



The Art of Applying to (physics) Graduate School

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A little about me...

- Home town: Phoenix, Arizona
- 1984: BS in Engineering Physics, University of Arizona
 - ◆ Got a job in an HEP group (after being fired from a gas station).
- 1984-1990: Grad Student, University of Rochester
 - ◆ PhD topic: Photon Production in Hadronic Interactions (FNAL)
- 1990-1992: CERN Fellow, CERN (Geneva, Switzerland)
 - ◆ Worked on OPAL Experiment at LEP e^+e^- collider
- 1992-2001: RA and Assistant Professor, Princeton Univ.
 - ◆ Worked on Superconducting Super Collider (Texas)
 - ◆ Belle e^+e^- Experiment at KEK, Japan 😞
 - ◆ Laser-electron scattering experiment at SLAC (Stanford)
- 2001-Present: Scientist, Fermilab
 - ◆ Past:
 - ◆ MiniBooNE short baseline neutrino oscillation experiment
 - ◆ Proton Source (Linac+Booster) Department Head
 - ◆ Director of LHC Accelerator Research Program (LARP)
 - ◆ Director of Joint University-Laboratory PhD Program
 - ◆ Present:
 - ◆ Mu2e rare muon conversion experiment
 - ◆ Integrable Optics Test Accelerator (IOTA) proton injection
 - ◆ Program director for Lee Teng Undergraduate Internship
 - ◆ Occasional Instructor at US Particle Accelerator School
- Sep. 2017-?: Professor of Physics, UC Davis
 - ◆ Mu2e
 - ◆ Director of Crocker Nuclear Laboratory

Experimental
HEP

Accelerator
Physics (mostly)

Bit of both



Why I decided to give this talk

- In retrospect, I think I had a lot of misconceptions when I was applying to grad school.
- I've served on graduate admissions committees at two universities (Rochester and Princeton)
 - ◆ Competitive universities must make tough choices
 - ◆ Surprisingly few no-brainers at either end of the spectrum.
 - ◆ Many sort of “in the middle”
 - ◆ Process much more subjective than most people think
 - ◆ Little things can matter
- Caveats
 - ◆ These are entirely my personal opinions - mostly correct opinions, but opinions nonetheless.
 - ◆ ***I am in no way representing Fermilab or anyone else.***
 - ◆ Some of my information may be a bit out of date.
 - ◆ particularly Masters vs. PhD



Scope

- This talk is aimed at people applying to physics graduate school
 - ◆ Specifically in experimental physics
 - ◆ Mostly applicable for theory, too, but...
- It's probably pretty similar for all “hard” sciences, and probably not far off for engineering, but if those are your interests, you definitely want to do further research.
- For the record, I use more or less identical procedures for things for internships, fellowships, and scientific hiring committees.
 - ◆ Lesson #1: Grad school is more like a job than school!



First: Do you want to go to grad school??

- If you really want to *do* physics, you probably have to go to grad school.
- Do you really want to *do* physics, or do you just want to do a challenging job which uses a lot of the same “tools”?
- Graduate school usually takes about 6 years, and pays very little.
 - ◆ During this time, people you went to college with will be buying their first house, BMW, etc.
 - ◆ Consider practical factors (living area, support, etc)
- The only reason to go to physics graduate school is for exactly the same reason you would go into art or music.
 - ◆ *There is no practical reason to go to physics graduate school.*
- Even if you do decide to go to graduate school, think long and hard whether there’s anything you need to “get out of your system” first (join the Peace Corps, climb Mt. Everest, etc).
 - ◆ *This is the last time for many years you can do such things with impunity!!!*



