Breaking the Myth of the “Non-Traditional” Physicist

The Real Story About Employment for Physics Graduates

University of Illinois Urbana-Champaign
Champaign, IL
September 8, 2016

Crystal Bailey
American Physical Society

www.aps.org/careers
Who is a Physicist?

Anyone with a Physics Degree

• BS
• BA
• MS
• PhD, etc.

Why?

• Definition is consistent with other disciplines (e.g. Chemistry)
  • Defines a common set of experiences (and texts)
    • Inclusive view is better for survival of discipline

What makes them Physicists?

Shared experiences creates familiarity—not only with the same Physics concepts, but also with the culture of the discipline.

However, most importantly, even a basic Physics training imparts essential problem solving skills—“how to think”—which is the hallmark of a physicist.
The AIP Statistical Research Center estimates that 1 in 6 physics bachelors will choose to finish a Physics PhD.

So ~17% of all Physics Degree holders will actually become Physics PhDs—and by extension “traditional physicists.”
At the time of the 2014 report, the AIP Statistical Research center found the number of physics PhDs conferred in the US to be the highest in the past century: **1,762**.

Based on current enrollments, we should expect PhD degree production to level off at around **1,700/year** in the next four years.

**Bottom line:** the US can expect to continue putting large numbers of Physics PhDs into the workforce.
What are PhDs doing with their degrees?

The largest percentage of Physics PhDs found initial employment in Postdoctoral and other temporary positions...

...but the vast majority of permanent jobs were in the private sector.
PhD Job Force: Demand

The majority (85%) of graduates who initially go into the academic sector are postdocs or temporary faculty. The remaining postdocs are mostly in national labs (21%).

Most postdocs go into their positions in the hopes of moving toward permanent employment.

Overall, 46% of Physics PhDs surveyed expected to have permanent careers in academia.
In fact, research shows that at PhD granting universities, previous experience as a postdoc (or as faculty) is a strong indicator of the likelihood of becoming a faculty hire.

At the same time, becoming a new faculty hire with only a graduate degree is unlikely—even at Bachelor’s granting universities.
Yet the number of departures of tenured and tenure-track faculty has changed little since 2003.

"While there were about 350 departures by tenured and tenure-track faculty during the 2006-2007 academic year... there were 475 recruitments for the same time frame, with 342 tenured and tenure-track faculty members hired in 2007-2008; this... is consistent with what we have seen in prior years."

--Focus on the Faculty Job Market in Physics and Astronomy Departments, AIP Statistical Research Center
Not all faculty positions are created alike

- The type of faculty position varies widely according to institution.
- Many individuals who do get new faculty positions will spend time waiting for a desired situation to open up.

Bottom Line: the job market for faculty in universities and other institutions is very stable.

“Stable” means that overall, not many jobs are being lost. At the same time, not many are being created, either.

Given that we are graduating over 1,700 PhDs/yr, with more than half of them going into postdocs with an intention of continuing as physics faculty, supply will continue to outweigh demand for the tenure-track academic career path.
PhD Employment in the Private Sector

Recall that the majority (70%) of graduates who initially went into permanent employment positions were in the private sector.

According to the NSF Survey of Doctoral Recipients, in 2013 the private sector was the largest single employment base of Physics PhDs: about 50% (the next highest was 4 year colleges, at 34%). It was also true in 2010 when the private sector employed 47% of PhDs.

This was also true in 2001, when the private sector employed 46% of Physics PhDs¹...

...and was also true in 1993, when the private sector again employed 46% of Physics PhDs².

In fact, the same data has shown consistent support for Physics PhDs in the private sector since 1971.

Industry has been the largest employment base for Physics PhDs for decades.

²NSF Integrated Survey Data, 1993
Not only does the private sector provide the largest number of jobs for physics PhDs, it also provides the highest-paying jobs, with a median starting salary near $95K.

By comparison, average typical starting salaries at Universities and 4-year colleges is around $60K...

...and a University postdoc position typically offers between the low $40K and $50K.

So, the private sector also offers well-paying employment to Physics PhDs.

