

Community views on diversity, equity, and inclusion in the Astropy project

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Table of contents

- 1 Disclaimer
 - 1.1 Abstract
- 2 Understanding and improving diversity, equity, and inclusion in the Astropy community
 - 2.1 Background
- 3 Methods
- 4 Overview of Findings
- 5 Community Recommendations
 - 5.1 Help Newcomers Find Support
 - 5.2 Embrace Intellectual Diversity
 - 5.3 Learn from Other Communities and Their Events
 - 5.4 Identify and Build on Positive Trends
 - 5.5 Give Guidance to Core Developers and Maintainers
 - 5.6 Make Community Member Roles and Pipelines Explicit
 - 5.7 Use “Buzzwords” with Care
 - 5.8 Offer Safe, Constructive Avenues for Feedback
 - 5.9 Implement and Enforce the Code of Conduct with Creativity
 - 5.10 Foster Healthy Collaborations within the Community
- 6 Consultant Insights
 - 6.1 View Astropy as a Catalyst for Change in the Broader Scientific and Computing Landscapes
 - 6.1.1 Offer the project as a place for diversity to grow in astronomy AND computing, OR either of those things separately
 - 6.1.2 Map and accelerate the trends in adjacent fields
 - 6.1.3 Getting involved in efforts that are already happening
 - 6.2 Embrace and Cultivate Intellectual Diversity
 - 6.3 Actively Learn from Adjacent Communities
 - 6.4 Be Open to, But Critical of Shared Services
 - 6.5 Consider Geography and Timezones
 - 6.6 Develop Community-Driven Definitions and Metrics for Diversity
 - 6.7 Use *Political Opportunity Structures* to Drive Change
 - 6.8 Celebrate Progress

- 6.9 Support the Community Manager in Developing DEI Expertise
- 6.10 Develop Future-forward Plans for DEI Efforts
- 7 Interview Questions for DEI Respondent
 - 7.1 Astropy Community Research
 - 7.2 Housekeeping for Interviewee
 - 7.3 Questions

1 Disclaimer

The views reflected in this report come from a variety of sources within the Astropy community and from Organizational Mycology. These views do not necessarily reflect the thoughts and opinions of Astropy leadership or the broader Astropy community. Given how sensitive these topics can be, please feel free to reach out to us at info@orgmycology.com with any questions, comments, or concerns.

1.1 Abstract

This report synthesizes community-driven recommendations derived from a comprehensive analysis of participant interviews, aiming to inform and enhance Diversity, Equity, and Inclusion (DEI) practices within the Astropy project. The feedback from the community reflects a shared concern for increasing newcomer engagement and supporting a broader definition of valuable contributions beyond traditional software development.

A common thread highlights the need for explicit support systems to help new members, including those from non-astronomy disciplines, integrate into Astropy. Participants advocate for strategies such as better advertising “good first issues”, expanding non-code roles like training and lesson development, and leveraging automated tooling to streamline initial contributions—bringing diverse expertise into the community dialogue, including individuals from the AI/ML sectors.

Suggestions also emphasize the importance of embracing intellectual diversity and learning from successful models in analogous communities. Astropy is encouraged to recognize and cultivate positive trends, such as impactful role models, and to offer clear guidance to maintainers for fostering an inclusive atmosphere. Furthermore, the report stresses cautious use of DEI terminology to prevent undermining genuine progress and advises a careful approach to communicate these efforts effectively. Other key recommendations include establishing transparent community roles, encouraging safe feedback channels, creative enforcement of the Code of Conduct, and nurturing healthy cross-disciplinary collaborations.

The insights gathered underscore the presence of latent potential within the Astropy community, to not only enhance DEI efforts but also to enrich the project’s output through the inclusion of a variety of perspectives and skills in the pursuit of collective goals.

2 Understanding and improving diversity, equity, and inclusion in the Astropy community

Open source software (OSS) projects tend to struggle with diversity, equity, and inclusion (DEI). It perhaps comes as no surprise: If we consider computer science and major scientific disciplines as reasonable proxies for people who might contribute to or use OSS tools, we can infer that OSS projects would struggle to engage and empower underrepresented communities. The percentage of computer science degree earners who come from underrepresented racial or ethnic groups, for example, has held steady at 20 to 25% for the last decade (see the [National Center for Education Statistics website](#)). Pointed outreach to underrepresented groups may help, but the lack of diversity in training programs is a bottleneck and makes natural inflows of diverse talent difficult to attain for OSS projects.

DEI problems in open source, though, are not just about the demographic makeup of the community. Various studies have found that individuals from underrepresented backgrounds often feel unwelcome, experience stereotyping or threatening behavior, and perceive that they are excluded from certain communities, conversations, or events. [The 2021 Linux Foundation report](#) provides an overview of these issues and cites a host of survey data to illustrate the need for change.

Astropy is aware of the need to improve the conditions that facilitate a diverse, empowered community and is developing a path forward for its own community. As part of this effort, we interviewed eight Astropy community members, with six of these interviews focused exclusively on perceptions of Astropy's current state as well as what might be done to improve DEI outcomes. To contextualize the conversation and be precise about what drives these outcomes, we asked interviewees about their perception of the state of DEI at four levels: in astronomy, in computing, in open source software, and in the Astropy community.

2.1 Background

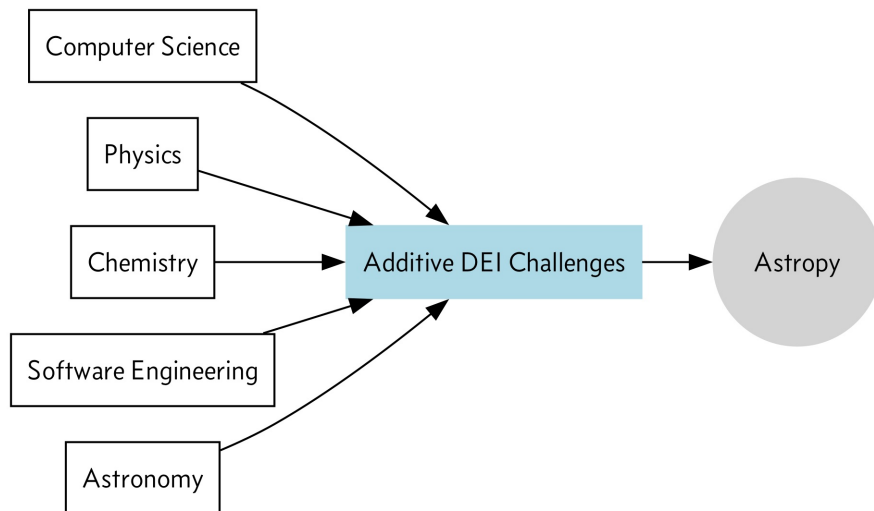
Astropy faces many challenges in its efforts to diversify its community and elevate the voices of underrepresented groups in community conversations and decisions. The fields of computer science, astronomy, physics, and open source software development have all performed poorly in attracting and retaining individuals who identify as members of underrepresented groups, in part because higher education operates as a bottleneck for the inflow of talented developers and users.

