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Leadership, Equity, Inclusion, Diversity, and Accessibility in Particle Physics Research

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Abstract. Big science is represented by projects like those in particle physics. Big engineering is the application of engineering principles to large-scale projects that have a significant impact on society, like popular use of AI/ML (think ChatGPT and Google Bard). Both big science and big engineering are among the noblest and boldest applications of the human intellect to understanding the universe and humanity's place in it. Both depend on human collaboration to generate the ingenuity needed to make their impacts positive ones. Both are marred by evidence of bias, particularly racial bias, that lessens intellectual diversity and hence excellence. LEIDA – Leadership on Equity, Inclusion, Diversity, and Access is needed to ensure that opportunities lost in the past due to marginalization of particular communities eventually ends and the full breadth of creativity and innovation possible determines the future of our field.

1 Introduction

Particle physics research, as with all fields within Science, Technology, Engineering, Mathematics and Medicine (STEMM), can benefit greatly if principles exemplifying diversity, equity, inclusion, and accessibility are upheld by the practitioners, and, particularly, the leaders within the field [1-5]. However, the field has historically been dominated by certain demographic groups, leading to persistent racial and gender discrimination and inequities [6].

The problem is not unique to physics, but progress for the field has been comparatively slow. According to the American Institute of Physics (AIP) statistics [7], in 1971, 1% of PhDs in physics were awarded to Black or Hispanic students whereas 11.1% of the US population identified as Black or Hispanic. By 2019, the number of Black and Hispanic PhDs had increased to 7% of the total, but their fraction in the US population had increased to 25.5%. In addition, intersectional identities remain rare in the field. There are fewer than 100 Black women in the United States with PhDs in physics and the proportion of PhDs awarded to all women is about 20% of the total each year. This is the lowest fraction in all the physical sciences. Although there has been progress, the field is far behind the representation possible even in comparison to other sciences.

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1.1 The Need for Progress in DEI

1.1.1 Impact of the lack of diversity

The lack of diversity and inclusion in particle physics can have several detrimental effects on the field. First, it can limit the range of perspectives, ideas, and approaches to problem-solving. This, in turn, leads to less innovation and creativity. Secondly, lack of representation that approximates that available in the general population can allow biases (groupthink) to flourish. This leads to incomplete scientific analysis as to how the field should advance. Leadership that consists of those with largely similar backgrounds and values that decide how they approach science is a significant cause of groupthink [8]. Those on the inside perceive themselves as superior and outsiders as less likely to make the right decisions. More damaging is that those who feel as though they are perceived as being outside tend to self-censor from expressing dissenting opinions. Lastly, lack of diversity and inclusion can create an unwelcoming and discriminatory environment for underrepresented groups leading to less talent entering the field than would otherwise be available as explained below.

1.1.2 Impact of the lack of inclusion and equity

Long-term changes in the diversity of the field, as in any human endeavor, requires that everyone feel a sense of belonging, that is that they are accepted as their authentic selves for the contributions that they bring. Without this sense of belonging, those who are underrepresented within a group do not feel that they are working in a positive and productive work environment no matter how much their work may be valued in fact. Recent surveys show the extent to which graduate students in master's and PhD programs worldwide see bias and discrimination through microaggressions, harassment, and unwelcoming behaviors directed toward women and those self-identifying as underrepresented within their fields [9]. Those who do not feel valued or respected leave the field even if they have been successfully recruited into it. Hence any improvement in diversity is transitory without the efforts to improve inclusion and equitable treatment of those new to the field. For this reason, diversity, equity, and inclusion are often stated as one idea – DEI. Unfortunately, the generation of DEI as a meme indicating discrimination is increasingly making it more difficult to discuss its importance for building belonging and accessibility for all those who can contribute – a notion that is nearly universally accepted as being a desired goal for science.

1.2 Defining Diversity

We adopt here an evolving definition of "inclusive excellence" to define what should be goals for particle physics. This, in turn, requires adopting definitions of diversity and inclusion that are consistent with goals for particle physicists that are more difficult to challenge because they speak to the mission for particle physics that has been accepted by its practitioners for many years:

- Explore and understand the fundamental nature of matter, energy, space, and time and the interactions between them
- Carry out this exploration by discovering the most elementary constituents of matter and energy and the fundamental nature of space and time
- Advance our understanding of the universe through the development of new technologies
- Create new theories to explain the fundamental laws of physics and predict the behaviors of matter and energy throughout the history of the universe.

