National Aeronautics and Space Administration

The NASA Hubble Fellowship Program:
A Review of 30 Years of Promoting Excellence in Astrophysics

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Acknowledgments

The NHFP is without a doubt one of our most prestigious fellowships in Astronomy. As such, it really is well-suited to help change the culture..., and to help open up opportunities in Astronomy (and other sciences) to a broader and more diverse pool of participants.

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This report reflects the contributions of hundreds of current and former Fellows who responded to the review panel survey and contributed to the review process by participating in panel discussions. We thank them immensely for providing their perspectives on the application process and reflections on their experiences in the NASA Hubble Fellowship Program (NHFP). The NHFP Leads, Dawn Gelino, Paul Green, Andy Fruchter, and Katey Alatalo, provided valuable detailed information about the entire application, review, and selection processes. We thank them for their professionalism and courage to undergo this review, with open and honest communications that indicated their desire to improve the Program. They made themselves and the Program transparent to critique, and we are grateful for that. Finally, we thank the Grants Administration office and Program staff for their dedication and initiatives that have made the NHFP one of the premier astrophysics fellowship programs in the country. The findings and recommendations in this report are offered in the spirit of improving something that is already highly regarded.

1. Executive Summary

In 2021, NASA Headquarters (HQ) initiated the first review of the NASA Hubble Fellowship Program (NHFP), with the aim to identify best practices, gaps, and areas of improvement. The review panel was charged with examining two broad areas:

1. Success of the NHFP under its current structure
2. Diversity, equity, and inclusion of the Program

The NHFP is the flagship in a tradition of NASA support of early career excellence in astrophysical research and sets the standard for postdoctoral fellowships in the field. The panel fully recognizes and supports this aspect of the Program as one of the necessary prerequisites for selection of the most outstanding applicants as Fellows. We applaud NASA HQ, the NHFP Leads, the NHFP in general, and the various application peer reviewers over the history of the Fellowship for identifying and promoting such a high standard of scientific excellence.

The Charter, reported in its entirety in Appendix A, included several questions, both general and specific, to guide the panel as it addressed each area of investigation. This review highlights what aspects of the current NHFP work well, flags those aspects that need improvement, and identifies areas in the NHFP that NASA should address. This report discusses the schedule and process of the review, followed by an introduction to the structure of the NHFP; the panel findings, organized into five themes; the co-Chairs' recommendations; a message to the Astrophysics Community; and the report's Conclusions. Following this report are a set of references and appendices that contain demographic data and other information used in this report.

Significant findings that emerged from the presentations and discussions include:

- the dedication of the NHFP Leads and supporting personnel, who strive to maintain the prestige of the Fellowship and integrity of the review process;
- the importance of the NHFP Fellowship in shaping careers, in defining the field of Astrophysics, and as a vehicle for cultural change in the profession;
- the need for the NHFP to formulate a shared mission statement, in alignment with NASA and SMD core values;
- the value of a holistic evaluation of applicants, including an assessment of inclusive, collaborative leadership, which will require a restructuring of the application and review processes;

- the need to provide additional information and discussion sessions for applicants, reviewers, and other stakeholders; and
- the necessity of data collection about applicants, and also about Fellows' experiences, so that the Program can be effectively evaluated over time.

The Astrophysics landscape has changed since the inception of the Hubble, Einstein, and Sagan Fellowships, after which the NHFP is modeled, and undoubtedly it will continue to evolve. In addition to conducting excellent science, current and future leaders require inclusive leadership skills, as progress in the field increasingly depends on teamwork, collaboration, and innovation. As will become apparent in the report, an overarching theme is the necessity for the NHFP to align with the core values of NASA's Science Mission Directorate. When this is undertaken the findings in this report have the potential to strengthen and amplify the value of the NHFP in the spirit of the needs of 21st Century Astrophysics. The NHFP provides a unique and exciting opportunity for NASA and the community to support the leaders of tomorrow and to set the foundations for a new modus operandi of modern Astrophysics.

The timing of this report is consequential, as it is written at a time of heightened awareness of the crisis of anti-Black racism, including in our field. By virtue of the Charge to the panel and the aspirations of the NHFP, this report examines diversity, equity, inclusion, and accessibility (DEIA) issues broadly. Indeed, given the multiple axes of identity that are part of NASA's broad conception of diversity and inclusion, there are many opportunities for the community generally, and for the NHFP specifically, to make significant advances toward a more diverse and inclusive field. At the same time, if that progress is progress for all but Black people, as has too often been the case historically, this cannot be viewed as a successful outcome. We recognize that recommendations herein cannot by themselves address deeper issues of anti-Black racism in our community. Therefore, whatever measures we take as a community to increase representation, it remains true that each and every one of us has a role in ensuring the success of underrepresented astrophysicists, and of Black astrophysicists in particular. In that spirit, following the recommendations toward increased diversity and inclusion broadly, we devote a chapter of this report to help each of us reflect on anti-Black racism within our field.

2. Schedule and Process

The NHFP review process began with the appointment of two co-Chairs in March 2021. In the following months, NASA Headquarters, in collaboration with the co-Chairs, identified potential members of the NHFP Review Panel. The nine members of the panel included astrophysicists and engineers, as well as social scientists with expertise in issues of diversity and inclusion. To gather data, the work included a series of presentations in June and July by the Hubble Space Telescope Operations Project (HSTP), the Leads for each of the Fellowship flavors (i.e., Hubble, Einstein, Sagan), past and current Fellows, and others. All presentations and discussions were virtual, in this second year of the COVID pandemic. The schedule is listed below; each meeting ended with a closed session (i.e., Executive Session) attended by the panel members only.

Meeting Day 1: Kick-off

- Introductions
- Purpose of the Review and Discussion of the Charter
- Establishment of Panel Interactions

Meeting Day 1: Program Implementation Review

- Presentation by the HSTP
- Presentation by the NHFP Leads on the Program in general

Meeting Day 2: Health and Well-being I

- Presentation by the Grant Administration office
- Presentation by the NHFP Leads on the Selection Process

Meeting Day 3: Equity, Diversity, and Inclusion I

- Presentation by members of the NHFP Fellows' EDI Working Group

Meeting Day 4: Health and Well-being II

- Presentation by the NHFP Leads on the Application Process

Meeting Day 5: Equity, Diversity, and Inclusion II

- Discussion session with former NASA and NHFP Fellows

The next stage of work consisted of a week of daily meetings in July, for in-depth discussions of the findings, followed by both synchronous and asynchronous work to organize and write the various sections of the report. The members of the panel, who are

not civil servants, worked with the two co-Chairs on the findings. Based on the findings, the co-Chairs formulated recommendations for NASA HQ.

The report was delivered to the Astrophysics Division at HQ for fact checking on August 24. The final report was submitted on October 7, 2021, so as to be available for the Astrophysics Advisory Committee meeting scheduled October 13 and 15, 2021. A Splinter Session at the January 2022 American Astronomical Society (AAS) meeting is also planned to present the report to the broader Astrophysics community.

3. The NHFP: Structure, NASA SMD Context, and Survey of Current and Former Fellows

3.1 Structure of the NHFP

The NHFP addresses the science of the three fundamental questions of Astrophysics:

- What is the origin and evolution of the Universe?
- How does the Universe work?
- Are we alone?

These three questions define the current "flavors" of the NHFP and reflect its history. The NHFP was created in 2018 when the Astrophysics Division at NASA Headquarters consolidated the Hubble, Einstein, and Sagan named Fellowship programs. The Program is administered for NASA by the Association of Universities for Research in Astronomy (AURA) under contract NAS5-26555, managed at the Goddard Space Flight Center (GSFC) by the HSTP. Contract activities are conducted from the Space Telescope Science Institute (STScI) in Baltimore, Maryland. Figure 1 shows the complex inter-relations of the various entities involved in managing the NHFP.

NASA HQ is ultimately responsible for the funding and oversight of the NHFP, via the Astrophysics Division in the Science Mission Directorate (SMD). The NHFP is considered one of the jewels in the Astrophysics Division's crown, setting the standard for scientific excellence in the field. Together with Integrity, Safety, Teamwork, and Inclusion, Excellence is one of the six core values of SMD, as we describe in the next section.

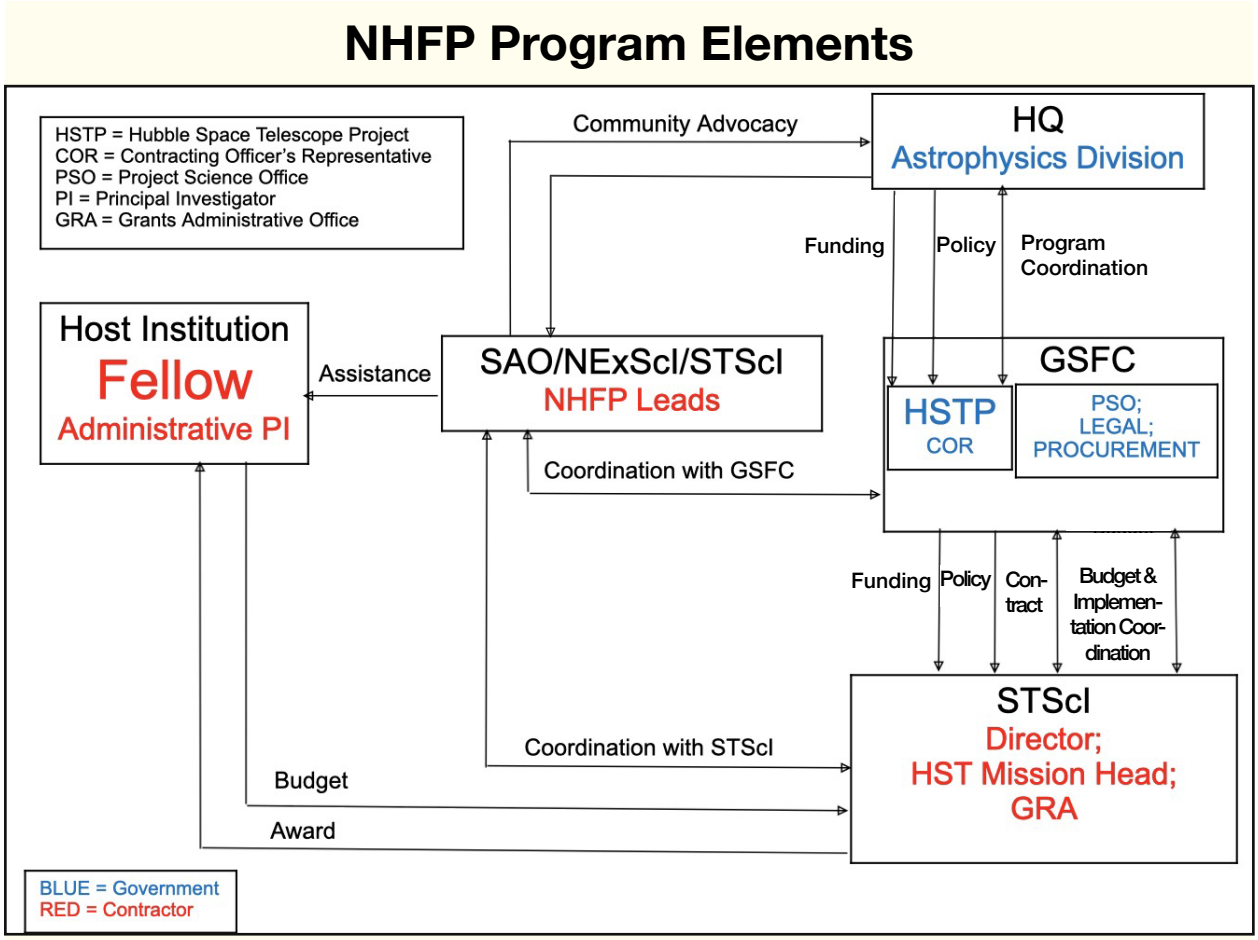

Figure 1. *Organizational chart of the NHFP management and administrative entities, from the HSTP presentation on July 9.*

3.2 Science Mission Directorate Core Values

The NASA SMD has issued a Science Plan setting the foundational principles of and vision for space-based science for the next five years, 2020-2024[1]. In it, SMD states that it incorporates NASA's five core values (Excellence, Integrity, Teamwork, Safety, and Inclusion, the most recent core value of the Agency), as well as a sixth value of Leadership. These values should be integrated into all aspects of the SMD work, and should set the expectations for the field. They are defined by SMD as follows:

- **Leadership:** "We know that scientific discovery is achieved through collaboration and therefore we seek to create space for people to come together to continue expanding our understanding of Earth and space for the benefit of all."

