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STEM Grad School Application 101*

Roy J. Zhao [1,2]

[1] Kavli Institute for Cosmological Physics, The University of Chicago, 5640 S Ellis Ave., Chicago, IL 60637, USA
[2] Department of Physics, The University of Chicago, 5720 S Ellis Ave., Chicago, IL 60637, USA

ABSTRACT

Greetings, my friends! This is the second in the series of uni life 101. In this guide, I hope to clarify as much as possible what you may need to consider in your journey preparing for graduate school and the applications (master's, doctorate, etc) in STEM areas. These are even more daunting than trying to find research, but I promise you will do just fine. The old man is always right, so trust him :)

As usual, if you have any additional questions or hope to have your old friend weigh in on anything, all of you know that my email (rzhaolx@uchicago.edu) and every dm possible are open for your questions, concerns, cries, and outrages for all eternity after mdr :) Do keep in mind that grad school application is much more of a case-by-case business than finding research (which already is), so it's much much more difficult to make generalized statements. Reach out to me with your questions/outrages/plans/written statements/whatsoever, and I will be delighted to help. Chances are, I will be able to give you much more individualized and useful insight if you reach out with specific info, or even more, I can get help from my amazing line of advisors! Like the last one, I will keep this one uncomfortably informal and naggy too. Just watch out :)

It is also my first time writing about grad school apps, so this guide may not be as decorated as I wish it to be. Please let me know what other info you'd like to know! I will try to make this guide a live document that improves over time based on your feedback. Check my github page for the newest update!

Okay, now deep breaths (again). Here we go!

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1. THE PREFACE...

Before anything, the first question I want to pose is: Are you sure you want to get a graduate degree? If you think you do, do you *really* know what you're getting yourselves into? Getting into industry jobs directly after your Bachelor's is a natural choice. It gives you more money (for a master's, you typically have to pay, and for a Ph.D., you normally receive a livable (???) wage based on your program, advisor, and TA-ship...). If you are considering returning to industry jobs eventually, it also gives you an early start in your career and the industry culture, so a graduate degree $\neq$ a jumpstart. In many cases, it will even delay your pace in the industry. **So think again! Is a graduate school degree what you really want or need, or is it just the inertia of going to school for the past 20 years of your life making it feel like a stable choice?**

Corresponding author: Roy Zhao
rzhaolx@uchicago.edu

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Now, in terms of what you're getting yourselves into, Master's degrees nowadays come in many shapes and sizes. Some of them are really just class-based; some of them are 1/2 class + 1/2 research; some of them are much more research-focused and may require a thesis. Though the one common point is: you will likely have to pay a great deal of money, especially in the states. I personally call master's programs "universities' money cow." It is a fair trade, consisting of them getting your money, and you get a reputable degree...and in good cases, also what you need! Make sure you confirm in any way you can that the program you're applying to is really what you want.

A Ph.D. is much more demanding. It normally consists of many classes for the first two years + a very scary candidacy exam in your second/third year + substantial research for a total of around 5-7 years. You will need to locate an advisor, pass your exams and conduct original research in your advisor's research group, and eventually defend your thesis. You get to expand the boundary of human knowledge and eternal bragging rights, but the expense is your time and mental state...as it really will be 5-7 years of constant stress and failure :) An M.D. is again different, as it is a professional degree, but the struggle is the same.

That concludes Roy's scary nighty-night bedtime story time...but let me assure you that there is a positive side! I wanted to scare you for a bit, because it is really our nature to focus on the glorious side of things, and the bad side is often inherently and intentionally neglected. Especially in this era of degree inflation, people want to get degrees just to be with the crowd instead of thinking whether it will be of benefit or interest to them. Don't live with this quiet desperation, break out! (This was Thoreau, not me :)

