DOCUMENT RESUME

ED 446 623 HE 033 466

AUTHOR	Mulvey, Patrick J.; Nicholson, Starr
TITLE	Enrollments and Degrees Report. AIP Report.
INSTITUTION	American Inst. of Physics, College Park, MD. Education and Employment Statistics Div.
REPORT NO	AIP-R-151.36
PUB DATE	2000-03-00
NOTE	14p.; For the March 1999 report, see ED 429 511.
AVAILABLE FROM	American Institute of Physics, Education and Employment Statistics, One Physics Ellipse, College Park, MD 20740-3843. Tel: 301-209-3070; e-mail: stats@aip.org; Web site: http://aip.org/statistics.
PUB TYPE	Numerical/Quantitative Data (110) -- Reports - Descriptive (141)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Astronomy; Bachelors Degrees; *Degrees (Academic); Doctoral Degrees; Educational Trends; *Enrollment Trends; Graduate Study; Higher Education; Masters Degrees; National Surveys; *Physics; Sex Differences; Tables (Data); Trend Analysis; Undergraduate Study

ABSTRACT

This report presents the results of a fall 1999 survey of U.S. colleges and universities that offer doctoral, master's, and bachelor's degrees in physics and astronomy, focusing on degree production and current student enrollment. Highlighted are the following: (1) after four years of significant declines, physics bachelor's degrees conferred in 1998 remained stable; (2) the number of first-year students entering U.S. graduate physics programs has remained relatively unchanged for three consecutive years; (3) the group composition of entering physics graduate students has changed; (4) there was a 4 percent drop in physics doctorates awarded; (5) a higher proportion of women and lower proportion of foreign students receive astronomy degrees compared to their physics counterparts; and (6) bachelor's degrees in astronomy rose 8 percent. An appendix provides trend data on degrees and enrollments over the last several years. (EV)

AMERICAN INSTITUTE OF PHYSICS

One Physics Ellipse
College Park, MD 20740-3843

EDUCATION AND EMPLOYMENT STATISTICS DIVISION
Tel. 301-209-3070

E-mail: stats@aip.org
http://www.aip.org/statistics

AIP REPORT

By Patrick J. Mulvey
Starr Nicholson

AIP Pub. Number R-151.36

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ENROLLMENTS AND DEGREES REPORT

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ENROLLMENTS AND DEGREES REPORT

HIGHLIGHTS

- After four years of significant declines, the number of physics bachelor's degrees (3,821) conferred in the class of 1997-98 was basically unchanged from the previous year. Although stable overall, bachelor's production continued to decline at departments that also have a physics doctoral program. (**Figures 2 & 3**)
- The number of first-year students entering US graduate physics programs has remained relatively unchanged for three consecutive years. Incoming enrollments for the 1998-99 academic year totaled 2,417. This follows five years of significant enrollment declines that will continue to impact advanced physics degree production for several years from now. (**Figure 5**)
- While the overall number of entering physics graduate students has stabilized, the composition of that group continues to change. Most notably, the number of non-US citizens enrolling as first-year graduate physics students now exceeds the number of US citizens. **(Figure 5)**
- The 1,323 physics PhDs conferred during the 1997-98 academic year represented a decline of 4% from the previous year, with a cumulative drop of 11% from the recent high of four years ago. Given present enrollment figures, the future certainly holds further declines for physics doctoral production in the US. (**Figure 7**)
- A higher proportion of women and lower proportion of foreign students receive astronomy degrees (at all levels) compared to their physics counterparts. (**Tables 2 and 7**)
- The number of bachelor's degrees in astronomy rose 8% from the previous year, bringing the 1997-98 total to 192. The number of PhDs conferred from the 39 doctoral-granting astronomy departments, 116, was basically unchanged from the previous year. (**Figure 9**)

Recent years have seen some dramatic changes in enrollment and degree patterns among US physics departments. There are 20% fewer physics bachelor's being conferred than just five years ago. The number of students emerging with physics masters degrees from the 72 masters-granting departments has fallen by almost a third and PhD production has fallen 11% during the last four years. Still, while degree production is down for all levels and declines will continue for a number of years at the doctorate level, the enrollment totals for first-year graduate students and junior-level physics majors have been relatively constant for the past three years. This suggests that a new period of stability in the offing.

