Is grad school right for me?

If so, how do I get there?

Transcript from Open Meeting UW Department of Physics

November 2, 2021.

Marjorie A. Olmstead:

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Good afternoon and welcome to our annual event. We used to call this the junior-senior meeting, but we realize that you really need to start thinking about graduate school before you're a junior if you're really heading there. And so, we have now opened this up to make it clear that anyone who's thinking graduate school may or may not be in their future should be thinking about what it takes now to get ready to go to graduate school, and also just whether or not going to graduate school is actually the right thing.

Our main goal today will be to talk about, "is graduate school right for me?" It's not right for everyone, but if it is going to be on your path, then what should you be doing now to improve your chances of getting to the graduate school that you hope to get to.

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Now, before I get started, I would like to do a caveat that graduate school as we're defining it today is looking into a PhD program -doctoral study in physics, and astronomy would be actually the same thing.

A master's degree in physics is not a common terminal degree for people who get a bachelor's in physics. Those who get a bachelor's in physics and also get a Masters are usually getting it en route to their PhD, or they decide they're going for PhD and they drop out and they get a Masters before they leave so that they do actually have a certificate that says they've learned something for the last couple of years. It's [the MS] something that by itself does not add a lot of career opportunities to a physics B.S. If you want to do that, then what you should be looking at is a master's in something else: Some flavor of engineering, data science, computer science, business. Those are all very common paths for physics bachelor's.

A physics standalone masters, on the other hand, is a common path for people in those other fields to learn some quantum mechanics. But if you're interested in those other fields, I'm not your expert on that. You're better off going off to the [events in] announcements from the departments that you’re actually interested in and it's important that you should talk to them early to find out, for example, what electives you should be taking in your junior and senior year to help convince those places that you are interested and sincere about your wanting to switch from physics to something else.

From now on, let's focus on, "what does it mean to get a PhD in physics."

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Our plan this afternoon is: I'll spend 10 or 15 minutes going over some national statistics on what you gain by getting a PhD relative to the bachelor's degree. Then I will turn the floor over to our graduate student panel, who will tell you a little bit about their journey to graduate school and answer your questions for 20-30 minutes, depending on how many questions we have, and then, after that, when our graduate students go off - because I know at least one of them has to TA at five o'clock- When they go off, we will then come back to some slides and talk a little bit more about what goes into an application for graduate school, and what sorts of things you need to do between now and the fall of your senior year to get ready for that application, and then just a little time giving you some more statistics and such on what does graduate school mean: How long does it take? what do you get paid? and how do you navigate Grad school shopper.com to figure out where you might want to go?

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We’ll start with Why go to Grad school?

A PhD is a case where you look out at the all the knowledge that is out there and somewhere, there is this fuzzy boundary between what is known, and what is not known.

Your goal as a graduate student is to find some place where you have the unique set of interests and skills and knowledge to push that frontier from frontier minus epsilon to frontier plus epsilon. Sometimes it's in a very obscure part of that frontier and sometimes it's right smack in the middle, on the cover of the New York Times. That latter one is rare, but it does sometimes happen. Your main goal is that there's some piece of the universe and you are the world expert. Nobody, even your thesis advisor knows as much about that one little piece of the knowledge frontier than you do.

It’s a really exciting place to be! The knowledge that you do this experiment, and there you are, at two o'clock in the morning, and you've just gotten this result. Wow! I know something about the universe that no one else in the universe knows! That's a really exciting feeling and pushing that through and then writing it up into a thesis and sharing with the rest of the world - that's one thing that you can imagine as being a PhD.

it's also true that you start out NOT knowing anything about this topic, but four years later, you are the world expert. And if you've done that once you can do it again. That's why post-docs tend to be only about two years because in the first few years of your PhD program you're learning: what does publishable data look like, what does it mean to be at that frontier of knowledge.

A PhD is also what I like to call your license to think. If you want people to pay you to sit in an office and cogitate, then a PhD is often part of that whole licensing or or preparation process. If you want to be the one who's directing the research project, writing the grants, teaching at a university, then you're going to need a PhD. On the other hand, if you're perfectly happy being a technician in a room where someone else has done all of that, then that's something you can do at the bachelor's level.

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You should only go to graduate school if that's going to get you to what your goals are. Whether that's participating in that incredible excitement of being at that intellectual frontier between the known and the unknown, or getting a much deeper understanding of what's really going on in your wavefunction and so forth, or because you want the different kinds of jobs with more control over the direction of the science that comes with a PhD.

On the other hand, you should not go to graduate school just because you don't have anything else better to do and you shouldn't go to graduate school just because you want to stay in the US and you want to get a visa. A physics PhD program is not going to be the answer to those issues - you're just postponing issues that you're going to need to deal with later.

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The American Physical Society and the American Institute of physics will send you all a survey after you graduate and find out where you are one year post graduation and this is the results of those surveys over the last 20 years or more. About half of physics bachelor's are working a year after they get out, and from our program, it's actually larger because we have such a large applied physics contingent.

Of the rest, maybe 5% are seeking employment and the rest are in some sort of graduate school. About two thirds of those are in physics or astronomy and the other third in something else.

Of those who do get a job, the fraction that will call their job doing physics or astronomy is actually quite small. In this AIP study from a couple of years ago, it was about 3% that had a job where they would call themselves a physicist.

The rest were in jobs that were engineering or computer science or data related for most of them, or they're the technical person in a non-STEM environment, and then a few are in non-STEM completely type jobs.

