frontiers | Frontiers in Astronomy and Space Sciences

TYPE Review
PUBLISHED 23 March 2023
DOI 10.3389/fspas.2023.1152567

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Space Physics, a section of the journal Frontiers in Astronomy and Space Sciences

RECEIVED 27 January 2023
ACCEPTED 13 March 2023
PUBLISHED 23 March 2023

CITATION
Liemohn MW, Linderman JJ and Settles IH (2023), Space physics guide to STRIDE: Strategies and tactics for recruiting to improve diversity and excellence.
Front. Astron. Space Sci. 10:1152567.
doi: 10.3389/fspas.2023.1152567

Space physics guide to STRIDE: Strategies and tactics for recruiting to improve diversity and excellence

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The space physics research community is not diverse. This is especially true at the senior experience levels, but is even true for our student populations, which are also not matching the demographics of the general public. Striving towards a demographic shift to match the general population promotes equity and inclusion. In addition, diversity increases research productivity. Unfortunately, bias exists, including within the space physics research community, and this negatively impacts hiring practices and perpetuates the demographic mismatch. Yet there are many strategies and tactics that can be adopted to counter this problem. A number of these methods are presented and discussed, specifically those regarding the search process for hiring new research group members. The key methods for achieving an equitable search process are as follows: develop a holistic rubric early, even before the job ad is posted; slow down the downselect from the full applicant pool to the short list of finalists so that the rubric can be carefully applied to each candidate; make the interview process as equitable as possible by considering the ways in which it could be biased; and conduct a fair decision-making process that focuses on the job-relevant criteria and avoids global rankings until the final vote.

KEYWORDS

space physics, equity, DEI, NSF ADVANCE, hiring, demographics

1 Introduction

1.1 Diverse teams lead to better space physics

Research has been conducted to study the effect of homogeneity or diversity within teams. Diversity is defined broadly here: gender and gender expression, race, ethnicity, geography, cultural heritage, sexual orientation, disability, and life experiences, to name a few. The argument for the homogeneous team approach is that, because the members act similarly and come from similar backgrounds, they will "mesh well" and have less conflict and faster decision making. The argument for the diverse team approach is that, because the members come to the group with many different perspectives and life experiences, they will consider problems from a variety of angles and therefore reach better and more creative solutions to problems. Which of these two paradigms is supported by the research?

TABLE 1 AGU space physics section gender information from the 2018 membership demographics report.

	Student	Early career	Mid-career	Experienced	Retired
Aeronomy					
Female	29.4%	28.0%	16.9%	9.3%	2.7%
Male	70.0	71.1	82.1	90.1	97.3
Prefer Not to Answer	0.6	1.0	1.0	0.6	0.0
Magnetospheric Physics					
Female	32.4	26.4	17.5	9.2	3.6
Male	66.8	72.6	81.5	89.8	96.4
Prefer Not to Answer	0.8	1.0	1.0	1.0	0.0
Solar and Heliospheric Physics					
Female	34.9	27.9	19.1	8.5	5.6
Male	64.3	70.9	80.1	90.5	94.4
Prefer Not to Answer	0.8	1.2	0.8	1.0	0.0
Space Physics and Aeronomy					
Female	35.6	29.9	21.1	10.7	5.5
Male	64.2	68.5	78.3	88.3	94.5
Prefer Not to Answer	0.3	1.7	0.7	1.0	0.0

The vast majority of studies conclude that the latter situation—the diverse team—leads to better outcomes (Page, 2008). In fact, nearly a decade ago, a special issue of Scientific American was devoted to this topic, with all papers in it providing strong evidence for diversity as a benefit to the scientific endeavor (Guterl, 2014b). One article in particular from that issue (Medin et al., 2014) summarizes several examples of how diversity leads to better scientific outcomes, as well as counterexamples where a lack of diversity limited the findings. Specifically in space science, Moldwin & Liemohn (2018) conducted a survey of citations to papers published in the Journal of Geophysical Research Space Physics, finding that international teams are more highly cited than those from just one country. In a much more comprehensive assessment of publications across many Earth and space science journals, Lerback et al. (2020) found that citations to an article are, on average, significantly higher when the coauthor team includes researchers from two or more countries. As noted by Greenwald (2017), international teaming helps enable large-scale research projects, allowing for experiments and investigations beyond the scope of any one country.

