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ABSTRACT

Based on surveys of departments of physics and astronomy in American institutions of higher education, this research and analysis looks at enrollments and degrees and reflects on continuing trends and changes in these fields. The survey was conducted during the fall and winter of 1993 and requested data on current undergraduate and graduate enrollments as well as degrees conferred during the previous academic year. These data are supplemented by information gathered from students and degree recipients themselves through separate student surveys. Findings include the following: (1) overall doctoral degrees continued to increase slightly while bachelor production remained relatively flat and indicators of potential declines have started to appear in enrollment data; (2) the enrollment level for students taking introductory physics remained stable at approximately 350,000 in recent years; (3) junior enrollment data (when most students must declare a major) showed a 2 percent decline in 1993 and 1994 which brought this number to its lowest since 1982; (4) first year graduate enrollment for U.S. students has remained level for 15 years while foreign student enrollment doubled in the same period; (5) 96 percent of students in doctorate departments were enrolled full-time; (6) though degree production rates remained stable, enrollment figures indicated a probable future decrease in degrees awarded. Includes 10 tables. (JB)

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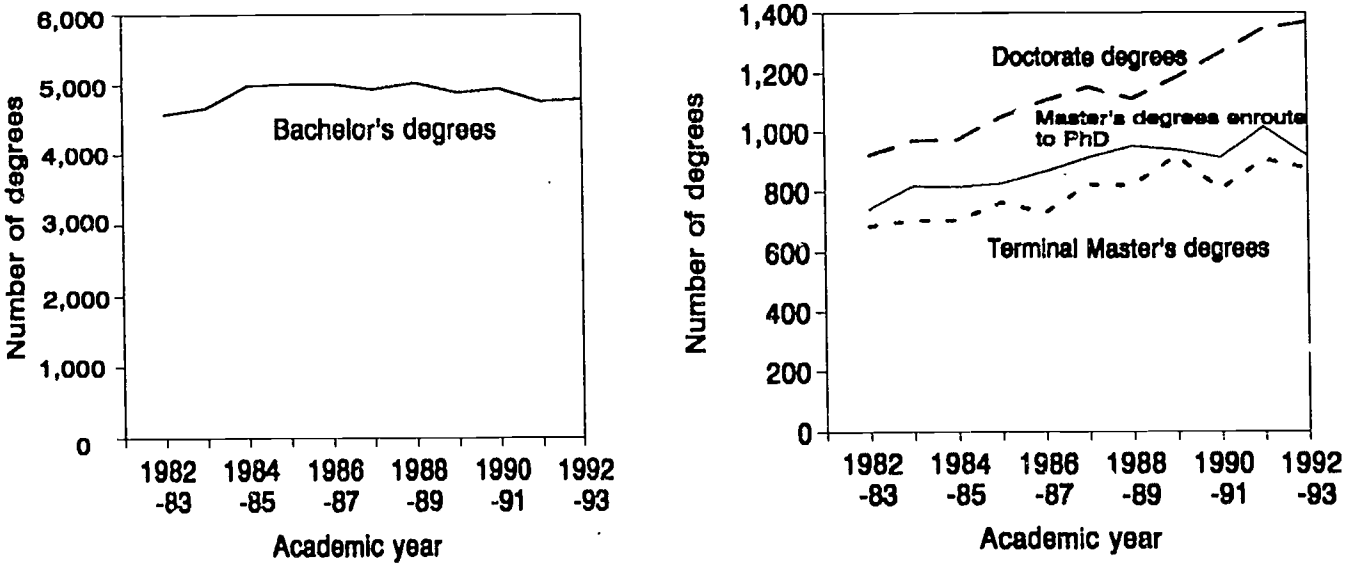
ENROLLMENTS AND DEGREES REPORT

The combination of the weak recovery from the economic recession and the end of the cold war has significantly altered the supply/demand picture in the physics community, at least for the present day. A few years ago the economy was stronger and funds for basic and military research were more readily available. Industrial research budgets were larger and many ambitious technical projects were still being developed in both the public and private sectors. Times have changed, and much of what was once true or thought to be true about the job market for physicists, no longer is. Military-funded research has been severely cut, industrial research budgets have been reduced and extensive downsizing and layoffs have become routine.

