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ABSTRACT

This report presents the results of a 1995-96 survey of U.S. colleges and universities offering doctorate, masters, and bachelors degrees in physics and astronomy, focusing on degree production and current student enrollment. It found that a decade-long increase in physics doctorate production appeared to be leveling off, with the 1995 degree total at 1,461. First year graduate degree enrollments continued to decline in 1996, falling 5 percent from 1995's total. The number of bachelor's degrees conferred has also been dropping steadily, falling to 4,263 in 1995, the lowest in three decades. The number of women obtaining degrees in physics has increased or remained steady in recent years, while students from minority groups continue to be underrepresented in the field. Although many graduate physics programs are finding it difficult to increase or even maintain their incoming graduate class, introductory physics course enrollments have remained strong, reaching approximately 380,000 students in 1996. Astronomy degree production has been increasing in recent years at both the bachelor's and doctorate level, with 133 astronomy doctorates conferred in 1994-95. An appendix provides data on degree and enrollment trends over the last 10 years. (MDM)

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HIGHLIGHTS

- A decade-long increase in physics doctorate production appears to be leveling off, with the 1995 degree total at 1,461.
- First year graduate physics enrollments continued to decrease in 1996, falling 5% from 1995's total. The cumulative drop from a recent high in 1992 is now 26%, promising steep declines in PhD production within a few years.
- The number of bachelor's degrees conferred has been dropping steadily. In 1995, the figure fell to 4,263 degrees, the lowest this figure has been in three decades. The decline in degree production is expected to continue for at least a few more years, as junior enrollments continue to fall.
- In an environment of declining enrollments, many graduate physics departments are finding it difficult to fulfill the goal of increasing or even maintaining the size of their incoming graduate class.
- Despite the current decline in physics bachelor's degree production, introductory physics course enrollments have remained strong, reaching approximately 380,000 students in 1996.
- Astronomy degree production has been increasing in recent years at both the bachelor's and doctorate levels. There were 133 astronomy doctorates conferred in the class of 1994-95.

The US physics community is in a period of adjustment. Enrollments in degree programs for both graduate and undergraduate majors are experiencing substantial declines. The government's research and development spending priorities remain uncertain. The competition for university faculty positions continues to be strong. While these system-wide forces sort themselves out, departments struggle with how they can modify or change the direction in which they are currently heading.

The Education and Employment Statistics division of the American Institute of Physics, with the help of physics and astronomy departments across the country, has been conducting the Survey of Enrollments and Degrees for over thirty years. Like the other reports in this series, this report presents historical enrollment and degree trends as well as current population distributions. It portrays the large service course demands placed upon physics departments by other departments for the instruction of introductory physics courses. It

provides detailed demographic breakdowns highlighting the continued underrepresentation of women and minorities among physics degree recipients. Departmental differences are underscored by dividing programs by highest physics degree offered. Two tables in the appendix of this report present ten years of degree production and enrollment totals for the physics and astronomy departments.

Conducted during the fall of 1995, the survey achieved a final response rate from all physics and astronomy departments of 91%. Response rate varied by the highest degree offered by a department: 99% for doctorate-granting departments, 96% for programs granting degrees up to the master's level, and 87% for departments offering only an undergraduate degree. Even though the bachelor's-granting departments had the lowest participation rate, when the data from all the responding departments are considered, the demographic information reported is based on 95% of the physics bachelor's. Estimates were developed for all non-responding departments based on information they supplied in previous years and are reflected in the data presented here.

The actual school-by-school figures that form the basis for the aggregates reported here are presented in the publication "Roster of Physics Departments with Enrollments and Degree Data". (A separate roster covers the degree-granting astronomy departments.) These supplemental reports are available upon request at no cost.

The number of departments included in this survey series has varied over time. The actual year-to-year variances are slightly larger than they appear in **Table 1** as each year a few departments drop their graduate status or eliminate the major altogether, while others may start new undergraduate programs or begin offering graduate degrees. These departmental shifts, often occurring at the smaller departments, do not significantly impact the trends presented in this report.

Table 1. Departments by highest physics degree offered, 1976-1996.