Team diversity makes good business sense as well. Rock & Grant (2016) present a concise review of studies from the corporate perspective. Hunt et al. (2018) conducted a survey of over a thousand companies, finding that for every measure of economic success, diverse leadership made the companies (on average) better. A similar analysis of business performance was conducted by Herring (2009), finding overwhelming support for diversity as a harbinger of success. Ellison & Mullin (2014) combined performance measures with those of "social capital," finding that firms with homogeneous workforces tend to have higher cohesion but lower productivity. These are only a few examples in favor of diversity from a "business return" perspective.

While the case can be made that productivity and results improve with a diverse workforce, this alone does not have to motivate us into action. Burt et al. (2022) showed that the "business case" for diversity is misaligned with current attitudes of young professionals in both the Earth and space sciences and more broadly across science and engineering, in general. Rather than seeking only the benefits that diversification can yield for (primarily white, male) institutions, many are motivated by their interest in equity and inclusion (Haacker et al., 2022).

1.2 But space physics is not diverse

The field of space physics has a demographics problem. According to the 2018 report of the American Geophysical Union[1] (AGU), it was revealed that the subsections of the Space Physics and Aeronomy (SPA) section are heavily dominated by men, as seen in Table 1. This is not unique to AGU; these numbers are typical across sections of the American Astronomical Society (AAS), according to its 2019 workforce survey report.[2] Note that neither of these surveys asked about non-binary gender identification. Membership statistics by race show an overrepresentation of white people (see Table 2). Sexual orientation data is also shown in Table 2. For comparison, the US

1 The American Geophysical Union 2018 membership demographics survey results are available here: https://www.agu.org/-/media/Files/AGU_Membership_Demographics_2018.pdf

2 The American Astronomical Society 2018 membership demographics survey results are available here: https://aas.org/sites/default/files/2019-10/AAS-Members-Workforce-Survey-final.pdf

TABLE 2 AAS race/ethnicity and sexual orientation information from the 2018 membership demographics report.

Category	Percent	US population
Race and Ethnicity[a]		
White	82%	76%
Asian or Asian American	9	6
Hispanic or Latino	5	18
Black or African American	2	13
American Indian or Alaska Native	1	0.7
Other	2	2.4
Prefer not to respond	4	
Sexual Orientation		
Heterosexual or straight	85%	88.3%
Gay or lesbian	3	3.3
Bisexual	4	4.4
Other	2	4.0
Prefer not to respond	5	

[a]Note that the numbers do not add to 100% because some individuals may be reported in multiple categories.

Census Bureau[3] provides similar percentages, with the population for the country being 50.5% women, respectively, and the breakdown by race/ethnicity and sexual orientation shown in Table 2. The sexual orientation percentages are close to the US population as well as some of the racial numbers, but many race/ethnicity percentages are well below the general population, as is the gender split.

This diversity disparity in the scientific workforce has been recognized in numerous studies and reports. Moldwin & Morrow (2016) presented results from a demographics survey of the community conducted for the last Solar and Space Physics Decadal Strategy report, finding similar results to those in Table 1. Skewed demographics were found within recent space physics conference attendee and speaker lists (Jones and Maute, 2022). James et al. (2019) examined the leadership and award selections for 30 science societies, finding that, over time, representation in lower positions and awards is becoming more equitable but this is not the case for more prestigious positions and awards. While some counterexamples exist, the statistics of the top-most levels of research communities still heavily favor white men. Guterl (2014a) presented a survey of demographics across many scientific disciplines, noting large discrepancies from the general population.

An argument can be made that the demographics disparity is an issue to be solved earlier in the educational path, as women and minority students leave the physical sciences for other career and life options. One of the largest pinch points is in high school; Hodapp and Hazari (2015) noted that the gender participation breakdown in physics classes is 47% women in high school and only 21% women in college. Similarly, Bradforth et al. (2015) found that, at one university, only 10% of entering college students expressing interest in a physical science or math degree eventually get a degree in those fields. Yes, this "leaky pipeline" needs to be remedied, but problems exist within the space physics academic and research community, as well, as is visible by the comparisons to population-level data.