Certainly such changes in demand are going to have an influence on physics enrollments and subsequent degree production patterns. By means of the Survey of Enrollments and Degrees, AIP has monitored physics education and degree production for over thirty years. The information presented in this report builds on well established trends and reveals

Figure I. Physics Degrees Awarded by Academic Year, 1983 to 1993.



recent changes. US physics and astronomy departments that offer degrees ranging from bachelor's to doctorate contributed to the information presented here.

Conducted during the fall and winter of 1993, the survey requested the departments' then current undergraduate and graduate enrollments, as well as information on degrees that were conferred during the previous academic year. For the current report, these figures are supplemented by information gathered directly from the students and degree recipients themselves through separate student surveys. These student data permit us to draw a broader and richer picture of the populations delineated in the departmental survey.

Table I. Departments by highest physics degree offered, class of 1980 to 1994.

Academic year	Doctoral-granting	Master's-granting	Bachelor's-granting
1979-80	175	96	501
1984-85	173	90	487
1989-90	176	86	496
1990-91	177	84	491
1991-92	178	83	491
1992-93	183	80	486
1993-94	183	79	484

OVERVIEW

Figure I presents the ten most recent years of undergraduate and graduate degree production. The definitions employed in representing the master's degree production data have been changed from previous years. All students receiving master's degrees from departments where that is the highest physics degree granted are classified as "terminal master's recipients". A proportion of these students may in fact not stop at the master's but transfer to a department that offers a PhD in order to pursue the higher degree. Also included in the terminal master's degree data are the master's degrees conferred at doctorate departments to students who are discontinuing their study of physics at those departments. The "master's enroute to a PhD" data represent only those students who received this degree on the way to pursuing a doctorate in the same department.

Throughout this report data are divided into categories of highest physics degree offered by an institution. This separates the four year colleges, which only offer a bachelor's degree, from the graduate departments which offer a master's or doctorate. **Table I** shows the number of departments in each of the three degree-granting categories over time. Though appearing relatively stable, there is always a small amount of departmental shifting as graduate and undergraduate programs are expanded, created or discontinued.

The annual totals of conferred degrees plotted in **Figure I** are presented in **Table II**. The table also shows the enrollment data that support these current levels of degree production. **Table III** presents the enrollment and degree data with the additional breakdown by department type. For the first time, the data for seniors in their fifth or higher year of undergraduate study have been included. The number of students in this category has doubled during the past eleven years. Considering the current turbulent job market, the degree trends show more stability than one would expect. The PhD's continue to increase slightly and the bachelor production remains relatively flat. Indications of potential declines are starting to appear in the enrollment data. More detailed discussions of the data presented in **Tables II & III** and **Figure I** will follow in the appropriate sections.

Table II. Trend in physics enrollments* and degrees, academic years 1983 to 1994.

Academic year	Number of physics degrees granted			Undergraduate physics major enrollments			Graduate physics student enrollments	
	Bachelor's**	Master's	PhD's	Juniors	Seniors	5th Year+***	Total	1st Year
1982-83	4576	1426	921	6299	5580	564	10429	2630
1983-84	4668	1521	971	6303	5658	586	10922	2855
1984-85	4983	1518	972	6601	6009	774	11337	2863
1985-86	5013	1589	1051	6689	6092	900	12011	2981
1986-87	5011	1596	1105	6592	6119	935	12616	3162
1987-88	4937	1733	1150	6412	5959	1058	13143	3274
1988-89	5033	1781	1112	6390	5914	1202	13361	3132
1989-90	4898	1857	1183	6313	5896	1235	13708	3059
1990-91	4950	1718	1264	6445	6031	1084	14065	3278
1991-92	4770	1918	1346	6435	6126	1142	14534	3306
1992-93	4800	1797	1369	6287	6130	1167	14430	3093
1993-94				6146	6145	1144	14201	2902

* Includes part-time students.

** The treatment of bachelor's degrees has been refined and is not directly comparable to previous versions of this publication.

*** Not all departments indicated which senior level students were in their 5th or higher year of undergraduate study.

INTRODUCTORY PHYSICS ENROLLMENTS

An important function of most physics departments is to provide introductory physics courses to non-physics majors. Only a tiny fraction, less than 2%, of the students who take introductory physics eventually end up with a bachelor's degree in the subject. The introductory courses typically fill a science requirement or act as service courses for other majors and are often tailored to the specific needs of the students' potential majors. As illustrated in **Table IV**, one variable is the level of math background required to take the course. Not surprisingly, the large group of engineering majors, all of whom are required to take physics, need to have some background in calculus. To a lesser degree, this is also true of the physical science majors, who include a small number of potential physics majors. Following this progression, the courses oriented towards biology/health related majors generally require only a background in algebra, while the courses for non-science related majors require little or no higher level math at all.

