The Importance of Policies: It's not just a pipeline problem

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Synopsis

1. **Continue towards a truly open science approach in Heliophysics**
2. **Find new solutions to provide more stability to soft money scientists**
3. **Work towards more accessibility and equity across different sections of our community**
4. **Government institutions like NASA and NSF support and provide trans-institutional Human Resource (HR) support for safe, anonymous reporting and mitigate the victim's career risk as much as possible.**

1 Introduction

For decades, a leaky pipeline analogy has been used when discussing diversity issues in STEM fields. However, this imagery is overly simplistic and does not capture critical issues that contribute to people leaving the field. It puts distance between structural issues, our actions, and why people leave the field. When we view our research structure as something more complex, we can start taking ownership and frame more impactful solutions instead of misidentifying important issues and providing ineffective short-term solutions.

Many of the issues discussed in the "Cultivating a culture of inclusivity in Heliophysics" position paper have counterparts within our policies and our institutions. To fully address and mitigate the current issues within our field, we have identified a need to cultivate a positive, safe, inclusive, and effective environment. However, we need both cultural and programmatic changes. We will try to identify systemic issues that inhibit many from fully participating and potential solutions, as well as groups and fields producing best practices for creating and enabling effective environments where innovation can occur.

2 The scientific process

Science occurs through collaborations, but we have not always acknowledged this [1]. Discoveries increasingly require scientists to cooperate, evidenced by the increasing size of scientific collaborations [2]. How we do science and collaborate directly impacts the results we achieve. How we build collaborative teams, mission teams, proposal teams, and even the selection of conference coordinators, chairs, and speakers impacts who can participate in science. Perhaps even more importantly this also determines who drives the conversation about how our science questions should evolve [3, 4].

Open Science: Open Science has many schools of thought, but it is based on a few key ideas: open data, open code, and open journals. All of these lower barriers of entry to science and help with the reproducibility of scientific results. Some groups within our field are already adopting these best practices, and groups like TOPS are working to make the field more open [5]. The Python development community within heliophysics is one such community. Best practices identified for open code are referenced in [6].

Best practices in team formation - a move away from collaboration cliques. : Science is a team endeavor. The formation of teams impacts who participates and how science is conducted. Science of Team Science (STS) is a field of research that looks at how scientists work best within teams, and collaborative environments [7, 8]. The National Academies has reviewed the STS, and best practices for different types of teams (geographically dispersed, culturally diverse, different types of leadership, etc.) [3]. The field of Team Science will allow us to more easily link the sciences to other disciplines such as industry or the humanities, which is vital to our goal of achieving a more diverse, inclusive, and safe research environment [9, 10].

For instance, it matters who is invited to a given team's very first or first few meetings. Inviting only those we think of first, typically those who look like and have similar backgrounds to ourselves, when forming a collaboration or a proposal team is exclusionary. It limits knowledge transfer between groups and a team's ability to identify blind spots. If diverse people are added later in the process, they have missed out on the opportunity to become essential. Individuals added later must expend extra time and effort to catch up to the rest of the team. This may include learning the team's jargon, tools and codes, and background of the work. This inhibits an individual's ability to be a fully functioning member, and some infer an inability of new team members to be constructive contributors. Thus, new members need to have support and resources to be able to come up to speed and feel that they can be full members who belong to the team. Subsequently, when minority and underrepresented groups within our community are continually added after initial meetings they will continue to feel looked over, secondary, and that they are not fully valued.

Interdisciplinary scientists and projects require a home: Interdisciplinary expertise is required to understand the interconnectedness of the heliosphere. Therefore, making it easy to participate in multidisciplinary work is necessary for Heliophysics to flourish beyond the advancements made in the past decades [4]. The high-level best practices in the Science of Team Science lead to effective teams, improved creativity, and innovative scientific results. Often, we see that individuals who do interdisciplinary work are not considered to belong to any sub-field and find themselves at times out of these close networks. It is crucial to make decisions for hiring and committee appointments where interdisciplinary expertise is considered a strength.

