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stats@aip.org
301.209.3070

Physics PhDs Ten Years Later:

Duties and Rewards in Academic Positions

Results from the PhD Plus 10 Study

Anne Marie Porter

The PhD Plus 10 Study was our first-ever follow-up of mid-career physics PhD recipients. In 2011, we contacted individuals who graduated with a physics PhD from the classes of 1996, 1997, 2000, and 2001 in the United States. Of those who responded to our survey, 597 were employed in academia. In this report, we focus on three groups: (1) respondents employed in physics or astronomy departments at four-year institutions, (2) respondents employed in departments other than physics or astronomy at four-year institutions, and (3) respondents employed at two-year colleges. In this report, we will describe the activities that academic employees perform during their work and what they find rewarding about their positions.

Who they are

Of survey respondents, 464 academic employees worked in physics or astronomy departments at four-year institutions, 106 worked in other academic departments at four-year institutions, and 27 worked at two-year colleges.

Academic rank and status. Tables 1 and **2** compare academic respondents at four-year institutions by academic rank and tenure status. At four-year institutions, most respondents were tenured associate professors. The number of respondents at two-year colleges was too small to calculate percentages. Out of the 27 respondents at two-year colleges, 22 had tenure or tenure-track positions. 7 were full professors, 6 were associate professors, 5 were assistant professors, and 6 were adjuncts or instructors.

Table 1

Academic Ranks of Mid-career PhD Physicists
Working at Four-year Academic Institutions

	Physics or Astronomy Departments	Departments other than Physics or Astronomy
Full Professor	15%	4%
Associate Professor	59%	56%
Assistant Professor	15%	19%
Instructor/Adjunct	2%	2%
Other	9%	19%

"Other" academic positions included research scientists, deans, directors, lecturers, administrators, a postdoc, and an IT specialist

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Table 2

Tenure Status of Mid-career PhD Physicists Working at Four-year Academic Institutions

	Physics or Astronomy Departments	Departments other than Physics or Astronomy
Tenured	69%	48%
Tenure-track	15%	17%
Non-tenure track	15%	26%
Other	1%	9%

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Department types. At four-year institutions, respondents in other departments reported working in engineering, mathematics, chemistry, information technology, advanced computing, biology, natural sciences, medicine, marine sciences, and biochemistry departments. At two-year colleges, the academic structure is more fluid, and respondents reported working in a variety of academic units including physics, astronomy, physical sciences, natural sciences, mathematics, and general education.

What they do

Four-year institutions. We asked respondents to "briefly describe your duties and responsibilities in your current job." Below is a list of the most frequently reported responsibilities by respondents at four-year institutions. Across all academic departments (physics, astronomy, and others), the most frequently reported responsibilities were identical:

1. Teaching undergraduate and graduate courses
2. Performing research (experiments, analysis, publishing, and grant-writing)
3. Mentoring students and younger professors
4. Performing activities for the department (committees, administration, directing programs, being department chairs, maintaining websites)

When describing their current responsibilities, respondents at four-year institutions reported what courses they taught and what types of research they performed (**Table 3**). Respondents across physics, astronomy, and other departments taught similar academic courses; however, they performed research on different topics. Not surprisingly, respondents in physics and astronomy departments focused on research within subfields in physics, astronomy, and optics. In other departments, some respondents performed research in physics and optics, but others researched topics in biology and medicine.

Table 3

Course and Research Topics of Mid-career PhD Physicists Working at Four-year Academic Institutions

	Physics or Astronomy Departments	Departments other than Physics or Astronomy
Course Topics	Acoustics Astronomy Chemistry Engineering Geology Mathematics Physics Physics History	Astronomy Geology Mathematics Neuroscience Physics Statistics
Research Topics	Accelerator physics Astronomy education Beam physics Climatology Computational physics Condensed matter physics Cosmo-chemistry Heavy ion physics Nuclear physics Optics Particle physics Physics education Planetary science Plasma physics	Biomedical optics Biophysics Cardiology Cryo-microscopy Pharmaceuticals Plasma physics Structural biology Ultrasounds

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There were also unique responsibilities when comparing departments (**Table 4**). In physics or astronomy departments, respondents' unique responsibilities involved public outreach, planetariums, and space mission support. In other departments, respondents' unique responsibilities involved artifacts, software, and IT activities.

