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ABSTRACT

An annual study of physical science graduate students' background characteristics and degree recipients' employment outcomes was conducted for 1994. Surveys were mailed to about 13,000 graduate physics students and 6,800 were returned. Highlights include the following: (1) most U.S. citizens take an average of 6.5 years to complete a doctoral degree in physics, up from 5.3 years in 1970; (2) the number of women in physics graduate study has increased from 4 percent to 15 percent over the past 25 years; (3) the percentage of U.S. minorities enrolling in physics graduate study continues to be small; (4) of doctoral recipients who secured U.S. employment, two-thirds accepted postdoctoral positions while the rest accepted permanent or other temporary positions; (5) as in past years, condensed matter was the most frequently reported sub-field of study for physics graduate students, and experimental research was the most frequently reported type of research methods used compared to thecretical and computer simulation; (6) a greater percent of astronomy doctoral degree recipients is granted to U.S. citizens and women compared with the distribution of physics doctoral degrees granted; and (7) among U.S. citizens, the source of financial support differed by gender as women were more likely than men to receive fellowships and less likely to be research assistants. (JB)

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AIP REPORT

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Patrick J. Mulvey

AIP Pub No. R-207.27

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1994 GRADUATE STUDENT REPORT

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HIGHLIGHTS

- The average number of years of study taken by U.S. citizens to complete a physics PhD has increased from 5.3 years in 1970 to 6.5 years in 1994 **(Figure 2)**.
- The representation of U.S. women in physics graduate study has increased from 4% to 15% over the past twenty-five years **(Figure 1)**.
- The percentage of U.S. ethnic minorities enrolling in physics graduate study continues to be small **(Table 3)**.
- Of the PhD recipients who secured U.S. employment, two-thirds accepted postdoctoral positions while the remaining one-third accepted permanent or other temporary (non-postdoctoral) positions **(Figure 5)**.
- As in previous years, condensed matter was the most frequently reported subfield of study (26%) by physics graduate students. Experimental research was the most frequently reported type of research method used (66%) compared to theoretical and computer simulation **(Table 5)**.
- A greater percent of astronomy PhDs is granted to U.S. citizens (69%) and women (17%) compared with the distribution of physics PhDs granted **(Table 8 & 12)**.
- Among U.S. citizens, the source of financial support differed by gender. Women are more likely than men to receive fellowships and less likely to be research assistants **(Table 4)**.

OVERVIEW

Pursuit of a graduate degree in any field is typically a long and arduous undertaking. Students enrolled in graduate study bring with them a range of background knowledge and experience that determines a unique pathway for each individual. The physics graduate population is no exception. This report looks at the process and outcome of graduate physics study for those physics students enrolled in the 1993-94 academic year and presents data on the group as a whole and by subgroups, including first-year students, foreign students and PhD recipients. Included are discussions about the increasing number of years to a doctoral degree and the current climate for initial employment.

Table 1. Academic background of graduate physics students, 1993-94.

	U.S. Citizens		Non-U.S. Citizens	
	Male %	Female %	Male %	Female %
High school physics course				
General	69	69	88	90
AP	23	20	11	9
None	8	11	1	1
Major of bachelors degree				
Physics	89	87	90	90
Engineering	6	4	7	7
Mathematics	2	4	1	1
Other	3	5	2	2
Type of bachelors institution				
PhD-granting	63	53	7	8
Masters-granting	8	8	1	1
Bachelors-granting	28	37	3	2
Foreign institution	1	2	89	89

The Graduate Student Survey (GSS) is an annual study conducted by the Education and Employment Statistics Division of the American Institute of Physics (AIP) towards the end of each academic year. The survey gathers information on graduate students' background characteristics and degree recipients' employment outcomes. In May 1994, AIP mailed the questionnaire to the population of graduate physics students whose names and addresses had been provided by their physics departments.

It should be noted that the AIP was not able to contact all of the students. A few departments were unable to provide student addresses. In other cases, students were no longer residing at the given address. In addition, surveys sent to graduating students with addresses in foreign countries were less likely to reach their intended recipients than surveys sent to domestic addresses. This resulted in an underrepresentation of foreign citizens among the degree recipient respondents.

The AIP mailed surveys to approximately 13,000 graduate physics students and received nearly 6,800 responses. This report contains tables and graphs based on data gathered from these respondents. A few tables in this report are supplemented by enrollments and degrees data collected by means of a survey of all U.S. physics departments. (Single copies of the report covering that survey are available free from AIP.)