In part, this may be a result of physics departments having taken an increasingly active role in trying to stem enrollment declines. For example, some departments have successfully been able to maintain their current enrollments through new recruitment and retention efforts, which in some cases include program or curriculum modifications. At the graduate level, some departments are also enrolling a larger number of foreign students, which is offsetting the declines that are still occurring among the US citizens.

Maintaining or increasing enrollments at the undergraduate level is of major concern, as individuals earning physics bachelors are the primary source of US citizens entering physics graduate programs.

The American Institute of Physics' Education and Employment Statistics Division conducts the Survey of Enrollments and Degrees each fall, contacting all degree-granting physics and astronomy departments in the US. Data on the number of degrees conferred by a department in the previous academic year as well as the current year's undergraduate and graduate enrollments make up the core of the survey. The responses are added to an established departmental database that tracks the changing dimensions of the physics and astronomy communities.

This year we received responses from 94% of the 762 degree-granting physics departments (see **Table 1**) and 100% of the 69 astronomy departments. Since the data on enrollments and degrees are so fundamental, a great deal of time and effort is spent obtaining responses from as many departments as possible. It is through the regular cooperation of departmental chairpersons, faculty and staff that we are able to tabulate these figures and trends for the nation as a whole.

Table 1. Departments by highest physics degree offered, 1998-99.

	Number of Depts.	Percent of Depts.
PhD-granting	183	24
Master's-granting	72	9
Bachelor's-granting	507	67
Total	762	100%

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The appendix tables of this report list aggregate data on annual degree production and enrollments for physics and astronomy departments. The actual school-by-school figures that form the basis for these totals are available in two separate publications, the *Roster of Physics Departments with Enrollment and Degree Data* and the *Roster of Astronomy Departments with Enrollment and Degree Data.* These reports are available no cost from this division or from our web site, http://www.aip.org/statistics.

INTRODUCTORY ENROLLMENTS

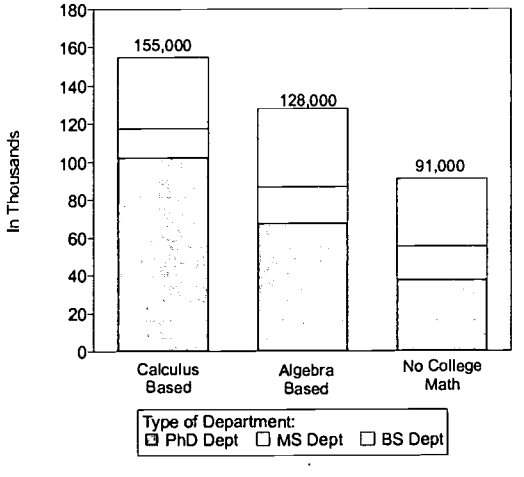
Introductory physics course enrollments have remained strong in recent years. During the 1997-98 academic year approximately 374,000 students received their first college-level exposure to a physics course at one of the degree-granting physics departments. Even though departments have been experiencing declines in their number of physics majors, the continuing demand for introductory physics instruction illustrates the important role physics departments play in providing service courses to a wide range of majors in other fields.

Figure 1 shows the distribution of students taking introductory physics by level of mathematics incorporated into the course. Only about three percent of the students who take a calculus-based introductory course are destined to become physics bachelor's degree recipients three or four years later. Due to the large number of non-physics majors taking an introductory physics course, the content and the math background required for specific courses may vary greatly in order to meet the needs of the different students.

UNDERGRADUATE ENROLLMENTS AND DEGREES

In the 1997-98 academic year there were 3,821 physics bachelor's degrees conferred in the US, about the same level as the previous year. The number of degrees being currently conferred is well below what was being produced in this country only a few years ago. During the late 1980's and early 1990's the number of physics bachelor's degrees conferred hovered around 5,000. This decline has occurred at a time when bachelor's degree production across all disciplines combined has been fairly level (see **Figure 2**).