Data only include US-educated PhDs who remained in the US after earning their degrees. The ranges of salaries represent the middle 50%, i.e., between the 25th and 75th percentiles. Government Lab includes Federally Funded Research and Development Centers, e.g., Los Alamos National Laboratory. UARI is University Affiliated Research Institute. The data for PhDs holding potentially permanent positions in academia include salaries based on 9-10 and 11-12 month commitments. Data are based on respondents holding potentially permanent positions in the private sector (158) and in universities and 4-year colleges (36) and on postdocs in government labs (65) and in universities and UARIs (291).

http://www.aip.org/statistics
But Won’t I Lose My Soul if I Go Into Industry? NO!

Besides “physics,” typical areas of employment for PhDs in the private sector included Engineering, Computer Science, Business, Finance, Education, or Medical Services.

Source: AIP Statistical Research Center Report Common Careers of Physics PhDs in the Private Sector, June 2015
What about the non-PhD physicists?

According to the AIP Statistical Research Center, 83% of physics bachelors will not earn a Physics PhD.

- Roughly one-third to one-half of Physics Bachelors will go straight into the workforce, mostly in STEM fields.
- Another third will go into graduate study in Physics and Astronomy.
- And the remainder will go into graduate study in other fields—including finance, law, and Medical Physics.

What types of employment are possible for these degree paths?
Initial Employment of Master’s Degrees

Between 2009-2011, about 50% of physics masters recipients entered or remained in the workforce.


- Private Sector: 44%
- College or University: 23%
- Government: 11%
- High School Teachers: 10%
- Active Military*: 2%
- Other: 10%


- Engineering: 43%
- Computer and Information Tech.: 21%
- Other Natural Science, Technology and Math: 14%
- Non-STEM: 13%
- Physics or Astronomy: 9%

Exiting master’s are individuals who, upon receiving their master’s degrees, leave their current physics departments.

Figure includes US employed physics master’s, including those who were employed part-time and master’s continuing in positions they held while pursuing their degrees. Other includes elementary and middle schools, health care facilities, and non-profit organizations.

*Figure excludes master’s receiving their degrees from military academies.

http://www.aip.org/statistics

http://www.aps.org/careers
Not surprisingly, physics master’s degree holders working in the private sector earned considerable more than their colleagues at colleges and universities.

MS grads who earned their degree while working in the private sector earned considerably more (~$83K).

A physics master’s degree will open the door to more advanced positions in a variety of technical fields, with higher salaries.

 Exiting master’s are individuals who, upon receiving their master’s degrees, leave their current physics departments.

The graphic represents the middle 50% of reported salaries, i.e., between the 25th and 75th percentiles. Figure does not include salaries for master’s holding part-time positions or salaries for respondents who reported starting their employment more than a year prior to earning their master’s degree. The College & University category includes two-year colleges, four-year colleges, universities, and university affiliated research institutes.

http://www.aip.org/statistics
On average between 1995 and 2012, about 40% of physics bachelors went directly into the workforce after graduation.

**Initial Employment Sectors of Physics Bachelor’s, Classes of 2011 & 2012 Combined.**

- Private Sector: 61%
- Civilian Gov’t, National lab: 5%
- Active Military*: 6%
- Other: 7%
- High School: 8%
- College & University**: 13%

**Field of Employment for Physics Bachelor’s in the Private Sector, Classes of 2011 & 2012 Combined.**

- Engineering: 30%
- Non-STEM: 30%
- Computer or Information Systems: 24%
- Other STEM: 13%
- Physics or Astronomy: 3%

STEM refers to natural science, technology, engineering, and mathematics.

http://www.aip.org/statistics

**Bottom line:** at all degree paths, the largest initial employment sector for physics graduates is the private sector.
Why Are Physics Grads Valuable to Industry?

Employers in STEM fields value physics graduates in their companies as members of interdisciplinary teams

- Standard physics curriculum creates familiarity with technologies commonly used in STEM workforce
  - Programming languages (e.g. C++, Fortran)
  - Circuit design and diagnostics (e.g. oscilloscopes, soldering)
  - Mathematical proficiency (e.g. differential equations, linear algebra)
  - Fabrication (e.g. lathes, bandsaws, screws)

- Language of Job Descriptions
  - Common job titles across STEM recruitments (including physics), e.g. “analyst,” “engineer,” “developer,” etc.
  - Common skills listed in recruitments for physics and engineering graduates:
    - perform testing/analysis
    - develop/design
    - implement
    - run queries and reports

\[^3\]APS Job Board search, 4-year degree job postings
• They Tell Us
  – “BYOCEO” meeting, April 2013. Nate Seidle, SparkFun:
    “Engineering is about putting the period on the sentence. The engineer may write
    the code, but the physics guy understands what it has to do with the larger
    context. Together they are very effective.”
  – ABET Survey for Applied Physics and Engineering Physics Graduates, Kettering
    University.