Table IV shows that the clustering of majors into different variants of introductory physics holds across all types of departments. The one exception to this pattern is that calculus-based courses in departments offering graduate degrees enroll more engineering majors than similar courses in departments with only an undergraduate program. Overall, the enrollment level for students taking introductory physics has remained stable at approximately 350,000 in recent years.

Table III. Undergraduate and graduate enrollments* and degrees by institution type, academic years 1983 to 1994.

Academic year	Number of physics degrees granted			Undergraduate physics major enrollments			Graduate physics student enrollments	
	Bachelor's**	Master's	PhD's	Juniors	Seniors	5th Year+***	Total	1st Year
Doctoral-granting institutions								
1982-83	2089	1210	921	2962	2645	259	9524	2288
1983-84	2100	1319	971	2955	2824	269	10006	2495
1984-85	2355	1286	972	3059	3105	361	10357	2443
1985-86	2315	1358	1051	3120	2961	507	10937	2574
1986-87	2360	1357	1105	3132	3148	499	11389	2667
1987-88	2360	1432	1150	3030	2991	603	11880	2737
1988-89	2421	1465	1112	3018	2972	626	12069	2638
1989-90	2365	1490	1183	2877	2993	671	12440	2623
1990-91	2376	1414	1264	3082	3077	617	12700	2782
1991-92	2261	1530	1346	3057	3096	633	13118	2831
1992-93	2253	1463	1369	3038	3125	720	13222	2688
1993-94				2920	3089	640	13042	2509
Master's-granting institutions								
1982-83	523	216		877	752	105	905	342
1983-84	584	202		830	722	119	916	360
1984-85	648	232		974	781	168	980	420
1985-86	632	231		1014	865	147	1074	407
1986-87	627	239		913	791	189	1227	495
1987-88	564	301		871	750	168	1263	537
1988-89	561	316		822	795	213	1292	494
1989-90	494	367		773	737	232	1268	436
1990-91	541	304		800	760	196	1365	496
1991-92	525	388		802	765	173	1416	475
1992-93	448	334		719	724	163	1208	405
1993-94				696	756	174	1159	393
Bachelor's-granting institutions								
1982-83	1964			2460	2183	200		
1983-84	1984			2518	2112	198		
1984-85	1980			2568	2123	245		
1985-86	2066			2555	2266	246		
1986-87	2024			2547	2180	247		
1987-88	2013			2511	2218	287		
1988-89	2051			2550	2147	363		
1989-90	2039			2663	2166	332		
1990-91	2033			2563	2199	271		
1991-92	1984			2576	2265	336		
1992-93	2099			2530	2281	284		
1993-94				2530	2300	330		

* Includes part-time students.

** The treatment of bachelor's degrees have been refined and not directly comparable to previous versions of this publication.

*** Not all departments indicated which senior level students were in their 5th or higher year of undergraduate study.

Table IV. Number of students enrolling in their first introductory physics course, academic year 1993-94.

	Total Number			Highest degree of Physics Department								
				Doctoral			Master's			Bachelor's		
Math required for course	Calc	Alg	No req	Calc	Alg	No req	Calc	Alg	No req	Calc	Alg	No req
Potential majors	(in thousands)											
Engineering	81	3	1	61%	3%	1%	63%	2%	4%	40%	2%	-
Physical sci.*	30	11	1	17	10	1	19	8	2	32	7	1%
Life sci.	19	67	6	13	53	9	7	57	6	15	55	6
Other **	14	43	69	9	34	89	11	33	88	13	36	93
Enrollments in Thousands of Students	144	124	77	94	67	34	15	19	13	35	38	30
Totals	345,000			195,000			47,000			103,000		

* Physical science majors include: physics, chemistry, mathematics, etc.

** Other majors include: humanities, social sciences, architecture, computer science, technology, etc.

Note: Only universities offering at least a bachelor's degree in physics are included in this table.

