic information is currently collected, clarifying what demographic

[1] The two studies commissioned by the National Academies are:
https://www.nationalacademies.org/our-work/foundation-for-assessing-the-health-and-vitality-of-the-nasa-science-mission-directorates-research-communities
https://www.nationalacademies.org/our-work/increasing-diversity-in=the-leadership-of-competed-space-missions

information from individuals (e.g., gender, race, ethnicity, disability status, veteran status) is collected, including the available response options provided in input forms for each of these categories. Knowing what information is optional, what is required, and what additional information is collected on institution type, rural status, and socioeconomic status of the region of the applicants' institutions would be useful. The AAAC advises the agencies to consider pooling information to mitigate potential risk associated with low-number statistics while collating these data. The agencies have started compiling the available data into a spreadsheet; this process is welcomed as an important first step by the AAAC.

After joint deliberations, if appropriate, the AAAC may recommend the creation of a task-force to be charged with assessing the demographic data collection practices and analysis at NIH[1] and other government agencies. Such a task for would provide commensurate recommendations for the Astronomy and Astrophysics divisions at NSF, NASA and DOE for emulation as directed by the A2020 Decadal Survey. The Task force could also be assigned with the charge to make implementable recommendations for defining uniform standards for data gathering, maintenance, analysis and dissemination of the federal resource allocations to the community by all three agencies. The task force charge may include the possibility of deposing a third-party agency to track, analyze and store the collected uniform demographic data if feasible. The AAAC recommends active cooperation amongst the agencies to respond to this very important recommendation from the 2020 Decadal Survey.

2. **NASA, DOE, and NSF should consider including diversity—of project teams and participants—in the evaluation of funding awards to individual investigators, project and mission teams, and third-party organizations that manage facilities.**

   The AAAC recommends that agencies also report on and include the demographic data of the panelists and review committees that evaluate and provide feedback on the merits of proposals if and when available on the spreadsheet.

3. **NASA, NSF, and DOE should reinvest in professional workforce diversity programs at the division/directorate levels with purview over astronomy and astrophysics. Because academic pipeline transitions are loss points in general, supporting the creation and continued operation of "bridge" type programs across junctures in the higher-education pipeline and into the professional ranks appear especially promising.**

4. **NSF, NASA, and DOE should implement undergraduate and graduate "traineeship" funding, akin to the NIH (National Institute of Health) MARC and NIH "T" training grant programs, to incentivize department/institution-level commitment to professional workforce**

development, and prioritize interdisciplinary training, diversity, and preparation for a variety of career outcomes.

5. **NASA and NSF should continue and increase support for postdoctoral fellowships that provide independence while encouraging development of scientific leaders who advance diversity and inclusive excellence (e.g., NASA Hubble Fellows program, NSF Astronomy and Astrophysics Postdoc program).**

6. **The National Science Foundation, NASA, and the Department of Energy should release data on proposal success rates on an annual basis, and should track metrics that allow them to analyze statistically what is being supported.**

7. **NASA, NSF, DOE, and professional societies should ensure that their scientific integrity policies address harassment and discrimination by individuals as forms of research/scientific misconduct.**

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[1] NIH has successfully collected demographic information from researchers over decades now for its external grants program that comprises about 80,000 applications/year, which is a larger volume of applicants than all of combined grant programs of NASA, NSF, and DOE collectively.

C. Investment in the larger context of the research ecosystem

Sustainability, accountability, reproducibility, data, and computing remain essential to process in astronomy and astrophysics research. The following recommendations acknowledge the connection between astronomy and the greater community and the means to strengthen the research program for all members.

1. **The astronomy community should, through the American Astronomical Society in partnership with other major professional societies (e.g., American Physical Society, American Geophysical Union, International Astronomical Union), work with experts from other experienced disciplines (such as archaeology and social sciences) and representatives from local communities to define a Community Astronomy model of engagement that advances scientific research while respecting, empowering and benefiting local communities.**

2. **The National Science Foundation should work with the appropriate federal regulatory agencies to develop and implement a regulatory framework to control the impacts of satellite constellations on astronomy and on the human experience of the night sky. All stakeholders (U.S. astronomers, federal agencies, Congress, satellite manufacturers/operators, and citizens**

who care about the night sky) should be involved in this process. This is an international issue; therefore, international coordination is also vital.