Academic Year	PhD-granting	Master's-granting	Bachelor's-granting
1975-76	171	116	524
1980-81	173	103	492
1985-86	173	91	485
1990-91	177	84	491
1995-96	183	79	499

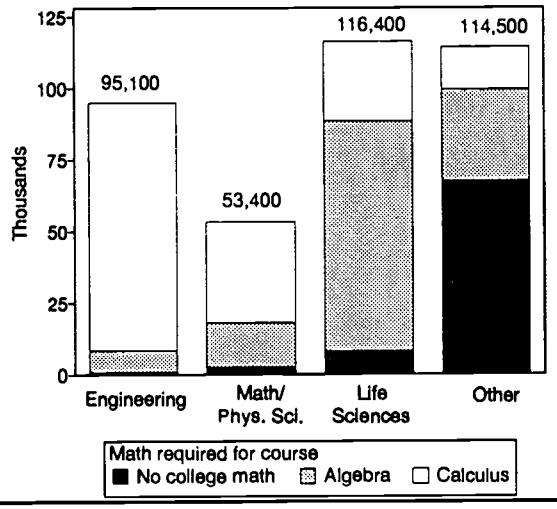
INTRODUCTORY ENROLLMENTS

Unlike the enrollments in the physics degree programs, enrollment in college-level introductory physics courses is holding strong. The total for the 1994-95 academic year was approximately 380,000 students. The continuing strong demand from other departments for introductory physics instruction illustrates the important role physics departments play in providing service courses to a wide range of non-physics majors.

The content of these introductory physics courses may vary greatly depending on the majors of the students enrolled. The amount of math background a student needs to enroll in a course is one key gauge of how these courses are tailored. As **Figure 1** illustrates and as would be expected, engineering, mathematics and physical science majors are primarily enrolled in an introductory physics course that requires knowledge of calculus. The majority of the life science majors who take

introductory physics enroll in courses that are algebra-based. The small fraction of students majoring in the social sciences and humanities who take any college physics at all are most likely to choose a course that requires little or no college math background.

Figure 1. Introductory physics enrollments by potential major and math background required for course, academic year 1994-95.

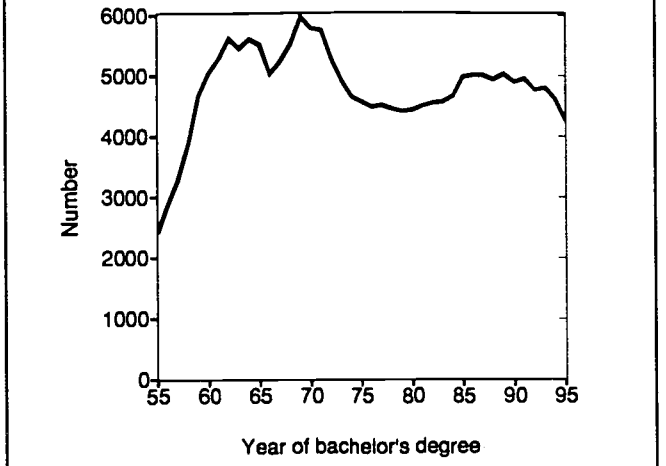


UNDERGRADUATE ENROLLMENTS / DEGREES

Physics bachelor's degree production is on the decline, down 8% from last year and 15% since the start of the decade. As can be seen in **Figure 2**, after almost two decades of fairly steady or slightly increasing undergraduate degree production, the number of new physics bachelor's degrees is declining at a rate similar to what was experienced in the early 1970's. The class of 1994-95 had 4263 degrees conferred, the lowest it has been since the late 1950's.

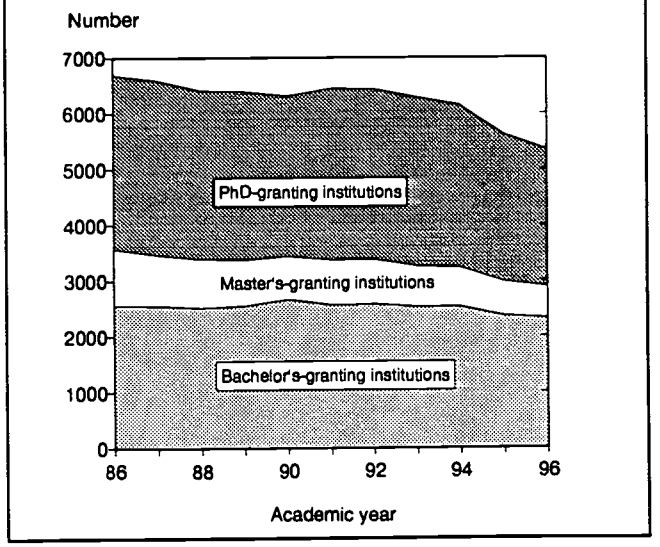
The junior enrollment data presented in **Figure 3** tracks closely to the bachelor's degree figures and foretells that continued declines in undergraduate degree production will continue for at least two more years. As is evident in the graph, the largest

Figure 2. Physics bachelor's production in the US, 1955 - 1995.