Over 80% of surveyed employers⁴ agreed that physics majors:

• Could easily grasp new knowledge and concepts
• Could competently use computer applications and databases
• Were able to identify, formulate, and solve problems
• Were able to use current techniques/tools for technical practices
• Were able to successfully analyze and interpret data
• Could engage in continued learning and problem solving

⁴ABET Survey of applied and engineering physics graduates, Kettering University
What else do STEM employers say?

That physics graduates are also missing important training and experience:

- Ability to design a system, component or process to meet a specific need\(^5\)
- Ability to function on multi-disciplinary teams\(^5,6\)
- Ability to recognize value of diverse relationships (customers, supervisors, etc.)\(^5\)
- Leadership Skills\(^5\)
- Familiarity with basic business concepts (i.e. cost-benefit analysis, funding sources, IP, project management)\(^5,6\)
- Communication skills (oral and written) – esp. how to tailor message to audience\(^5\)
- Real-world experience in companies before graduation\(^6\)
- Awareness of career paths outside of academia\(^6\)

\(^5\)ABET survey of applied and engineering physics graduates, Kettering University
\(^6\)APS Workshop on Nat’l. Issues in Industrial Physics
To summarize:

Based on available information we can say the following about the physics discipline regarding student career preparedness:

• Some content/knowledge overlap with other STEM disciplines.
  – e.g. particularly technical skills, techniques, equipment
• Some characteristics which are distinct from other STEM disciplines.
  – ability to grasp wider scientific context of work
  – ability to formulate problem solutions from first principles (i.e. the people who start the process rather than “putting the period on the sentence”).

Some important content is missing from physics training, including communication and leadership skills, an ability to function well in an interdisciplinary context, and an awareness of careers outside of academia.

Students are able to engage in a degree of career self-advocacy. But the discipline should also provide them with appropriate, realistic training for future careers in non-academic sectors.
What Can Students Do?

Perform a detailed self-assessment
• Understand what you love doing, what you’re good at doing, and what you want. Think beyond job specifics.
• Take advantage of existing tools to help you understand your strengths (e.g. the Strong® Interest Inventory).

Attend Informational Interviews
• Use connections (LinkedIn® and alumni networks are especially helpful) to reach out to a company or industry you’re interested in.
• Not only builds connections in the company, but gives you an “insider education” about that industry.

Build Your Network
• Develop a “pitch”—be able to describe your background and what types of career paths you’re interested in a few sentences.
• Talk to EVERYONE!!
Keep a Career Journal and Document Skills

• Every experience gives you valuable transferrable skills. Try to sit and write down every single one (don’t just focus on “hard science”). This list is a set of “building blocks” for every resume you will ever write.

Capitalize on Opportunity

• Know good places to search for science and technology jobs (e.g. the APS Job Board)
• Understand the skills the job requires, and honestly assess whether you have them, or would be interested in building them.

Know How to Write and Effective Resume (not a CV)!

• They are not interchangeable!
• Resumes are the only document appropriate for non-academic jobs, and should be only one page long.
• Write a unique resume for every single position you apply for.

http://go.aps.org/physicsresume
Take Advantage of APS Resources!!

APS Online Professional Guidebook
- Detailed advice on key aspects of career development.
- Features 5-minute “webinette” clips from the top APS careers webinars
  - APS webinar “Putting Your Science to Work,” with Peter Fiske
  - APS webinar “Career Self-Advocacy: How I Got A Six Figure Job in the Private Sector,” with Meghan Anzelc
- Topics include self-assessment, networking, interviewing and negotiation strategies, and more.