Figure 1. Introductory physics enrollments by math level of course and type of department, academic year 1997-98.



Note: Includes only degree-granting departments with physics programs.

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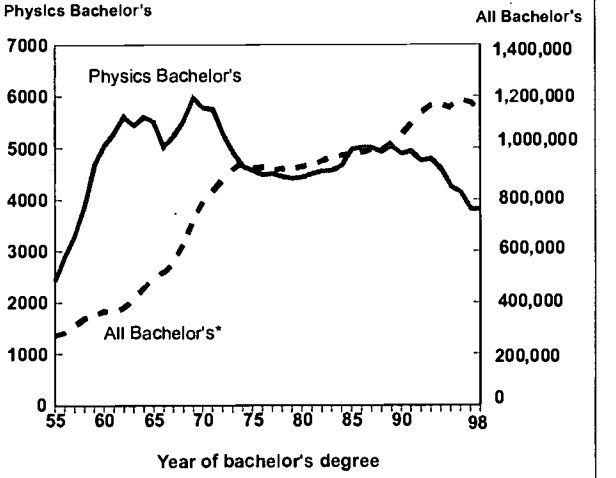
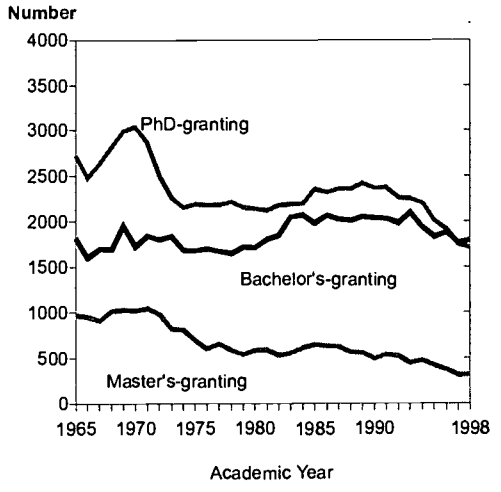
Figure 2. Physics bachelor's and total bachelor's produced in the US, 1955 to 1998.



AIP Statistics Division, Enrollments and Degrees Report, and
* NCES Digest of Education Statistics

Figure 3. Physics bachelor's degrees awarded by department type, 1965-1998.



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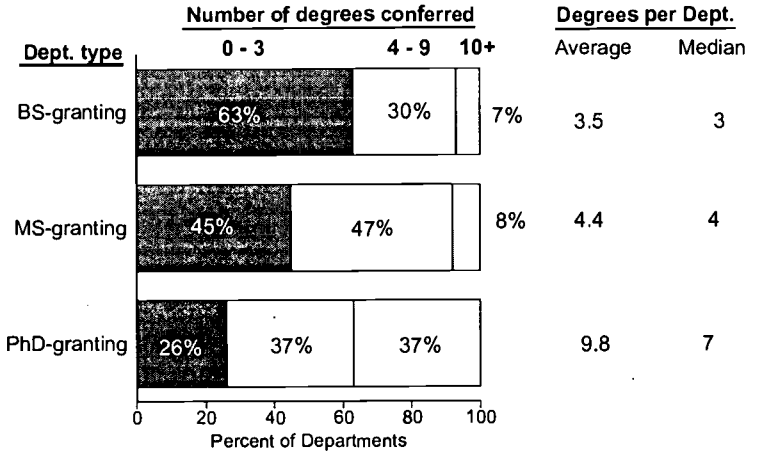
The recent drop in physics bachelors' production has not been uniform across department type. Specifically, departments that also offer a graduate program in physics have experienced the greatest losses (see **Figure 3**). Comparing current degree production levels to those from the 1991-92 academic year, departments with the masters as their highest degree have experienced a 39% drop in undergraduate degree production. This compares with declines of 24% at the doctoral-granting departments and only 10% at the bachelor-only departments. As a result of these uneven declines, the doctoral-granting departments, which historically have generated most of the physics degrees at the undergraduate level, now produce fewer such degrees than their bachelor-only counterparts.