Building on the earlier point about computer science education, we can look to astronomy education data to further explore the problem. The number of African Americans earning Ph.D.s in astronomy, for example, has fluctuated between zero and three individuals each year since 1999. In

2018, 805 Ph.D. earners identified as white and 76 identified as African American/Black, Hispanic, or American Indian/Alaska Native/Native Hawaiian. Raw numbers remain astonishingly low even among racial and ethnic groups whose numbers have increased in this period, such as Hispanic Americans (one earner in 1999 to 7 in 2019). The National Academies Astro2020 (p. 96) report put it succinctly: “Racial/ethnic diversity among astronomy faculty remains, in a word, abysmal.” The slightly promising trend in Hispanic American Ph.D. earners suggests that some improvements are being made, but other groups are not benefitting nearly as much. Further explanations and explorations of these data can be found in Chapter 3 of the [Astro2020 report](#).

Unsurprisingly, respondents in our interviews confirmed that they observed or experienced these disparities both within Astropy and in other communities they participated in. The reasons they provided often pointed to historical reasons (e.g., racism in science more broadly, longstanding inequalities in access to education and resources) as well as the overconcentration of practitioners in the U.S. and Europe (to the exclusion of other countries).

Astropy’s situation is perhaps even more challenging because it sits at the intersection of a non-diverse scientific discipline and the open source software community, which similarly struggles with advancing DEI. A [survey led by GitHub in 2017](#) queried 5,500 contributors to open projects. 95% of these surveyed contributors identified as men and 3% identified as women, while just 16% identified as ethnic or national minorities. Factors such as hostile interactions, dismissiveness, conflict, and unwelcoming language or content contributed to these outcomes.



Statistics and anecdotes about DEI in Astropy’s core fields are daunting, and it would be easy for Astropy to take a passive approach. The community could, for example, trust that positive (albeit slow) trends will continue and wait for conditions to improve in the fields its community members come from. But rather than meet these realities with resignation, Astropy has continued to try to improve and diversify its community. The approach

lends itself to the project becoming a mechanism of change for these other communities (e.g., astronomy and OSS) rather than a passive victim of shortcomings in overlapping fields. We designed and conducted our interviews with this in mind, asking Astropy community members how they felt about the current state of DEI and documenting their ideas about how to move forward. It is our hope that the findings can help Astropy become a catalyst for diversifying the fields it touches and promote equity, inclusion, and a welcoming environment within and outside of its community.

3 Methods

Astropy is aware of the need to improve the conditions that facilitate a diverse, empowered community and is developing a path forward. As part of this effort, we interviewed eight Astropy community members, with six of these interviews focused exclusively on perceptions of Astropy's current state as well as what might be done to improve DEI outcomes. We oriented two of the interviews toward possible improvements to the Code of Conduct because these participants are actively engaged in ongoing CoC content and process revisions; furthermore, CoCs play an important role in shaping DEI outcomes in projects. To contextualize the conversation and be precise about what drives DEI outcomes in the Astropy community, we asked interviewees about their perception of the state of DEI at four levels: in astronomy, in computing, in open source software, and in the Astropy community.

We also asked direct questions about how Astropy could direct its human and financial capital towards initiatives to create a more diverse, inclusive environment. Specifically, we asked respondents how leadership can use its influence to improve DEI outcomes in the community and how Astropy resources might be used to create events, materials, mentorships and other products in its DEI efforts.

Our interviews also built on what we learned from the [Community Survey](#), about the importance of first-time contributions, the need to create robust and traversable user-to-contributor pathways, and the value of a welcoming environment in broadening participation. Some of our questions asked directly about participants' experiences in moving from user to contributor (or not) and in helping others to do the same.

The full interview protocol can be found in [Appendix A: Interview Questions for DEI Respondents](#).

We recorded our 60-minute videoconference interviews and transcribed the conversations into text. We then analyzed the transcripts using standard qualitative data analysis techniques, which aim to identify and explore themes that were common across participants and insights that were novel and valuable, even when only one participant mentioned them. We put these findings into conversation with existing DEI guidance

documents, the results of the Community Survey, and ongoing discussions with the Astropy community manager to present the themes and offer recommendations.

Where possible, we included excerpts from the interviews to illustrate themes in community member responses. In many cases, responses were too identifiable and/or too sensitive to include here. The excerpts that are included in this report are de-identified and anonymized, with minor details obscured to protect the identity of the respondent.

4 Overview of Findings

We present our findings in two parts: Community Recommendations and Consultant Insights. The Community Recommendations section presents the themes that emerged directly from interviews, describing the common perceptions respondents held and their ideas for improving the state of DEI in Astropy. The Consultant Insights section places these themes in conversation with our understanding of Astropy's opportunities and capabilities as well as outside expertise. This outside expertise includes published materials from DEI researchers and practitioners, our observations and interactions with other open source communities, and trends in the broader computing and scientific landscapes.

5 Community Recommendations

Our analysis of participant interview transcripts resulted in several community-led recommendations that we feel are valuable to consider when developing new approaches for advancing DEI in the Astropy project. Some of the recommendations echoed themes in Astropy's recent community survey, providing strong rationale for taking action on those points. Where possible, we provide quotes to support a given theme; in some cases, though, we do not provide an attribution or quotes in order to protect the identities and privacy of the respondents.

5.1 Help Newcomers Find Support

In DEI interviews and the [community survey](#), respondents overwhelmingly expressed a desire to improve avenues for newcomer participation in Astropy. Specifically, respondents noted that newcomers have trouble finding ways to get started working with and within Astropy communities. Ensuring a welcoming, accessible newcomer experience is vital to promoting a more diverse community and facilitating equity and inclusion, so we probed on this topic when it emerged in our interviews.

We are aware that Astropy maintains a list of "good first issues," but interview participants were either unaware of the existence of the issue tag or believed the list was too short or specific for most newcomers to find a

place to contribute.

