



Where do new PhDs WORK?

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**Survey questionnaire data
reveal that recently graduated
physics PhDs have a varied
set of career options.**

We have all heard it. Physics degree recipients are versatile problem solvers who work in all sectors of the economy in all types of positions. For the PhD degree classes of 2017 and 2018, that mantra is as true as it has ever been. Against the backdrop of a strong US economy in recent years, those new physics PhDs secured meaningful employment in a variety of fields. Their specialized training made them strong candidates for specific academic and nonacademic positions, while their general scientific, mathematical, and analytical skills made them attractive hires to a broad range of employers.



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The data about initial employment that form the basis of this article come from 2017 and 2018, the most recent data available from surveys conducted by my colleagues and me at the Statistical Research Center (SRC) at the American Institute of Physics (AIP, publisher of PHYSICS TODAY). The employment outlook for new PhDs from the class of 2020 will assuredly be different. According to the National Bureau of Economic Research, the US entered a recession in February of 2020, ending the longest economic expansion in US history. The recession was caused by the COVID-19 pandemic, which continues to spread. Prospects for the classes of 2021 and beyond may also be different.

One consistent element of the job market is that colleges and universities will continue to educate students and fill faculty positions. Companies will continue to need employees, even if new hires will be working remotely. And university and government laboratories will continue to need staff and postdocs to carry out their research agendas. As national economies reopen, a new normal will be established that may or may not resemble the past.

Initial employment split

The numbers of recently graduated physics PhDs in the US are at a record high. About 1900 degrees were awarded to the class of 2019 (see figure 1). Since the early 1990s, non-US citizens have accounted for about half of the physics PhDs awarded in the US. The proportion of non-US citizens peaked in 2005 when they represented 60% of the degrees conferred. For the class of 2019, non-US citizens represented 46% of physics PhDs.

The postdegree outcomes for new physics PhDs fall into four main categories: postdoctoral fellowships, potentially permanent positions in academia or the private sector, other temporary positions, and unemployment. For this article, new PhDs are categorized according to the status of their employment in the February following the academic year in which they received their PhD.

“I love my job and it is a very good position with excellent people and excellent research. However, postdocs are systematically underpaid.”

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The two most common postdegree outcomes—postdocs and potentially permanent positions—have displayed an inverse cyclical pattern for the past four decades (see figure 2). For most of the past two decades, the prevailing initial employment outcome for new physics PhDs has been a postdoc. Things changed for the class of 2018. More new PhDs accepted

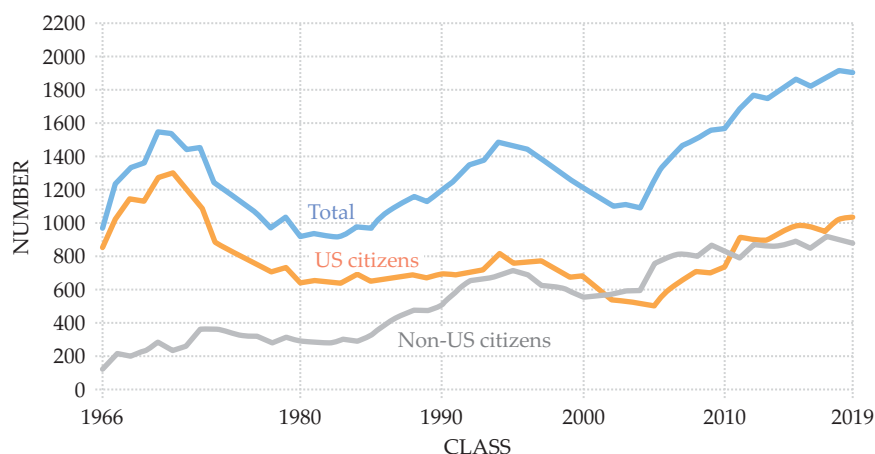


FIGURE 1. NUMBER OF PHYSICS PHDs awarded at US universities, classes of 1966 through 2019. The past 15 years has seen an increase of 175%. (American Institute of Physics, Statistical Research Center, Enrollments and Degrees Survey.)

potentially permanent positions than accepted postdocs, albeit by only 3%.