None of this mission can be carried out effectively without a wide swath of different skills applied by large groups of people who are dedicated to each part of this mission. Exactly which skills are needed is not always obvious. Any group must also work together harmoniously and creatively to make significant advances. Inclusive excellence is the recognition that a community's success at carrying out its mission is dependent on how well it engages, values, and rewards the diversity of its constituents. The diversity in this case emphasizes the need for people with differing opinions, life heritages, social experiences, capabilities, and previous life challenges they have overcome. This defines their problem-solving approaches and even informs which problems they are motivated to tackle. The inclusive part of inclusive excellence assumes accessibility that serves a vast range of abilities to operate within an extensive range of situations that arise as part of the activities that engage the mission. In short, teams that represent a broader range of approaches to problems are likely to be more creative in reaching compromise that maximizes the chance that the best ideas go forward and hence lead to better science [1]. The most likely reason for this is that greater cognitive diversity in teams results in more creative problem-solving [10, 11].

Diversity that contributes to the particle physics mission is the cognitive diversity representing the ways people think, process information, make decisions, and see the world. However, cognitive diversity is not easily identified nor quantified and there are few compulsory compliance efforts to increase it. The "meritocracy" we suppose we are looking to uphold in searches for new people to join our research endeavors is based on subjective efforts to identify "the best" candidate for a job, leadership position, faculty slot, and so forth. It should be acknowledged that this approach to finding excellence is highly flawed [12, 13]. It is the case, however, that groups with higher identity diversity also tend to have more cognitive diversity [14]. We should never assume for any individual that identity correlates to a viewpoint or approach that differs from the majority. However, for sufficiently large groups, this correlation between the degree of identity diversity and cognitive diversity is an effective way to gauge increases in cognitive diversity that lead to greater ability for particle physicists to affect the mission universally agreed upon.

2 Effecting Change

Arguing for change to better affect what particle physics is intended to do often runs into several arguments that there are no systemic effects acting to reduce diversity and inclusion. While the words in these arguments vary, the essential ideas posit that: racism and gender bias are problems of the past; there are alternative reasons for underrepresentation of particular identity groups in physical science that are more plausible than the action of systemic bias; evidence of systemic bias should be visible to anyone if its effect is as large as claimed. While a short paper is not appropriate to adequately address each of these in turn, it is important to recognize that there is extensive literature that disproves each of these arguments [15, 16]. Other studies verify the ways in which systemic bias is readily recognized by those in the minority discriminated against while being equally invisible to those in the majority [17]. Still other articles identify ways in which race and ethnicity affect epistemic outcomes in physics [18].

Increasing the field's propensity for excellence in achieving its mission requires increasing diversity, equity, accessibility, and inclusion (DEAI) to gain the benefits of inclusive excellence for particle physics. Several white papers from the Snowmass 2021 Proceedings on the Community Engagement Frontier describe what are presumed to be feasible means for affecting positive change [19-24]. DEAI in physics is a broad and complex topic requiring nuanced thinking about why and how previous efforts to increase it

have not produced results at the level we are comfortable declaring "successful". However, the white papers indicate major themes that are likely to be central to improving: better supports and infrastructure for previously marginalized communities, effective engagement with those communities with the particle physics community, a determination among leaders of the field that we can and will do better.

We emphasize here that senior researchers are in a critical role for there to be success with improving DEAI. Agreement with the tenets is insufficient and good intentions are ineffectual as the past should make readily clear. Acknowledging the existence of racial, gender, ableist, and other forms of identity discrimination is required to begin the questioning of biases and privileges in the system and structures that have long perpetuated these inequities. Efforts for inclusivity must strive at every point to create and sustain an environment where all individuals, regardless of background, feel they have a voice that will be heeded without backlash, subtle (as in eye rolls) or overt.

In addition, senior researchers should include responsibilities related to advancing antiracism and inclusion in leadership role descriptions and requirements for advancement into management. Technical mastery alone is insufficient to gain the benefits that can come if the workforce incorporates a broader swath of talents. Getting to the point of recognition of this is perhaps the hardest barrier to overcome. Yet studies in numerous social endeavors from high-tech companies to social groups to scientific research is clear: our ability to advance improves with managers that have both technical and inclusive competence over just technical/scientific competence alone [11]. Training future leaders on how to develop systems with more widely shared, inclusive decision-making processes and methods to distribute authority, particularly over the allocation of resources, should become part of what we ask the field to adopt. While it may seem a radical shift, requiring evidence of this kind of training in grant applications, prize/award nominations, and in selection of leaders for national and international level collaboration would be the strongest signal that the field is adapting itself to the reality that its future must be more diverse, inclusive, accessible, and equitable than its past.

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