The demographics disparity is seen in funding trends. Bernard & Cooperdock (2018) found that racial disparity in funding rates by programs within the National Science Foundation (NSF) had not improved over the last 40 years, and the follow-on study by Chen et al. (2022) found that the situation regarding NSF funding rates for different racial groups has still not changed. A provocative call for action by Stevens et al. (2021) challenges racial disparities in grant awards by the National Institute of Health.

This demographics inequity is particularly noticeable in leadership positions. Centrella et al. (2019) conducted an analysis of Explorer-class astrophysics mission proposal principal investigators (PIs) to NASA, revealing that 3 of 61 unique PI proposers were female, and only 14% of the membership of the full science teams from the 102 proposals examined were female. That is, women are not being included on PI-led mission teams at the same level as men and therefore not receiving the experiential training to eventually propose their own mission as PI. This survey was followed by another from the National Academies of Science, Engineering, and Medicine (NASEM) of all the PI-led mission proposals to NASA (NASEM, 2022a). Of the 524 proposals to 32 Announcements of Opportunity for PI-led spaceflight hardware projects (from instruments to full missions) across all divisions of the NASA Science Mission Directorate, only 13% were led by a PI inferred to be a woman. These percentages are similar to the right-side

3 The US Census Bureau data can be found here: https://www2.census.gov/programs-surveys/popest/ and a graphical form of the LGBT data here: https://www.census.gov/library/stories/2021/11/census-bureau-survey-explores-sexual-orientation-and-gender-identity.html

columns of Table 1 on gender within the senior ranks of the research community, i.e., highly skewed in favor of men.

1.3 Homogeneity leads to bias

This diversity disparity creates a downwardly-spiraling feedback loop that has consequences for the research community. Specifically, the lack of diversity allows for the unhealthy development of a workplace environment that is negative or even hostile to historically excluded groups, a situation that drives people from the field and dissuades young professionals from entering it. Hurley (2014) noted that gender imbalance in a group setting has negative impacts on how women interact in a scientific discussion. Similarly, Kessel (2022) described her fortunate situation of having good mentors in her career, but often found herself being the only woman in the room. Clancy et al. (2017) detailed gendered and racial harassment for women of color in planetary sciences, Popp et al. (2019) found that women geoscientists experience negative bias at work more than twice as often as men, and a large-scale study confirmed these findings across many scientific research communities (NASEM, 2018). Lerback & Hanson (2017) found that editors of geoscience journals (including space physics) pick too few women as reviewers, thus denying them the career development opportunities from this experience. The AGU SPA section recently had several years with zero or one woman nominated to be an AGU Fellow (Jaynes et al., 2019). Furthermore, scientists in our field too often assume that their anonymous reviewer is male, choosing to use he/him pronouns instead of the broader they/them option (Liemohn, 2022), which can make women feel unwelcome or unrecognized. These are just a few recent studies and anecdotes of bias specifically documented regarding our research community.

Lack of diversity is a widespread problem across science and engineering disciplines. Using a "resume study" in which identical applications–except for the name–were evaluated for postdoctoral positions in physics, Eaton et al. (2020) found statistically significant differences in who was found "hireable." Faculty evaluating CVs exhibited both a gender bias in favor of presumed male candidates and a racial bias in favor of Asian and white candidates; black women and Latinx women and men candidates were rated the lowest. In a similar resume study, Correll et al. (2007) found that changing both the perceived gender of the applicant as well as the parental status with the inclusion (or exclusion) of a line about active involvement in a parent-teacher organization revealed diverging results for men and women. The parenthood bias that they found is that women experience a statistically significant "motherhood penalty," with potential employers questioning their commitment to the workplace, while men benefit from a "fatherhood bonus" in which they are perceived to be more stable. Another place for bias is with academic letters of recommendation. Within geoscience, Dutt et al. (2016) analyzed over 1000 such letters and found that letters for men are longer and with more superlative adjectives than those for women. Hiring committees are biased in how they consider gender and relationships, allowing these non-job-relevant issues to enter the discussions for women far more than for men candidates (Rivera, 2017). Academia has an institutional bias, as well, with one study finding that, for computer science, 25% of PhD-granting institutions produce 80% of tenure and tenure-track faculty (Clauset et al., 2015). Even citations are a skewed metric, with King et al. (2017) finding that men self-cite their own papers nearly twice as often, on average, compared to women. As a final point, once hired, retention is systematically lower for women (e.g., Dennehy and Dasgupta, 2017), although female peer mentoring and female role models help (e.g., Carrell et al., 2010). A lack of diversity perpetuates these biases, which then creates obstacles to increasing diversity in the field.