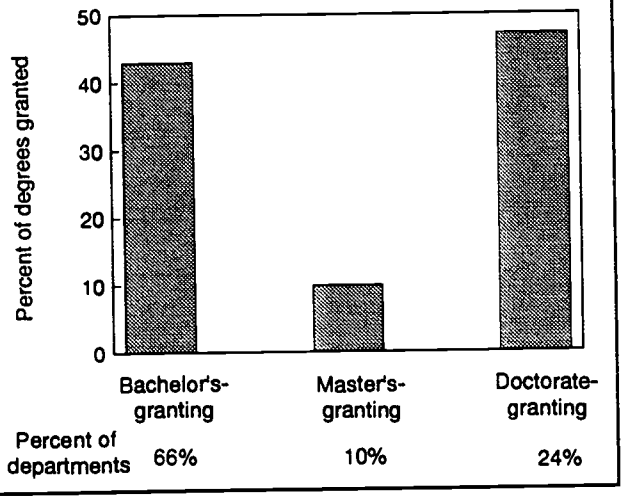
enrollment declines have occurred at departments with a graduate program. During the last five years the junior enrollments at bachelor's-granting departments have fallen by only 10%, whereas at master's- and doctoral-granting departments the decline has been 31% and 20% respectively. Although the departments with graduate programs represent a quarter of all the departments that offer a physics bachelor's degree (See **Figure 4**), they produce almost half of the physics bachelor's

Figure 3. Number of physics juniors enrolled by institution type, 1986 - 1996.



conferred each year. The combination of the uneven enrollment distribution and the more rapid decline at the graduate-level departments is likely to cause physics bachelor's degree production to fall to below the 4000 mark by the class of 1997.

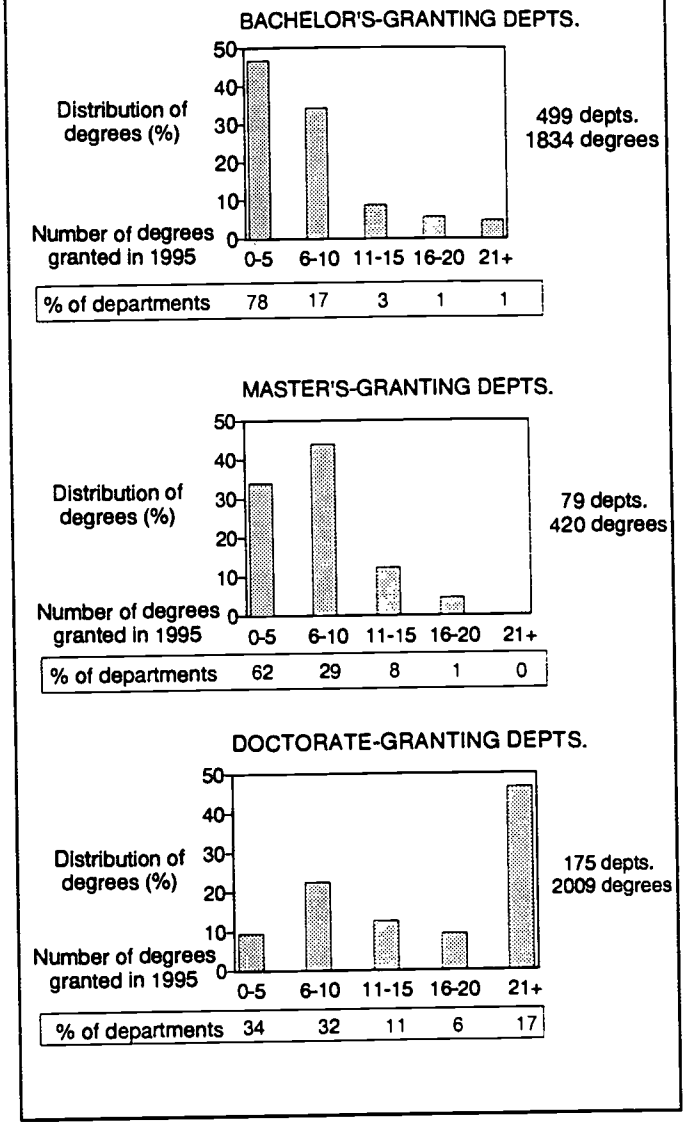
Figure 4. Distribution of physics bachelor's degrees by highest degree offered at the physics department, 1995.