- **Excellence:** "Tackling such difficult questions requires courage and a dedication to excellence. It requires a culture where there is a willingness to learn and change and to take risks… Our commitment to challenge ourselves means that we must learn from both our successes and our failures. We must dig deep for lessons, be willing to make adjustments, and continually expand our knowledge."
- **Integrity:** "SMD is committed to ensuring that all decisions are made with integrity and transparency…. To be successful, we must establish clear guidelines and criteria for decision-making processes and communicate these expectations to all stakeholders so that there is a common understanding."
- **Teamwork:** "SMD believes in the importance of diverse teams to most effectively and innovatively tackle strategic problems and maximize scientific return… we seek to grow our workforce by providing opportunities for personal and professional development and cross-divisional collaboration."
- **Safety:** "NASA has a strong safety culture which extends to all aspects of SMD's work. Not only are we concerned about protecting life and property, but we also recognize the importance of psychological health and safety. We strive to create an environment where everyone can contribute to our work. People must feel comfortable bringing up issues and concerns without fear of retribution or reprisal. This extends to all members of the science community who work with us."
- **Inclusion:** "SMD is committed to fostering an inclusive environment of belonging where diversity of thought, backgrounds and perspectives are welcomed and celebrated. SMD recognizes that success is only achieved through full participation of inclusive and diverse teams, belonging and contributing as organizations and individuals. We are dedicated to creating a multi-pronged approach that brings systemic and lasting change in this area by fostering inclusion, diversity, equity and accessibility across all elements of our work…."

Excellence has been at the heart of the NHFP, as demonstrated by the breadth and depth of the many groundbreaking scientific discoveries achieved by Fellows over the history of the Program. For example, Fellows have established the existence of objects in the Kuiper Belt by observing and characterizing them in situ, thereby expanding our knowledge of solar system formation, composition, and dynamics. They have observed and characterized galaxy populations throughout the Universe, leading to increased understanding of how galaxies formed and continue to evolve. They have also developed

instruments for ground-based telescopes and space missions, enabling the collection of high-resolution data and images that further advance our understanding of celestial objects. It is noteworthy to add that Dr. Andrea Ghez, a 1992 Hubble Fellow, shared the 2020 Nobel Prize in Physics for her discovery of the supermassive black hole at the center of the Milky Way galaxy. Many former Fellows hold leadership positions in academic institutions, government agencies, and industry.

As previously directed by NASA HQ, the selection criteria the Program uses currently places most of the emphasis of the review on scientific excellence, as demonstrated by the applicant and recommenders' statements, as well as the number of publications, talks, and accolades. However, the new principle of Inclusion implies that leadership in the field is valued as much as scientific excellence. Defined as commitment to "fostering an inclusive environment of belonging where diversity of thought, backgrounds and perspectives are welcomed and celebrated", Inclusion, by our interpretation, is a call for a new dimension of leadership, where all voices are recognized, heard, and valued, as necessary ingredients of scientific innovation and success.

The panel expectation is that Leadership and Inclusion should also be cornerstone values for the NHFP, and that the Program definition of scientific excellence should be fully aligned with all of the SMD core values. This recommended re-alignment of the Program requires a revision of the modi operandi in many of its facets, including a new definition of "excellence" for the NHFP, where collaborative, inclusive leadership augments scientific excellence. The focus of the panel's work, reflected in the findings provided below, has been on how this realignment could be achieved. As it will become apparent, some of the findings are "low-hanging fruit" that can be implemented on a shorter timescale and produce immediate results, while others, in particular the culture change required to achieve the goals set by diversity, equity, inclusion, and accessibility (DEIA) work, require long-term efforts for a more systemic change.

We advocate for the NHFP to fully align all of its elements with all core values of the Science Mission Directorate, and especially in the criteria for selection of the Fellows. As the most recently added value, Inclusion will require an in-depth understanding and revision of the Program's mission and implementation.

3.3 Survey of Previous and Current Fellows

With the goal of uncovering strengths and areas of opportunity for the Program, we distributed a survey to current and previous NASA Postdoctoral Fellows who received Chandra, Einstein, Michelson, Sagan, Spitzer, and NHFP Fellowships between 1990, the

first year of the Hubble Fellowship, and 2020, the most recent year the NHFP was awarded. Over 1,000 Fellows were emailed and 310 completed the survey. On average, participants received a Fellowship in the year 2008 (standard deviation, SD = 8.13). For those who received two Fellowships, the first year was chosen as the year of the fellowship. The majority of the respondents were Hubble Fellows (n=183, including NHFP Fellows), supplemented by 19 Chandra, 57 Einstein, 6 Michelson, 39 Sagan, and 16 Spitzer Fellows.

The survey (Appendix D) asked participants about the most useful aspects of the Fellowship and Fellow symposia. Participants also completed a number of free response questions, and those data were used to inform and support our findings. A table with all of the means for questions with numerical answers appears in Appendix D.

Separately, a group of current and recent NHFP Fellows, the NHFP Fellows' Equity, Diversity, and Inclusion (EDI) Working Group, conducted its own survey focused on DEIA issues in the Program (see Appendix C). The group presented its findings to the panel and some of those data are included herein. The results of the panel survey are used throughout Section 4 to support our findings.

3.4 Findings Organization

The remainder of this report focuses on the panel's findings. We organized the findings into five broad categories:

- **Mission of the NHFP**
  - How aligned is the NHFP to SMD values, particularly to Leadership and Inclusion?
- **Management of the Program**
  - Are there improvements in the lines of communication and in the general management processes that can ensure a more efficient and effective Program?
- **Application and Review Processes**
  - Are there barriers in the application process that prevent the applicant pool from being as broad and deep as possible?
  - Are the processes in place for application evaluation and Fellow selection aligned to current best practices?

- **Diversity and Accessibility of the Program**
  - How representative of the Astrophysics community are the NHFP Fellows and their host institutions?
- **Support of the Fellows**
  - How supportive of the Fellows' well-being and professional development is the NHFP?

While the themes are well-defined, many of our findings cross the border of two or more of them. This is because the NHFP elements affect one another in multiple ways. This is especially true for DEIA objectives, which permeate most of the findings, a sign that DEIA is a foundational pillar that underlines every aspect of the Program. Each Finding sub-section opens with relevant anonymous quotes from Program stakeholders, including previous and current Fellows, selection review Chairs, and institutional administrators.

Following the findings is the co-Chairs report, providing Recommendations for how to address the stated panel concerns. Finally, in the spirit of continuing the legacy of excellence of the NHFP into the future, the report concludes with a message from the panel to the Astrophysics community.

4. Findings

4.1 Mission of the NHFP

"The 'prestige' factor was certainly palpable; it put me in a cohort of exceptionally successful peers that encouraged me to up my own research efforts."

"One has a sense that the fellowship opens opportunities generally because one is sought out for all manner of things from talks to collaborations."

What is the mission of the NHFP? From what this panel was able to discern given the available documentation and discussions, including the approved Charter for this committee, at present there is not a formal statement of NHFP mission. The most specific articulation of a mission for the Program at present is the following, which is included in the NHFP's opening webpage[2]:

> "The NASA Hubble Fellowship Program (NHFP) supports promising postdoctoral scientists pursuing independent research that contributes to NASA Astrophysics, using theory, observation, experimentation, or instrument development. The Space Telescope Science Institute administers the NHFP on behalf of NASA, in collaboration with the NASA Exoplanet Science Institute (NEXScI) at the California Institute of Technology and the Chandra X-ray Center at the Smithsonian Astrophysical Observatory. The NHFP preserves the legacy of NASA's previous postdoctoral fellowship programs."

The review criteria listed under the announcement of opportunity[3] can also be considered an articulation of the current Program mission:

> "The primary task assigned to the NHFP Selection Committee is to identify the best science programs proposed by applicants, which can span the breadth of NASA Astrophysics. The prime criterion used by the committee in their evaluation is excellence and expected impact of the proposed research. The committee also takes into account the following criteria:
>
> - Results and impact of prior research, including PhD thesis
> - Feasibility of proposed project within the fellowship timescale
> - Evidence of scientific leadership
> - Evidence of service and public outreach activities
> - Sufficient intellectual, physical, and administrative support from the host institution and faculty advisor"

We take the above to be the current operational mission statement of the Program. As for the aspirational mission statement, there is a collective understanding in the Astrophysics community that the NHFP program is ultimately about excellence and prestige: that the NHFP Fellows represent the crème de la crème of the field, the best of the rising cohort of astronomers and astrophysicists in the world. The Fellowship, by virtue of its selectivity and prestige, confers an imprimatur to these rising stars that can be career-propelling, if not defining. Indeed, the panel heard versions of the statement that "the best scientist is selected, not (just) the science" multiple times during the Program presentations.

Our survey of former Fellows strongly indicates that they view the Fellowship as substantially beneficial in positioning them for success. From our survey results, 252 (81.8%) of the participants who responded to the question strongly agreed that a NASA fellowship helped them with their overall career success and another 51 (16.6%) agreed. Only two participants disagreed and three participants were neutral (two did not respond). When asked whether the Fellowship helped them obtain a better faculty or staff scientist role, 152 (52.1%) of the participants who responded strongly agreed and 95 (32.5%) agreed. In this case, 29 participants were neutral, eight disagreed, and eight strongly disagreed. These responses show that the Fellowship is generally perceived by recipients as having significant value in advancing their careers.

It is clear from the surveys of former Fellows (including the former Fellows on this panel), as well as from this committee's discussions with Program leaders, university administrators, and SMD leadership, that the current notional mission of the Program is to serve as a career launchpad for highly promising researchers. While nebulous in form, this understanding is sufficiently broadly held that it has positioned the Program for significant impact in shaping the future leadership of the field, and thus the field itself.

> **Finding 1:** *NHFP is a singularly important vehicle by which NASA SMD can continue to influence the future of the field, through the identification, support, and development of the field's future leaders.*

However, the lack of a formal, explicit articulation of the Program's mission is problematic for at least two very important reasons. First, it is not possible to ensure that the processes of identification and selection of Fellows are fair, equal in opportunity, and inclusive if there is not total transparency—for applicants as well as for reviewers—in what the Program's defining concepts actually mean in practice: "*best science programs*" by what standards?; "*excellence*" with respect to which metrics?; "*scientific leadership*" of what? How is best science used as a proxy for best scientist?

Second, without an explicit mission statement to serve as a guide, it is not possible for the Program to guarantee full alignment with either the overarching SMD vision or with the expectations of the community for what this signature program should produce in terms of human capital for the future of the field. The lack of a mission statement is a major missed opportunity for the Program, allowing inconsistencies and misalignments between constituencies, including the astrophysics community, NHFP applicants, NHFP reviewers, NHFP letter writers, NASA SMD, and other stakeholders.

