Breaking the Myth of the "Non-Traditional" Physicist

The Real Story About Employment for Physics Graduates

University of Illinois Urbana-Champaign
Champaign, IL
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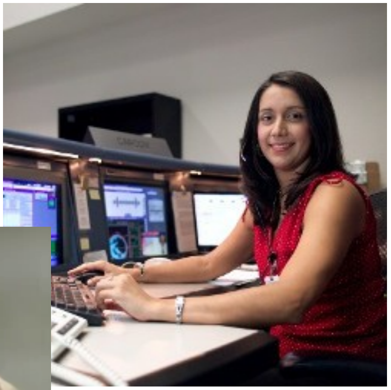
Who is a Physicist?

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.

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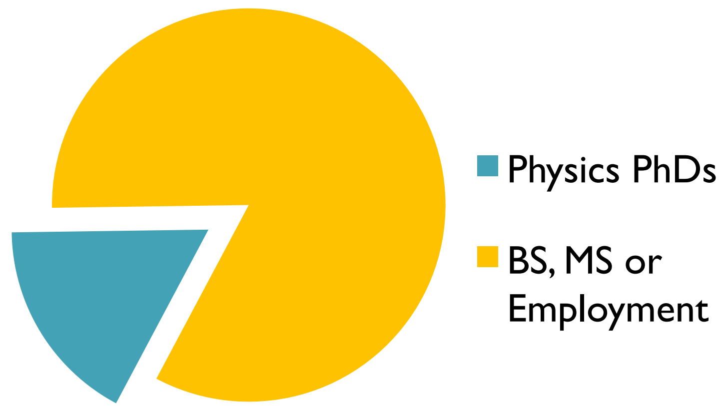
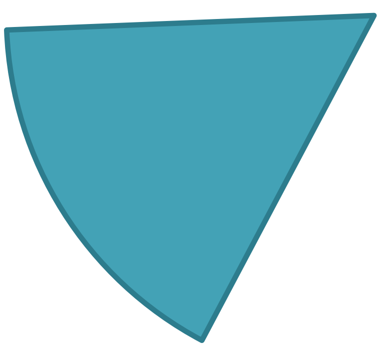
Where do Physicists Work?

Not where you think!

What is a "traditional physicist"? A physics professor? A PhD researcher? The "most common" career path?

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."

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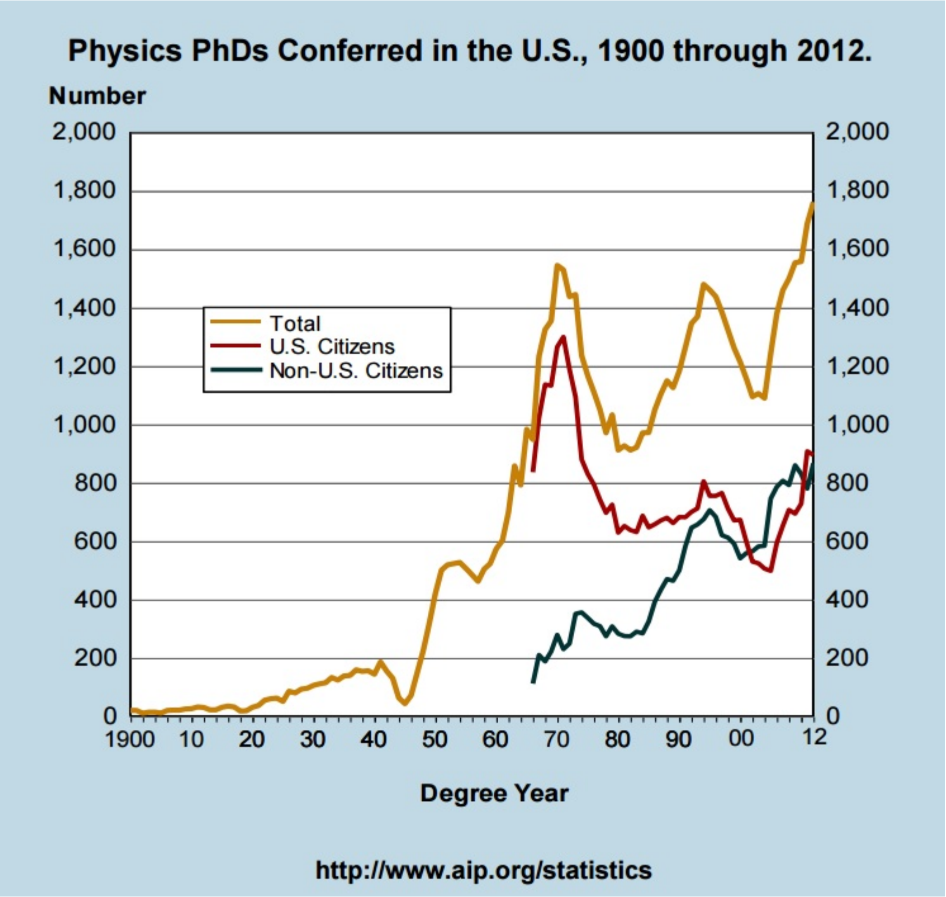
PhD Job Force: Supply

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.



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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.