3. **To ensure that the skies remain open to radio astronomy, the National Science Foundation (NSF), in partnership with other agencies as appropriate, should support and fund a multi-faceted approach to the avoidance and mitigation of radio-frequency interference. It is critical that the astronomical community formally monitor commercial and federal uses of the spectrum managed by the Federal Communications Commission and the National Telecommunications and Information Administration and actively participate in the spectrum management process by seeking critical primary allocations to radio astronomy in the high-frequency bands above 95 GHz, by providing comments to filings for spectrum allocations, and by supporting the efforts of the Committee on Radio Frequencies, the National Radio Astronomy Observatory, and the Electromagnetic Spectrum Management division of NSF. To be most effective, international coordination is required.**

4. **The astronomy community should increase the use of remote observing, hybrid conferences, and remote conferences, to decrease travel impact on carbon emissions and climate change.**

5. **The AAAC recommends that the three agencies initiate cooperation on the topic of the climate crisis in the three broad domains of education and public engagement, reducing emissions in the profession, and conducting audits to assess the impact on the profession and preparing for the future.**

   Human-induced climate change will be the single greatest challenge faced by humanity and by our profession in the upcoming decades. It is imperative to begin the process of preparing for the impending impact of the climate crisis, as well as to address, audit and limit how our profession contributes to carbon emissions. This is a broad issue that addresses all realms of astrophysics, as well as the lives of all of those who participate in the astronomy profession. As such, the AAAC strongly recommends a tri-agency collaborative approach to tackling the question of the climate crisis. Below we detail more specific goals set by the AAAC in each of the three categories identified in the recommendation.

   Education and public engagement

   - Astrophysics is a natural basis to discuss the planetary atmospheres, the greenhouse effect, and the physics of global climate change. Introductory Astronomy/Astrophysics classes can be used to teach students the basics of global warming. The three agencies should discuss the possibility of developing, distributing, funding, and encouraging the sharing of teaching resources that include materials on climate change.

- Astronomers and Astrophysicists also enjoy a privileged position with respect to a powerful platform for public engagement in science by virtue of the content of their work. The three agencies should consider encouraging public engagement with a specific focus on communicating with the public and our community about the urgency of the global climate crisis, and the efforts toward climate crisis solutions.
- The three agencies should discuss how to coordinate and dedicate common resources for education and broader engagement with the public. This could take the form of targeted resources, the refocusing of priorities when assessing successful proposals, and the encouragement of concrete climate-related actions for broader impact programs.

Reduce emission in the profession

- The three agencies should discuss strategies for reducing community carbon emission due to work-related travel. This discussion could focus on a number of different facets: (i) reduce travel by increasing remote observing capabilities; improve remote observing software and tools; foster new remote observing modes, and encourage remote observing in the community (ii) retain and encourage the practice of remote review panels and remote conferences deployed during the pandemic years, (iii) encourage large collaborations to perform routine carbon audits and report on their carbon footprint mitigation on travel associated with research activities, and enable them to present carbon offset plans (iv) engage in discussions regarding the value of hybrid conferences for reducing carbon emissions versus the importance of in person meetings for the professional development of junior members of the profession. The AAAC strongly recommends engaging junior members of the community in this very important discussion.
- High-performance and high-throughput computing resources (HPC and HTC, respectively) make significant contributions to the carbon footprint of the profession. The three agencies should discuss strategies for improving the efficiency of HPC and HTC as well carbon offset plans for HPC and HTC.
- The three agencies should assess and reduce the carbon footprints of existing astronomical facilities, as well as ensure that carbon footprints are minimized in the design of any new facilities. Carbon footprint should be considered in environmental assessments and mitigation plans in proposals for new facility construction, commissioning, maintenance, and operation. Further, facility operators and institutions participating in large collaborations should be required to present carbon footprint estimates and mitigation plans.

Impact on the profession and preparing for the future

The three agencies should begin the assessment of how the climate crisis will impact the profession in the upcoming decades, prepare for possible impacts, and put mitigation and adaptation strategies into place. Questions recommended for consideration and examination include: How will climate change impact the careers of future members of the profession? What will be

the impact on members of the profession due to a number of increasing uncertainties (increased severity of weather events, possibility of increased geopolitical risks, energy crisis and climate anxiety, funding uncertainties in a world facing a climate crisis)? What will the impact be on seeing, observing conditions, and our ability to conduct ground-based observations? Which observatories, institutions, or laboratories, will face the largest challenges (e.g., wildfires, severe dust or snow storms), and how can these be mitigated? Do climate-related relief funds for facilities experiencing extreme weather events need to be put into place?

6. **For the upcoming year, the AAAC recommends initial collection of facts relevant to energy usage and reporting it at one of the annual committee meetings.**

   Developing key priorities within each of three broad categories listed in the previous recommendation is critical. And amongst the key priorities, there is a need to identify those that are potentially the most fruitful in terms of joint cooperation between the three agencies in order to identify a road map and prioritized list of action items to be implemented over the next ten years. Regular reporting on these matters to the AAAC is recommended.