With regard to the first concern, the common-sense solution, as well as that supported by research and best practice, is that the Program goals and metrics for adjudging applicants be explicitly articulated[4,5]. With regards to the second concern, we refer to NASA SMD's stated Core Values, which set the baseline for programmatic alignment (Section 3.2).

The SMD Core Values suggest a vision of excellence for the future of the field that is characterized by **collaborative, inclusive leadership**, in addition to scientific impact. In our view, this means a future led by individuals who demonstrate the rare but vital combination of competencies, skills, and potential to tackle hard questions and deal with adversity, to build and lead diverse and inclusive teams, to forge meaningful collaborations across diverse collections of people and organizations, and to foster the next generation of diverse leaders. Realization of this vision requires a process for selecting and supporting those individuals that is characterized by **transparency**. Notably, however, multiple participants indicated a lack of transparency in the current application process (see Appendix D).

> **Finding 2:** *The NHFP program does not currently have, and has not historically had, a formally articulated statement of mission. Because its guiding principles of excellence and leadership are not clearly defined, it is not possible for the Program to ensure fairness in its selection process, nor is it possible to assess the degree of alignment with NASA SMD values or the community's expectations for its future leaders.*

4.2 Management, Eligibility, and Duration of the Program

"There is a 3 years after PhD limit to be eligible [for] these fellowships. This poses a disadvantage to anyone who has had to take some time off after receiving their PhD for e.g. maternity leave, personal or family health issues, or many other circumstances, which more often affect candidates in minority or marginalized groups, so modifying that one "3-year requirement" might help."

"Typically, one does graduate school, then moves to a postdoc, then moves to another postdoc after 3 years, then moves to a faculty position. That is becoming less practical as more academics have partners who work. A 5-year fellowship would help with this, as well as giving postdocs the ability to work on more ambitious projects."

The merger of the Hubble, Einstein, and Sagan prize fellowship programs into the NHFP is a success from the point of view of the effectiveness of the program management practices, despite the complex organization of the Program (Figure 1). The managing staff in the HTSP and at STScI consists of dedicated, competent professionals. The NHFP Leads work exceptionally well together, make decisions together, and are proactive in supporting the Fellows in their various needs. The Leads have implemented a number of improvements following suggestions from the past NHFP Merging Committee Chairs.

The panel found that there is space for additional improvement in the support provided to the Grant Administrative Office (GRA): in the lines of communication (Figure 1) among, for example, the Fellows and the Leads; in the process to decide and implement policy changes, such as providing waivers to extend the duration of the tenure; and in the Fellows' awareness and understanding of how the Program is organized and who has responsibility for addressing issues as they arise.

The GRA feels frustration over the additional workload since the merger occurred, as it was not accompanied by added resources. It was also reported that policy and scope changes are often made without consideration of implementation and compliance issues, which are left to the GRA to investigate and explain. The Fellows are unaware of the policy change process and often ask the GRA policy questions that it is not equipped to answer. There is not a clear process for proposing and implementing policy changes.

> **Finding 3:** *There is a lack of resources to adequately manage the expanded NHFP program, and a lack of a defined process by which policy changes are proposed, reviewed, approved (or denied), and communicated to Fellows.*
>
> **Finding 4:** *Policies and constraints (such as NASA regulations and federal law) are not communicated effectively or at all to the Fellows. It is often unclear to Fellows who is responsible for managing certain aspects of the program and thus whom to approach to resolve issues (Figure 1), including situations of harassment and other inappropriate behavior.*

The complicated organizational structure of the NHFP (Figure 1) can impede effective communication of rules and policies, and may result in actions and responsibilities that

are forgotten or disregarded. Additionally, the grant policies were inherited from the HST observing grants program, which awards grants for specific research projects; this may not be the most appropriate framework for the NHFP. For example, while the expectation for HST grant recipients is that they will complete a project, the NHFP includes elements that aim to develop Fellows as scientists. As stated by the Leads in their presentation on Program Implementation, *"... the Hubble grant process, inherited by the NHFP is not always appropriate e.g., completing a specific project using Hubble data vs. enabling fellows to grow as scientists, fostering their careers"* (page 10, NHFP Leads' presentation on June 14, 2021). The Leads reported that in fact, the Fellows are free to pursue science interests very different from the original science proposed in their application. Therefore:

> **Finding 5:** *Inheritance of the HST observing grant policies does not always serve the NHFP well.*

The COVID pandemic has highlighted the need for the Fellowship to be flexible in the tenure period requirement, which is currently three years, as Fellows struggled to juggle their research and the need to provide care to families and friends. We applaud the Program for taking these constraints into account and awarding waivers to the affected Fellows, allowing them to extend the duration of their tenure accordingly. This is an important example of the NHFP implementing a practice aligned with the SMD Core Value of Safety. However, family care or illnesses also occur outside of a pandemic, placing the same burden on the Fellows, as articulated by them in our survey.

> **Finding 6:** *The fact that the Fellowship only lasts three years with no possibility of extension, funded or not, can make it more difficult for individuals who have a partner and/or children whom they need to consider in order to accept the opportunity, and/or for individuals who have an illness that keeps them from working full-time during the Fellowship tenure. Furthermore, as discussed in section 4.5, the NHFP policy to not extend the duration/time of the Fellowship (i.e., not more than three years) limits opportunities for Fellows to explore other career development activities (e.g., teaching, directing programs).*

Similarly, the rules of "three years past PhD" for eligibility for the Program penalizes candidates who had to interrupt their career to care for family or for personal reasons.

> **Finding 7:** *The eligibility criterion of three years past PhD date creates a barrier for applicants who take extensive breaks to undertake career opportunities, care for family, recuperate from an illness, or handle other life circumstances.*

The application process can be a burden for early career scientists. The need to identify the host institutions and hosts early in the application process favors applicants with strong networks or experience. The panel's concerns in this regard include changes in situations after the application is submitted, the reliance on networking to find placement, and a lack of adequate information/training regarding how to apply (e.g., making the application process more accessible, access to resources that can strengthen an application, standardizing formats of CV and statements, etc.). The current application process may favor candidates from the top PhD-granting universities, which provide them with more visibility and resources.

Finding 8: *The choice of a host institution and mentor relies on effective networking and on the visibility of the candidates themselves in the community. This may introduce a barrier to candidates who lack the visibility conferred by graduating from one of the top-10 PhD-granting institutions.*

4.3 Application, Review, and Selection Processes

"Public application evaluation rubric following [DEIA] best practices, more transparency in how fellows are selected, better tracking of applicant and awardee demographics. De-emphasize, anonymize or remove letters of recommendation and postpone choosing host institutions until awardees are given an offer."

"Rethink research and researchers' evaluation. Also increase the n[umber] of fellowships. I believe oversubscription has increased dramatically in recent years. High oversubscription means a lot of selection becomes random."

The NHFP application material consists of a summary of past research, research proposal, CV, and three letters of reference. The letters often play a significant role in the evaluation of the candidates, and it has been pointed out by previous and current Fellows (and selection review chairs) that this emphasis on letters favors candidates from the larger and better known universities, and those with famous advisors.

Finding 9: *There is a lack of alignment between what applicants submit and what is evaluated, e.g., scientific leadership. Evidence for scientific leadership in the current application format comes primarily from letters of recommendation and/or applicants' CVs.*

Finding 10: *There is an exceptionally strong level of diversity among the Fellows in terms of scientific research areas. The breadth and balance of Hubble, Sagan,*

and Einstein Fellows accurately reflect current trends in Astrophysics research. The final set of selected Fellows in the three concentration areas appropriately represents the goals of the original programs and community interests.

Great opportunities exist to increase diversity along almost all the other axes of diversity, however, including demographics of the Fellows, types and geographic distribution of the host institutions, and Fellows' PhD institutions. A group of current and former NHFP Fellows are planning to host online information sessions, and are collecting application materials from former Fellows to facilitate applications from those who do not have access to past applications from peers or mentors. Access to these information sessions and application materials will create greater equality of opportunity for applicants. While this initiative is laudable, it is indispensable that the Program itself be responsible for these efforts, as they otherwise will be hard to maintain.

The NHFP receives a large number of applications (>400) and has a very high oversubscription rate (currently ~17:1). The current approach to reviewing applications is to begin with a triage stage based on five reviews, three from reviewers within the scientific subdiscipline of the applicant and two from a different subdiscipline. The averaged score from these reviews is used to advance ~50% of the applications to ~7 sub-disciplinary panels. Panelists then evaluate the post-triage applications within their science area, with top applications advanced to a Merging Panel, consisting only of panel chairs and a Merging Panel chair, which produces the final rankings.

Finding 11: *Although the NHFP review is time-consuming, with each panelist reading 45-50 applications and panel chairs reading another 20-25, the current workload is not a major deterrent to potential reviewers. There is widespread recognition of the importance to the field of participating in this selection process.*

The NHFP Leads reported that most invitations to members of the community to participate on the selection review panels are accepted.

Finding 12: *The set of applications that is considered by the panels has many more meritorious applications discussed than the number the NHFP can support. The current NHFP success rate (6%) is extremely low. Such a low success rate discourages potential applicants and introduces a significant risk that the selection of awardees is tainted by biases.*

Finding 13: *The Leads reported some additional logistical challenges to virtual selection panels and would favor returning to a fully in-person review process. For example, the Leads reported that some panelists would not set aside time to focus solely on the review of applications but would instead continue with their other duties, such as teaching and/or committee work. An in-person review necessitates almost full focus on review of applications.*

While the NHFP evaluation criteria are communicated to reviewers, the current format leaves the decision of how to weigh those criteria in the triage stage to individual reviewers.

When the panels meet to consider the 50% of applications that have survived triage, there is an effort to build consensus about the weights given to the evaluation criteria, which generally results in more uniform scoring of applications. A total of 8-10% of the original applications make it through sub-disciplinary panel review to be considered by the Merging Panel.

Finding 14: *Contrary to best practices[6], the review process does not provide a dedicated forum for reviewers to discuss and establish shared expectations prior to meeting as a panel, triaging proposals, or making initial rankings, and such discussions do not occur across disciplinary panels at any point. This is a lost opportunity to clearly communicate the NHFP mission, to ensure that triage does not remove competitive applications from further consideration, and to normalize expectations across the subdiscipline panels and the Merging Panel.*

Without an explicit mission statement for the Program, it is difficult to assess the alignment of the review criteria with Program goals and the stated vision of NASA SMD.

Finding 15: *There is a lack of transparency in how NHFP applications are evaluated. Not having clear evaluation criteria creates greater implicit bias in favor of prototypical applicants on the part of evaluators.*

The Fellowship Leads have proposed to formalize the evaluation of applications with a rubric, as suggested by a former Merging Panel Chair, that will establish uniform criteria to define excellence in the Program. The panel applauds the Leads for taking the initiative of developing this rubric. With the assistance of external experts for the formulation of the rubric, we are confident this will result in a valuable and effective new set of evaluation criteria that better reflect the core values of SMD.

Finding 16: *Transitioning to a rubric-based approach to evaluating applications is an important step of a revised review process better aligned with NASA core values. However, this change alone is unlikely to substantially alter who is selected to receive NHFP fellowships without an accompanying rethinking of the application process and materials.*

4.4 Diversity and Accessibility of the Program

"Perhaps NASA could incentivize the choice of other institutions by offering a fourth year (or some possibility of a fourth year) to applicants who do not end up at one of the "big six." Alternatively, it would be nice to find a way to discourage the supplement of NASA fellowships by private institutions' funds that create fourth, fifth, etc. years for applicants who go there. This is an asymmetry that really kills us. The well-funded places get to have these people completely externally supported while not fully spending the endowment on their prize fellowship, and reducing the number of fellow postdocs overall. This is bad for everyone else, including other postdocs! Meanwhile, if a Hubble fellow goes somewhere else, the rich places still get their prize postdocs, internally supported."