The third initial postdegree employment outcome category is other temporary positions. People in those nonpostdoc positions are mostly visiting professors, lecturers, and research scientists at colleges and universities. In recent years, 7–10% of new physics PhDs have accepted such positions. The fourth outcome category, unemployed, has accounted for about 5% of the respondents in recent years.

Not represented in the data shown in figure 2 and in the remainder of this article are the initial outcomes of new PhDs who did not remain in the US. For the classes of 2017 and 2018, about 25% of the non-US citizens and about 10% of the US citizens were either working or seeking employment outside the US in the winter following the year in which they graduated. More than half the non-US citizens and almost all of the US citizens who had left the US indicated they had accepted a postdoc.

The pattern of swings in the proportion of new physics PhDs who accept postdocs or potentially permanent positions is similar for both US and non-US citizens, but there are distinct and fairly consistent differences. Since the class of 2002, the proportion of US citizens accepting potentially permanent positions has been consistently greater than that of non-US citizens. For the combined PhD classes of 2017 and 2018, 47% of the US citizens accepted potentially permanent positions compared with 35% of the non-US citizens. The reverse is true for postdocs, with 40% of the US citizens and 51% of the non-US citizens accepting them.

The postdoc

Postdoc positions provide a temporary period of mentorship during which new degree recipients can either continue to do research and publish papers in the area of their dissertations or pursue other, new areas of research.

Typically two years in length and often renewable, postdoc positions pay less than potentially permanent positions in the private sector. Even so, they are an attractive employment option for many new PhDs. The decision to accept a postdoc is

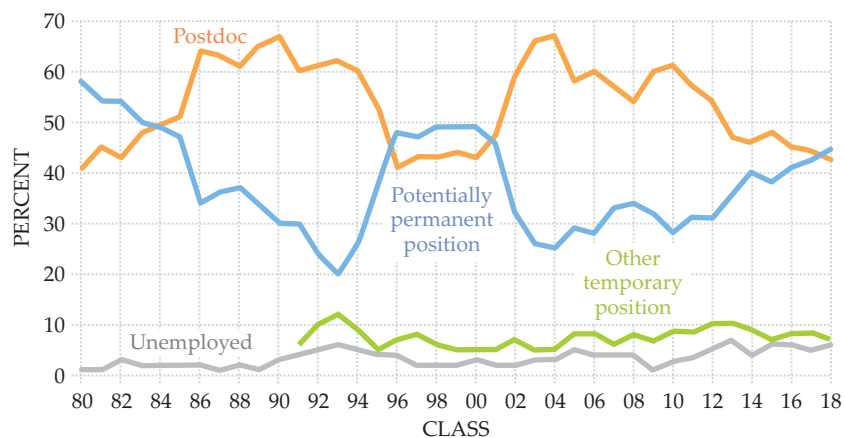


FIGURE 2. INITIAL EMPLOYMENT OUTCOMES of physics PhDs, classes of 1980 through 2018. For the first time since the physics PhD class of 2000, a greater proportion of new PhDs accepted a potentially permanent position in 2018 than accepted a postdoctoral appointment. The category of “other temporary position” was added to the survey instrument starting with the degree class of 1991. (American Institute of Physics, Statistical Research Center, PhD Follow-up Survey.)

influenced by professional goals, personal circumstances, and the realities of the job market. My colleagues and I asked new PhDs who accepted postdocs to indicate to what extent specific factors influenced them. As figure 3 shows, the decision to accept a postdoc is driven not by a single factor but by a combination of them.

“I am attempting to get a job in data science and finding it very challenging. I was unprepared to translate my skills to a corporate environment and had few connections.”