One more thing for Ph.D. applicants before I let you go: if you don't get into any schools in your first round of applications, don't take it personally! Ph.D. applications are getting unimaginably competitive, and there is always an element of chance. They are evaluated greatly based on the really situation-specific circumstances. e.g. is your potential advisor taking students, or do they have money? Did this program accidentally take too many students, so they won't admit as many this year? Does the school just have too many applications in your field so it is much more competitive? **The result of your application is greatly dependent on luck, so always have a back-up plan if you apply!** I also did not get into any school in my first round of apps... :) I hope this doesn't happen to any one of you, but if the unluckiness befalls, don't give up! Definitely reach out to me and at least I can tell you a bit more about what to do next, if a Ph.D. is still what you want. **If someone tells you that you will always get what you deserve by working hard, they are lying. This world is a beautiful place to be observed but a terrible place to live in – what they should instead tell you is: that things always miraculously work out, in such a way that you will come in appreciation of your experiences looking back months or years after. This, though, is definitely true.**

Okay, that was my naggy self again, here's the real stuff you've been waiting for on looking for programs: let's dive into the "find your fit program" talk!

2. FIND YOUR FIT!

Lucky for us born with electronics and the WWW, we have much more resources to locate and study the daunting amount of grad school programs than just word of mouth. Start by checking the name of your most inclined subject! Simply keywords like "Chemistry Ph.D. program at UCLA" or "MBA programs at UBC" will work perefectly as a starting point. Many schools and programs have nearly all the information on their websites. e.g. if you're interested in astronomy, then checking different schools' astro or physics programs will be a good starting place. If your interest is a bit more interdisciplinary, keep your eyes and mind open! I will use one of the most extreme examples: if you are interested in developing *Machine Learning* methods for *molecular imaging* in *biological systems*, then you could ideally apply for any of the following: computer science, applied math, biology, bioengineering, molecular engineering, chemistry, physics, and many more possible choices.

Keep in mind that the internet isn't the only way to get information! Always watch out for potential connections in your area, or even someone who has gone through the journey (me?). Never be afraid to connect with strangers and ask questions. Actually, I have attended a psychological study held by a professor at the Booth School of Business at UChicago. In the session, he showed that people are much happier to provide help than we imagine –

all of us need to be valued, and being asked to help is a great contributor to value. Make sure to ask your questions to anyone, including the people whom you think may not be as helpful!
Now, back to finding your fit. The next step will be to check each program's requirements for graduation, courses, their research and faculty, geographical locations and available opportunities, employment outcome, vibe of the place, reputations, thoughts from alumni, and so many other perks, to make sure you make the most optimal choice! Each program will have a different structure and outcome, so always think about whether you're going to vibe well with the setting and people while you're in the program (this is a good part of your life too!), and what you would like to get out of these programs.

Talking to your advisors and postdoc/grad students in your lab group can also help. We suffered through the process, and each of us has accumulated MANY hacks and thoughts over the years. They also likely have the most up-to-date information or gossip about what schools have better advisors/funding situations/vibes, etc. Sometimes, your advisor may have served on admission committees for years, and they can really give you insight on the admission process, and can be invaluable sources if you need someone to proofread your statement. Even better, sometimes they will recommend their connections at other schools if you demonstrate your capabilities to them! **Academic connections are strong, so if they are down to recommend you to their connections (which sometimes can be their advisor or students), then the chance of you getting in will be immensely increased.** Similarly, the power of your reference letters is also a function of your advisor's reputation and whether the people on the admission committee know your advisor.

One thing that people often wonder is: should I reach out to profs that I'm interested in working with to express my interest in working with them? I will in general support that, but be sure to check these profs' websites before! Some profs don't like to be disturbed, and they will make it abundantly clear on their websites. Others simply may not respond. That's okay! The chance of getting a reply to these cold emails is pretty low. So I would also suggest framing your email in terms of questions, or asking if they would consider taking a student, etc. If your advisor is a potential connection or the prof you are emailing has a chance of knowing your advisor, make sure you include your advisor's name (possibly even in your email title, which helped me get many replies!). Again, if you decide to reach out to your potential advisors, keep the email short and concise. No one has the time to read paragraphs. Simply attach your CV or research paper/conference and point to the attachment in your email. I will say it again: KEEP IT SHORT! Having too much information is much more detrimental than having not enough. Keep the details in your CV and even in your statements in your apps. If your potential advisors tell you that they have no interest or capability to take more students, then listing them in your statements will not be a good idea. On the contrary, if the prof sounds excited, then definitely list their name in your statement. Depending on your conversation, you could even ask if this person could recommend you to the admission committee, though make sure your contact is really down to do that before you ask!