Type of Employment of Physics PhDs by Employment Sector One Year After Degree, Classes of 2013 & 2014 Combined

Sector of Employment	Initial Employment Type			Overall %
	Postdoc %	Potentially Permanent %	Other Temporary %	
Academic*	75	20	71	52
Private	1	70	18	31
Government	21	8	3	14
Other	3	2	8	3
	100%	100%	100%	100%

Note: Data only include US-educated physics PhDs who remained in the US after earning their degrees. Data are based on the responses of 655 postdocs, 523 individuals working in potentially permanent positions and 126 individuals working in "other temporary positions."

*The academic sector includes two- and four-year colleges, universities, and university affiliated research institutes.

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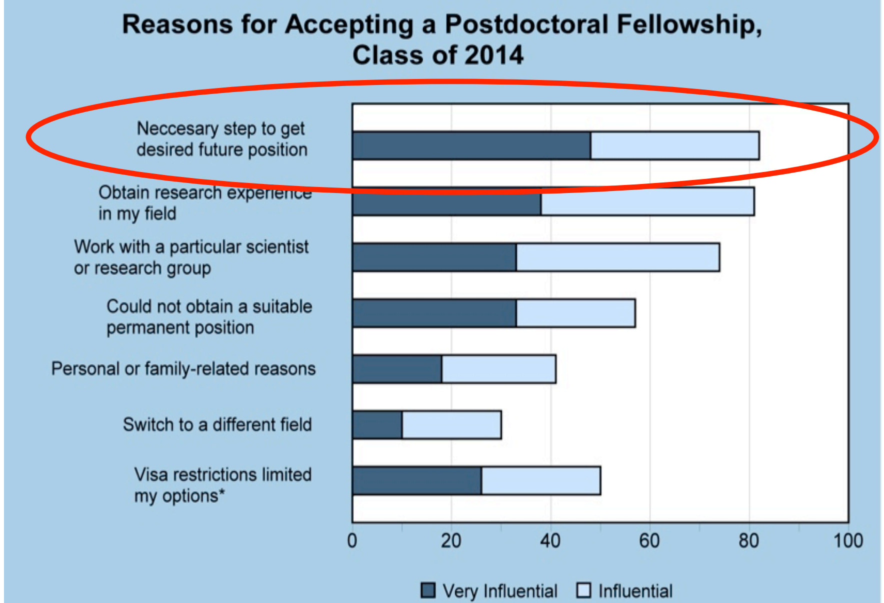
PhD Job Force: Demand

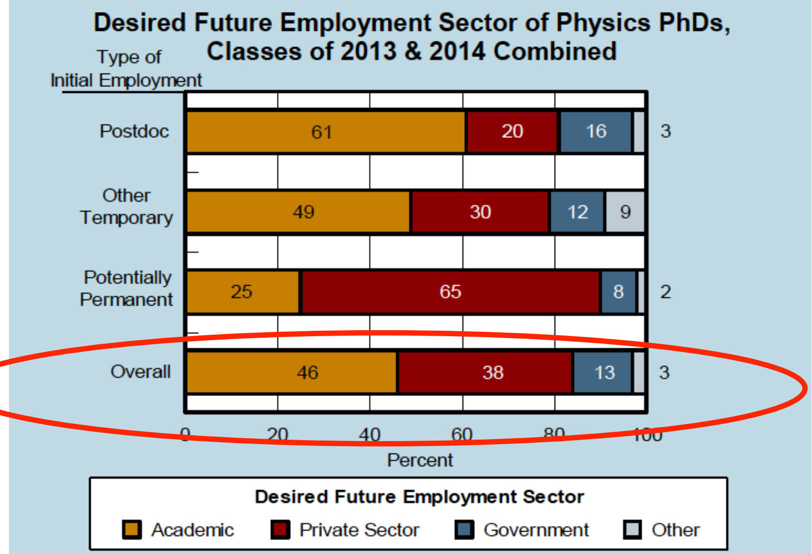
The majority (85%) of graduates who initially go into the academic sector are postdocs or temporary faculty. The remaining postdocs are mostly in national labs (21%).

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



Data are limited to PhDs who earned their degrees in the class of 2014 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 postdoctoral fellowships. They were presented a four point scale that included “very influential”, “influential”, “of little influence”, and “not at all influential”.

*The data on “visa restrictions limited my options” are limited to non-US citizens.



“Desired future employment sector” is based on the responses of PhDs when asked which employment sector they would like to be working in ten years in the future. Data are limited to physics PhDs who remained in the US following receipt of their degrees. Data are based on the responses of 403 postdocs, 288 potentially permanently employed PhDs, and 84 PhDs employed in “other temporary positions”.

*The academic sector includes two- and four-year colleges, universities, and university affiliated research institutes.

Overall, **46% of Physics PhDs** surveyed expected to have permanent careers in academia.

Immediate Previous Positions of New Physics Faculty, 2007-08 for Tenured and Tenure-Track Hires*

	Highest Degree Awarded	
	PhD (%)	Bachelor's (%)
Postdoc	54	32
Research Scientist	24	8
Tenured or Tenure-Track Professor	20	16
Graduate Student	1	11
Adjunct, Part-time, or Visiting Faculty	1	28

*Includes permanent non-tenured faculty at schools without tenure.
(Only the 5 most common categories of previous position are shown.)

http://www.aip.org/statistics

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.

