CHAPTER 5 – THE PHYSICS WORKFORCE: ENTRY AND EXIT POINTS

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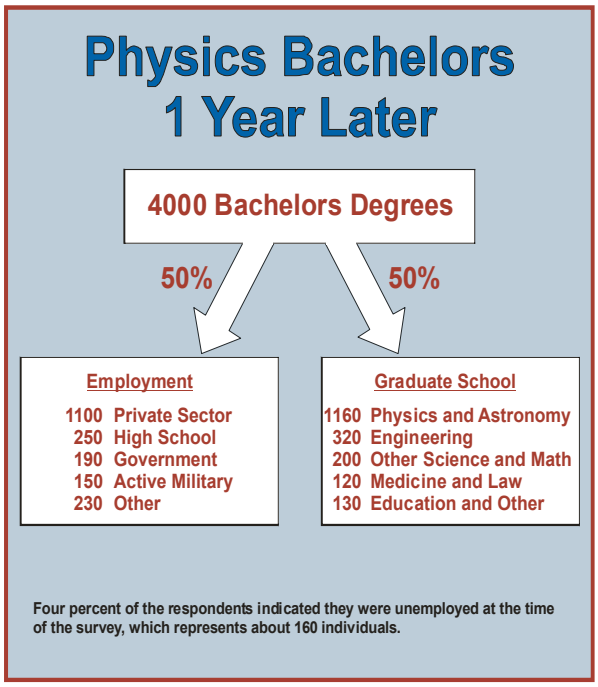
This presentation will look at entry points and exit points in the physics workforce, and some of the complexities around those very simple ideas. Most of the data I am going to show you today come from surveys that the American Institute of Physics (AIP) conducted. The data are also compared to data from the National Science Foundation (NSF) Division of Science Resources Statistics (SRS) and data from the National Center for Education Statistics (NCES) to make sure that AIP's sample frames are not biased. The work I will be reporting on was conducted by AIP staff Ray Chu, Rachel Ivie and Patrick Mulvey.

I am going to look at three things: the early career bachelor's, the initial employment of PhDs, and the academic labor market.

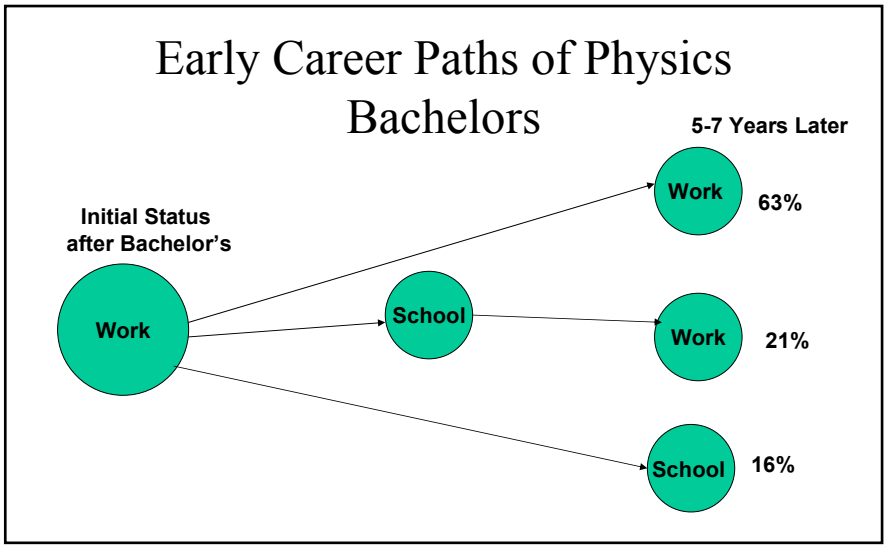
Let's start with the bachelor's. The chart to the right illustrates what generally happens to bachelor's within one year of earning their degree. Roughly half go on to graduate school and half go into the labor force. About 3 to 6 percent say, "I'm not doing anything. I'm going to Europe for the summer, so check back with me later."



These numbers do vary depending on the economy. When the economy is bad, fewer people go to work and more go on to graduate school. When it is good, it shifts a few percentage points in the other direction, but not dramatically. And then, the kind of jobs that they get in the private sector also depends on the economy.

