THE GRADUATE STUDENT

WHERE DOES HE COME FROM? WHERE DOES HE GO?

Statistics show the typical graduate student is male and 25 and has a bachelor's degree from a large PhD-granting institution. The draft and cuts in support are changing his luck.

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STATISTICAL ANALYSIS of US graduate physics education in the last five years reveals fairly stable patterns of where the students come from and where they go. Now, however, changes in these patterns are widely expected because of the drafting of graduate students and shrinking federal support.

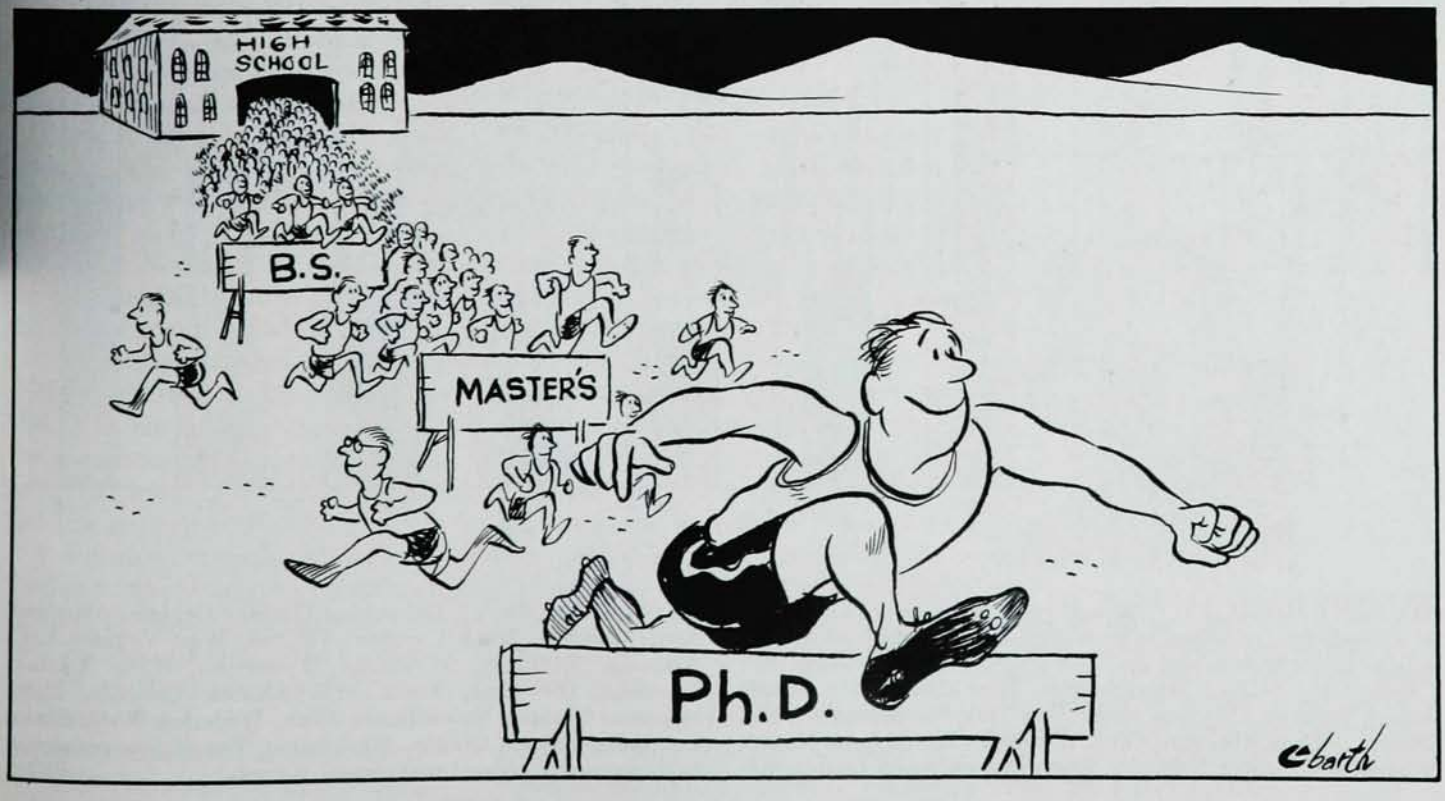
Continuing American Institute of Physics surveys reveal that physics students tend to stay in one part of the country and to earn their bachelor's degrees in institutions that grant higher degrees. Their choices of specialization have remained in relatively constant proportions during the last five years. The bulk of those obtaining PhD's choose to work at a college or university although the majority of new master's-degree holders choose positions in industry.