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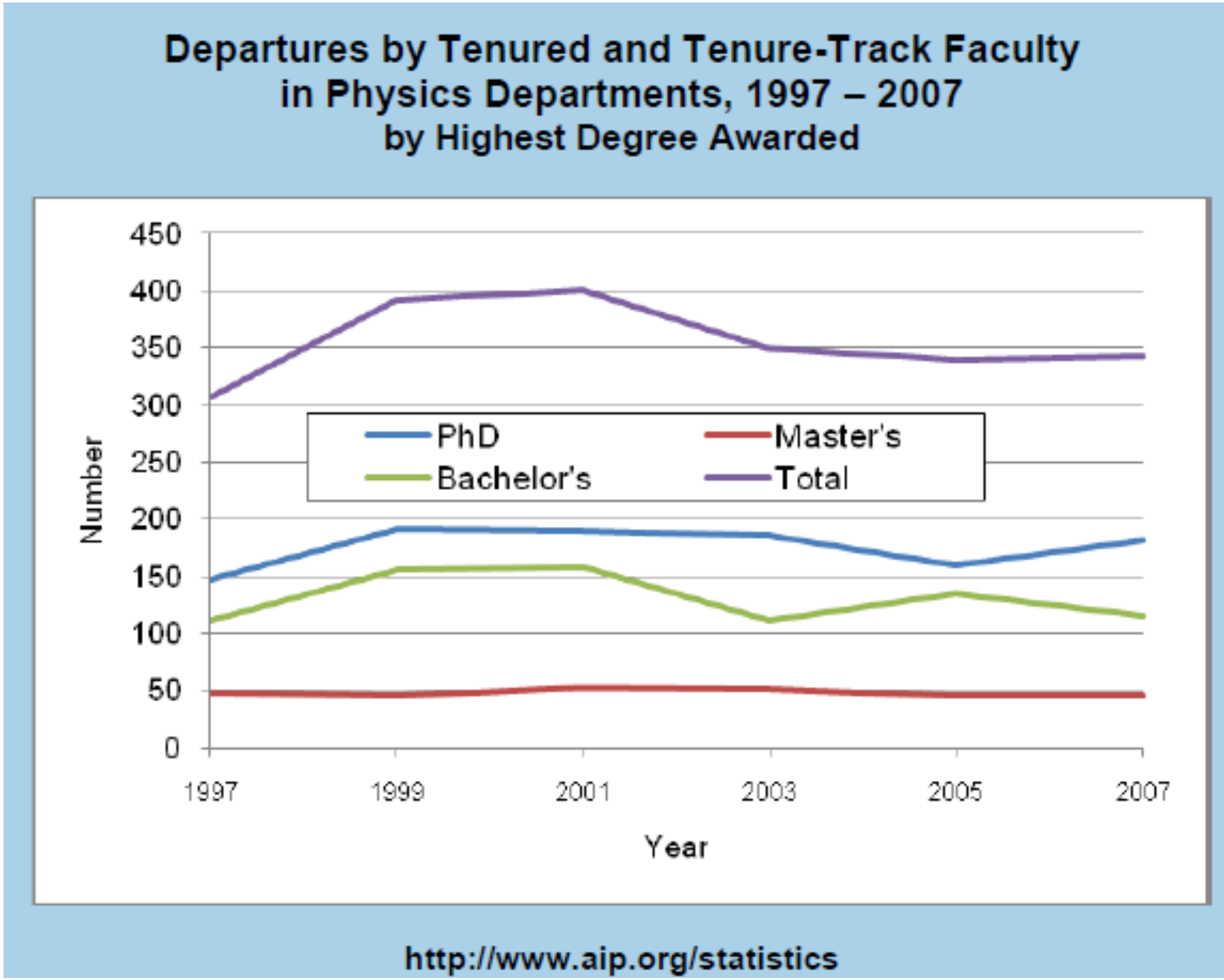
Yet the number of departures of tenured and tenure-track faculty has changed little since 2003.



"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

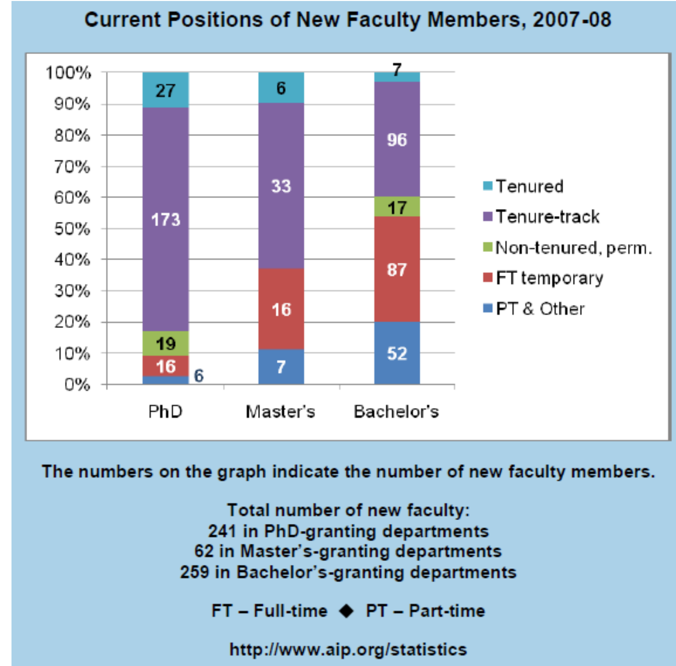
Not all faculty positions are created alike