Similarly, genuinely interdisciplinary projects often struggle to find a funding source, as funding agency divisions may not consider interdisciplinary proposals as core to their objectives. Likewise, interdisciplinary science questions are often not seen as compelling by review panels who are often looking at very focused science topics with clear outcomes. A possible way to mitigate this is to build funding sources and academic departments within the field, whose core objectives are to foster interdisciplinary projects, such as **a trans-, or interdisciplinary division within NASA**, recognizing the potential for scientific discoveries in our field in the vast unknowns between disciplines.

3 Soft money science

Most of us will be or have been on soft money for at least a portion of our career [11]. The Heliophysics community often regards soft-money positions as temporary, being filled by graduate students or early career researchers. However, many members of the Heliophysics workforce are supported by soft money throughout their careers. Soft money positions can have benefits, such as fewer or no teaching obligations and greater flexibility in work locations and hours, but there are also pitfalls. Some difficulties that soft-money employees encounter are directly related to HR and grant and contract policies of their employers and funding agencies. Heliophysics research can bring millions of dollars to universities and other institutions, but the departments and investigators

who secured this funding often see little or no return on their overhead. For example, the facilities and administration (F&A) costs charged by universities on grants and contracts that support soft-money employees may go directly into the general education funds of these institutions. This can make it difficult for departments to provide adequate computing resources, laboratory access, office space, and furniture to soft money employees, as these things often cannot be directly paid for by grants and contracts. Additionally many institutions include a separate line item in grant/contract budgets for fringe benefits. When soft-money employees are classified as full-time, regular employees by their institutions, they usually receive these benefits. However, soft-money employees classified as temporary or independent contractors may not have access to these benefits, providing little incentive for these individuals to continue working in Heliophysics. **Policies that encourage hiring full-time employees over temporary workers would contribute to a more stable, experienced Heliophysics workforce.**

The short time frames and budgets of grants and contracts drive the need for soft money researchers and employees working at full cost accounting institutions to write new proposals constantly. Anxiety over job security can motivate researchers to leave academia and the field. For example, researchers with Ph.D.s supported through soft money are often regarded as less capable than those holding tenure-track faculty positions even though they are equally qualified. Many soft-money researchers mentor students and post-docs, manage projects, and serve on service committees. In effect, soft-money researchers carry out many of the same duties as faculty. Still, they are often ineligible for many opportunities that support professional development, mentoring, and large-scale or long-term projects (e.g., NSF CAREER awards, Major Research Infrastructure). Including soft-money researchers in these policies and proposal calls would help ease the anxiety and improve the Heliophysics workforce morale. For example, the overhead allocation to support bridge funds could support all employees who are in between grants for a month or two. Another idea would be to return a fixed portion of each grant's overhead (2%, 5%) directly to each researcher on the grant and pooled into a discretionary 'rainy day funds' that does not expire. **Every step to improve financial and funding security helps keep people in Heliophysics.**

4 Accessibility and Equity across different sections of our community

Many communities within heliophysics have different needs to *fully* participate in day-to-day science activities. For example, physics buildings at research institutions are often old and "grand-fathered" into not meeting ADA requirements. Due to the lack of funding at many institutions, these challenges are not adequately addressed, and the burden falls on the disabled individual to navigate campus support. While renovating an entire building may be impossible under budget constraints, we must consider more minor things, including retrofitting automatic doors on restrooms or wheelchair lifts. Additionally, participating in conferences is physically demanding and presents limitations to many. One often must move quickly from a poster hall to another room to catch a talk. Scientists with physical limitations may stay in one area and miss out on other opportunities. If one cannot stand for several hours in a poster session, they can request chairs, but this can also

cause issues. If one is in a chair, one cannot support a crowd of people visiting their poster. The standards for ADA accommodations at conferences need to change from special requests which burden the disabled individual to standards that present minimal barriers to networking.

