

First-Year Graduate Students in Physics and Astronomy: Characteristics and Background

Results from the 2014–15 and 2015–16 Graduate Student Surveys and the annual Enrollment and Degrees Surveys

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This report examines the demographics, educational background, financial support, teaching assistant experience, and career goals of first-year graduate students enrolled in physics and astronomy departments in the US. For this report, we define first-year graduate students as individuals who have spent fewer than two years within a department and includes students who may have transferred or previously earned a graduate degree at a different institution. This report frequently compares first-year graduate students enrolled in departments that offer a doctorate (referred to as PhD departments) with students enrolled in departments that offer a master's as their highest graduate-level degree (referred to as master's degree-only departments).

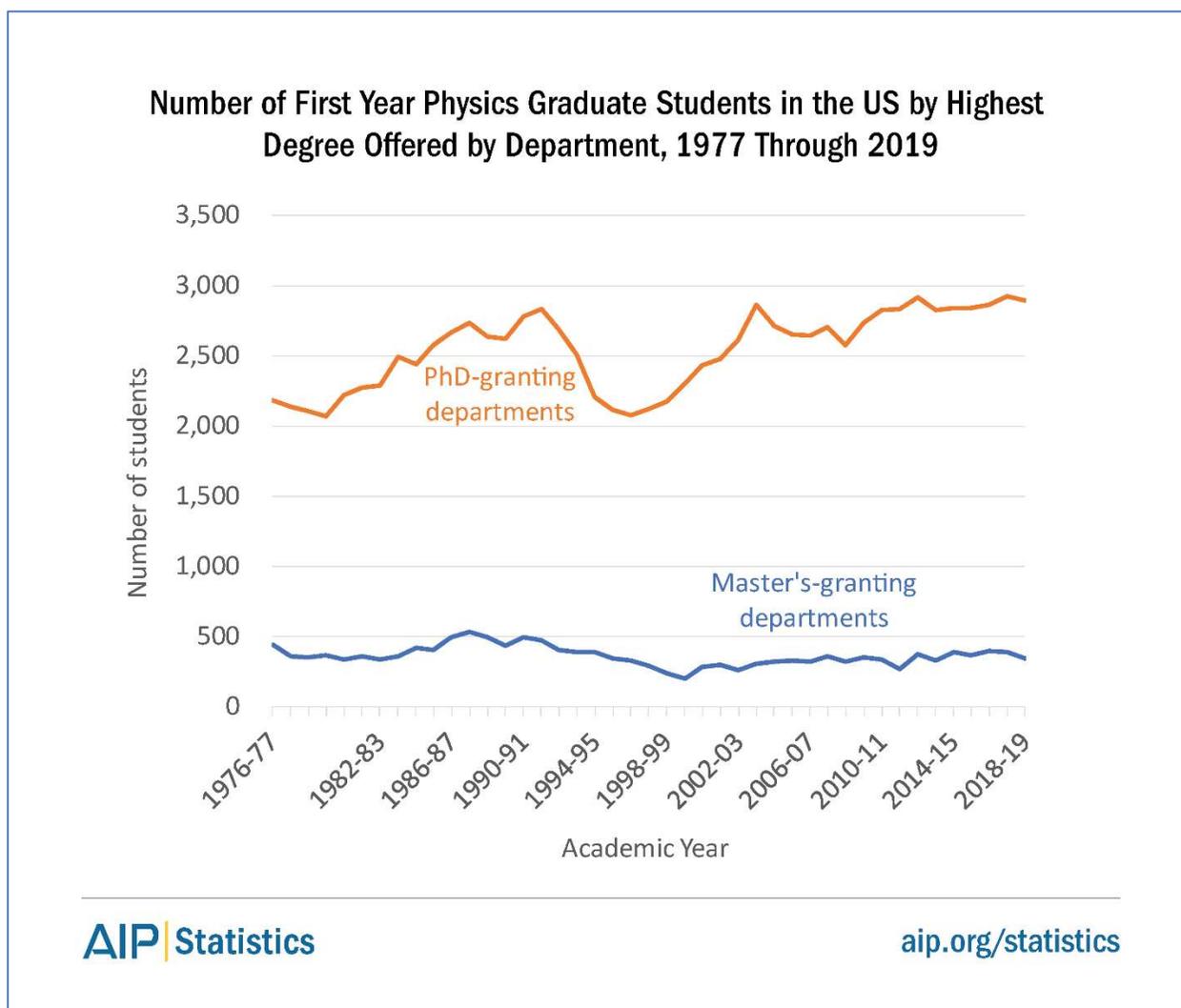
The data presented in this report are drawn from two sources. Data on the number of physics and astronomy students enrolling in US graduate programs come from the annual American Institute of Physics (AIP) departmental Enrollments and Degrees survey and includes enrollment data through the 2018-19 academic year. Data concerning student background and educational experiences come from AIP surveys of first-year physics and astronomy graduate students. First-year students were surveyed in 2 consecutive academic years, 2014-15 and 2015-16.

Data for physics and astronomy students were collected separately for both data sources. The first portion of this report addresses first-year physics graduate students and the second part discusses first-year astronomy students.