"The NHFP should consider capping the number of fellows at a given institution at any given time to something like 1-2, not just limiting it to one fellow per institution in a given cycle. This would put many of the institutions that receive a very large share of fellows on the "not accepting new fellows" list more regularly, thereby forcing candidates to consider other institutions."

Our definition of diversity encompasses all axes: race, ethnicity, disability, gender, sexual and religious preference, geographical location, etc. The panel discussed two primary areas for DEIA: the lack of underrepresented minorities in the groups of selected Fellows, and the lack of diversity in the locations and size of the host institutions. Note, however, that several of the findings of the previous sections are also findings in this section, providing evidence for how one part of the NHFP can affect another. In the following, we focus on race/ethnicity because these data are most readily available.

In the United States, the field of Astrophysics has traditionally been composed of white men and (to a smaller extent) white women. The membership in the AAS, for example, indicates that in 2018, 82% of its members identified as White, 5% as Hispanic/LatinX, and 2% as Black or African American. This is not representative of the United States as a whole[7] nor are the demographics of the NHFP (and other) Fellows over the history of the Hubble, Einstein, and Sagan Fellowship programs, or the more recent history of the NHFP. As NASA does not collect demographic data, the panel distributed a survey

through the University of Colorado at Boulder to understand the demographics of past and current Fellows. Additionally, the NHFP Fellows' EDI Working Group, which is a sub-group of current and past Fellows, disseminated a survey, drafted together with the Leads, to understand the demographics of applicants and selected Fellows for the 2021 program. These data are far from complete, but they do provide a starting point for examining the diversity of fellowship recipients. See Table 1 and Figure 2 for the breakdown of ethnicities for US-based members of the AAS[8] and past (including pre-merger legacy Fellows), present, and upcoming NHFP Fellows (as of Fall 2021); for context, we provide the breakdown for people who received PhDs in Physics (2018 and 2019 combined).

Ethnicity	AAS (%)	All Fellows, as reported herein (%)	Physics PhD[9] recipients (%)
White	82	79	45
Asian or Asian American	9	14	5
Hispanic or Latino	5	5	2
Black or African American	2	0.1	<1
American Indian or Alaska Native	1	NR	NR
Other	2	NR	48
Prefer Not to Respond	4	2	NR

Table 1. *Ethnicity of US-based members of the American Astronomical Society (2018); past, present, and upcoming Fellows (as of 2021, NHFP Fellows' EDI Working Group); and recipients of PhDs in Physics (2018, 2019 combined). NR: Data was not reported. Some totals are greater than 100% because respondents were allowed to choose more than one identity. Categories with <10 respondents are not included. The AAS sum exceeds 100% because respondents were asked to check all that apply. 3% of respondents checked more than one ethnicity.*

In alignment with the SMD pillars of Leadership and Inclusion, the NHFP has an opportunity to promote inclusive leadership, which would enhance opportunities for astronomers of color and astronomers who identify along multiple axes. Through the Fellowship, NASA can broadcast the centrality of DEIA to the Astrophysics community, thereby underscoring NASA's commitment to the future health of the profession. The current structure of the NHFP has missed the opportunity to use the Fellowship as a

vehicle (because of its visibility) to address issues with systemic structures, and improve equity, in the field of Astrophysics. A consequence of enhanced diversity among NHFP Fellows is the need for the community as a whole to support them as they move through their career, to ensure they are retained in the field as they advance into other positions (see Section 6).

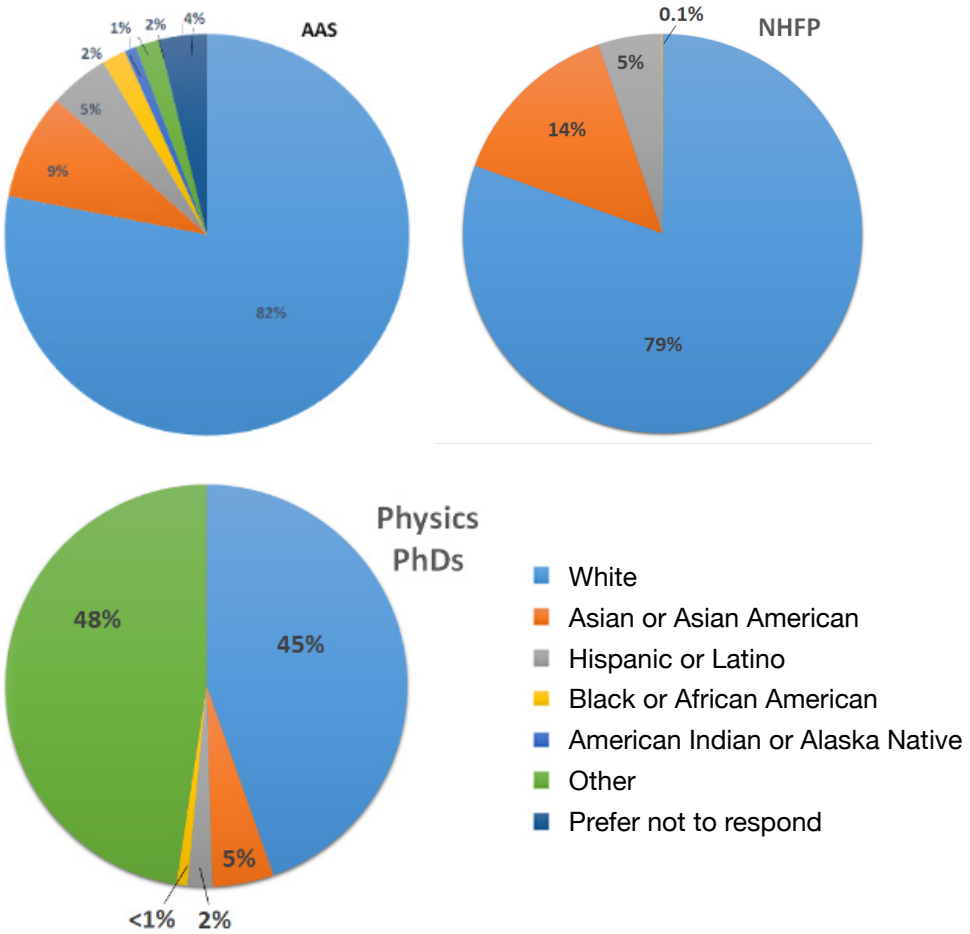

Figure 2. *Graphical representations of the data presented in Table 1. Values for "NR" and "Prefer not to respond" are not included in the NHFP or Physics PhD charts. Some totals are greater than 100% because respondents were allowed to choose more than one identity.*

Finding 17: *The NHFP and previous NASA Fellowship programs have a poor record of awarding Fellowships to astronomers from underrepresented groups, including those who identify along multiple axes. Consensus among presenters to the panel, including past and current Fellows and administrators at academic institutions, as well as panel members, indicates that DEIA, as a component of the application and review, would advance NASA's core values.*

Finding 18: *Lack of demographic information does not allow the efficacy of the NHFP to be fully measured or evaluated.*

The main thrust of the Program, and the loftiest evaluation criterion, is excellence in science, that could be supported by various community-accepted metrics (e.g., number of publications and invited talks, number of citations, h-index, etc.). This focus diminishes the other aspects of being a scientist, and more importantly, neglects to account for biases in these metrics. It also does not take into consideration "soft" skills which are becoming increasingly relevant and necessary in 21st-century Astrophysics. These include inclusive leadership, teamwork, conflict resolution, and management. In keeping with the SMD core value of Leadership, Teamwork, and Inclusion, as defined by the Science Plan, we find that:

Finding 19: *There is a missed opportunity for NASA to use the Fellowship as a vehicle to improve equity of our field, and to set the standards for the inclusive leadership attributes that will define the Astrophysicists of tomorrow.*

The limited number of Fellows' PhD institutions and host institutions does not reflect the diversity of PhD institutions in the field, and the fraction of Fellows who selected a top 10 PhD-granting institution as their host is high. There are barriers both to submitting successful applications from underrepresented minorities and to hosting Fellows at a wide variety of institutions due to the lack of sufficient support or guidance and research resources. See survey comments in Appendix D.

As part of their application, candidates indicate up to three host institutions, listing them by order of preference. The selected Fellow is placed at their host institution in order of the Fellow's ranking, but no more than two new Fellows can be added per year to any given institution, with a maximum of five total hosted by that institution. The current list of host institutions and Fellow affiliations indicates that there is a relatively small number of universities that are common choices among the Fellows, mostly located on the east or west coast of the US. Few Fellows elect to spend their tenure in the midwest and

central parts of the country or at smaller institutions. Allowing two Fellows per year per institution may have a detrimental effect on institutional diversity.

> **Finding 20:** *Only a small fraction of the US institutions host Fellows, traditionally, mainly R1 schools on the east and west coasts. Some host institutions "double" up on this number by virtue of institutional structure that makes them distinct (e.g., JPL and Caltech). This may be unfair to other institutions which are strictly held to the cap.*

Another finding concerning diversity of the NHFP Fellows stems from the observations that the selected Fellows obtained their PhD from many of the same top PhD-granting institutions of the country. While availability of resources to support candidates in their application process could be a reason (see Finding 8 in Section 4.2), another issue concerns lack of knowledge of the NHFP's application and review processes.

> **Finding 21:** *Only a small fraction of US institutions graduate Fellows. A survey of the Fellows found that 40% of them come from the top 10 PhD-granting institutions.*

One of the dominant criteria for selection of the host institution by the Fellows is geographical location. In addition, larger, more well-endowed institutions are able to provide more incentives to attract Fellows, which results in fewer Fellows placed at other institutions. These include telescope access, computing resources, professional development opportunities, and the potential for extra years of support. Less well-endowed institutions can also provide leadership development opportunities to Fellows (e.g., via mentoring undergraduate students, building new research groups, procuring and administering resources); likewise, NHFP-funded Fellows are a tremendous resource to small institutions that may have few (if any) postdocs because they can mentor graduate students, organize events, and add vibrancy to a department. The department can then divert critical resources that would have paid for a postdoc position to other needs. The desire to expand the diversity of the host institutions, as a way to bolster the science accessibility to the community, was expressed by some of the Fellows themselves in our survey (Appendix D) and in conversation with them.

> **Finding 22:** *The lack of diversity in the host institutions represents a missed opportunity for NASA to broaden the impact of the NHFP and provide the Fellows with an increased variety of professional and personal experiences. The addition of a Fellow to any institution, regardless of size, location, or perceived prestige, can be very effective in providing role models and mentoring opportunities for the*

students at the host institution, and multiplies the NASA investment in the Fellow as the leader of tomorrow.

In order to understand why institutions may or may not be selected by Fellows or may or may not have the ability to host Fellows, the panel co-Chairs solicited input from administrators at NASA Centers and universities around the country. For the most part, administrators recognize the prestige of the NHFP and are eager to host Fellows. While many recognize that their institutions cannot provide the same tangible resources or community visibility as their better-known counterparts, they argue that they can offer a variety of career development opportunities that are unique and may appeal to Fellows, specifically those who are interested in teaching and mentoring. Many universities, as members of a consortium of state-funded institutions, can provide access to ground-based telescopes, too.

Finding 23: *Administrators at universities that are not usually selected by (or assigned to) Fellows, as well as those at NASA Centers, report that their institutions can provide unique professional development opportunities that appeal to Fellows.*

It was noted by one of the Administrators that the language of the NHFP Announcement of Opportunity may introduce a bias against non-academic host institutions.

Finding 24: *The language of the NHFP Announcement of Opportunity (AO) contains terms such as "faculty" and "academic institutions" when referring to host institutions, which reflects language used in academia and may represent a bias against non-academic organizations as host institutions.*

4.5 Support of the Fellows

"Leadership and mentorship training would be highly beneficial. At the end of my fellowship, I was transitioning into a faculty role mentoring undergraduate students and leading my first large collaboration with no training in either area."