The variation in the size of departments emerges most clearly when we group programs by highest physics degree offered, see **Figure 5**. The bachelor's-granting departments averaged about 3.5 degrees per department with nearly half of the degrees coming from departments granting between zero and five degrees. Conversely the doctoral-granting departments averaged 11.5 degrees per department and with almost half their degrees coming from departments which conferred 21 or more degrees. The master's-granting departments fall in between, averaging about 5 degrees per department.

One possible explanation for the declining undergraduate enrollments is the continued difficulties being experienced by all levels of physics degree recipients in the current job market.

Figure 5. Distribution of bachelor's degrees by department type and number of degrees granted, class of 1995.



In fact, some students may have their long range as well as their short range prospects in mind when choosing an undergraduate degree field other than physics. In recent years about one-third of the new physics bachelor's went directly on to physics graduate study. Given the well-publicized difficulties in the physics PhD job market, many students may be choosing fields where current and future employment prospects appear more promising.

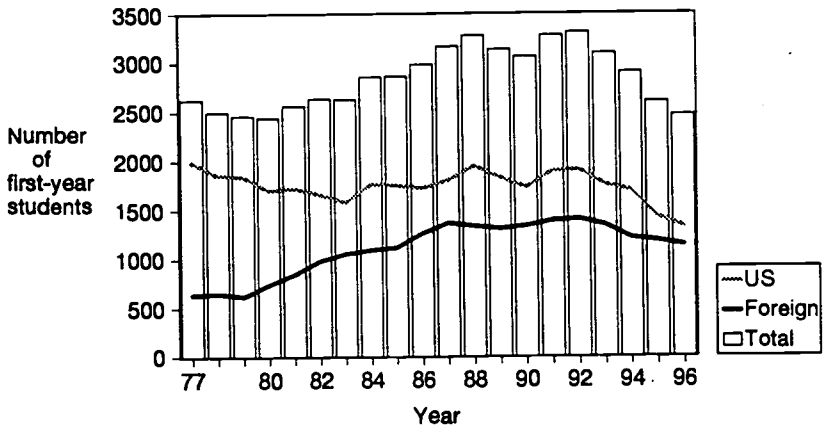
GRADUATE ENROLLMENTS

The most striking change in graduate physics departments in recent years concerns the number of students entering programs. In 1996 the first-year graduate physics students dropped to 2,462, declining by 5% from the previous year and 26% since 1992. As illustrated in **Figure 6**, the decline is occurring among both US and non-US students, although the US students are falling off at a greater rate than their non-US counterparts. These declines, which are similar at both the master's- and doctorate-granting departments, have started to impact overall graduate student enrollments, which now have experienced a 13% overall decline since 1992. Total physics graduate student enrollment in 1996 was 12,596 and included 43% non-US students with permanent resident status or temporary visas.

First-year graduate enrollments are driven by two major factors: students' desires to pursue a specific field and departmental decisions on how many students to enroll. From the student's perspective, it seems reasonable to assume that the well-publicized employment difficulties being experienced by recent physics doctorate recipients could easily discourage otherwise qualified students from pursuing an advanced degree in physics. Clarification of the major influences governing students' choice of field is being explored in new student surveys, and will be covered in greater detail in upcoming reports. However, this year's Enrollments and Degrees Survey was able to shed some light on this issue from the department's perspective by querying chairpersons about departmental policies and desires regarding incoming student enrollments.

Departments were asked whether they had an explicit target during the past three years for increasing or decreasing the size of their incoming graduate class. Sixty-two percent of the PhD-granting departments indicated that they did not have a specific goal to change the size of their incoming class. Twenty-two percent of these departments were hoping to increase their enrollments and 16% were trying to decrease their enrollments. The figures for the master's-granting departments showed a greater tilt towards desired growth, with 42% favoring an increase compared with only 5% looking to decrease enrollments.

Figure 6. First-year US and foreign graduate physics students, 1977 to 1996.