Table 4

Unique Responsibilities of Mid-career PhD Physicists Working at Four-year Academic Institutions

Physics or Astronomy Departments	Departments other than Physics or Astronomy
Planetarium management Public outreach Space mission instruments and systems development	Artifact collection Computer cluster maintenance Software development System administration Web services

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Two-year colleges. Teaching was the most frequent responsibility reported by respondents at two-year colleges, and their primary responsibilities included teaching courses in physics, astronomy, and mathematics. Many respondents also performed administrative tasks for the college, mentored students, performed public outreach, served as department chairs, and served on committees. The respondents from two-year colleges who performed research indicated that they did it over the summer months at different institutions.

How often they use different skills

Four-year institutions. In our survey, we asked academic respondents "how often do you use or do the following things in your current job?" Respondents rated how often they used 24 different skills (daily, weekly, monthly, less than monthly, or not at all). **Figures 1–5** compare the skill usage at four-year institutions across five categories: research skills, interpersonal skills, technical skills, managerial skills, and communication skills.

Across all departments, respondents most often performed complex problem solving, taught courses, and managed projects. Not surprisingly, respondents in physics and astronomy departments used physics principles, conducted basic research, and collaborated with physicists more often than respondents in other departments. Respondents in other departments were more often involved in applied research, design or development, proposal writing, and more often collaborated with individuals from diverse professions.

Figure 1

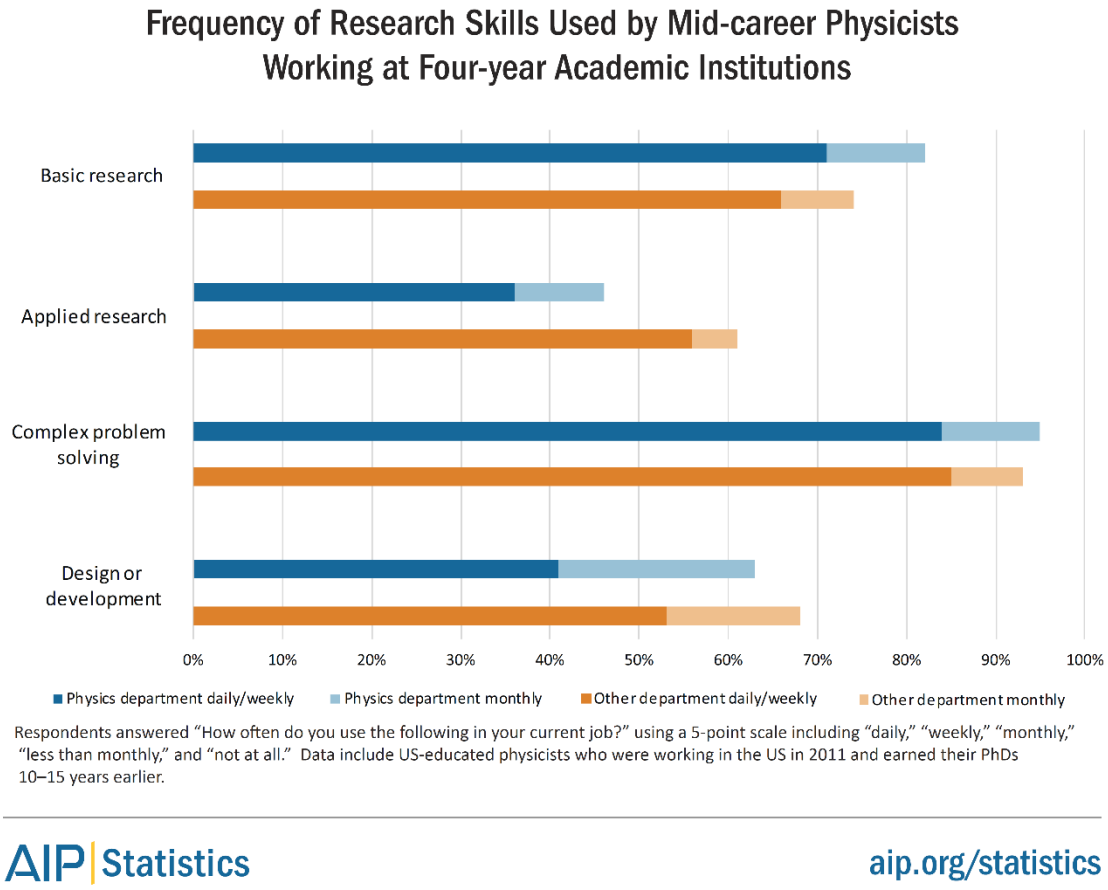
Frequency of Research Skills Used by Mid-career Physicists Working at Four-year Academic Institutions
Basic research
Applied research
Complex problem solving
Design or development
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Physics department daily/weekly
Physics department monthly
Other department daily/weekly
Other department monthly
Respondents answered "How often do you use the following in your current job?" using a 5-point scale including "daily," "weekly," "monthly," "less than monthly," and "not at all." Data include US-educated physicists who were working in the US in 2011 and earned their PhDs 10–15 years earlier.
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Figure 2