Judging from the overall number of junior-level physics majors enrolled, physics bachelor degree production looks likely to continue at the current levels for the next couple of years. Although the overall junior-level enrollments have been flat for the past three years, declines are still occurring at departments offering the physics bachelors and masters as their highest physics degree. This is being offset by increasing junior enrollments at departments that offer a physics doctorate, which had suffered especially steep declines in bachelor production in recent years.

Although their enrollments have declined the least, degree production at the 507 physics departments that do not go beyond the

Figure 4. Distribution of physics departments by size of physics bachelor's class and type of department, class of 1998.



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undergraduate level are still relatively small. In the class of 1998 they averaged only 3.5 degrees per department (see **Figure** 4). This compares to an average of 9.8 for the 176 doctoral-granting departments that have undergraduate degree programs and 4.4 for the masters-granting programs. In fact, about one-third of the bachelors-only departments are so small that they produced only 1 or no physics bachelors during the 1997-98 academic year.

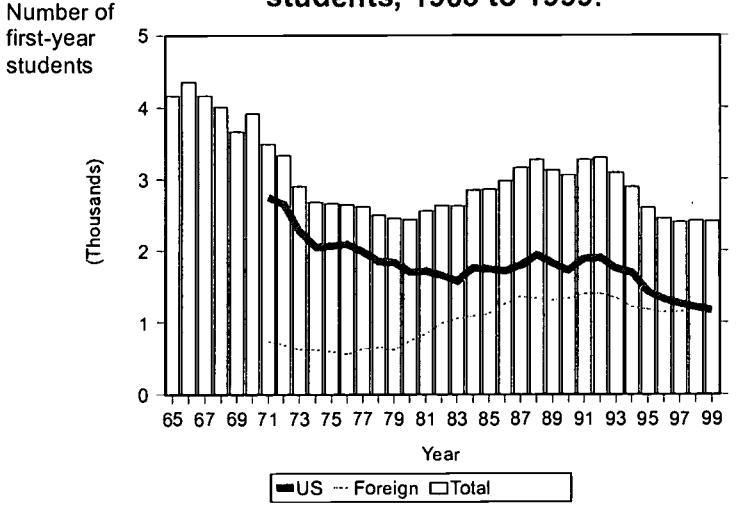
GRADUATE ENROLLMENTS

In the fall of 1998, US physics departments reported a total of 2,417 new graduate students. This represents the third consecutive year that first-year graduate student enrollments have remained stable following the sharp decline in incoming physics students that occurred during the early 1990s (see **Figure 5**).

Although the overall number of students entering physics departments has remained basically unchanged for three consecutive years, the number of US citizens in that total continues to fall. In 1998-99 there was a 3% drop in the number of US first-year student enrollments, adding to a cumulative decline of 39% from the recent US high in 1992. As can be seen in **Figure 5,** the number of incoming US students continues to set new all-time lows for the three-decade history of this report series. As seen in the figure, the decline in enrollment of US citizens has been offset by an increase in the numbers of foreign students enrolling. Foreign student enrollment increased by 3% from the previous year and now comprises 52% of all entering physics students in the 1998-99 academic year.

Some of the sharpest enrollment declines have occurred at departments where the master's is the highest physics degree offered. In the most recent year, the size of the incoming class at master's departments declined 18%. The 243

Figure 5. First-year US and foreign graduate physics students, 1965 to 1999.