The basic facts of physics graduate school

- First of all, you don't have to pay for it (this comes as a surprise to some people).
 - ◆ If admitted, you will usually be offered a support package (teaching, research, fellowship) which pays tuition plus a monthly stipend.
 - ◆ There are rare offers of admission *without* support. Don't take them
 - ◆ Exception: if you already have support from somewhere else
 - ◆ You will generally take classes for ~two years, during which you will choose your thesis topic (or at least course of research).
 - ◆ This involves finding a adviser/group willing to support you for the remainder of your tenure!
 - ◆ Depending on the school, there may be a qualifying exam or exams to establish your official candidacy.
 - ◆ Note: most schools will not admit you for a terminal Master's degree.
 - ◆ This may be changing
- After that, you will concentrate full time on your thesis research
 - ◆ To the exclusion of just about everything else in your life!
 - ◆ Might involve getting shipped off to some remote place
- In the end, you will defend your thesis:
 - ◆ Usually a formality once your advisor is happy.
 - ◆ Some universities require a published article.



Some practical considerations about schools

- How broad is their program?
 - ◆ Important if you're not absolutely certain about what you want to do.
- Support considerations?
 - ◆ Like most things, it's a market. Prestigious schools know they don't have to pay as well to attract students.
 - ◆ Stipends are usually similar, but other support may vary, for example...
 - ◆ If you're sent to remote lab, what is their cost of living allowance policy (these can vary *greatly*)?
 - ◆ This can make the difference between this being the best time of your life or at time of hardship and near starvation.
- General treatment?
 - ◆ *Talk to students* and find out about the atmosphere.
 - ◆ Is it easy finding research projects/support?
 - ◆ Do they get to go to conferences, schools, etc?
- Fraction passing qualifying exams:
 - ◆ Most schools won't admit you if they don't think you will pass their exams, BUT
 - ◆ Some schools need bodies to teach class sections, whom they then try to cull them out with difficult exams (beware big engineering schools!)
- How long does it usually take?
 - ◆ Short is good!!



What graduate schools are looking for

- Graduate schools are not *necessarily* looking for the “smartest” students. They *are* looking for:
 - ◆ **Students with potential to do first rate research.**
 - ◆ Students who are capable of completing their program.
 - ◆ Students who they believe likely *will* complete their program.
 - ◆ Students whose interests are compatible with the research program at their institution.
 - ◆ Students who they are willing to deal with for several years.
- “Smart” only matters to the extent that it affects the factors above.
 - ◆ There are correlations, but there are also outliers
 - ◆ Great students who are useless at anything practical
 - ◆ Lesser students who really shine in the lab



General preparation for graduate school

- Keep your grades up, but don't obsess about pure academics.
 - ◆ I can't stress this enough
- Try to get involved with research!
 - ◆ Summer internships!
 - ◆ Work study programs
 - ◆ Honors projects
- Talk to people!
 - ◆ Ask about the research people are doing
 - ◆ Develop relationships with your professors
 - ◆ Not only will this help you learn, *it will help them write better reference letters* when the time comes
- Educate yourself about science
 - ◆ Again, talk to researchers
 - ◆ Attend talks and seminars
 - ◆ Surf the web, read Wikipedia
- Investigate grad schools
 - ◆ Talk to people
 - ◆ Surf the web, email students
- Prep for the GRE

These things have never been easier!



Application process

- All schools now use online applications
 - ◆ A lot less work for everyone involved!
- The application consists of...
 - ◆ Things provided by applicant:
 - ◆ All relevant personal information.
 - ◆ An essay or essays regarding background, goals, etc
 - ◆ Application fee (\$50-\$90, depending on school and residency)
 - ◆ Things provided by others:
 - ◆ GRE scores
 - General and Physics Subject Test, sent directly by ETS
 - ◆ Official Grade Transcript
 - Sent directly by registrar
 - If you've transferred, you might need one from each school.
 - ◆ 2-3 Letters of recommendation
 - Submitted directly by referees
 - ◆ TOEFL score for non-English-speaking foreign students
- This is remarkably little information on which to judge someone!