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The NSF asked people who had an undergraduate degree in physical science - which is defined as chemistry, earth science, physics, astronomy - and asked them, What is your job, now that they were well into their career? And again, less than a quarter are in something that you would call chemistry, geology or physics. The rest are spread along all kinds of different career paths. About half of them are in what we would call science, technology and engineering, and others in STEM-related jobs - that tends to be health fields. But people are an arts and humanities, people are designing video games. There are all kinds of different things that you can do with a physics degree, which means you don't go to graduate school because you don't know what else to do, because there are so many options of what you could do. You should go to graduate school because you want a PhD in physics.

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If you go straight out, you will make pretty good money. Physicists are up here with the engineers and the computer scientists, and the chemists and the biologists are down here earning over 30% less or so than your typical physicist. If you expand out physics bachelor's,

the pay is best in the private sector, or if you're working as a technician in a government lab, It’s not bad. It's better if you're in a STEM field than if you're not.

If you go back and get the PhD, salaries go up, but you'll notice that especially here in government and academy there's actually overlap between the highest paid bachelor's and the lowest paid PhDs one year past the degree. So you don't go to get a PhD because you want to earn a lot of money; you go to get a PhD because you actually want to learn physics.

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About 1900 - 2000 people a year get a physics PhD in the US. Only a little over half go to US citizens - there's a large international community that comes in to graduate school.

About 20% of graduate students are female, which is about what it is here at our undergraduate I think we're maybe 23 in our physics department undergrads. About 16% of those US citizens are not white; the median age at getting a PhD is about 29 to 30. The thing to notice here is that the bachelor's degrees have been going up steadily in the last 10 years, and if you switch that over by six years, which is the number of years, approximately, between your bachelor's and your PhD, what you'll find is that the bachelors are continuing to grow, but the PhD is really leveled off. What that means is it's harder to get into graduate school than it used to be. PhD programs are not growing, while the number of physics of physics undergrads is.

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The number of physics PhDs has actually been growing some, but it has been growing a lot more than the number of faculty positions that are out there. The total number of departments in the country that offer a degree in physics, has been pretty constant 750 - 760. Two-thirds of those offer only the bachelor's level. What that means is a job like mine, being a professor at a Research I university: there's only about one of those for every 10 people getting their PhD every year. It doesn't mean that you can't get one of those positions, but it does mean that you should always have some backup options if you're going to get a PhD. There's lots of backup options.

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Those same people who survey the undergrads also survey PhDs, and they took a look at people who got their degrees 10 years earlier, and asked what they were doing. And they were very happy and they were working in lots of different areas -in finance, in government, in health ,and in all sorts of technical industries.

What they had in common was that they were solving a complex problem, that they were managing, and that they were writing for technical audience. So those are all things that you get in your process of doing your PhD that are very highly transferable skills.

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When asked what made them successful in those careers, most of those things were soft skills:

working hard, being persistent, having good problem solving skills, having good interpersonal skills, and having connected with and having supportive mentors and colleagues.

Notice being smart or solving E&M problems was not really on the list. So it's a wide variety of things that your PhD can prepare you for.

Students who've gotten their PhD under my direction: One of them is currently a Vice President at State Street Securities, a couple are working at a national laboratory, supporting users who come to use a synchrotron, and there's one or two who are faculty members, and there's others who work for Intel, some that work for a startup company - all over the map of things that you can do with your PhD in physics.

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So at this point I'd like to take some questions on those slides I just showed, and then also open up to our graduate student panel. If any of you have questions you can unmute and ask or raise your hand or put something in the chat.

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Okay, in that case, maybe you'll have more questions directly to our panelists.

So what I'd like to do now is introduce our panelists, have you guys say a little bit about your path, how you came to UW, and things that you might have liked to know when you were an undergraduate and were getting ready for this transition. Then we'll open up for questions, from me, from Catherine, from Paula, as well as from the undergrads we have here with us.

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So our panelists - are you all are here? we have Rithi, and Sam and Charles and Ellis.

So why don't you introduce yourselves Rithi, do you want to go first?

Ritika Anandwade: Hi! My name Rithi, I know it says Ritika there, I just go by Rithi and never change it on Zoom.

I did my undergrad at the University of Illinois and I I think I took a bit more of an unconventional route to get here. I graduated in 2020 and I didn't get into any Grad schools when I applied in 2020. Luckily, at that point, I had been doing undergrad research with an advisor who was willing to support me for an extra year while I applied to graduate schools, and then I got in here.

Was there anything else that - sorry I know you listed a whole bunch of things, and now I can't remember what all those points were.

Marjorie A. Olmstead: Can you talk about what seemed to make a difference for you in helping you decide that Grad school was right for you.

Ritika Anandwade: Yes, okay on so I started doing some undergrad research so I got involved with a research group my sophomore year. I found that I really liked the whole research process and I was lucky to be involved in a research project that was very undergrad driven.

So we got to be involved designing the project from the start to the finish, and that just kind of proved to me that I really like designing experiments and I like doing experiments and I like

the whole scientific process, so that helped me solidify that I wanted to come to Grad school.

Marjorie A. Olmstead: Thank you. Sam?

Sam Borden: Everybody my name is Sam I use he/him/his pronouns. I did my undergrad at Yale, where I started research in my junior year, actually in the geophysics department. At some point during my whole process of taking physics and geophysics classes, I realized I actually wanted to pivot and take something that was more focused on a pure physics side. So starting my senior year, I started doing research on neutrino-less double beta decay. I realized the field was just prime for making a discovery, and that's what really kickstarted me to look into applying to graduate schools. Because I was like, here's a really cool experiment, things are going to be discovered, maybe I want to keep working on this. And so that's actually how I ended up picking the program that I wanted to apply to, because U dub is one of the few schools that is doing that kind of research. So that's kind of what what guided me through that process.