Specifically for Ph.D. applicants, choosing your advisor will arguably be the most important thing for your degree, as this person will be your academic and financial boss for over 5-7 years, so make sure you do your research! It is crucial to not only make sure they are academically competent and fit, but also make sure they are genuinely good human beings! A great and caring advisor can save you from any misery in the mortal world, and an evil one can make your Ph.D. into hell mode... This goes along with choosing a place that vibes right with you. Just things to think about :)

3. WHAT ABOUT A TIMELINE?

I personally find having a semi-formalized timeline to be really helpful, so I will try to do the same!

Keep these in mind while you go through this timeline: I made this keeping a standard 4-year-degree path in mind. We all live our lives differently, so if you decide to do a 3- or 5-year degree, simply treat the "4th year" below as your last year when you plan to apply and trace back. Meanwhile, many of the things in the early preparatory stage have soft deadlines (i.e. many things can be done any time during your first two years, like finding a position in a research group), but please please do them early when you can and don't slack off or procrastinate. There are so many things to look and prepare for, so there is no way for it to be done overnight or even in a few months. Get

these opportunities early, as you need time to familiarize yourself with the new work. If you start late, you will regret it like you did in high school!

Some of the items I will mention below will probably fit better in context if you make it to the next section. Just hang in there!

- 1st semester/quarter: enjoy life!!! Don't stress too much! Enjoy being in unis, making friends, hanging out eating brunch, and having fun! You're living a life, not just getting a degree. If you have a bit more capacity, start to think about what kind of research/intern/volunteer you want to do, and what you want to do after college.

- The rest of your 1st + 2nd year: Start to look for research/intern/volunteer, either during the school year or summer (see my last guide on finding research ops?). **I will STRONGLY suggest getting something going during your second year.** In the meantime, if grad school is of possible interest, start to research the programs: what are they like? What are you going to get out? What's the cost? What do they require in terms of their material? What is their testing requirement? Do you have to take the GRE or MCAT, etc? Are you going to apply for any external fellowships or scholarships to fund your grad school journey (if you want to apply but don't know where to look, start from your school's scholarship page!)? If so, what will that timeline and requirement look like? Once you have this info, summarize it and make your own timeline and stick to it! If you have the capacity, start studying/taking your standardized tests. If you have ongoing research/intern, work hard and give your potential letter writers material to brag about you!

- 3rd year: you should have something on your CV by now. You should also have a somewhat clear idea of the programs you want to apply to, and have a clear understanding of their requirements. If you need to take any standardized exams, it will be best to study and take them this year. Keep working hard in your group – give your letter writers material to brag about you!

- Summer of your 3rd year: there will be a lot of work...it will be best to have an almost finalized program list, at least a first round of standardized testing, and your letter writers should line up also. It will be a good idea to confirm if they will be willing to write a letter for you. It will be good to have a first draft of your statement during the summer, but if you are a fast writer, it is also okay to do it during the application season, but you will be extremely busy!

- Fall of your 4th year: it will be like Grade 12 again! Make a clear spreadsheet of your deadlines, remind your letter writers, finalize your statements, and submit your apps ahead of time! The deadlines are commonly Nov 1st — Dec 15th, but it varies by school so you REALLY need to stay organized.

