

INITIAL EMPLOYMENT OF PHYSICS DOCTORATE RECIPIENTS: CLASS OF 1992

Today's job market requires patience, flexibility and perhaps some creativity on the part of recent physics graduates.

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The current folklore regarding today's job market for recent physics PhD recipients describes a dichotomy between discouragement and the challenge to be imaginative. Hard statistics are needed to help put into perspective the much publicized but meager anecdotal information about the initial employment of physics doctorate recipients in the 1990s. Such data are available from a battery of annual surveys conducted by the American Institute of Physics.

Physicists, perhaps more commonly than other professionals, choose their discipline at an early age, invest considerable time studying for their careers and appear to derive great satisfaction from them. But changes in our economy call for changes in the approaches doctoral graduates pursue to initiate their careers in physics. Practices that brought desired results in the 1980s need to be reexamined for the 1990s.

For 20 years I have monitored the entry-level job market for physics graduates by means of four comprehensive annual surveys of physics departments and physics students. I have been able to enhance significantly the information obtained in this way by communicating directly with many graduate advisers and other university physics faculty, well-informed physics department staff members and concerned students. These contacts, along with the statistical information gleaned from thousands of completed survey questionnaires, not only have helped me identify the effects of past recessions on employment but also have broadened my perspective on the flexible and imaginative ways in which new physicists

manage the transition between graduate school and that first step toward achieving their career goals.

The recession of the early 1970s was perhaps the most severe in recent years. A reduction in financial support from the government forced a reversal in the trend of faculty expansion in university physics departments. By the academic year 1972–73 the first-year physics graduate enrollment had decreased to 2200 from 3200 in 1969–70. In the years 1970–72 more than 1500 physics doctorates were conferred annually, only one doctorate in five was granted to a foreign student, and as many as 20% of the degree recipients were without job offers at the time of their graduation. Six months after graduation, however, only 2% of the graduates remained unemployed; the others had accepted, in nearly equal proportions, either permanent jobs or postdoctoral fellowships. Within that same six-month period one-quarter of the new “postdocs” had transferred to permanent positions.¹

The next recession came in the early 1980s, by which time the number of physics doctorate recipients had declined to 900 per year, and one-quarter of the graduates were foreign. Only 4% of that cohort had no job lined up upon graduation, but a gradual shift toward nontraditional work activities, which had begun in the mid-1970s, continued: For example, instead of engaging in research or teaching, an increasing proportion of the new physicists became involved in engineering or systems analysis, two areas that demanded graduates with computer skills.

Putting the statistics together

The employment characteristics of physics doctorate recipients who were members of the graduating class of 1992 reveal the continuing impact of the recession of the late 1980s. During the 1991–92 academic year 1346

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students were granted physics doctorates by 178 institutions, all of which respond consistently to AIP's annual Survey of Enrollments and Degrees: Each fall every degree-granting physics department reports on its current year's enrollment and on the degrees it conferred the previous year. Our established method for finding out the postdegree plans of a graduating class is the annual Graduate Student Survey: Every May we ask graduate students at all levels to identify their subfields of study, educational backgrounds and initial employment, if applicable. For the class of 1992, the graduate student survey produced 777 responses from individual physics doctorate recipients.

Examination of the respondents' citizenship revealed an underrepresentation of the foreign contingent: The percentage of foreign physics doctorate recipients in the class of 1992 was 48%, whereas among the survey respondents that percentage was only 40%. During the past 15 years, the proportion of foreign graduates has risen steadily, from less than 25% in the late 1970s to nearly 50% today. And an increasing number of non-US citizens have taken advantage of the provision in their F-1 visas that allows them to engage in postdoctoral research in the US for up to three years. However, as the job market has tightened, attitudes within the physics community have changed, and attention has become focused on whether foreign graduates are taking jobs that would otherwise go to US citizens. Thus it seemed important that our analysis be based on the correct ratio of US to foreign degree recipients.