1.4 We can do better

In summary, systemic bias exists in scholarly research communities, including space physics. This is not unique to this field or science in general, but it is a problem that our community should collectively address. This bias has led to a lack of diversity in the field, and this homogeneity of input can lead to groupthink and continued bias. The evidence is clear that diverse teams are good for science, with a wide range of perspectives leading to creativity and innovation. While individual space physicists rarely intend to be biased, microaggressions occur and systemic bias within institutions and research community cultures perpetuates the problem, including Earth and space sciences (e.g., Rosen, 2017; King et al., 2018; Popp et al., 2019).

The good news is that we can use existing tools to begin addressing the lack of diversity. The authors have served on a University of Michigan ADVANCE Program committee called STRIDE (Strategies and Tactics for Recruiting to Improve Diversity and Excellence).[4] STRIDE, created with NSF funding and sustained *via* a university commitment (Stewart et al., 2007), equips faculty across campus to run equitable faculty searches. The committee analyzes the peer-reviewed literature on the topic and conducts workshops describing and promoting empirically-based best practices. This review summarizes some of the main highlights from STRIDE that are of particular relevance to the space physics community. It is intended to be applicable not only for academic faculty searches but for selection processes across our field, from choosing a new student researcher in your group to society leadership positions.

2 Steps to doing better

There are many evidence-based strategies and tactics that can be adopted to conduct equitable searches. A comprehensive review can be found in Stewart & Valian (2018). Specifically, based on U-M STRIDE activities and complementary analysis, Stewart et al. (2016) identified three major obstacles that impede change towards increased diversity: other priorities (e.g., traditional definitions of "excellence" being prioritized over diversity of perspective); unfavorable department climate (not wanting to talk about diversity, difficult personalities); and external factors (such as the "pipeline problem" or practices around dual-career hiring). In the

4 The University of Michigan STRIDE committee website can be found here: https://advance.umich.edu/stride/

sections below, several key processes are summarized that overcome these constraining factors.

2.1 Develop a holistic rubric early

You want to hire an excellent candidate for your open position. You seek the "best" person, but how do you judge who among the applicants is truly best? There are many attributes that could contribute to the characterization of best. Early in the process, even before you finalize the job posting, it is important to define the criteria against which applicants will be assessed. You should use an assessment rubric that includes not only the skills required for the job but also potential indicators of those skills.

The list of desired features should include all facets of the candidate that are vital for the position. One common answer for "best" is to consider the number of papers, especially first author ones, and the number of citations to those papers. Because candidate's careers may reflect the accumulation of bias or advantage (access to top labs as a graduate student, for example), and citation practices themselves can reflect bias (King et al., 2017; Hofstra et al., 2020; Kozlowski et al., 2022), "counting" is a poor proxy for quality. Assess the work directly–the innovation, the significance, the impact. Leadership positions are also regularly used as an indicator of excellence; here too, look for evidence of talent and leadership strengths even if not yet recognized with an official leadership position. Another criterion is a person's funding record, assuming that the position is senior enough to warrant that assessment. If it is a faculty position that will require teaching, then assessing their experience or potential for high-quality instruction should be included. This is much more than their ability to give a good research presentation; it includes their philosophy on teaching pedagogy and their willingness to adopt inclusive teaching tactics and active learning techniques in the classroom.

