Physics Is Great, But Where Do I Go Next?

Graduate Programs in Physics

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July 24, 2018

Your Options with a Physics Degree

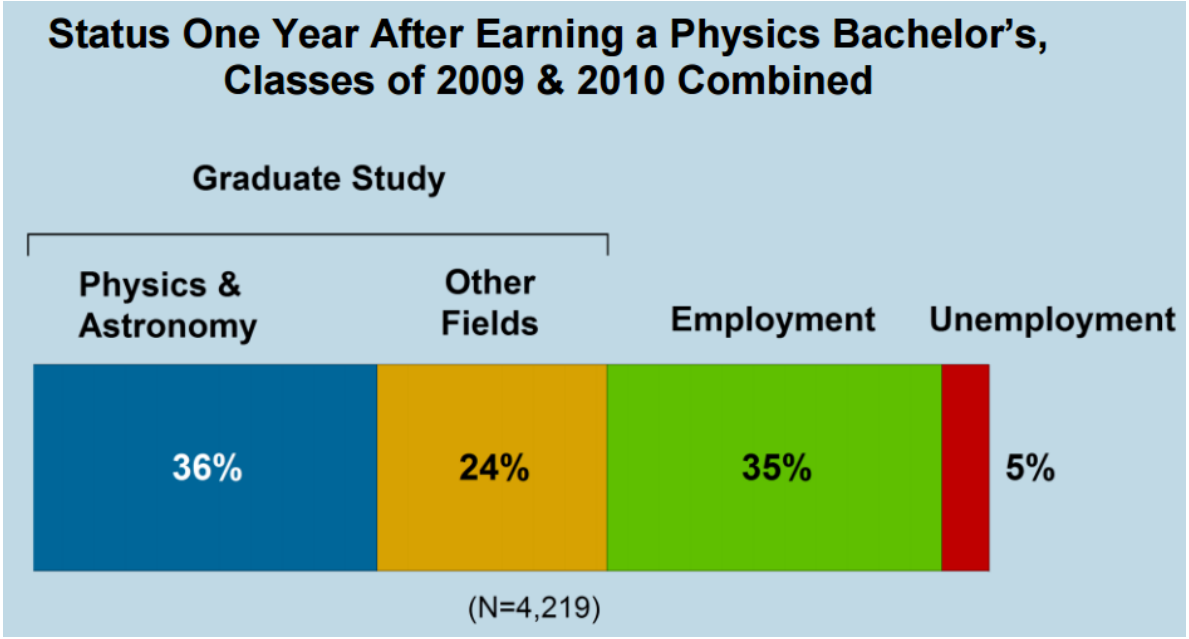
"Verifying his bank account balance, the grad student is worthless."

After you graduate, you could...

- Join the workforce $\Rightarrow$ \$\$\$
- Master's, professional degrees (JD, MD, etc.)
- "Enrichment"
- **PhD in physics, applied physics, astronomy**