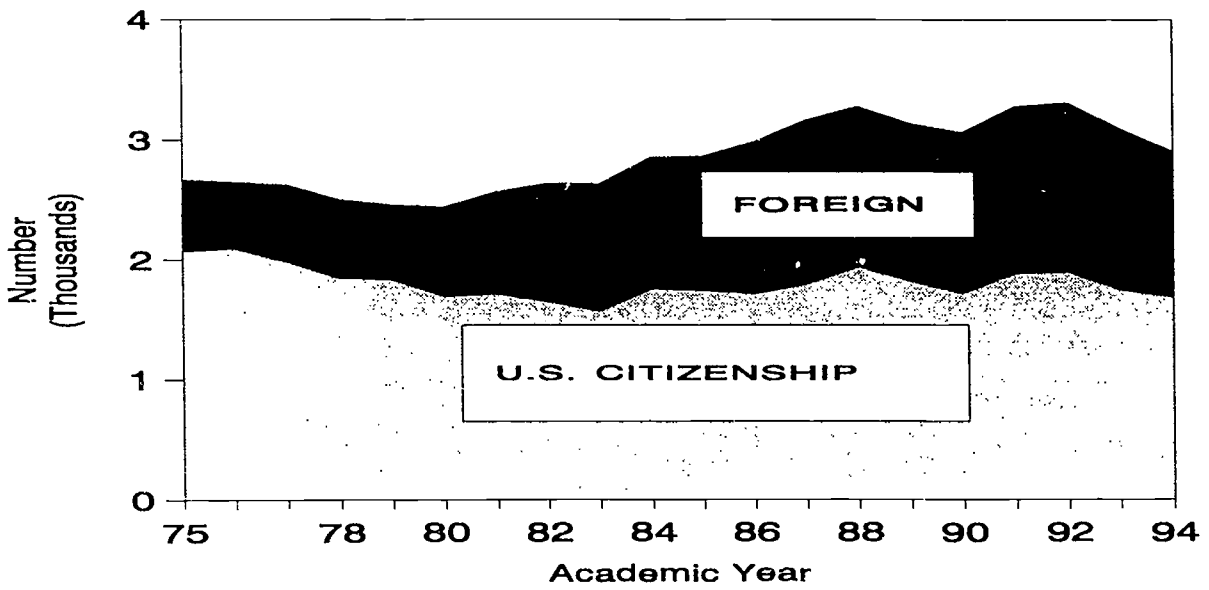
UNDERGRADUATE PHYSICS ENROLLMENT

Many undergraduate students, upon entering college, have a specific area of interest and pursue a course of study as freshmen, but declaration of a major is required of most students only upon reaching their junior year. The junior enrollment data presented in **Tables II & III**, which represent the potential pool of bachelor's degrees, show a 2% decline in both 1993 and 1994. This brings total junior enrollment to the lowest it has been since 1982. This decline may be a harbinger of a decline in bachelor degree production in coming years.

Nationally, more than half of all bachelor's degree recipients, regardless of discipline, take more than four years to obtain their degrees, according to the US Department of Education. Many of these students extend their senior status through a fifth or later year of undergraduate study. Shown in **Table II** are the reported fifth or higher year senior figures for physics. Only considering the data from the 58% of the departments who supplied the senior breakdown, approximately 22% of the senior class maintain senior status for more than a year. Furthermore, these figures vary both in physics and across all disciplines by the financial control of the institution. In the case of physics departments at public institutions, 25% of the undergraduates were in their fifth or higher year of study as compared to 14% at private schools.

This increase in the time needed to obtain a bachelor's degree could be attributable to the increase in cost of higher education coupled with the decrease

Figure II. First-Year Graduate Students in Physics by Citizenship, 1975 - 1994.



in federal, state and local funds available to students. Many students requiring extra years to complete their degree shift to a part-time student status. Our data show that most part-time physics students also hold jobs, which may suggest financial hardship. While the implications of the growing amount of time needed to obtain a bachelor's degree are not totally clear at present, it is an issue we intend to monitor closely.

GRADUATE ENROLLMENT

The driving force behind any future degree production is the number of potential graduates that enroll in that discipline. With the well publicized employment prospects being encountered in the physics community today and the uncertain opportunities in the future, the number of students entering graduate study in physics is of growing concern. As depicted in **Figure II**, first-year enrollment for US students has stayed relatively stable during the last 15 years. In contrast, the foreign student component has doubled its size during the same time period.