Furthermore, fear of failure and concern over contributing detrimental code also impacts newcomers' propensity to become contributors. Indeed, one astropy user we interviewed expressed fear of "breaking" something with new code, which has partially kept her from being a contributor:

The imposter syndrome that kind of gets you where you're like, "Ooh, scary. What if I add this thing and it's bad or it breaks something?"
Graduate student astropy user

In considering how to alleviate these fears, there was some optimism among interviewees that automated tooling could reduce the social or psychological burden of contributing, particularly for newcomers who might be nervous about the quality of their work:

There's lots of new concepts happening, but in terms of the actual, like, difficulty of pushing a piece of code and then getting an automated response and then tailoring it before I think the humans really need to see it is you need a little bit of experience and mostly just gumption. Astropy maintainer

Furthermore, much of the work of Astropy historically has been the work of software development. But in recent years, efforts such as training, lesson development, documentation, code formatting, and community leadership have become new roles valued within the community. Each of these non-coding areas is an area where on-ramps and invitations to contribute can be extended in different ways. It was clear that many "users" of Astropy care deeply about the software and its continued availability and are looking for ways they can contribute to that end. Closing the loop and connecting "newcomer" enthusiasm to areas of effort would be beneficial.

An astropy maintainer we interviewed noted that reframing some of these contributions as substantive and making them more visible to potential contributors could be a bigger priority for the project:

One of the weird things I think is important is also making more avenues for contributing to the code ... From qualitative experience watching new contributors, many times there are people who don't know astrophysics, but who are interested in contributing to the code base. And so, you know, they're maybe not bad at algorithms. Or oftentimes many of them are just interested in like stylistic and linguistic improvements, which astropy was in desperate need of, and less desperate need, but still needs. So we've seen a lot of people that swing in for two, three contributions, supplementing the code. So I think one thing that would be great would be figuring out how, but I think part of it is that non-substantive contribution than ones that are just like to the stylistic beauty of the code. It's a nice itch to scratch, but I don't think it's fulfilling in the same way that, you know, making something, making it something that's a contribution. I think

people end up drifting onto the next thing, but it'd be nice if it stuck around. So figuring out how to do that would be great. Astropy maintainer

Finding new avenues for community members and potential community members to contribute may also benefit from a broader view of the disciplines and backgrounds that are suitable for Astropy, a topic we expand upon in the next point.

5.2 Embrace Intellectual Diversity

Newcomer challenges are exacerbated when the community member is coming from a non-astronomy, non-scientific OSS discipline. In other words, it is difficult for individuals from other disciplines to “find a place” in the community, even when they believe their unique skillset could be beneficial to the project.

We interviewed an Astropy newcomer from a country that is underrepresented in Astropy. His background is in artificial intelligence and machine learning, where he developed a skillset that he believes could be useful in many different scientific domains. Accordingly, he is continually looking for opportunities to contribute to OSS projects and often collaborates with astronomers and astrophysicists. He has, however, found it difficult to make strong ties in the Astropy community, ties that he thinks would lead to fruitful collaborations:

I do find a bit difficult in finding the relevant community because of my different background. So as I am from AI background and not much familiar with the science or astronomical aspect, I believe that collaboration could be helpful as there are different expertise involved from the collaborator as well as from me, but yeah like there's a lack of communication that I can cite here. The reason is that there are some terms which I may find it difficult ... So due to that, there's not much interaction happening between the between me and the community, which causes some issues while collaborating. Astropy newcomer

He is seeking avenues through which he could find these potential collaborators, a sentiment we also heard in the community survey regarding specific astronomy sub-disciplines:

I would like to focus myself on collaborative opportunity itself. If we could have a common forum or something like that which is already available as on Slack, then like people can basically talk about the open problems there and people like me who are much more into the ML stuff or who are not much into Astro can accordingly comment on it ... it's just that we know that we have this data and this is the problem. So how to solve the problem is what we can do. And identification of problem is what, from the Astro perspective, will be needed. Astropy newcomer

A revised way of finding Astropy community collaborators would enable him to improve his existing strategy for making connections, which depends on reading lots of academic papers and finding places where novel approaches might help improve the method. As he explains, he currently combs through academic papers and presentations and reaches out to the authors when he has an idea:

As far as I can see, typical papers from ... a good, a decent journal, all the works there are typically based on very old ML techniques. So again, that's what I feel is causing, I mean, the lack of collaboration is basically what is causing this problem. Although there can be techniques which can improve the results, way better than what they have achieved, but they are basically unable to because of lack of awareness of these novel algorithms. Basically I go looking throughout those presentations, like particularly from the professors, and by seeing the problem in their particular work there's a substantial opportunity to improve those results. And that's how I had to reach them and accordingly collaborate and work with them on those topics. Astropy newcomer

To be sure, this interviewee does view himself as somewhat of an “other”: He is aware that the primary goal of Astropy is to improve astronomical research, and his tone suggested he was hesitant to upset the balance of disciplinary backgrounds in the community. He did, however, have some ideas about how to manage this problem:

So maybe like people who are interested in AI as well as Astro could be given a specific role and they could interact at that specific channel. Similarly, you can say that Astropy can maybe float a Google form or something like that, asking people about their interest and suitably make a Google group or in Slack itself, make a community or make different channels wherein people can join and discuss stuff. Astropy newcomer

In other contexts, we have seen the value of inviting participation from individuals with disciplinary backgrounds that may not seem like an ideal “fit” for the project. Technical writers can aid with documentation; data management specialists can find efficiencies in the data storage, manipulation, and processing pipelines inherent in OSS work; social scientists can provide data and insights that help improve collaboration and coordination; and users from wildly different domains can surface and explain issues that might be in typical users’ or contributors’ blindspots. Promoting intellectual diversity in the project, then, can be beneficial to many different aspects of project health, including but not limited to code quality.

5.3 Learn from Other Communities and Their Events

We asked interviewees about their perception of DEI in both the Astropy community and the other communities they participate in. These questions elicited positive and negative examples, with the positive examples from other communities being useful anecdotes for Astropy to learn from. An astropy contributor, for example, recalled an incident he was a part of at a major astronomy conference and expressed appreciation for how it was handled:

[At the conference], I actually ended up filing a violation of the harassment policy. Somebody had made a, um, transgender unfriendly joke at the reception. So I went through the process and one thing they did to make it easier is that you could call a phone number, but they also had an online form. And then, I was in my kind of state of emotional distress at that time when I decided to report something, I said, “Oh, there’s a online form. I can submit that.” But ultimately, I had a phone call with a human resources person that the [conference organizer] had hired to investigate those things. And it went very differently than what I was expecting. But the thing that really surprised me was I thought I was going to have to bring witnesses and prove that the person said it. And it wasn’t like that at all. It was kind of like, “Well, what do you think should happen to the person?” And we talked about that some. They had to view some materials, you know, some educational materials. So I guess if that were more widely known, then maybe people would feel more comfortable with reporting it because the, yeah, the HR person that [conference organizer] had hired, it was really, really pretty good.”

These small interventions—offering multiple ways to report violations and making the process transparent—offer immense utility in making people feel that they have agency in the community. Likewise, making the *people* who handle these issues visible to the community can also ease concerns about reporting and otherwise discussing incidents or structures that make them feel uncomfortable.