"In addition to pursuing research that contributes to NASA Astrophysics, the NHFP program could include explicit training in teaching, mentoring, and/or professional leadership."

Fellows are clearly appreciative of the Fellowship and have gone on to successful careers in Astrophysics and other fields. As noted in the introduction, many have become leaders in the field. The NHFP is a tremendous opportunity to encourage early career astronomers

and enable their careers. Nevertheless, our conversations with Fellows indicate a desire for enhanced and consistent professional development opportunities, and that there are large variations in the quality of the support and mentorship they receive, depending upon the host institution and the opportunities it provides. In fact, the challenges for less well-endowed institutions to provide this could be a barrier to those institutions hosting Fellows. This is exacerbated by the prohibition on host institutions to charge overheads on salary and benefits, which may result in fewer resources being available. In addition, Fellows report that there are policy barriers to development activities under the current Program, and a general lack of communication with regards to policies and support (quotes related to this appear in Appendix D). The NHFP should ensure proper support of Fellows' professional development by, for example, supporting opportunities for teaching, mentoring students, and doing outreach at their host institution or NASA Center; participating in professional development workshops and training; and receiving career-focused mentoring themselves.

> **Finding 25:** *Fellows do not feel supported in their professional development, such as developing teaching, mentoring, and outreach skills or leadership and managerial skills. Fellows are disappointed by the lack of opportunities for teaching, mentoring, and outreach and are frustrated by policy barriers preventing them from engaging in such activities.*

> **Finding 26:** *Many Fellows reported frustrations over inconsistent host institution policies that could be detrimental to their health/welfare/finances, such as healthcare for LGBTQ Fellows or lack of paid parental leave.*

As mentioned above, the NHFP should be viewed through a holistic lens as an opportunity to support and encourage future scientists. As such, the program is about more than just the excellence and impact of the proposed science. This is being recognized through the new emphasis on leadership, for example. However, there are still structural and policy barriers in the Program that need to be addressed so that Fellows are encouraged and enabled to pursue non-traditional pathways. See Appendix D for quotes about the timeline of the Fellowship.

As we've described above, there is a strong desire by some of the past and current Fellows, and by the institutions themselves, to diversify the host institutions supporting Fellows beyond the "top ten." This can be done by removing incentives that lead Fellows to choose one over another and by creating incentives for, and communicating the advantages of, choosing smaller or less-endowed universities. We heard from representatives at several universities in response to our informal poll about their desire

to host Fellows, as well as the value to both the Fellow and the institution. Adding a postdoc to a small department with few postdocs can make a big difference by creating vibrancy, adding new research directions, freeing up resources, and providing mentorship to undergraduates and graduate students. An institution that has fewer postdocs can often provide more opportunities for leadership, teaching, and professional development. While the ultimate choice of the host institution stays with the Fellows, NASA should make it clear that it supports a wide range of host institutions.

We also heard from two NASA Centers and several Fellows about the value of holding a Fellowship at a NASA Center. There is a clear level of frustration among Center scientists that this cannot be done. We agree that this is a lost opportunity that needs to be addressed.

> **Finding 27:** *It is a lost opportunity for NASA Centers to not be able to host Fellows directly, without an affiliation with a nearby university. This unnecessary restriction comes from artificial barriers to providing funding to host the Fellows and concerns over access for foreign nationals (understanding that Fellows from designated countries would not be allowed in a NASA Center).*

5. Co-Chairs' Recommendations

"... programs should resist the temptation to select only those candidates with the highest number of first-author publications. They should also consider service work, commitment to advancing [DEIA] in the field, and collaborative work."[10]

"No one is going to write off a Hubble Fellow as "doesn't care much about research" just because they start an Equity and Inclusion Reading Group or spearhead a new mentoring initiative. However, a less 'prestigious' postdoc might feel that doing so would jeopardize their future career."

5.1 Summary

Based on presentations by the NHFP Leads and others who help to administer the Program, results from surveys of past, current, and upcoming Fellows, and presentations by the NHFP Fellows' EDI Working Group, panel members identified five themes that emerged from extensive discussions:

- Mission of the NHFP
- Management of the Program
- Application and Review Processes
- Diversity and Accessibility of the Program
- Support of the Fellows

The themes coalesced from common topics that appeared multiple times in the presentations and discussions, and that allowed the panel to effectively address most of the questions posed in the Charter and by NASA officials (Appendix B). Specific findings are listed in the report, and here we summarize them (F1 = Finding 1; F2 = Finding 2, etc.) and provide accompanying recommendations.

5.2 Recommendations by Theme

5.2.1 Mission of the NHFP

The NHFP is an important vehicle by which NASA SMD can continue to influence the future of Astrophysics. However, the Program does not currently have, and has not historically had, a formally articulated statement of vision or mission, which limits how well the Program can ensure fairness in its selection of Fellows or assess the degree of alignment with NASA SMD values or the community's expectations for its future leaders **(F1, F2, F5)**.

Recommendation 1: *The NHFP program should articulate a clear and specific mission statement that is aligned with SMD Core Values. This should be accompanied by revised processes for the selection of Fellows, and an evaluation plan for the Program, that are in turn aligned with the SMD vision. This will require reimagining the nuts-and-bolts processes (application, review, selection, support) through which the Program's mission is put into practice.*

Recommendation 2: *Review the existing policies and rules of the NHFP within the lens of the mission of the Fellowship, aligning them with the six SMD core values discussed above.*

5.2.2 Management of the NHFP

There are insufficient resources to adequately manage the Program, now that all three flavors are housed together. There is also a lack of a defined process by which policy changes are proposed, reviewed, and approved or denied **(F3)**.

Recommendation 3: *Provide GRA the needed resources to manage the expanded Program.*

Recommendation 4: *Implement a clear process for review and approval of Program policies and policy changes that minimizes surprises and considers implementation issues up-front.*

Policies and constraints in general are not communicated effectively or at all to the Fellows, such that they often do not know who is responsible for managing certain aspects of the Program **(F4)**.

Recommendation 5: *The NHFP needs to establish a more centralized management of the program with simplified lines of communication, ensure consistency with regard to benefits and employment status, and needs to establish a sole point of contact (POC) within the NHFP to communicate the necessary (or requested) changes to a POC at NASA.*

Recommendation 6: *Better communication of policies and paths to change them needs to be provided to the Fellows in a clear and consistent way. At the beginning of their tenure, for example, in an orientation session focused on the "need to know" aspects of the Program management and Fellowship tenure, the Fellows should be informed as to who the POCs are and the process for requesting changes.*

The limited duration of the Fellowship, three years with no possibility of extension, funded or not, can make it challenging for Fellows who have caregiving responsibilities or need to manage illnesses or other personal or family situations **(F6)**.

> **Recommendation 7:** *On a case-by-case basis, grant extensions of tenure to the Fellows whose tenure duration is negatively impacted by personal circumstances.*

Furthermore, the eligibility criteria of three years past PhD date creates a barrier for applicants who take a break to care for family or for illness or other life circumstances **(F7)**.

> **Recommendation 8:** *Remove the three-year criterion. Instead, ask applicants to explain in their applications why they should be considered early career scientists.*

The requirement to choose a host institution at the time of application favors applicants with strong networks and experiences and may introduce a barrier to candidates from underrepresented communities **(F8)**.

> **Recommendation 9:** *Do not require host institution specification on application and do the pairing after selection of Fellows. Establish a more structured and accessible mechanism for matching applicants with host institutions and host advisors. For example, discuss with the selected Fellows the appropriate institution after the award, which empowers the Fellows from underrepresented communities to hold a valuable card for negotiating with the host institution.*

5.2.3 Application and Review Processes

As stated above, valuing inclusive leadership is the mechanism by which the NHFP has a singular opportunity to change the culture of the field of Astrophysics.

There is a lack of alignment between what applicants submit and what is expected by the NHFP Leads when application materials are reviewed, limiting the ability to deduce a holistic view of the applicant **(F9)**. Survey participants indicated a greater need to have criteria that focus on a more holistic view of the scientist and noted known biases in reference letters (see Appendix D).

> **Recommendation 10:** *Ask the candidates to explicitly address scientific leadership in the application.*

Recommendation 11: *Re-envision the necessity or form of reference letters to, for example, remove or anonymize them; provide guidance (e.g., a rubric) to letter writers to avoid bias; or train the reviewers in recognizing bias in the letters.*

There is an exceptionally strong level of diversity among the Fellows in terms of scientific research areas, and the final set of selected Fellows in the three concentration areas appropriately represents the goals of the original programs and community interests. Additionally, there are many more meritorious applications discussed than the number the NHFP can support. However, the current NHFP success rate (6%) is extremely low and may limit applications from and selections of qualified individuals **(F10, F12)**.

Recommendation 12: *The NHFP should strongly consider increasing the number of Fellowships awarded to reach an oversubscription rate (i.e., submission numbers vs. selection numbers) more consistent with those of NASA's other competitive programs and similar fellowships.*

The NHFP Leads reported that most invitations to members of the community to participate on the selection review panels are accepted, so the current workload does not seem to be a major deterrent to potential reviewers **(F11)**.

Recommendation 13: *In considering revisions to the NHFP review and selection process, NASA should not be overly concerned with the impact of revised, and potentially more involved, procedures on reviewer acceptance rates.*

The Leads reported favoring a return to a fully in-person application review process **(F13)**.

Recommendation 14: *Before returning to a fully in-person review process, the Leads should carefully consider the benefits of virtual review panels and the impact that returning to in-person panels may have on the diversity (both demographic and institutional) of the reviewers.*

The review process does not provide a forum for reviewers to discuss and establish shared expectations of the applications prior to meeting as a panel, and there is a lack of transparency in how NHFP applications are evaluated. Because the alignment of the review criteria with Program goals and the stated vision of NASA SMD is not defined, there may be greater implicit bias in favor of prototypical applicants on the part of evaluators **(F14, F15, F16)**.

Recommendation 15: *Ensure that revised review criteria are clearly aligned with the Program mission, and SMD and NASA priorities and vision statements.*

Recommendation 16: *Specific, transparent review criteria will help to ensure that a greater number of qualified applicants, particularly those from underrepresented groups, are able to see the alignment of their experience and expertise with review criteria. Greater transparency will also help individuals who do not have inside knowledge about what makes a good proposal produce more effective applications.*

Recommendation 17: *Enable reviewers to meet before triage to establish a shared set of evaluation criteria and to discuss how to interpret these criteria in light of the NHFP mission and SMD Core Values. Additional discussions about reviewer biases or concerns about applicant proposals, and how to mitigate them, should also occur.*

Recommendation 18: *After creating a vetted rubric, require reviewers to evaluate a combination of successful and unsuccessful anonymized applications from previous cycles before the triage stage to allow for calibration and discussions of expectations and review scores. The shared expectations should then carry over to the review panel discussions.*

Transitioning to a rubric-based approach to evaluating applications is unlikely to substantially alter who is selected to receive NHFP Fellowships **(F16)**.

Recommendation 19: *NASA should re-envision the NHFP review process to incorporate best practices in unbiased, holistic evaluation. This exercise should include experts from the social scientists and may result in, e.g., implementing a dual-anonymous selection review; moving to a two-stage application process; anonymizing or removing entirely letters of recommendation; removing the statement of past work and/or CV components of the application; requiring applicants to not report numbers (e.g., citation rates or h-index); incorporating interviews for finalists; and enabling multimedia submissions; or a combination thereof. The re-envisioned review process would necessarily have to implement and build-in clear mechanisms to reduce bias, including explicit rubric criteria and protocols that explain how the interview process should be conducted (e.g., cameras off during video interviews).*

5.2.4 Centering Diversity, Equity, Inclusion, and Accessibility in the NHFP

Including a DEIA component to the application and review processes will broaden the pool of applicants and may broaden the pool of host institutions. The NHFP could use the Ford Fellowship Program[11] as a model for some aspects of this implementation by considering, for example, how the applicant describes "sustained personal engagement with communities that are underrepresented in the field".