To adjust for the skewed response of foreign graduates, I telephoned 42 graduate physics departments whose foreign doctorate recipients had not responded to our survey but which had kept in touch with their graduates. In this way I was able to collect data on the initial employment of an additional 163 foreign and 42 US graduates, raising the total from 777 to 982. Thus adjusted, our data base reflected an accurate ratio of US to foreign graduates. Having combined two sources of data on the new physicists—namely the information reported on questionnaires by the individual doctoral graduates and that gathered from their thesis advisers, from academic staff or from alumni offices—we needed to replace the term “respondents” with the more generic description “contributors to the survey.” In surveys of this type a 40% response rate is considered adequate for statistical purposes. In our 1992 survey the response rate was 58%, and broadening our sample brought the figure to 73%.

The focus of our analysis was the initial employment available in the US to the 1992 graduates and the extent to which the graduate's citizenship influenced the type of employment offers he or she received. Figure 1 divides the 982 contributors both by citizenship and by postdegree activity. Before 1992 every graduate's postdegree activity fell into one of five broad categories. To

describe the employment status of as many as 10% of the 1992 contributors, however, we needed to create a sixth category. Members of that group reported accepting temporary or part-time nonpostdoctoral positions, in many cases created for them by their universities, often in chemistry or engineering departments. In preceding years only a negligible proportion of doctoral graduates had been obliged to resort to temporary or part-time initial employment. Approximately equal numbers (as well as roughly equal proportions) of US and foreign citizens belong to this newly created category. My phone calls indicate that this category includes, for example, one-year visiting professorships and research done with one's former thesis adviser while actively seeking or waiting for a postdoctoral fellowship. The category also covers teaching summer courses at one's alma mater and internships created by physics departments for graduates.

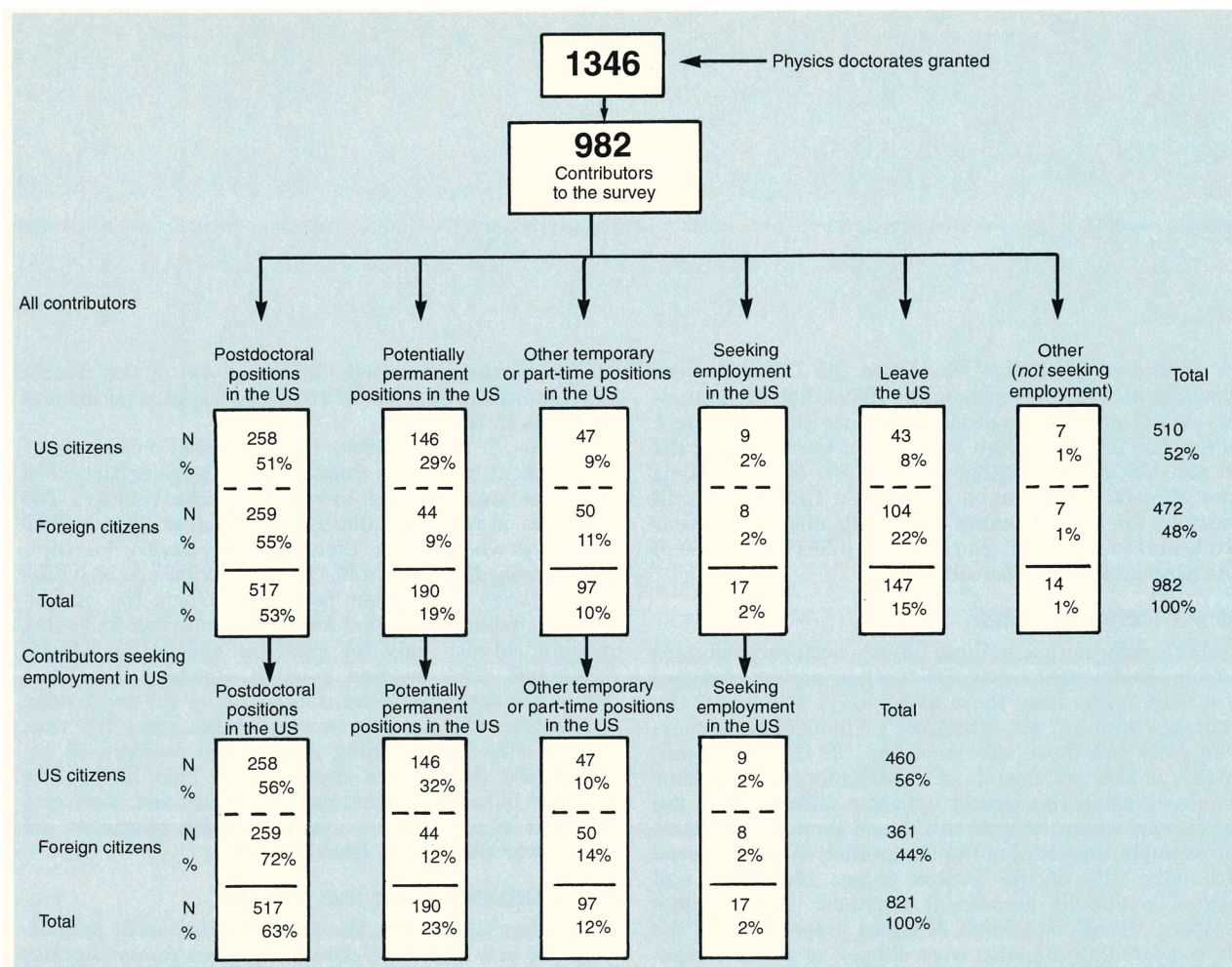
The proportion of graduates specifically seeking postdoctoral fellowships rather than permanent positions has increased steadily since the early 1970s, when we began to ask about that type of employment in our then new follow-up employment survey. The dominant reason given for choosing a postdoc as one's initial employment is the belief that it will lead to a tenure-track faculty position; another major reason is that a postdoctoral research position makes extensive use of and can expand one's training. It is worth noting that most of the fellowships can be extended and that they include benefits.