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The most cited reason for acceptance was that a postdoc is a “necessary step to get a future position.” That finding is not surprising, as completing a postdoc is generally considered a prerequisite to getting a faculty position, especially at a research university. As I discuss below, the notion that a postdoc is a required stepping-stone to a faculty position is corroborated by the hiring practices of colleges and universities. The motivation to “work with a particular scientist or research group” and to “obtain research experience in my field” also influenced new PhDs in accepting a postdoc.

Although the employment prospects and circumstances for non-US citizens differ from those for US citizens, non-US citizens cite many of the same reasons for accepting a postdoc. Non-US citizens often require a change in their visa status if they are to remain in the US after receiving their PhD. Almost half of the non-US citizens who accepted a postdoc in the US indicated that visa restrictions limited their options. Possibly also related to visas is that almost twice as many of the non-US citizens as the US citizens said that they took a postdoc because

they “could not obtain a suitable permanent position.”

Non-US citizens can obtain a valid visa for a postdoc by getting authorized for Optional Practical Training (OPT). Universities that need postdoctoral researchers are adept at assisting non-US citizens in obtaining the authorization. Because all employment during a period of OPT authorization must be related to the individual’s major field of study, the employment options of non-US citizens are more limited than those of US citizens. It is unknown what proportion of the non-US citizens who left the US after receiving their degree did so because of their inability to obtain the necessary visa.

Many of the reasons new PhDs accepted a postdoc centered around gaining valuable additional experience. Indeed, 94% of postdoc holders reported feeling that the knowledge and skills they were

developing would help advance their careers. Three-quarters of the postdocs in the classes of 2017 and 2018 were employed at a university. Most of the rest were employed in the government sector, which includes the national laboratories (see figure 4).

Like postdocs, PhDs holding other temporary positions were also primarily (70%) employed in academia. Those other temporary academic positions can provide valuable teaching experience for physicists who hope to continue teaching in a college or university setting. They frequently come with the title of visiting professor or guest lecturer. For some new PhDs, these nonpostdoctoral temporary positions fell short of what they hoped to be doing in the year after receiving their PhD. Not being able to obtain a suitable permanent position was an influential factor for 75% of PhDs who accepted a temporary position. The majority (60%) of nonpostdoctoral positions lasted one year.

Since the PhD class of 2010, the proportion of new physics PhDs in potentially permanent positions has steadily increased. Forty-four percent of the degree classes of 2017 and 2018 accepted such a position. As mentioned above, that development marks the first time in almost two decades that the proportion of physics PhDs accepting potentially permanent positions exceeded the proportion accepting postdocs. The overwhelming majority (73%) of the potentially permanent positions were in the private sector. Companies that employ new PhDs range from the smallest startups to the largest corporations. By contrast, 16% of the new PhDs holding potentially permanent positions worked in an academic setting. Many had job titles such as assistant professor or assistant lecturer.

Many people may not purposefully track the time they spend looking for a job. Nevertheless, the time a person perceives they spent seeking employment can be seen as an indicator of the strength of the job market. New physics PhDs were asked, “How long did you spend actively seeking employment before accepting your position?” Of the PhDs who accepted a postdoc or other temporary position, 20% indicated they spent zero months actively seeking employment. It’s likely that some new

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graduates did not consider the time they spent cultivating contacts and professional connections before receiving their degree as being part of their job search. Of the PhDs holding potentially permanent positions, 12% also indicated spending zero months on job searches. The median length of time that PhDs in all three employment categories searched for employment was three months.

Academic employment

As seen in figure 4, only 16% of PhDs accepting potentially permanent positions were working in an academic setting. That statistic forms only part of the academic employment picture. People who were in postdocs and other temporary positions when they were surveyed will go on to seek new positions. About 60% of the PhDs who held postdocs or other temporary positions indicated a desire to work in academia.