THE GRADUATE PHYSICS STUDENT

The graduate physics student population consists of individuals with varied demographic and educational backgrounds. For example, 45% of the 1993-94 graduate physics students were non-U.S. citizens and 15% were women. **Table 1** divides the respondents by gender and citizenship to show their high school physics background, bachelor major and the highest physics degree offered by their undergraduate institution. Throughout this report, both the students' undergraduate and current graduate institution are classified as bachelors, masters, or PhD-granting institutions. This classification is used by AIP to identify the highest physics degree offered by that institution and does not apply to all degree programs at that school. The table shows that the U.S. women

Table 2. Non-U.S. graduate physics students' region of citizenship by gender, 1993-94.

	Non-U.S Citizens		
	Male %	Female %	Overall %
China	82	18	30
Europe, Canada, Australia	87	13	23
India	77	23	8
Former Soviet Union	94	6	8
Korea	87	13	8
Taiwan	88	12	6
Other Asia	86	14	7
Middle East	87	13	4
South & Central America	84	16	4
Africa	93	7	2
			100%

were more likely than the U.S. men to have attended a bachelors-granting institution while the men were more likely to have attended a PhD-granting institution as undergraduates.

Table 2 lists the foreign respondents' region or country of citizenship, with almost one-third of the foreign respondents coming from China and nearly one-fourth from the traditionally advanced industrial countries. **Table 3** illustrates the ethnic identity of the U.S. citizen respondents. In addition to the replies this table summarizes, 5% of the respondents declined to classify themselves into ethnic and racial groups. The table shows the continued underrepresentation among African Americans and Hispanics. However, these

Table 3. U.S. graduate physics students' ethnic background by gender, 1993-94.

	U.S. Citizens		
	Male %	Female %	Overall %
African American	78	22	2
Asian	81	19	5
Hispanic	78	22	2
White	85	15	90
Other	82	18	1
			100%

were also the groups with the highest representation of women students.

Overall, the percent of women in graduate physics study has climbed over the years. Specifically, data collected by AIP's GSS over two and a half decades show the increase of U.S. women over time in graduate physics study. **Figure 1** illustrates the percentage of U.S. and foreign women respondents enrolled since 1970 and shows the especially strong increase in representation among U.S. women.

Figure 1. Percent of women physics graduate students by citizenship, 1970-94.

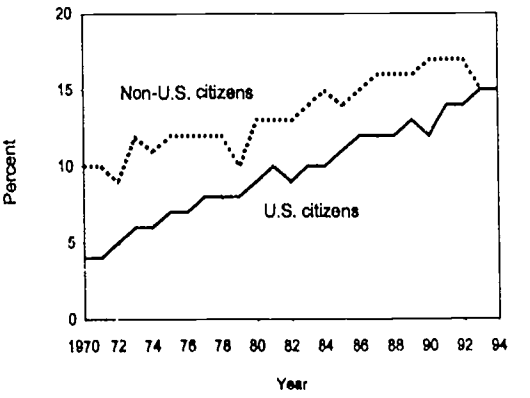


Table 4. Primary source of financial support for graduate physics students at PhD institutions by gender and citizenship, 1993-94.

	U.S. Citizens		Non-U.S. Citizens	
	Male %	Female %	Male %	Female %
Research assistantship	42	36	44	41
Teaching assistantship	28	27	40	43
Fellowship	14	25	7	6
Family, savings, loan	4	6	4	7
Non-dept employment	6	5	-	-
Military service	4	-	1	-
Foreign government	-	-	4	2
Other	2	1	-	1

Table 5. Graduate physics students at PhD-granting departments with 3 or more years of graduate study by subfield and research method, 1993-94.

	Research Method			
	Exp. %	Theo. %	Com sim %	Overall %
Condensed matter	69	22	9	26
Particles and fields	56	39	5	13
Nuclear physics	80	16	4	8
Atomic and molecular	31	15	4	7
Astrophysics	49	30	21	6
Optics	82	9	9	6
Atmospheric / Space science	63	9	28	4
Biophysics	80	8	12	3
Materials science	88	2	10	3
Plasma physics and fusion	61	21	18	3
Applied physics	90	1	9	2
All other	54	29	17	19
				100%

Some gender differences can be seen in the type of financial support graduate students receive. **Table 4** lists sources of financial support for the GSS respondents at PhD institutions. The U.S. women respondents showed a higher percent of fellowship support, while U.S. men received more research assistantships. Physics graduate students are able to count on substantial support throughout graduate school. However, the form of support typically changes, with teaching assistantships concentrated in the first few years of study and research assistantships more prevalent in the later years.

