

Demystifying Physics Graduate School and Applications

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CUWIP, Princeton
January 2017

- Public school in CA
- Smith College, 2009
 - Research!
 - Study Abroad!
 - App #1 in 2009
 - *Rejected*
- Paralegal, DC
- Peace Corps, Uganda
- Summer at CERN
- GS Applications
 - Physics GREs
- Research in Indonesia
- Graduate School

Spider Telescope



Demystifying Physics Graduate School and Applications

graduate student



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Today we'll talk about...

- General format of graduate school
 - What's it like to be in graduate school?
[It's hard! But fun if you like research and constant learning!]
- The graduate school application — some nitty gritty
 - Physics GRE
 - General GRE
 - The Essay
 - Tips/tricks/good things to do!



General Format of Graduate School:

- **First two years:** courses and qualifications
 - The specifics are different for every school, but *most* involve some sort of exam
 - Maybe do a rotation of a few labs
 - Choose adviser/research
 - Teaching (*sometimes*)
- ~Year 2/3, begin research full time
- Write your thesis and defend! Ta-da!
- Note: you get a yearly salary during your PhD, and most student loans are deferrable

****For this talk I'm assuming you know you want to, or are heavily considering, going to grad school for physics!*

Think about the journey, as well as the destination.



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What's next? In the academic route, you do a 2-3 year post-doc (full time researcher, 2x pay of graduate student) — or straight to industry, etc.



The Application



For our Freshmen and Sophomores:

Things to do early

1. Get to know professors
 1. Talk to them and ask them about their research
2. Take part in research, if possible
 1. If there's no research at your college/university, reach out to nearby schools (email/visits/phone calls!)
 2. Summer research, but also *sometimes* during the year
 1. REUs: https://www.nsf.gov/crssprgm/reu/list_result.jsp?unitid=69
 2. SULIs: <https://science.energy.gov/wdts/suli/>
 3. SURFs, just emailing professors, etc
3. Learn as much physics as possible!
4. Learn to code! Even if it's on your own.



BUT What if....?

1. I didn't talk to professors?

1. It's never too late! Everyone likes to talk about their research!

2. I didn't take part in research?

1. Graduate school in physics is, in the end, about doing research – so it's good to get a feel for this before committing! **But you're not too late!!**
 1. If you're at the end of your undergrad, consider taking a year before applying to give research a go.
 1. There are programs you can apply to, or you can just look through professors' research on their website (country-wide! But smart to choose a school/field you're interested in applying to!) and emailing them!
 2. Important to have the experience both because... it's important for your application, and important for *you* to know what you're committing to!

3. What if I didn't get the best grades ever? Can I still go to grad school?

1. That can be okay! There's a whole range of schools with physics degree programs – all do excellent research, even if they're not at the most difficult school to get in to
 1. More about the lab and the professor than the university
2. Maybe you've done a lot of research? (or can still!)



Pieces of the Grad School application

1. School transcripts
2. 3 recommendations, generally from professors
3. Essay(s)
4. GRE exams: general and physics subject exams
 1. Available in April, September, and October
5. The online application itself
6. (sometimes) CV

Due in early/mid
December/January



**First: Show your stuff.
(The Essay)**



The Essay: You're not a number

- (Not final) decision time: **Experimental or Theory?**
- Purpose:
 - Foremost: To answer the specific essay prompt for the school – even including actual words from the prompt is a good idea!
 - To provide a narrative for everything you've done!
- Audience: professors, post docs, and graduate students in physics
- Example format for the Statement of Research:
 1. Introduction
 2. Professors/school paragraph
 3. Paragraph on past research (and *maybe* on classes you've taken – but only if they're more than typical)
 4. Conclusion



The Essay, Common Mistakes

- **#1 mistake:** do not write *exactly* the same essay for each school
 - Think about *specifically* why you want to go to that school.
 - Is it because they have a professor (or several!) you really want to work with?
 - Maybe they have an affiliated institution (for example, a national lab) that would be a great resource?
- Stay within the school's stated limits! (Margins! Word counts!)
- Answer the prompt!
- Include professors you'd like to work with
- *Not* making a choice between theory and experiment
- *Show don't tell.*
 - Instead of writing something like: "*My collaboration/professor thinks my work is great.*"
 - Write: "*In my collaboration I have done X, Y, and Z.*" In other words - list what you've done.