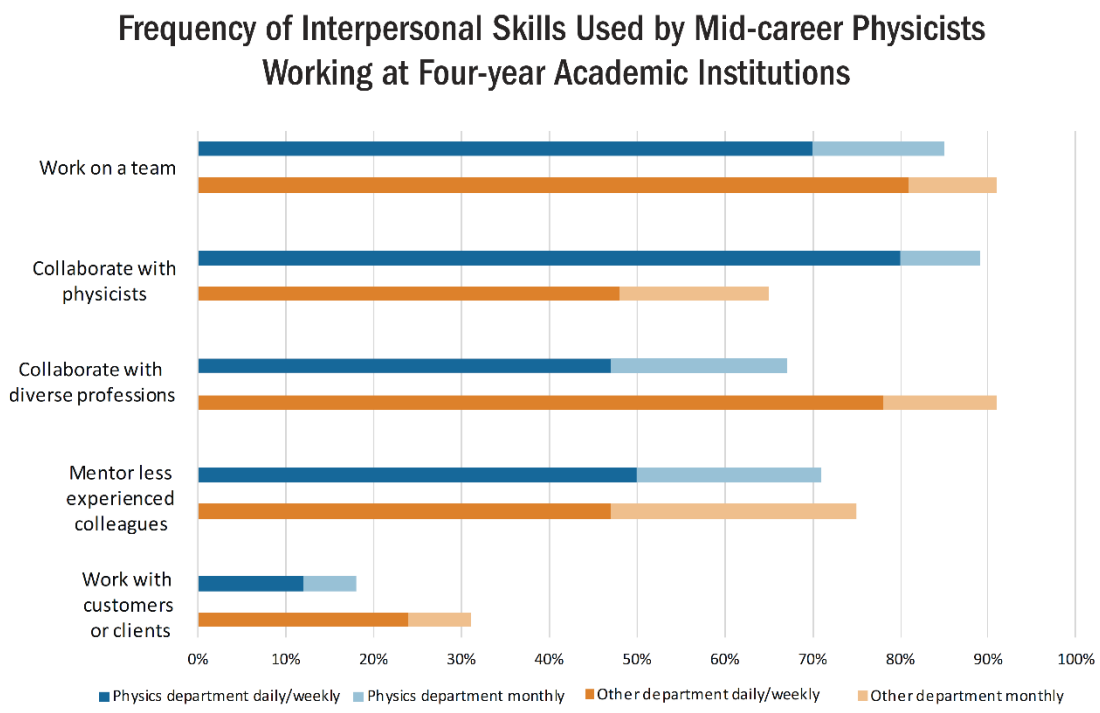
Frequency of Interpersonal Skills Used by Mid-career Physicists Working at Four-year Academic Institutions
Work on a team
Collaborate with physicists
Collaborate with diverse professions
Mentor less experienced colleagues
Work with customers or clients
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Physics department daily/weekly
Physics department monthly
Other department daily/weekly
Other department monthly
Respondents answered "How often do you use the following in your current job?" using a 5-point scale including "daily," "weekly," "monthly," "less than monthly," and "not at all." Data include US-educated physicists who were working in the US in 2011 and earned their PhDs 10–15 years earlier.
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Figure 3