All graduate physics students focus their research on an area of concentration. By their third year of study, doctoral candidates are typically able to identify their specific research field. The GSS provided 30 areas of concentration for the respondents to select from, including an "other" option. **Table 5** shows the most heavily populated subfields of study reported by the respondents at PhD-granting institutions, excluding first and second year students, and describes the type of research method strongly emphasized in each area

FIRST-YEAR STUDENTS

First-year graduate physics students are described in Table 6. From this table it is evident that the students at a masters-granting institution were more likely than those at a PhD-granting institution to have received a bachelors degree in a subject other than physics. In addition, students at masters institutions received less generous financial support than students at PhD-granting departments.

Table 6. First-year graduate physics students' characteristics by type of graduate institution, 1993-94.

	MS-granting institution %	PhD-granting institution %
Citizenship*		
U.S.	67	57
Non-U.S.	33	43
Gender*		
Male	80	85
Female	20	15
Major of bachelors degrees		
Physics	79	89
Math	6	2
Engineering	9	6
Other	6	3
Source of support		
Teaching assist	53	56
Research assist	9	13
Fellowship	4	16
Family, savings, loan	16	8
Non-dept job	15	4
Other	3	3

* Data from **Enrollments and Degrees Report**

Table 7 looks at the first-year students' age stratification by citizenship. The older age of non-U.S. citizens entering physics graduate study can be partly explained by the fact that 33% of them entered with an advanced degree compared to only 9% of the U.S. students. The age of the students also differs by current graduate institution with about two-thirds of the students at masters institutions aged twenty-five or older and less than half of the students at PhD institutions in that age group.

Over half of the first-year respondents had completed their bachelors degree within the previous academic year. The type of institution they attended shows an interesting difference based on their current graduate institution. Students who attended either bachelor or PhD institutions and decide on graduate study overwhelmingly continued on to PhD institutions, 88% and 94% respectively. On the other hand, students who attended a masters institution for their undergraduate degree and decided on graduate study were more likely (57%) to continue on to a masters institution. Of these masters institution students, 54% remained at the same institution compared with only 22% of the PhD institution students.

Table 7. First-year graduate physics students' age by type of graduate institution, 1993-94.

	MS Institution		PhD Institution	
	U.S. Cit. %	Non-U.S. Cit. %	U.S. Cit. %	Non-U.S. Cit. %
< 25	37	28	59	41
25 - 26	15	28	17	27
27 - 28	15	13	7	14
29 - 30	11	6	4	10
31 - 32	4	9	4	5
33+	18	16	9	3

Table 8. PhD characteristics, 1993-94.	
	%
Citizenship*	
U.S.	54
Non-U.S.	46
Gender*	
Male	88
Female	12
Age	
< 27	4
27 - 28	17
29 - 30	30
31 - 32	23
33 +	26
Years of FTE graduate study	
<5	6
5 years	21
6 years	27
7 years	22
8 years	12
9 + years	12
Major of bachelors degrees	
Physics	92
Math	2
Engineering	5
Other	1

* Data from **Enrollments and Degrees Report**

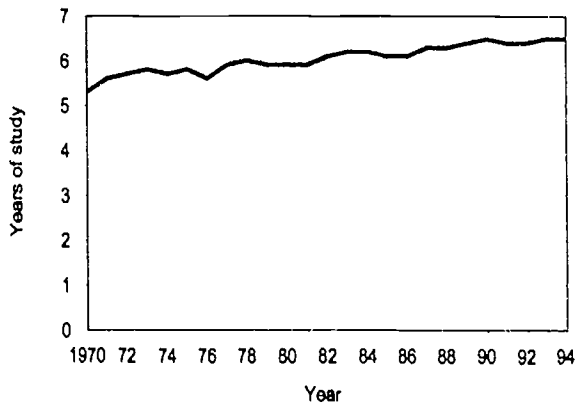
PHD RECIPIENTS

Of the 1481 PhDs reported by 183 graduate physics departments in the Enrollments and Degrees Report, 605 PhDs responded to the GSS. Because the GSS is administered starting in May, it has been difficult to contact graduates who received their degrees the previous fall or winter. Addresses provided for these students are more than four months old and often no longer correct. For example, the PhD recipients we did hear from matched departmental data on gender but not on citizenship, due perhaps to some non-U.S. citizens returning home immediately after graduation and thus not receiving our mailing. To use the most accurate and complete information available, gender and citizenship in **Table 8** are taken from the Enrollments and Degrees Report, while all other characteristics are based on the information given by the 605 PhD respondents to the GSS.