Typical Choices

Old, but still representative statistics

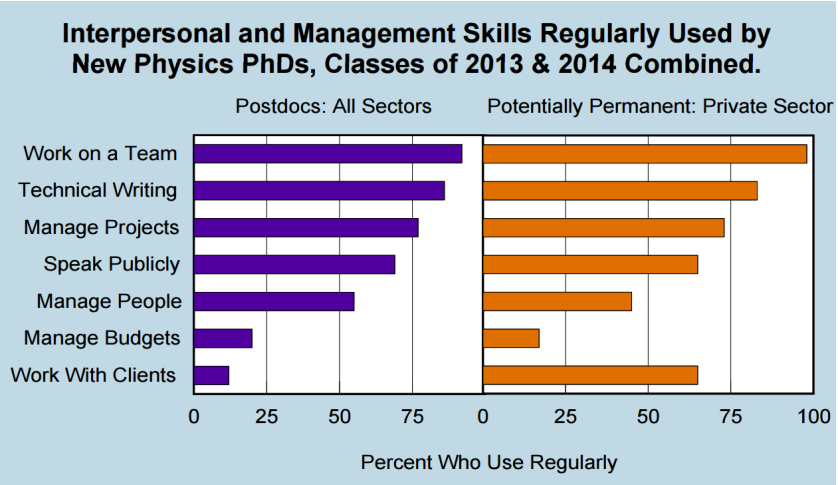


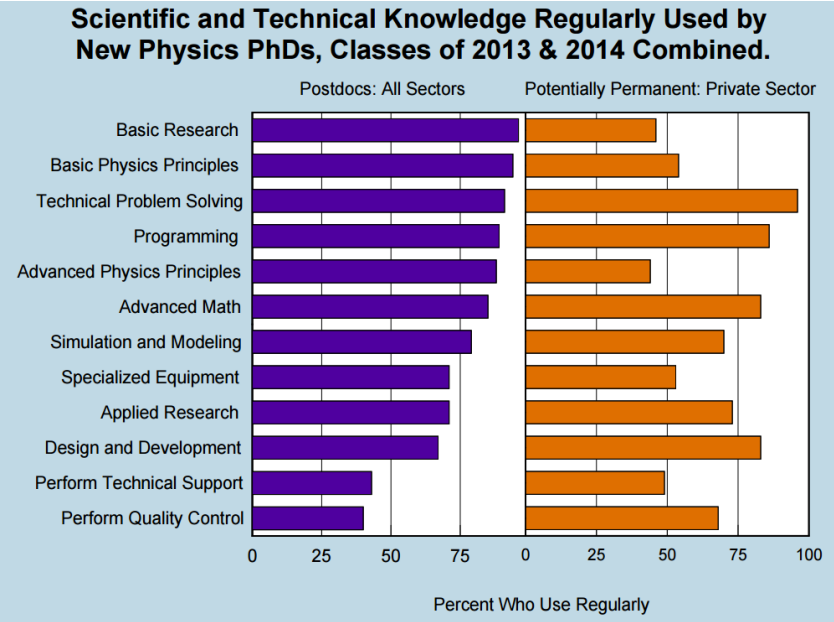
PhD is a quite common choice,
though definitely not the majority

Definition
What is a PhD?

- Doctor of Philosophy
- Undergrad:
  learning *old* knowledge
  PhD: discovering *new*
  knowledge, original contribution
- Focus on *research*,
  NOT coursework
- Solve problems that
  nobody has solved before

Goals and Rewards
Why PhD? What do I gain?



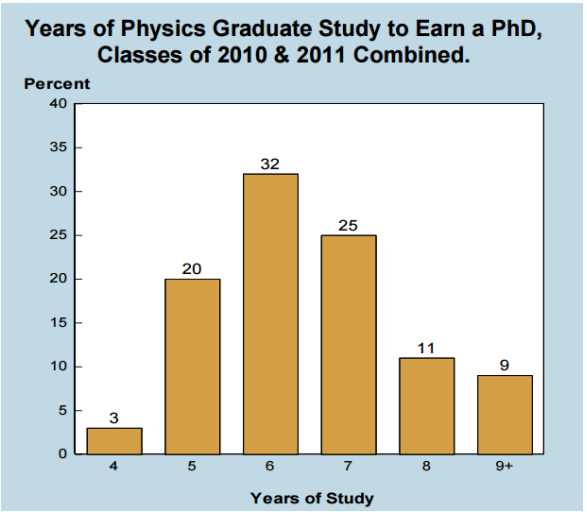


PhD program exists 'primarily' to train scientists. *However*, training as a scientist means much more than what you think!

- Generalizable physical principles
- Mathematical modeling, statistical analyses
- Critical thinking abilities
- Programming skills
- Team project experiences
- Technical writing/speaking