The more recent enrollments for first-year physics graduate students exhibit a significant drop. For the second consecutive year, the entering student enrollment has fallen by 6%. This two year decline is about the same by both type of graduate department and student citizenship, as shown in **Table III** and **Table V**, respectively. First-year student enrollments normally fluctuate within any graduate department. Thus, patterns and their causes are often difficult to identify. However, in-depth analysis indicate the recent declines are not uniform. Rather, they are, in larger part, the result of a few departments dramatically cutting the size of their first-year classes.

The total annual graduate student enrollments shown in **Table II** have increased slowly but steadily through the 1980s and into the early 1990s. The recent drop in first-year enrollments has now produced a small decline, 2% in the last two years, in total enrollment. This is the first dip in total graduate student enrollment since 1980.

Study status and citizenship varies by type of institution. **Table VI** shows that the vast majority (96%) of the students at the doctorate departments study on a full-time basis, while at the master's departments only 71% of the students attend full-time. Another departmental difference is that the foreign citizens make up a larger proportion of the student body at departments that grant a doctorate as opposed to a master's only.

Table V. Trend in entering US and foreign graduate physics students, academic years 1976 to 1994.

	Number of first year graduate students			
Academic year	US	Foreign	Total	Foreign students %
1975-76	2095	551	2646	20.8%
1980-81	1720	844	2564	32.9
1985-86	1721	1260	2981	42.3
1986-87	1799	1363	3162	43.1
1987-88	1944	1330	3274	40.6
1988-89	1825	1307	3132	41.7
1989-90	1724	1335	3059	43.6
1990-91	1890	1388	3278	42.3
1991-92	1903	1403	3306	42.4
1992-93	1753	1340	3093	43.3
1993-94	1691	1211	2902	41.7

Table VI. Full-time and foreign graduate physics enrollments by type of institution, academic years 1985 to 1994.

	Graduate students at doctoral-granting institutions			Graduate students at master's-granting institutions		
Academic year	Total	Full-time %	Foreign %	Total	Full-time %	Foreign %
1984-85	10357	93	37	980	62	30
1985-86	10937	93	39	1074	58	29
1986-87	11389	93	40	1227	63	32
1987-88	11880	93	41	1263	63	36
1988-89	12069	93	42	1292	64	37
1989-90	12440	94	43	1268	66	36
1990-91	12700	93	42	1365	64	36
1991-92	13118	93	42	1416	65	37
1992-93	13222	94	42	1208	67	35
1993-94	13042	94	42	1159	69	34

One reason for the smaller presence of foreign citizens at master's-only departments is that one quarter of the foreign graduate students entering US departments already hold a master's degree or its equivalent. A further explanation for both the smaller proportion of foreign students and the prevalence of part-timers in master's-only departments may be that many of these departments render a service to local employers by providing additional technical training to their employees. The students involved attend classes on a part-time basis, many in the evening, while maintaining industrial, governmental (including military) or academic employment. For the most part, the foreign students are in this country on temporary visas and are ineligible for off-campus employment. Ninety percent of the foreign students enrolled at master's institutions, compared to sixty percent of the US citizens, attend on a full-time basis.

DEGREES

Figure I and the degree portions of Tables II and III clearly show that degree production totals have been relatively stable for the bachelor's and steadily increasing for the doctorates in recent years. However, the enrollment figures also presented in these tables strongly suggest that a decrease in the production of both bachelor's and doctorate degrees is on the horizon.

While the impact of recent enrollment declines on degree production may ultimately be quite strong, it is also not immediate. Due to the length of time required to get a PhD, students well into their doctorate programs may not be inclined to abandon

Figure III. Percent of Bachelor's Degrees and Doctorates in Physics Granted to Women, Class of 1983 -1993