One indicator of potential future openings at physics and astronomy departments is the annual number of hires made. If hiring remains stable, there will not be enough open faculty positions to absorb all the individuals who want one. Nevertheless, a significant proportion of physics PhDs will eventually secure employment of some kind in academia.

Advice for individuals on looking for and obtaining an academic position can be found in two other articles in this month's issue (see pages 30 and 52). Statistical data from NSF and AIP provide a complementary, quantitative look at the hiring practices of US physics departments. According to NSF's 2017 Survey of Doctorate Recipients, about 39% of physics PhDs were employed at an educational institution.¹ NSF includes in that category four-year colleges and universities, medical schools (including university-affiliated hospitals and medical centers), university-affiliated research institutes, two-year colleges, community colleges, technical institutes, precollege institutions, and other educational institutions. As for individuals, NSF considered people who earned their physics PhD in the US, in any year, who were less than 76 years of age, and who were working in the US in 2017.

Data from the 2017–18 AIP Academic Workforce Survey provide insight into the backgrounds of the individuals who are hired into tenure and tenure-track faculty positions at US physics departments. Only 1% of the faculty members hired at PhD-granting physics departments and 12% of those hired by departments in which a bachelor's is the highest degree offered were employed right out of graduate school.² The largest proportion (61%) of new academic hires at PhD-granting physics

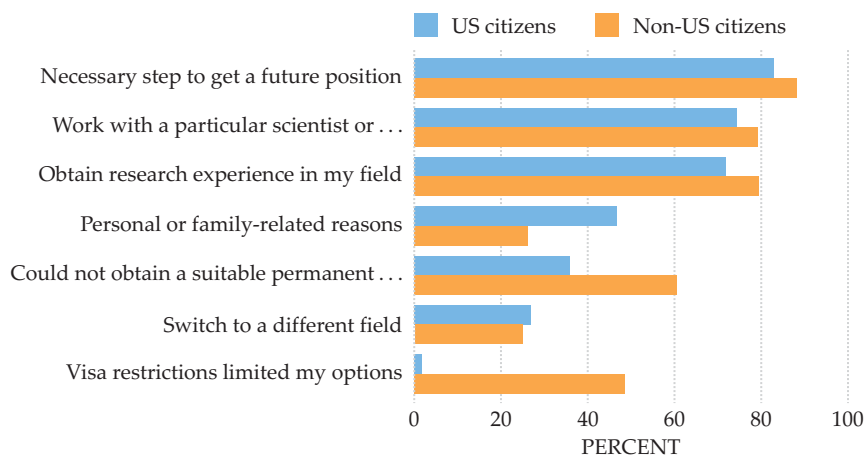


FIGURE 3. SPECIFIC FACTORS THAT LED NEW PHYSICS PhDs TO ACCEPT A POSTDOC. The three most cited influences for taking a postdoc were related to career goals and pursuing research interests. Here, data are limited to PhDs who earned their degree in the classes of 2017 and 2018 from a US university and remained in the US. Respondents were asked to rate the level of influence each statement had on why they took a postdoctoral fellowship. They were presented with a four-point scale that included “very influential,” “influential,” “of little influence,” and “not at all influential.” The data in the figure represent the proportion of individuals choosing one of the two positive response choices. (American Institute of Physics, Statistical Research Center, PhD Follow-up Survey.)