Beyond negative incidents that were handled well, interviewees also discussed encouraging experiences they’ve had in other communities. One respondent described bringing a family member—an aspiring OSS contributor from a heavily underrepresented group—along to a Python-oriented conference. Perhaps to their surprise, the welcoming environment led to a strong sense of self-confidence and a host of networking opportunities:

Yeah, so I guess like having that explicitly stated, you know, and not just saying a bland general statement about diversity and inclusion, but naming the categories specifically, [and making the physical environment more welcoming], I think that made us all feel a lot more at ease that [family member] was at a good place.

Beyond these examples, looking to other communities can help to identify problems that are common across all types of OSS projects and adapt the solutions to them. OSS leaders know this well, given that they often share

frustrations and ideas in informal ways. Formalizing this problem-and-idea sharing process could enable more members of the community to engage in developing solutions to some of the more common problems OSS projects face.

5.4 Identify and Build on Positive Trends

Across nearly all of our interviews, participants noted how positively they viewed the trend towards gender balance in the astronomy community, broadly, and the Astropy community, specifically. A graduate student astropy user, for example, noted that she has benefitted from observing and participating in a field where women have excelled in teaching, research, and software development:

I will say that my I know that my perspective is biased for a fact, because I have been very lucky to do my undergrad at [university name] where things are pretty balanced. A pretty good ratio of gender diversity, both in the cohorts that were there, but also in the faculty. And that was something that really, really stood out to me strongly in contrast to the physics department at the same school. Because I remember out of the, I think we had like three classes, three core astronomy classes that were required. And I'm pretty sure that at least two of them were were taught by women, and that was nice. Because it's like, "Okay you have not only do you have a role model that's ahead, I do have a place in this space to do astronomy." Graduate student astropy user

Highlighting positive trends like this one within the Astropy community can serve as a source of pride and motivation for the project to keep those trends in motion. This effort can be as simple as finding ways to "feature" role models in project communications (e.g., newsletters or forums).

In particular, the community is certainly eager for insight into younger role models' careers, as one participant described their appreciation for "older" stories but also a desire for more relatable trajectories:

I'm not sure about open source in general, but I do feel like I see more men in that direction, and it's usually elder white men who are just kind of there. And, "Oh, well, back in my day when we used punch cards." As much as I love those stories and they entertain me to no end, you know, it does feel a little less, I guess, less fair.

Similarly, the community is yearning to diversify the racial and ethnic makeup of both the scientific disciplines and the Astropy project:

I have definitely noticed that there is nowhere near racial parity, for lack of a better word. It's very much white-dominated ... But I also know this is more, even more broadly a STEM problem too, you know, for a lot of folks with underprivileged backgrounds who just

don't have the resources to get into higher education in STEM. It just perpetuates, you know, further and further. Graduate student astropy user

Elevating role models from underrepresented backgrounds requires careful attention to detail, though: Projects must not “tokenize” members of their communities and likewise should avoid adding additional service work to their workload without appropriate input and reward. Self-nomination is a good way to identify potential role models who would be willing to promote visibility and inclusion.

5.5 Give Guidance to Core Developers and Maintainers

A recurrent theme across any type of social science inquiry into OSS projects is the demeanor of the project's core developers, contributors, and maintainers. To be frank, these individuals can get caught in a bind: The time demands of the (often voluntary) work are not always amenable to kind, patient, and thoughtful interaction. Furthermore, these groups grow accustomed to interacting with one another in ways that prioritize efficiency and technical development over social dynamics.

While necessary at times, it is important for core project members to remember that they represent the community in ways that the average user or contributor does not. They are continuously interacting with users, contributors, and potential community members at a higher rate than others, and therefore become the “face” of the project for many newcomers.

From the perspective of interviewees, Astropy does a good job of managing the tone and content of interactions with individuals who may not yet grasp the various norms and approaches to communicating about technical topics:

I think most astropy maintainers are pretty studious to then present a, um, a friendly face, you know, even if something's quite clearly wrong. When it's another maintainer, you're like, “Please fix.” If it's a person contributor, you're more like, “Uh, oh, thank you so much. I see that there's an issue here. There are some ways to address it. Please let me know if you need any help.” I think the friendly face is important.

Reiterating the “friendly face” to core project members—whether through formal trainings or small interventions—helps to keep this reality front-and-center as the project grows and evolves. Beyond the friendly face, core members should also be persistent about following up with one-or-few-time contributors who they'd like to see continue to engage and contribute. As one maintainer noted, it's often as simple as pointing these individuals to similar problems that match their skillset:

I mean, yeah, we don't assign them to anything. If they actually had a very tight PR, so it was well-focused on one issue, then that often takes the form of right here: "Thank you so much for contributing. There are plenty of other of these types of PRs. We have a list of them on our issues page on GitHub, so please take a look." That's if their PR was well-crafted from the get-go. Astropy maintainer

5.6 Make Community Member Roles and Pipelines Explicit

Interviewees and survey respondents alike mentioned that the process of moving from user to contributor to core project member is not always explicit or easy to map out. When a newcomer, especially one from an underrepresented background, is considering joining a community, the lack of clarity on this potential trajectory can be a deterrent. In other words, it is easier and more comfortable to learn both technical practices and social norms when one's future role in a community is easy to imagine.

Making the various community member pipelines explicit could go a long way in diversifying both the Astropy community and the project's leadership. Conversations among leadership and the community about these trajectories may also help to address latent problems in those pipelines. In one of our interviews, for example, we asked about the potential trajectories for community members towards leadership positions. This conversation generated an insight about the Coordinating Committee's diversity that is certainly worth acknowledging and strategizing:

Yeah, well, the field of astronomy, I guess, itself, it still tends to be skewed pretty heavily towards North America and Europe. And yeah, that shows up in the composition of the Astropy Coordination Committee. Astropy contributor

In this case, the interviewee ascribes the lack of CoCo diversity to the lack of diversity in the discipline more broadly. The next section, consultant insights, will dive a bit deeper into how Astropy might view itself as a catalyst for change in this domain. Regardless, sparking these kinds of conversations about how newcomers, and even experienced community members, perceive their future in the project can surface actionable insights to improve the project's pipeline from role-to-role.

5.7 Use "Buzzwords" with Care

The temperature around DEI conversations has risen in recent years: From business leaders to governments to scientists, not everyone is on board with the idea of intentionally promoting diversity, equity, and inclusion in organizations. The recent fervor around this topic has made word choices

and explanations of concepts critical to productive discussion. For this reason, community members suggested that Astropy use care and caution when communicating about its DEI efforts.