The PhD respondents had a very similar distribution of subfields of study as had the graduate student respondents shown in **Table 5**. Over a quarter of the PhDs specialized in condensed matter while nearly another quarter was scattered among 21 fields grouped into the "other" category. Twice as many doctorates described themselves as experimentalists than as theoreticians and computer simulation specialists combined. The fact that the PhD respondents' subfield distribution so closely resembled the graduate student respondents' illustrates a very small net shift among the subfields over the course of PhD study.

Regardless of a student's subfield of study, there is concern in the physics community about the increasing

Figure 2. Mean number of years of study taken by PhD respondents (U.S. cit. only) to obtain their degree, 1970-1994.

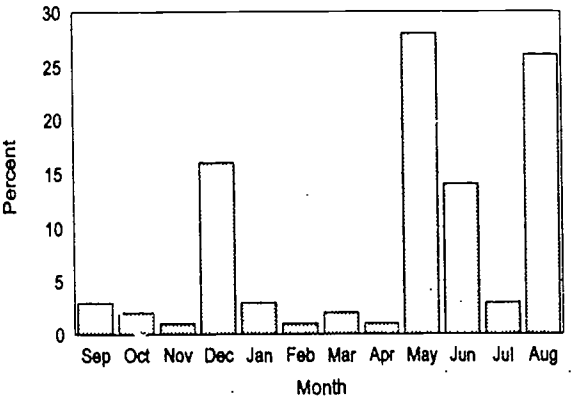


number of full-time equivalent (FTE) years taken to complete a PhD. **Figure 2** considers U.S. respondents only and sketches the mean number of FTE years of study taken to complete a PhD since 1970. Respondents with nine or more years are grouped together, causing a slight underestimate in the computed mean but not diminishing the twenty-five year trend towards increasing time to complete a physics PhD.

POST-DEGREE OUTCOMES

The GSS was conducted from May through August 1994 and the respondents who received their PhD between September 1993 and August 1994 were considered in this degree class. **Figure 3** illustrates the month that the PhD respondents received their degree. In addition to response problems with winter graduates, another drawback of the GSS administration was that most August graduates had not yet received their degree at the time of survey completion. This was an important issue when analyzing the employment outcomes for the PhDs because some August graduates had yet to begin a comprehensive job search. For example, in 1994, 26% of the PhD respondents received their degree in August and of those, 27% did not yet have job commitments when they answered the survey.

Figure 3. Percent of PhD respondents earning degree by month, 1993-94.