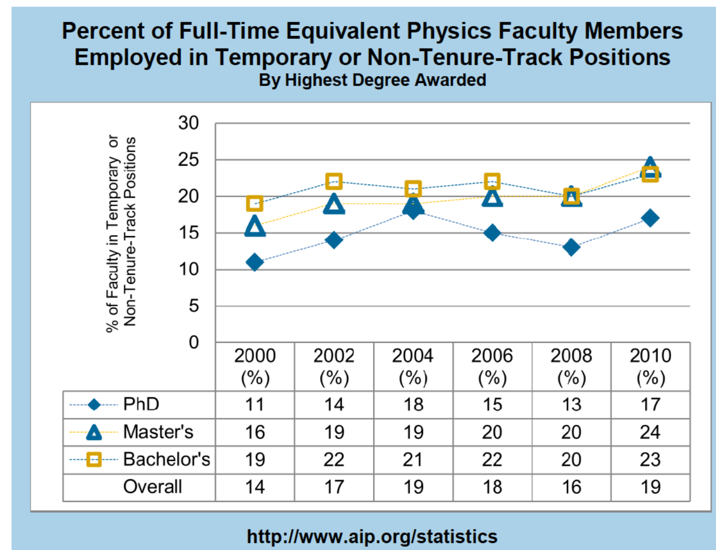
- The type of faculty position varies widely according to institution.
- Many individuals who do get new faculty positions will spend time waiting for a desired situation to open up.

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.





	2000 (%)	2002 (%)	2004 (%)	2006 (%)	2008 (%)	2010 (%)
PhD	11	14	18	15	13	17
Master's	16	19	19	20	20	24
Bachelor's	19	22	21	22	20	23
Overall	14	17	19	18	16	19

PhD Employment in the Private Sector

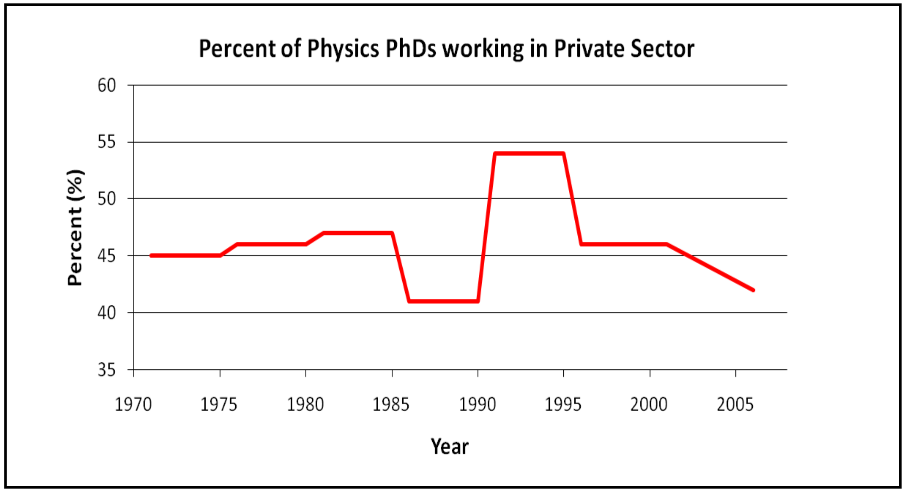
Recall that the majority (70%) of graduates who initially went into permanent employment positions were in the private sector.

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 PhDs[1]…

…and was also true in 1993, when the private sector again employed 46% of Physics PhDs[2].

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



[1]NSF Survey of Doctoral Recipients, 2001, 2010, 2013
[2]NSF Integrated Survey Data, 1993

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

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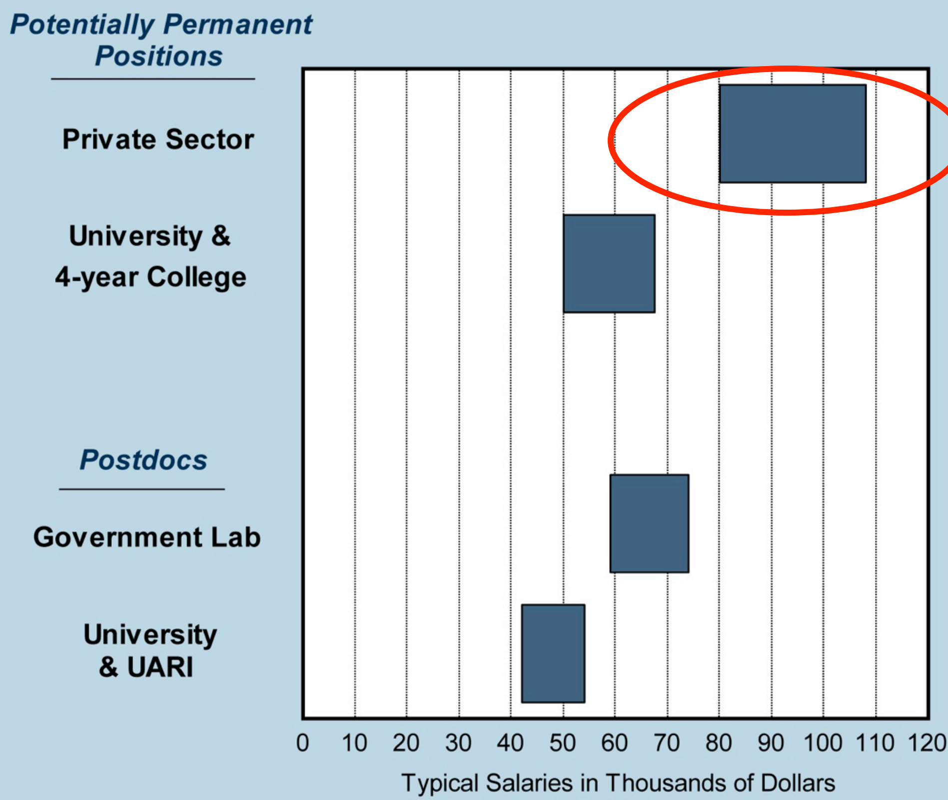
Not only does the private sector provide the largest number of jobs for physics PhDs, it also provides the highest-paying jobs, with a median starting salary near $95K.