During the 1980s postdoctoral positions were in abundant supply and constituted the initial employment for 50–55% of the US and 65% of the foreign graduates. For the class of 1992 the data in figure 1 record no change in the availability of postdocs for US graduates, but foreign graduates experienced a 10-percentage-point decline from the 1980s. New physicists who identified themselves as “unemployed” made up only 2% of the contributors, and that proportion was independent of citizenship.

Were the respondents representative?

One question that could arise despite our high response rate is whether the graduates we heard from are representative of all physics PhD recipients. The enhanced data collection used in this survey of the class of 1992 divides the new graduates into three categories: the graduates who returned their questionnaires for the 1992 graduate student survey, the PhD recipients about whom I obtained information by telephoning their departments, and graduates about whom we have no direct information. The first group, as mentioned above, yielded 777 responses. To that data set we added information on 205 additional graduates from the second category. The third group is made up of 364 noncontributors.

A background check using our data from the physics departments tells us that of the 364 noncontributing



Initial employment of physics doctorate recipients from the class of 1992. A comparison of US and foreign citizens shows, for example, that among those who remain in the US, proportionately more foreign citizens get postdoctoral positions, while a higher percentage of US citizens obtain permanent positions upon graduation. **Figure 1**

graduates, 184 (about half) are US citizens, that the geographic distribution of the universities from which they received their doctorates is very similar to that of the respondents' universities and that a higher proportion of them (10% versus 5% of the contributors) graduated from physics departments that grant at most two doctorates per year. So contributors and noncontributors share several background characteristics.

Another question that arises is whether the employment status of the graduates who contributed to our initial employment survey is representative of those who did not. In other words, were the 364 noncontributors more likely or less likely to be unemployed or underemployed, thus skewing our results? To shed light on the initial employment characteristics of noncontributors, we compared the 205 contributors in our second category, who did not respond to the graduate student survey, with the 777 who did. Table 1 describes the employment status of the former group. It should be noted that 163 (roughly 80%) of those 205 new graduates are foreign citizens; consequently one should not extrapolate the characteristics of the US citizens among the contributors to all the US noncontributors.