Further, the NHFP, consistent with NASA's values and SMD priorities, should ground DEIA efforts in diversity broadly (e.g., by considering race, ethnicity, disability, sexual and gender identity, geographical location, rural vs. urban community of origin, and institutional diversity, among others). Additional efforts are required to specifically address issues of anti-Black racism in our field; toward this end, the observations by Dr. Sherard Robbins (Chapter 6), are provided not only for the NHFP Program but for the broader astronomy community.

The NHFP and previous NASA Fellowship programs have a poor record of awarding Fellowships to astronomers from underrepresented groups, including those who identify along multiple axes. Finding evidence to the contrary is hampered by the fact that the Program has not collected demographic data. In general, NASA has missed an opportunity to use the NHFP Fellowship as a vehicle to improve equity in the field of Astrophysics, now and into the future **(F17, F18, F19)**.

> **Recommendation 20:** *Consistent with a definition of excellence that features collaborative, inclusive leadership in addition to science, an explanation of previous and planned DEIA efforts should be a required component of the Fellowship application and review. The task assigned to the DEIA component should be broadly defined to allow applicants to describe, for example, personal experiences that demonstrated perseverance to stay in the field or individual efforts that resulted in enhanced access for members of underrepresented groups to scientific knowledge, activities, or facilities.*
>
> **Recommendation 21:** *Collect demographic information to evaluate the efficacy of any revised application structures and probe bias. Additional information could be collected during exit interviews.*
>
> **Recommendation 22:** *The Program should revise the entire structure of the NHFP (application material, evaluation process, selection criteria) through the lens of inclusive leadership and in alignment with the similar SMD core values. This most*

likely will require external expert help from specialists in the field who can identify needed processes.

Only a small fraction of the US institutions host Fellows **(F20)**. This lack of diversity in the host institutions represents a missed opportunity for NASA to broaden the impact of the NHFP **(F22)**.

Recommendation 23: *NASA should reconsider allowing affiliated institutions to host four total Fellows per year, every year, and instead hold the combined total to the same cap as it does for other institutions.*

Recommendation 24: *NASA should develop centralized avenues to provide resources (e.g., telescope access, computational resources) to Fellows at institutions that lack them. NASA should also provide incentives to Fellows attending smaller institutions and better communicate the advantages those institutions can provide. Additionally, consider joint appointments with institutions that are geographically close to one another.*

Only a small fraction of US institutions graduate Fellows **(F21)**.

Recommendation 25: *To reach a wider applicant pool, the NHFP Leads should establish proactive outreach activities (e.g., workshops at meetings of the AAS, the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), and the National Society of Black Physicists (NSBP); virtual workshops) for applicants and other stakeholders (e.g., reviewers, letter writers) in advance of the deadline to provide information about the application process. This information could include how to address rubric criteria in the application materials, as well as information about the review process.*

Administrators at universities that are not usually selected by (or assigned to) Fellows, as well as those at NASA Centers, are willing and able to host Fellows **(F23)**. Also, Fellows themselves report an interest in expanding their activities beyond research during tenure in the Fellowship **(F25)**.

Recommendation 26: *Allow applicants to express interest in both research and additional activities (e.g., outreach, mentoring, service) as part of the application. This may provide opportunities for the Fellowship tenure at smaller host institutions or NASA Centers that actually may be a better fit for those elements. Great science can be and is done at smaller institutions.*

The language of the NHFP Announcement of Opportunity (AO) contains terms that reflect language used in academia and may represent a bias against non-academic organizations as host institutions **(F24)**.

> **Recommendation 27:** *Remove references to academic environments from the AO text and the policy and guideline documents, and make the language inclusive of other non-academic hosts.*

5.2.5 Support of the Fellows

Comments from the Fellows indicated that they would like to have more networking and career-development opportunities and the Program's permission to explore career paths that are not necessarily aligned with their NHFP-funded research. The former and current Fellows who spoke to the panel indicated that there is currently an untapped network of hundreds of former Fellows who could provide career advice or opportunities to early-career (and other) Fellows.

The merging of the former Hubble, Einstein, and Sagan Fellow programs has limited interactions among Fellows of the "same flavor" and resulted in fewer networking and other professional development opportunities. Furthermore, the three-year time period of the Fellowship limits opportunities for Fellows to explore other career development activities such as teaching **(F25)**.

> **Recommendation 28:** *The NHFP should institute a formalized program of professional development support and mentorship of Fellows. This could include conferences and workshops, online or in-person workshops, and individual mentoring from former and current fellows.*

> **Recommendation 29:** *The NHFP should make outreach, teaching, mentoring, and other aspects of career development an integral part of the program and encourage/require host institutions to make these available to Fellows.*

> **Recommendation 30:** *Remove the restriction that prevents Fellows from taking a leave from the program, allowing them to attempt other career pursuits or address sudden family situations.*

Fellows reported frustrations over inconsistent policies for supporting Fellows at their host institutions **(F26)**.

Recommendation 31: *Leveraging its status as a federal funding Agency, NASA should require that Fellows be offered employment status and be given full fringe benefits by the host institution. Current efforts to initiate this by NASA represent a step in the right direction. Consider also providing strong encouragement to host institutions to offer healthcare to significant others and paid parental leave or disclose their policy for benefits etc. so the Fellows can make an informed decision.*

It is a lost opportunity for NASA Centers to host Fellows directly, without an affiliation with a nearby university **(F27)**.

Recommendation 32: *Create a policy that allows NASA Centers to host NHFP Fellows directly. NASA Centers may not be able to host fellows of all nationalities. Non-US citizens considering one of these as a host institution should contact the institution to make sure that they can indeed be hosted there. Even if foreign Fellows may not be allowed to choose a Center as a host, they can choose other institutions, which is already the practice at JPL and STScI, for instance.*

In several instances, the panel was confronted with specific implementation questions (see Appendix B) intended to probe how well the Program supports the Fellows. While we fully appreciate their importance, the panel considers these questions beyond the scope of the review, and more appropriate for another review board, focused on specific directions for implementation.

6. Message to the Astronomy Community Dr. Sherard Robbins, Visceral Change

Dr. Sherard Robbins, PhD, founder and President of Visceral Change, a company based in Tucson, AZ, has over 10 years of experience in DEIA work. As a member of the panel, Sherard contributed specific observations on the DEIA aspects of the NHFP. He has the following comments for the Astronomy community.

Introduction

As an expert and leader in the world of multicultural organizational development, I was able to position myself not only as an active voice in relation to providing clarity and insight on DEIA best practices, but I was also able to formulate a series of observations and findings. I believe these would be helpful not only for NASA as an organization, but for the field of Astrophysics as a whole. My findings are as follows:

Findings

1. Anti-Blackness Predicate

After the deaths of George Floyd, Breonna Taylor, and Ahmaud Arbrey, organizations and institutions around the world began centering their professional frameworks around diversity, equity, and inclusion with a diligence unlike we had seen in the past. Many workplaces were creating training and development opportunities, instituting strategic plans, and reimagining what inclusive spaces looked like. Yet, what is most unique about this change is that the vast majority of the uptick in institutional DEIA work over the past year seemed to stem from these three deaths (George Floyd, in particular); which suggests, in one way or another, an acknowledgement of anti-blackness. Further, many institutions cited not only these three deaths, but anti-blackness directly as the impetus for their DEIA work; yet, none of these institutions explicitly stated, referenced, or acknowledged anti-blackness in their existing work or future work plans.

This theme remained true throughout my work with the Astronomy, Physics, and Astrophysics fields and its relevant organizations, including as a panel reviewer for the NHFP. As a panelist, I found that there seemed to be a greater rhetorical commitment to anti-blackness from the parties involved in the DEIA work rather than a practical one. One obvious reason might be the exclusionary nature of anti-blackness work which almost exclusively focuses on Black issues and not those of other racial and ethnic identities. This matters because, if the focus of one's work is diversity, then inherently the focus needs to be on all identities. However, this becomes a promulgation of anti-blackness

when institutions and organizations use issues that are historically unique to the Black community (such as police brutality) as a stepping stone to gain support for larger issues that do not concern this community directly (such as making a broad case for diversity in general vs. issues that directly involve Black identities)—which is evidenced by the lack of harkening to or recognition of the very events or concerns that launched the DEIA initiatives to begin with.

In the case of the Astrophysics community, it is vitally important to remember that there are multiple layers to diversity, equity, inclusion, and accessibility, and that the community should be aware of what DEIA means to them before shifting towards it. For example, as a testament to the data above (Section 4.4: Table 1 and Figure 2), it stands to reason why a focus on the Black community would warrant more attention. However, if the focus is actually found to be diversity and inclusion as a whole—all-encompassing of many identities—then the approach and its impetus should reflect that. Therefore, I believe that there needs to be a clear distinction for the Astrophysics field to decide whether their predicate for DEIA is grounded in diversity broadly, or whether DEIA is grounded in anti-blackness. Understanding this distinction will help set the tone for how the future of the work in the astronomy field manifests.

2. Excellence through Equity

What seems to prevail in these three fields is this ethos of exclusion, couched in a sense of "tradition", to which many members of the Astrophysics community largely ascribe. Many Astrophysicists struggle with understanding exactly what role DEIA plays in their field as the crux of DEIA work is not simply quantifiable. For example, there has been research done on what is called First and Second Order Changes, where First Order Changes speak to the data driven results (surface) and Second Order Changes speak to the intangible results (deep culture). The argument for DEIA is that equity is not, by itself, quantifiable, but largely measured by institutional and cultural impact. In such a tradition where the norm has been established for decades upon decades, it is only known that one creates space by ***improving*** the "norm," rather than ***amending*** it; although such measures of equity and inclusion would require, in some cases, radical emendation. For example, over the course of the covid-19 pandemic beginning in 2020, even when institutions adjusted their criteria to diversify their recruitment by removing standardized testing and moving towards a partially anonymous application process, studies found that the type of students that gained admittance shared many of the same qualities and, ultimately, identities as those students prior to the implementation of these measures. This suggests, therefore, that the process by itself, is not the issue, but the behaviors (through biases) of the search committees, is as well.

For host institutions, if the culture is such that a particular student profile stands out to the committee (specific GPA, extracurriculars, research topics, past courses…), then whether or not an anonymous process is in place, the committee is still highly likely to gravitate towards that type of student. This is because an anonymous review process does not mean that there is "more space" for recruitment. Thus, it stands to reason that, in the back of the minds of many committee members, reputation and, relatedly, biases are ever present. For the NHFP to be truly inclusive, the two things I find would be most helpful would be to (1) open up the institutional possibilities of their applicants and (2) untrain the biases of the search committee.

Conclusion

In sum, I offer three pillars that might serve as a message to the Astrophysics community at large. These three pillars should help practitioners and agents of DEIA begin instituting the necessary changes to their institutions and organizations in order to shift their cultures of inclusivity.