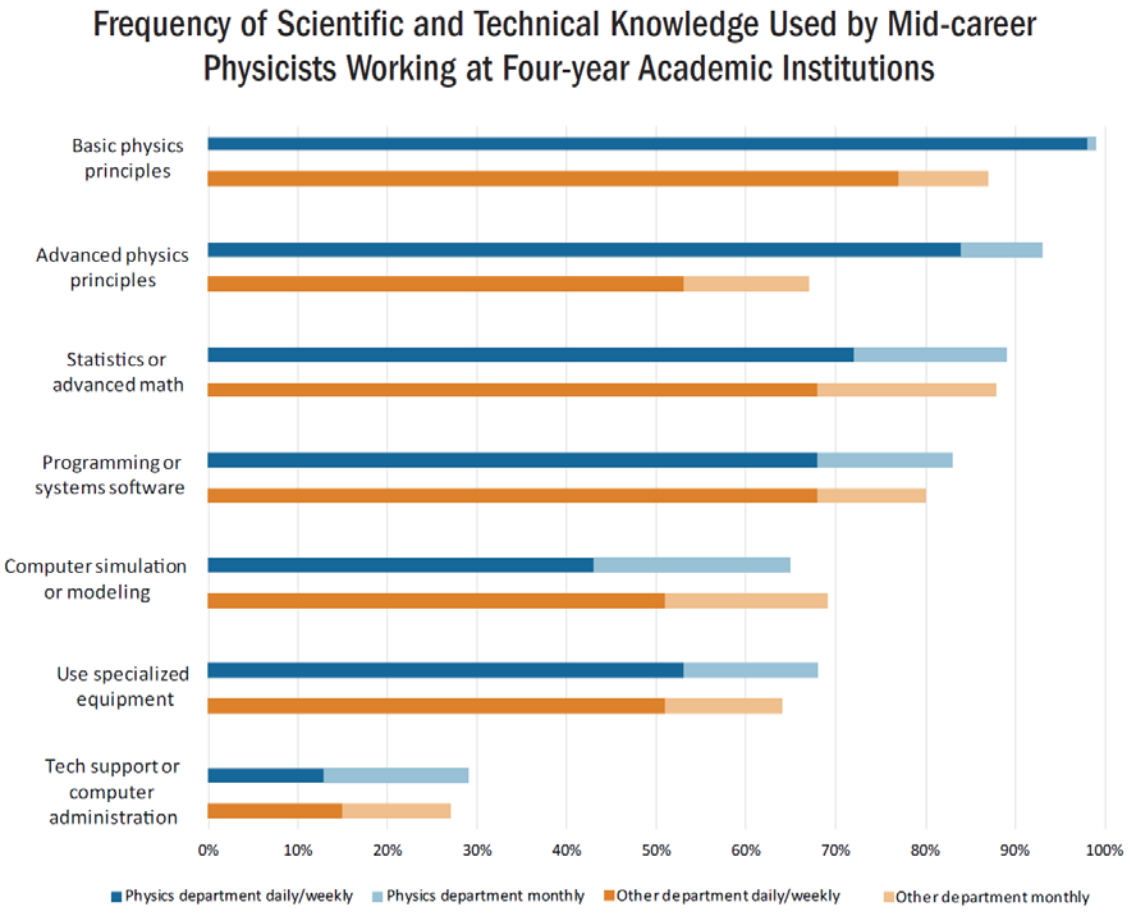
Frequency of Scientific and Technical Knowledge Used by Mid-career Physicists Working at Four-year Academic Institutions
Basic physics principles
Advanced physics principles
Statistics or advanced math
Programming or systems software
Computer simulation or modeling
Use specialized equipment
Tech support or computer administration
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Physics department daily/weekly
Physics department monthly
Other department daily/weekly
Other department monthly
Respondents answered "How often do you use the following in your current job?" using a 5-point scale including "daily," "weekly," "monthly," "less than monthly," and "not at all." Data include US-educated physicists who were working in the US in 2011 and earned their PhDs 10–15 years earlier.
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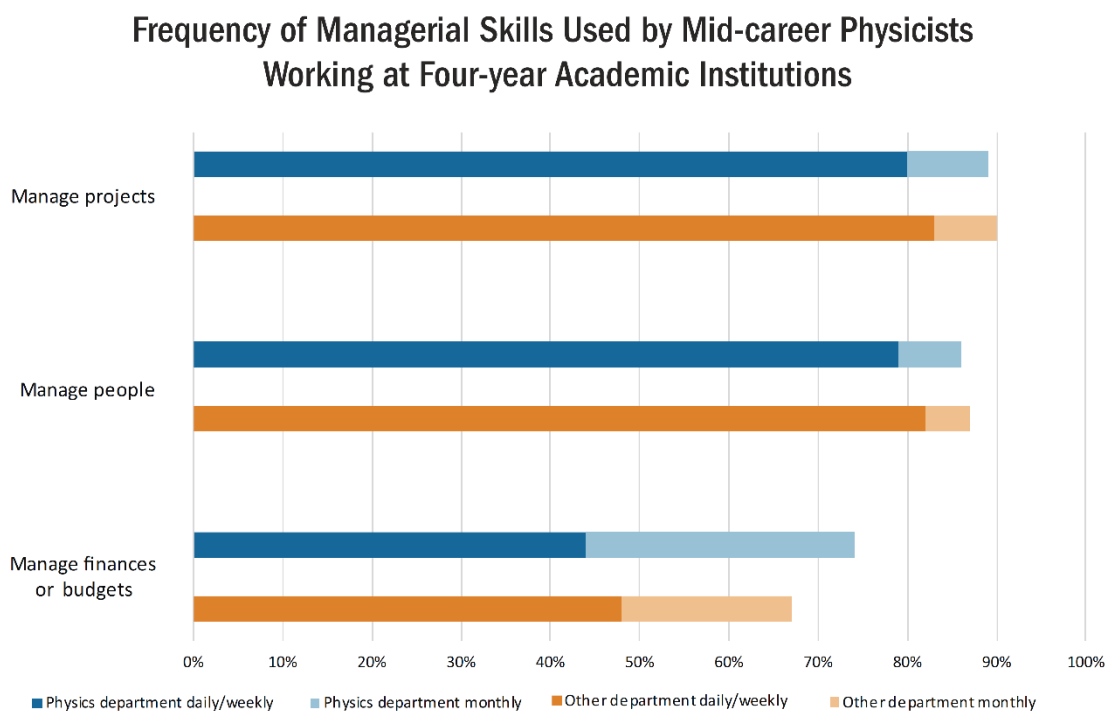
Figure 4