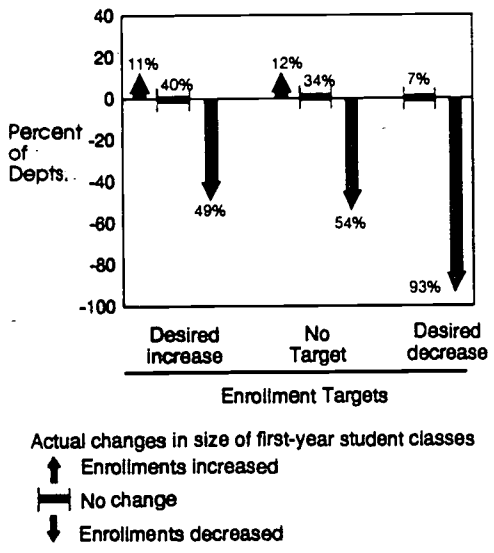
Note: Refinement in wording may slightly raise the 1995 foreign citizen totals relative to that reported in earlier years.

With 59% of the doctorate-granting departments and 30% of the master's departments experiencing enrollment declines during the past three years, it is apparent that the hopes of most of the departments to maintain or increase their incoming class size has not been met.

Figure 7 illustrates the first-year student enrollment changes for the PhD-granting departments by whether a department had an explicit target to increase or decrease the size of its incoming graduate class during the last three years. A department was considered to have maintained stable first-year student enrollments if the change from the opening years of the 1990s to the middle of the decade was less than 10%. Smaller departments had to have a net gain or loss of at least two students to escape the stable enrollment category. Beginning and end points were both calculated using multi-year averages to limit the effect of yearly enrollment fluctuations.

For the doctorate-granting departments which had no target for increasing or decreasing their incoming enrollments, 54% experienced enrollment declines, while 12% experienced increases. The net loss of students at these departments suggest that the declining enrollments are at least to some extent driven by the shrinking availability of qualified students choosing the field rather than by deliberate departmental policy to limit enrollments. To the extent that this is true, it is not surprising that departments which desired to decrease their incoming enrollments were overwhelmingly successful, as their desires coincided with the overall propensity of the students. On the other hand, the departments with a goal of increasing enrollments were largely unsuccessful, with only 11% experiencing enrollment increases compared to 49% experiencing a reduction in first year students.

Figure 7. Change in PhD departments' first-year student enrollments by department enrollment objective.



Departments were also asked whether their current enrollment objectives would have led them to accept a larger number of incoming students in the fall of 1995 if additional qualified candidates had applied. The first thing that becomes clear is that departments were not consciously limiting their enrollments in the fall of 1995 because of concerns over students' potential difficulties in the job market. Out of the 168 PhD departments responding to the question, only 5 departments indicated that such concerns led them to limit the number of students they admitted. Of the remaining departments about half indicated they would have accepted a larger number of incoming students if additional qualified candidates had applied. The other half stated that they would not have increased the size of their incoming class, even if additional fully-qualified students had applied, because they were limited by faculty size, funding, or other constraints. The widespread perception of a continuing poor job market for new physics graduates suggests that departments wanting to increase or even maintain graduate enrollments may continue to experience difficulties in the near future. The long term ramifications of such difficulties for the physics education pipeline are not yet clear.

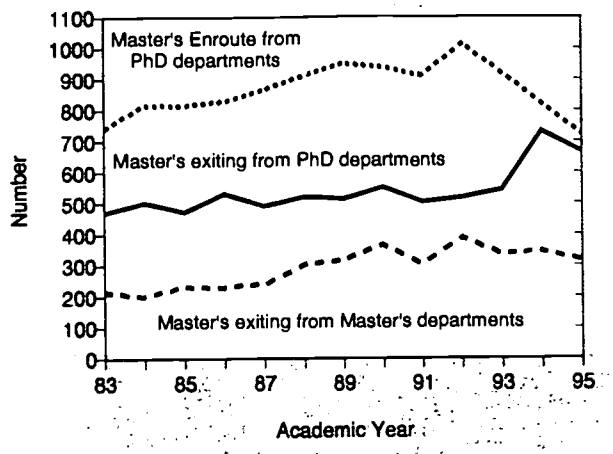
GRADUATE DEGREES

Our reports have traditionally distinguished between two types of physics master's degrees: an enroute degree received by a graduate student at a doctorate-granting department who then continues to work toward a physics PhD, and a Professional or Terminal Master's received by a student exiting a program at the master's level. An exiting master's recipient can come from a department where the master's is the highest physics degree offered, or from a department that also offers a PhD. In the class of 1995 thirty-nine percent of the Professional/Terminal Master's were conferred to non-US citizens; this compares to 48% of the physics PhDs.