A few words about deadlines

- Application deadlines vary by school, with the earliest in *mid-December*
 - ◆ This is the date by which the school wants to have ALL required material **in hand** (not “sent”, “requested”, “postmarked”, etc)!
 - ◆ Late applications will generally NOT be considered.
 - ◆ A straggling letter or transcript might be forgiven, but why take the chance?
- Even in this incredible, wondrous Information Age, **not everything can be done instantly**, in particular
 - ◆ If a school was not on your original GRE list, the ETS requires 5 days plus mailing time to deliver your scores.
 - ◆ Transcripts are still usually sent by mail, and there may also be processing time (check with your school!!).
 - ◆ Although reference letters can be submitted electronically, it is **NOT** acceptable to email a professor and say “I need a reference letter and the deadline is in three hours, OK?”.
 - ◆ I’ll discuss letter etiquette shortly



Admissions Process Example (Rochester and Princeton)

- An admissions committee is formed out of regular faculty
- (~350) Applications are divided out amongst (3 or 4) groups of two.
- Each pair meets to divide their applications into three groups: **A**, **B**, and **C**, **A** being the best.
- *Each* member of the committee reads *all* the **A** applications and assigns each a numerical score. These are combined to rank order them.
- The committee meets to decide on and rank the top (60) candidates, to whom offers are made.
- **B** applications are kept on hand so the rest of the department can consider making a case for them, or if specific subfields are found lacking.
- **C** applications are thrown away.

Details may vary, but not much



Comments on the Process

- No hard and fast rules or formulae. Chairman of the committee gives guidelines, but it's up to each member how they rank applications.
- *Can be quite subjective*. Ultimately, it's the overall *impression* of the application. Very small factors can influence this.
 - ◆ More than a few "A"/"C" splits between two readers
- A single member's opinion, *one way or the other*, can strongly influence, or even determine, the outcome on a particular application. This might involve factors beyond your control.
- A significant fraction of the committee has probably never done it before.



Some general guidelines for applying

- It's very hard to make yourself look better than you are.
- It's very easy to make yourself look worse than you are.
 - ◆ Portraying yourself accurately will make you look good relative to those who don't.
- Always keep in mind:
 - ◆ **Your application is being read by smart people who are knowledgeable about physics, so you are unlikely to successfully bullshit them.**
 - ◆ They were all once where you are now, and are generally sympathetic.
- **Be honest!**



What the committee looks at (actually, what I looked at), in order of importance.

➤ Letters of recommendation.

➤ GRE scores

◆ Have their flaws, but...

◆ the only standard metric

➤ Personal statement

◆ Not as important as some other things, BUT

◆ The only thing over which you have total control!

This has moved up

➤ Grades

◆ Pretty good (A's and B's)?

◆ Consistent with what is said in letters?

◆ Beyond that, can't really compare from one school to another so not very useful in detail.