Respondents answered "How often do you use the following in your current job?" using a 5-point scale including "daily," "weekly," "monthly," "less than monthly," and "not at all." Data include US-educated physicists who were working in the US in 2011 and earned their PhDs 10–15 years earlier.

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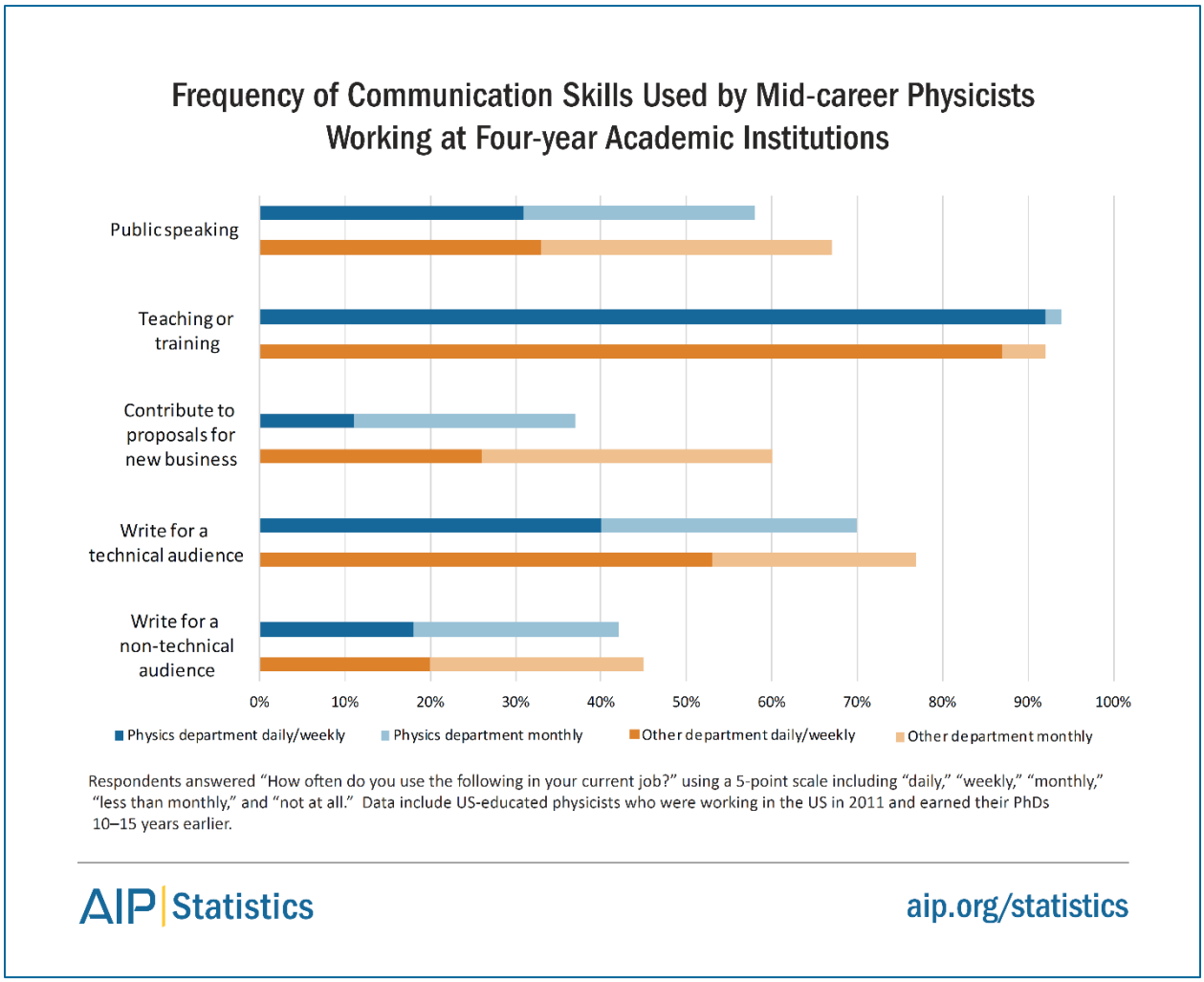
Figure 5