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.

Starting Salaries for Physics PhDs, Classes of 2013 & 2014 Combined



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).

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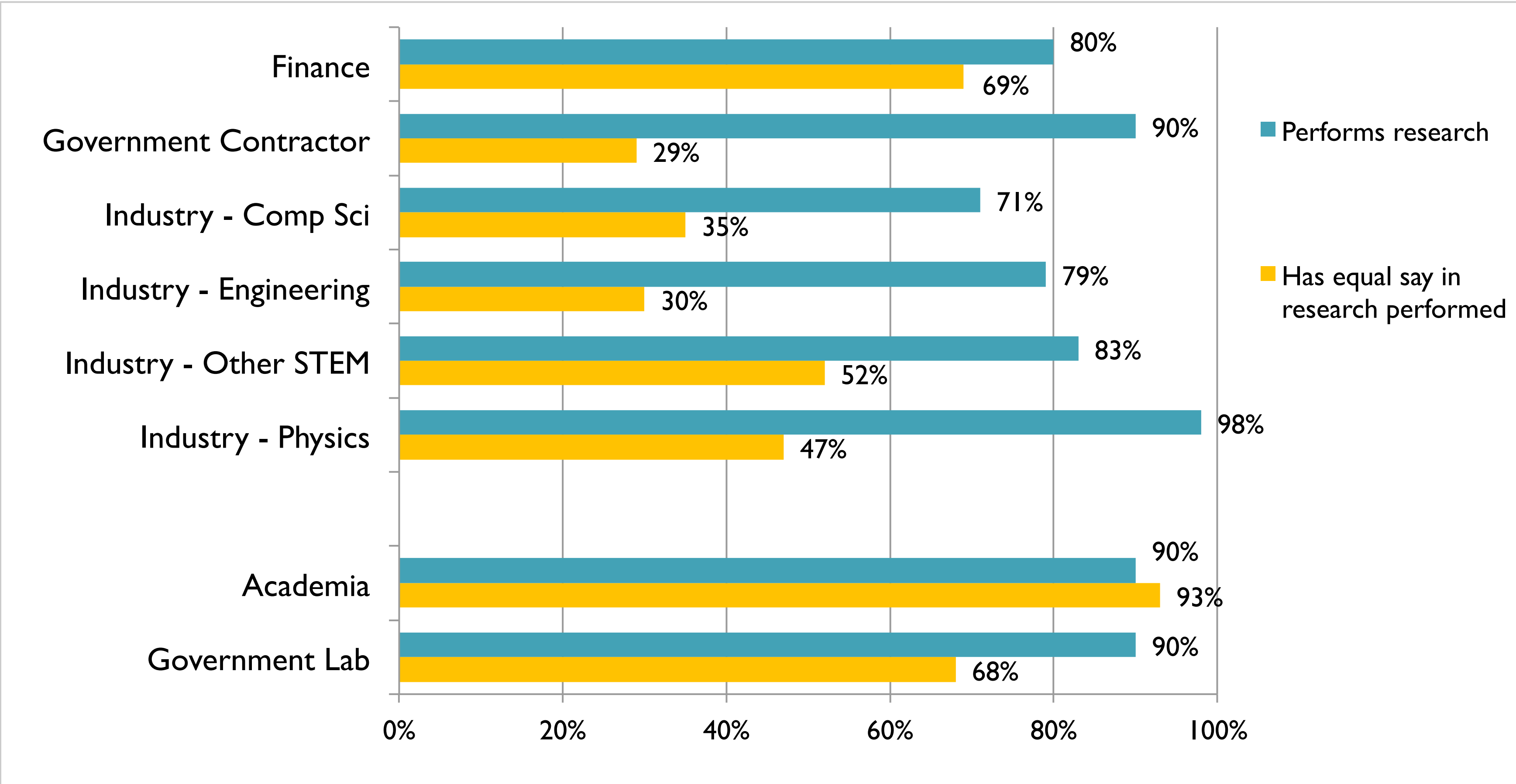
But Won't I Lose My Soul if I Go Into Industry? NO!