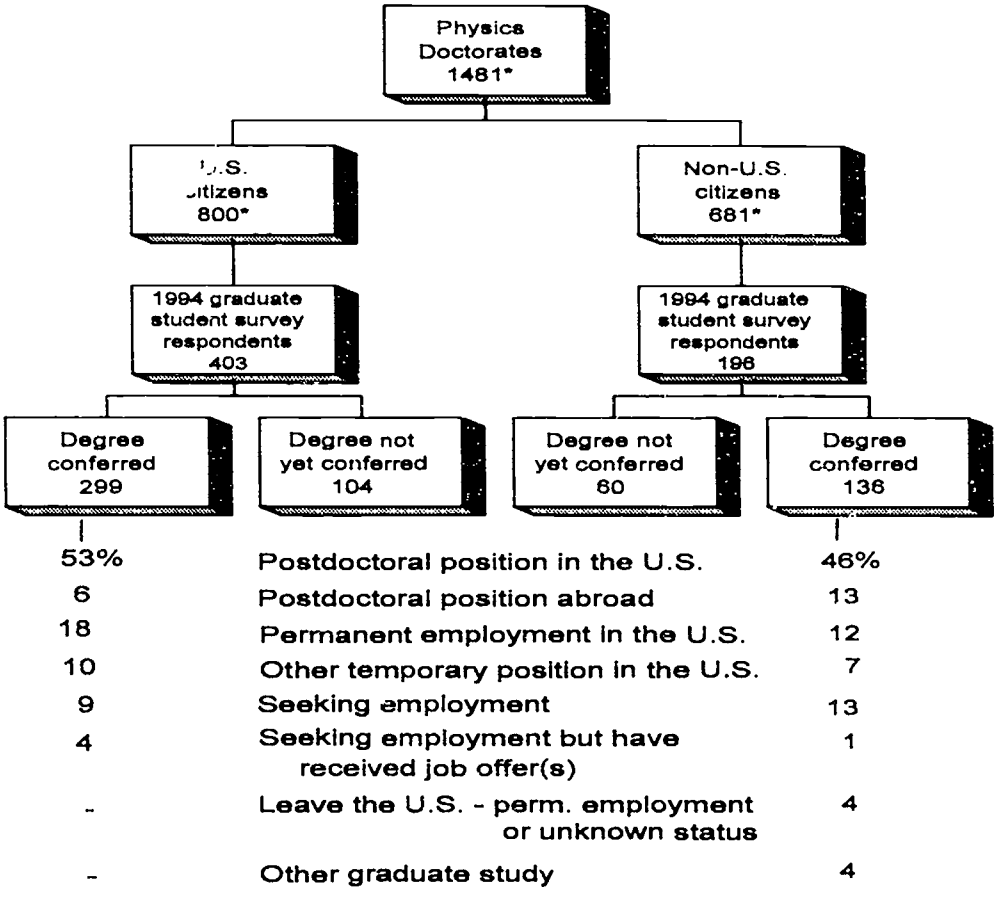


The GSS asked PhD recipients to identify the types of job offers they had received. Their options were permanent position, postdoctoral appointment or other temporary job offers. **Table 9** lists the number of permanent, postdoctoral and other temporary position offers that were received and the number of positions accepted. The type of jobs sought after and accepted by non-U.S. citizens may be affected by legal constraints on work permits in this country.

Table 9. Job offers accepted and received by PhD recipients, 1993-94.

	Permanent position		Postdoctorate position		Temporary position	
	Number of offers	Number accepted	Number of offers	Number accepted	Number of offers	Number accepted
U.S. citizens	143	77	407	210	71	36
Non-U.S. citizens	37	22	193	108	23	12

Figure 4. Post-degree status of physics doctorates who had earned their degree by the time of survey completion, 1993-94.



* Data from **Enrollments and Degrees Report**

Table 10. Current post-degree plans of physics doctorates who had not obtained their degree at the time of survey completion, 1993-94.

	U.S. citizens	Non-U.S. citizens
Postdoc position in the U.S.	28	34
Postdoc position abroad	4	15
Permanent employment in the U.S.	20	3
Other temporary position in the U.S.	7	2
Seeking/Will seek employment	30	28
Seeking employment but have received job offer(s)	9	5
Leave the U.S. (unspecified)	2	10
Other graduate study	-	3

Figure 4 presents a flow chart of employment outcomes by citizenship for PhDs who had received their degree at the time of survey completion. Half of these respondents went on to postdoctoral appointments. U.S. citizens accepted permanent positions at a greater rate than foreign citizens, while more of the latter remained without a job commitment. The percent seeking employment is divided into two categories in **Figure 4** - those continuing to look after having received at least one job offer and those who had not yet received an offer. Many of the respondents who have received a job offer but are still seeking employment may be waiting for a permanent position offer. This is suggested by the fact that 85% of those with offers, but still looking for employment, received an offer for a postdoctoral or temporary position, while only 15% had been offered a potentially permanent position and still chose to continue looking.

PhD recipients who had not received their degree at the time of survey completion were removed from the **Figure 4** discussion and are identified in **Table 10**. However, the remainder of this section considers all degree recipients with U.S. employment regardless of their degree status when they completed the survey.

Figure 5 shows the percent distribution for only the PhD recipients who had secured U.S. employment. In comparison to the previous year, and considering only recipients with employment, a smaller percent took postdoctoral appointments (66%) in 1994 than in 1993 (73%). These data may signal a declining availability of postdoctoral positions due to the backlog of recent years' PhD recipients accepting second and third postdoctoral positions in an effort to postpone entrance into the permanent employment sector. Moreover, a greater percent of the employed PhD respondents took other temporary positions (12%) than the 1993 employed PhD respondents (8%). This may be the effect of a spillover of students unable to obtain a postdoctoral position.