Pillar 1: Institutions

At the institutional level, organizations must remember to never engage recruitment (diversity) without retention (inclusion). This means that whenever an institution sets out to diversify their hiring or recruitment in order to increase representation, they should have measures in place to support the newly hired individuals' time in the office, and to foster their success, as well. One of the greatest challenges we see in multicultural organizational development is the treatment of diversity as a quota rather than an opportunity. Thus, the reason why I connect recruitment to diversity and retention to inclusion is because diversity in this case, is external and speaks more to the idea of 'representation'—meaning that diversity is something that may closely resemble a First Order Change. This is because one can actually quantify diversity via collecting information on social identity. Whereas inclusion is internal and speaks more to the ideas of value and involvement—which more closely resembles a Second Order Change. This is because significant shifts in inclusion involve intangible victories, such as a positive sense of belonging, investment, and access to opportunities that suggest and foster growth, promotion, and tenure. Some of these opportunities might be found in networking opportunities for communities of color, as well as mentorship opportunities to ensure that guidance and advice are being instilled in an equitable way.

Pillar 2: Community

Social justice is a commitment to upsetting the established order. This means that there are people in this world who benefit from the way things are right now—and who would actually find greater issues with social change than without it. This is not to suggest that

those who benefit are somehow dangerous or problematic, but to acknowledge that they are inherently, consciously, or unconsciously, receiving social privileges by helping to maintain the status quo.

One major way to begin implementing change for DEIA is to move away from our "normal" group of Astrophysicists and begin supporting and encouraging engagement from a more diverse group. Celebrating the diversity that already exists by citing and honoring students' papers and awarding fellowships to prospective students from smaller schools are two simple ways to break away from the traditions of most folks within the field. Ensure that communities of color, women, and other marginalized identities are afforded the same opportunities to find success in Astrophysics by intentionally recruiting them where they are.

Pillar 3: Individuals

Arguably, most importantly, we all must begin to conduct change at the individual level. Sustainable organizational change in terms of DEIA requires two elements—design change and behavioral change (Table 2). Design change involves restructuring the system in a way that allows policies and procedures to be as inclusive and equitable as possible. Behavioral change engages the attitudes and actions of an organization's people in order to create a more inclusive and equitable culture. At the individual level, behavioral change includes attending training and development workshops as a way to continuously or begin to increase one's competence in the work of diversity and inclusion. Resources like books, articles, and diverse scholars are a great way to engage the diversity within your field and to promote that throughout. The idea behind the relationship between design and behavior is that institutions and organizations will ultimately create a workplace whose equitable design allows for inclusive behaviors to exist. Reexamining what the needs of the Astrophysics community are (who is missing, what is not working, etc.) in terms of DEIA would be the most ideal place to begin.

Organizational Design		Organizational Behavior		Sustainable Outcomes
Same Design	+	Same Behavior	=	Same Outcome
Same Design	+	Changed Behavior	=	Same Outcome
Changed Design	+	Same Behavior	=	Same Outcome
Changed Design	+	Changed Behavior	=	Changed Outcome

Table 2. *Organizational Alignment Card (Visceral Change, 2021).*

7. Conclusions

The NASA Hubble Fellowship Program is, and will continue to be, one of the premiere Fellowship awards in the US conferred on emerging leaders in the field of Astrophysics. Its prestige and promise in new investigators will continue to be held to high standards by a well-organized Program, led by dedicated professionals who are to be commended for their commitment.

The NHFP aims at excellence, and the 21st-century Astrophysics landscape calls for more than just scientific excellence (e.g., as measured by number of papers, stature in the field, etc.) if the great challenges of the future are to be met. Teamwork, mentoring, and community building should be paramount for the leaders of tomorrow. A re-definition of excellence to include both science and leadership is crucial for the NHFP, one that fully embraces the six core values of SMD and places a focus on inclusive, collaborative leadership as one of the main defining criteria for the selection of Fellows.

Changing the demographics of the Fellows is imperative for the field, as the NHFP embodies the aspirations, values, and standards of the Astrophysics community. And while "first order" changes have been presented and suggested in this report as the first essential step, a much more challenging endeavor is to change the culture of the community—a "second order" change—to fully reflect the values of diversity and inclusion, without which significant innovation is not possible.

The necessary work behooves all of us. As discussed in Section 6, change becomes possible only when behavior changes—behavior of organizations and of individuals. While the NHFP will find and promote inclusive leaders among underrepresented communities, the burden is next on the institutions and the community as a whole to nurture these leaders, elevate their visibility, and champion them for high posts in order to lead and inspire the next generation.

8. References

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9. Appendices

Appendix A: The Charter for the Review of NASA Hubble Fellowship Program

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

Terms of Reference

Review of NASA Hubble Fellowship Program

The NASA Hubble Fellowship Program (NHFP) supports outstanding postdoctoral scientists pursuing independent research that contributes to NASA Astrophysics, using theory, observation, experimentation, or instrument development. The Space Telescope Science Institute administers the NHFP on behalf of NASA, in collaboration with the NASA Exoplanet Science Institute (NExScI) at the California Institute of Technology and the Chandra X-ray Center at the Smithsonian Astrophysical Observatory.

The NHFP preserves the legacy of NASA's previous postdoctoral fellowship programs. Once selected, fellows are assigned to one of three sub-categories corresponding to NASA's "Big Questions":

- How Does the Universe Work? – Einstein Fellows
- How Did We Get Here? – Hubble Fellows
- Are We Alone? – Sagan Fellows

This review of the NHFP will assist NASA increase the effectiveness of the program and bolster its excellence. The review will use readily available data to assess effectiveness and excellence, and will focus on two main areas:

1. Success of the NHFP under its current structure
   a. How does the NHFP compare to other named astrophysics fellowships in terms of fellow support, career satisfaction, and scientific success of the fellows?
   b. Does the final set of selected fellows in the three concentration areas (Hubble, Sagan, and Einstein) proportionally represent the goals of the original programs and community interests?
2. Diversity, equity, and inclusion of the program
   a. Are there barriers to increasing diversity? Axes of diversity to consider include demographics of the Fellows; types and geographic distribution of the host institutions; Fellows' PhD institutions; scientific research areas.
   b. Is the program equitable? Are the Fellows provided the resources they need to succeed at their host institutions? Are resources proportionally distributed among the three concentration areas?
   c. Is the Program inclusive? Areas to consider: reach of the Fellowship recruitment ad, eligibility criteria for applicants, selection process, host institutions, areas of scientific research.

Appendix A: *Continued*

Some specific questions that can be asked under focus area #1:

- What is an appropriate size of the NHFP given national postdoctoral fellowship standards, national needs in these fields, and NASA's needs?
- Is the balance of Hubble, Sagan, and Einstein Fellows appropriate for the NHFP given current trends in astrophysics research?
- Are there specific instances of policy problems for Fellows and their host institutions?
    - Ascertain problem areas from current and past Fellows and NHFP leadership
    - Identify impediments to success and recommend solutions
    - Are there sufficient lines of communication between the NHFP leads, the STScI Grants Administrators, the HST Project at GSFC, and NASA Headquarters? Do the current lines of communication effectively communicate NHFP policy to the fellows and prospective candidates?
    - Are procedures for Fellows to report harassment or other inappropriate behavior by individuals in their institution appropriate and effective? Are these well-advertised to the Fellows?
- What longitudinal tracking of Fellows' future career paths takes place and how can it be used for improving the NHFP program?
- Are there any long-term concerns for the NHFP program?

Some specific questions that can be asked under focus area #2:

- Is the NHFP Fellow selection review appropriate?
    - When is a proposal "top ranked"? How is proposal success defined?
    - Was bias of any kind observed in the review of the applicants' proposals?
    - Are reviewers' conflicts of interest and situations of real or perceived bias handled appropriately?
- Why wasn't the pool of selected applicants more diverse until recently? Are there things the NHFP can do to realize a more diverse group of Fellows?
    - Which demographic factors are underrepresented in the pool of selected Fellows?
    - Does the NHFP review and selection process (e.g., review criteria and mechanics, triage, letters of reference, final merging process, etc.) create barriers to a more diverse set of Fellows?
    - Are all potentially excellent applicants given appropriate opportunity and consideration?
    - What should be prioritized: awarding this Fellowship on the basis of an applicant's experience and potential growth or selecting scientists who are already very accomplished?
    - What are the demographics of the host institutions and what impact does this have on the diversity of Fellows?

Appendix A: *Continued*

- What are the evaluation and selection criteria utilized and do they impose disadvantages for applicants from non-Tier 1 schools?
- How do we increase diversity in the selected host institutions?

- How can we engage other communities of scientists that could do great astrophysics, like data science PhDs or non-Tier-1 schools?
- How much of the issues regarding diversity, equity, and inclusion are larger issues indicative of the field, and what role can this review play in addressing/resolving these issues?

In addition to these major themes, other areas of consideration for the review panel would include:

- Eligibility rules for Fellows and host institutions
- Does the program foster leadership development for the Fellows; for example, by encouraging community service and mentorship by and for the Fellows?
- Should the purpose of the Fellowship stay the same, or evolve with the changing landscape of how astrophysics research is done (e.g., teamwork, leadership for big projects, etc.)?

This review will suggest appropriate program success metrics and a mechanism for future review of the NASA Hubble Fellowship Program. What data could most usefully be collected to assist future assessments of the program?

The review panel will present its report to NASA by Fall 2021, with a presentation at the Fall 2021 meeting of the Astrophysics Advisory Committee (APAC). NASA will organize a Splinter Session at the January 2022 meeting of the American Astronomical Society for public comment on the review.

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Date: 2021.07.10 14:27:11 -04'00'

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate

Appendix B: Questions from the Charter and from NASA (separate from the Charter) and Some Answers

This appendix includes questions from the Charter and from NASA (separate from the Charter) and some answers.

Charter Questions	Findings	Recommendations
TOPIC AREA 1: Success of the NHFP under its current structure		
How does the NHFP compare to other named Astrophysics fellowships in terms of fellow support, career satisfaction, and scientific success of the fellows?	The NHFP Leads provided data for 17 prized Fellowships, including salaries, travel and relocation expenses, duration of the tenure. Comparison with the NHFP shows the latter is in the average for all variables.	None
Does the final set of selected fellows in the three concentration areas (Hubble, Sagan, and Einstein) proportionally represent the goals of the original programs and community interests?	See Finding 10	See Recommendation 12
What is an appropriate size of the NHFP given national postdoctoral fellowship standards, national needs in these fields, and NASA's needs?	See Finding 12	See Recommendation 12

Appendix B: *Continued*

Charter Questions	Findings	Recommendations
TOPIC AREA 1: *Continued*		
Are there specific instances of policy problems for Fellows and their host institutions?	See Findings 3-7, 26	See Recommendations 3-9, 28-30
What longitudinal tracking of Fellows' future career paths takes place and how can it be used for improving the NHFP program?	The panel is not aware of any longitudinal tracking of the Fellows' careers. Our own Fellow survey provided data to the helpfulness of the award in defining careers; See Mission of the NHFP (Section 4.1), where some results are reported.	See Recommendation 21
Are there any long-term concerns for the NHFP program?	See Findings 19, 20, 21	See Recommendations 1, 2, 22
Is the NHFP Fellow selection review appropriate?	See Findings 14–18	See Recommendations 14–19

Appendix B: *Continued*

Charter Questions	Findings	Recommendations
TOPIC AREA 2: Diversity, equity, and inclusion of the program		
Why wasn't the pool of selected applicants more diverse until recently? Are there things the NHFP can do to realize a more diverse group of Fellows?	The Leads reported that reviewers were more acutely aware of DEI in the last cycle, resulting in selecting a more diverse class of Fellows. See Findings 20-,23 and Section 6	See Recommendation 20-25
How can we engage other communities of scientists that could do great Astrophysics, like data science PhDs or non-Tier-1 schools?	See Findings 20-23	See Recommendations 23-25
How much of the issues regarding diversity, equity, and inclusion are larger issues indicative of the field, and what role can this review play in addressing/resolving these issues?	See Section 6	See Section 6

Appendix B: *Continued*

Charter Questions	Findings	Recommendations
OTHER AREAS:		
Does the program foster leadership development for the Fellows; for example, by encouraging community service and mentorship by and for the Fellows?	See Findings 25, 26	See Recommendations 26, 28, 29
Should the purpose of the Fellowship stay the same, or evolve with the changing landscape of how Astrophysics research is done (e.g., teamwork, leadership for big projects, etc.)?	See Findings 1, 2, 19	See Recommendations 1, 2, 22

B1. Additional Questions to the Panel from NASA (separate from the Charter)

Q1: Is allowing two Fellows per year per institution having a detrimental effect on institutional diversity? What is the right number and cadence?