Two-year colleges. Due to a smaller sample size, we were unable to directly compare responses from faculty members at two-year colleges with those from faculty members at four-year institutions. Respondents from two-year colleges most often reported using the following skills: teaching, using basic physics principles, and collaborating with individuals from diverse professions. Contributing to proposals, performing applied research, and providing technical support were skills used least frequently.

What is rewarding about their work

Most frequent rewards. We asked respondents: "what are the most rewarding aspects of your current job?" **Table 5** lists the most frequently reported job rewards at four-year institutions and two-year colleges. Physics, astronomy, and other department respondents reported identical rewards, although in slightly different orders of frequency. Across all departments, respondents at four-year institution most frequently reported rewards about autonomy, mentoring, learning, problem-solving, and collaborating. At two-year colleges, respondents most frequently reported rewards about teaching, interactions with students, collaborations, and autonomy.

Table 5

Most Frequent Job Rewards Reported by Mid-career Physicists Working in Academia

Physics or Astronomy Departments	Departments other than Physics or Astronomy	Two-Year Colleges
1. Autonomy in intellectual freedom	1. Autonomy in intellectual freedom	1. Helping students learn
2. Mentoring and guiding students	2. Complex and challenging problem-solving	2. Introducing students to science
3. Learning new things	3. Collaborating with colleagues	3. Autonomy in teaching topics
4. Collaborating with colleagues	4. Learning new things	4. Collaborating with faculty
5. Complex and challenging problem-solving	5. Mentoring and guiding students	5. Working with diverse students

Respondents were asked "What are the most rewarding aspects of your current job?"

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Unique rewards. **Table 6** lists the unique job rewards reported by respondents in physics or astronomy departments, other departments, and two-year colleges. Respondents in physics or astronomy departments felt rewarded when they performed public outreach, developed instrumentation, helped students struggling with physics, and published in physics journals. Respondents from other departments felt rewarded when they developed software and when their work was applied in society. Respondents from two-year colleges described unique teaching rewards such as working with diverse students and working at an institution that prioritizes teaching.

Table 6

Unique Job Rewards Reported by Mid-career Physicists Working in Academia

Physics or Astronomy Departments	Departments other than Physics or Astronomy	Two-Year Colleges
Developing physics instruments and measurements	Developing systems and software	Working with students from diverse backgrounds
Educating the public and doing public outreach	Seeing how their work impacts users and society	Working at an institution that prioritizes teaching
Working with students who are struggling with physics		
Getting published in *Physics Today*		

Respondents were asked "What are the most rewarding aspects of your current job?"

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Reward themes. When examining all job rewards reported by respondents employed in academic positions, we found five major themes: teaching rewards, research rewards, institutional rewards, collaboration rewards, and societal rewards. **Table 7** shows the percentage of how often different themes were reported in the survey responses.

At physics or astronomy departments, respondents most frequently reported teaching and research related rewards. At other departments, respondents most frequently reported research related rewards. Due to a smaller sample size, we were unable to directly compare responses from faculty members at two-year colleges with those at four-year institutions. Of two-year college respondents, teaching rewards were reported the most often, and were 62% of the total number of reported job rewards.