This concern cuts both ways. Individuals and groups who are hesitant about DEI initiatives question the rhetoric and language used by its proponents; on the other hand, proponents also hold concerns about watering down the conversation by relying too much on buzzwords, as was the case with a graduate student astropy user we interviewed:

It's a little frustrating because at the same time, it is a big issue I think for a lot of spaces. And a lot of communities, but also recently there's been a lot of trends, where people just throw those words around like buzzwords and it's frustrating because it dilutes the whole purpose of, you know, talking about the issues with equity and having the people who are in a community actually be represented by whoever's meant to be representing them. Stuff like that. That's kind of broadly, I think, those things are important and it's not good to downplay.

She continued, noting that word choices can influence who ends up in a community and, in turn, what work gets done:

Because it does really influence not only the social dynamics that happen if you're including people, versus you're not being nice, but it also does affect not only the way things done, but what things get done. Because if you have a very narrow definition of people, you only have one narrow group, then the probability that everyone thinks the same way is much higher. If you have a really diverse group, you're going to get a lot of different ideas. You're going to get a much better breadth, I think, of idea generation, things to do. And I think that's something that can be, you know, if you're trying to contextualize within Astropy, if you want a tool that everyone truly can use and everyone goes, "Ooh, yeah, this is the one tool for, you know, Python and astronomy," then you gotta have breadth, obviously. And I don't think you can realistically get breadth if the people who are trying to create that all come from one background and have the same sort of things to say about it. Graduate student astropy user

Consulting with DEI experts who have a strong command on DEI-focused language and messaging can help in this regard. OrgMycology is limited in its capabilities in this domain, but is happy to offer suggestions for organizations and individuals who hold expertise on communicating about DEI.

5.8 Offer Safe, Constructive Avenues for Feedback

Feedback and collaboration are central elements of any successful OSS project, where contributors, core developers, and maintainers must work together in cohesion. The structure and tenor of these feedback loops are as important as the content: Unhealthy interactions can stymie motivation to participate, especially when participation is voluntary. Incidents have occurred within the Astropy community that speak to the need to provide more guidance and training on interacting with respect and kindness:

[A contributor in the community] is not a native English speaker, and she feels like she's kind of been bullied or put down by... I mean, it's easy, and it's easy for it to be as simple as somebody saying like, "Oh, so-and-so is not such a good speaker" or something. And like minimizing their participation in a workshop or other presentation.

Two interviewees mentioned that meeting people in-person helped to feel more comfortable with the level of attention their contributions receive on platforms like GitHub:

Oh, yeah, I think in my case, it was just being able to corner people. I mean, I literally had to corner them and get them to help me. I did notice, so after the conference, I had this large pull request, which is the first time I had ever undertaken something for open source that was that big. And yeah, I remember for a few weeks afterward, it felt like nobody was talking to me on GitHub, like the pull request was sitting there. But I mean, things pulled together, like when it got close to the feature freeze deadline, then that's kind of when people turn their attention towards getting the pull requests straightened out. And I got the attention that I needed and then it all worked. I think we can all work online. I mean, we're all having to get used to that because of the pandemic, but before, when I worked on a European project, we always used to say, like, if we saw people once a year or so, that's kind of enough to keep the contact with them and then you can interface remotely the rest of the time.

Considering conditions such as these is important when designing avenues for users and contributors to receive feedback. Face time, in other words, can help put potential contributors at ease and make contributions more accessible to a wider variety of individuals. While scaling this approach is difficult, even short videoconferences may provide some of the social interaction necessary to get users over the threshold to contributors and help them feel that feedback is constructive and healthy.

5.9 Implement and Enforce the Code of Conduct with Creativity

Codes of conduct are very useful for making community members feel safe and comfortable interacting within a community. Many projects, however, struggle with how to implement and enforce these codes of conduct. The primary problem, according to interviewees, is the balance

between anonymized and private incident reporting and human-centered incident reporting. On one hand, anonymized reporting can make community members less fearful of retribution for reporting an incident.

On the other hand, the opacity of reporting in this way can make it difficult for a reporter to know who is handling the issue and what the outcomes may be. Furthermore, reporting forms cannot always capture important signals such as tone, emotion, and other cues that are vital to ensuring the reporter is psychologically safe. Interviewees both hypothetically and anecdotally (see point #3) discussed this balance and often valued human followup even when they might prefer using a reporting form for the initial report:

I'm not sure that making it informal would solve that issue, but I think maybe having a liaison of some sort, a human being who's there who's like, "Hey, you filled out the form, great. Let's talk about it, you know, what's something that maybe you felt uncomfortable putting in the form. And here's some clarification on how we make sure that retribution doesn't happen, stuff like that. And maybe have on the page where code of conduct stuff, you know, like, "If you need to report it here, or talk to somebody, get in touch with this person." That can be the liaison who is like, "Okay, well, you know, if you feel uncomfortable reporting it in a very official capacity, let's talk about it." Let's figure out a solution that works for that individual. If they're really, really that fearful of confronting whatever's going on. It is important to listen to people who, you know, are unfortunately having to deal with reporting people breaking a code of conduct. And I think it is important to try to make that process as comfortable as possible.

No matter the process, it is essential that someone in the project is visibly accountable for handling reports and ensuring that the process works as intended. Often this can be more than one person, such as a community manager and an ombudsman. Listing these responsible parties on websites and info pages, as well as making them visible to the community at events and workshops, can help community members know who to go to when incidents arise.

5.10 Foster Healthy Collaborations within the Community

Interviewees appreciated the collaborative environment Astropy has fostered, comparing it to the sense of competition they observe or participate in with other scientific domains:

And, you know, there's so many science spaces where for whatever reason... I know the reason and I don't agree with it, that collaboration is not something that's truly encouraged. It's more competition. And I understand that, you know, there's limited money and that causes a lot of the competition. But I think for science to

truly happen, you need collaboration and you need to say, “Oh, we have this core group of people, let’s bring people in, let’s continually expand.” And I mean, obviously you’re going to hit scope issue at some point. But, it is nice that it seems like there’s genuine efforts on Astropy’s part to do that.

Across all interviewees, though, there was an expressed desire to make these collaborations more diverse and inclusive. In some cases, this was geared toward intellectual diversity (see above); in others, interviewees believed there should be more effort put into international collaborations. Among the strongest perspectives was an interviewee who had experience making collaborations more inclusive, describing how they and their advisor continually sought to act with intent and invite underrepresented groups into their research:

We’re doing an REU, research experience in undergrad, where we bring in undergraduates to our our school and we’re like, “Hey do some stuff.” And now that I get to pick them with my advisor and go, “Okay which undergrad do we want?” And so I get a say in that, and that’s really cool. One of the things that we talk about all the time is, “Hey, let’s think about it, who really needs this more?” And, and you know, “Is it weird to be picking?” No, not really, because still systemically the odds are not stacked in the favor of the people who are underrepresented. And so if we do have an opportunity to extend that hand, then we should absolutely do so.”