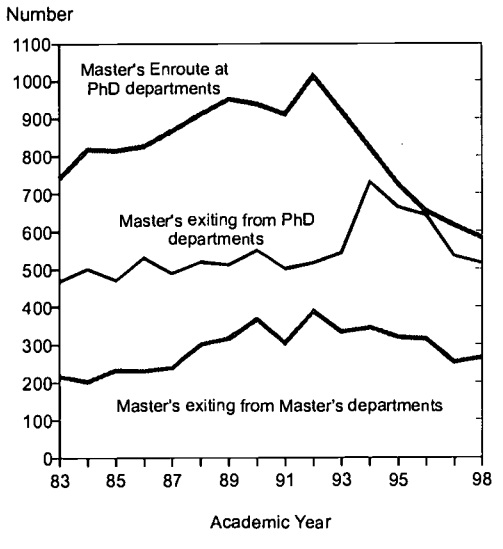
Note: Staring in 1995 refinement in wording may slightly raise the foreign citizen totals relative to that reported in earlier years. A citizenship breakdown of first-year student enrollments is not available prior to the academic year 1970-71.

Source: AIP Statistics Division, Enrollments and Degrees Report.

students entering those departments in the 1998-99 academic year represent only half of what masters departments enrolled in 1992.

As a result of the large declines in first-year student enrollments in the early 1990s, overall graduate enrollments at US graduate physics departments continue to fall and are expected to do so for the next few years. The 10,971 students enrolled during the 1998-99 academic year represent a decline of 3% from the previous year and a cumulative decline of 25% from 1992. Only a small fraction (6.5%) of the graduate students are enrolled at one of the 72 masters only institutions.

Figure 6. Master's degrees conferred by type of degree and department, 1983-1998.



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GRADUATE DEGREES

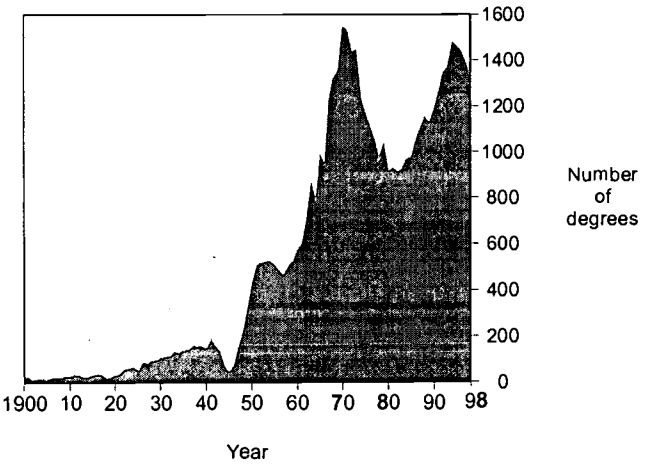
In the 1996-97 academic year there were 255 graduate physics departments in the US, about three-quarters of which offered the PhD as their highest degree. These doctorate-granting departments reported producing 1323 PhDs and 1099 masters. At departments where the masters is the highest degree an additional 266 masters were conferred, bring the total number of masters degrees for the 1997-98 academic year to 1,365.

Master's degree recipients fall into two main categories: (1) students leaving a physics department with the masters as their highest degree; and (2) students earning a Master's Enroute degree, an interim degree earned at a doctoral-granting department by a student pursuing a physics PhD at that same department. By this definition, only departments with doctoral programs can confer a Master's Enroute degree. For the class of 1998, such degrees were granted to 583 individuals.

Although not all doctoral candidates receive this interim master's degree, it can be used as one measure of impending changes in future PhD production. As shown in **Figure 6**, the number of master's enroute degrees conferred has declined for 6 consecutive years, and now stands 42% below the recent high in 1992. This is another harbinger of sustained declines to be experienced in PhD production in coming years.

For the class of 1998, there were 782 students exiting physics departments with the masters being the highest degree they will receive from that department. This number is unchanged from the previous year and follows three years of declines. Two-thirds of these exiting masters degrees came from departments that also offer a doctoral level physics degree. The majority of exiting masters' students enter into the workforce after receiving their degree, although a significant number choose to enroll at another graduate department, with many continuing in physics.

Figure 7. Number of physics PhDs conferred in the United States, 1900 to 1998.



Sources: ACE (1900-19), NAS (1920-61), AIP (1962-98) AIP Statistics Division, Enrollments and Degrees Report.