**go.aps.org/physicspdguide**

APS Careers Website
- APS Job Board
- Physicist Profiles and Job Prospects pages
- Employment and Salary Information
- APS Webinars archive

www.aps.org/careers
APS Local Links

- Locally based, grassroots gatherings of students and physicists.
- Focus on students and physicists working in academia, industry, and national labs.
- Groups meet about every 6-8 weeks, usually in a pub or restaurant (“neutral ground”).
- Goal is to build mutually beneficial relationships, raise awareness of non-academic careers, and promote recruitment of student and postdocs into industries.
- Current sites include:
  - Ann Arbor
  - Austin
  - Boston
  - DC - Baltimore
  - Denver - Boulder
  - Los Angeles
  - Silicon Valley
  - St. Louis
  - Research Triangle

http://go.aps.org/local_links
What Can Faculty Do?  
Broaden Your Students’ Career Focus

- APS Online Professional Development Guidebook
  Key professional development topics such as skills self-assessment, networking, resume writing, and more

- APS Careers Webinars
  Free, cover a wide variety of topics including careers in industry and entrepreneurship.

- APS Physicist and Job Prospects Profiles
  Information about salary, job outlook, and placement and advancement strategies for common physics career paths

- Physics InSight Careers Slideshow
  downloadable slideshow featuring physicists working in diverse fields, salary and employment info, and more.

Other Resources

- AIP Statistical Research Center
  Up to date statistics on physics employment, salaries, job outlook, job satisfaction, and more.

- YOUR Local Career Services Office
  Comprehensive self-assessment tools for students and expertise on non-academic fields.

www.aps.org/careers  
bailey@aps.org
Encourage More Industry Contact/Mentorship

- APS IMPACT Program
  Industrial Mentorship for Physicists, due to launch by November 1.
- APS Distinguished Lectureship on the Application of Physics.
- APS Local Links Program
- LinkedIn
  Connect with your students now, and you’ll be connected with industrial physicists in the future!

Include Physics Innovation and Entrepreneurship in Labs and Courses

- Experiential learning/“maker” spaces (e.g. the Innovation Hyperlab, Garage Physics)
- Enhanced co-op or internship programs
- Entrepreneurship tracks which incorporate physics and engineering or business courses
- Adapted “standard” courses which include relevance to applications and/or workforce
- New courses on communication, IP, business structures, etc.
- And others....
Engage a Community of Practitioners

- VentureWell (formerly Nat’l Collegiate Innovators and Inventors Alliance)
- Scienceworks Physics Entrepreneurship Bachelor’s Degree at Carthage College
- University of Colorado, Denver/Innovation Hyperlab
- Case Western University Physics Entrepreneurship Master’s
- Loyola University, Kettering University

“Reinventing the Physicist” Conference – June 2014

- Representatives from 50 institutions in attendance
- Dedicated sessions for physics innovation and entrepreneurship at APS annual meetings.

VentureWell Open Conference – March 2016

- Annual meeting focusing on interdisciplinary adoption of innovation and entrepreneurship (I&E) education.
- Significant cohort of physics educators gave talks and posters on individual approaches to teaching I&E in physics.
Introducing Pathways to Innovation & Physics Entrepreneurship: Launching Institutional Engagement (PIPELINE)

• NSF-funded program brings together efforts of six institutions (Loyola University Maryland, Rochester Institute of Technology, Wright State University, UC Denver, and George Washington University).

• Advised by experts from established physics entrepreneurship programs (e.g. Carthage College, Case Western, Kettering University).

• Goal is to develop and disseminate a comprehensive set of implementation strategies for physics innovation and entrepreneurship education. These will include curricular, co-curricular and extra-curricular activities.

• The project will also develop research instruments which will investigate the link between PIE experiences and student and faculty attitudes about innovation and entrepreneurship, and which can be used by other departments for gauging, monitoring, and improving institutional change around PIE.

• Award notification was Friday, 9/2... so “hot off the presses!”

• Website is being built, check aps.org in late September. APS News article also forthcoming.
Remember:

• Academic Physics is not the most common path!
  – Most physics grads at all degree levels go into the private sector.
  – Many of those who do (especially at the PhD level) will do scientific research.

• Students Can Plan Effectively by Broadening Your Focus
  – Use resources to learn about and prepare for career paths outside of academic physics.

• Faculty Can Help by Providing Better Career Awareness and Training to Students
  – Foster stronger industry connections/mentorship, and add workforce targeted experiences and content to existing physics curricula.

Questions? Comments?
bailey@aps.org
Physics Innovation and Entrepreneurship (PIE) Education

Experiences, courses, and research opportunities which:

• Explicitly connect physics concepts with their real world applications.

• Utilize physics principles to create innovative solutions to real world problems.

• Include content relevant for careers in the private sector, such as communicating to audience, intellectual property, private and public funding sources, business models, budgeting, etc.