Table 7

Percentage of Reported Job Rewards by Theme

Reward Theme	Physics or Astronomy Departments	Departments other than Physics or Astronomy
Teaching	31%	23%
Research	31%	44%
Institutional	22%	15%
Collaboration	10%	11%
Societal	6%	7%

"What are the most rewarding aspects of your current job?"

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In the following section, we describe all five reward themes reported by respondents, and provide samples of quotes that represent each theme.

Teaching rewards. This theme includes any reported rewards related to teaching activities and interactions with students. Respondents in academia enjoyed working with students, especially those who were motivated, passionate, and from diverse backgrounds. They felt rewarded when they positively influenced their students' way of thinking and helped them better understand both the teaching material and the natural world around them. For some, they felt rewarded when they supported students who initially struggled in class, or students who were initially uninterested or anxious about the course material. Additionally, many enjoyed mentoring students who might become future scientists or science teachers. They frequently reported helping their students design research projects, find employment, or further their education. Other respondents focused on developing their own teaching skills, and enjoyed designing and innovating new education techniques.

Physics and Astronomy Departments

"Working with students who are passionate about learning"

"Seeing students who begin to understand the beauty of nature through physics"

"Inspiring others to expand their intellectual horizons"

"When I get to the be the one to turn the 'light bulb' on for one of my students"

"Seeing students succeed and move on in their education"

"Helping students find research solutions to their questions"

"Teaching people who are resistant to learning physics, and when they learn to enjoy it, it is exciting"

"Seeing students go from low confidence and little knowledge to functioning scientists"

"Developing educational materials to help students learn"

Departments other than Physics or Astronomy

"Seeing that I make a difference in my students' mindsets"

"Seeing students mature and become successful"

"Teaching graduate students critical thinking and research skills"

"Devising new ways to teach elementary things"

Two-year Colleges

"I enjoy [working with] good students who strive to succeed"

"Seeing the amazement in my students' eyes when they understand a concept"

"Helping students who do not have other educational opportunities"

"Helping students advance, find rewarding work or further their science education"

"Teaching students from diverse backgrounds"

"Working with pre-meds to get over their fear of physics"

"Teaching science to possible future scientists/engineers"

Research rewards. This theme describes any reported rewards related to mental and procedural tasks during the research process. Many academic respondents enjoyed their work when it was intellectually challenging, involved solving new and cutting-edge scientific problems, and involved discovering new things about the world. In research projects, they enjoyed designing experiments, creating new software or instrumentation, finding results, and publishing their findings. Most research rewards were reported by respondents at four-year

institutions, but there were some two-year college respondents who also enjoyed performing research over the summer and publishing results.

Physics and Astronomy Departments

"[Doing] exploratory, creative, intellectually challenging research"

"The feeling that I am discovering fundamental principles, and learning new physics. Priceless"

"Discovering something new about my world"

"Learning new physics and being involved with cutting-edge physics problems"

"Seeing a research idea come to fruition"

"Figuring out how to do complex experiments"

"Freedom to define and explore new, compelling problems in space and planetary science"

"Getting physics results after preparing new instrumentation over several years"

"Always learning something new—often inspired by student questions"

Departments other than Physics or Astronomy

"Discovering something no one else has known before"

"Discovering how the world works and solving puzzles"

"Challenge of working on cutting edge problems in biology"

"New experiments and new theories to explore and develop"

"Creating new algorithms to solve real-world problems accurately and efficiently"

"Opportunities to keep learning about different subject fields"

"Creating new software"

Two-year Colleges

"Publishing research results"

"Having the summer free to do my own research"

"I especially enjoy returning to a national laboratory each summer to continue with my physics research"

Institutional rewards. This theme includes any rewards that were related to an institution's benefits, resources, or supports for their current positions. Most importantly, academic respondents valued autonomy and flexibility in their current positions, and enjoyed managing their own research interests, teaching interests, and work schedule. Others valued job benefits provided in their positions such as job security, salary, sabbaticals, and free time over the

summer. Respondents had different opinions about what they valued in their department and university work environment. Some preferred it when their institution prioritized teaching. Others preferred it when their institution prioritized research, especially when there was less pressure to publish research findings.