Don't stop there, though. The studies listed in Section 1.1 above provide clear evidence that those with different perspectives and experience bases are beneficial to the group, and beneficial to the mindset of those within the group. Therefore, when evaluating applicants, you might consider the background of each applicant, noting their educational and career trajectory and how this might bring new thinking into the group. This could be included in the applicant review as an evaluation criterion based on augmenting the existing group dynamics culture (as opposed to "fitting in").

It is not only what they personally bring but also the possibility of the doors that they intend to open for others and their potential to shift the field towards greater inclusion. Regarding this, it is equally useful to assess the candidate's philosophical approach to diversity, equity, and inclusion (DEI) and their history of commitment to DEI. One of the best ways to obtain this information is to request a diversity statement (Sylvester et al., 2019; Bombaci and Pejchar, 2022), but it can also be embedded in an applicant's cover letter, research statement, or teaching philosophy.[5] Moreover, the applicant's record of action in DEI areas could be a category of evaluation. From these inputs, you have information to assess the potential of the applicant to be a DEI advocate and role model, and the potential for the candidate to make positive contributions to the culture of the group (or department) and to organizational change.

Finally, it is useful to broadly define the research scope in the call for applicants. Studies show that expanding the search beyond the traditional center of the research field is useful for attracting a more diverse applicant pool (e.g., Stacy et al., 2018; Settles et al., 2022). Therefore, even if you are searching for applicants to fill a specific role in a funded project, it is beneficial to not limit the job ad to require experience in that particular niche within the research field. Rather, adopt a more capacious definition of the qualifications for the position. Here is example text of a rather narrow job description (a real posting from the lead author): "Perform basic research on magnetosphere-ionosphere-thermosphere dynamics and coupling using physics-based modeling with a focus on the generation and consequences of ionospheric upflow and outflow." It then went on to mention several specific numerical models. Simply stating the research focus as "geospace dynamics" would have been a more expansive description that likely would have yielded a larger and more diverse set of applicants.

The issue might arise regarding collecting enough information—from either the applicant or from letter writers—in order to adequately assess all candidates against your rubric of job-relevant criteria. The answer is to ask for it. When developing the job ad, ask for materials that will provide you with the content needed to assess applicants against all of your criteria. For letters, be specific in your request about the points that you want addressed in the letter. Another option is to not request open-ended letters at all but rather use a form with specific, criteria-related prompts.

2.2 Slow down the downselect

You will hopefully get many applications for your opening. This poses its own problem, though: we are busy and it is tempting to go fast through the initial screening in order to quickly get to a short list of finalists for the job. The key take-away for you is this—go slowly and methodically through them.

The human brain has two modes, one fast and one slow, as summarized by Kahneman (2011). The "fast brain" response—your reflex thoughts about a given stimulus—automatically provides an assessment, without you having to exert effort and often before we are even aware that an evaluative decision is needed. We cannot control what pops into our head. We can, however, control what we do with that initial thought. This is "slow brain" thinking, the deliberative thought process and the mindset that we consider as "our personality." This second response takes energy, and our brain is conditioned to minimize caloric expenditures, so we have to make a conscious decision to enter slow-brain mode and think about a situation.

This slow-brain thinking is what we need to do when evaluating applicants. When we allow fast-brain thinking to dominate, then we revert to schemas, which include negative stereotypes (see chapter 1 of Valian, 1999). Intentional slowness can overcome this problem. O'Meara et al. (2021) introduced the concept of equity checkpoints; these are specific times in the search process during which you deliberately stop and consider that step with respect to whether you

5 An excellent DEI rubric is available from UC Berkeley: https://ofew.berkeley.edu/recruitment/contributions-diversity/rubric-assessing-candidate-contributions-diversity-equity

TABLE 3 Appropriate and inappropriate conversation topics with job applicants.