Marjorie A. Olmstead: Thank you. Charles?

Charles Andre Cardot: Hello everyone, my name is Charles Cardot. I'm a first year Grad student I'm in Rithi's cohort, I also use he/him/his pronouns. and you may have to remind me what just - why I what helped me choose going to going to Grad school, it's like my future right?

Marjorie A. Olmstead: What grad school's like and so forth, too, but you've only had 6 weeks so maybe that's not quite the right answer for you.

Charles Andre Cardot: Not enough time to develop strong feelings, one way or another, I guess.

The thing that made me want to go to Grad school is that when I was an undergrad, it was very much like one of like the only options that was kind of presented to us, which - probably something you guys have experienced something similar. It was very intimidating to me and I didn't know what I wanted to do, but it was the thing that was right ahead of me. So I was kind of thrust into research pretty early on, and I didn't really like what I was doing for a good bit of time. I started out in particle physics and I sort of stumbled my way through that. until I found I was very much more interested in studying fundamental quantum systems. That's kind of a really broad term, but it sort of led me towards at first a sort of condensed matter, and now more X Ray spectroscopy type stuff. But to make the long story short, I began very uncertain and very much disillusioned with the idea of having my future already decided for me within my first six months of undergrad. That was really intimidating, but the more that I started to actually look at the type of research that I was doing and then start to cultivate it into what I was what I really want to do, and I was able to sort of seek out the research opportunities that were more engaging for me. For example, I was thought that I was going to be an experimental physicist all the way through and through and I thought that I would go out and like find a job at probably an engineering company or someone that needed physicists, but the more and more that I started doing condensed matter, I found that the theory aspect of it was actually really interesting. In COVID it'll give you the chance to do like a lot of remote type of coding theory work and that made me think okay, maybe I could do this as an educational academic experience. That was sort of what led me to say, "Okay, I could I could see myself going to Grad school for this." And because there's a pretty strong X-ray spectroscopy theory group at UW and I had done and REU here, it was a really good fit for me. That's kind of what led me to choosing this. And I'll admit I still have my reservations about Grad school, but you know, I think that I was willing to give it a shot to see if this is what I want to do. But I also know that

it's not like the end -all, be-all. It's not like once you're here, you can't change your mind. I should hope that no one feels like it's a like you're locked in, like you're stuck.

Marjorie A. Olmstead: Thank you. and Ellis?

ELLIS THOMPSON: Hi! I'm Ellis and I use she/her pronouns. I kind of stumbled into physics research by happenstance almost, which I know is kind of unconventional. I went to a pretty small liberal arts school called Vassar College, and there wasn't a big sort of STEM engineering -they didn't even have engineering degrees there. But I knew I liked science, I wanted to do science, and I ended up choosing physics. I kind of just was looking for something to do in the summer, so I applied for an REU. I was majoring in physics, so I just thought okay i'll apply for an REU in physics and I ended up really liking the research I did. My first REU was in condensed matter physics, working on an experiment making and measuring quantum materials. From then on, my drive to continue to do research was really focused on that topic. I just was very interested in quantum materials. One thing that I will say something that really helped me as I was on my journey to Grad school - was searching for different research opportunities, I know at U dub there's like lots of labs you can join, but there's also lots of research opportunities outside of your school and those are really good things, good places to look. I guess when I applied to Grad school I applied to a really broad range of schools and I ended up at UW because I just really liked the one of the professors here. I talked to him beforehand and I'm working with him now and I've had a good experience so far. So hopefully I can help you guys with some questions.

Marjorie A. Olmstead: Great Thank you. So do does anyone have questions, or Paula or Catherine, if you want to ask questions that you've heard from other students. Okay so there's one in the chat here.

What would you recommend for someone who's not sure PhD is right, they're not quite sure about the structure and the tedium of undergrad, but you want to delve deeper into physics and you want to have a little bit more independence in your career.

Any of you want to speak?

ELLIS THOMPSON: I can say something, and if that's okay. One thing is that a physics PhD program is not like physics undergrad - it's very different. So, if you don't want to go to, if you don't want to get a PhD in physics, because you don't like taking lots of hard classes at once, that's -- you only have to do that for a very short amount of time in your PhD. So, I would say, don't consider that as a roadblock to you. That was that was mainly the point I wanted to make: if that's one of the reasons you're unsure, then you can take that reason off of your list.

Marjorie A. Olmstead: Other questions.

How about - I guess, some of you were and some were not required to take the GRE when you applied. Can you make comments on how that went and studying and balancing that with coursework and so forth.

Sam Borden: yeah I can I can jump in. Are you specifically asked me about the physics GRE or the general GRE, because I had a different experience with both of those. So for me at least personally, the physics GRE: some of the best advice that I got was in junior year to take the April physics GRE and then already have scheduled like in October, September those other two physics GRE's so you're ready to take them, too. But that gives you like some leeway to kind of just use the April test as a practice gauge to see, okay, how much studying do I need to do over the summer? How busy will I be during these classes? was something that helped me a lot.

ELLIS THOMPSON: I just want to jump in and say something else. I just want to say that I, personally, didn't get a particularly high physics GRE score or regular GRE score. I mean they were OK, but they weren't top tier or whatever, and I did completely fine in admission. So I just wanted to say that there's lots of aspects of the application and if you just go into the GRE with a mindset of this is just one piece and it's not going to make or break your application, and I think that's really helpful, too.