We classify all students who graduate from a master's department as exiting with a Professional Master's degree. The classification of master's degree exiting from doctoral-granting departments is more complex. Some students may have only intended to pursue a master's degree, and are achieving their academic goals by earning what we often term a Professional Master's degree. For others, the PhD may have been the intended final degree, but they exited the program early with what is commonly referred to as a Terminal Master's degree. Since the distinction between a Terminal and a Professional Master's degree at a doctorate-granting department rests in part on a student's original intentions, which may or may not be actually known by the department, we combine these two categories for the analysis in this report. It should be noted that although the majority of Terminal and Professional Master's degree recipients enter directly into the job market upon receiving their degree, some continue with graduate studies in other disciplines, as well as in physics at a different physics department.

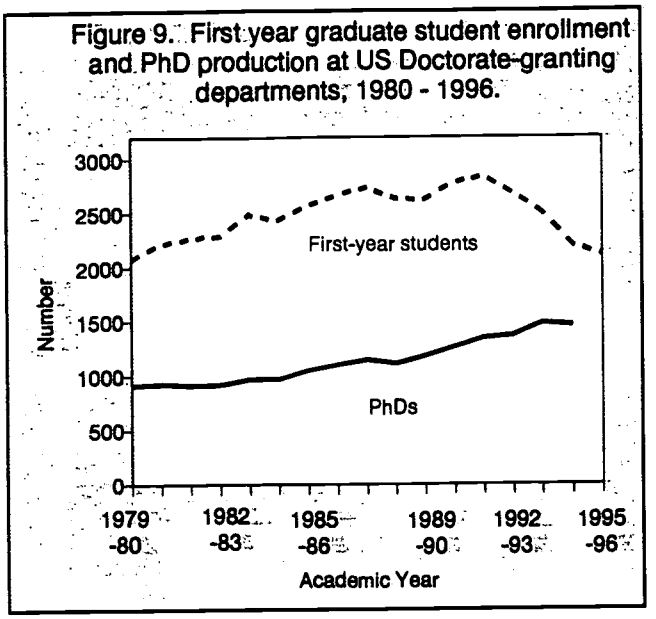
The recent trend of Physics Master's degree production is given in **Figure 8**. On one hand, master's degree production from departments

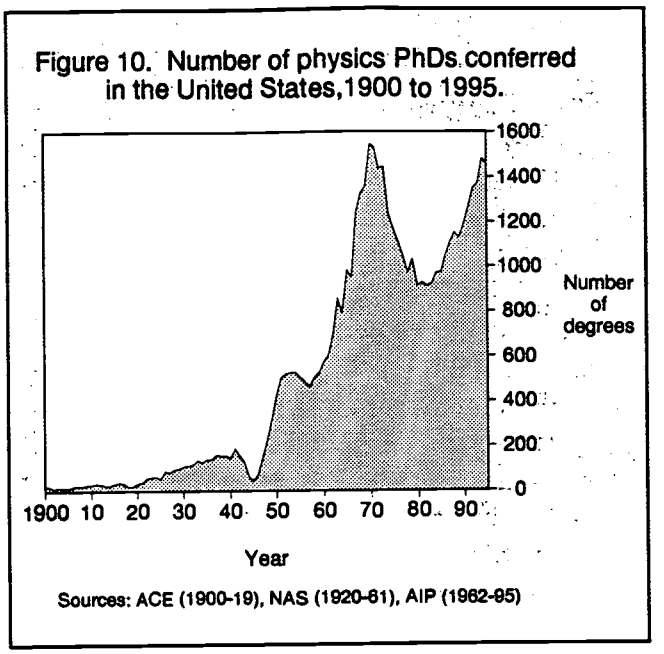
Figure 8: Master's degrees conferred by type of degree and department, 1983-1995.



where the masters is the highest degree available has fallen by 18% since a recent high in 1992. This dip in degree production mirrors recent declines seen in first-year students at these departments. In contrast to this, the number of students exiting with a master's degree from departments which also offer a doctorate has actually risen in recent years. Moreover, this increase has occurred in the face of sharp declines in first year students enrolling in these same departments. Two possible explanations for this discrepancy may be a huge expansion in professional master's programs within PhD departments or a more modest but still substantial increase in the proportion of students originally intending to pursue a doctorate who exit prematurely with a masters. Early responses from our subsequent survey suggest the latter, and this issue will be addressed in greater depth in the next report in this series.