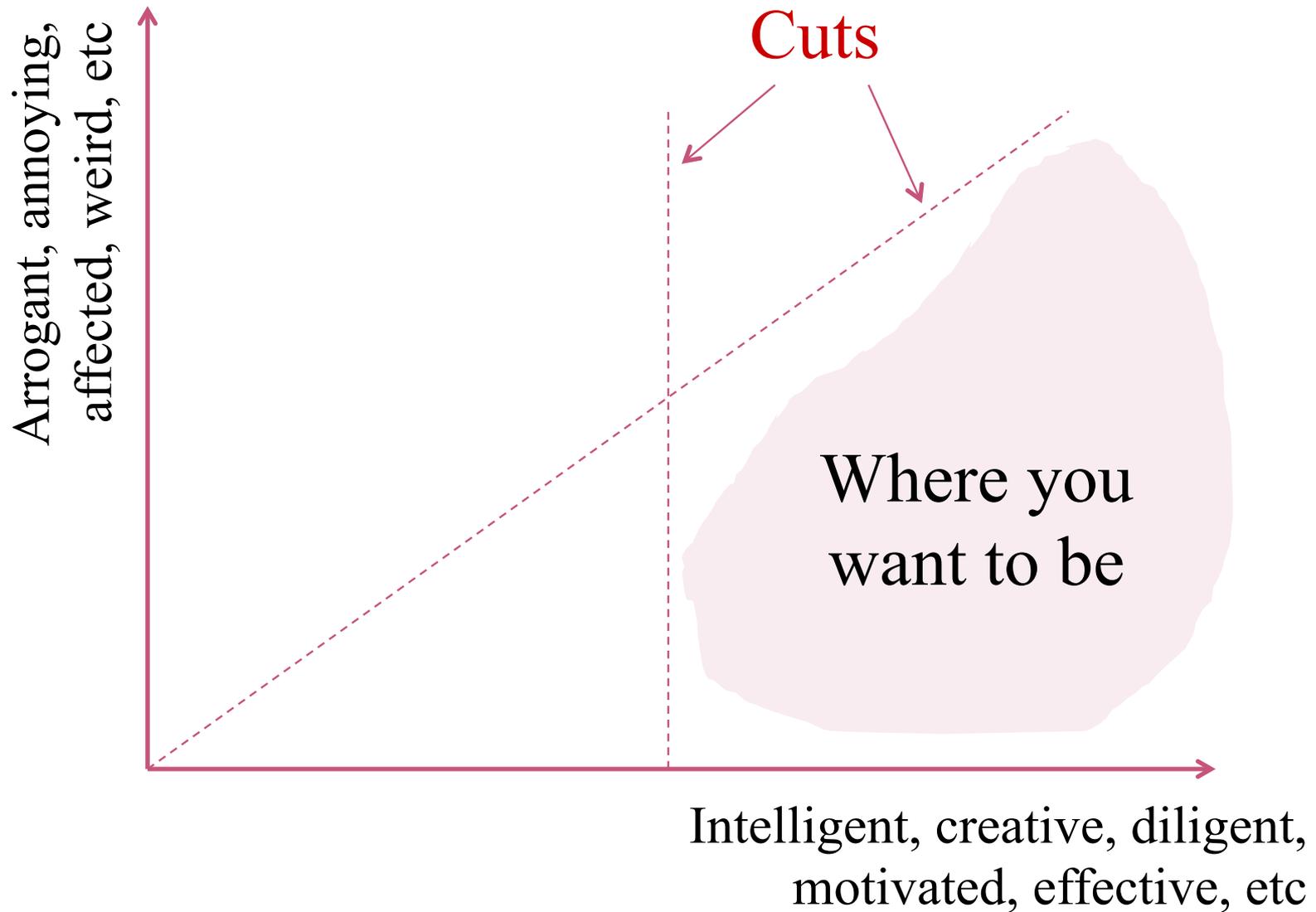
➤ Diversity considerations

◆ Rules keep changing. Not usually a big factor.

Note! Always on the lookout for anything odd or inconsistent in the application.



General Considerations in the Selection Process





Things that obsess students which nobody really cares that much about

- Although people *are* impressed by broad interests (particularly if they're unusual combinations), the exact wording of your diploma isn't that important (e.g. your “minor”, “second major”, “certificate”, etc).
 - ◆ The meaning of these things varies too much from school to school to have much meaning.
 - ◆ Talk about your broad interests in your personal statement!
- Although people are impressed by academic achievement, no one generally cares if you've taken any graduate courses or a particularly heavy load.
 - ◆ Possibly a bit for theory



Letters of recommendation

➤ Perfect

- ◆ someone for whom you done an independent project, who is in a position to compare you favorably to specific students who have gone through the program.

➤ Good

- ◆ someone who can comment in detail on your **motivation, creativity, independence**, etc, in any sort of scientific or technical project.
- ◆ someone who can comment on *outstanding* performance in a class.



Letters of recommendation (cont'd)

➤ Neutral

- ◆ academic letters which merely back up what's already in your transcript (“She earned an ‘A’, ranking 3rd in a class of 20”).

➤ Bad

- ◆ negative letters. Be sure you understand the referee's opinion of you.
- ◆ letters from famous or “connected” people who don't really know you.
- ◆ letters that have nothing to do with scientific or technical ability.
- ◆ letters from relatives (I shouldn't need to say this, but...)