Physics and Astronomy Departments

"The ability to use my own best judgment, both in how I teach, and what I choose to research"

"Tremendous variety of professional responsibilities"

"[Having] a flexible schedule is great for family life"

"Flexible work hours, compensation level, and job security"

"[Having] more free time in summer than most people"

"Research with not so much pressure to publish or obtain grants"

"The reduced publish-or-perish culture of an undergraduate-only institution means one can pursue higher-risk research projects"

Departments other than Physics or Astronomy

"Having the freedom to do research on topics I choose. The ability to set my own schedule and work priorities"

"High degree of academic freedom to pursue interesting research questions"

"The ability to work on problems that are interesting to me"

"Teaching in a school that puts undergraduate education first over research and grants"

"Opportunity for travel/sabbatical"

Two-year Colleges

"I can design and execute my own labs, choose my own text, sequence topics as I like"

"Flexibility, freedom to set my own goals and hours"

Collaboration rewards. This theme describes any rewards related to social interactions with non-students. Many respondents enjoyed their work when they collaborated with colleagues during research and teaching, particularly with collaborators from other disciplines and other countries.

Physics and Astronomy Departments

"Working collaboratively on interdisciplinary research projects"

"Discussions with non-science faculty on broad array of interesting topics"

"Opportunities to interact with others, often from fields outside of physics, which can spark

interesting lines of research"

"Interactions with scientists around the world"

Departments other than Physics or Astronomy

"Collaborating and working with smart, motivated people from diverse research fields"

"The opportunity to collaborate with exceptional colleagues both within and outside of my primary discipline"

Two-year Colleges

"Working with colleagues from other disciplines"

"Working with a diverse range of people"

Societal rewards. This theme includes any rewards related to society or the larger scientific community. Respondents working in physics or astronomy departments enjoyed creating scientific instruments, measures, and hardware that helped other scientists in their fields. Furthermore, respondents felt rewarded when their work was recognized by the scientific community, such as being published in *Physics Today*. Lastly, they felt rewarded when they helped the general public better understand science and improved science education. Respondents employed in departments other than physics or astronomy felt rewarded when they designed software and systems that helped others in their fields. Respondents from two-year colleges did not specifically mention any rewards related to society or the larger scientific community. However, the number of respondents from two-year colleges was small, and these rewards might have been reported with a larger sample size.

Physics and Astronomy Departments

"Discovering new things that could be of benefit to other researchers and society"

"Discovering something new in particle physics and sharing that with the public"

"Translating new science in meaningful ways to people who may think they cannot understand science"

"Changing the science literacy of US Citizens"

"Contributing to spaceflight hardware development"

"Being part of a major effort to impact science teaching"

"Recognition from others in my field, via citations to my papers, invitations to present lectures, invitations to serve on scientific organizing committees"

"When my research was mentioned in an article in *Physics Today*"

Departments other than Physics or Astronomy

"Creating software that is widely used by scientists"

"Solving problems and creating systems that are used daily by tens of thousands of users"

"Being able to contribute meaningfully to the larger science enterprise and community"

"Knowing that the tools I create are being applied to important biological problems"

"The work is challenging, stimulating, engaging, and most definitely employed to improve human health"

Summary

In this report, we compared mid-career physics PhD recipients employed in physics or astronomy departments at four-year institutions, departments other than physics or astronomy at four-year institutions, and those employed at two-year colleges. As expected of mid-career graduates, most individuals were associate professors with tenure status. Across four-year institutions, employees reported similar job responsibilities. Four-year institution employees most often reported teaching college courses, performing research, mentoring students and younger teachers, and performing activities that serve their department. Those working at four-year institutions taught a wide variety of courses and performed research in a wide variety of scientific fields. Employees working at two-year colleges most often reported performing teaching responsibilities.

When academic employees reported on what they found rewarding about their work, they reported rewards related to teaching, research, institutional benefits, social collaborations, and positively impacting society and the scientific community. The most frequently reported rewards at four-year institutions and two-year colleges included: having the autonomy to pursue intellectual and teaching interests, mentoring and working with students, learning new things during research, collaborating with colleagues, and solving challenging and complex problems.

Survey methodology

During 2011, we contacted over 3,400 physics PhD recipients from the classes of 1996, 1997, 2000, and 2001, and who graduated from US institutions. We received responses from 1,544 individuals that were currently working in the US. We know that the respondents are not representative. It was easier to find members of the more recent classes than the earlier classes, and based on an analysis of the respondents by contact wave, we believe that it was harder to contact individuals employed in industry than those in academia or the government. So, academics are over-represented among our respondents.

For a complete overview of the methodology, please see the Appendix in *Common Careers of Physicists in the Private Sector* by Roman Czujko and Garrett Anderson. This report is available online here (or at https://www.aip.org/statistics/reports/common-careers-physicists-private-sector).

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1 Physics Ellipse, College Park, MD 20740