Typical Requirements & Timeline

What you actually do during your PhD

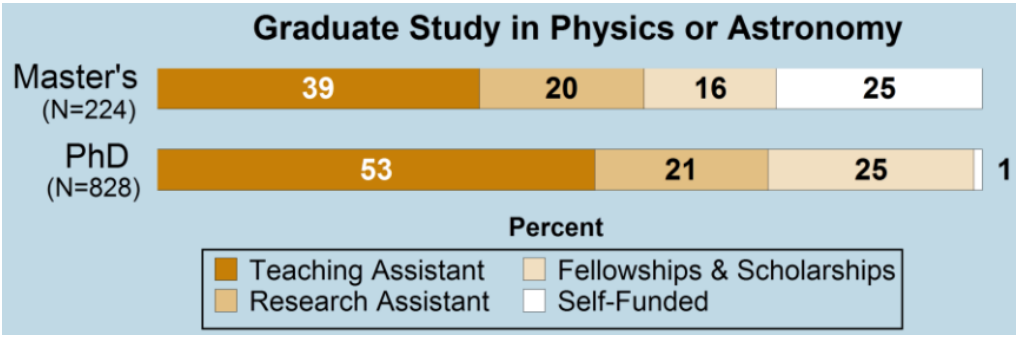


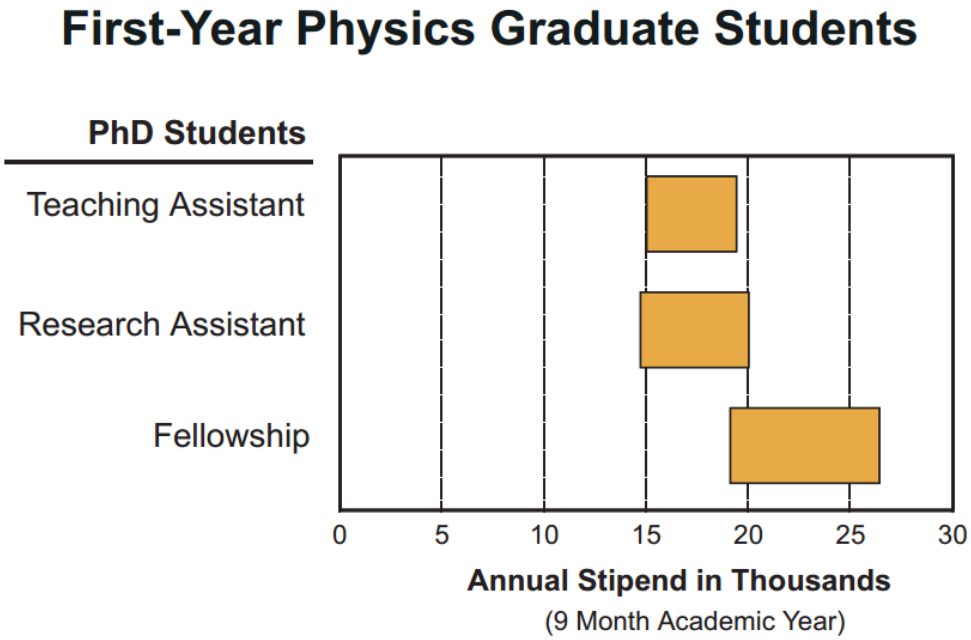
- **Coursework:** 1–2 years, ∼4 cores + some electives
- **Rotation & Seminar:** broaden experience & decide specialty
- **Qual./Candidacy:** final "test" before full-time research
- **Full-time Research:** research on your topic of interest
- **Thesis Defense:** write and defend your thesis

These vary from school to school!

Financial Aid in PhD Programs

Don't pay for it!





2009-2010 Survey

You are expected to be *fully supported* during your PhD, but stipend is *not much*

- Varies broadly
- Based on rent and other living costs
- Theorists: tougher
- Fellowships help!

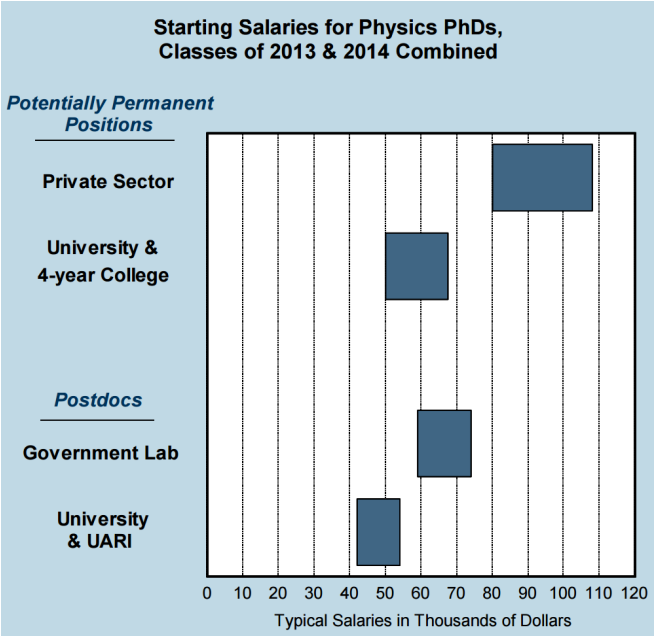
Usually enough for living, but *really not that much*

After Your PhD

This is far far away, but still...