Marjorie A. Olmstead: One thing I can say is that students who do real well on the GRE- I know one of them said that the two most useful things that I did was - one was to TA freshman physics and the other was having been on a math team in high school where I learned how to do the balance between my silly mistake rate and speed. A lot of the GRE is how fast you can solve problems that are really at the one-hundred level, there are a few that are at the advanced level and that might make a difference at the top, but having good facility with your basic physics is actually an important part of it.

Can you speak to the transition from college to graduate school what sorts of things at the same what sorts of things are different? Maybe Rithi, because you're the one who made the transition from the school which is probably closest to U dub in style.

Ritika Anandwade: I'm University of Illinois. it's also a really big, STEM-heavy, state school. So one of the biggest transitions for me has just been location, I guess. Seattle is a very different climate than central Illinois and getting used to how the expectations are just different now.

You don't have to particularly get 4.0's in your classes, you have to pass your classes. They're really hard, but the focus is learning the material now. So I think that's something that i'm still struggling with, because I'm only six weeks into Grad school.

Marjorie A. Olmstead: Anyone else want to comment?

Sam Borden: Sam in kind of following up what Rithi said - One of the best metaphors I've heard for Grad school that I think really rings true for me is Grad school is where you learn to know which balls to drop when you're juggling just a lot of them. And so, like Rithi was saying, that you have a lot more leniency in certain aspects, but you do have a lot of work. So in undergrad you might be doing homework all the time, but you still have a lot to keep doing a Grad school I guess.

ELLIS THOMPSON: jumping off of that point, something that I didn't expect when going into Grad school was just: most people go in at a time when they're kind of transitioning from being in college to adulthood almost. For me, when I moved to Seattle to go here, I had to pay rent and do all my stuff for the first time, like cook for myself and all this stuff, so that's the one thing I think that can be difficult. You need to balance schoolwork and this program, but you also do it in kind of in a transitional part of your life so if, ... i'm kind of getting tongue tied, but I know other people who started graduate school when they're a little bit older or they took a year gap, and so I think that can kind of ease the transition if that's something that you would be worried about.

Marjorie A. Olmstead: Thank you.

Any other comments we have? Say you're going to graduate in a year and a half, and you hadn't really thought about doing Grad school or you've been stuck at home with COVID for the last year and a half, and so you haven't started doing research. What sorts of things can they do now to be ready to apply a year from now? I'll talk a little bit more of that later as well, but appreciate having you guys' points of view as well.

Charles Andre Cardot: I can take a stab at this one. I would say, a year and a half, so if you're -if I'm doing my math right - maybe halfway through your third year if you're on the regular track. I'd say that's still plenty of time. To be frank, if you're if you're just thinking about it now, and you want to make the commitment the [to the] push, a year and a half is plenty of time to get research in, for example. If you really want to, you can apply to REUs for this coming summer.

And you've got - I think the first ones start to be due around December 15, so you have a month and a half to prepare for something like that. Additionally, if you decide that's not the route, you know there's fully almost 12 months of time that you can be finding a professor at UW or perhaps outside of the department that you want to do research with and start getting that if research is something that you feel that you're lacking in terms of your application. I would say that it's definitely it's well within the realm of possibility that you could build a very strong portfolio that period of time.

Marjorie A. Olmstead: anyone else?

I'd also encourage you to take your 300-level core courses this year, because one of the things that grad schools are going to look at is how well you're doing in those courses that you're going to retake when you get to graduate school, because that's a good predictor of how you're going to do, once you get to graduate school. So taking your e&m, your quantum, classical mechanics, try and get those this year so that you'll have them on your record before you apply in a year and go to office hours, too.

Sam Borden: actually, Marjorie, that's a great point. Something that I did struggle with when I was thinking about applying to graduate school is getting a third letter of recommendation, because I had two research experiences and, for me, it was pretty hard pulling up a third letter of recommendation. So, going to office hours for classes you're doing particularly well in or building some sort of a one-on-one relationship with your professors is really helpful just to build out your application.

Marjorie A. Olmstead: Do we pay you enough to live on? can you talk a little bit about just sort of the transition that you're - yes, you're not paying off your student loans, but you're not acquiring more either. That's something that students are often concerned about.

ELLIS THOMPSON: I think that the pay is pretty Okay, as you said. We're really lucky, because we have a Union, so our pay is guaranteed to stay the same, we have guaranteed raises built into the system. And there's other schools that have unions, so that's like something to look for if you're looking at schools. But I think it's exactly what Marjorie just said, you're not going to be saving a bunch of money, but I don't think that you're - it's not like you're going to be starving, you know, your graduate schools in general pay you enough to live in the city that you live in.

Marjorie A. Olmstead: And they pay your tuition as well.

ELLIS THOMPSON: Yes, yeah so that's nice, too.

Marjorie A. Olmstead: Are there other questions people have for our

grad student panel?

Do you guys have any other things that you wish you had known when you were a sophomore or junior, and were just starting to think about Grad school? What are the things that you wish you knew then that you do know now.

Ritika Anandwade: One thing I probably oh sorry Charles, was I cutting in to you? okay um I kind of wish I took some more engineering type classes. The kind of research that I want to do now there's a lot of like you should know how to work with electronics, so I kind of wish I took an intro EE class or something and learned a little bit more about electronics because

if you want to be an experimental physicist, there's a lot of engineering skills that you'll pick up on the way, but sometimes I wish that I had taken some of those classes, just so I kind of knew what I was doing and so it'd be like I really just don't know what to do.