There are many more elements than conferences and building layouts that can be adapted to make community members feel welcome. Unfortunately, we are not able to list them all in this paper. Still, we have tried to highlight some key areas where more work is needed surrounding accessibility and equity across different sections of our community:

- **Consider the needs of those with visible and invisible disabilities in the initial phases of policy making and planning.**
- Accommodation for scientists with disabilities (e.g. teleworking, virtual conference participation)
- Reasonable deadlines that fit into the Month long clearance processes that many within our community are tied to.
- Family care inclusivity and equity
  - Child/family care grants including care at conferences and support at home,
  - Ability to work half-time for an extended periods
  - Continued support for family leave
- Reduced costs of participating in our field, e.g. the cost of conferences, laptop computers, software, and publishing in and reading journals.
- Hybrid or fully online options for conferences and workshops- mitigates issues with travel. Many smaller workshops found that more people attended from a larger set of geographic institutions during the pandemic as the barrier of travel costs were removed.
- Encourage open science practices such as using freely available coding languages (e.g. Python, Julia), publishing in open access journals (e.g. provide NASA/NSF funding for gold open access like NERC/SFTP), and making our research open will enable more people to participate as well as enhance the reproducibility of scientific results.

5 Promoting hybrid meetings.

With the increasing pace of technology and online connections tools, we have greater flexibility than ever in how we collaborate. We are no longer limited to being in the same physical space for meaningful discussions. There are benefits and challenges unique to in-person or virtual collaboration. Hybrid meetings allow for the best of both worlds: more accessible in-person discussions and networking for those who can come on-site and the ability to contribute viewpoints and scientific debate for those unable to travel. However, we must be careful that this physical separation between on-site and online colleagues does not also produce a "participatory" bias. Care must be taken in establishing the culture/norms of these hybrid meetings ensuring online voices are adequately heard. Some possible suggestions include:

- Having someone on-site with the specific responsibility for raising the voices of those not physically present (e.g. reading out questions, raising a hand on behalf of a virtual participant).
- Having laptops/phones/etc out for engaging with the remote team members via chat.
- Dual online/in-person poster sessions; webcams and screens for live chat with online participants
- Asynchronous collaboration: e.g. recorded talks, persistently available poster access, question and answer in a message board format

6 Common, collaborative, affordable tools.

Science is a collaborative endeavor and is often done best when we collaborate across institutions. However, many institutions, especially within the government and industry sectors, limit employees' access to different collaborative tools. This impacts the ease and effectiveness of collaborations across institutions. Additionally, we have many different tools for virtual collaboration available to us. Today, we can communicate and collaborate via options as diverse as Email, Google Meet, Stack Overflow, Overleaf, Github, and Jupyter Notebook. However, this also means that there are a large number of spaces we have to monitor. Finally, although internet-based collaboration tools may always be "on," we must develop a culture that does not necessarily expect us always to be on and interacting with those tools. A healthy balance between synchronous and asynchronous collaboration will maintain connection and productivity. Whether it is a feeling of isolation because your institute doesn't support a specific tool, e.g., Overleaf, or a feeling of constant work leading to burnout, our collaboration tools and relationship with them can greatly impact how welcome we feel within the community.

7 Need to address Power imbalances

In the current academic infrastructure, there is inherent unbalanced power at all career levels. Whether it is a graduate student at the mercy of their Ph.D. advisor, a postdoc who is unsupported by their supervisor, or a senior scientist who experiences unhealthy dynamics with their mission PI, these individuals deserve a structural system that allows them to report abuses and harassment safely. Everyone deserves to be able to exist in a safe environment to perform their research, see abusers held accountable, and help ensure our field is safe for those who come next. In short, they deserve a chance for justice [12]. **We must build institutional systems that check power imbalance, such as dual anonymous reviews [13, 14].**

8 Accountability for Both Good and Bad Behavior

Accountability is a necessary but complex topic. We want to acknowledge that people can grow and change. However, we need precise mechanisms for reporting and accountability for bad actors and continual harassers. At the moment, there is an actual quantifiable risk to their careers and reputations to people who bring forward complaints (See "Picture a Scientist", the 2017 documentary). This can include further implicit bias when the harasser, or supporters of the

harasser, review papers and proposals. While the risk may never be zero, some mechanisms can help mitigate this risk and address other issues of bias.