Appropriate topics	Inappropriate topics
Education and past work experience	Physical appearance (height, weight, skin color, hair color, tattoos, piercings, gender expression)
Knowledge of the discipline	Personal finances (including credit rating)
Skills desired for the position	Personal relationships (marital status, children, sexual orientation)
Past activities regarding your evaluation criteria	Religious or political affiliations
Philosophical approach regarding your evaluation criteria	Age
If they have US citizenship, *only* if *required* to perform job duties (e.g., restricted hardware)	National origin, birthplace, cultural heritage, or ancestry
How applicant would handle job-related problems (i.e., leadership/management approach)	Details of an applicant's criminal record (can only ask if a record exists, only if all applicants are asked)

are engaging in inclusive processes that support equitable decision-making. Others have analyzed the effectiveness of equity advocates on search committees (Liera, 2020; Cahn et al., 2022), in which a person's role on the committee is to make sure the committee uses unbiased practices in advertising, assessing, interviewing, and selecting candidates. These studies show that these tactics work to significantly improve the diversity of the short list.

When conducting the downselect and applying your rubric, it is important to remember that many traditional indicators of scientific success are biased in favor of white men.[6] This skew has been shown to exist in citations to scientific journal articles (King et al., 2017), letters of recommendation (Dutt et al., 2016), teaching evaluations (MacNell et al., 2015) and annual performance evaluations (Bauer and Bates, 2002); the intersectionality of these issues non-linearly disadvantages scientists with multiple minority group identifications (Kozlowski et al., 2022). The systematic enhancement of these metrics in favor of white men should be taken into account when assessing a candidate's quality. This is especially critical when comparisons are made between applicants from different groups in order to finalize the list of interviewees.

2.3 Equitable visits

Once you have a short list of finalists, it is important to make the interview process as equitable as possible. For example, include breaks in the schedule and travel time between meetings so that candidates who need a little extra time to move around or gather their thoughts can be at their best; ask also about accommodations that may be helpful. Provide all finalists with the same information about the research group or department, institutional policies, and details of the surrounding area without asking about their personal situation (e.g., do not assume only women candidates want information about schools and do not ask finalists if they are parents). Develop a list of questions ahead of time and ask all interviewees the same set. Ask about pronouns ahead of time and distribute this to all interviewers. If in person, then pay for any travel expenses in advance. Consider the environmental cues that reflect on who "belongs" with respect to what will be seen during the interview (such as wall pictures of only white men as scientists). For the job talk, be as consistent as possible in the format. There are specific topics that are either illegal or inappropriate to ask of job candidates; Table 3 provides a list of in-bounds and out-of-bounds topics, distilled from the University of Michigan faculty hiring manual.[7] In short, focus the interview on job-relevant questions and topics of conversation (that is, your selection criteria) and make the experience as uniform as possible.

If virtual, do a dry run to check connectivity. Fiechter et al. (2018) found that remote interviews were negatively influenced when the connection was bad or the image quality was not ideal. Checking these ahead of time, with all applicants, allows issues like this to be resolved before the stress-filled day of the interview.

To further minimize bias, these equity-focused accommodations should often be orchestrated by someone not involved with the final decision. This could be an administrative staff person or someone outside of the hiring group. In whatever way it is handled, you should have these aspects of the visit done before the first finalist goes through the process, so that it is the same for all.

The job talk is a particularly important part of the finalist interview, so it is worth some extra advice on this issue. Studies have shown a systematic bias in favor of men compared to women with respect to the questions and interruptions they receive during job interview presentations (Blair-Loy et al., 2017; Dupas et al., 2021). Informing the audience to hold questions to the end and then, before taking any questions—i.e., remind the audience that this is a job interview presentation and that the candidate should be allowed to fully complete their prepared remarks—helps to mitigate this problem. Choosing a DEI-conscious moderator for the job talk can also be helpful.

6 More information on the bias in traditional indicators of scientific success are available at the U-M ADVANCE resources website, under the STRIDE heading: https://advance.umich.edu/resources/#stride

7 The University of Michigan faculty hiring manual is available here: https://advance.umich.edu/wp-content/uploads/2018/10/Handbook-for-Faculty-Searches-and-Hiring.pdf

2.4 Fair decision-making process

When it comes time to make the final decision, the biggest piece of advice that we have is to recenter your rubric. Whether in the committee or in a larger group setting, keep all discussions focused on the job-relevant criteria and cut off tangential or inappropriate remarks.