Marjorie A. Olmstead: Thank you.

Programming is another one, as well, to pick up.

Marjorie A. Olmstead: there's a question of as you are getting paid to be a TA, what fraction of your time does that take?

Charles Andre Cardot: In terms of fractions of time, I would say that it takes up somewhere between 15 to 20 hours a week is reasonable, and then it can go up when there are midterms in the classes that you're teaching, and that's relatively standard across the board. I think that, from what I can tell you, UW seems to do a pretty decent job of making sure that students aren't working too many hours and they've given us a lot of resources, like people that we can reach out to if we feel like we're overworked, so in terms of like time commitment to the job aspect of it, it seems relatively reasonable. I mean it's very much like a part time job. You're taking classes at the same time, and some of us are also doing research, too.

ELLIS THOMPSON: I'm an RA right now, so keep in mind that past your first or second year, most people would probably have some sort of RA as well, so then you'll have to spend less time less of your time TAing.

Marjorie A. Olmstead: Are there other questions people might have?

Marjorie A. Olmstead: In that case, i'd like to thank our graduate student panel. It was wonderful having you here, nice to meet you and put faces to names of people that i've heard great things about, but hadn't met yet. And so, thank you and i'll let you go off. I know that one of you has an office our and some others may as well, and so

If there are no more questions right now, then i'll start talking a little bit more about what a graduate application actually looks like and then also go on to talk about what schools are –

there was one other thing, do you have to have an idea of what you want to do research wise by the time you get to graduate school?

And that depends, of course, on where you go, but at a place like UW, the answer's no, but i'll let our panel answer that as well.

ELLIS THOMPSON: So at UW we actually were required to take a class in the first year, where every week we listened to a talk from one or a couple of the professors, and we have to do like we have to do a lab tour. It's required for us to at least check out one lab group the first quarter so like I think they really encourage looking around before you settle down into a lab group here.

Sam Borden: I would say that's true and I think Industry for all places, but I think having an idea of maybe what some field, you want to work in this at least helpful when you apply.

ELLIS THOMPSON: yeah that's a good point, I think that can make your application more competitive, I don't know if that's true, but I feel like that maybe is true. But also you can write something in your applications and then do something completely opposite when you go to Grad school, so it doesn't need to be like super set in stone.

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Marjorie A. Olmstead: I would agree with that. I remember when I gave my presentation on my thesis somebody had pulled out, because they always like to embarrass students with what they said they were going to do, and I actually did end up doing what I had said I was going to do, and the guy was just totally amazed, because he was so used to having this as being the standard laugh line when he introduced someone.

All right, in that case, thank you very much to our panel.

From the CHAT: A resource from a recent grad of U. Chicago on applying to grad school, recommended by Sam: https://github.com/gwisk/gradguide/blob/master/gradguide.pdf

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And I will now move on to, "What does an application look like?" and some other ideas about how you can acquire that. Thank you to our Grad students.

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If you recall what we talked about before with: What are the skills and qualities that are useful when you get your PhD and have a job that requires a PhD? One of the things is that your success in going through graduate school depends on a lot of things that don't show up on your transcript. Are you committed, are you creative, are you mature, can you work independently, do you have confidence in your physics abilities and can you communicate what you know to other people? That information comes from your letters and your personal statements, so it's important that you get that there, and also that you have a good match between what your goals are and the research in your department.

If you're sure you want to work on a field that a school doesn't offer then don't apply there. On the other hand, if they're really, really good at something, and you have absolutely no interest in it, then you might not want to be there, so they're going to be looking for a good match between your interests and the department's interest.

As you heard all of the graduate students talk about, they all had some sort of a research experience before they decided to go to graduate school. You're going to need it. They're going to expect it from somebody who went to UW that you were able to get involved in research.

Your undergraduate performance and your GRE if you have it, those are also really important, but if you have a superb transcript and lousy letters and no research, you're not going to get in. On the other hand, if your letters say this person in the lab is absolutely amazing and their physics knowledge is not reflected by their transcript, then that person is much more likely to get in even if their transcript is not as stellar.

You need a strong performance but doesn't necessarily have to be super on top.

Also, you can distinguish yourself from everybody else by meeting deadlines, making sure that your essay has good spelling and grammar and make sure somebody else reads it before you submit.

SLIDE 19

When I get asked to write a letter of recommendation, the school sends me a checklist. Usually, it's got about five of the things on this page. One year I just collected every one that I was asked about, and they usually ask where does this person rank relative to other students at the same level. They have things like the top 5%, the top 10%, top quarter, above average, and other. So they're looking for people to write letters for you who can say that you are much better than the typical students at things like critical thinking, self confidence, resilience, intellectual depth.

You need to make sure that faculty know you personally well enough to comment on these things. Just being able to say, "This person was in the top third of a highly competitive class of Grad school bound juniors and seniors," they know that I gave you a 3.7, they don't need extra information from me on that. You should be adding extra information.

SLIDE 20

To be able to get that on your transcript and on your letters and in your statement, you need to start by building a very strong foundation in your first couple of years. Get involved in the department. Start joining the Society of Physics Students, come to office hours, if you can find someone who's got a research project that you don't need to take quantum mechanics for, by all means start working on it. You can join one of the engineering teams to get involved as well.

You should also start exploring physics: start reading about things in Physics Today or Scientific American and figure out which ones get you excited enough to want to check the references and which one start putting me to sleep. That will tell you what sort of physics you're interested in, and then you can use that to determine which part of the departmental community you want to plug into.

And also, as was mentioned earlier, getting electronics and a useful computer language is also an important thing to do in your first couple of years.