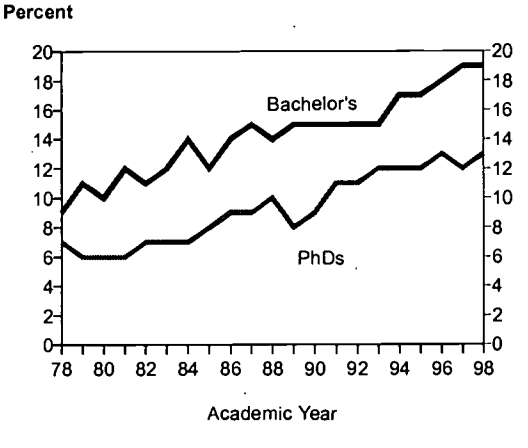
The number of PhDs conferred to the class of 1998 was 1,323, a 4% decline from the previous year (see **Figure 7**). The number of PhDs conferred has now fallen 11% from the recent high of 1994. As noted above, a continued decline in the number of PhDs conferred over the next few years is virtually inevitable.

GENDER, RACE and CITIZENSHIP

Although gaining slowly, women remain a drastically underrepresented group among physics degree recipients at all levels (see **Figure 8**). The overall percentage of women at both the bachelor's and doctorate levels (19% and 13% respectively) is about double what it was two decades ago. The proportion of women bachelors does not seem to vary with the size of the program, and is only slightly influenced by whether a program goes only up to the baccalaureate or continues to the graduate level.

There are 13 women's colleges in the US that offer a bachelor's degree in physics. All but one of these institutions has only an undergraduate program in physics. These women's colleges and universities are few in number and make

Figure 8. Percent of bachelor's degrees and doctorates in physics granted to women, class of 1978-1998.



Note: A from change occured in 1994 resulting in a more accurate representation of women among physics bachelors. Some of the increase in 1994 may be a result of that change.

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Table 2. Percent of women and foreign citizens among recent physics degree recipients, Class of 1998.

Degree	Women %	Foreign* %
Bachelor's	19	5
Professional / Terminal Master's	20	41
PhDs	13	46

* Foreign citizens include individuals with permanent resident status and temporary visas.

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only a modest contribution to the total number of women receiving physics degrees each year. They represent about 1.7% of the departments that offer undergraduate physics degrees, although they are responsible for producing 5% of the women that earned physics bachelor's degrees during the last decade. Like many departments across the country these departments have been experiencing declining enrollments in recent years.

Table 2 presents the proportion of women and foreign citizens among physics degree recipients in the class of 1998. The proportion of foreign citizens has remained relatively unchanged for all three degree types in recent years, but is likely to rise among future PhD classes as a result of the increasing proportion of incoming students with foreign citizenship.

Similar to women, the representation of African and Hispanic-Americans among physics degree recipients remains low (see **Table 3**). However, unlike the uniformity of degrees conferred to women across department types, degree production for under-represented minorities tend to be more concentrated in a small number of departments. This is especially true for African-Americans.

Similar to years past, 56% of the bachelor's degrees, 50% of the masters degrees, and 33% of the PhDs awarded to African-Americans in the class of 1998 were conferred at one of the nations historically black colleges and universities (HBCU). There are 34 HBCUs that have a

Table 3. Number and percent of physics degrees granted to US citizens by minority / ethnic group status, Class of 1998.

	Bachelor's		Exiting Master's		PhD's	
	Number	Percent	Number	Percent	Number	Percent
African-American	191	5	28	6	9	1
Hispanic	96	3	14	3	8	1
White	3081	85	395	85	640	90
Asian-American	179	5	15	3	34	5
Other	71	2	12	3	20	3
Total US Citizens	3618	100%	464	100%	711	100%

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degree program in physics, with 7 offering a physics masters and 3 offering a PhD. **Table 4** lists the institutions that conferred the largest number of physics bachelor's degrees to African-Americans in recent years; all of them are HBCUs with the exception of Chicago State University.

