WHY IS EQUITY, DIVERSITY, AND INCLUSION (EDI) SO DIFFICULT FOR SCIENTISTS?. J. A. Rathbun[1], S. Diniega[2], L. C. Quick[3], C. Richey[2], [1]Planetary Science Institute (rathbun@psi.edu), [2]Jet Propulsion Laboratory, California Institute of Technology, [3]NASA Goddard Space Flight Center.

Introduction: It has been difficult for the planetary science community to adopt standards to increase diversity within our field. Here we comment on possible reasons for this, share data on the current state of diversity in the US planetary science community, and offer recommendations for individuals and organizations to increase EDI in planetary science.

How is EDI like Quantum Mechanics? Many astronomers and planetary scientists take Quantum Mechanics as part of their training, and many students find the subject particularly difficult. Thomas Moore, in his introductory physics textbook, Unit Q writes: *"You may justifiably feel that the quanton behavior described here does not make sense. Quantons in this context simply do not behave like anything that we are familiar with in daily life... This is one of the basic problems of quantum mechanics... it is simply something that we will have to deal with."*

EDI is like Quantum Mechanics in that: it is difficult and not about fault or blame, and it can be studied academically. Furthermore, incidents experienced by one group (quanta, members of underrepresented groups) occur outside of the experiences of another (macroscopic objects, members of the majority groups). However these experiences ARE connected and affect the system as a whole.

In the case of both EDI and Quantum Mechanics, when phenomena (in this case negative experiences faced by members of underrepresented groups) aren't dealt with, bad things happen. However, EDI is unlike Quantum Mechanics in that it affects real people with real feelings; it is not JUST an academic subject and it often elicits emotional responses from members of both the minority and majority groups.

The data – Who is involved in Planetary Science in the US? Although the percentage of women in the US planetary science community has greatly increased in the past several decades, it is not yet at parity [1]. Additionally, racial and ethnic minority groups are the most underrepresented groups in US planetary science, by more than an order of magnitude compared to white women. This is NOT due to a lack of interest in the subject, as for example, black first-year college students indicate an interest in STEM at higher rates than their white peers [2]. In addition, there is no measureable difference in STEM entrance among Black, Latinx, and White students [3]. And yet, the representation of Black and Latinx students in space science fields decreases at every educational stage, from bachelors degrees in Astronomy and geoscience, to PhDs, to planetary science professionals [4]. White women, on the other hand, are underrepresented at the bachelors stage and the level of underrepresentation remains generally constant from that point forward [4].

The number of bachelors and PhD degrees awarded to Black students in the geological sciences has remained flat for at least two decades. Over the same time period, degrees awarded to Latinx students has increased, but not in proportion to their rates in the US population [5]. Moreover, the problem doesn't end when the PhD is acquired. The percentages for members of underrepresented groups who attain career-building opportunities such as faculty positions, professional awards, and invited/plenary speaker spots are typically very low with the respect to the percentage of those groups within the planetary science population [6]. For example, the percentage of women on spacecraft science teams is well below their percentage in the field [1], and a recent study has shown that ethnic minorities are least likely to be given talks at large meetings [6].

The theory – and how to learn more: Social Scientists have long studied why representation in some fields is not representative of the greater community. One contribution to this lack of representation is collective individual unconscious biases. Implicit biases come from mental "schemas" of what the world contains and what "normal" looks like. (To go back to the earlier analog, an example schema is Classical Mechanics, based on our experience with the macroscopic world.) Schemas are one method the human brain uses to enable quick interpretation of the vast amount of information that is available in our environment. Unfortunately, when people (unconsciously) try to make connections that are not standard, such as visualizing a woman as a scientist or a person of color as a principal investigator, then the disconnect between reality and our mental schema can result in an unfair bias against that connection. More concepts, with references, are discussed in [7] and [8].

Example of a change that worked: NASA has recently added the following text to its calls for proposals: "NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and fully expects that such values will be reflected in the composition of all proposal teams as well as peer review panels (science, engineering, and technology), science definition teams,

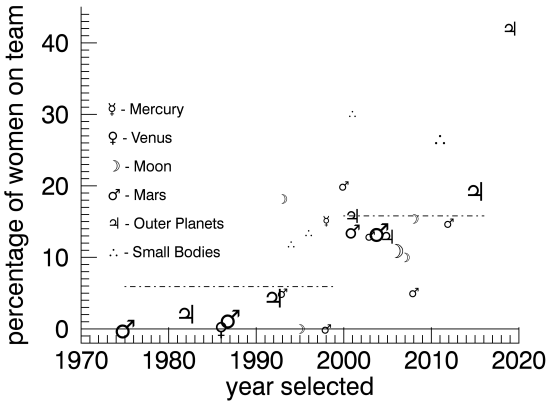

Figure 1: Percentage of women on science teams of NASA robotic spacecraft missions. Based on [1] with the additional point for the New Frontiers Dragonfly mission.

and mission and instrument teams." The first mission to be selected since this language has been included is the New Frontiers Dragonfly mission to Titan. We have analysed the team composition using the method of [1] and found that this team is 42% women, well above the percentage for previous missions (figure 1).

What can you do? Similar to the case of dealing with Quantum Mechanics, you don't have to be an expert to deal with EDI, but solving the problem of EDI in planetary science does require awareness that a personal mental "schema" may not be correct in all situations/for all people, and a willingness to look into and heed suggestions from experts in this area. Some suggestions for actions include:

1. Fill out demographic information when requested by DPS, NSPIRES, etc.
2. Learn about issues that affect the members of our community who are also members of underrepresented groups. [Readings include diversity presentations on the DPS PCCS webpage and blogs such as Women in Planetary Science and Astronomy in Color. We also suggest google-searching and reading about unfamiliar social science terms and studies.]
3. Pay attention to whom you work with. Who is missing from your collaborations? What can you do to fill those gaps and engage with different people?
4. Think along multiple axes of identity: race, gender, LGBTQ+ status, ability status, etc.
5. Amplify voices of scientists who are least likely to be heard. Be aware of your social capital and use it to help members of underrepresented groups.
6. Fill out surveys for meetings (like this one) and include both positive and negative comments about the degree of inclusiveness and accessibility in both the environment and program.
7. Learn how to apologize when you make a mistake when working with members of underrepresented groups. Everyone will have missteps, but the point is to stop causing harm by doing better next time.
8. Understand your own implicit biases and correct for them as you would correct for any other observational bias. (www.implicit.harvard.edu)
9. Have explicit, well-defined expectation criteria for hiring, evaluating personnel, admission, prizes, etc. Where possible, make review processes double anonymous [9].
10. Track demographics and strive for at least 30% of any one underrepresented group to avoid issues such as tokenism and stereotype threat [10, 11].
11. Have clear harassment policies. Use effective training techniques, sanction perpetrators, and protect members of marginalized groups.
12. Tap people on the periphery of your network to create new, more diverse, networks. This may include actively seeking out collaborations with minority serving institutions, and with minority students and faculty at majority institutions.
13. Prioritize EDI by, e.g., providing financial support for, and rewarding individuals who, facilitate changes that remove structural barriers for underrepresented groups in planetary science. Efforts to improve our community should be valued along with technical achievement, as both impact the types and quality of science that we can achieve.
14. Pay attention to the demographics of meeting attendees, invited speakers and those who are given contributed oral presentations. While gender can often be inferred from the lead author's name, simple google searches can elucidate other forms of diversity such as race and career stage. Organizers can also simply ask participants.

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