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

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



- Academia: difficult
- High private-sector salaries (median ∼$100k)
- Tenure: even harder (∼10%)
- Very broad range

Eventually, majority ends up in private sector, NOT academia. However, there are *a range of opportunities* after physics PhD.

Is PhD for Me? Am I for PhD?

PhD sounds great, but 5+ years commitment of extremely hard work is obviously *not for everyone*.

$\Rightarrow$ *How should I decide?*

Some questions to ponder upon:

- Do I *really* love physics and/or astronomy? (Are you enjoying the summer so far?) What else do I enjoy?
  - Which sub-fields? ONLY one? (might be a bad sign)
- Am I going to be *good* at this? (research, self-motivated work, time management, etc.)
- Am I okay being 'not so rich' for a while? Financial concerns?

Talking to *current grad students* should help!

PhD! I Choose You!

If you eventually choose physics/astronomy/AP PhD...

- Are you *sure*? This isn't going to be easy...
- If you are, welcome! It will be *hard, but rewarding* 5+ years!

... but admissions sound difficult, so

How should I prepare???

Where? Whom?

What does applying to a graduate program even mean?

- U.S. PhD programs: apply to the *department*, not individual faculty members
- At least a couple to work with from each program
  - Young, active professors
  - This requires extensive research!

Schools	Deadline	Faculty Members	Research Interests
Harvard (Physics)	Dec. 15th, 2016	**Cora Dvorkin**	data-driven cosm., BICEP/Keck
		Masahiro Morii	ATLAS, electro-weak, cosm.
		John Huth	ATLAS, electro-weak, cosm.
		Roxanne Guenette	neutrino, MicroBooNE, DUNE
Harvard (Astronomy)	Dec. 15th, 2016	**Daniel Eisenstein**	cosm., BAO, SDSS
		John Kovac	cosm., CMB, BICEP/Keck
		Lars Hernquist	cosm., galaxy simulation
U. Chicago	Dec. 15th, 2016	**Edward Blucher**	SNO+, DUNE, CP violation, m-am
		David Schmitz	nu mixing, CP violation
		Young-Kee Kim	ATLAS, top quark, W
		David Miller	ATLAS, SUSY, Jets
		Joshua Frieman (AST)	cosm., SDSS, DE
		LianTao Wang	particle phenomenology, BSM
		Nickolay Gnedin (AST)	numerical cosm. & GR sim.
		Wayne Hu (AST)	CMB, phenom., cosm., galaxy cluster
		Scott Dodelson (AST)	cosm., inflation, DE, CMB, SDSS, DES
		Avigal Vieregg	cosm., astro-particle, BICEP/Keck, GNO
		John Carlstrom	cosm., CMB, SZ
Stanford	Dec. 13th, 2016	**Ariel Schwartzman (SLAC)**	ATLAS, jets
		Giorgio Gratta	EXO-200, gravity at microns, Majorana
		Lauren Tompkins	ATLAS, Higgs
		Leonardo Senatore	Inflation, cosm. Data & theory, large-scale
		Steven Allen	XOC, LSST, gal. clustering
		Patricia Burchat	LSST, DE, KIPAC, CP violation
		Risa Wechsler	cosmology, galaxy formation, simulations
		Chao-Lin Kuo	CMB, BICEP/Keck

My list when I applied

When?

It is *never too early* to start thinking about the whole process.

No need to panic, but keep it in your mind.

Timeline (assuming you're a rising senior)

- Summer: make a rough *list of programs to apply to*
  - Which subfield? Interesting Advisers? Location? Stipend?
  - Talking to professors can help
- Early- or mid-Sep: applications open
- Early- or mid-Dec: *deadlines*
- Early-Jan to mid-Apr: admission *results*
- Apr. 15^{th}: your *final decision*!

Application Requirements

"Requirements" (vary among programs, some optional)

- (Un-) Official Transcript
- Research & Others (CV)
- GRE (General + Physics)
- Recommendation Letters (3)
- Statement of Purpose
- Other Basic Legal Info.

Sounds like a long list?