Two years before you graduate, so those of you who are right now sort of a year and a half away from graduating, you want to be taking your core 300-level classes, you want to be getting to know your faculty outside the classroom, whether it's in office hours or as a TA or on a research project, And then in December -January, you should be applying for some sort of a research experience next summer. If you're a US citizen or permanent resident, the National Science Foundation research experiences for undergraduates is a great way to go and explore another university. There's also a lot of opportunities here on campus, not just in physics, but also in other departments and, of course, stay involved in that departmental community, so we know who you are, will put you up for awards, will let you know when something happens.

That summer before your last year, you're going to want to be doing research full time, whether it's UW or elsewhere. And, assuming that the GRE survives COVID, you're going to want to be studying for it and you're going to need to register for that September or October date. You should also be researching potential graduate schools in the summer, whether you travel to visit them, if that's possible. That's not as essential as visiting them once you've gotten in, but you should be figuring out what are schools that meet my requirements as to geography or to field and other areas.

The other thing you should make sure you do is meet with Catherine. Catherine Provost is our Director of Student Services and she is the academic counselor for our grad students. She is a really good resource knowing what do you need for graduate school.

SLIDE 21

Your last year, in the first couple of months you'll take the GRE if it survives, you'll be figuring out which schools to apply to and making a spreadsheet of what are their deadlines, what are their specialties. You want to be talking to faculty to find out if they want to write letters for you and those come together, because those faculty are also going to give you feedback on your list of schools that you want to apply to. You're going to need to be drafting your personal statement, your research statement. Sometimes those are one unified statement, sometimes they're separate. One is more your personal journey to becoming a physicist, and the other is what you plan to do going forward. You'll also want to have your CV or your resume put into a two page format to be able to share as well. If you are a top notch person who knows what kind of research, you want to do and you're a US citizen or permanent resident, you can apply for an NSF. That's due in October, and there are other fellowships as well.

That will take a lot of time, and doing well in your classes, at the same time can be a real challenge. Don't try and take 18 credits that fall semester you're going to be applying to grad school, because all of these things up here - that's basically another three credit class in terms of time, and so make sure you leave yourself enough time to do it.

In November, December you'll get feedback on those statements and give them to the people that are going to be recommending you. They'll give you some feedback on that and you'll revise, and you're going to want to make sure that you do enough research on the departments to tailor your personal statement to each school. Then, get things submitted before the deadline, if at all possible, and remember to open those applications at least two weeks before the deadline, because that's what triggers the process to get the letters of rec asked for from the Faculty.

In winter quarter you'll hang around, chew your fingernails, learn some more physics, and hopefully get into a subset of your schools. Pretty much nobody gets into everywhere, but you will hopefully get into more than one. Then you should make a list of what criteria matter to you, and then visit and explore and talk to people to figure out which schools meet those criteria.

You need to decide by the 15th of April and then don't forget you still need to do well enough in your classes to actually graduate.

SLIDE 22

Just to give you a feel for what it takes: U Dub is not in the top 10, but we're in the next group of schools. We get about seven or 800 applications every year for which we admit on the order of about 100 and then we enroll about a quarter to a third of the people that we admit.

I looked at the current students and got the database to tell me what their undergraduate GPA was, and you'll see that admission is rare below around a three five GPA. It's not impossible, but it's rare, and that most students have a GPA that's up around 3.8 or 3.9.

Research is expected. Pretty much everyone has some.

As far as whether being from U Dub is an advantage - about 10% of our current graduate students got their undergraduate degree here at UW.

We produce about 2% of the total bachelor's in the whole country, so if it we'e completely uniform, then you have a better chance of getting in here, but it's not completely uniform. Basically, if you get really strong letters and your GPA is up around three eight or so, we will probably let you in, but we will also probably encourage you to go somewhere else to build your network.

OK so there's a couple there's a question here about what happens if you don't get anywhere and you still want really want to go? The answer is, you take a gap year and you do things to improve your record. Usually, it's doing more research. Often, if you have done really well in your senior year courses, if you hadn't done so well earlier, than your transcript will be much stronger. Some students will go on and get a Masters somewhere in either physics or something else. Some people will go and just do research for a year and try again, and many of those students do get in the next year.

SLIDE 23

Because schools only have five or six pieces of paper about you: they have your transcript and, they don't this year but they will probably in future years, have your GRE, have three letters of recommendation, and then they have your personal statement, CV and cover letter.

Each one of those needs to tell a different piece of the story, because it's hard to learn enough about you in five or six pieces of paper to make this decision about graduate school. As we said earlier, you do need to study for the GRE, and that's balancing your speed and your silly mistakes. The book *Conquering the Physics GRE* is reported by students to be really helpful.

SLIDE 24

The personal statement needs to be honest and sincere. You want to get a good match in graduate school. If you lie on your statement or you're not completely truthful, then you might end up at a place which is not a good fit for you and that's not good for anybody.

You also may remember your high school English teacher always saying, "show don't tell," and that's true here as well. You should be thinking along the lines of, I know this, based on my experience doing this," or "I accomplished X, by doing Y as measured by Z." Those sorts of things - be concrete about what your interests are and what they're based on.

You should speak to your strengths. If you don't know your specialty, that's fine, but don't sound completely wishy washy. You can point out to say, "I did a research experience in biology and I discovered that I don't like biology, but I really like imaging and so i'm curious about the people who do surface scanning tunneling microscopy to be able to go more into imaging." You can do something like that that shows that you did an experience, you gained something from it, you made decisions based on it, and you know where you're going going forward.

