Astro2020 State of the Profession White Paper

Realistic Job Training for Astro PhDs

Thematic Areas: State of the Profession

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Key Issue and Overview of Impact on the Field

Much of our field still operates as if the primary goal of an astrophysics PhD is to train students for a future career in academic research. But this is increasingly mismatched to the reality of the academic job market. Permanent academic employment in a tenure-track position has now become the *minority* path for students graduating with BS degrees in astronomy and astrophysics, with the majority of junior astronomers instead entering jobs in commercial sectors[1]. Non-academic jobs are similarly a growing employment sector for astronomy PhD graduates[2]. In this white paper we outline several recommendations for better aligning student and postdoc training with the available job opportunities.

The number of astronomy PhDs has increased by a factor of about 40% over the last decade, from an average of about 120 in the mid 2000s to 170 degrees awarded in 2017[3]. Astronomy departments in US universities that award PhD degrees also enrolled over 200 new graduate students in each of the last three years[3]. The number of undergraduate astronomy degrees has grown even more dramatically, from an average of less than 350 astronomy BS degrees awarded in the 2000s to over 500 BS degrees awarded in 2017[3]. All of these gains are measured solely from astronomy departments, but there is a similar dramatic growth in physics PhD and BS degrees[4] that include many students focused primarily on astrophysics research. The increase in student enrollment is likely tied to the rapid growth in astronomical discoveries over the past few decades. A cursory reading of news articles makes it clear that astronomers worldwide are making one discovery after another on planets, stars and galaxies that make up our Universe. The rapid growth in astronomical discoveries will continue to accelerate over the next decade with ambitious projects like the James Webb Space Telescope and 30-meter-class ground-based observatories beginning operations. Thus, we expect the number of students enrolling in astronomy PhDs to remain high or continue increasing over the next decade.

Despite this dramatic increase in astronomy PhDs awarded per year, the number of available permanent academic and scientific positions has remained nearly constant over the past decade. The average number of permanent positions at US institutions advertised in the American Astronomical Society's Job Register[5] over the last five years is 60-75 per year. This number is also consistent with the number of entries listed on the "astro rumor mill," an open-source website listing jobs along with shortlist and hiring announcements[6]. Many of the advertisements for junior faculty positions attract 200 or more applicants. Employers are also changing to the needs of a culture that values

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[1] https://www.aip.org/sites/default/files/statistics/employment/initialempbsmsphd-a-12.pdf
[2] https://www.aip.org/sites/default/files/statistics/lsags/presentation-2014-aas.pdf
[3] https://www.aip.org/sites/default/files/statistics/rosters/astrost17.pdf
[4] https://www.aip.org/sites/default/files/statistics/rosters/physrost17.1.pdf
[5] https://jobregister.aas.org
[6] http://www.astrobetter.com/wiki/Rumor+Mill+Faculty-Staff

independent research and thinking, a desirable objective that is expressed by many students when stating why they wish to remain in academic jobs despite the low salaries and large uncertainties on future employment. Such freedom is also acknowledged by some of the large companies like Google that allow their employees to use a fraction of their time to pursue independent projects.

The 2010 Decadal Survey summarized by the *New Worlds, New Horizons in Astronomy and Astrophysics* report[7] from the US National Research Council (NRC) noted this disconnect between the production rate of astronomy PhDs and the availability of permanent research positions. But its recommendations focused solely on increasing academic employment opportunities. Permanent astronomy research positions are unaffected by this recommendation, since universities and national research centers have limited budgets for permanent staff, with funding sources that are largely controlled by factors outside of the NRC purview. Increasing the number of term-limited postdoctoral research positions offers, at best, only a short-term solution to the problem.

The nature of research funding in astrophysics makes it easy for faculty advisors and research group leaders to ignore the issue of permanent employment for our PhDs. For most astronomy research groups, the principal expenses are labor costs to support analysis and interpretation of data from simulations or observations. Facilities costs are generally covered by large national agencies (NSF, NASA, and DOE), and a few nights of observing time on a large observatory, or a few hours on a space telescope, are enough to keep a small team engaged in research over a year. Labor costs are lower at the level of students and postdoctoral fellows, and so small grants can support the bulk of astronomy research by funding students and postdocs. It is also easy for academic departments to increase the scientific output by modest buy-in payments in large collaborations, gaining data access and often followed by increases in the workforce at the junior level. Departing students and postdocs are simply replaced by a new set of PhDs, resulting in a situation where junior scientists are continuously in the training mode from one position after another. There is currently little incentive for individual principal investigators to change this situation. But it is not healthy for astronomy as a research field when many junior scientists face an uncertain future.