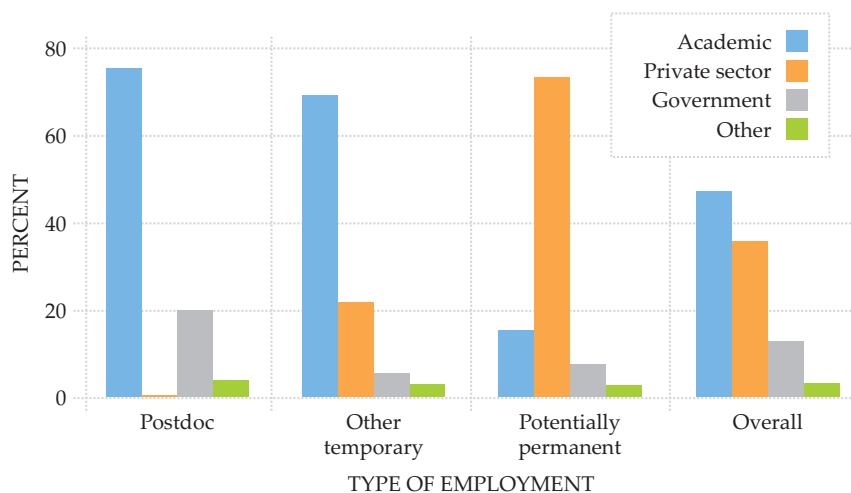


FIGURE 4. EMPLOYMENT SECTOR OF NEW PHYSICS PhDs, classes of 2017 and 2018 combined. Three-quarters of new physics PhDs who secured potentially permanent positions were working in the private sector. Here, “other” includes nonprofit organizations, hospitals and medical facilities, and other, unspecified employers. (American Institute of Physics, Statistical Research Center, PhD Follow-up Survey.)

“I took a lectureship because that’s what was available to me given time constraints and opportunities.”

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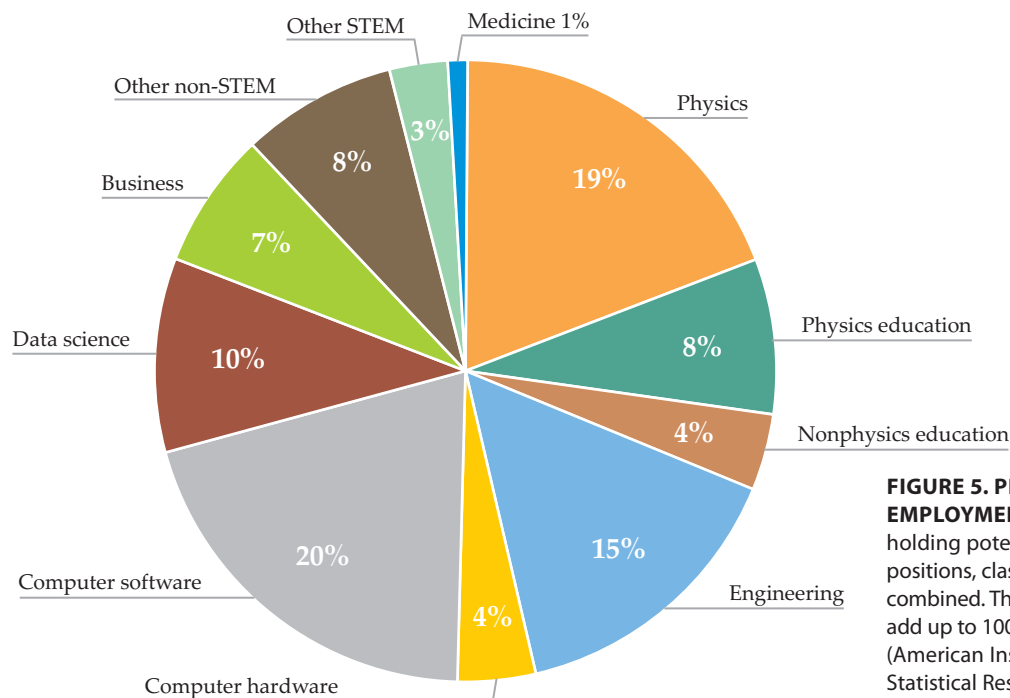


FIGURE 5. PRIMARY FIELD OF EMPLOYMENT for physics PhDs holding potentially permanent positions, classes of 2017 and 2018 combined. The percentages may not add up to 100 because of rounding. (American Institute of Physics, Statistical Research Center, PhD Follow-up Survey.)

departments were individuals who had previously held a postdoc. For new hires at physics departments that offer a bachelor's as their highest degree, 41% had a previous position as a postdoc and 24% had held a nonpostdoctoral temporary academic position.