Seeking out programs and universities to partner with could be a practical way to foster more diverse collaborations within Astropy and in the discipline more broadly. As one participant mentioned, historically-Black colleges and universities are not well-represented in Astropy; being intentional about making those collaborations happen may be beneficial to the project’s overall diversity and health.

Beyond research collaborations, experienced members of the Astropy community noted that in-person events are vital to building connections and being comfortable moving from user to active contributor. Travel expenses and visa issues, though, prevent many potential community members from ever being in the same room as their peers:

So definitely there’s inequities and I guess people, you know, being able to have access to things like computing resources and travel. Well, travel, yeah, because really being able to be in person helps a lot and it helped so much for me to be working with the Astropy people at the Python in Astronomy Conference. But I was, at the time I was working for [notable astronomy organization] and they paid for my trip, so I didn’t have any funding issues to go to it. Astropy contributor

Finally, participants expressed enthusiasm for the idea of creating and growing mentorship programs within Astropy. Even the most skilled developers can use guidance on navigating the more experience-based norms and practices of the community and broader OSS field. Mentorships,

like all of the suggestions offered by the community, should be managed with intent and care. As one interviewee noted, it is important to ensure that these programs are sufficiently diverse so as to not recreate the same DEI issues communities in this domain have faced in the past; similarly, finding ways to not overburden underrepresented groups with these acts of service is essential:

I guess as long as you're mindful of who gets to be the mentor and who gets to be the mentee so that it's not, again, closing the loop in a way that we don't want to, the same type of people being in the space, that's a good idea ... So have some, you know, obviously it's not fair to put the burden of responsibility on underprivileged groups. astropy user

Mentorship programs designed with intent, according to one interviewees, should also be co-created between the mentor, mentee, and Astropy leadership.

So maybe a way there should be some built-in thing where it's like, there's some framework upon which the mentorship works and then the details get figured out basically between the mentor and the mentee to kind of customize the experience. So to say, "Hey, these are the things that everyone gets." And then for the format part of it, "What works for both of us? What's the way that this mentorship can function that would be most advantageous?" It's almost like if you need accommodations in a course, you kind of have an individualized process for that, right? Graduate student astropy user

6 Consultant Insights

The insights offered from the community members we interviewed reflect both challenges and opportunities that Astropy leadership can learn from in improving the project climate around DEI issues. Below, we offer some interpretation of the community's ideas alongside approaches we've seen work well for projects and organizations who have addressed similar issues. These recommendations are not exhaustive; indeed, our final recommendation suggests that further inquiry is needed that goes beyond the bounds of the Astropy community, ideally in consultation with DEI-specific experts. In other words, future DEI work at Astropy might aim to survey and interview those individuals who are *not* involved in the community, but were once involved or would be good fits for the project. Likewise, partnering with organizations in the Astropy's broader overlapping environments (e.g., astronomy and open source software) could aid in addressing some of the ecosystem-oriented challenges such as the lack of diversity in scientific disciplines. This approach would be a good step in acting upon the first recommendation: View Astropy as a Catalyst for Change in the Broader Scientific and Computing Landscapes.

6.1 View Astropy as a Catalyst for Change in the Broader Scientific and Computing Landscapes

As discussed in the first section of this report, a significant portion of Astropy's need to improve DEI conditions stems from its position at the center of overlapping communities. Each of the scientific (e.g., astronomy, physics) and computing fields it draws its community members from are among the worst performers in fostering diverse, equitable, and inclusive environments. But rather than wait for these fields to change, Astropy can (and is beginning to) take steps to be part of the solution. Below, we offer some concrete recommendations for becoming such a catalyst in the broader scientific and computing ecosystem.

6.1.1 Offer the project as a place for diversity to grow in astronomy AND computing, OR either of those things separately

Across every open source community we've worked in, consulted with, or observed, project leaders and community members are continuously looking for unicorns: Individuals who hold a very high level of expertise in both the scientific domain as well as software development. This orientation is true in recruiting for "core" positions (e.g., core contributors and maintainers), and in some sense is unavoidable once a project reaches a certain level of technical maturity. But there is substantial opportunity to reorient this unicorn-focused approach when growing and sustaining the broader community, such as in the project's attempt to recruit new users and novice contributors. Calls for participation—whether in conference presentations, blog/website/social media posts, workshops, or announcements—can use language that welcomes "non-unicorns" into the project to explore and find a role for themselves. Project leaders who present about Astropy, for example, could welcome participation with statements like, "Are you an astronomer looking to improve your software development and use practices?" or "Are you a strong software developer looking for interesting astronomy problems?" With some work and ongoing reflection and revision, these types of statements can go a long way in making "non-unicorns" feel comfortable joining Astropy as a way to improve all of their scientific and computing skills while driving the project forward.

6.1.2 Map and accelerate the trends in adjacent fields

We provided links in the Background section to some reports that track DEI-related trends in fields such as astronomy and computing. These types of reports, however, may not be updated and published often enough for Astropy to use in its community-building efforts; likewise, the metrics and methods these reports use may not be adequately precise for the goals of Astropy's leadership. Some effort and resources could be put toward mapping DEI-related trends in astronomy, its subfields, physics, computing,

and the like. This effort could also be led by the community, offering opportunities for members who wish to improve DEI efforts to join teams who collect and present such data. This effort is undoubtedly time-consuming in a community already needing more time to work on science and software development. But releasing such data periodically signals to both newcomers and existing members alike that Astropy is aware of and actively trying to shape the direction of its core disciplines in ways that will make the project itself stronger.

6.1.3 Getting involved in efforts that are already happening

Astropy participates in a number of programs with adjacent communities, including offering workshops at conferences and related activities. Leadership and the community could begin to curate lists of such opportunities for improving DEI and pursue a wider variety of these programs. [The Big Ten Academic Alliance's Summer Research Opportunity Program](#), for example, offers undergrads from underrepresented backgrounds the chance to get involved in high-level research efforts at an earlier stage than they otherwise might. Various related programs and travel funds go a long way in both demystifying academic research (and its core software) and providing resources and skill development for underrepresented students. Astropy benefits from many different university affiliations on its leadership team and within its community, so coordinating with academic programs on their DEI efforts is a viable and sustainable way to take these steps forward. Beyond this, Astropy is in a unique position to be a value-add to these programs: Often these programs focus on getting students into individual labs or departments to do bench science or use existing computational tools, and working with communities like Astropy would extend the opportunities available to students in learning open source methods at the frontiers of scientific research.

Across all these efforts, Astropy should strive to be a place where underrepresented individuals can learn new technical and collaborative skills while also growing a strong network. Indeed, DEI experts routinely point out that networking is one of the major challenges facing scientists from underrepresented backgrounds given that they often lack the resources and starting points that well-represented groups benefit from. Astropy is a home for some of the most influential scientists and developers in the field, a capability that could be used to advance the careers of underrepresented groups.