Source: AIP Statistical Research Center Report Common Careers of Physics PhDs in the Private Sector, June 2015

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

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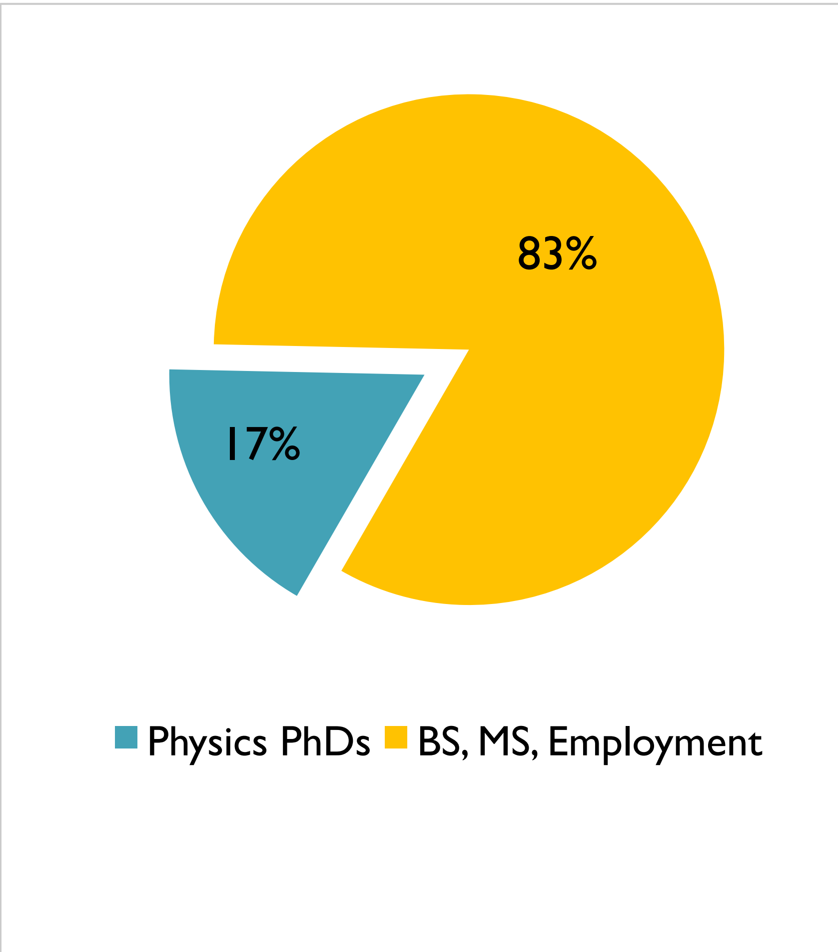
What about the non-PhD physicists?

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?

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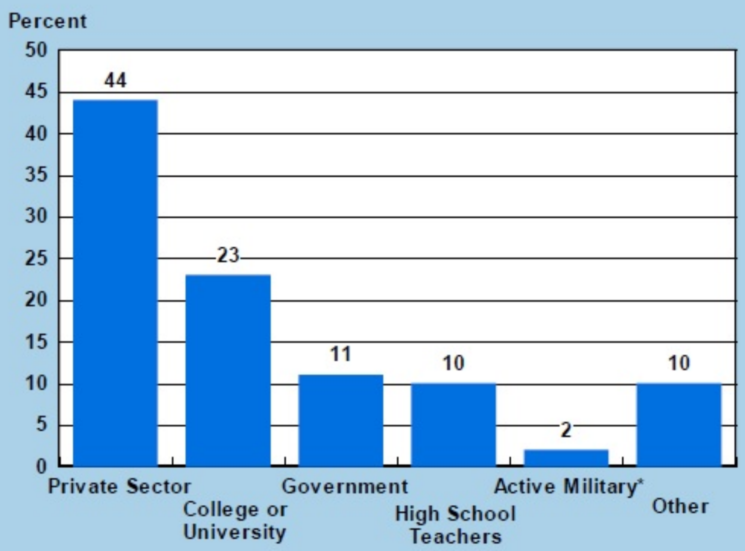
Initial Employment of Master's Degrees

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

Employer Distribution of Exiting Physics Master's One Year After Degree, Classes of 2009, 2010, & 2011 Combined.



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.

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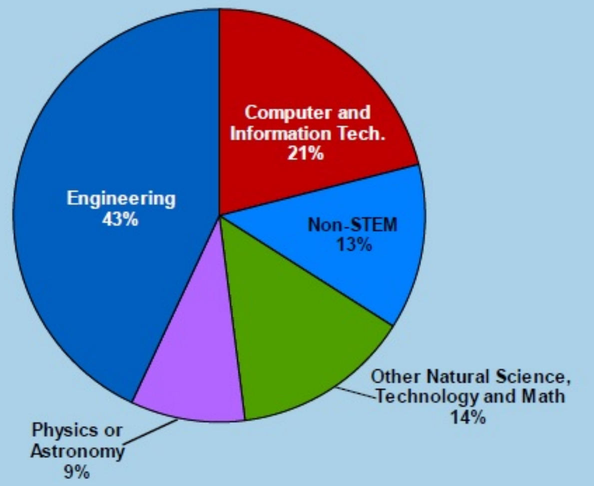
Field of Employment of Exiting Physics Master's Working in the Private Sector One Year After Degree, Classes of 2009, 2010, & 2011 Combined.



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. Figure is based on responses of 158 individuals.

STEM refers to science, technology, engineering and math.