You should connect to your target department. Don't write to U dub saying I am so interested in studying nuclear fusion, because there is no one in our department who was doing that. So be careful as you're writing. Mention specific research areas and faculty if at all possible, because those will be the ones who will then have your application run underneath them. Some schools will also call you for an interview, some will just let you in and then invite you, and try and talk you into coming.

If you have irregularities in your record, they should be addressed. And one thing about irregularities - either you or your letter writers should make sure they mention it. I remember writing a letter for someone who got into Stanford and is now a full professor at Princeton, but who had totally blown the GRE and had one of his 32x classes that was really poor, but I was able to say this person in the lab was totally amazing. And not only that, but this particular student was from Iran and the week before his midterm he had seen on the TV his parents’ neighborhood get blown up and he hadn't yet heard from his parents and therefore he sort of flunked his midterm in classical mechanics. That's the kind of thing that I, as letter writer can write, even if the student is not comfortable. When, as I said, I wrote that letter it got him into Stanford, so it worked.

Have someone edit your letter for grammar spelling and coherence, and give a copy to the people who are writing letters for you.

SLIDE 25

You're going to need three people who have a PhD, at least one of them, preferably two, with a PhD in physics, and they need to know you well outside the classroom. If someone says, you know I’m not the best person to write a letter for you, then, say thank you, and do you have advice as to whom else I might ask.

At least one should be someone that you've done research with. It doesn't matter whether that's at U Dub or elsewhere, or even if you did research in chemistry, that's fine. Provide them with a copy of your statement of your resume.

If there's different aspects that you want different letter writers to emphasize, for example, you were a TA for someone , say i'd like you to speak to my ability to teach and so and so's going to write about my research, that's fine. Give me a list of bullet points - I don't know who down in the SPS did everything, but I know stuff got done, so let me know who it is that actually was behind that if it was you.

Give us plenty of time and remind us - a minimum of two or three weeks and then two or three days before the deadline. I want to get an email if I haven't actually turned them in.

SLIDE 26

Are there questions here on what Grad schools want and how you can give it to them?

Okay there's one question about do you need to take the GRE, and the answer is, if you're applying this year, many schools will again be waiving it. How many schools will still require it once COVID has gone through the system is really up in the air. A lot of schools, including UW, are now doing this experiment - two years without the GRE. Personally, I hope that one of the few good things to come out of COVID is that the GRE will disappear, but I don't know what's going to happen going forward. The GRE is something where it's hard to get a good score on the GRE unless you know a lot of physics and have great facility with it, but it's easy to get a lousy score on the GRE for a whole lot of reasons that are totally uncorrelated with how much physics you know. And there is at least a growing understanding of that so in many places the GRE can help you but it won't hurt. Hopefully that's the way it's going to be going forward.

Are there other questions?

Marjorie A. Olmstead: And because i'm not sure it will get into the recording, let me just read something on the chat that Sam said that there's something out of Chicago that is, student put together on applying to stem PhD programs, and he gave a link there that i'll make sure he gets into the information about this talk, even if it doesn't actually get into recording – let me just save that somewhere on my computer so that that actually happens.

https://github.com/gwisk/gradguide/blob/master/gradguide.pdf

SLIDE 27

What happens in graduate school? What does it cost and so forth?

SLIDE 28

When you arrive at Grad school, your first year is the one that is closest to undergrad but even then it's different because you're only taking physics classes and everyone in your class is taking exactly the same classes. You're building a cohort, you're taking them together, you're teaching together, you're eating, living, sleeping together, often too. The whole community is different.

As you take those classes and you start reading about other people's ideas, you start narrowing down what kind of physics is it that you actually want to be pursuing. You'll start hanging out in a research group and learning what sorts of physics there is. Reading other people's ideas, getting trained learning how to run the equipment, and so forth.

Then there comes this point where it's time to figure out what your thesis is actually going to be. You don't have to have some great new idea from nowhere, your advisor will help you with that. Your advisor probably has a few things that are in that grant proposal which is paying you that say, these are things you want to look at. But you have the opportunity to make that yours and figure out which little piece of that you're going to call your own.

Then you go out and you do calculations, you take data, you analyze that data, you make posters at meetings, you talk to people about your results, and then you turn it into publications and after you've done that a couple of times, it's time to graduate.

SLIDE 29

This first part where you're getting all the background material and deciding exactly which place you're going to start pushing the frontier takes about two or three years. And then, depending on the project, it can take another two to four years to then bring that to completion: you get all the data, you need figure out what it means, and write it up. What that means is it typically takes about six years to get a PhD.

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Only about 4% of students report getting a PhD in only four years, and most of those are going to be people who came from abroad who got a master's degree first, because you're going to take classes for a year and start getting into research for a while, takes a little bit, but I've heard it said that if you work, seven days a week, you get through in five years, and five days a week, you get through and seven. There's something to be said for that and but, most people work five or six days a week, occasionally seven and get done in about six years.

One in six or so reported taking eight or more years on that AIP survey, but many of those will be people who actually took time off, whether it's to have a child or to travel, or changed their mind completely on what sort of research area they wanted to go into, or occasionally you're working on a great big experiment and the experiment breaks, and you decide you're going to hang out until it actually works again and get data as opposed to write up your thesis on old data.

SLIDE 31

As I mentioned earlier, you do get paid to go to graduate school and your tuition gets paid as well. This is old data on what fraction of students have a TA versus a research assistant versus a fellowship as a function of time in the program, and this is probably still fairly good. Usually by the end of your second year you’re getting into research and then this 20% being TAs here is probably more often being that you're a TA one quarter per year, so that the grant can get stretched further, than that you're actually being a TA 100% of the time.