From Princeton: Essay food for thought

A list of questions you might want to address are given below. Feel free, however, to add any other information that you consider relevant.

- a) What **background in math, physics, or other sciences have you had** that is **beyond the usual curriculum** of the physics major and that you think is important for us to know?
- b) What **research experiences** have you had? If you have made important or original contributions, please explain what they are and, if relevant, how they have influenced your interest in physics.
- c) Are you planning to do **experimental or theoretical physics**, or are you undecided? If your physics courses or research experience has influenced you in this decision, explain how.
- d) What **kinds of physics are you most interested in pursuing in graduate school**, and **why**? What has influenced you in this decision?
- e) The research program of our faculty is on the web. Give examples of groups and faculty with whom you might be interested in working. Please see: <http://www.princeton.edu/physics/research/>
- f) What special aspects of your personality, talents, interests and skills make you think that you will be a good physicist?

Sincerely yours,

Herman Verlinde
Director of Graduate Studies



Let's make a plan.

Here, I recommend you take a minute and look at the essay worksheet (copied next slide).



Note: This is just a suggested format. Look carefully at the essay prompt for each school and be sure to address their question and stay within their restrictions.

[Paragraph 1] Introduction

Things you could include in this paragraph:

- How you first became interested in physics, or your sub-field
- A quick 2-3 sentence summary of your past accomplishments which you'll expand on more fully later on in the essay.
- State specifically why you'd like to go to the school in question.

[Paragraph 2/3] Professors/School-specific

- Choose two to four professors who you'd like to work with at that school.
 - Do your homework! Write to the professors to talk to them about their research, look at their website (often out of date!), and search them on the arXiv to see their recent papers.
 - This will tell you if they're active researchers (if they're not, they're probably not taking students!)
- Note that, should you attend this school, you will not be *forced* to work with only one of the professors you mentioned.

[Paragraphs on past experience] Research/awards/excellence in courses

- Should be accessible to physicists who haven't done research in your subfield
- Be sure to mention specific things that came from your research
 - This doesn't have to be a published paper (though if it is, you should definitely mention that!). It could be regular group meetings where you practiced presenting on your work or a written report of some sort, or software developed or an apparatus you built/helped build.
- Be sure to mention tools you used: mathematics, programming languages, experimental apparatuses.
- An easy way to get started on this section is to:
 - Write a few sentences summary on a project. The also list:
 - What tools were used? (Mathematics, programming languages, experimental instruments...)
 - What experiences did you gain from this project? Did you practice speaking with your group? Give regular updates on your progress? Interact with other physicists? Write, or take part in writing, a paper (even if it's only internal) on the project? Attend any conferences?

[Last Paragraph] Conclusion

- Reiterate strongly your desire to work in your field of research
- Reiterate why you want to go to the university you're applying to (specifics)



**Next: Okay, maybe
you're kind of a
number.
(The Physics GRE)**



Hurdling the Physics GRE: Basic Facts

1. Out of 990
 1. Score > 650 makes you competitive for a good school
 2. Score > 750 or 800 makes you competitive for the top schools
 3. Ex: Columbia admits 630-990
 4. *Caveat: harder to get in for theory research*
2. The test is scaled. $>85\% = 990$ | $50\% = 650$ (*usually*)
3. 100 questions, 170 minutes = **speed is key**
4. Given in April, October, and September
5. Multiple choice.
 1. Right answer is worth $+1$, no matter the problem
 2. Wrong answer is $-1/4$ point, no matter the problem



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5. Multiple choice.
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REMEMBER!
SCHOOLS CONSIDER THIS EXAM IN
ADDITION TO THE REST OF YOUR
APPLICATION!