7. **The agencies should identify budgetary options that would permit the recommended funding increases in the individual investigator research grants.**

8. **The National Science Foundation Division of Astronomical Sciences should establish a mechanism of associated research funding for data analysis and production of high level data products for large principal investigator-led programs on MREFC (Major Research Equipment and Facilities Construction)-scale astronomical facilities in order to accelerate the scientific output and maximize the timeliness and community impact of these key large projects.**

9. **The agencies should improve coordination among U.S. archive centers, including a plan for standardized pipeline development and data formats.**

10. **NASA and the National Science Foundation should (1) convene a broad panel of experts to identify the needs for supporting laboratory data to interpret the results from the new generation of astronomical observatories, (2) identify the national resources that can be brought to bear to satisfy those needs, and (3) consider new approaches or programs for building the requisite databases. This panel should include experts in laboratory astrophysics as well as representative users of the data, who can best identify the highest-priority applications.**

To ensure that the astronomical community can robustly interpret observations from both present and proposed facilities/missions that are funded by significant investments from NASA, NSF, and DOE, support for laboratory measurements and databases is critical. Although all three agencies have laboratory astrophysics programs, their strategic alignment with national priorities and the community that they serve must be assessed. To this end, the AAAC recommends that an advisory group to NASA, NSF, and DOE be established to identify strategic and community needs, and to set priorities in laboratory astrophysics. This advisory group should consist of subject matter experts in laboratory astrophysics broadly defined and include end users who aim to leverage the data obtained from laboratory measurements to interpret observations from near-term and future astronomical facilities/missions. The advisory group should include both users and practitioners of laboratory astrophysics and offer guidance: (1) by critically assessing what experimental measurements and databases are of the most strategic importance to maximize the scientific output and impact of present and/or proposed facilities/missions; (2) assessing if new approaches or programs are required to perform key experiments and/or construct databases of strategic importance; and (3) develop an interagency framework to implement and sustain laboratory astrophysics recommendations in a coordinated and comprehensive manner that will enable the identified experiments and databases to be successfully completed on timescales aligned with the missions/facilities that they will support.

D. Operations and construction of facilities

Existing space- and ground-based observatories remain critical for advancing our knowledge among the key science drivers of the next decade. Meanwhile, facilities currently under construction or prioritized for future funding will offer new insights and new opportunities. Maintaining a proper balance between operations of current and future facilities will be challenging yet critical for the coming decade. We echo the following recommendations from the 2020 Decadal Report:

1. **The National Science Foundation (NSF) should develop a sustainable plan for supporting the operations and maintenance costs of its astronomical facilities, while preserving an appropriate balance with funding essential scientific foundations and the remainder of the NSF Division of Astronomical Sciences portfolio. The addition of new MREFC facilities should be contingent on implementation of this plan.**

2. **The NSF Division of Astronomical Sciences should establish a regular cadence of reviews of its operational portfolio, at a frequency that is sufficient to respond to changes in scientific and strategic priorities in the field. An appropriate target is at least two reviews per decade.**

E. Development of new technologies

New technologies and the capabilities they engender open up windows into future research directions. The development of new technologies also serves to train the next generation of scientists for careers as instrument builders in astronomy research or in the private sector. The following recommendation is intended to foster innovative technologies for the coming decade and beyond.

1. **The agencies should identify budgetary options that would permit the recommended funding increases in technology development.**

The AAAC strongly advocates in favor of consideration of new lines of funding as well as increases to existing programs for technology development.

F. Additional AAAC Recommendations

Here, we briefly focus on relevant AAAC Recommendations from last year that are not included in the 2020 Decadal Report.

1. **NSF, NASA, and DOE Office of Science should continue their efforts to mitigate the impacts of COVID-19, with a focus on early career scientists to the extent possible.**

2. **Congress should consider appropriations augmentations to fund NASA, NSF, and the DOE Office of Science in their efforts to mitigate the on-going impacts of COVID-19 on the astronomical sciences.**

3. **The AAAC encourages ongoing NASA/NSF coordination, through the Planetary Protection Coordination Office, to clearly define the role that existing and future ground and space-based astrophysics surveys and facilities can play in the discovery and characterization of NEOs.**

4. **The AAAC recommends that the agencies continue the development of Artificial Intelligence (AI) and Machine Learning initiatives across astrophysics including the potential creation of institutes focused on AI in the context of astrophysics.**

5. **The AAAC recommends continuation of the expansion of dual anonymous reviews within NASA, and requests that NSF and DOE develop and adopt similar reviews or other practices that provide the committee with sufficient evidence of bias mitigation in their review processes.**

6. **The AAAC strongly encourages and supports continuing discussions among the various stakeholders to ensure that they will all continue to have a voice in the ultimate fate of Arecibo Observatory.**

7. **Congress should provide sufficient appropriations to NSF to ensure that NSF's strategic commitments to operations and maintenance of its major facilities can be met, but not at the expense of the research and instrumentation funding portfolio within NSF-AST. The AAAC recommends a significant augmentation of the Facility Operation Transition activity.**

8. **The AAAC encourages inter-agency initiatives to maximize the scientific yields of the Vera C. Rubin Observatory and Nancy Grace Roman Space Telescope by considering survey designs that maximize the synergy between these two facilities.**

9. **NSF should report their budget forecasts and implementations to the AAAC so as best to overlap with the other agency report timelines.**