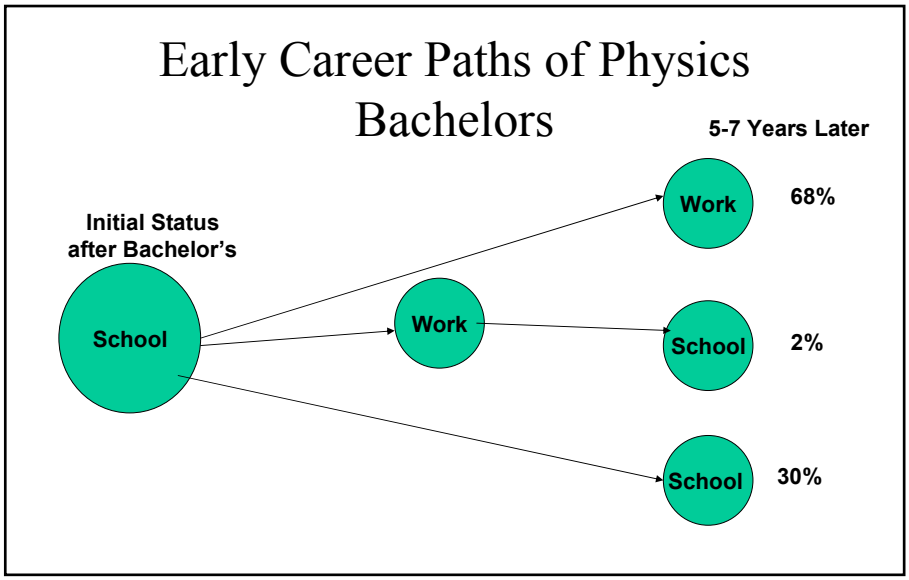
Right now, as you have heard from the chemists, they are suffering, but, so are the engineers and the computer programmers. These are the kinds of things that physics bachelor's do, so physics is feeling the effects of the difficult employment market as well.

Let's take a look at the physics bachelor's recipients who started in the labor force right after graduation to see what happens to them 5 to 7 years later. The chart to the right shows primary status. Fewer than two out of three (63%) of the individuals who go right into work are still working full-time five to seven years later with no interruption in that

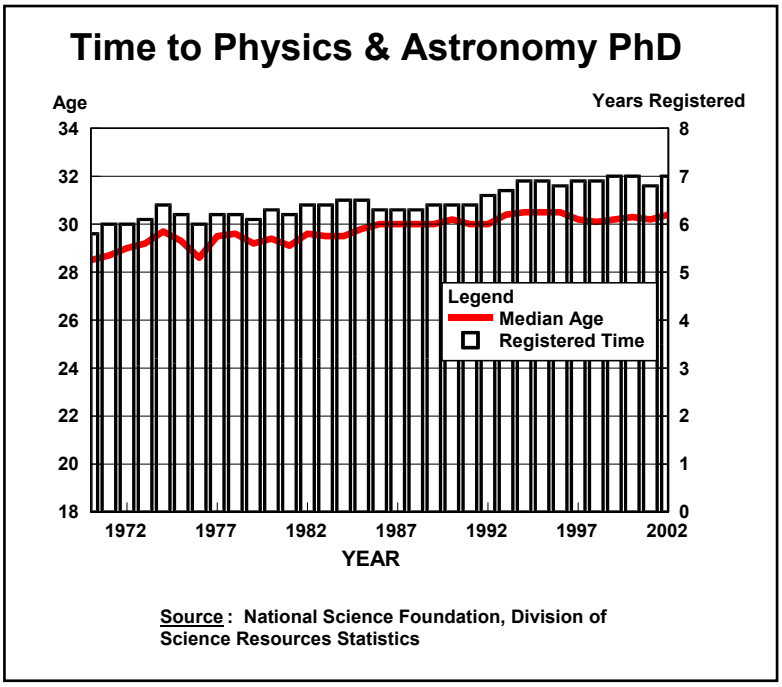


status, as seen in the accompanying chart. Some of them have gone to school and are working again (21%). These are individuals who may have worked for a year or two, who then went on to earn a master's degree. A few of these individuals did not actually earn a degree, but they did go to school full-time for a period of time, and are now back in the labor force. Another 16% started working for a year or more and then went on to graduate school and are still in graduate school 5 to 7 years later. Most of these are actually in PhD programs, although a few of them are late entrants into master's programs. People who go on to education and business master's programs tend to do so years after they went to the labor force. In fact, some of these are not yet in the sample.

Among the individuals who start off in school, the majority (68%) are working 5 to 7 years later. A significant number of these are people who went into masters' programs of one kind of another, whether physics or another field, and earned a degree. It also includes those who earned a terminal master's and had originally intended to get a PhD. And it includes a few individuals who were full-time students but dropped out of the program short of actually earning a degree.