6.2 Embrace and Cultivate Intellectual Diversity

As discussed in the Community Recommendations section, open source scientific computing is growing in both size and scope: Practitioners interested in a wide variety of programming languages and computational techniques are looking for opportunities to contribute to projects while advancing their own expertise and careers. We are referring to this as

“intellectual diversity” for simplicity and believe that it could be a key mechanism of increasing other forms of diversity within and outside of Astropy.

By “intellectual diversity,” we mean “a variety of educational backgrounds, skill profiles, career interests, and computing approaches.” Interviewees pointed out that the project is experiencing an increase in interest from practitioners who are students or experts in fields like machine learning and artificial intelligence (including one of the interviewees, who views himself as a machine learning practitioner first). While this could, at first glance, appear to be a threat to the cohesion and unified goals of the Astropy community, we believe it offers exciting opportunities to invite a wider, more diverse set of community members into the user, contributor, and maintainer groups.

This is certainly not to suggest that other fields have achieved desired results in the way of DEI; in fact, fields like machine learning and artificial intelligence suffer from many of the same DEI issues as the fields closest to the Astropy project. There are, however, key opportunities within this scenario:

- Astropy could serve as a welcoming place for these practitioners who do not feel welcome in their home fields. This does not necessarily suggest that Astropy is competing with these fields or that the fields do not naturally overlap; however, it may feel easier (as one respondent mentioned) to join a community focused on solving specific scientific challenges than it does to join a community focused on beating the benchmarks of a previous algorithm.
- Multiple respondents mentioned feeling encouraged by the progress astronomy has made in training and elevating women within the field. Astropy is a good example of this and has certainly contributed to the uptrend; it therefore may be well-positioned to have similar impacts in open source computing of all kinds.
- Emerging computing fields (e.g., machine learning, AI) often include practitioners from countries that are not well-represented in astronomy. Giving these individuals an opportunity to work on problems within their computing domains, perhaps in teams with experienced astronomers and astronomy software developers, could offer an entrypoint for non-U.S. and non-European scientists and developers.
- Fostering intellectual diversity within Astropy can also help the project attract more funds. In other words, widening the scope of computational and scientific approaches opens up new sources of funding that are supporting these fields and approaches. With diverse membership, Astropy would be in a position to apply for such funds.

6.3 Actively Learn from Adjacent Communities

In at least one interview, the respondent effusively praised the experience he had at a SciPy event based on both positive and negative experiences (see the Community Recommendations section). Continuously looking for these positive examples and experiences may help Astropy identify what works for its community and steps it can take to foster these positive experiences.

- Query the community after they return from events (large, small, or both). Simply asking community members in short, structured survey questions such as “What was one positive experience you had interacting with others at ____? One negative?” is a lightweight way to curate these ideas. Likewise, a community channel for sharing these positive and negative experiences might also help leadership have visibility into what is working or not working in the broader community. These types of queries may also feel less threatening and easier to respond to than question about the Astropy community itself.
- Engage in conversations with other communities about DEI issues. Astropy has already taken steps to do this with communities like pyOpenSci and via collectives like NumFOCUS, but the project could hold these conversations more regularly to share ideas. Ideally, these conversations would be happening at all levels of the organization, including leadership-to-leadership, community manager-to-community manager, maintainer-to-maintainer, and across these groups.
- Take note when incidents—both positive and negative—become topics of discussion in the broader ecosystem. Whether through informal networks or in public places like forums, leaders in the OSS community often become aware of both good and bad social incidents. Taking time to debrief and discuss these incidents within project teams is a good way to ensure that steps are taken to avoid replicating these issues in your community.

6.4 Be Open to, But Critical of Shared Services

Astropy community members are already busy with considerable commitments in many areas: software development, day-jobs (e.g., professorships or industry positions), and career advancement and professional development. It can therefore be tempting or simply necessary to consider shared services models for some core community activities. One example of this is the idea of a fiscal sponsor (e.g., NumFOCUS) providing a range of administrative and community services. Astropy is currently experiencing this with its fiscal sponsor organizing and maintaining a Code of Conduct enforcement committee for all fiscally sponsored projects. To be sure, an organization like NumFOCUS convenes a range of projects that face challenges similar to Astropy, so results may be positive if they adequately crowdsource and member-check proposed solutions. But as we’ve seen in other domains, offshoring tasks that require ongoing commitment and attention over the life of a project can lead to the community losing touch with its own needs and its own perspective on potential solutions. For instance, the root-causes of Code of Conduct

violations may differ across projects, and enabling the community to be involved in Code of Conduct process formation may help to address blindspots at the cross-project level. Finding a balance where the community can collectively hold its enforcement, and have enabling infrastructure and guidance that makes it “lightweight” to do so, are what we’d recommend for a growing community like Astropy.

6.5 Consider Geography and Timezones

Both the community survey and the DEI interviews indicated that there is a dominant gravity for timezones in North America when scheduling events and workshops. This can lead the community to have conversations and make decisions during times that are difficult for those in other global timezones to participate in, leading to feelings of exclusion. Astropy is already a very asynchronous community, but in its synchronous moments, it could be useful to bring more consideration to those in minority timezone areas. Additionally, when key annual events are held in the USA, there can be very restrictive visitation visa restrictions for travel to the United States for people from some locales. It can be worthwhile to consider annual events taking place each year in countries with less restrictive visa requirements.

6.6 Develop Community-Driven Definitions and Metrics for Diversity

The Astropy community should work to collectively define its own targets and progress benchmarks for increasing and expanding diversity as a community. It is clear that the astronomy community at-large still has significant DEI issues, and it is also clear that many in the Astropy community aspire for the project to challenge those trends with a new model of working and including others.

For this to be successful, it will be important for the leadership of Astropy to be the ones driving the community to define what DEI looks like for Astropy. We encourage Astropy community members to continue to advocate for finding the time and space to have these conversations, and bring the conversations toward key measurable goals for the community. One way to do so is to issue an open call for ideas, centered around the question of “What do we want the Astropy community to look like in ten years? Who do we want to ensure feels comfortable participating in our spaces?”

These open prompts often lead to side discussions, and can be directed toward coworking events, workshops, and other synchronous activities aimed at developing solutions. It can be thought of as a “DEI Hackweek,” with the understanding that planning will require substantial consideration of guardrails and Code of Conduct enforcement.