Yes, it is!

which means that the application requires a lot of preparation.

Expect and plan to spend a *significant* amount of time your junior summer & senior fall.

Resources to Help You Prepare

PhD admissions isn't easy, but there are resources to help!

- Supplementary slides to this presentation
- Current grad students (don't be afraid to come talk to me!)
- Professors
- GradSchoolShopper.com
- PathwaysToScience.org
- PhysicsGRE.com
- APS Careers

and more!

Summary

PhD will be *difficult, but rewarding*. Your future is *not limited* to academia (in fact, mostly government, private sector, etc.).

If you do choose to go to grad school...

- It will not be easy
- Start thinking about it early, prepare in advance

But don't panic! There are *resources to help you*.

- This presentation
- Example SOP, CV
- Professors
- Alumni
- Current grad students
- Online resources

THANK YOU!

(and don't be scared to talk to me more!)

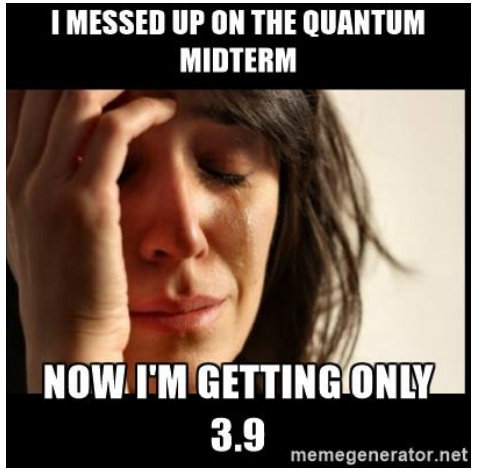
Supplementary Slides

Official Transcript

Three *CRUCIAL* points

1. It is your *complete* transcript, NOT just GPA
   - Which courses you take matters
   - Major v.s. non-major
2. Transcript *sums up* your academic life
   - Somewhat reflects critical thinking abilities, overall diligence, work ethic, etc.
3. Coursework is the 'easy' part; grad school is about research
   - Many applicants have great GPA's
   - GPA does *NOT* measure your ability as a scientist
   - 4.0 guarantees nothing. Don't panic.

(only kind of true)



(don't be that person)

Recommendation Letters

Personally, I couldn't emphasize this enough:

Letters can be *game changers or deal breakers*

Why do letters matter?

- People *disagree* on what traits make a good scientist, and it is difficult to measure those traits.
- Naturally, this becomes *subjective*.
- Then, words from *someone you trust* matter.

What should be on your letter?

- Research Potential
- Independence
- Communication Skills
- Work ethic

CV: Research and Other Experiences

Research is probably the most important, but also the most difficult.

- *Few* undergrads come with significant results / publications
  - Push for a paper submission if you can
  - Don't panic if you don't have publications
- Show your *potential*: letters and SOP
- Presentations & posters: APS/AAS meetings, on-campus symposiums, etc.
- Not necessarily in the subfield you apply for; anything helps

The best way to sum up everything: *Curriculum Vitae*

- Look at examples & templates (use LaTeX, please)
- Get in the habit of updating it regularly

Statement of Purpose / Personal Statement

This is a rare chance to show your *personal aspects*; use it wisely to your advantage! Some key questions to ask yourself are:

- Why physics/astronomy? Why PhD? Career goals?
  - Avoid clichés: "Looking up in the night sky, I dreamed of..."
  - Professional & mature
- What background/preparations? Why you? Why that school?
- Which subfield and why? Potential advisers / groups?
  - Not an official commitment
  - Okay to be undecided, but explain
  - Undecided but open $\neq$ hesitant and lost

Start writing early and expect to *edit multiple times*. Others' perspectives really help, but it is ultimately *yours*.

GRE: Gross Redundant Exam

2 GRE's (basically harder SAT's)

- *General*: V & Q (170), W (6), offered frequently
  - English abilities. Q should be easy.
- *Physics*: 990, 100 multiple choices, 170 mins, Apr, Sep, Oct
  - *All* undergrad. Not much new, but *hard to recall* everything
  - Bad predictor for success, but important for admissions
  - More important for theorists

They don't matter as much as you might think!
(especially for astronomy)

"It doesn't measure what we want, but it measures something."
–Someone from Harvard Physics Admissions Committee