Strategic Plan

In this White Paper we outline a series of recommendations to improve the state of the profession through changes in the training of astronomy PhDs and postdocs. Rather than relying on individual advisors, we focus on structural changes by universities, national societies, funding agencies, and research collaborations to train and support junior astronomers. These institutional changes are pragmatic, with some already being incrementally implemented on the university and collaboration level, and they would effectively promote more uniform support of junior astronomers by incentivizing advisors.

[7] https://www.nap.edu/read/12951/

Recommendation #1: Universities

Universities should recognize that placing PhD students and postdocs in non-academic jobs is equally valued as placing them in an academic position. This policy should be implemented within astronomy/physics PhD programs with small changes to the curriculum, and addressed at the postdoc level by rewarding faculty who place their postdocs in permanent positions (academic or otherwise). The research skills gained by junior astronomers are already desirable for many tech and finance industry jobs given their ability to analyze large datasets, delve deeply into statistics, and pursue easily interdisciplinary studies, among other qualities. But university curricula lag behind, and would benefit from including courses on data science and statistics rather than relying on outside entities such as the Insight Data Science Fellows Program to train PhD scientists for industry jobs. Departments can also help their students and postdocs by setting up networking opportunities, via seminars or other events, with former graduates who now work in industry. Similarly, departments should ask former graduates to run resume and interview training sessions. While most universities have career centers, they are not focused on graduate students, and general advice from a career center is much less valuable than the specific training provided by an astronomy PhD who has successfully managed to transition to industry. A more ambitious goal would be to organize internships in industry as a replacement for a portion of academic requirements needed to satisfy the PhD, and internship support could additionally alleviate the income issues faced by graduate students in higher cost-of-living areas. Ultimately, astronomy departments should align with the overarching goal that at least half of their conferred PhDs will lead to employment outside of academia.

Recommendation #2: National Societies

National societies in astronomy, such as the AAS, should take an active role in changing the culture within the field. We suggest several activities that are each aimed at different demographics in the academic hierarchy. First, the existing workshops for junior faculty should include training in how to their mentor students and postdocs for a range of post-PhD careers. Junior faculty are often more likely to accept and introduce new changes than more senior and established faculty, and so should be encouraged to train their students to use software languages and tools that are applicable to both industry jobs as well as academic research. The basic message to junior faculty should be that successful mentoring includes preparing PhD students and postdocs for employment outside of the academic research structure. Second, national societies should provide incentives that appeal to established senior members. This could take the form of awards or prizes for mentorship that bridges the gap between astronomy and industry, or grants with part of it paying student stipends while they do industry internships. Third, national societies should maintain a networking database of past and current members who work outside of academia. This resource would facilitate communication between current and former PhD students and postdocs, allowing them to easily contact people who work in their desired field to talk about their job and preparation. Exposure to people with the same educational background and career success is a simple and valuable form of mentoring that is glaringly lacking for many

current PhD students. The database should include the job title, organization and contact information of PhD astronomers working employment outside of academia, and the broad database assembled by our national academies would be indispensable for students undergoing the career transition from academia to industry.

Recommendation #3: Funding Agencies

National funding agencies, such as the Astronomy Division within NSF and Astrophysics SMD of NASA, should implement policies that support student training for careers beyond academic research. At a basic level, the “mentoring statements” required by NSF should include explicit instruction that a broad range of career outcomes, academic and non-academic, represent successful mentoring. This prevents review panels from judging the only kind of mentoring success as placing postdoctoral fellows in faculty positions. Review panels should instead recognize the reality of the academic job market and might be encouraged to actively reward PIs who are actively involved in efforts to help junior scientists transition from academic research to jobs in desirable industries. We also encourage funding agencies to require a networking plan to facilitate communication between junior scientists former academics that have made a successful transition away from academic research. This could be part of the employment monitoring in our previous recommendation.

Recommendation #4: Scientific Collaborations

Large collaborations provide additional opportunities to support the career training of junior scientists, since they include broader membership than a single department and hold regular meetings that can function as networking events for students and postdocs. The most valuable junior support that collaborations can provide is meetings in groups with former researchers who have made successful transitions to non-academic careers. The PIs or leaders of large research collaborations must also take an active role to monitor the employment status of junior members of the team and to make publicly available such statistics, just as statistics on research progress is made available and reported to national agencies as part of renewal grants for the research effort. Given that astronomy is, or will soon be, structured into large collaborations, big changes in the field as a whole are likely to come through restructuring of priorities individually within such research collaborations. We encourage open communication within such teams about employment opportunities outside of academic research. This will help overcome the existing close-minded nature within departments and universities on the employment situation and encourages graduate students who are members of these teams to prepare for employment outside of academia. Meetings with ex-scientists from the field will also allow students to see and learn how their skills could be useful for certain industries. Several collaborations already have some of these policies in place to support their junior scientists, including the SDSS, CANDELS, and Euclid collaborations, and junior scientist mentoring support can be more uniformly implemented by national agencies when funding a large research endeavor in astronomy or cosmology.