If many are participating in the evaluation of the finalists, then soliciting their feedback through an evaluation form is convenient. Make this form based on your search criteria and ask for supporting evidence for any ratings. Get this feedback quickly, preferably before the next candidate has their interview.

Postpone global rankings until the final vote. Any use of rankings earlier than this has an anchoring effect and biases further conversation about the candidates (Sensoy and DiAngelo, 2017). This is especially true if senior group members get to speak first, which can then intimidate junior members from giving a different assessment. Rather than an open vote in which people see or hear who is voting for whom, consider using ranked-choice voting with a secret ballot[8]. This method has been shown to be effective when there is close contention between several finalists (Santucci, 2018). Of course, talk about pros and cons of the finalists in relationship to your job-relevant criteria, and even rank within those criteria, but it is not necessary—or even desirable—to achieve consensus in an open forum.

After the offer is made, you should focus on actively recruiting the person. This is the time to ask the candidate what they would need to know more about to be able to accept the offer, including information relevant to their family and partner situation like dual career hiring considerations or local schools, and help them access that information or resource. Only after the offer is made—and the decision is now theirs on whether to accept—are these non-job-relevant topics permitted in the dialogue.

3 Discussion

The space physics research community is not diverse. This is especially true at the senior experience levels, but is even true for our student populations, which are also not matching the demographics of the general public. Striving towards a demographic shift to match the general population supports our commitment to equity and inclusion. In addition, diversity increases research productivity. Unfortunately, bias exists, including within the space physics research community, and this negatively impacts hiring practices and perpetuates the demographic mismatch. Stachl et al. (2021) notes that positive shifts can be achieved with "discussions grounded in our own data," thus the focus in this report on the demographics and perceptions within the space physics research community.

There are many strategies and tactics that can be adopted to counter this problem, though. Section 2 above details a number of these methods, and they are summarized in Table 4. This is a list of steps that address the broad definition of diversity and is not tailored to focus on any one historically excluded group. The recommendations in Table 4 are suggestions that could be adapted to better suit a particular hiring situation. One example of this is how excellence is defined for the position; the wording, rubric, and emphasis placed on each of your specific job-relevant criteria would result in different search outcomes.

Note that this review only covers the search and hiring process. In addition to recruitment, a complementary aspect of this issue is retention, another critical component of the NSF ADVANCE program (DeAro et al., 2019). This topic is expertly covered by, for example, Settles et al. (2006), Stewart and Valian (2018), Stachl et al. (2021), and Hughes et al. (2022). At the author's institution, this is specifically addressed by STRIDE's sibling committee, Respect In Striving for Excellence (RISE)[9], which offers resources and programming for academic workplace climates across campus (Linderman et al., 2022). A full coverage of this is beyond the scope of this review.

Despite the negative tone of Section 1, the space physics research community is already improving our discipline with respect to DEI. One example is with research-centered awards. After the years of very low nominations of women in the SPA section to be AGU Fellows, a special task force was created to remedy the situation (Jaynes et al., 2019; Keesee et al., 2022). A similar group started in the United Kingdom (Walach et al., 2022). This has resulted in a marked increase in the diversity of nominations for not only AGU Fellows but also other awards. Halford et al. (2022) offers a perspective from the fellows' selection committee, detailing the process and offering advice on creating a good nomination. A second example is the creation of the Equitable Letters in Space Physics project (Burrell et al., 2021), from which many tips have been compiled for writing a good recommendation letter (Burrell et al., 2023). Regarding gender, Table 1 shows improved percentages at the earlier career stages, suggesting that our field may become more diverse with time—if we provide the opportunities and support to these newer investigators.