Who is the grad student?

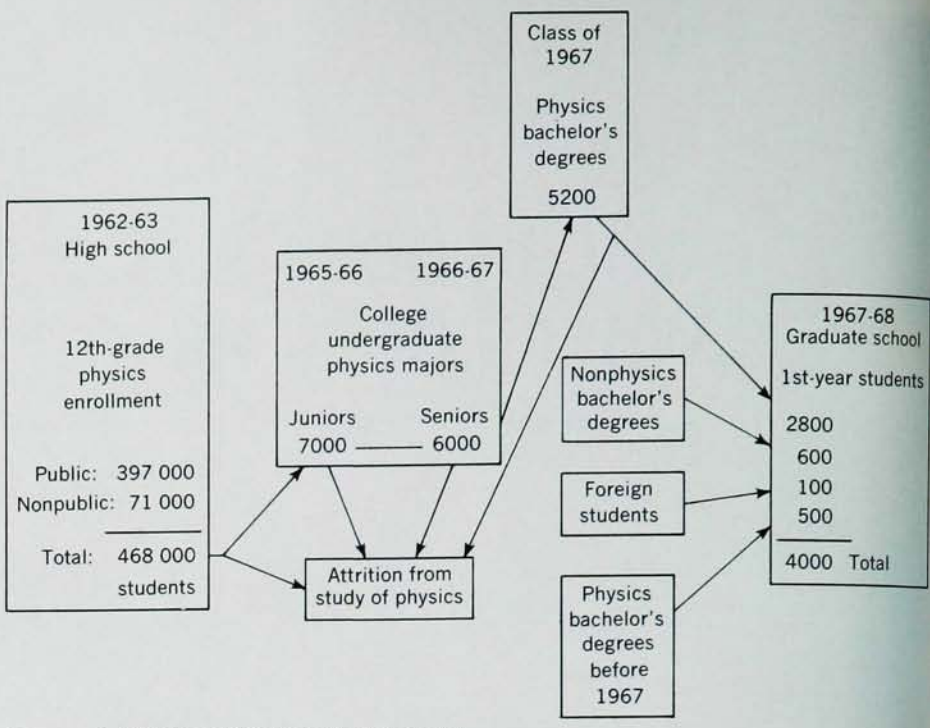
Here we analyze students in terms of age, sex, source of income, type of baccalaureate institution, geographical origin, field of interest and employment plans. Then we can make some tentative projections into the future.

During 1962–63 about 468 000 high-school seniors were enrolled in physics courses across the US. Five years later, when members of that high-school class would normally enter graduate school, 4000 students began graduate study of physics (figure 1). Of these 95% had taken physics in high school, but only 2800 had followed the most straightforward route, majoring in physics in college and then going directly to graduate school.