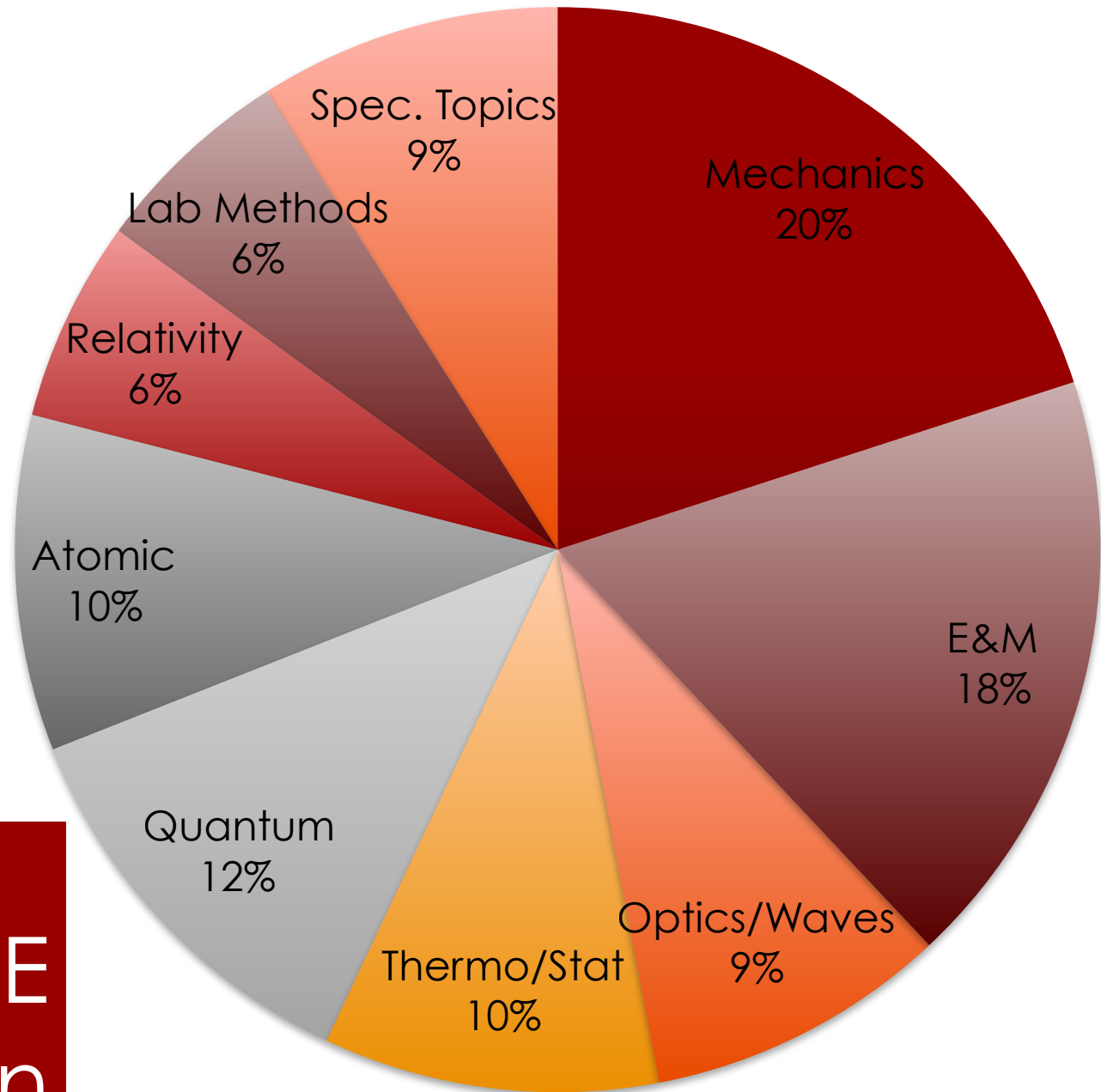


Hurdling the Physics GRE: The run-down

1. “Why do I have to do this?”
Don’t get angry at the test. (Unless that helps you.)
2. You’re going to have to memorize.
 1. How do you best jam your head with facts? (CWRU flash cards?!)
3. You have 5 practice tests.
 1. Worked solutions and comments on GREphysics.net
4. You don’t have a guide book.
I do not recommend purchasing any :(
5. SPEED. Going fast is key.
 1. Dimensional analysis, limits, and quick and dirty methods are your BFF
 2. Every right answer is worth +1 no matter the difficulty level – so skip the hard ones! (**Doing practice exams will help you learn when to skip and when to stay.**)
 3. Every wrong answer is -1/4 – so you can guess by eliminating!



pGRE Breakdown



(Diagram from a U. ND seminar.)



Hurdling the Physics GRE: Study Plan

■ Step 1: make plan.

- **Key question: how much review do you need?**
- My answer was: OMG A LOT.

■ 5 Practice tests,

- with time in between for checking, learning, and re-doing questions
Check out GREphysics.net! And be sure to look at the comments!
And When you don't know something – ask the internet!)
- + memorization and more practice
- *Do the older exams first, even though they're harder*
(I started with 1996)

10 weeks?

■ You may also want to...

- Keep doing old problems up until the test – just to stay sharp.
- First two chapters of Griffiths' *Introduction to Elementary Particles*. It's a fun read! And there's guaranteed to be a problem or two from there.
- Memorize memorize memorize! and get good nights of sleep.



My study plan

Note: my situation was unique to me - as I mentioned in the intro, it had been years since I'd cracked a physics textbook

I was studying for the October 19th, 2013 physics GRE exam.

June and July 2013: Note taking on all of Halliday and Resnick
(if I didn't understand something, I asked the internet)

August: Flash cards from my notes on Halliday and Resnick

Late August, with 7 weeks remaining: Practice Tests!

Practice tests:

- As recommended by some websites, I took the 1996 test first. Then I scored it, and went over each problem using grephysics.net (again – be sure to look at the comments!!). If I got the problem wrong, skipped it, or got it right but maybe wasn't completely certain why – I went over it thoroughly, wrote it in my notebook, and searched more for better explanations if the one on the website wasn't good enough.

- I wrote down and highlighted anything I thought I should memorize, then when I was finished going through the problems, I made more flashcards from those highlights. If time permitted, I took a day or two to study those flash cards before moving on to the next test.

- **Your last two practice exams should be the 2001 and 2008.** Take the 2001 as if it were your last practice test, then use the results from that test to learn the areas you still need to shore up. Do your best to fill those holes and memorize as much as possible, then:

- **Take the most recent practice test last (for me it was 2008),** about a week before your actual test. This should give you the best idea of how you will do on test day, and an idea of what you still need to master and memorize.



Hurdling the Physics GRE: Useful websites/resources

1. Ohio State Website:
http://www.physics.ohio-state.edu/undergrad/ugs_gre.php
 1. For the 1986, 1992, 1996, and 2001 exams (you should get the 2008 one in the mail from ETS! Maybe they'll even give you another since it's been a while!)
 2. (!!) I do **not** recommend you do the problem sites on the Ohio State website.
2. **GREphysics.net** is a goldmine and your new best friend.
 1. I cannot repeat this enough: be sure to read the comments!
3. Solutions to the 2008 exam were put together by another kind soul:
<https://physicsworks.wordpress.com/2011/07/16/gr0877-solutions/>
4. (More solutions at this site, though I have not fully vetted it:
<http://physgre.s3-website-us-east-1.amazonaws.com/>)
5. **Case Western has free flash cards!** *They'll mail them to you!*
6. If you are going to read textbooks, read Griffiths! He is actually a contributor to this terrible exam.



Hurdling the Physics GRE: **And finally...**

And finally, CHILL OUT! This test is hard for everyone.* Really. So just do your best.