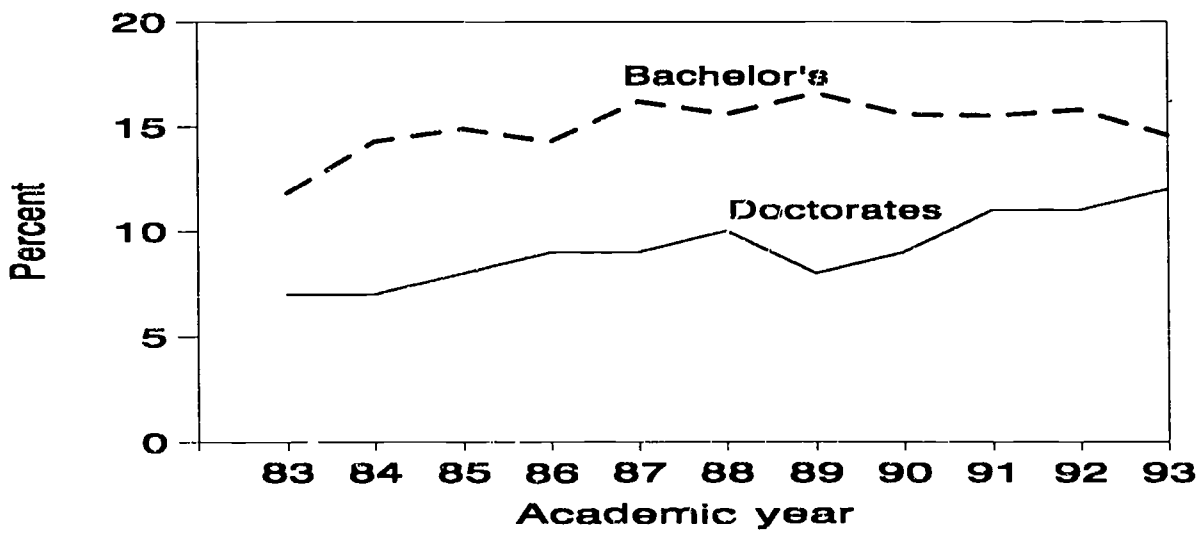


Table VII. Number of physics degrees granted by sex, minority group status, and citizenship, 1992-93.

Type of degree	Sex	Total no. of degrees	Black		Hispanic		Oriental		Asian Indian		Arab		Other Foreign
			US	Foreign	US	Foreign	US	Foreign	US	Foreign	US	Foreign	
Bachelor's	Men	4096	142	9	63	9	135	74	32	50	12	6	31
	Women	704	51	1	10	3	32	4	5	12	2	2	10
	Total	4800	193	10	73	12	167	78	37	62	14	8	41
Master's enroute	Men	769	9	1	4	8	22	159	6	36	2	10	75
	Women	151	6	-	2	-	5	30	1	16	-	1	9
	Total	920	15	1	6	8	27	189	7	52	2	11	84
Terminal master's	Men	745	36	3	6	5	9	137	3	22	2	9	48
	Women	132	19	2	1	2	6	35	1	13	-	2	7
	Total	877	55	5	7	7	15	172	4	45	2	11	55
Doctoral	Men	1199	8	5	13	28	30	322	4	51	5	17	135
	Women	170	-	-	1	1	6	62	-	10	2	1	12
	Total	1369	8	5	14	29	36	384	4	61	7	18	147

Note: The minority data presented in this table are underreported and represents lower limits.

their studies. However, if the decline in first-year student enrollments persists, overall enrollments will continue to fall and gradually lead to degree production declines in the near future.

The doctorate production figures presented in **Figure I** have increased by nearly 50% since the class of 1983. This growth is almost entirely attributable to the foreign students on temporary visas. In 1983, only 24% of the doctorates had foreign citizenship, while for the class of 1993, the figure has risen to 48%. This expansion is a reflection of the foreign enrollment patterns presented in **Figure II**.

The "Terminal master's degree" data in **Figure I** combines figures from all graduate departments into a single statistic. When departments are broken out by highest degree granted, it is found that the doctorate departments traditionally produce approximately two thirds of the "Terminal master's degrees".

Figures for the percentage of women earning degrees in other science disciplines, with the exception of engineering, consistently exceed those of physics. **Figure III** shows the representation of women at the bachelor's and doctorate degree levels in physics for the last decade. The data presented show a relatively stable picture for bachelor's in recent years and a period of slow growth for the doctoral recipients. This increase of 5% for the doctorates may be the combined result of numerous efforts to attract and retain more women in graduate physics programs and the increased presence of foreign students, among whom women are better represented. Even with these modest gains within the doctorate population, the percentage of women receiving

degrees at both the bachelor's and doctorate level have the potential for substantial future gains.

The very low representation of some minority and ethnic groups in physics has also received considerable attention in recent years. It is sometimes juxtaposed to the larger presence of students from other countries. **Table VII** presents degree data with a breakdown by gender, minority group status and citizenship. Among the more notable findings are the continued predominance of the East Asians and the higher representation of women students among non-citizens than among US students. These totals are based on figures reported by the individual physics departments, a small proportion of whom were unsure of their figures or were not able to provide the data. In light of this, these totals should be treated as lower limits.