6.7 Use *Political Opportunity Structures* to Drive Change

Given that Astropy operates at the intersection of various fields and institutions (e.g., academia, industry, and government or astronomy and computing), the project also has these fields' *political opportunity structures* to draw from when crafting DEI strategies. This term refers to the available structures external to a movement (in this case Astropy) that help the movement accrue and mobilize resources. The most influential example is the role of Black churches in the United States Civil Rights Movement: Movement leaders and participants had pre-existing organizing capabilities and resources through their churches, enabling them to effectively mobilize for change.

Consider what structures exist within the fields of astronomy, computing, academia, and all other Astropy-adjacent communities. What other efforts are ongoing within the field that could lead to more diversity and inclusion? Where are others in adjacent fields already accruing resources and building communication structures to enact change, even if those changes are not directly DEI-related? Answering these questions as leaders and community members may help to put more power and efficiency behind DEI efforts.

6.8 Celebrate Progress

It is important when working on challenging topics like DEI to celebrate strides in the community and improvements as they occur. Interview participants, for example, universally lauded the progress astronomy has made in enabling women astronomers to thrive and some pointed directly to Astropy as an example of this positive trend. Continually assessing the state of Astropy's DEI efforts and creating opportunities to celebrate success can be a motivating factor to push additional efforts forward.

Practically, Astropy could dedicate some form of communication to celebrating DEI successes. Quarterly newsletters, informal presentations, or Slack/forum announcements, for example, could routinely report on progress being made in advancing DEI. Furthermore, these announcements need not only be focused on Astropy: Drawing on the existing diversity of disciplines and sub-disciplines gives ample materials to work with, and celebrating the successes of other communities is a sustainable way to draw in new users and contributors in a welcoming, inclusive way.

6.9 Support the Community Manager in Developing DEI Expertise

Given that DEI is an issue in the community, Astropy should give support to the Community Manager in developing DEI expertise as a part of their work. *[Note: It is vital that DEI is not viewed solely as a community manager problem or responsibility—DEI improvements require a community-wide effort].* Trainings, consultations with DEI-specific experts, and reading materials are all low-cost options for beginning to equip the community manager with the skills to facilitate DEI improvements. Furthermore, encouraging the community manager to work with other scientific organizations that are struggling with the same challenges can provide a way of creating more astronomy-centered or general knowledge on the topic.

6.10 Develop Future-forward Plans for DEI Efforts

Similar to recommendation 6, Astropy should consider developing a formal and adaptable strategy for DEI improvements in the near and long terms. Thinking towards the future of DEI for Astropy would include prompting an ongoing discussion of what the community would like to see going forward and how to continue to make these efforts a community conversation. Futures Thinking Exercises and co-creation of this vision can promote buy-in among the community by bringing those interested in leading DEI efforts together.

7 Interview Questions for DEI Respondent

7.1 Astropy Community Research

Improving diversity, equity, and inclusion is a high priority for Astropy. With that in mind, we've designed an interview schedule that we will use to query a small subset of the Astropy community. We will ask them about their perceptions of the state of DEI in the community, what they think can be improved, and where Astropy might best direct its resources to addressing DEI issues.

Our broad research questions are as follows; specific interview questions appear later in the document.

1. Can we identify ways on how we can improve DEI in the Astropy community?
2. What types of workshops would help with DEI?
3. How should any available funding be used to improve DEI?
4. What should Astropy be doing, concretely, around DEI?
5. How can we help people “cross the threshold” to be an active, contributing member of Astropy?

6. Are there distinctions/disconnects between social media forums? FB vs. slack vs. twitter?
7. What should the role of the community manager be in Astropy's DEI efforts?
8. What feedback mechanisms would help advance DEI, beyond the Code of Conduct?

7.2 Housekeeping for Interviewee

Thanks so much for being here, I really appreciate your willingness to do this. Let's get some of the housekeeping out of the way and then we'll get into the conversation. We are interested in understanding community thoughts around diversity, equity and inclusion. We are conducting this work on behalf of Astropy. There's no right or wrong answers, and you're welcome to ask me to clarify any question. Your participation is voluntary. You can choose to skip or not answer a question and you can stop the interview at any time. We will not be attributing any of your responses by name in the report we create from this, however some members of Astropy will be aware of your name and what you've said. We'd like to record this for our use internally for our research team. The recording will not be shared with Astropy Some colleagues are observing this session. They may have some questions at the end of our session but for most of the time it'll just be us chatting. What questions can I answer for you about the research we're doing?

7.3 Questions

1. Tell us about your involvement with Astropy:
 - How did you get started?
 - What is your experience with the astropy community?
2. What comes to mind when we bring up the topic of diversity, equity and inclusion?
3. Tell us about your perspective on the issue of diversity, equity and inclusion... (tailor this question to their background)
 - In astronomy?
 - In computing?
 - In open source?
 - [for everyone] in Astropy?
4. We're thinking of DEI broadly and we made a list of types of equity issues. We are especially interested in DEI efforts focused on the contributor and development community. Which do you think needs the most attention for Astropy?
 - Race
 - Gender
 - Sexuality

- Socioeconomic status
 - University resources/background (e.g. HBCU vs. R1 vs. SLAC)
 - Geographic location
 - Non-English speakers
 - Available Funding
 - Academic Status (grad student, postdoc, tenured, untenured, resourced/not resourced)
 - Non-academic involvement with astropy
5. Let's say that Astropy has time and resources to devote to diversity, equity and inclusion efforts. What would you put them towards? Here's a list of other possibilities (feel free to add to it). What do you think would be the most impactful for the Astropy project?
-List of things: Mentorship programs; Workshops (general or targeted); DEI audit; More resources for Code of Conduct and reporting; Update Code of conduct in other ways; Bug barbeques and other community events; Reach out to communities not represented well in the Astropy project; Non american astronomers; Amateur astronomers; Instructors who use astropy for teaching; Publicize Learn Astropy resources; Inviting folks to online forums such as discourse, stack exchange or facebook.
- Why does that seem like a good approach?
 - Are there other things you've experienced in other communities that might help?
6. What are some ways that initial contributions to the Astropy project could be more accessible, particularly for people from groups that are underrepresented in the Astropy community?
7. How did you first contribute to AstroPy? (this doesn't just mean code, it can mean anything, documentation, sticker design, supporting others)
8. Have you helped others contribute? (Probe for why or why not)
9. Let's consider DEI from the perspective of project leadership and the astropy community. With that in mind...
- What do you think leaders could do better?
 - What types of training and workshops might leadership take to better understand DEI needs?
 - Do you feel that there are sufficient feedback mechanisms for community members who may feel uncomfortable interacting with the community or otherwise engaging with Astropy? (e.g., beyond the Code of Conduct)
10. If you could design a mentorship program with Astropy, what would you build into it?
- How would you design it?
 - What would be the best way to deliver it (e.g., length of time, virtual/in-person, etc.)?

11. Anything else we should know about DEI, or other comments for the astropy community?

Thank you so much for your time.