*yes, there are people who find this test easy, but that's not normal and they generally had some extra training



General GRE:

- In general worry less about this one.
- But again: how much preparation do **YOU** need?
- Verbal, Math, 2 Essays
- There's a million books on this. Pick one – borrow it from the library, or however – make sure you know the format of the test beforehand so you don't have to worry, and make sure you know the tips/tricks
 - Like any good girl scout – be prepared!
- Pick a non-stressful time and place, get a good night's sleep, eat a light breakfast, and take the thing.
- Don't forget: You get a calculator on the math part! (I forgot.)



Other concerns...



Which schools to apply to?

■ It's all about the research group/professors.

- Choose schools by the professors/research groups that you would like to work with. End of story.

■ Another consideration: how much preparation do they give you? (Classes/teaching.)

■ *Diversify!*

- There are so many elements out of your control here.
- BUT, ask yourself for each school: If this was the only school I got in to, would I go?
- Choose school to apply to by the lab and professors you want to work with!



Tips/"Tricks"/Generally really good things to do!

- Talk to people!!
- Talk to the professors you'd like to work with!
 - Ask them questions about their research, read the abstracts to their papers (or the whole paper! Give it a shot!)
 - Email them – their websites are public for a reason! For you! Ask to Skype with them if you cannot visit, but if you can visit – even better!
- Visit schools before you apply and ask for meetings with professors
- Do things like going to CUWIP!

Applications too expensive? They were for me. There's funding/waivers!

Resources



- General questions and questions on research
 - Your undergraduate adviser!
 - Any professor you've had a class with/done research with!
 - Anyone who is/has been in graduate school for physics!
- Physics GRE
(Resource slide is duplicated next.)
- Essay
 - Examples online! Anyone who's applied to physics graduate school recently
- My blog posts:
 - Hurdling the physics GRE: <https://sophia.smith.edu/blog/physics-alums/2013/11/08/the-physics-gre/>
 - General graduate school advice: <https://sophia.smith.edu/blog/physics-alums/2014/11/04/grad-applications-rough-and-ready-advice/>
- But also



The Internet.



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Let's make a plan.

Considerations:



1. 2 months for physics GRE study
 1. When will you take it? {**April, September, October**}
 2. Take it twice?
2. Take the general GRE (**offered often, but takes time for scores** – look it up!)
 1. Best to get it out of the way the summer before!

-
3. Get together your CV. A good thing to do early!
 4. August/September: Think about research and schools
 1. email potential advisers
 5. Choose your recommenders (as early as possible!)
 6. Busy-work: Gather transcripts, order GRE scores
 7. Writing your essay(s) – leave time for revisions!
 8. The online application itself (probably the last thing you do)

Due in early/mid
December/January



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Things we haven't covered

■ **Recommenders**

- Ask them early.
- And when you ask: “Can you write me a **good** recommendation?”

■ **CV** – look at examples! (Online or from those you know.)

- There are many. Find your favorite and mimic the format.
- Use LaTeX!
- Proofreaders

■ **Other:**

- Taking time between undergrad and grad school
- Study abroad?
- Do I really want to do this?

Some FAQ from the workshops



1. Do all/most schools require the physics GRE?

Most do, but not every school across the board.
Once you make your school list, be sure to check!

2. Am I going to go in to debt in graduate school?

You really shouldn't! You're not paid a lot, but you'll be paid. Typical salary is something like \$30k per year, depending on the institution.

3. I did poorly in a course, should I talk about why in my essay?

This is a tough one. It depends. Better not to emphasize it - though if you have a very short explanation (like you had a big life event) you could mention it. Make it short, like just a couple sentences, and you could even talk about something you learned from it. FYI: I do not recommend mentioning this more than once. For example, if an application requires a personal statement in addition to a statement of research, that's a good place to put it.

(Note: if, instead of mentioning it in an essay, a professor could mention it in a recommendation — like this happened but you're still awesome — that would be the best option.)

4. Should I only get physics professors for my recommendations?

Not necessarily. Though remember that grad school in physics is about *research*. So it's better to have your recommenders be in disciplines related to your research field.

1. Like I play volleyball at a collegiate level and the coach knows me very well — should I ask her to write me a rec? I don't recommend this - see above!