Our community has also shared advice on moving towards a more diverse field, a more inclusive culture, and a more equitable structure of interaction and engagement. A comprehensive review by Bagenal (2022) offers several suggestions for enhancing diversity in the space physics community. Jones et al. (2022) provides an excellent presentation of actions to improve inclusivity in space physics, while Kenny et al. (2022) and Halford et al. (2023) also include action item lists to achieve this goal. Liemohn et al. (2021) postulates that this positive shift in the diversity of the space physics community will result in many new discoveries, and Liemohn (2022, 2023) offers advice on achieving this shift. Palmroth (2022) shares a success story in achieving a dream, with the advice of striving for something 10+ years out to enable a paradigm shift in thinking as well as celebrating each other's victories and accomplishments. Palmroth (2022) encourages us to more proactively support each other and welcome new people into the group.

8 More on ranked-choice voting: https://www.fairvote.org/rcv#how_rcv_works

9 The University of Michigan RISE committee website can be found here: https://advance.umich.edu/rise/

TABLE 4 Summary of suggested remedies to possible equity issues during the hiring process.

Hiring step	Potential issue	Possible remedy
Developing applicant evaluation strategy	Too focused on publications and funding record	Consider all aspects of "excellence" for the position
Developing the job ad	Too narrowly focused	Intentionally generalize the wording
Request for application materials	Entirely focused on research experience	Specifically ask for information on other experiences, including DEI philosophy and action
Initial evaluation of full applicant list	Reading too quickly and applying schemas	Intentionally clear ample time with no distractions
Rating applicants	Bias within traditional measures of success	Adjust individual evaluations based on known biases of metrics
Selecting finalists	Applying artificial cutoffs on numeric evaluations	Use broad rating categories instead of rankings
Finalist visits	Inequitable experiences	Brainstorm for potential issues and preemptively address them, ask interviewers to prepare a list of questions they ask everyone
Interview seminar	Aggressive interruptions for some speakers	Clearly state "rules" for job talks before each presentation
Finalist visits and internal discussions	Asking inappropriate questions or discussing such topics during evaluations and deliberations	Distribute the list of off-limits questions, actively cut off talk of non-job-relevant topics
Final discussion	Ranked list that "anchors" some at the top, hard to refute and redirect the conversation	Don't calculate a global ranking, but rather separately discuss each criterion and each candidate
Final decision	Anxiety about publicly voting differently than senior group members	Use ranked-choice voting with a secret ballot

Beyond our immediate research cohort, others have also been striving for a more equitable space physics research community. Lewis et al. (2022) encourages Earth and space scientists to embrace committee work as an opportunity for "regenerative gatekeeping," using the service role as a chance to implement policy change within your institution or society. Hamden et al. (2022) describe the intent and format of the NASA PI Launchpad Workshop, a program designed to increase the diversity of leaders ready to propose a spaceflight mission concept to NASA's Science Mission Directorate. Williams et al. (2017) detail the role of AGU in increasing diversity and inclusion in the field, including making ethics violations equivalent to scientific misconduct and grounds for dismissal from a leadership position or award selection. Atherton et al. (2016) offer six recommendations for ensuring equity for physicists across the spectrum of gender presentation and sexual orientation. The NASEM (2022b) report on creating the proper conditions for a vibrant research community recognizes the problem of inequity in science disciplines and offers a long list of suggested actions for us to undertake to address it. Quite a few resources exist, accessible to space physicists and ready for implementation.

In summary, we urge the space physics research community to adopt these best practices for equitable hiring. These techniques should lead to a more diverse cohort of new members in our discipline, which will yield benefits for our science, our community members, and for humanity.

Author contributions

The writing of this paper was led by ML with equal, smaller contributions from all other authors. All authors contributed to the article and approved the submitted version.

Acknowledgments

ML thanks JL for asking him to serve on the U-M STRIDE committee and thanks IS for her adept leadership of that committee. ML thanks U-M for its support of the University of Michigan Space Institute. The authors thank U-M for their sustained and robust support of the STRIDE committee and the U-M ADVANCE Program. The lead author would like to thank the University of Michigan for its financial support, the US government, in particular research grants from NASA (80NSSC19K0077, 80NSSC21K1127, and 80NSSC21K1405) and NSF (AGS-1414517), and the European Union Horizon 2020 Research and Innovation programme under grant agreement 870452 (PAGER).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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