Competition for tenured and tenure-track academic openings at US physics departments is not just limited to PhDs who earned their degree from a US institution. For the new academic hires in the 2017–18 academic year, 20% at doctoral-granting physics departments and 7% at bachelor's-only departments had earned their PhD outside the US.²

Faculty positions for physics PhDs are not limited to physics and astronomy departments. One in five academically employed physics PhDs work in a department other than physics or astronomy, according to a survey conducted by SRC of US-trained physics PhDs who had received their degrees 10–15 years earlier.³ Clearly, the academic employment possibilities for physics PhDs are broader than just physics departments. The substantial fraction of physicists employed in nonphysics departments exemplifies the interdisciplinary nature of physics and the versatility of physicists.

My colleagues and I asked new physics PhDs what their primary and secondary fields of employment were. If either was in physics, they were also asked if their employment field was the same as their dissertation field. For the most part, PhDs who accepted postdoctoral fellowships not only were working in physics but were also continuing in the area of their dissertation work. New physicists holding nonpostdoctoral temporary positions were fairly evenly split among those working in the field of their dissertation, those working in another area of physics, and those working in a nonphysics field.

The various types of employment that new physics PhDs accept is most prominent among degree recipients who accepted potentially permanent positions. Almost three-quarters (73%) of them indicated that their primary field of employment was in neither physics nor physics education (see figure 5). Recall that

most PhDs in potentially permanent positions work in the private sector. Many of them secured employment in the fields of computer software, engineering, and data science. To help better understand which employers hired PhDs into those fields and what skills they use, the SRC has developed an online tool, *Who's Hiring Physics PhDs?* (see the online resources box on page 46).

Salaries and perspectives

Although most grad students pursue physics because of their interest in discovering how the natural world works, they soon recognize a practical side to a physics degree: supporting themselves financially post-PhD. Starting salaries for the PhD classes of 2017 and 2018 varied by category of position, but the bigger variance came from the sector in which they were employed (figure 6). Physics PhDs who secured potentially permanent positions in the private sector earned considerably more and had a much wider range of salary than PhDs who held other types of employment.

“I have found employment in the private sector to be more challenging and engaging than I imagined while still in academia.”

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The median starting salary for physics PhDs working in potentially permanent university and four-year college positions was \$60 000, which is about half as much as the median salary for their cohorts employed in the private sector. About half of the PhDs holding potentially permanent positions at universities and four-year colleges reported that their positions were

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for 9–10 months of work. Those academic salaries were not adjusted for the length of their contract.

Far less striking but still notable is the difference between the salaries of postdocs at government labs and at universities. Physics PhDs who accepted postdocs at government labs had a median salary of \$70 000, whereas those with postdocs at universities, which employ the majority of postdocs, had a median salary of \$50 000.

The level of monetary compensation for the work one does is important, but other aspects of employment matter as much or possibly more for some individuals. When asked to self-assess how they perceived different aspects of their employment, new physics PhDs in the classes of 2017 and 2018 responded overwhelmingly positively.

The majority (85%) who accepted potentially permanent positions indicated they felt that a physics PhD was an appropriate background for their position. That again speaks well to the ability of physics PhDs to apply their knowledge and skills to the various fields in which they find work. New PhDs were also asked if they considered themselves underemployed; 16% of the individuals who had a postdoc said they were. Of the PhDs holding potentially permanent positions, 20% said they were underemployed. PhDs holding other temporary positions were generally less positive about their employment; 50% felt underemployed.

An uncertain future

Predictions by economists of when the economy will recover vary considerably, as do predictions by health-care professionals of when an effective COVID-19 vaccine will be deployed. The timing of both milestones will affect the academic and research environments for physics PhDs.