There are currently no actual accountability mechanisms in place for unethical behavior. The current institutional mechanisms are fundamentally flawed. Non-Retaliation policies only apply within an institution – but our careers require us to transcend communication across institutions and around the globe. There is currently no non-retaliation policy for influential scientist to convince their powerful peers that their subordinate is unworthy of employment. The Geoff Marcy case is just one example of how powerful scientists can maintain positions of power and continue to influence individual careers and the culture of a field [15].

Consequently, individuals have an inherent career risk of reporting harassment and seeking justice for enduring harmful working conditions. This is unacceptable and must be addressed immediately. Therefore, we recommend that government institutions like NASA and NSF create trans-institutional Human Resource (HR) support for safe, anonymous reporting. As harassment can occur and impact a person's career at any stage, scientists from all career levels would benefit from trans-institutional HR support.

Funding institutions such as NSF and NASA can help hold researchers accountable is to create an ombudsperson role for missions (institutions within themselves) and non-mission-related funded projects (such as a proposal call). These ombudsperson roles can start as an extension of a Project Scientist on a mission (or equivalent point of contact on proposal calls) and eventually be integrated into a newly created position to ensure maximum accountability for unethical behavior in all forms.

9 Recommendations

Individuals need the support of organizations to help create a culture of inclusion, openness, and innovative science. The recommendations below help empower individuals and institutions to ensure our community is welcoming to all.

- Work more closely with experts in the Diversity, Equity, Inclusion, Accessibility, and Justice (DEIAJ) research community and adopt the best practices they have identified for creating a positive climate and culture for our field.
- Create a database of resources and models/frameworks for cultivating an open and inclusive climate.
- Create and maintain clear and easily accessible tools for reporting bad conduct as well as a way to hold individuals and institutions accountable.
- Coordinate across agencies to bring awareness to reports of harassment. Create and maintain a list of convicted harassers shared within the field. This is one way to address the challenge of the disconnect between institutions/societies/organizations/funding agencies etc. when it comes to reporting harassment.
- Create effective and thorough protection regarding retaliation for reporting cases of harassment, especially in imbalanced power dynamics (faculty vs graduate student, civil servant vs contractor,

so on).

- Enable access to bystander/allyship and other types of training to encourage fundamental change by enabling people to speak up and act when they see something.
- Codify codes of conduct for the field, e.g. mentoring relationships, workshops, or committees.
- Address wage gaps. While not discussed here, this is an important issue as to why some people leave the field.

Not everyone is yet convinced that having a culture where all are respected, accepted, and welcomed will benefit science. Likewise, not everyone is yet convinced that these issues affect them, are something they should worry about, or are something that they have control over. Therefore it is important to emphasize the following:

- Equity and inclusion benefit everyone.
- Both intentional and unintentional actions by peers and organizations have a major impact.
- Everyone has unconscious biases. The key is to understand them and implement a conscious ethic of identification/detection and mitigation.
- Antiracism is an important principle to understand. It focuses on what we are doing to address racism at all levels and encourages all to help eliminate both individuals and institutional racism.
- Power imbalances, particularly indirect power imbalances, do impact careers.
- People tend to interact socially (both at work and after work) with people they feel most comfortable with. This can result in exclusion from important connections, access to networking opportunities, and in severe cases, the climate phenomenon of "invisibility."
- Microaggressions are commonplace, often unintentional, actions that contribute to a climate of exclusion or hostility. Studies show that many identify microaggressions integrated over time as more harmful and damaging than explicit racism or sexism.

Parts of our culture and set of policies systematically push parts of our community out of heliophysics. For example, while we often use metrics such as the number of scientific publications to determine promotions and awards. Meanwhile women, non-binary, and people of color typically have disproportionate DEIAJ and service responsibilities pulling them away from their research and writing paper. If the burden of growing, supporting, and retaining an inclusive community falls disproportionately on a subgroup, it should be recognized and valued professionally. If this same subgroup is also disproportionately subjected to implicit and explicit biases, we will continue to see a leaky pipeline. Allies, and our institutions much change the culture, our policies, and our spaces to support everyone. Otherwise, these very actions aimed at improving DEIAJ are having the opposite effect and end up pushing these groups disproportionately out of the field.

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