Table 4. Institutions averaging 4 or more African-American physics bachelors, 1996-98.

	3 year average
Xavier U (LA)	14
Southern U & A&M Coll (LA)	10
Lincoln U (PA)	9
Jackson St U (MS)	5
North Carolina A&T St U(NC)	5
Tuskegee U (LA)	5
Chicago St. (IL)	5
Clark-Atlanta U(GA)	5
Delaware St U (DE)	5
Alabama A&M (AL)	4
Benedict Coll (SC)	4
Grambling St U (LA)	4
Hampton U (VA)	4
Norfolk St U (VA)	4
Spellman Coll (GA)	4

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ASTRONOMY

The 69 departments with an astronomy degree program fall into two distinct groups. About half are stand-alone departments devoted strictly to the field of astronomy, while the remaining half are administered in conjunction with a physics program (see **Table 5**). We received responses from 100% of the astronomy departments. It should be noted that students also receive degrees in astrophysics from stand-alone physics departments as well as from departments granting astronomy degrees. Astrophysics degrees conferred by these physics-only departments are included in the earlier section on physics degree production.

Approximately 162,500 students took an introductory astronomy course during the 1997-98 academic year (see **Table 6**). This overall enrollment figure is unchanged from the previous year. Historically, about twice as many students took their introductory astronomy course at one of the many physics departments where there is no astronomy degree program. About six out of every seven of the students who took their introductory astronomy course at an astronomy department were enrolled in a course that had no math pre-requisite.

Introductory astronomy enrollments comprise almost a third of the introductory enrollments for physics and astronomy combined. This proportion is even more surprising when you

Table 5. Number of degree-granting astronomy departments by highest astronomy degree offered, academic year 1998-99.

Department Type	Combined with physics	Separate astronomy	Total
PhD-granting	8	29	37
Master's-granting	2	2	4
Bachelor's granting	23	5	28
Total	33	36	69

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Table 6. Introductory astronomy course enrollments by department type, academic year 1997-98.				
	Bachelor's-granting	Master's-granting	Doctoral-granting	Total
Astronomy & combined departments	9,400	2,600	39,400	51,400
Physics department	45,300	22,500	43,300	111,100
Total	54,700	25,100	82,700	162,500

Note: Table only includes enrollments at degree-granting physics and astronomy departments.

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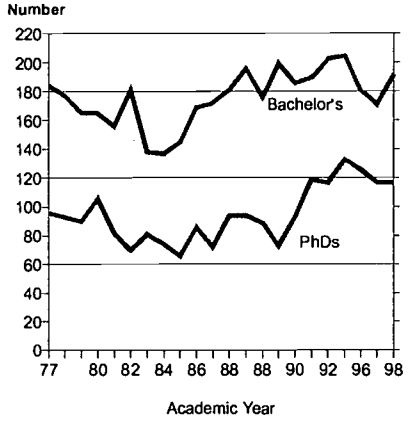
consider that an astronomy course is not usually a requirement for the vast majority of majors. Much of astronomy's enrollment comes from students using it as the subject to meet their university's science requirement.

The astronomy class of 1997-98 consisted of 192 bachelor's degrees, 29 exiting master's degrees and 116 doctorates (see **Figure 9**). Undergraduate astronomy degree production has not experienced the steady and sustained declines associated with physics bachelor's production in the 1990's. Although some declines in astronomy PhD production have occurred recently and further small declines may occur in coming years, astronomy PhD production is not expected to fall with the magnitude and speed projected for physics.

Table 7 presents the makeup of astronomy degree recipients by gender and citizenship for in the class 1998. In the degree class of 1998 women represented 33% and 19% of the astronomy bachelors and doctorate recipients respectively. As has been true in the past, women have a higher representation and the foreign citizens a lower representation in astronomy than in physics. **Appendix A1** presents ten years of astronomy enrollment and degree data at both the undergraduate and graduate levels.

Figure 9. Astronomy bachelor's degrees and doctorates awarded in the US, 1977-1998.