Letter etiquette

- Don't be shy about asking people for letters. Professors and other supervisors understand it goes with the territory, but be courteous:
 - ◆ Figure out whom you want to write letters to particular schools.
 - ◆ Ask(!) them if they would be willing to write you letters, *and try to get a feel for what sort of letter they would write.*
 - ◆ “Would you be comfortable...” is a good way to ask if there's doubt.
 - ◆ Give them plenty of time
 - ◆ *At least 3 weeks is best*
 - ◆ Give them the information they need (usually access to online application system).
 - ◆ Politely remind them when half the time has passed.
 - ◆ Repeat until you confirm that the letter was submitted.
 - ◆ Verify with the schools that they have received letters and all other supporting materials.
 - ◆ This is much easier now, since almost all schools handle applications electronically. It used to require forms, envelopes, stamps, and even phone calls!



The personal statement

- The only thing in your application over which you have complete control, and an excellent opportunity to shoot yourself in the foot.
- The goal is to get the reader on your side.
 - ◆ Try very hard to make your statement say something *unique* about you.
- Keep it short!!!! One page max, half page better.
- First and foremost, address any rough spots or possible issues in the rest of your application.
 - ◆ Don't whine and rationalize, but...
- Say as much *as you know* about your interests and what you want to do.
 - ◆ **Be totally honest here!!**
 - ◆ **Make *specific* comments about how your interests line up with the department (ie, take the time to read their webpage)**
- Point with pride to experiences or qualifications which you feel make you a good candidate
 - ◆ **Make sure they are backed up by the appropriate letters.**
 - ◆ **Feel free to provide a URL, particularly if it highlights your contribution**
 - ◆ **Draw attention to impressive stuff on your transcript**
- Take the time to double-check spelling, grammar, etc!!



Personal statement “don’t”s

- Making it too long!
- Long rambling boiler-plate about your love of physics
 - ◆ “When I was a small child, I looked at ripples in a pond...”
- Trying to make up an overly specific thesis idea in an area you clearly don’t understand very well.
- Sounding pompous.

Summary

- Be honest
- Be concise!
- Say something *unique* about yourself
- Say something *specific* about the department



“Extra Stuff”

➤ Acceptable:

- ◆ Publications or technical documents you have written, or played a large part in writing.
- ◆ A URL to something you have done which you feel displays relevant motivation and/or technical abilities.
 - ◆ Not just a personal website!

➤ Sometimes acceptable

- ◆ Once in a great while, it’s appropriate to have an extra letter sent, if it’s someone who has something relevant to say about you who doesn’t quite fit into the standard categories:
 - eg, a recent post-doc who went through the program
 - If you do provide an extra letter, explain it in your statement

➤ Unacceptable:

- ◆ Writings that have nothing to do with scientific or technical abilities (e.g. poetry - yes, I’ve seen poetry).
- ◆ Computer program source code!!



Advice while you're in Grad School

- Remember, it's ultimately about you!
 - ◆ Keep an open mind
 - ◆ Look around
 - ◆ Ask yourself honestly if you're on the right track
 - ◆ Don't lock yourself into an unsatisfying path out of "loyalty".
- Don't be afraid to be assertive
 - ◆ You're trying to establish yourself as a leader
 - ◆ Find something that excites you and go for it
- Don't be afraid to market yourself
 - ◆ Never take credit for something you didn't do, but make sure you get credit for the things you did.
- No matter how specialized your own work is, never lose sight of the "big picture"
- Once you decide what you want to do, the most important thing is to finish up and get out!



Parting comments

- Think long and hard about whether you really want to go to graduate school.
 - ◆ and if so, when.
- Apply to lots of places.
- Don't get your heart set on one place!!
- Once you're in graduate school, look around and keep an open mind about what you want to do. Remember, **it's your life.**
- The most important thing, once you've decided what you want to do, is to finish up and get out!
- If you have questions about applying to graduate school:
 - ◆ Don't ask your fellow students; they haven't been to grad school.
 - ◆ Don't ask graduate students; they don't know how they got in.
 - ◆ **Ask people who have served on graduate admissions boards!**