A few people (2%) started in school, went to work, and went back to school. That is a fairly low-base phenomenon but not nonexistent. And then we have the individuals who continue in school, and these are largely the PhD students. The vast majority of them are actually in physics, although that is not true of the other career paths.



How about at the PhD level? The chart to the right looks at time to degree and median age at the time of degree (shown in the red line in the chart). Clearly, the age at the time of degree has increased over the last 30 years, but over the last 10 years it has been reasonably stable, fluctuating just below 30.5. The registered time in graduate school has also increased, but it too has been reasonably stable at seven years or just below that for the last decade. So, most of the increases we see here occurred in the 1970s and 1980s.

There are, of course, all kinds of interesting phenomena that are buried in these numbers. Foreign citizens have dramatically increased, and it takes them time to get here. U.S. citizens are increasingly taking time off before starting graduate school. Of the U.S. citizens who are in a PhD program, more than 20 percent took at least one year off before starting.

What happens to physics PhDs one year after earning a PhD? The chart to the right is AIP's best estimate of how many actually stayed and how many actually left. It is based largely on feedback we received from their thesis advisers and department chairs. This represents the distribution in a typical year where slightly fewer than half of those who stay in the U.S. go into postdocs. The private sector is the dominant employer for the rest who stay in the U.S.

Physics PhDs – One Year Later

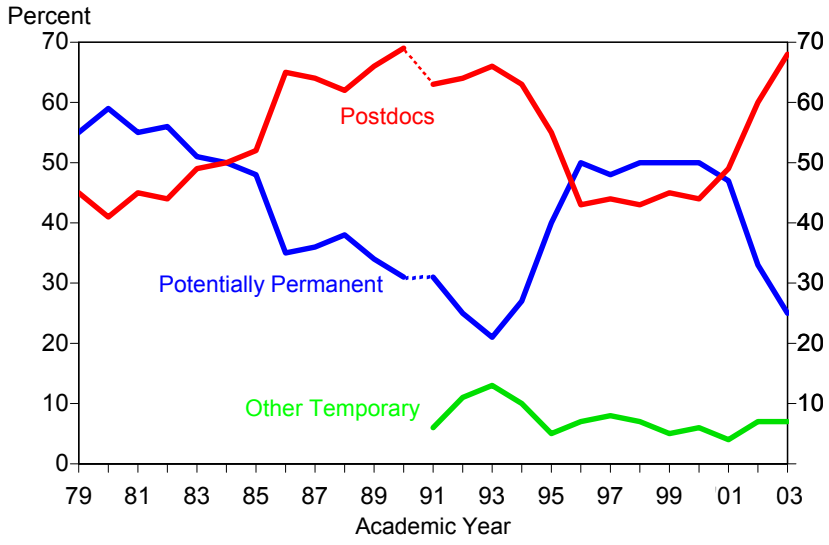
Status	Number
Postdoc	470
Other Temporary Employment	50
Permanent Employment	
Private Sector	340
Academe	90
Government + Non-Profit	60
Left the U.S.	130
PhD Class of 2001	1160

Source: AIP Initial Employment Survey. About 2% of respondents were unemployed at the time of the survey.

Postdoc status however changes over time, as shown in the next chart. Even in a field like physics, the number of PhDs going into postdocs does vary from year to year. Part of that is a reflection of the economy. You can see that the percent going into postdoc positions changes dramatically, with a big jump recently.

The green line at the bottom of the chart shows "other temporary" employment. AIP decided to add this a dozen years ago to take into account people who take sabbatical replacement jobs.

Initial employment of physics PhDs, 1979-2003.

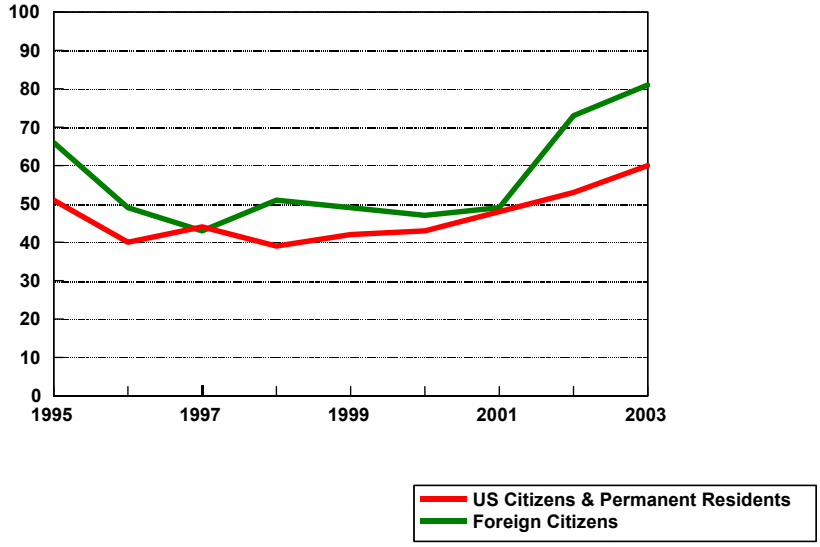


AIP Statistical Research Center, Initial Employment Report.