Note: The astronomy doctorate totals presented here do not include astrophysics degrees conferred by physics departments. Those degrees are included among the physics totals.

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Table 7. Percent of women and foreign citizens among recent astronomy degree recipients, Class of 1998.		
Degree	Women %	Foreign* %
Bachelor's	33	4
Professional / Terminal Master's	43	25
PhDs	19	30

* Foreign citizens include individuals with permanent resident status and temporary visas .

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APPENDIX

Table A1. Trend in astronomy enrollments* and degrees, academic years 1988 to 1999.

	Number of astronomy degrees granted				Undergraduate astronomy major enrollments		Graduate astronomy student enrollments	
Academic Year	Bachelor's	Master's Enroute	Exiting Master's	PhDs	Juniors	Seniors	1st-year	Total
1988-89	196	71	22	94	213	275	169	780
1989-90	176	75	19	89	223	236	186	842
1990-91	200	65	25	73	312	284	226	914
1991-92	186	80	31	93	290	331	175	935
1992-93	190	46	56**	119	337	348	173	939
1993-94	203	73	34	117	257	388	180	901
1994-95	205	72	43	133	269	351	165	905
1995-96	181	55	44	126	272	361	149	874
1996-97	177	67	23	117	265	332	155	837
1997-98	192	78	29	116	252	330	143	777
1998-99					263	340	165	799

* Includes part-time students.
** Thirty-four Master's came from the Arizona Summer Science Institute for science teachers at the University of Arizona.

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Table A2. Trend in physics enrollments* and degrees, academic years 1988 to 1999.

	Number of physics degrees granted			Undergraduate physics major enrollments		Graduate physics student enrollments	
Academic Year	Bachelor's	Total Master's**	PhDs	Juniors	Seniors	1st-year	Total
1988-89	5033	1781	1112	6390	7116	3132	13361
1989-90	4898	1857	1183	6313	7131	3059	13708
1990-91	4950	1718	1264	6445	7115	3278	14065
1991-92	4770	1918	1346	6435	7268	3306	14534
1992-93	4800	1797	1369	6287	7297	3090	14430
1993-94	4615	1899	1481	6146	7289	2902	14201
1994-95	4263	1710	1461	5620	6836	2604	13285
1995-96	4156	1614	1438	5335	6489	2462	12596
1996-97	3826	1406	1385	5057	6116	2404	11786
1997-98	3821	1365	1323	5006	5857	2423	11302
1998-99				5026	5593	2417	10971

* Includes part-time students.
** Includes both Terminal / Professional Master's and Master's Enroute.

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Table A3. Trend in physics enrollments* and degrees by institution type, academic years 1992 to 1999.

Academic Year	Number of physics degrees granted			Undergraduate physics major enrollments		Graduate physics student enrollments	
	Bachelor's	Total Master's**	PhDs	Juniors	Seniors	1st-year	Total
Doctorate-granting institutions							
1992-93	2253	1463	1369	3038	3845	2688	13222
1993-94	2203	1554	1481	2920	3729	2509	13042
1994-95	2009	1390	1461	2648	3453	2209	12173
1995-96	1918	1299	1438	2461	3344	2117	11545
1996-97	1746	1152	1385	2200	3133	2074	10900
1997-98	1710	1099	1323	2223	2899	2127	10432
1998-99				2363	2814	2174	10256
Master's-granting institutions							
1992-93	448	334		719	887	405	1208
1993-94	475	345		696	930	393	1159
1994-95	420	320		610	813	395	1113
1995-96	376	315		556	703	345	1047
1996-97	314	254		530	667	330	886
1997-98	320	266		561	636	296	870
1998-99				478	576	243	715
Bachelor's-granting institutions							
1992-93	2099			2530	2565		
1993-94	1937			2530	2630		
1994-95	1834			2362	2570		
1995-96	1862			2318	2442		
1996-97	1766			2327	2316		
1997-98	1791			2225	2322		
1998-99				2185	2203		

* Includes part-time students.

** Includes both Terminal / Professional Master's and Master's Enroute.

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