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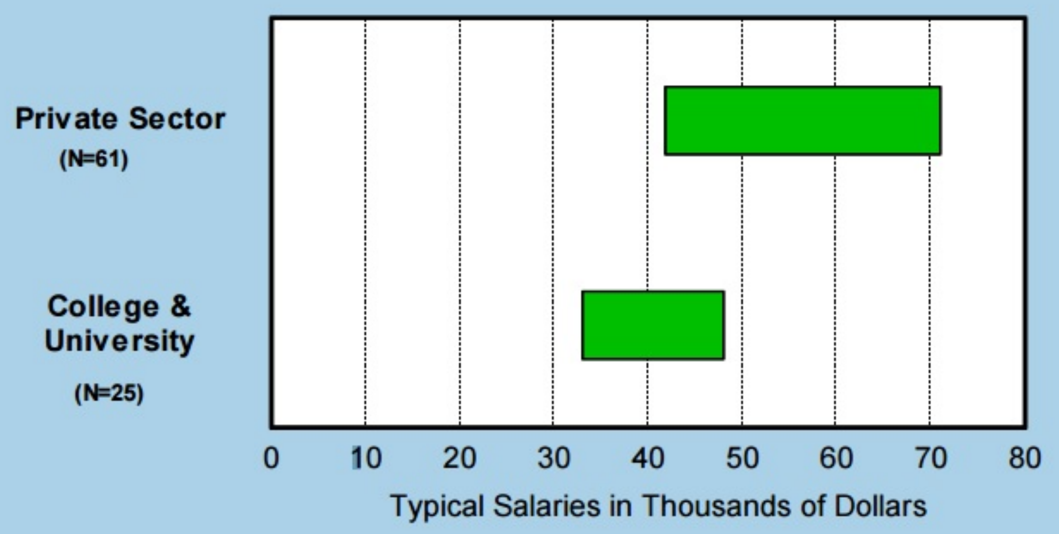
Not surprisingly, physics master's degree holders working in the private sector earned considerable more than their colleagues at colleges and universities.

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.

Typical Starting Salaries of Exiting Physics Master's One Year After Degree, Classes 2009, 2010, & 2011 Combined.



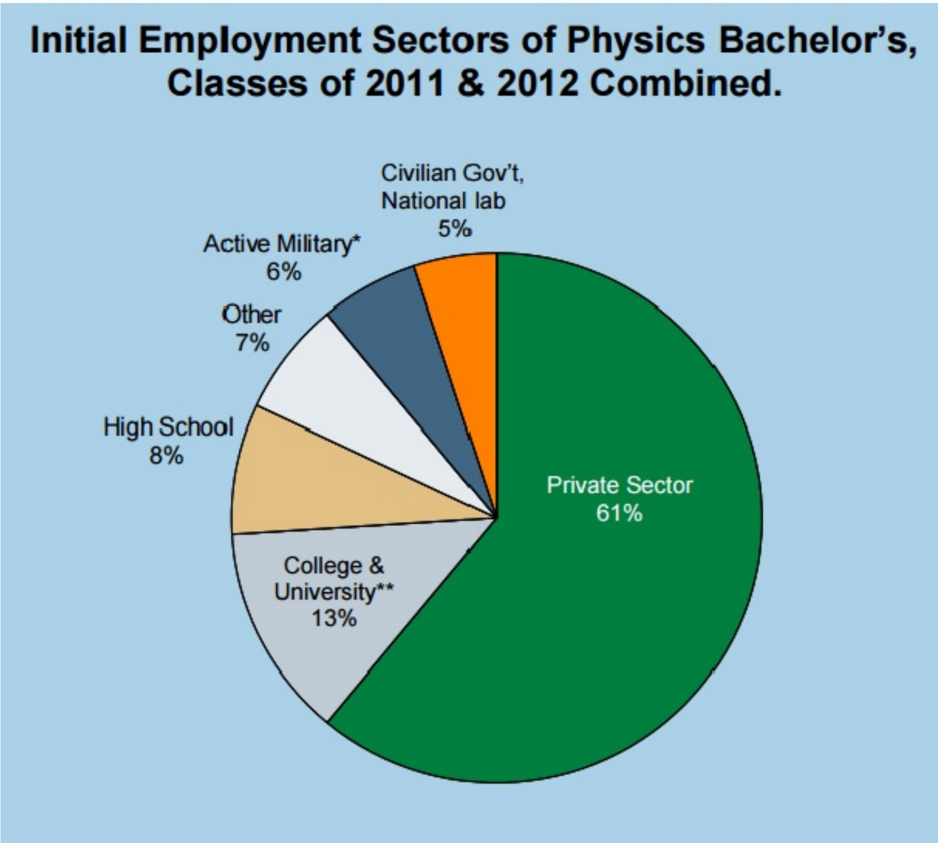
Exiting master's are individuals who, upon receiving their master's degrees, leave their current physics departments.