A1: This is a policy question that pertains to HQ. Perhaps a more pertinent question should be: how can the Program diversify the pool of applicants and selected Fellows to better reflect the multiracial, multicultural dimensions of our society? How does the very low selection rate affect bias, and thus equity, of the process of review and award? See also F23 and R23.

Appendix B: *Continued*

Q2: With respect to allocation of Fellows to institutions, how should the program handle situations where institutions are officially separate but are affiliated (e.g. Harvard / CfA, Princeton / IfA)?

A2: See Finding 22 and Recommendation 23.

Q3: Not everyone can be a NHFP Fellow at STScI or JPL (Fellows from designated countries are not allowed). This policy very likely can't be changed, but is it being made clear to the applicants?

A3: While this question would be better asked of the Leads, the panel suggests providing a specific entry on the Q&A page of the Fellowship with a clear statement to this effect, and in the section about host institutions' choice. Additionally, consistent with Finding 4 and Recommendations 4 and 5, the panel suggests holding workshops at professional meetings to disseminate information on the NHFP policies and processes.

Q4: There appear to be insurmountable barriers to hosting NHFP Fellows at NASA Centers (except JPL). Is this appropriate? If not, what policy needs to be changed?

A4: See Finding 31 and Recommendation 32.

Q5: Fellows are normally required to be resident in the US. This policy was waived (we think) during the COVID-19 pandemic. What does the panel think about allowing the waiver to continue? Under what circumstances should such a waiver be allowed and what conditions should apply?

A5: No finding.

Q6: What policy is preventing some or all NHFP Fellows from receiving paid parental leave and how should it be amended?

A6: The understanding of the panel is that parental leave and other benefits are provided by the host institution, and depend on the status of the Fellows at that institution. It is suggested that, in order to receive as many benefits as possible, the Fellows be considered full employees at the host institution.

Appendix B: *Continued*

Q7: In your view, is the NHFP primarily a career award or is it primarily awarded on the basis of the proposed work? What is the right balance between these two ways of judging merit?

A7: This question touches upon the meaning of "excellence" for the Program. As discussed in detail in the Findings sections, the panel is recasting the meaning of excellence to include collaborative, inclusive leadership (Finding 9), and alignment with the six core values of SMD (Recommendations 1, 6, 17, and 22). It follows that neither past nor proposed work should be the dominant criterion for evaluation of the Fellows, but rather there should be a holistic approach that takes into consideration all six SMD core Values (Recommendations 10 and 19).

Q8: Is dual-anonymous evaluation of the NHFP applications possible and/or desirable?

A8: There are pros and cons to the use of dual-anonymous peer review (DAPR) for the NHFP. On one side, preventing the reviewers from knowing the identity of the applicants would remove biases related to status and pedigree of the applicant; on the other side, it would disfavor applicants from under-represented communities who would not be able to share their stories and be evaluated holistically.

The panel discussed possible workarounds. For example, the review could be conducted in two stages, with the first stage being dual anonymous and the second relying on known identities of the applicants, or eliminating reference letters altogether in a DAPR situation. While a fully DAPR review/evaluation would safeguard the anonymity of the applicant, it may not allow for a holistic evaluation at the same time.

The suggestion is to focus on enhancing awareness of bias in the reviewers, and on revising the evaluation rubric to include specific evaluation criteria which would direct discussions on the application's alignment with NHFP mission and SMD vision statements. See Recommendation 19.

Appendix C: Presentation by current and past fellows

A subgroup of current and past Fellows, the NHFP Fellows' EDI Working Group, disseminated their own survey to past, present, and upcoming Fellows to collect demographic and other information for the Program. They presented their findings to the NHFP review panel on June 28, 2021. Requests for this presentation can be made to Dr. Michael Zevin michael.j.zevin@gmail.com.

Appendix D: NFHP Review Panel Survey Questions, Results, and Free Responses
(Dr. S. Johnson, 2021)

This appendix includes the survey questions[12] and results of the survey disseminated to past and current NASA and NHFP Fellows by the NHPF Review Panel. It also includes comparisons to other survey and community demographic data.

D1. Demographics
Demographic data were collected by the NHFP panel. Details can be found in Table 1 and Figure 2 in the main document, and Table D1.

Table D1. *Demographics of the NASA and NHFP Fellows compared to AAS membership and recipients of PhDs in the Physical Sciences.*

	2021 NHFP Applicants (n=332)[13]	All NASA and NHFP Fellows (n=310)	2018 AAS US-based Membership (n=2027)[14]
Men	62%	64%	67%
Women	34%	33%	31%
Other Gender	0.5%	1%	1%
Prefer Not to Specify	1.5%	2%	2%

	2021 NHFP Applicants (n=332)	NHFP Fellows (2018-Present, n=98)	All NASA and NHFP Fellows (n=310)	2018 AAS US-based Membership (n=2027)	PhDs in the Physical Sciences 2019[15]
White	59%	72%	74%	82%	77%
Asian or Asian American	26%	19%	12%	9%	10%
Hispanic or Latinx	8%	7%	8%	5%	7%
Black or African American	3%	0%	0.4%	2%	2%

Appendix D: *Continued*
Table D1: *Continued*

	2021 NHFP Applicants (n=332)	NHFP Fellows (2018-Present, n=98)	All NASA and NHFP Fellows (n=310)	2018 AAS US-based Membership (n=2027)	PhDs in the Physical Sciences 2019[17]
American Indian or Alaskan Native	0.5%	0%	1%	1%	0.2%
Other	--	--	3%	2%	4%

D2. NHFP Review Panel Survey Questions and Responses

D2.1 Responses to the Program in General

We asked participants the degree to which they felt supported by their fellowship and the participants indicated a high level of agreement that they were supported by the program and that the logistical support and compensation were positive. There were no differences by race or gender here.

1 = strongly agree 3 = neither agree nor disagree 6 = strongly disagree

Table D2. *Responses to how well the Fellowship supported the Fellows.*

	M	*SD*
The fellowship supported me in general.	1.48	0.77
The logistic support was timely and programmatic.	1.75	0.87
The compensation provided by the program was satisfactory.	1.36	0.75

We also asked the following question "Please indicate the degree to which you agree with the following statements. The fellowship program helped…."

1 = strongly agree 3 = neither agree nor disagree 6 = strongly disagree

Lower numbers indicate a more strong agreement. Therefore, from the means, most participants indicated that the program helped mostly with their overall career trajectory and the visibility of their work and least with winning scientific awards and receiving tenure (many individuals have not yet received tenure).

There were few differences by gender or race. However, one difference is that women indicated that the fellowship was more helpful for them in earning scientific awards compared to men. White participants indicated that the fellowship did a better job connecting them with mentors than people of color.

Table D3. *Responses to how the Fellowship helped...*

	Overall	
	M	*SD*
with my overall career trajectory.	1.20	0.47
connect me with valuable mentors.	2.18	1.01
form new collaborations.	2.13	1.00
increase the visibility of my work within the community.	1.61	0.73
learn about other work being done in the field.	2.17	0.95
me obtain other funding opportunities.	2.27	1.00
me obtain a better faculty/staff scientist role.	1.72	0.95
obtain a promotion in my job.	2.77	1.21
earn scientific awards.	2.90	1.12
earn tenure at an academic institution.	2.79	1.28

D2.2 Sample Quotes about Transparency

Make the application process more transparent. Give examples of successful applications. Have a "prospective applicants" section on the website with an example timeline for applying (what sorts of preparatory work are necessary in the earlier years to be a successful applicant, etc.).

I don't necessarily think the requirements need to change, but the selection process should be more transparent and holistic.

The eligibility criteria are not very transparent, so actually having a clear selection process would be a good first step. Some kind of dual anonymous selection (at least on the proposal) could be trialled.

D2.3 Sample Quotes related to Needing More Professional Development

Could include more professional development opportunities specifically about leadership and/or team building. Like, how do you start a group and make it successful and inclusive?

Prepare future leaders for the field, where leadership is broadly construed to include all of the ways in which researchers are expected to contribute to the academy and society.

More of a focus on diversity, equity & inclusion. Maybe have seminars and workshop on team building and developing leadership skills.

D2.4 Sample Quotes about Holistic Application Criteria, incl. Leadership

I get the sense that fellowship evaluation strongly depends on the number of publications and letter content. Perhaps the evaluation could be more holistic—e.g., include community involvement and outreach. Take into account barriers that the applicant has faced that may affect their productivity during graduate school.

Make diversity of background, experience, and/or leadership potential an explicit criterion. This will convey better than anything else that diversity is actually valued, and the result will naturally be a much more diverse applicant pool.

I suggest that selection criteria be expanded for leadership to include evidence of advancement of equity-forward values as a stand-alone criterion, such that a candidate otherwise excellently rated, but with no demonstrated track record in advancing cannot be as highly ranked. Selection committees to be: (i) be trained in unconscious bias; (ii) include experts and/or training in how to recognize and evaluate equity-forward leadership; (iii) include stakeholders, e.g. early career astronomers, including those from underrepresented groups. Equitable competition in the selection of leaders and the committees that shape the direction of the field.

D2.5 Sample Quotes about Letters

Not sure what they [the fellowship criteria] are now. Less emphasis on letters of reference would be good, more flexibility about timelines, recognition of value of broader range of research outputs (not just refereed papers), e.g., contributing code and data sets to the public, participating in planning for future facilities and policy-work. Mentoring and outreach could also be important part of evaluation.

Put less emphasis on recommendation letters (especially from older men) and run interviews for potential candidates.

Requesting letters of recommendation as part of the application package can put applicants from underrepresented groups at a disadvantage, with biased language from a single letter drastically decreasing their chances of success.

D2.6 Sample Quotes about Timelines

More flexibility in the time between PhD and the award to recognize differences in career trajectories and family commitments (not just parental leaves) and also the effects of the Covid-19 pandemic which has affected different researchers in dramatically different ways

Could consider 10 year from PhD range for non-traditional applicants/those who have taken time off.

Maybe should add some flexibility for the fellowship timeline to individuals who have taken non-traditional career paths, and make that explicit.

D2.7 Sample quotes about institutions

Yes. The institutional representation of Fellows is gross. It is nearly always the same ~10 institutions that host Fellows. The limit on the number of fellows per institution per unit time should change dramatically (Princeton, Caltech, Harvard, and Berkeley do not need a fellow every single year). Paper count is not a good metric.

The programs should consider updating rules that prevent a small minority of institutions from dominating where fellows are sent. Here, (e.g.) rather than allowing an institution only one fellow per year (which, in the case of, say, 5 fellowship awards per year, means that roughly the same ~5 institutions host fellows every year), the timespan could be broadened to allow fellows only every few years. Such an approach may also help with IDE efforts, as fellows would begin to select increasingly diverse locations for their fellowships, and many of these new (previously underused) institutions likely have more-diverse undergraduate populations (and maybe even graduate populations), thereby raising visibility of these fellowship programs to under-served groups.

The program should be sure that the Fellows are widely distributed among U.S. institutions. Having most of the fellows go to just a few places isn't a good idea since it facilitates the re-elitization of Astronomy. For example, the program could offer incentives for Fellows to choose to work at non-elite places.