Number of First-Year Graduate Students in Physics

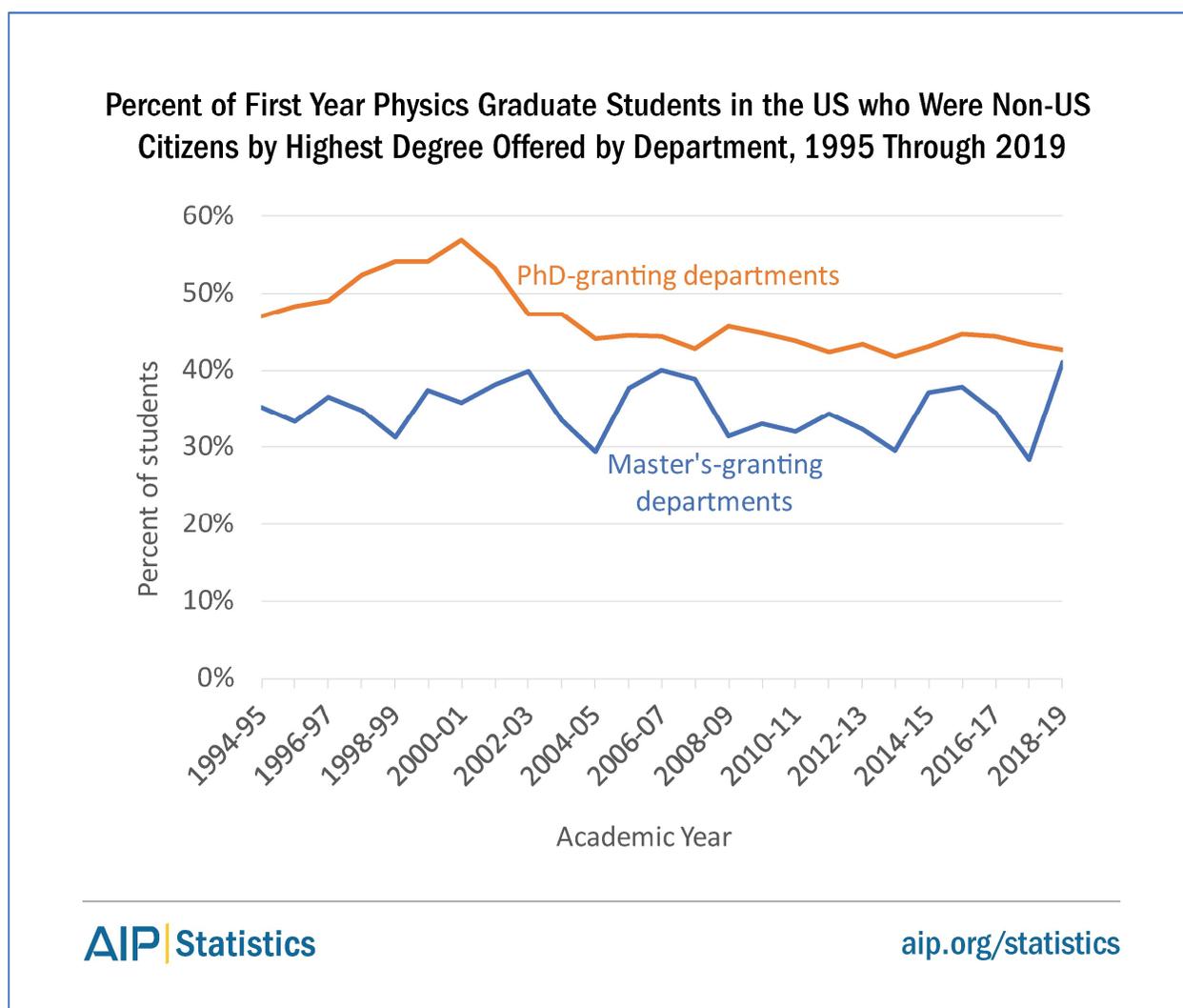
According to the AIP Enrollment and Degrees Survey, the number of first-year students enrolled in physics graduate programs has remained relatively stable in recent years (see **Figure 1**). In the 2018-19 academic year, there were about 3,200 first-year physics graduate students enrolled in one of the 258 graduate physics programs in the US. Ninety percent of the students were in enroll at one of the 201 PhD departments and the remaining students were enrolled in one of the 57 master's degree-only departments.

Figure 1



Since the early 2000s, the overall percentage of non-US citizens enrolling in US physics programs has remained relatively stable at over 40%. **Figure 2** shows the trend in the representation of non-US citizens by the highest graduate degree offered by departments. Non-US citizens have consistently represented a larger percentage of the first-year students enrolled in PhD departments than at master's degree–only departments.

Figure 2



In the academic years of 2014-15 and 2015-16, 44% of first-year physics graduate students were non-US citizens. Over 70% of international students came to the US from countries in Asia, particularly China and India (see **Table 1**).

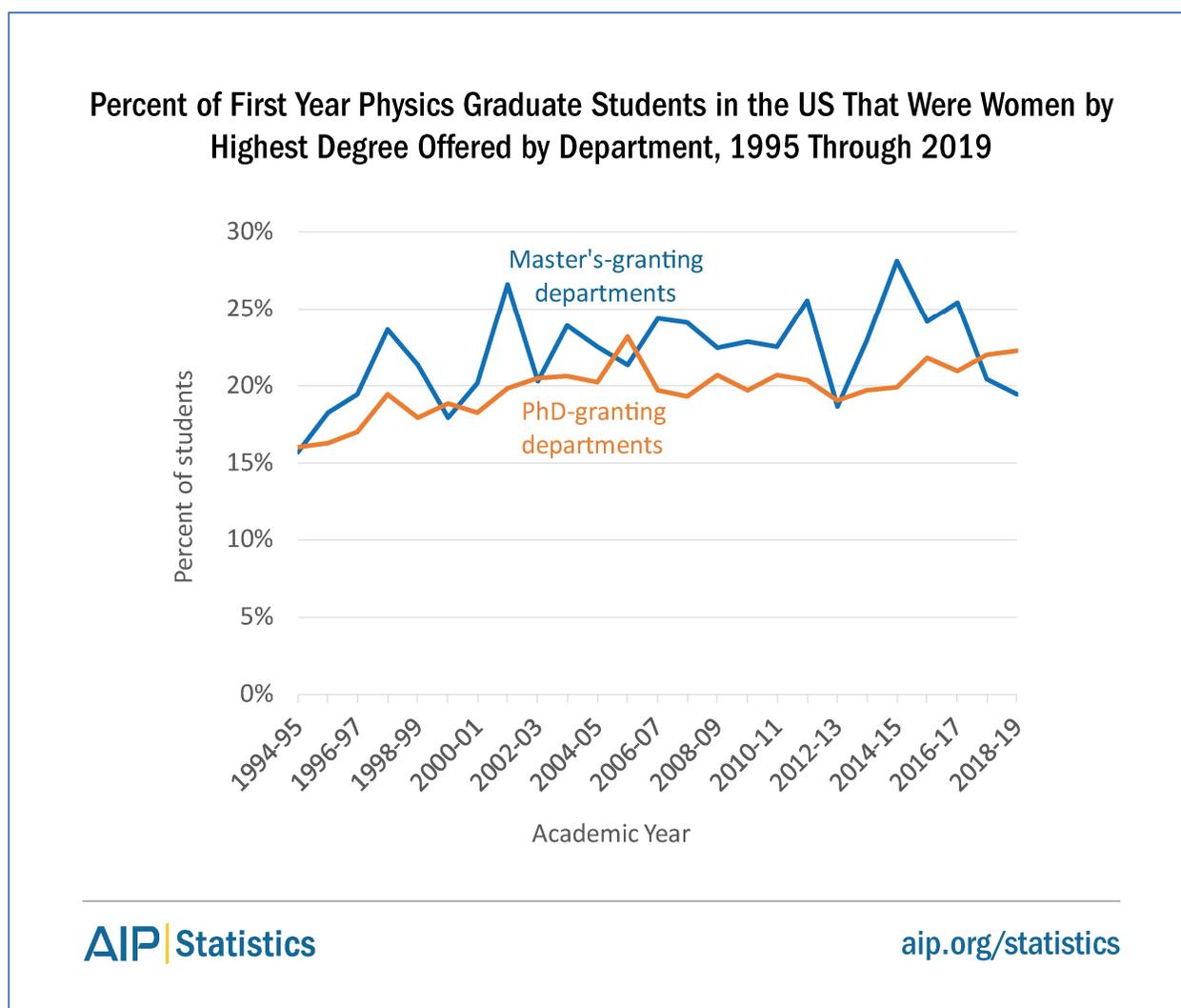
Table 1

Regions and Countries of Citizenship for Non-US First Year Physics Graduate Students in the US, Academic Years 2014-15 and 2015-16 Combined