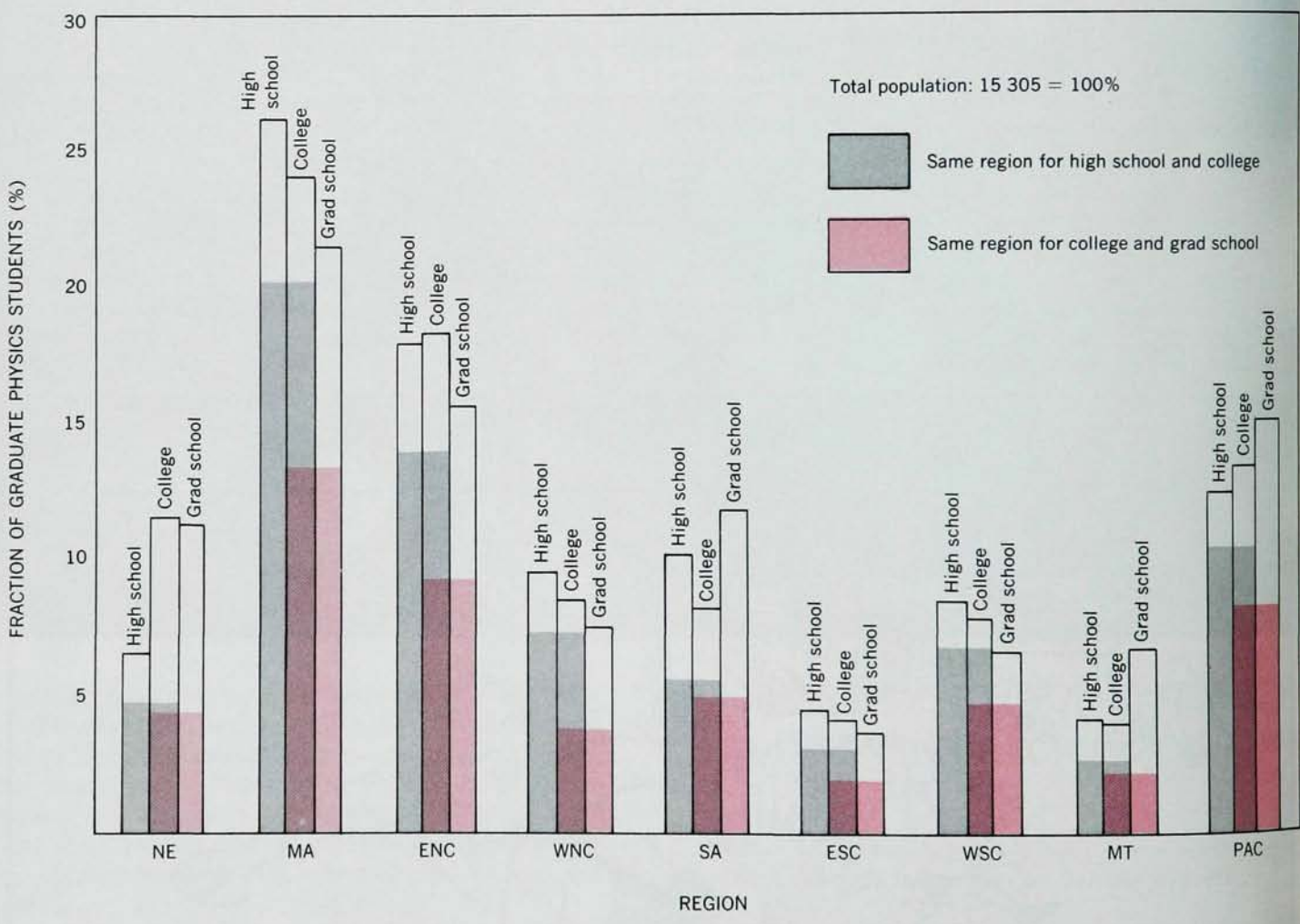
Students generally had stayed in the same region of the country as they progressed from high school to college to the university (figure 2). Although