- Winter & spring of your 4th year: relax after you submitted your apps! Some programs do send interview requests, so prepare for those. It will be slightly easier, but don't slack off for classes! Best of luck waiting for offers at this point :)

4. THINGS YOU NEED

I have already mentioned many of the items in the timeline - so I will emphasize that the audience for your applications is different! The first thing we should do is to identify our enemy. For Ph.D. applications, the people reading your application will almost entirely be faculty members, with one or two admins (your program directors and administrators), and occasionally one grad student. Normally in the US, departments pick a number of victims from their faculty to form a committee and read your applications. For master's, things could differ, so do your research on who will read your apps. If you are applying for a doctoral position, it means professors contribute the most weight to how your application will be evaluated, so use practical language ONLY! Starting your statement with "I have loved biochemistry for as long as I could remember" will really tone down your application and take away your precious space. Even for master's, the admission officers or faculty will focus much more on concrete evidence and initiative that you will thrive in their program, instead of your flowery language unless they have a direct impact (say, hospital shadowing experience for med school apps). **Practical language is key!** Demonstrate your past success, your grades, your passion and your plan for grad school, NOT your flowery writing...undergrad apps are past tense now!

To make things more specific, I will list (roughly) the application materials you will need to submit. Then let's talk about them one by one.

- Transcript
- Curriculum Vitae (CV)
- Reference letters (typically 2-3 for Master's, 3 for doctorates)
- Standardized Exams: GRE/MCAT/LSAT/moreee
- Statement of purpose
- Personal statement (some schools want this)
- Writing Sample

That's commonly everything that an application will ask for. Let's now break that down and conquer it step by step!

Transcript: This one's is almost self-explanatory...? Of course, they'd wanna see your grades...so actually show up to your 8 AM classes and study!

For transcripts, **instead of telling you things you need to stress over, I will jot down one thing that you shouldn't worry about too much: occasional bad grades.** By this, I mean a couple of C's and B's on your transcript, or even a fail! No one will, and no one on the admission committee has the time and devotion, to read over your transcript with a magnifying glass to see where, when, and how you messed up a really specific class. It will be a good idea to either maintain or have an increasing trend, but don't stress over too much if you mess up one course. Uni life is a marathon, so no one cares if you were the best or worst in any intermediate sections.

The takeaway: your GPA is basically an activation energy (if you didn't take chem or physics, it's basically a precise threshold for atoms/molecules to react). As long as your GPA is okay, your application will be considered further. Many of my professors told me that a 3.7, 3.8, 3.9, or 4.0 makes no difference to them! It is much more the case that if you pass the GPA threshold, then your other application will be considered further.

CV: A CV should be a **complete** academic history of yours, so take as many pages as you may need. Many of your professors should post their CVs on their personal or lab webpage, so I recommend checking the format and content of these.

But of course, none of us are profs (yet), so do put in the following items: your name, your school and major, your GPA (if you are proud of it), your club + intern + research experiences, your teaching experiences (and sometimes your contribution to Diversity, if they ask!). For these experiences, you could write a few short sentences or a short paragraph outlining what you did. The purpose of the additional writing is just to supply some specific information to your readers on the level that they need. e.g. if you apply for a biochem graduate program and only say you did "DNA sequencing in XXX's lab." If the experts are reading, they will have so many question marks on their heads: "was it theoretical or experimental?" "what kind of method?" "She did this for how long and with whom?" etc. Make sure to write this as you would for a research abstract or an elevator pitch!

The most helpful thing is probably to see a working example? A CV should contain all of your academic information, including your name, degrees (or ones you are working towards), introduction to your research, and any poster/publication you may have. Professors typically have these on their website (e.g. the CV of my advisor Mark Morris), so you could use them as an example. CV-drafting is its own enterprise, and is worth a whole guide by itself...but I feel like examples will help the most. For us early-career poor souls, we usually don't have too much to add on, so your CV can also be a good place to offer some details on your projects/research/experiences. I recommend a bullet point title with some quick sentences sketching out what you did. If you'd like mine, let me know and I will be more than happy to send it :)

One of my CV research entries as a quick example:

Semi-analytic Theory in Extragalactic Astrophysics Jan 2022 - Jan 2024
Advisor: Prof. Steven R. Furlanetto (UCLA)

- This project, with funding provided through the UCLA Undergraduate Research Scholar Program (URSP) Fellowship and NASA Solar Systems Exploration Research Virtual Institute (SSERVI), uses semi-analytic modelling to constrain the dust mass, radius, and morphology of early galaxies by simultaneously studying the dust rest-UV attenuation and far-IR continuum emission. As one of the first studies in uniting multi-band dust observations, this study provides physical insights into the physics of dust formation, evolution, and observational effects in early times. We also propose an interesting finding that faint galaxies exhibit higher levels of dust production and retention, which is contrary to the current consensus.
- Publication from the above project:
  Zhao, R. J., Furlanetto, S. R. "Dust in High-Redshift Galaxies: Reconciling UV Attenuation and IR Emission." JCAP 09.018, 38 pp (2024).
  https://ui.adsabs.harvard.edu/abs/2024arXiv240107893Z/abstract

Reference Letters: Aha, the only part that's really out of your control (kinda)! No matter what degree you apply for, I recommend having people whom you have worked with as letter writers. For profs whose classes you scored A's in without much meaningful interaction, the letter will only hold minimal power, as this really can be read from your transcript! **I will always suggest keeping in mind thinking about who your two or three letter writers can be throughout undergrad, and maintain a meaningful level of interactions with them. Of course, being an undergrad means this is hard, so if you don't have more people, that's alright. Just make sure you have the very least one person who worked with you, and can accurately speak for your capabilities in research/work ethics/character apart from just saying "hey she was awesome she got an A."** Now, of course we talked about grad school being much more goal-oriented, so ONLY have people who are in your field! This can be your profs, sometimes postdocs you work with, or your intern/industry research collaborator, but not your soccer coach!

The sole goal for the first few years is to impress your letter writers and make sure you give them stuff that they can brag about you! The letter-asking game begins in the late summer/early fall of your application season. Traditionally, most of these programs have November/December deadlines, with a few rolling ones. As the time approaches late August and the sun starts to set early, talk to your letter writers! Make sure they are willing to write a letter, and make sure that they know your application timeline! Two or three months before the deadline, ask them formally to write a STRONG letter for you. **Don't be shy! Communicate with them that you would like a STRONG LETTER (yes, use this phrase when you ask!!! seriously!) and what you hope them to incorporate in your letter - they don't remember everything! Sometimes you could even make a list of what you hope them to include (conferences, research contribution, life circumstances) and ask them if they need it.**

Not everyone is as organized as Roy (am I?), so a good idea will be to make a Google spreadsheet to share with your letter writers, with all the schools/programs, their deadlines, and a checkbox for your writers to check once they have uploaded your letter. What will happen is each of your programs/schools will send your writers one email for them to submit the letter, and they'd have to create an account and answer annoying questions (well, some of them can be about you!) just like you do. If you apply for 15 programs, they get 15 scattered emails if you send them somewhat separately...They have to keep track of each of them. So if they have more than one person to write letters, this number can very quickly get out of control, so make your schools + programs + deadlines abundantly clear on the spreadsheet to keep them on track. They normally write ONE letter for all the programs, so once they have written the letter, they will not mind uploading it to 100 different places. However, if they have not submitted your letter to one particular program a few days in advance, remind them! Don't let them submit on the last day! Fortunately, I can say that most schools will likely accept late letters because profs can be notoriously late, but why take the chance and let that happen? :) The same thing stands if you are submitting reference letters for scholarships/fellowships/other

non-grad-school programs.

The takeaway: that application season will be stressful for both your letter writers and you. Communicate early and effectively. This can include: reaching out early explicitly asking for letters, making spreadsheets, sending letter request emails in one batch, and sending reminders if they are not on track! The communication between you and your writers is key, make sure you get preferences for them and make things easier for them (then you're making things easier for yourself)!