	Percent
Asia	71%
China	30%
India	15%
Nepal	9%
Bangladesh	3%
Sri Lanka	3%
Other Asian Countries	11%
Europe	8%
Americas	8%
Middle East	11%
Africa	2%
Australia & New Zealand	<1%

Women comprised more than a fifth of the first-year physics graduate students in the 2018-19 academic year. The percentage of women among first-year physics graduate students at both PhD departments and master's degree-only departments has increased slightly since 1995 (see **Figure 3**). In the 2018-19 academic year, 22% of first-year physics graduate students in PhD departments were women, and 19% of students in master's degree-only departments were women.

Figure 3



Characteristics of First-Year Physics Graduate Students

First-year graduate students enrolled in master's degree-only departments tended to be older than students in PhD departments (see **Table 2**). A large percentage of students enrolled in both types of departments planned to receive a doctorate degree, indicating that many students enrolled at master's degree-only departments intend to later enroll at a different institution that offers a physics PhD. Over 90% of students were enrolled full time in both PhD and master's degree-only physics departments. Most students had selected their research subfield by the second half of their first year of graduate study. Eleven percent of students at a master's degree-only department indicated that selecting a specific subfield was not required for their degree.

Table 2

Characteristics of First Year Physics Graduate Students in the US by Highest Degree Awarded by Department, Academic Years 2014-15 and 2015-16 Combined

	Highest Degree Awarded by Dept.	
	Masters	PhD
Median Age	25.4	23.4
Highest Degree Desired		
PhD	62%	93%
Masters	20%	3%
Unsure	17%	3%
No Degree Intended	1%	1%
Enrollment Status		
Full-time	92%	98%
Part-time	8%	2%
Research Field		
Selected	75%	81%
Unsure	14%	18%
Not Required	11%	2%

Educational Background of First-Year Physics Graduate Students

Most first-year physics graduate students had earned a bachelor's degree in physics or astronomy prior to enrolling in a US graduate physics program (see **Table 3**). Most students who earned bachelor's degrees in other subjects majored in engineering and mathematics. About one-fifth of the US citizens among first-year physics graduate students reported starting their undergraduate education at a two-year or community college.

About a quarter of US citizens and half of non-US citizens had previous physics or astronomy graduate-level training at a different institution. A large proportion (30%) of non-US citizens received a physics master's or equivalent degree from a foreign institution prior to enrolling in their US graduate physics program. There were no gender differences in the educational backgrounds of first-year students.

Table 3

Educational Backgrounds of First Year Physics Graduate Students in the US by Citizenship, Academic Years 2014-15 and 2015-16 Combined

	US Citizens	Non-US Citizens
<u>Undergraduate Education</u>		
Bachelor's in Physics or Astronomy	91%	88%
Prior Two-year or Community College Education ⁽¹⁾	19%	---
<u>Prior Physics or Astronomy Graduate-Level Training</u>		
None	76%	52%
Master's degree from a US Institution	3%	4%
Master's or equivalent degree from a non-US institution	2%	30%
Course work at another US institution	18%	5%
Course work at a non-US institution	1%	9%

(1) Percentage responding "yes" to the question, "After graduating from high school, did you start your college education at a 2-year or community college?" The percentage of students with non-US citizenship and prior community college education was not reported due to the variety of education systems outside of the US.

To determine if there was a delay before starting their graduate physics education in the US, we asked first-year graduate students if there was a gap of more than 5 months between receiving their bachelor's degree and enrolling in a US graduate physics program for the first time. Overall, 42% of first-year physics graduate students reported a delay of more than 5 months. A greater percentage of students enrolled at master's degree-only departments and non-US citizens had a delay (see **Table 4**). For the non-US citizens who had delayed their US graduate program enrollment, 46% indicated the delay was a result of having been previously enrolled in a graduate physics program at a non-US institution.

Students were asked to report the length of their enrollment delay. Students at master's degree-only departments had a half-year longer delay than those at PhD departments, and non-US citizens had a 1.5 years longer delay than US citizens. There were no gender differences in a graduate education delay.

Students who delayed their enrollment were asked to provide open-ended descriptions of what they did between receiving their undergraduate degree and enrolling in a US physics graduate program. Many international respondents reported that they were enrolled in a master's program outside of the US. Of those who were employed during the delay, most respondents worked in teaching positions. Some international respondents worked as faculty members or lecturers in departments overseas. Both US and non-US citizens worked as high school teachers, teaching assistants, or tutors. Some respondents worked in research positions at their undergraduate institutions or at national laboratories, while still others used their science skills

Table 4

Reported Delay of First Year Physics Graduate Students Between Undergraduate Education and Enrolling in a US Graduate Physics Program, Academic Years 2014-15 and 2015-16 Combined

	Highest Degree Awarded by Department		Citizenship	
	Masters	PhD	US	Non-US
Delay of more than five months	58%	41%	32%	55%
Median length of delay in years	2.5	2.0	1.0	2.5