The effect of the current decline in graduate enrollments is most sharply reflected in the number of individuals receiving Master's Enroute degrees. These degrees have fallen 29% from the recent





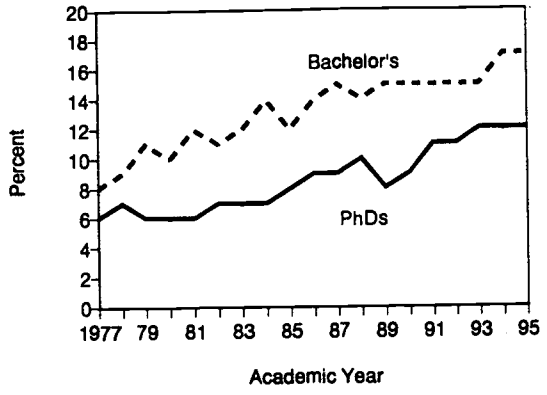
high in 1992 (See **Figure 8**). Although not all students pursuing a PhD obtain this interim master's degree, their recent and rapid decline is another signal that a substantial decrease in PhD production is not far off.

The PhD class of 1995 totaled 1,461 degrees. About half (48%) of this total consisted of non-US citizens, a proportion that has stayed stable for several years. Over half of these non-US citizens hailed from East Asia, primarily China. The leveling off of degree production in 1995 is expected to mark the end of the steady increase in PhD production experienced during the 1980s and early 1990s. Recent doctorate production as well as first-year student enrollments at the doctorate-granting departments are illustrated in **Figure 9**. It becomes quite clear that the sharp decline in first year student enrollments coupled with the increase in the number of students exiting doctorate departments with master's degrees discussed earlier foretells sharp and sustained declines in PhD production in the coming years, continuing the cycle of instability of PhD production evident in **Figure 10**.

WOMEN AND MINORITIES

Figures for the percentage of women earning degrees in other science disciplines consistently exceed those of physics. **Figure 11** shows the representation of women at the bachelor's and doctorate levels for the last two decades. During this time period both degree groups have approximately doubled as a proportion of all degrees. The proportion of women among the bachelors has actually been very stable throughout the 1990s and the increase in women shown in 1994 is largely due to refinements in data collection methods. Some of the increase seen in the 1980s in the proportion of women among the doctorates resulted from a rise in the number of non-US citizens receiving a physics PhD during that time period, a group among which women were better represented.

Figure 11. Percent of bachelor's degrees and doctorates in physics granted to women, class of 1977-1995.



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

When considering the representation of minorities among the physics degree populations, **Table 2** does not include degree recipients with foreign citizenship. As in past years, Hispanic and African-American students continue to be seriously underrepresented at all degree levels. Not only is their representation low but it drops significantly, especially for African-Americans, between the bachelor and doctorate degree levels. In contrast, Asian-Americans continue to be overrepresented among the degree populations.

Bachelor's degrees granted to African-Americans are not only low in numbers but also they are not distributed evenly across physics degree-granting departments. The nation's thirty-two historically black colleges and universities (HBCU) that have degree-granting physics departments produced over half (59%) of all physics bachelor's granted to African-American students in the class of 1995. These HBCUs are primarily four year colleges and are fairly evenly split between public and private control.

ASTRONOMY

The 72 degree-granting astronomy departments in the US are divided into two distinct groups: 37 are separate stand-alone departments and the remaining 35 are combined with a physics department. Over half the departments (58%) offer a doctorate as their highest astronomy degree. It should be noted that students receive degrees in astrophysics from physics departments as well as separate astronomy departments, and the degree data given in this section pertains only to the latter. Astrophysics degrees granted by the physics departments are included in the physics degree totals presented earlier.

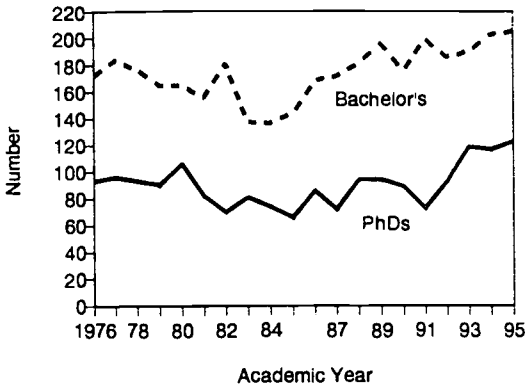
Table 2. Number and percent of physics degrees granted to US citizens by minority / ethnic group status, class of 1995.