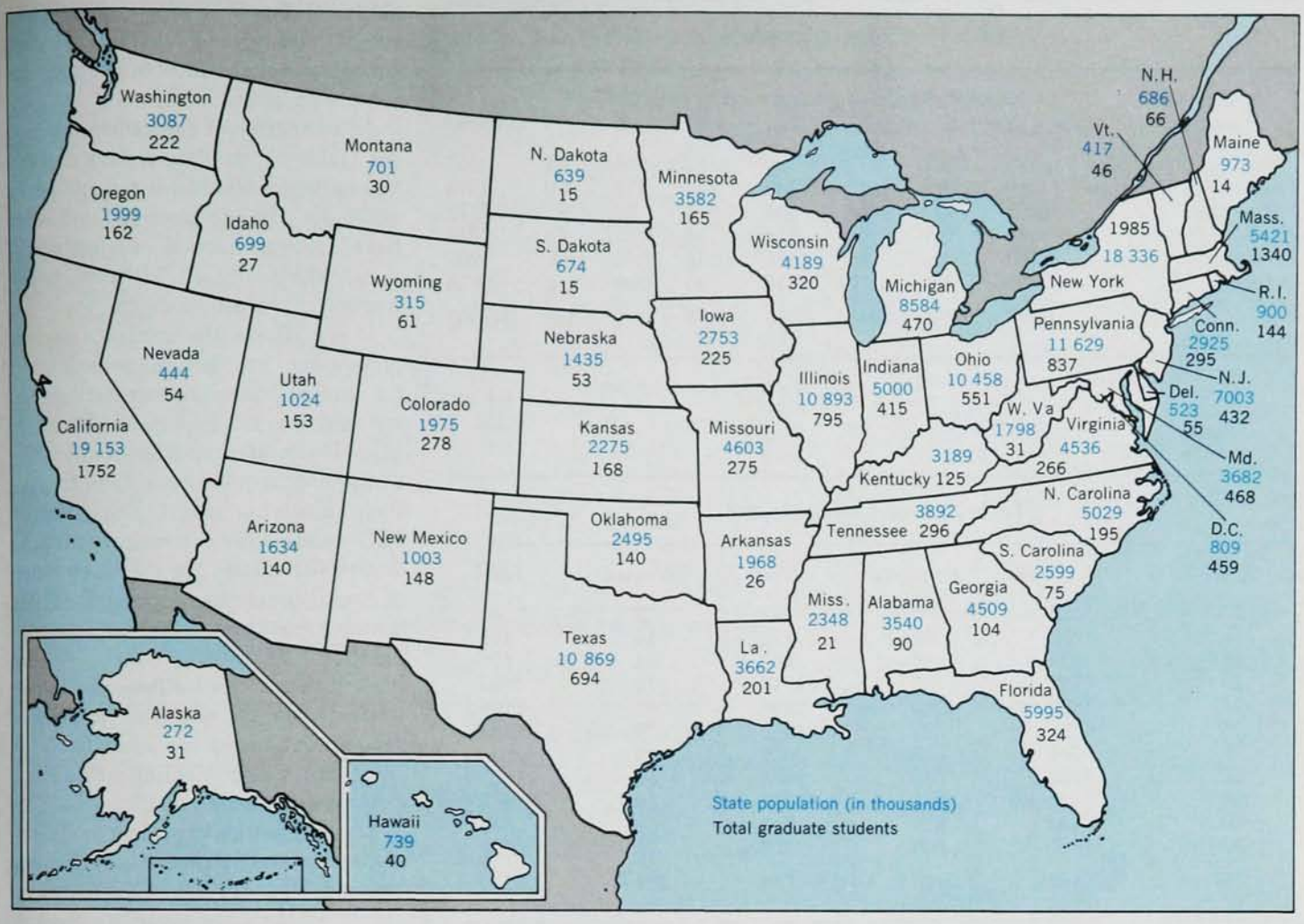
STUDENT ORIGINS. Flow chart indicates the academic background of the 4000 students who began graduate study of physics in 1967–68. Only about half of those who received a bachelor's degree in physics the previous June went on to graduate work. The numbers are from AIP surveys made annually. —FIG. 1



Sources: 1. AIP, Annual Graduate Student Survey
2. AIP, Annual Survey of Enrollments and Degrees



STUDENT MOBILITY. Gray and color areas show percentages of students who remained in same region for both high school and college or for college and graduate school. The regions are: NE: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont; MA: New Jersey, New York, Pennsylvania; ENC: Illinois, Indiana, Michigan, Ohio, Wisconsin; WNC: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota; SA: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia; ESC: Alabama, Kentucky, Mississippi, Tennessee; WSC: Arkansas, Louisiana, Oklahoma, Texas; MT: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming; PAC: Alaska, California, Hawaii, Oregon, Washington. The regions correspond to those used in federal government surveys. —FIG. 2



STUDENT DISTRIBUTION. Figures for each state give the total population (in thousands) and the number of graduate students. States with the lowest populations tend to have the highest ratios. —FIG 3

some movement emerges, particularly from the interior to both coasts, fully 75% did not change regions when they started college. Only 53% remained in the same region when they moved from college to graduate school, however.

A look at the distribution of undergraduate and graduate institutions helps explain this mobility. The concentration of large graduate institutions in the Northeast and far West is greater than that of undergraduate institutions. For example 33% of the PhD-granting institutions are in the New England and Mid-Atlantic regions; another 21% are in the Mountain and Pacific regions. The comparable figures for undergraduate institutions are 25% and 13%, respectively.