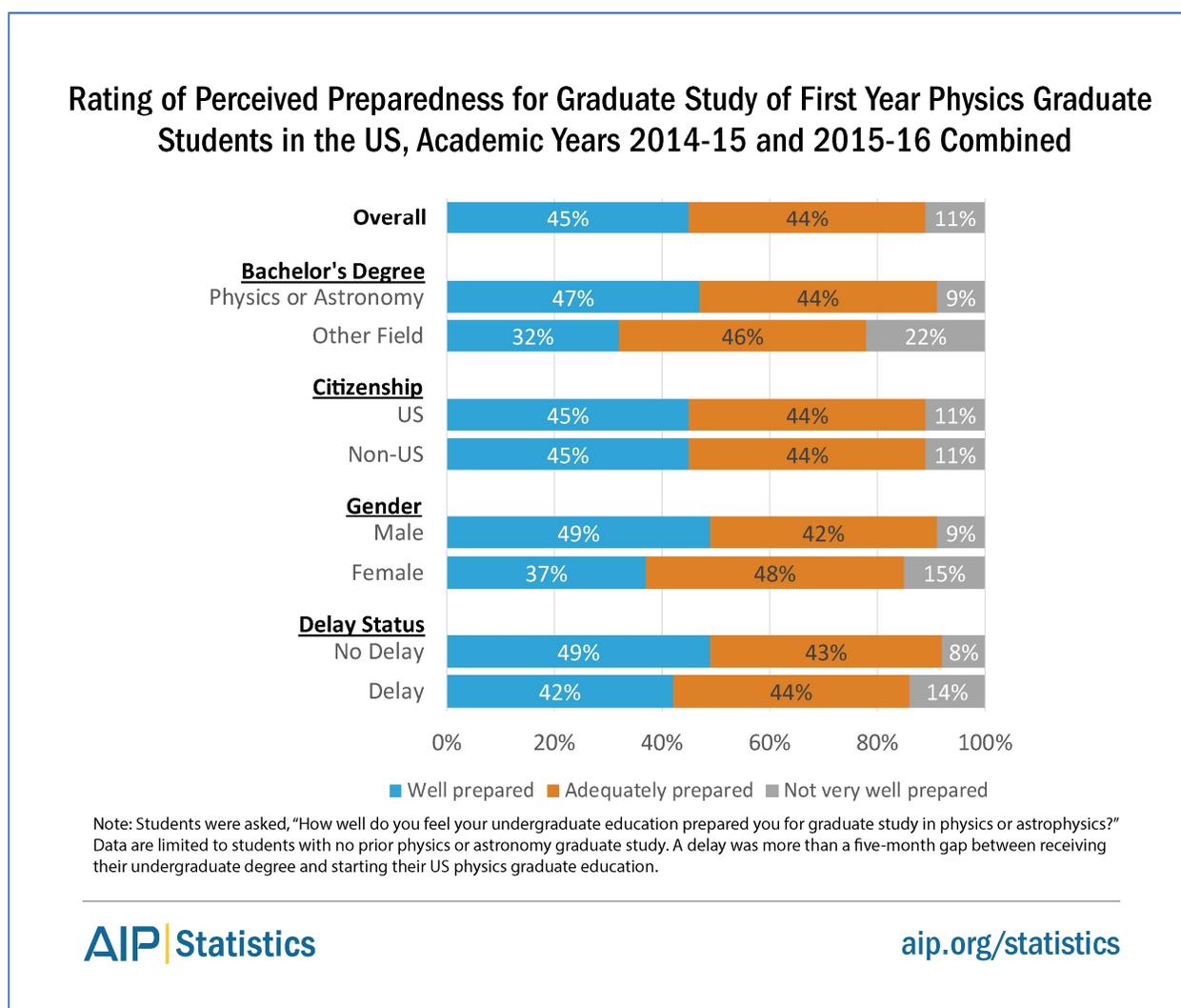
Note: First-year students were asked, "Was there more than 5 months between receiving your bachelor's degree (or foreign equivalent) and enrolling in a US graduate physics program for the first time?"

in industry positions. Not all respondents held a position relevant to their degree with and were employed in retail or in other jobs outside of science.

Respondents participated in many other activities during their delay. Some focused on the graduate school application process and prepared for required entrance exams such as the GRE, while still others relaxed, spent time with family, traveled, or cared for their children.

The first-year physics graduate students were asked to rate how well they felt their undergraduate education prepared them for their graduate studies (see **Figure 4**). Overall, 89% felt adequately or well prepared. First-year students who had received a bachelor's degree in a field other than physics or astronomy, who were women, or who had a delay (of more than 5 months) between receiving their bachelor's degree and starting their US graduate education reported feeling less prepared. There were no differences in preparedness between US and non-US citizens.

Figure 4



Financial Support of First-Year Physics Graduate Students

First-year physics graduate students received financial support from a variety of sources. Overall, 64% had a teaching assistantship as their primary type of financial support, 18% had a fellowship, and 9% had a research assistantship.

There were some differences between first-year graduate students attending PhD-granting departments and master's degree-only departments in the types of financial support they received (see **Table 5**). A greater percentage of students at PhD departments received fellowships, while a greater percentage of students at master's degree-only departments relied on financial support from family members, personal savings, or loans. In addition, a smaller percentage of students with assistantships or fellowships at master's degree-only departments received full tuition waivers.

Table 5

Primary Types of Financial Support for First Year Physics Graduate Students in the US, Academic Years 2014-15 and 2015-16 Combined

	Highest Degree Awarded by Department	
	Masters	PhD
Primary Financial Support		
Teaching Assistantship	56%	65%
Research Assistantship	13%	9%
Fellowship	4%	20%
Family, Savings or Loans	10%	3%
Other Sources ⁽¹⁾	17%	3%
Tuition Waiver Status⁽²⁾		
Full Waiver	80%	93%
Partial Waiver	10%	4%
No Waiver	10%	3%