Compounding the uncertainty, President Trump has suspended various categories of visas through the end of 2020,

ONLINE RESOURCES

► Who's Hiring Physics PhDs?

www.aip.org/statistics/whos-hiring-physics-phds

This resource lists the names of employers that hired new physics PhDs into potentially permanent positions by field. It includes job titles, salaries, and skills used.

► PhD Plus 10 Study

www.aip.org/statistics/phd-plus-10

This resource provides a series of reports exploring the employment of midcareer physics PhDs.

► Physics Faculty Salary Calculator

www.aip.org/statistics/salary-calculator

This resource lets you explore salaries for physicists by institution type, degree, job title, tenure status, gender, and location.

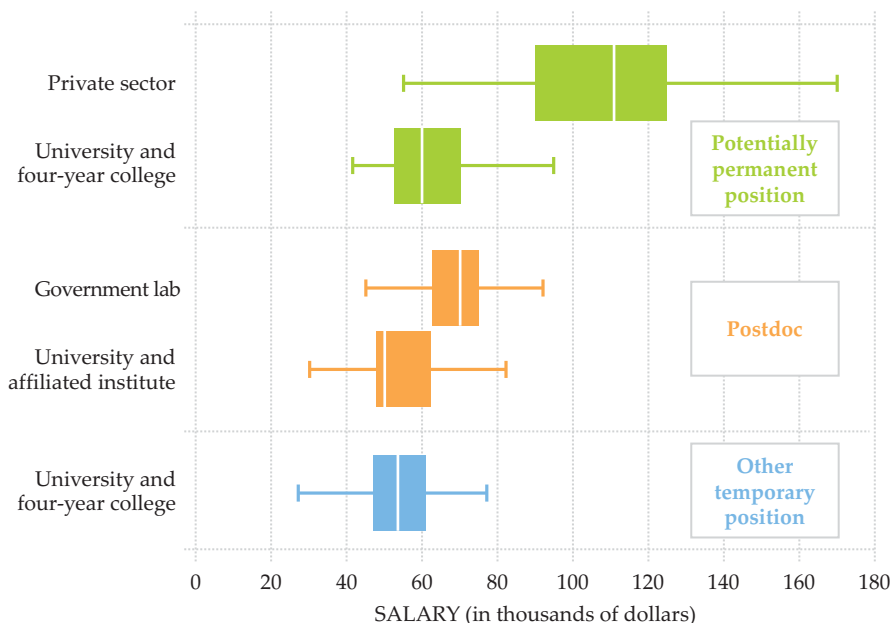


FIGURE 6. MEDIAN STARTING SALARIES for new physics PhDs. For those working in the private sector, it was \$110 000 for the combined classes of 2017 and 2018. (American Institute of Physics, Statistical Research Center, PhD Follow-up Survey.)

“Being employed in industry is so much better than being a graduate student.”

including the H-1B program. The policy does not apply to the J-1 exchange visitor program used by postdocs and professors or to the OPT program, though some fear those programs may be curtailed through subsequent actions.

But it is clear that physics PhDs are well prepared for a diverse set of career options. Although PhDs will continue to be employed in what was once considered the traditional career path of teaching and research in an academic setting, the majority will continue to find fulfilling employment opportunities in a wide array of other employment sectors and fields.

Regardless of whether they find work directly related to their thesis, in another area of physics, or in a different field, they will be able to leverage their acquired skills and knowledge to obtain professionally challenging, rewarding, and well-compensated positions.

REFERENCES

1. NSF, National Center for Science and Engineering Statistics, Survey of Doctorate Recipients: 2017, table 12-3, https://ncesdata.nsf.gov/doctoratework/2017/html/sdr2017_dst_12-3.html.
2. A. M. Porter et al., *Faculty Job Market in Physics and Astronomy Departments*, American Institute of Physics (2020), tables 5 and 6.
3. PhD Plus 10 Survey, American Institute of Physics (2018), table “Mid-Career PhD Physicists Employed at Four-Year Colleges & Universities.”

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