A student's origin also may be defined in terms of the type of institution in which he received his bachelor's degree. PhD-granting institutions account for 56% of the bachelor's degrees, a percentage that has held steady for the last five years. Bachelor's-granting institutions accounted for 18.9%, foreign schools for 12.5% and master's-granting institutions for 11.7%. The remaining 0.9% was supplied by "other" institutions.

Where they are now

The US Office of Education estimated the total graduate-student population to be 709 000 at the beginning of the 1967–68 academic year. Our surveys show that 2.2% of this population was studying physics at 285 departments in the 50 states.

To describe the general characteristics of all 15 300 graduate physics students, let us begin with geographic distribution. The number of such students and the total population of each state is given in figure 3. Massachusetts, with 0.25 per thousand, has the highest ratio of physics students to population. The less populated states tend to have high ratios; Wyoming and Rhode Island rank second and third behind Massachusetts.

An all important characteristic is financial support. In table 1, we see that the pattern of support changes with the number of years in graduate school. Teaching assistantships are most important for first-year students; by the fourth year, research assistantships outnumber teaching assistant-

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Table 1. Financial Support

Source of support	Number of years of graduate study, as of 1967–68 ≤ 1	2	3	4	5	6	≥ 7	Totals
Teaching assistantship	1488	1085	673	390	182	84	53	3955
Research assistantship	410	742	1017	1145	881	471	250	4916
Fellowship	928	1042	881	534	276	68	42	3771
Employment	841	545	282	166	94	63	23	2014
Savings	95	58	29	11	12	2	2	209
Others	185	108	56	34	24	16	12	435
Total	3947	3580	2938	2280	1469	704	382	15 300

Table 2. Age, Citizenship, Sex

Age	U.S. Citizen	Foreign	Men	Women	Total
≤ 20	26	5	29	2	31
21	93	29	111	11	122
22	439	66	453	52	505
23	1712	182	1818	76	1894
24	1923	260	2096	87	2183
25	1891	293	2108	76	2184
26	1794	302	2029	67	2096
27	1352	285	1585	52	1637
28	993	216	1179	30	1209
29	622	220	811	31	842
≥ 30	1997	600	2519	78	2597
Total	12 842	2458	14 738	562	15 300

Table 3. Specialization

Speciality	Experimentalists per cent	Theoretists per cent	Total per cent
Astrophysics	3	7	5
Atomic & molecular	7	5	6
Biophysics	1	1	1
Electromagnetism	1	2	1
Elementary-particle	12	22	15
Nuclear	18	12	16
Optics	3	1	2
Fluids	2	2	2
Solid-state	31	15	25
Other	22	33	27

Table 4. Percentage of Freshmen in Graduate Physics

All freshmen degree-credit students		First-year graduate physics students		Percent
Sept. 1959	485 688	Sept. 1963	4061	0.84
Sept. 1960	536 999	Sept. 1964	4167	0.78
Sept. 1961	589 137	Sept. 1965	4358	0.74
Sept. 1962	595 302	Sept. 1966	4162	0.70
Sept. 1963	604 282	Sept. 1967	4010	0.66

ships by almost 3 to 1. Employment refers to off-campus jobs; this category probably includes most of the 14% who are part-time students.

In an analysis of age, citizenship and sex (table 2), the figures show that the age curve for graduate students peaks at 24–26. The age groups 27 and older have a larger fraction of foreign students; age groups 20–24 have a larger fraction of women students.

If we divide the graduate-student population into groups according to the students' baccalaureate institutions, we find several important characteristics. Doctoral candidates from smaller institutions require more time to pass their qualifying exams. The ratios of PhD candidates to terminal master's-degree candidates for the three types of baccalaureate sources are 9 for PhD-granting institutions, 2.3 for master's-granting institutions and 4 for bachelor's-granting institutions. Physics students who did not major in physics as undergraduates are more likely to come from a large institution than from a four-year college.

The distribution of present graduate-student specializations and the division between theoretical and experimental (table 3) has not changed in the last five years. Of the individual categories, solid-state physics is the most popular, followed by nuclear and elementary-particle physics in that order.