The dramatic increase in potentially permanent employment from 1993 to 1997 happened for a couple of reasons. One is that the number of PhDs started declining because of the terrible international recession. But, at the same time the job market and the Internet started to explode, so by 1996 and 1997, there were real jobs there.

When we tease apart the number of new PhDs from U.S. institutions accepting postdocs by citizenship, we see a number of things. The foreign citizens noted in the chart to the right are just those on temporary visas.

New Physics PhDs Accepting Postdocs, By Citizenship



Source: AIP Statistical Research Center, Initial Employment Survey

The periods of time when U.S. and foreign citizens seem to be taking postdocs at the same rates overlap with when the H-1B visa cap increased dramatically. Now that the cap has reverted to 65,000, and visas in general are much harder to get, there is now a 20 percent difference in likelihood of U.S. citizens and permanent residents versus foreign citizens taking postdocs. When the likelihood of taking a postdoc was basically the same (i.e. in 2001), foreign citizens who did not take a postdoc position got jobs in the private sector. Now that the economy weakened, working visas are much harder to get, and the increase in the percentage of foreign citizens accepting postdocs is a reflection of that. Fewer than half of the foreign citizens who are not in postdocs manage to find work in the private sector, whereas it used to around 75 to 80 percent.

There is an interesting age phenomenon in the physics academic workforce. The table to the right shows the age of full- or part-time employed physics faculty in degree granting departments, based on a sample survey. Roughly 18 percent of the faculty are under the age of 40. About 14 percent of the faculty are 65 or older. About one quarter of the faculty are 60 and older.

So are they retiring? Are they leaving? Yes, but not all on the same day. We have had a retirement rate that has been in the high 2 percent, low 3 percent range for about 6 or 8 years now. About 200 faculty members retire every year, as shown in the table on the following page.

Age of Physics Faculty in Universities and 4-Year Colleges, 2004

Age Cohorts	Faculty %
Younger than 35	6
35-39	12
40-44	17
45-49	15
50-54	13
55-59	10
60-64	13
65-69	9
70-74	3
75 and older	2

Source: AIP Statistical Research Center, 2004 Society Membership Survey

And let us point out the fact that retirement is not the sole way that academic openings happen. If we look just at the tenure/tenure-track number, the 200 retirees each year represent less than half of the 500 jobs for which departments are actively recruiting at the tenure/tenured track level each year, as seen in the next chart.

Faculty retirement in physics* departments, academic years 2000-01 through 2003-04

	2000-01& 2001-02	2002-03 & 2003-04
Average number of retirees per year	233	194
Average rate of retirement among non-temporary FTE faculty	3.1%	2.7%

*Physics data are population estimates.

Astronomy data include only stand-alone astronomy departments. Astronomy departments combined with physics are presented in the physics totals.

Source: AIP Statistical Research Center, preliminary data from 2004 Academic Workforce Survey.

In physics, and I assume in other disciplines, departments are very risk aversive when it comes to hiring. So out of those 500 tenure/tenured track openings, 1 out of 3 do not get filled in any given year. They roll over and become part of the recruitment for the following year. There are also quite a few temporary openings. These are sabbatical replacements, etc.

Faculty recruitment in physics* departments, for positions starting in academic years 2002-03 and 2004-05

	2002-03	2003-04
Total recruitments	**679**	**619**
Tenured or tenure-track	512	483
Non-tenure-track permanent	39	37
Temporary	128	99

*Physics data are population estimates.

Astronomy data include only stand-alone astronomy departments. Astronomy departments combined with physics are presented in the physics totals. For institutions without tenure systems, non-tenure-track permanent recruitments were included with tenured/ tenure-track recruitment totals.

Source: AIP Statistical Research Center, preliminary data from 2004 Academic Workforce Survey.

In the largest PhD granting departments, you sometimes have research teams with 80 or so faculty but 100 bodies. The department chair is juggling the books and the dean has no idea what is going on, and somehow everybody magically gets a paycheck every month.

Also factored in here are all of the people moving from one institution to another.