Figure 5. Type of U.S. employment secured by PhD recipients, 1993-94.

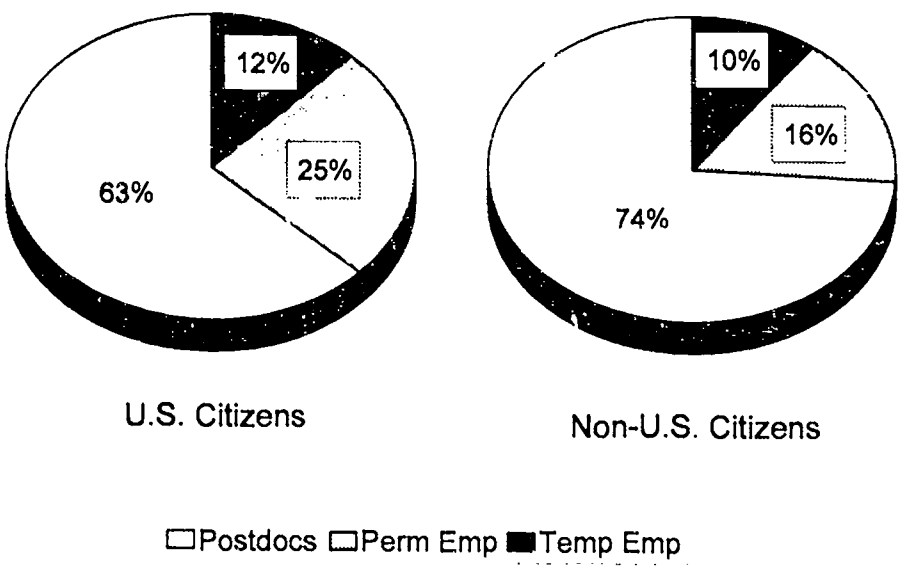


Figure 6. PhDs' research method by employment outcome, 1993-94.

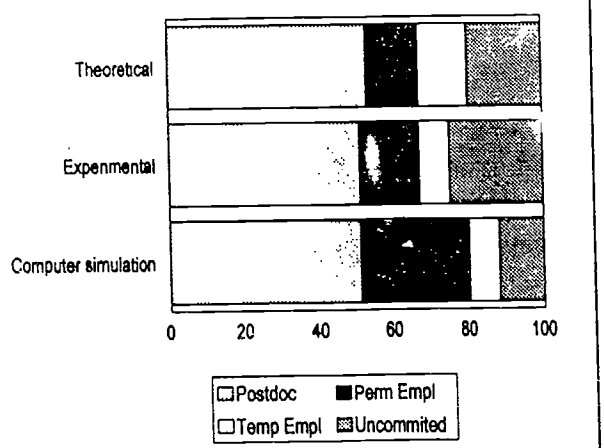
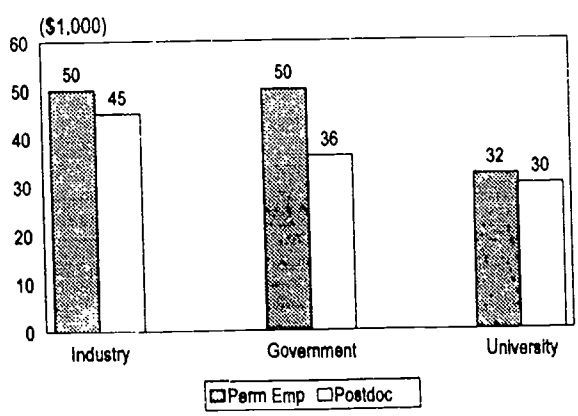


Figure 6 shows the PhDs' employment outcomes, excluding those accepting employment abroad. It identifies PhDs by their primary research method used during graduate study. Interestingly, the figure shows a similar percent for both experimental and theoretical research method in accepting postdoctorate and permanent positions. However, the smaller group of recipients who used computer simulation as their primary research method show a greater percent of PhDs accepting permanent positions and fewer students still without a job commitment near the end of the academic year.

Figure 7. PhDs' median salary by postdegree outcome and employment sector, 1993-94.