A longer view

Until now we have concentrated on the graduate-student population during 1967–68. Extending the analysis to the last five or even ten years exposes trends in enrollments in physics and affords comparisons with other natural sciences.

The fraction of college entrants who go on to begin physics graduate study four years later is declining (table 4). The increasing time required to earn the PhD undoubtedly is a factor.

A look at the numbers of physics graduate degrees conferred in the last decade, in comparison with degrees in other sciences (table 5), shows physics holding its own, however.

Where do they go?

During the summer of 1968 we asked all recipients of graduate physics degrees about their plans. Specific questions concerned the number of job offers received; 60% coöperated. The results (table 6) show 10% more of the PhD's received at least one job offer

Table 5. Science Degrees Granted in the US

Year	All disciplines	Physics	Physical sciences[1]	Mathematics[2]	Engineering	Biological sciences
			Master's degrees			
1960–61	78 227	1321	3799	2238	8178	2358
1961–62	87 855	1431	3929	2680	8909	2642
1962–63	91 366	1850	4132	3323	9635	2921
1963–64	101 050	1907	4567	3603	10 827	3297
1964–65	112 124	2045	4918	4294	12 056	3604
1965–66	126 100	2050	5470	5220	13 990	4390
1966–67	132 800	2193	5810	5950	15 130	4570
			Doctor's degrees			
1960–61	10 575	615	1991	344	943	1193
1961–62	11 622	699	2122	396	1207	1338
1962–63	12 822	858	2380	490	1378	1455
1963–64	14 490	792	2455	596	1693	1625
1964–65	16 467	983	2829	688	2124	1928
1965–66	17 500	948	2960	770	2350	2030
1966–67	18 800	1233	3140	860	2650	2160

1. Includes astronomy, chemistry, earth science, meteorology, physics and other physical sciences.
2. Includes mathematics, statistics and computer systems.

Table 6. Job Offers by Speciality

	Master's degree					*Doctor's degree*				
	Number receiving degree	*Number of job offers*				*Number receiving degree*	*Number of job offers*			
Speciality		*0*	*1*	*2*	*≥3*		*0*	*1*	*2*	*≥ 3*
Astronomy & astrophysics	47	22	14	3	8	71	24	25	12	10
Atomic & molecular	54	16	19	9	10	125	45	38	23	19
Electromagnetism	13	5	8	0	0	10	2	1	0	7
Elementary particles	81	33	30	8	10	220	65	72	46	37
Nuclear	154	62	49	10	33	218	54	83	48	33
Optics	35	3	8	8	16	9	5	1	1	2
Solid-state	244	100	60	33	51	318	103	83	64	68
Other	371	154	81	51	85	229	56	88	38	47
Total	1000	395	269	122	214	1200	354	391	232	223
Percentages		39.5	26.9	12.2	21.4		29.5	32.6	19.3	18.6

than did those with newly received master's degrees.

New degree holders who had already accepted job offers were asked to report their starting salaries. The results, given in table 7, show that the greatest doctor's–master's differential is in industry.

Table 7. Starting Salaries

Type of employer	*New PhD holders*	*Median monthly salary*	*New master's holders*	*Median monthly salary*
	per cent	*$*	*per cent*	*$*
College or university	62	935	23	867
High school			7	650
Industry	20	1275	43	965
Government (federal)	14	1090	23	855
Other	4	962	4	800

Comparison of enrollment with the total number of graduate degrees granted makes it obvious that not all who leave the university do so with a degree. An attrition study now in progress gives us some information on students who terminate their study of physics between degrees. Preliminary results show that the largest fraction leaves after two semesters to take engineering jobs in industry.

Although our surveys for 1968–69 are not yet complete, we expect that the draft and reductions in financial support to students are causing variations in our trend data. We hope, of course, that these variations are temporary.

One difference from earlier years that we have already mentioned is a leveling off in the percentage of students who started graduate study in September 1968. The usual distribution of plans for new physics bachelors is as follows: 55% enter graduate school to study physics; 19% enter graduate school but do not study physics, and 26% start full-time employment. A survey last summer revealed a distribution among these choices of 44%, 16% and 40% respectively. □