	Bachelor's degrees		Terminal/Professional Master's		Doctorates	
Ethnic group	Number	Percent	Number	Percent	Number	Percent
White	3407	87	522	87	683	91
African-American	194	5	34	6	7	1
Asian-American	164	4	20	3	45	6
Hispanic	73	2	12	2	9	1
Other	72	2	9	2	11	1
Total US Citizens	3910	100%	597	100%	755	100%

Table 3 presents enrollment and degree data by highest astronomy degree available at that department. Introductory astronomy enrollments at physics departments have been included in the table and represent over two-thirds of the total introductory astronomy course enrollments at degree-granting physics and astronomy departments. A decade's worth of astronomy enrollments and degree production is given in **Appendix A1.**

Twenty years of doctorate and bachelor's degree production are shown in **Figure 12.** Although both degree groups have been increasing in recent years, first-year graduate astronomy enrollments are experiencing declines similar to those in physics and foretell a drop in doctorate production at astronomy departments in the near future.

Figure 12. Astronomy bachelor's degrees and doctorates awarded in the US, 1976-1995.



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

Table 3. Astronomy enrollments (1995-1996) and degrees (1994-1995) by highest astronomy degree available at that department.

		Bachelor's-granting	Master's-granting	Doctorate-granting	Totals
Enrollments					
Introductory course enrollments	Astro & combined depts.	7,800	1,900	37,600	47,300
	Physics depts.	41,400	22,400	38,500	102,300
Undergraduate majors	Juniors	72	11	189	272
	Seniors	82	24	225	361
First-year graduate students		-	7	142	149
Total graduate students		-	29	845	874
Degrees					
Bachelor's		34	13	158	205
Professional / Terminal Master's		-	11	32	43
Doctorates		-	-	133	133
Number of Departments	Combined	20	2	13	35
	Separate	6	2	29	37

The discipline of astronomy may be considered similar to physics, even to the extent that about half the departments are administered in conjunction with a physics department, but there are some pronounced differences between the individuals who pursue these fields. The proportion of women receiving degrees from astronomy departments, **Table 4**, exceeds that of physics by about 10% for each degree category. Another difference between students attending physics and astronomy departments is the percent of non-US students receiving degrees. The proportion of foreign students receiving astronomy degrees at each level is less than for physics, most notably at the PhD level where the proportions are 48% and 29% for physics and astronomy respectively.

Table 4. Percent of women and foreign citizens among recent astronomy degree recipients, class of 1995.

Degree	% Women	% Foreign*
Bachelor's	27	5
Professional/Terminal Master's	28	24
PhDs	23	29

* Foreign citizens include individuals with permanent resident status as well as those with temporary visas

APPENDIX TABLES

Table A1. Trend in astronomy enrollments* and degrees, academic years 1986 to 1996.

	Number of astronomy degrees granted				Undergraduate astronomy major enrollments		Graduate astronomy student enrollments	
Academic year	Bachelor's	Master's Enroute	Terminal Master's	PhDs	Juniors	Seniors	1st-year	Total
1985-86	169	58	27	86	232	252	170	711
1986-87	172	37	44	72	268	255	173	755
1987-88	181	49	26	94	250	285	171	731
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					272	361	149	874

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

Table A2. Trend in physics enrollments* and degrees, academic years 1986 to 1996.

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
1985-86	5013	1589	1051	6689	6992	2981	12011
1986-87	5011	1596	1105	6592	7054	3162	12616
1987-88	4937	1733	1150	6412	7017	3274	13143
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				5335	6489	2462	12596

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

Table A3. Trend in physics enrollments* and degrees by institution type, academic year 1990-96.

Academic year	Number of physics degrees granted			Undergraduate physics major enrollments		Graduate physics student enrollments	
	Bachelor's	Total Master's**	PhDs	Juniors	Senior	1st-year	Totals
Doctorate-granting institutions							
1989-90	2365	1490	1183	2877	3664	2623	12440
1990-91	2376	1414	1264	3082	3694	2782	12700
1991-92	2261	1530	1346	3057	3729	2831	13118
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				2461	3344	2117	11545
Master's-granting institutions							
1989-90	494	367		773	969	436	1268
1990-91	541	304		800	956	496	1365
1991-92	525	388		802	938	475	1416
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				556	703	345	1047
Bachelor's-granting institution							
1989-90	2039			2663	2498		
1990-91	2033			2563	2470		
1991-92	1984			2576	2601		
1992-93	2099			2530	2565		
1993-94	1937			2530	2630		
1994-95	1834			2362	2570		
1995-96				2318	2442		

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

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