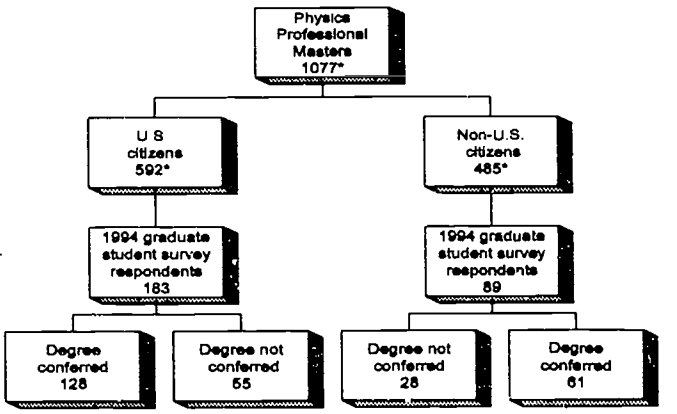
Finally, the median salaries of the PhD respondents employed full-time in the U.S. are shown in **Figure 7**, stratified by their employment outcome and sector. Universities remain the lower paying employment sector, compared to industry and the government, for both permanent jobs and postdoctoral positions.

MASTERS RECIPIENTS

The classification of professional masters degree recipients includes students graduating from masters-granting institutions and students at PhD institutions who indicate they are leaving the department with a masters degree. Whether a student's initial objective was to stop at a masters or go on to a PhD is impossible to distinguish on the basis of the GSS. Thus, for the purpose of this report, the term professional masters degree will be used to refer to any student leaving a department with a masters degree during the academic year regardless of his/her intentions. In 1994, physics departments reported granting 1,077 professional masters degrees, of which 68% were conferred by doctoral institutions. The GSS yielded data on 272 masters degree recipients and the results are presented in the following tables and figure.

Table 11a and Table 11b provide a picture of the background characteristics for this year's masters respondents. Similar to the presentation on the physics PhD employment outcomes, **Figure 8** shows the post-degree outcomes of the physics masters recipients by citizenship excluding those who had not yet obtained their degree at the time they responded to the survey. Although the percent of individuals seeking employment is high, the low response rate to the GSS makes these findings potentially unreliable indicators of the masters degree recipients' job search experiences. For example, it is possible that masters recipients with new or continuing employment are a disproportionately large percent of the non-respondents.

Figure 8. Post-degree status of physics masters recipients, 1993-94.



47%	Permanent employment	26%
7	Continuing employment	-
7	Other temporary position	4
11	Graduate study	47
21	Seeking employment	16
7	Seeking employment but have received job offer(s)	2
-	Leave the U.S.	5

* Data from Enrollments and Degrees Report

Table 11a. Masters degree recipients' characteristics, 1993-94.

	%
Gender*	
Male	85
Female	15
Citizenship*	
U.S.	57
Non-U.S.	43
Age	
<25	14
25 - 26	25
27 - 28	20
29 - 30	14
31 - 32	8
33+	19

* Data from Enrollments and Degrees Report.

Table 11b. Masters degree recipients' characteristics, 1993-94.

Major of bachelors degree	%
Physics	87
Engineering	7
Astronomy	2
Biology	1
Other	3
Type of graduate institution	
PhD-granting	65
MS-granting	35
Source of support	
Teaching Asst	38
Research Asst	20
Fellowship	7
Family, savings, loan	11
Non-dept emp	22
Other	2

ASTRONOMY GRADUATE STUDENTS

The graduate astronomy student respondents showed a lower percent of foreign students enrolled in astronomy than in graduate physics. The Enrollments and Degrees Report classified 80% of the students as U.S. citizens. **Table 12** and **Figure 9** present background characteristics about the responding astronomy doctorate recipients and their employment outcomes. The astronomy PhD respondents were younger and on average took slightly less time to a PhD than the physics degree respondents described earlier in this report. In addition, women respondents continued to be better represented among the astronomy doctorates when compared to the physics doctorates. The median salary for PhDs securing a postdoctoral position was $34,000 while the median salary for PhDs accepting permanent employment was $35,500.

Table 12. Astronomy PhD characteristics, 1993-94.

	%
Gender*	
Male	83
Female	17
Citizenship*	
U.S.	69
Non-U.S.	31
Median age	29
Median years of FTE graduate study	6