Thus we want to compare the 163 foreign doctoral graduates with the 302 foreign graduates who *did* describe their initial employment on our survey questionnaires. To facilitate this comparison we matched the employment categories in table 1 with those in figure 1 (with the exception of "Other," which represents the group not seeking employment). The distribution of the foreign nonrespondents among the employment groups is very similar to that of the respondents: A majority took postdoctoral positions in the US, one-quarter left the US, and one-tenth accepted permanent positions in the US. The statistics convince me that the foreign graduates we haven't heard from are very likely to have initial employment characteristics similar to those of the graduates whose data we present in table 1.

Another question we encounter concerns the proportion of foreign students who leave the US as soon as they graduate. A majority of the foreign doctorate recipients who leave the US each year never intended to seek employment in the US, because they have positions waiting for them in their native countries. This scenario applies especially to citizens from Taiwan, South Korea, some Arab countries and Western Europe. The percent-

age of foreign graduates who leave the US each year remained at 20% throughout the 1980s, but their numbers nearly doubled, from 80 to 150 per year. Figure 1 shows that 22% of foreign students in the class of 1992 left the US on graduating, whereas 8% of US citizens went abroad. However, most of those US citizens will return to the United States when their one- or two-year postdoctoral fellowships end. In the 1980s only 4–6% of US citizens took postdocs abroad.

How many find jobs?

To obtain information on those physics doctoral graduates seeking employment in the US (bottom portion of figure 1) we take away from the upper portion of figure 1 the graduates who are not interested in immediate employment (1%) and those who leave the US (15%). Examination of the citizenship of contributors in the four remaining categories clearly indicates differences in the initial employment offered to US and foreign graduates. For example, one-third of the US graduates, as compared with only 12% of the foreign degree recipients, had secured potentially permanent positions. Almost equal numbers, though somewhat different proportions, of the US and foreign graduates were obliged to accept temporary or part-time employment, without benefits, although the lengths of time they remained in those positions differed significantly. According to their faculty advisers, only a few US graduates still held those positions after a year, most having moved on to more “traditional” positions.

A foreign citizen granted a doctorate from a US university who wishes to accept permanent employment in the United States needs to find an employer willing to get his or her visa changed to one of permanent resident status. Some citizens of the People’s Republic of China form an exception to this rule: Any PRC citizen who was in the US at some time between 5 June 1989 and 11 April 1990 falls under the Chinese Student Protection Act (Executive Order 12711), which entitles that person and his or her family to become lawful permanent residents without applying for an immigrant visa. The number of students from the PRC is almost equal to that of all other foreign graduate students combined, and EO

12711 accounts for most (33 out of 44) of the foreign graduates from the class of 1992 who accepted permanent positions in the US.

Table 2 breaks down the graduates in the three employment categories from figure 1 according to type of employer, work activity and median annual salary. The last row of table 2 indicates the number of new PhD physicists who revealed their starting salaries; we calculated the median salaries for these contributors, including only salaries for full-time positions. Where the calculation was based on a small number of contributors we list median salaries only for cases in which the salaries “clustered” (that is, had a small standard deviation). Table 2 is designed to aid comparison of US and foreign graduates. We find, for example, that more US than foreign citizens are taking postdoctoral positions at national labs, that foreign graduates are more likely to be engaged in nontraditional work activities and, most conspicuous of all, that on average foreign physicists are paid lower salaries, at least initially.

New strategies for the 1990s

In seeking solutions to the problem of scientific employment for new PhD physicists, the physics community has debated the pros and cons of reducing the number of incoming graduate students. Those considerations gained momentum last spring, when admissions committees were compelled to raise arguments in favor of or against changes in enrollment. With the academic year 1993–94 well under way, this seems to be an appropriate time to examine how the 15 largest graduate physics departments (representing 20% of the first-year graduate enrollment) addressed that concern. Five of those institutions (all from the Great Lakes region) reported drops of 50% or more in their first-year graduate classes, but only two of those universities mentioned budget cuts as a reason for the reductions. On the other hand, based on the early returns of the 1993–94 enrollment survey, the combined total of 235 new graduate students at another five of the largest physics-PhD-granting universities (the University of California at Berkeley, MIT, Cornell, the State University of New York at Stony Brook and the University of Illinois at Urbana–Champaign)