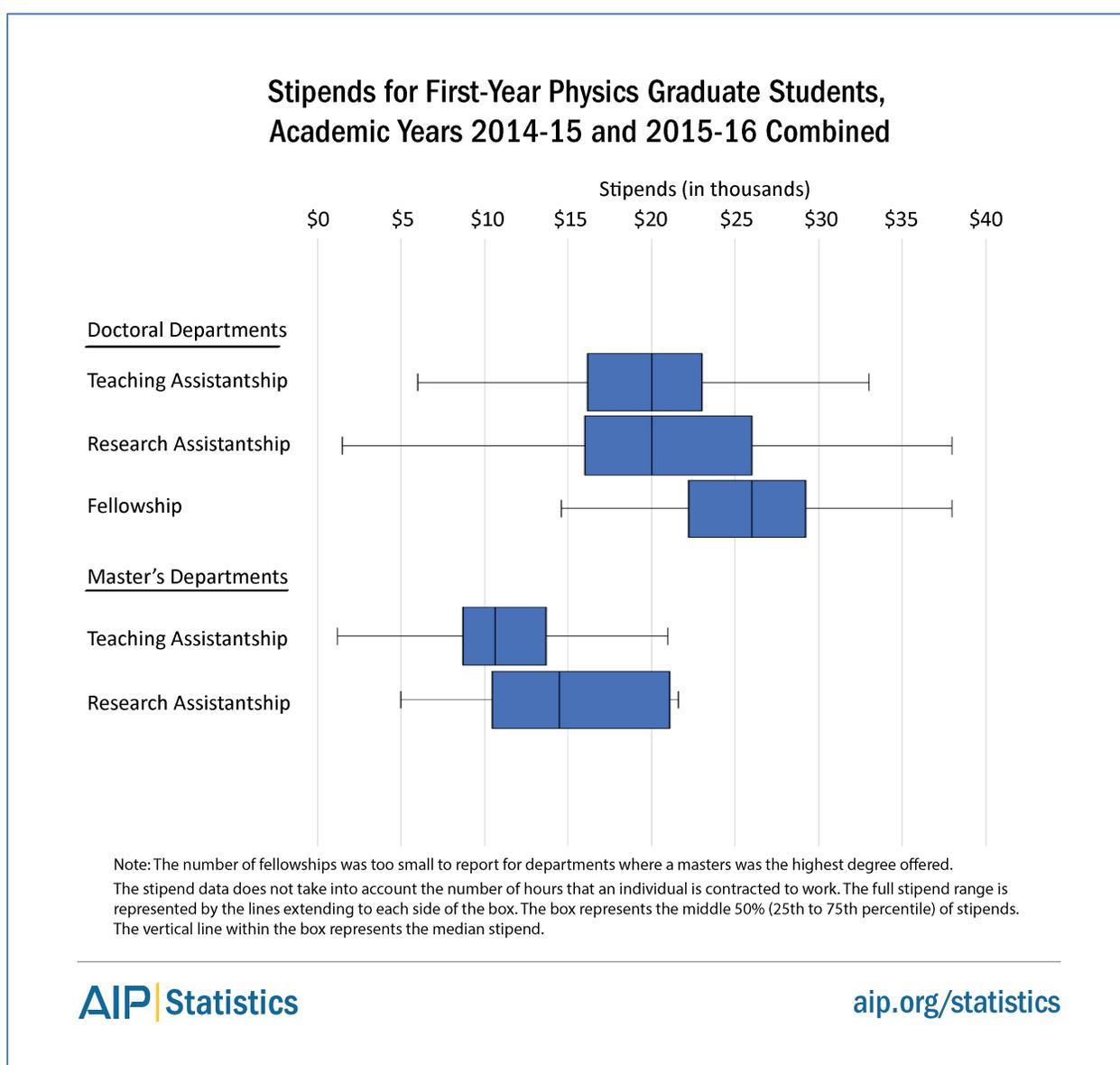
(1) Other financial sources include tuition reimbursement from outside employment, income from outside employment, foreign governments, military service, scholarships, other financial aid, and grants.

(2) The tuition waiver question was asked only of students whose primary type of support was a TA, RA, or fellowship.

When comparing men and women, a greater percentage of women (22%) received fellowships as their primary type of financial support than did the men (16%). There were no other differences by gender or citizenship in the types of financial support, tuition waiver status, or stipend amount.

The median stipends or salaries for first-year physics graduate students enrolled at PhD departments were considerably higher than those at master's degree-only departments (see **Figure 5**). Students at PhD departments whose primary source of support was a teaching assistantship or research assistantship had a median stipend of \$20,000 a year. PhD students with fellowships were generally better financially supported with a median stipend of \$26,000. At master's degree-only departments, the median teaching assistantship and research assistantship stipend was around \$10,600 and \$14,500, respectively. The survey did not capture the number of service hours students were required to work for these assistantships. It is possible some of the differences in stipend levels are a result of differences in required work load.

Figure 5



Teaching Assistantship Experiences of First-year Physics Graduate Students

Graduate students who worked as teaching assistants (TAs) were asked if they received any formal instruction in teaching or were formally supervised and evaluated. Almost three-quarters of the TAs had received formal teaching instruction (see **Table 6**). The most common type of evaluation TAs received was from their students, with 79% receiving such evaluations. About half of the TAs received formal supervision or evaluations from a faculty member, and 38% received formal supervision or evaluations from an experienced teaching assistant.

Teaching assistants were also asked what tasks they performed during their work. Almost all TAs were required to grade class materials. Supervising or running lab sections, as well as holding office hours, were other more common tasks that were performed.

Table 6

Teaching Assistantship Training and Tasks for First Year Physics Graduate Students in the US, Academic Years 2014-15 and 2015-16 Combined

<u>Formal Instruction</u>	
Received instruction in teaching	72%
<u>Formal Supervision or Evaluations</u>	
Evaluated by their own students	79%
Evaluated by a faculty member	52%
Evaluated by an experienced TA	38%
<u>Performed Tasks</u>	
Graded papers, tests or lab reports	94%
Supervised or ran lab sections	79%
Held office hours	72%
Held recitations	35%
Assisted the professor in lecture or labs	21%
Gave class lectures	12%
Other tasks ⁽¹⁾	6%

(1) Other tasks included proctoring exams, running discussions and workshops, hosting help room sessions, and creating class materials.

Future Career Plans of First-year Physics Graduate Students

First-year physics graduate students were asked where they would like to be employed 10 years after receiving their highest anticipated physics degree. There were differences in career aspirations by the students' highest anticipated physics degree and citizenship (see **Table 7**). A greater percentage of students who intended to end their physics graduate training with a master's degree aspired to work in the private sector or medical field, while students intending to receive a PhD were much more likely to aspire to work at a university. US citizens were more likely to indicate a desire to work in the private sector, government, or the medical field than non-US citizens. The majority of non-US citizens aspired to work at a university. A greater percentage of US citizens than non-US students, and a greater percentage of students intending to receive a PhD versus those intending to receive a master's degree were unsure about their future employment goals.

Table 7

Preferred Future Employment of First Year Physics Graduate Students in the US, Academic Years 2014-15 and 2015-15 Combined

<u>Employment Goals</u>	<u>Highest Anticipated Degree</u>		<u>Citizenship</u>	
	Masters	PhD	US	Non-US
Unsure	9%	16%	20%	13%
University	3%	44%	26%	57%
Private Sector	44%	17%	24%	15%
National Lab or Gov't	15%	13%	16%	8%
2 or 4-Year College	11%	7%	10%	3%
Medical & Hospital	11%	2%	2%	3%
Other	7%	1%	2%	1%

Note: First-year graduate students were asked, "Where would you like to be employed 10 years after receiving your highest physics or astrophysics degree?"