Standardized Exams (GRE, MCAT, LAST, etc): Many programs also require standardized testing...I know...I know...annoying stuff...yeah...I agreee...Make sure to prep for this early! By that, I mean **it will be better to 1) check if your program requires/recommends/doesn't care about an exam, and 2) make a timeline for studying and taking these exams.** I recommend having the first trial of your exams done before or during the early part of your third year (but as always, it's just my own thought, so stick to your own pace!), as the workload in your third year really picks up with classes and research, so it will be hard to study for these exams. If your program takes your exam but don't force it, you have a bit more freedom in either taking it or not, but if you can, I will suggest taking one and simply don't submit if you sucked :) No one will know. If your program does not accept it, don't bother! Make sure you do research for programs that you MIGHT be interested in, so there's always leeway for changing your mind and still not messing up with your plan later.

Statement of Purpose: Anddd more writing...is it not always clear what people want when they ask you to write a statement to demonstrate the purpose of your apps, isn't it? My way of thinking about it is: the purpose of your statement should be to persuade the admission committee why they should admit you over someone who has the same grades, and to provide a coherent structure that connect all the dots in your apps. Without a statement, you are nothing more than a bunch of letters, so this piece of writing is your chance to tell them your stories beyond those. This can go many ways:

- Make sure you clearly demonstrate your fit to the program, in terms of your research/career goal. For a master's, what do you hope to get out, and how do you make sure you will get the outcome you want? How do you contribute to the program? For Ph.D., what are you interested in working on and who are you interested in working with? Have you succeeded in previous research, especially if you have done similar research topics with the potential advisor you identified? If not, what are your transferable skills and character that support the change in research topics?

- Address your background and motivation. Your statement should be what connects your grades and accomplishments on your transcript and CV into a coherent story about yourself. What do you want them to know about your research/motivation that's not shown in your transcript/CV? Don't assume people just get it, make sure you write everything you want them to know very explicitly!

- *For Ph.D. applicants explicitly, you should identify your potential advisor(s) and projects you can work with, and how your background can be handy in the group(s) you identified. This is a part where you could also act early: you could always reach out to them to see if they are interested in taking new students! If they are not, then strategically, listing them will not be too good of an idea.

- This is also a place to explain if you have any circumstances. If you had any life stuff you had to deal with and your grades/research took a hit, make sure you mention it so people know! If your letter writer witnessed this, ask them to add this in their letters as well.

This is also a part where an example can help you get the feeling for these things. Let me know if you'd like to see mine! Though keep in mind it is really just one way/one structure you can approach it. It should be in whatever form that best to connect the dots and pieces of your other application materials and make them a coherent story to present yourselves. I know a Ph.D. student (well, he just got his Ph.D.!) from UCLA who started his statement by complaining about a physics textbook, so it really can take any form, as long as it coherently and accurately shows your points!

Personal Statement: From this point on, we introduce things that are not required by all the programs. Some programs ask you to write a personal statement that's separated from your statement of purpose...Make sure to read their prompts carefully to see what they are asking for! Most of the times, they will likely ask you to outline your motivation to study the subject, your contribution to diversity in STEM fields, and possibly your personal circumstances that may have interfered with your study. It is highly school-dependent, so make sure to check their prompts early, and arrange the information between your two statements so they don't overlap!

Writing Sample: Some programs ask you to upload a writing sample. This could be a good place to showcase your ongoing research. For example, if you keep a semi-formal research log with your advisor, but your work isn't really extensive enough to be published or to appear in a conference, attach it there! If you have a paper/conference as a draft, feel free to do so as well. Most programs will keep this optional, but if you have something...well, it doesn't hurt :)

5. AN END?

Phew...I know it's long, but it is a complicated process in life. I hope this helps, and again, feel absolutely free to reach out for anything you need pointers on. I will be delighted to share my hacks, or at the very least, share my experiences with you :) Grad school apps are much more individualized, so I will be able to give you much more insight if you reach out. At the very least, if I can't answer that, I will go bug my stream of amazing advisors for you!