The left-hand column in the table to the right shows the backgrounds of new physics faculty in PhD-granting departments in 2002. These are the people who were actually hired into tenure/tenure track openings. The rows show what these individuals were doing before they got hired. So as you can see in the first row, only a third of the openings in PhD-granting departments in 2002 were filled by PhDs who earned their degrees in the U.S. within the last 5 years.

Table 6. Backgrounds of New Physics Faculty, 2002*

	Type of Department	
	PhD (%)	Bach. (%)
Earned PhD in US within last 5 years	34	55
Earned PhD outside US, any year	30	14
Earned PhD in US > 5 years ago		
Previous Employer		
US Academic Institution	29	29
Industry, National Lab, Other	7	2

AIP Statistical Research Center: 2002 AWF Survey

*Includes permanent non-tenured faculty at schools without tenure, and tenured and tenure-track faculty at other schools.

As shown in the second row, nearly as many openings were filled by PhDs who earned their degree outside the U.S. and came to this country with a degree in hand. A few of these are people who came here for a postdoc, but by and large, they are international superstars. A physics department sees an international superstar and they find a way to hire him, and it usually is a "him." As bad as the U.S. has been doing economically, we are still outperforming a lot of other industrialized countries, so we see quite a few people coming here from Western Europe, and Germany in particular. Their economy is still doing badly, although it is doing better that it was in the late 1990s when the U.S. economy was doing so well. So, a significant number of new hires were faculty from Germany and from the former Soviet Union. Europe continues to be the dominant source for that second row and that second row is very different than the source for our foreign graduate students.

The third section of the table shows openings filled by PhDs who earned their degree in the U.S. more than five years ago—mobility between departments. These are individuals who are moving from department to department, short of getting tenure, and individuals who move after they get tenure for whatever reason, either to move up the food chain, to change their work, for geography, to change institutions, etc. And then, a nontrivial number of new hires at the tenured level are mid- and late-career individuals from government labs and from what is left of corporate labs. When the few physicists who are left in corporate labs retire, they often get a full professorship somewhere in a research department. This was not a phenomenon that you would see in the mid 1980s—it is a much more recent thing.

So you have individuals who are entering the academic labor force at very different stages in their career. It is not that we have all these people who are 60 and older who are going to retire at a certain age and then we are going to bring in those who are 40 and younger. We are bringing them in at all different ages, and that is one of the reasons that the 40 and younger are staying small—we are bringing in lots of people who are 45 and 55 and older, and so people are getting hired at different stages in their career.

Audience Comments/Questions:

- Audience Question – What is causing this? Is it the absence of a young crop to fill those positions or is it the benefit of bringing in a senior person with a research reputation and program?

Response – It is a number of things. One is the availability of superstars. The U.S. economy outperformed everybody in the second half of the 1990s, and we could make offers to faculty in other countries that they just could not match. So that was part of it. The other is that start-up funds for new hires are prohibitive. And so every time you have an opening you have to deal with this. What kind of risk are you willing to take? Do you hire a young PhD who may have potential and give this person $800,000 in start-up lab equipment and graduate students and postdocs, or do you offer a similar dollar amount to someone with an international reputation who is 50 years old? Clearly, it is a complex decision. It does not always come out in favor of the young person.

I do not have really good data because we did not track this kind of phenomenon 20 years ago, but I really have a strong sense that there is what I would call risk aversion, and that one of the ways that it probably exhibits itself is the percentage of folks who come in as tenure-track in research departments. An extremely high percentage of them get tenure. I think if we had good data 20 years ago, we would see that maybe slightly more than half got tenure and the others did not. I do not think departments are willing to take that kind of a risk with the cost of start-up.

- Audience Question – Even though the number of women getting PhDs has risen, you are not hiring that generational crop as much?

  Response – Right. To the degree to which mid- and late-career folks are less likely to be women, that would tend to be the case. Depending on what country you are hiring your superstars from, they may have fewer women at those ages as well. But there is a really strong push to hire young women. And so in general, in the academic market in physics the new hires in tenure-track positions are very, very close to the availability rate, availability being the percent among U.S. PhDs. There are differences by whether you are talking bachelor's granting institutions or research institutions.

- Marcos Salazar, American Psychological Association – It is more than just risk aversion too for the senior hires. How do you fund the lab for the existing person? If they have the grants to bring in the overhead, then you make the deal on the overhead. It is two very important factors at work, and the biological sciences and chemistry have to pay close attention to that.

  Response – When you look through the rolls you will find that when you really have identified the international superstar who was recently hired, that individual came with an entire cadre of folks. It was not just that one individual, but there is now a team of six people from the same country. You want to sweeten the deal for someone who is really going to put your department on the map.