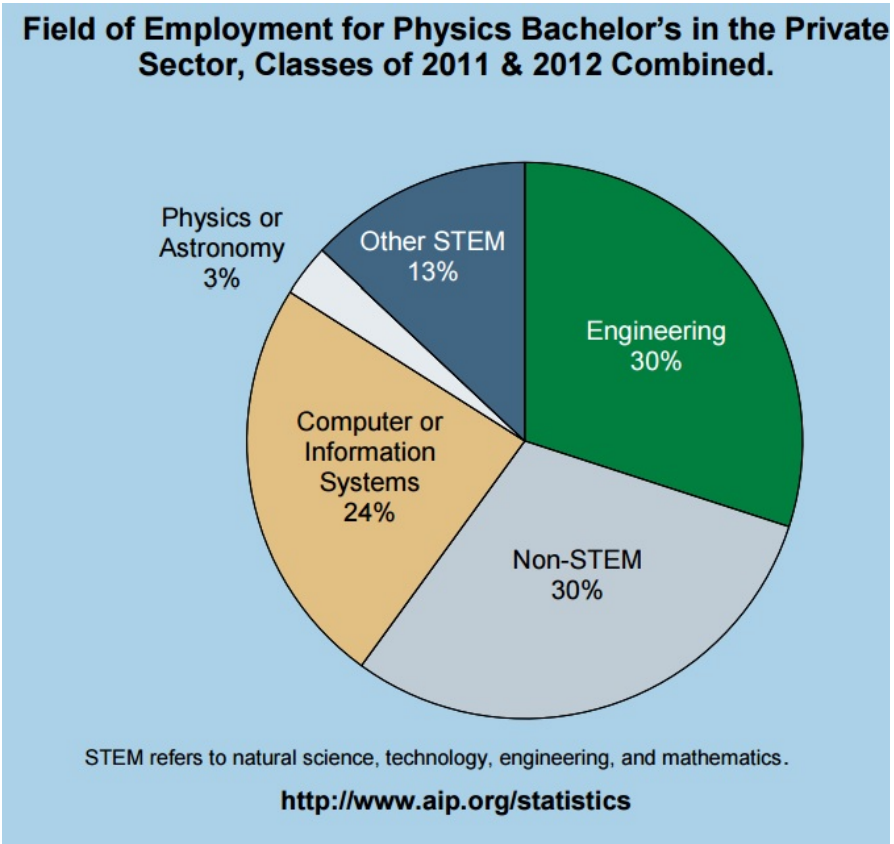
The graphic represents the middle 50% of reported salaries, i.e., between the 25th and 75th percentiles. Figure does not include salaries for master's holding part-time positions or salaries for respondents who reported starting their employment more than a year prior to earning their master's degree.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

http://www.aip.org/statistics

Initial Employment of Physics Bachelors

On average between 1995 and 2012, about 40% of physics bachelors went directly into the workforce after graduation.





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[3]
  - 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 employers[4] agreed that physics majors:

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

[4] ABET Survey of applied and engineering physics graduates, Kettering University

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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

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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.

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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!!

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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 asses 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

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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

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APS Local Links

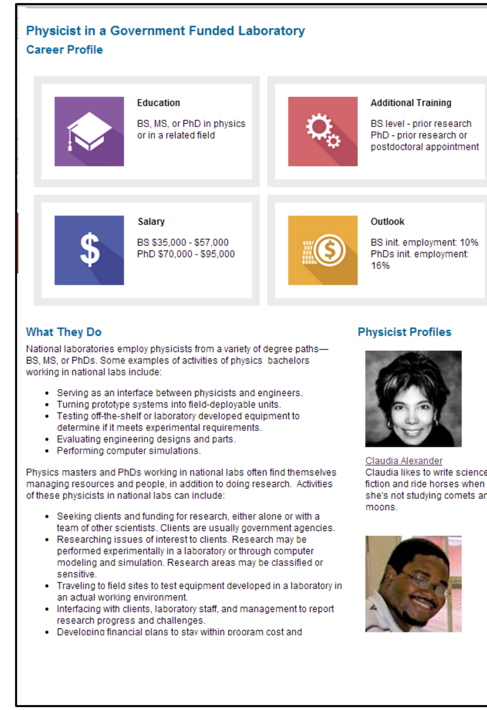
- Locally based, grassroots gatherings of students and physicists.
- Focus on students and physicists working in academia, industry, and national labs.
- Groups meet about every 6-8 weeks, usually in a pub or restaurant (“neutral ground”).
- Goal is to build mutually beneficial relationships, raise awareness 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


Physicist in a Government Funded Laboratory
Career Profile

Education
BS, MS, or PhD in physics or in a related field

Additional Training
BS level - prior research
PhD - prior research or postdoctoral appointment

Salary
BS $35,000 - $57,000
PhD $70,000 - $95,000

Outlook
BS init. employment: 10%
PhDs init. employment: 16%

What They Do

National laboratories employ physicists from a variety of degree paths—BS, MS, or PhDs. Some examples of activities of physics bachelors working in national labs include:

- Serving as an interface between physicists and engineers.
- Turning prototype systems into field-deployable units.
- Testing off-the-shelf or laboratory developed equipment to determine if it meets experimental requirements.
- Evaluating engineering designs and parts.
- Performing computer simulations.

Physics masters and PhDs working in national labs often find themselves managing resources and people, in addition to doing research. Activities of these physicists in national labs can include:

- Seeking clients and funding for research, either alone or with a team of other scientists. Clients are usually government agencies.
- Researching issues of interest to clients. Research may be performed experimentally in a laboratory or through computer modeling and simulation. Research areas may be classified or sensitive.
- Traveling to field sites to test equipment developed in a laboratory in an actual working environment.
- Interfacing with clients, laboratory staff, and management to report research progress and challenges.
- Developing financial plans to stay within program cost and

Physicist Profiles

Claudia Alexander
Claudia likes to write science fiction and ride horses when she's not studying comets and moons.

- 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

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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….

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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.

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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?
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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.

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