First-Year Astronomy Graduate Students

AIP's Enrollment and Degrees Survey found that there were 241 first-year graduate students enrolled in US graduate astronomy programs in the 2018-19 academic year (see **Figure 6**). Compared to first-year physics student enrollments, there was a greater percentage of women and US citizens among first-year astronomy graduate students. In the 2018-19 academic year, 40% of first-year astronomy students were women (see **Figure 7**), and 21% were non-US citizens (see **Figure 8**). This compares to 22% women and 42% non-US citizens among first-year graduate physics students. In the 2018-19 academic year, only three astronomy departments offered a master's as their highest degree; as a result, we are not reporting any analyses comparing master's degree-only and PhD departments.

Figure 6

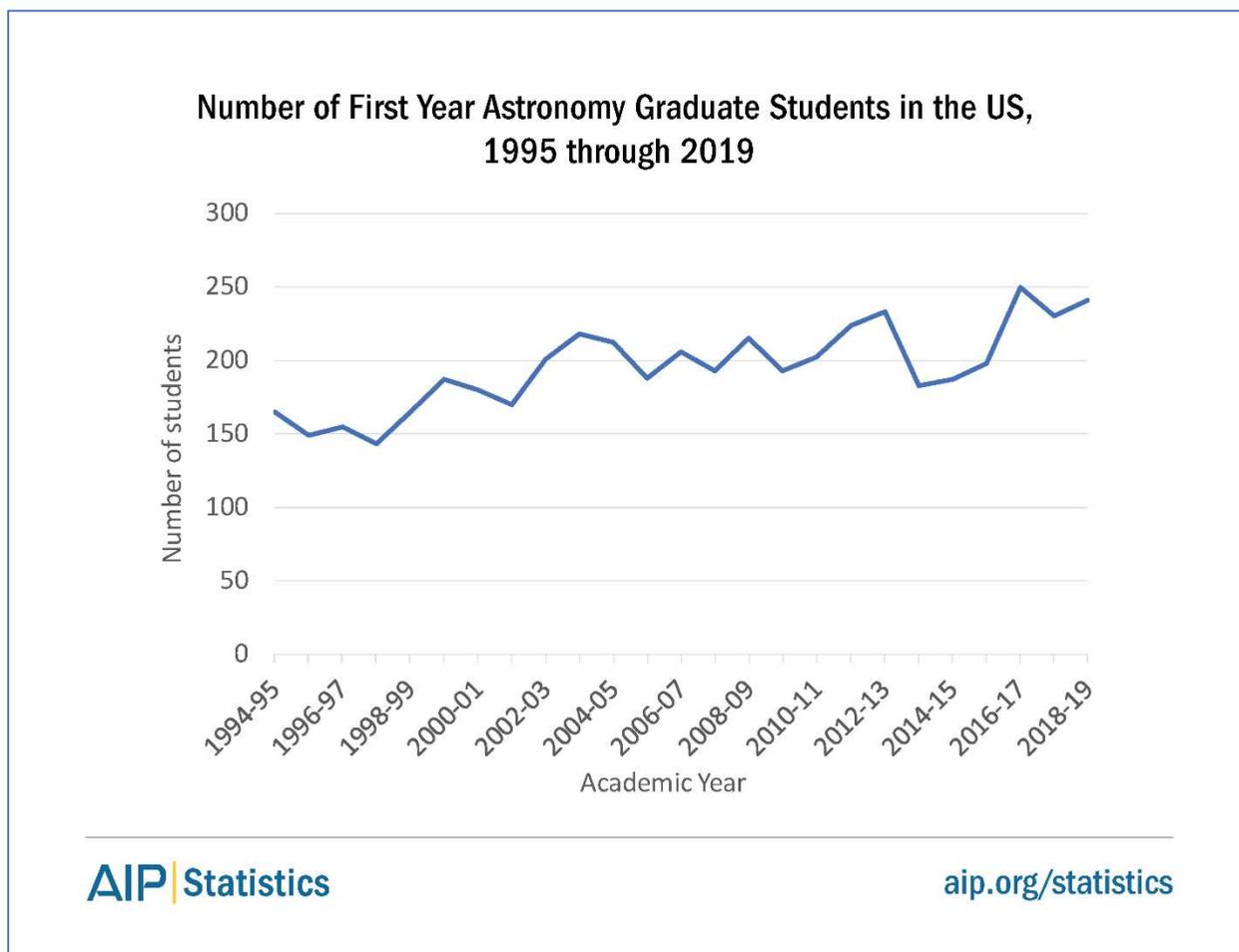


Figure 7

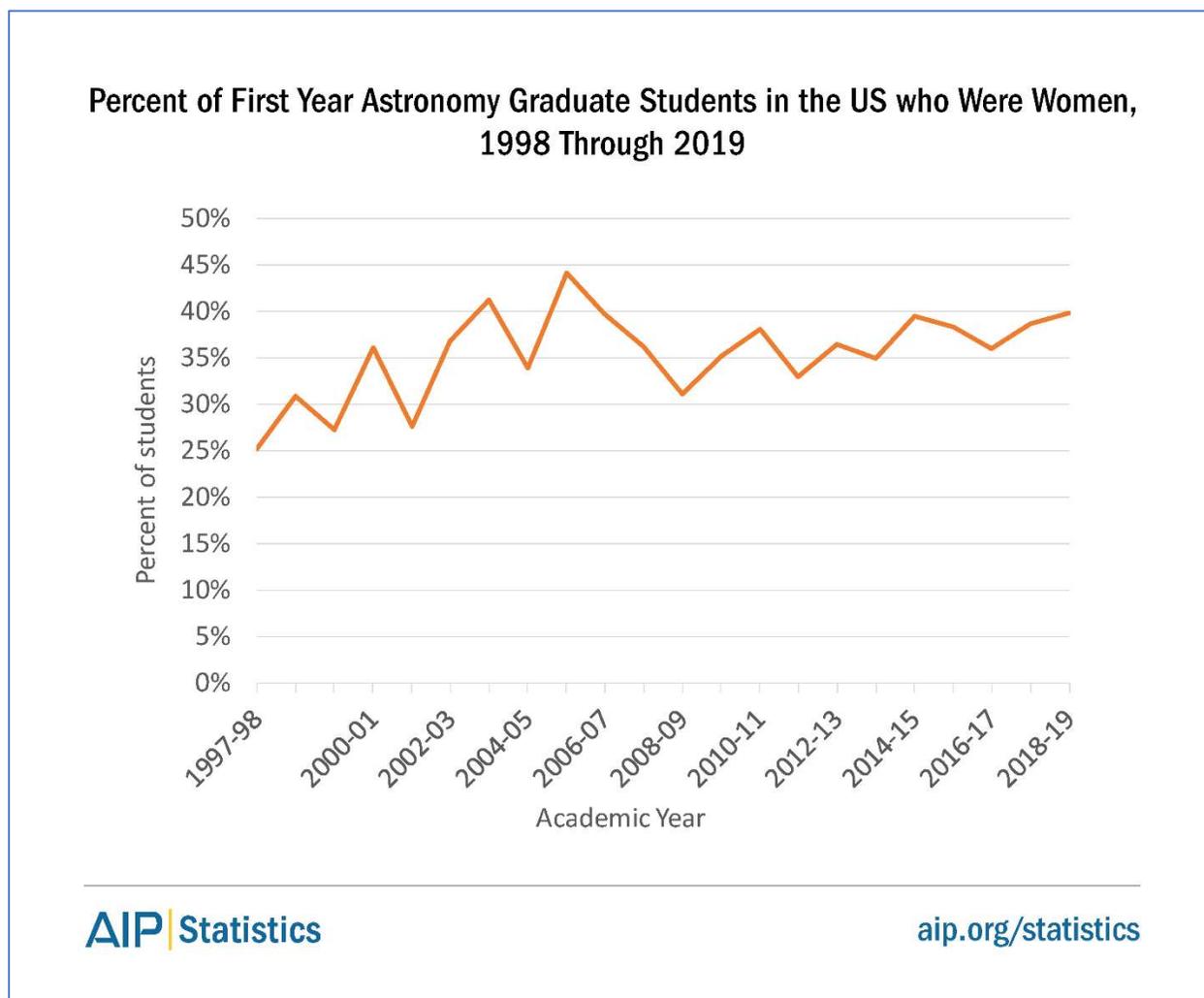
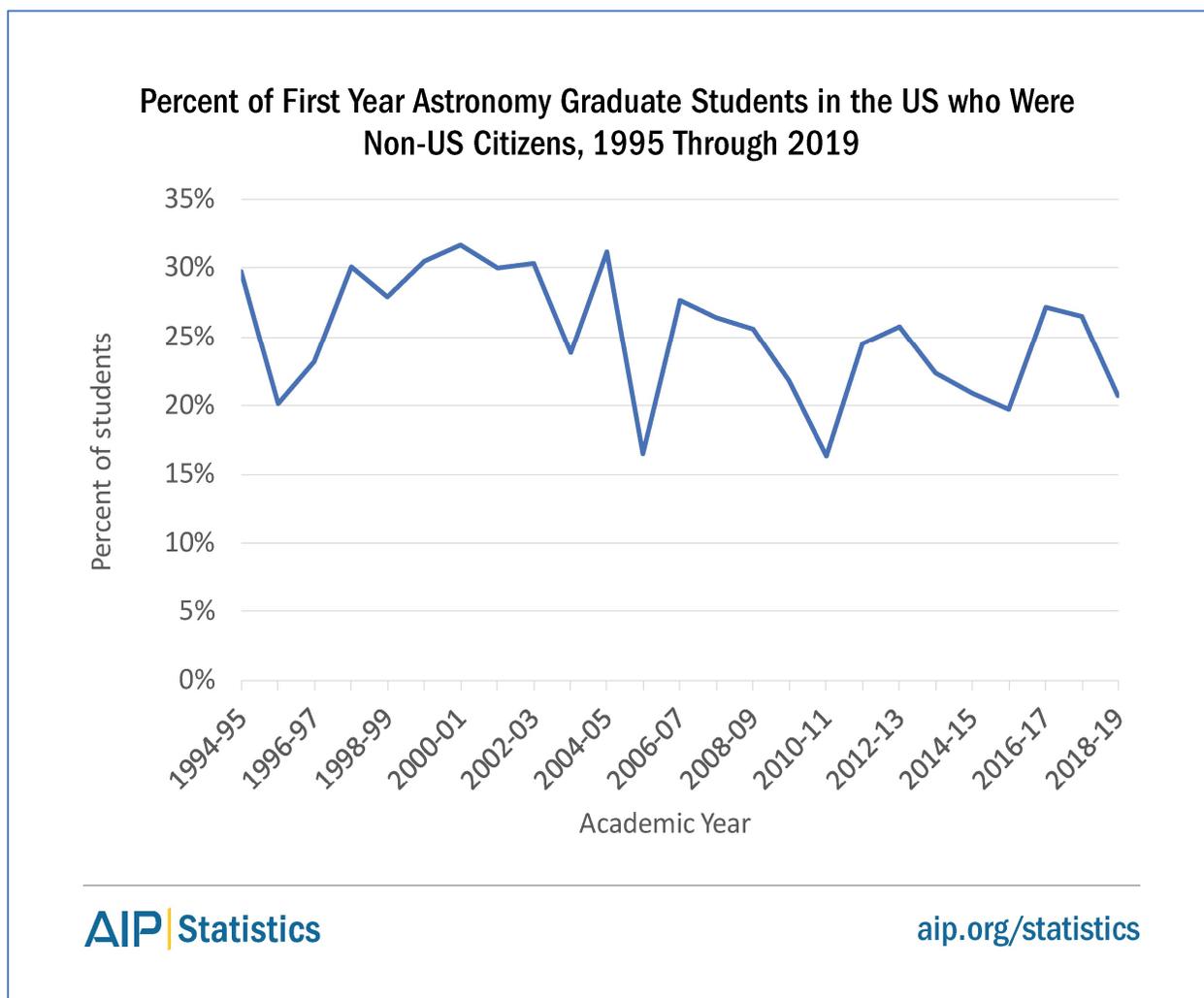


Figure 8



All first-year astronomy graduate students were enrolled full time., virtually all planned to receive a doctorate degree, and most had selected their research subfield or specialty (see **Table 8**). The median age of first-year astronomy graduate students was around 23.

Table 8

**Characteristics of First Year Astronomy Graduate Students in the US,
Academic Years 2014-15 and 2015-16 Combined**

<u>Median Age</u>	22.9
<u>Highest Degree Desired</u>	
PhD	98%
Masters	1%
Unsure	1%
<u>Enrollment Status</u>	
Full-time	100%
<u>Research Field</u>	
Selected	80%
Unsure	17%
Not Required	3%

The majority (92%) of first-year astronomy graduate students held a bachelor's degree in physics or astronomy, and 12% indicated they started their undergraduate education at a two-year or community college (see **Table 9**). Almost all (95%) of first-year astronomy graduate students felt well or adequately prepared for their graduate studies.