ASTRONOMY

There are 68 degree-granting astronomy departments, of which 60% have a doctorate program. This ratio differs from the physics departments where only 24% of the 741 departments offer a doctorate. An additional contrast to physics departments can be seen in the smaller representation of foreign graduate students, with 20% foreign student enrollment at astronomy departments, compared to 42% for physics.

The trend data in **Table VIII** culminate in this year's doctorate and terminal master's production figures, which are the largest one year totals in the history of this survey series.

Table VIII. Trend in astronomy enrollments* and degrees, academic years 1984 to 1994.

	Number of astronomy degrees granted				Undergraduate astronomy major enrollments			Graduate astronomy student enrollments	
Academic year	Bachelor's	Master's enroute	Terminal Master's	PhD's	Juniors	Seniors	5 Year+	Total	1st Year
1983-84	137	48	25	74	242	217		688	154
1984-85	145	54	18	66	239	212		716	151
1985-86	169	58	27	86	232	252		711	170
1986-87	172	37	44	72	268	255		755	173
1987-88	181	49	26	94	250	285		731	171
1988-89	196	71	22	94	213	275		780	169
1989-90	176	75	19	89	223	200	36***	842	186
1990-91	200	65	25	73	312	218	66	914	226
1991-92	186	80	31	93	290	268	63	935	175
1992-93	190	46	56**	119	337	304	44	939	173
1993-94					257	318	70	901	180

* Includes part-time students.

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

*** Data not available prior to 1990.

Note: The definition of Master's degrees has been refined and is not directly comparable to figures presented in previous reports.

Table IX. Astronomy degrees awarded by type of institution, class of 1992-93.

Highest degree offered	Department type	Number of Degrees: Bachelor's	Terminal Master's	Master's Enroute	Doctorate	Number of Departments
Bachelor's-granting	Combined	29				17
	Separate	9				6
Master's-granting	Combined	6	1			2
	Separate	6	4			2
Doctoral-granting	Combined	7	2	2	9	11
	Separate	133	15	44	110	30
Totals		190	22	46	119	68

Thirty of the astronomy departments are administered in conjunction with the same universities' physics departments and are identified in **Table IX** as "combined". The degrees awarded in the 1993 academic year are split by whether a department is combined or separate, and by highest degree. The enrollment figures in **Table X** are divided only by department type and data from the physics departments' introductory astronomy course enrollments are included.

This report was prepared with the help of Starr Nicholson.

Table X. Astronomy enrollments by type of institution, academic year 1993-94.

		Bachelor's-granting	Master's-granting	Doctoral-granting	Totals
Introductory* course enrollments	Astro. Depts.	6500	1500	41,000	49,000
	Physics Depts.	37,500	19,000	49,500	106,000
Astronomy majors	Juniors	63	17	177	257
	Seniors	78	20	220	318
	Fifth Year +	16	5	49	70
First year Graduate Students	US		12	130	142
	Foreign		4	34	38
Total Graduate Students	US		36	689	725
	Foreign		7	169	176

* Totals for combined departments are included under Astronomy Departments.

EDUCATION AND EMPLOYMENT STATISTICS DIVISION PUBLICATIONS

The Education and Employment Statistics Division collects data on the composition and dynamics of the scientific labor force and the education system. Below is a list of the Division's current publications along with a brief description of each. Single copies are available free of charge by writing to: *American Institute of Physics, Education and Employment Statistics Division, One Physics Ellipse, College Park, MD 20740-3383 or by calling (301) 209-3070.*

Academic Workforce Report
A discussion focusing on faculty openings and candidate availability in selected physics subfields.

Enrollments and Degrees Report
An examination of academic enrollments and degrees conferred in physics and astronomy programs nationwide.

Graduate Student Report
A summary of the characteristics and career goals of physics and astronomy graduate students.

Initial Employment Report
A description of the initial employment search and eventual employment of physics and astronomy degree recipients.

Bachelor's Degree Recipients Report
A summary of the characteristics and career goals of physics and astronomy bachelor's degree recipients.

Physics in the High Schools II
An analysis and interpretation of information collected in a nationwide survey of teachers of physics at the secondary level.

Salaries: Society Membership Survey
An analysis of the effect of factors such as geographic location, employment sector, gender, years from degree, and degree level on salary levels and salary increases.

Society Membership Profile: Rich Diversity and Common Concerns
A description of the employment and demographic characteristics of the membership of the 10 AIP member societies.