Table 1. Initial employment of nonrespondents to the graduate student survey

Citizenship	Postdoctoral positions in the US	Potentially permanent positions in the US	Other temporary or part-time positions in the US	Seeking employment in the US	Employed outside the US	Total
US	25	6	7	1	3	42
Foreign	85	20	12	5	41	163
Total	110	26	19	6	44	205
Percent	54	13	9	3	21	100

Table 2. Employment characteristics of new physicists working in the US

		Postdoctoral positions		Potentially permanent positions		Temporary or part-time positions	
		US	Foreign	US	Foreign	US	Foreign
Number of contributors		258	259	146	44	47	50
Total population		354	355	200	60	64	69
Type of employer	University	58%	76%	12%	10%	55%	54%
	College or high school	—	—	13	17	29	24
	Industry	6	4	52	50	10	10
	FFR&DC [†]	22	11	9	5	—	—
	Government	12	4	12	12	—	—
	Other	2	5	2	6	6	12
Work activity	Research	90%	95%	14%	10%	29%	34%
	Teaching	—	—	8	17	50	32
	Teaching and research	—	—	11	5	5	10
	R&D	10	5	56	40	5	5
	Nonphysics prof'l.	—	—	7	5	5	8
	Other	—	—	4	23	6	11
Median annual salary (in thousands of dollars)	University	\$29.0	\$27.0	\$33.0	*	\$26.5	\$25.0
	College or high school	—	—	32.0	*	32.0	*
	Industry	46.0	45.5	52.0	\$50.0	*	*
	FFR&DC	34.0	31.5	50.0	*	—	—
	Government	36.0	32.5	45.0	*	*	*
	All employers combined	\$32.0	\$28.0	\$46.0	\$40.0	\$30.0	\$24.0
Number contributing salary information		215	144	117	15	23	15

Based on the 804 contributors to the graduate student survey who were employed in the US.

*Insufficient data.

[†]Federally funded research and development centers.

represents a small increase, up from 220 new graduate students in 1992–93.

When those five universities were asked what approaches they were taking to their graduates' employment problems, they enumerated the following:

▷ conducting career-oriented seminars with invited speakers from less traditional fields for physicists, such as the chemical industry, transportation and the media, and including discussions of entrepreneurship and consulting

▷ offering faculty members incentives for early retirement to create vacancies

▷ admitting a portion of the new graduate students into master's degree rather than doctoral programs.

For the great majority of physicists in our survey, it was first the subject matter and subsequently the research environment that prompted their decisions to devote approximately ten years to becoming physicists. One would not expect such a goal to be readily abandoned. But many advisers have noted that recent graduates are willing to be more flexible in exploring applications of their physics skills. A few theoreticians whose dissertations were in nonlinear dynamics thought to apply their specialty to economic forecasting and joined the staffs of investment companies. Medicine is another area of research frequently referred to as eager to attract physicists. In Houston, Baltimore and Chicago, for example, medical research centers and teaching hospitals have offered postdoctoral fellowships as well as permanent positions to new physicists.

In gathering all these statistics and speaking with physics educators and students from around the country, it became clear to me that circumstances differ from one part of the country to another and so does the employment outlook. Even though most doctoral physicists are willing to move to a different region of the country for a challenging position, some regions seem oversupplied with good job applicants, while other regions appear to have a dearth of candidates. For example, some major universities in the South and Southwest that emphasize more applied programs indicate that their students do not have trouble finding jobs, whereas physics faculty in the Great Lakes region express greater concern over their students' job prospects. Nevertheless one can say that the 1990s are producing graduates whose expectations reflect an awareness of the economy and a more realistic outlook concerning the demand for physicists (judging from their letters and comments to me). But that does not mean that the desire of a new physicist to work in the specialty of his or her dissertation has diminished. What it does mean is that graduates must sometimes keep their career goals—whether traditional or nontraditional—on the horizon for a time while taking a more flexible attitude toward the immediate objectives they will pursue.

Reference

1. Details on these findings can be found in S. D. Ellis, "Physics Manpower 1973: Education and Employment Studies," pub. R255, AIP, New York (August 1973). ■