Snowmass2021 - Letter of Interest

Physics Graduate Admissions and our Einstein Problem

Thematic Areas:
■ (CommF2) Career Pipeline & Development
■ (CommF3) Diversity & Inclusion
■ (CommF4) Physics Education

Contact Information:
Kimberly Palladino (University of Wisconsin-Madison, Oxford University) [kpalladino@wisc.edu, kimberly.palladino@physics.ox.ac.uk]

Abstract: High energy physics plays a key role in graduate admissions. Experimental groups are often large and well funded, and thus able to affect the admission of large numbers of students. High energy theory, although less well funded for student research positions, is often the first subfield to capture the imagination of budding physicists and is thus disproportionately represented as an interest of applicants compared to the number of completed PhDs and further academic positions. The competitive nature of high energy theory already begins to play out in graduate admissions where high expectations for standardized exam scores, publications, and theory research experience winnows admissions to a limited number of future theorists. However, members of under-represented groups in physics often lack the exposure to both experimental research and academic rigor of theoretical physics, while holding aspirations to engage in the media-popularized career path of theoretical physics. Admissions committee members may be looking for Einsteins to enter the theory field, and applicants aspire to being Einstein, but the mismatch of prior experience may disqualify more students from under-represented groups from entering physics graduate school. This is our Einstein problem in admissions. Quantifying this effect, facing our bias, and providing more information and opportunities to undergraduate students, as well as reforming graduate education may all be led by high energy physicists to impact the diversity of the field.

Defining the Problem

The lack of diversity in physics PhDs is well documented[1]. Although many causes for this have been identified[2], the very specific impact of intending to study high energy theory at the time of application has not been addressed. As data for this phenomenon is limited within an institution, let alone across the field, the following discussion is quite suppositional and built anecdotally.

The first image of a physicist many people encounter is that of Einstein. Particularly for those that continue in physics, there is an attraction to theory work, as it is likely that people who are interested in many other aspects of physics at the outset may end up in the more directly parallel field: astronomy, materials science, chemistry, and computer science. The diversification of physics interests may evolve with exposure to more physics subfields and careers.

A number of structural issues may limit the exposure of under-represented minorities in physics (URMs) to the broadest subfields of physics. The work of high energy particle theory and cosmology captures the imagination, and aligns with the pencil and paper problem solving experiences of many physics courses. It is not surprising that a large number of students apply to physics graduate programs intending to study theory[3].

The number of PhD positions in high energy theory is limited, and if URMs are disproportionately applying with theory in mind, they may disproportionately be denied admission to graduate programs, not only because of this simple numerical reasons, but also via bias, if they do not remind admissions committee members of a theorist -an Einstein. Thus, with a brief review of the general pattern of graduate admissions, our defining of the Einstein problem will be complete.

Physics Graduate Admissions

Although US graduate admissions is not generally directly to a particular research group or area of study, the economic realities of funded research positions mean that student interest areas are taken into account when admissions decisions are being made. The small numbers of positions available within theory groups leads to a high level of selectivity in choosing future theory students. This selectivity is exacerbated by the fact that the number of positions is so restricted that students admitted with an interest in theory are more likely to accept the spot as they will have often received fewer admittances.

In such a competitive environment, physics GRE scores may play a significant role in in the admissions decision, even as globally, such test scores are being given less, or, no consideration. As the applicant pool is generally strong, any objective mismatch between qualifications and study goals may be used to make quick admissions decisions.

For a student that indicates an interest in high energy theory, but not immediately deemed to be a top contender in that area, admissions committees must then divine whether the student may be a god fit for another area, often experimental high energy physics. Such options often go to students who have had experimental research experience, or for whom committee member may feel a subjective affinity to, both of which tend to be biased against URMs. Experimental high energy groups are often large, with established mentorship and training, that students with less preparation or exposure to physics research at the undergraduate level can succeed. This can lead to more URMs in experimental high energy physics.

What may be the outcome of these admissions decisions for URMs? Fewer URM students in physics graduate school in total numbers, or admitted URM students having uncomfortable experiences as they attempt to study theory while departmental advisors may steer them toward experimental work. Even 'successful' outcomes may have experimental physics staling URM physicists from the less diverse theory field, or URM theory PhDs leaving physics due to the tight theory job market. Even economic worries may keep URM students from pursuing their true interests in theory.

Potential Mitigations

Exploring these ideas will take more precise data collection following applications through to PhD completion. Full demographics as well as fields of study will need to be captured in a unified manner.

Many of the suggestions from [2] contend with the issues that may mitigate the Einstein problem con-

cerns. More research experiences for URM undergraduates will both broaden application areas of study, as well as strengthen the applications of those students that want to stay in theory. Bias mitigation efforts such that admissions committees stop looking for theory students to fit a particular profile image, including the elimination or reduction of importance of Physics GRE scores.

But if we do recognize this as an issue, we can directly provide information to undergraduates interested in graduate school with more information about the economics of different fields, and the wide variety of theory adjacent work available within experimental physics.

Of course, we also may take Einstein himself as an example. His early career prospects were fraught, and he needed to persevere to study his interests[4, 5]. We owe it to the future Einsteins to support their work. We may radically re-envision how students are supported early in their graduate careers such that paths to theory are not closed off prior to the first semester of graduate school beginning. Justice in admissions, increased diversity in experimental and theoretical high energy physics, and vibrant, creative communities of physicists are our goal.

---

[1] A. I. Physics, "Data on underrepresented groups among phd recipients." Available at https://www.aip.org/statistics/minorities/phds (2020/08/31).

[2] D. Norman, T. Searles, E. Bertschinger, T. Dobbins, R. Hilborn, S. Malcom, M. Ong, J. Pando, E. Price, and C. Stark, "The aip national task force to elevate african american representation in undergraduate physics astronomy (team-up)." Available at https://www.aip.org/diversity-initiatives/team-up-task-force (2020/08/31).

[3] B. Henderson, "What does any of this have to do with physics? einstein and feynman ushered me into grad school, reality ushered me out." Available at http://nautil.us/issue/43/heroes/what-does-any-of-this-have-to-do-with-physics (2020/08/31).

[4] S. Joyner, "Einstein, rejection, and crafting a future." Available at https://archinect.com/features/article/150136437/einstein-rejection-and-crafting-a-future (2020/08/31).

[5] D. Herschbach, "Einstein as a student, chapter 15 in einstein for the 21st century." Available at https://faculty.chemistry.harvard.edu/files/dudley-herschbach/files/einstein_student_new_0.pdf (2020/08/31).