About one-third of the first-year astronomy graduate students had previous graduate-level training in physics or astronomy prior to enrolling in their current department. Most students with previous training had taken graduate-level coursework at another institution.

Thirty percent of first-year astronomy students had a delay of more than 5 months between receiving their undergraduate degree and enrolling in a graduate program in the US, with a median delay length of 1-year.

Table 9

**Educational Backgrounds of First Year Astronomy Graduate Students in the US,
Academic Years 2014-15 and 2015-16 Combined**

<u>Undergraduate Education</u>	
Bachelor's in Astronomy or Physics	92%
Prior Two-year or Community College Education ⁽¹⁾	12%
<u>How Well Undergraduate Education Prepared Students for Graduate Studies</u>	
Well prepared for graduate studies	56%
Adequately prepared for graduate studies	39%
Not very well prepared for graduate studies	5%
<u>Prior Astronomy or Physics Graduate-Level Training</u>	
None	69%
Master's degree from a US Institution	7%
Master's or equivalent degree from a non-US institution	7%
Course work at another US institution	13%
Course work at a non-US institution	4%
<u>Delay Between Undergraduate Degree and US Graduate Program Enrollment</u>	
Delay of more than five months	30%
Median length of delay	1 year

(1) Percentage responding "yes" to the question: "After graduating from high school, did you start your college education at a 2-year or community college?"

About half of first-year astronomy students held teaching assistantships as their primary type of financial support (see **Table 10**), which is a smaller percentage than first-year physics students (65%). However, a greater proportion of first-year astronomy students had a research assistantship or fellowship than their physics counterparts. The vast majority of first-year astronomy students received a full tuition waiver.

Table 10

Primary Types of Financial Support for First Year Astronomy Graduate Students in the US, Academic Years 2014-15 and 2015-16 Combined

Primary Financial Support	
Teaching Assistantship	47%
Research Assistantship	20%
Fellowship	30%
Family, Savings, or Loans	2%
Other Sources ⁽¹⁾	1%
Tuition Waiver Status⁽²⁾	
Full Waiver	94%
Partial Waiver	5%
No Waiver	1%

(1) Other financial sources include tuition reimbursement from outside employment, income from outside employment, foreign governments, military service, scholarships, financial aid, and grants.

(2) The tuition waiver question was asked only of students whose primary type of support was a TA, RA, or fellowship.

First-year astronomy students with fellowships reported the highest stipend amounts (see **Table 11**). Because we do not know the number of hours students are required to work in their assistantships, the median stipend amounts of first-year astronomy students are not directly comparable to those received by the first-year physics students.

Table 11

**Median Stipend Amounts for First Year Astronomy Graduate Students,
Academic Years 2014-15 and 2015-16 Combined**

Teaching Assistantship	\$22,000
Research Assistantship	\$24,240
Fellowship	\$26,750

First-year astronomy students who worked as TAs were asked if they received any formal instruction in teaching or were formally supervised and evaluated. About half (54%) indicated they had received formal teaching instruction (see **Table 12**). Like physics TAs, the most common source of evaluations came from their students (73%). About a third of the TAs received formal supervision or evaluations from a faculty member, and a quarter received formal supervision or evaluations from an experienced TA. Also similar to physics TAs, the most common responsibilities of astronomy TAs centered around grading class materials, holding office hours, and supervising lab sections.

Table 12

Teaching Assistantship Training and Tasks for First Year Astronomy Graduate Students in the US, Academic Years 2014-15 and 2015-16 Combined

<u>Formal Instruction</u>	
Received instruction in teaching	54%
<u>Formal Supervision or Evaluations</u>	
Evaluated by their own students	73%
Evaluated by a faculty member	35%
Evaluated by an experienced TA	26%
<u>Performed Tasks</u>	
Graded papers, tests, or lab reports	99%
Held office hours	81%
Supervised or ran lab sections	68%
Held recitations	54%
Assisted the professor in lecture or labs	51%
Gave class lectures	29%
Other tasks ⁽¹⁾	7%

(1) Other tasks included holding class discussions, creating class materials, and proctoring exams.

When first-year astronomy students were asked about their career aspirations 10 years in the future, about half of students wanted to work at a university with graduate-level programs (see **Table 13**).

Table 13

Preferred Future Employment of First Year Astronomy Graduate Students in the US, Academic Years 2014-15 and 2015-16 Combined

<u>Employment Goals</u>	
Unsure	22%
University	49%
2- or 4-Year College	11%
Private Sector	10%
National Lab or Gov't	7%
Medical & Hospital	-
Other	1%

Note: First-year students were asked, "Where would you like to be employed 10 years after receiving your highest physics or astrophysics degree?"

Survey Methodology

Each fall the Statistical Research Center conducts its Survey of Enrollments and Degrees, which asks all degree-granting physics and astronomy departments in the US to provide information concerning the numbers of students they have enrolled and counts of recent degree recipients. At the same time, we ask for the names and contact information for students currently enrolled in their graduate programs.

Much of the data in this report comes from physics and astronomy graduate students who were identified as being new to a department in the academic years 2014–15 and 2015–16. An initial invitation to participate in the survey was sent to graduate students in April of their first year at the department. Non-responding students were contacted with up to three additional invitations. Respondents were considered first-year graduate students if they had completed fewer than two years of graduate study at the department they were currently attending, regardless of whether they had been previously enrolled at a different graduate-level program either within or outside the US.

According to the findings from the Survey of Enrollments and Degrees, there were 3,232 first-year physics graduate students enrolled in the 2014-15 academic year and 3,210 in the 2015-16 academic year. We did not receive contact information for all known first-year physics students in the two student cohorts. We received responses from approximately 30% of the students for whom we believe we had valid contact information. As a result, we received usable survey responses from 20% of the total number of known first-year physics students in the two academic years that were the focus of this study.

According to the findings from the Survey of Enrollments and Degrees, there were 187 first-year astronomy graduate students enrolled in the 2014-15 academic year and 198 in the 2015-16 academic year. We did not receive contact information for all known first-year astronomy students in the two student cohorts. We received responses from approximately 46% of the students for whom we believe we had valid contact information. As a result, we received usable survey responses from 32% of the total number of known first-year astronomy students in the two academic years that were the focus of this study.

We thank the many physics and astronomy departments and graduate students who made this publication possible.

The tables and figures in this report are available for download from www.aip.org/statistics

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