We mentioned earlier you're not adding to your savings, but you're not really depleting them either. You're not taking out additional loans. Current U dub students are paid about $30,000 a year and an NSF fellowship is about $34k. Some schools will pay you more - my son has an NSF at Stanford and he gets a supplement to that, whereas here the NSF is about what our standard student who is writing a thesis is getting.

Basically, people have shared housing, if they have a car it's used, but they have a new computer they have enough money to go home for Christmas.

SLIDE 32

So the last question is, how do you figure out where you're going to go?

SLIDE 33

Physicists did invent the World Wide Web, and so we got one of the very early URLs - gradschoolshopper.com belongs to schools that you might want to go to if your undergraduate degree is in physics. And so, this will be a list of the roughly 200 places across the country that offer a PhD in physics or astronomy or related field, and they'll have core information: how many students, how many faculty what sort of funding do they have in different areas, and so forth.

One way to narrow the list down is as you're reading papers ,start keeping track of where the work is being done. Look at where did the authors get their PhD, and if there's a postdoc who just got a PhD somewhere else, then that's probably another good place to be trained to do that kind of research.

Talk to physicists you trust, whether that's grad students or faculty or your neighbor's uncle - any of those can give you information that you need then to run through your own filter on what good fits are for you in terms of the program and geography and other interests that matter for you when you're going to graduate school.

SLIDE 34

Considerations people go into is: what is the reputation of the school? how big is it? where is it located? and all of those can be important considerations.

One thing to keep in mind about rankings is that they're out of date. A lot of schools can be making exciting new hires and that will not be reflected in the ranking. When rankings are made by US news and so forth, they send out a survey to people like me and ask what do you think are the best schools? And so i'm going to say oh yeah Well, my friend from Grad school - he's the Chair of that department, so that must be really good department and I'll put it in. So it's not a scientific survey for these things, but there is sort of a core of the top 10 or 12 places, and if you want to get an academic position at one of those top places, you pretty much need to go to one of those top places. If you look at a place like U dub, which is in the next tier, a large fraction of the people we hire either get their degree or postdoc at one of those top places.

But you can still get a really good education, and you can still get a really good job, by going to the other 150 schools that offer a PhD. You can often find a pocket of a really top ranked some field, for example at University of Rochester. Rochester is the home to Xerox and it's the home to Kodak and so it's got a really good optics program. It's got some of the best high power lasers in the world and can do all kinds of really great research in that one particular area, but there are many other areas that it would not be on your list.

Which brings us to the size: if you have a large place like UW, we have 40 faculty - there's no more than two or three that are doing exactly the same thing, and it means that you can change your mind once you get there. On the other hand, a small school they might have chosen to focus in one area. For a while the University of Missouri had 12 people doing condensed matter and then two more people who were ready for retirement, who were doing something else. So it was great if you wanted to do condensed matter, but it wasn't so great if you changed your mind and wanted to do something else.

One thing to keep in mind is that your professional network going forward is largely based on your grad school and postdoc contacts, because once you go and get a job, you've got your local people, but the ones who are going to be reviewing your grant, or who are going to be inviting you to conferences, those are very frequently people that you met while you were in graduate school.

Finally, there's the idiosyncratic things that is right for you and not necessarily anybody else. Do you want to work on something which is interdisciplinary? U dub is wonderful at interdisciplinary work. Other places have much more silos between departments.

Geography. Do you need to be near mountains or near water in order to feel sane? Do you need to live close to mom and dad or weekend distance from mom and dad? Do you have a partner who's going to be wanting to go to a school in the same area?

It's also important to make sure that the department has a climate where you feel comfortable and you can learn, because the most important thing in a scientific collaboration is trust. You need to go someplace where you're going to be able to trust the people around you and feel comfortable interacting with the people around you, and given that, you can go and do great science pretty much anywhere.

SLIDE 35

So to summarize: Connect with faculty early in your career.

Do research often, both here during the academic year and full time definitely the summer after your junior year, earlier if possible.

Take as many of those core quantum mechanics, e&m, 32x classes, is what we call them here at UW, but only take as many as you can do well in, because you want your transcript to look strong in those courses.

As was mentioned earlier, don't overload your senior year because the whole process of applying to graduate school and writing up your research and everything else, takes a lot of time.

When you're applying most students apply to about seven or eight schools, a couple of reach schools, a couple of safety schools, and then a couple of schools that they expect to be able to go to. Don't apply anywhere you're not willing to go, as that wastes everybody's time.

You want to stand out. You want to apply well before the deadline - sometimes a committee will start meeting and if yours is the only application to look at and there's not much to compare it with, you might look pretty good.

You should visit or call or email if there's someone you really want to work with, but don't bug them needlessly or endlessly. It's fine to make a connection if there is a good reason that you really want to work with someone.

Check that your file is complete. Find Catherine's equivalent at these other places, and make sure to follow up with your letters & transcripts, if they're late for any reason.

SLIDE 36

So, to finish up:

It's not for everybody, but grad school in physics can be a really grand adventure. It's an exciting time where your primary responsibility is to yourself and you're also independent. There are very few times in your life when that will be the case, and so that's really fun.

Don't say, "oh I don't want to get a PhD because I don't want a job like a professor." Don't worry about it because 80 to 90% are not going to have a job just like mine. PhDs prepare you for a wide variety of careers and also a wide variety of life experiences.

And, finally, if this is really what you want, and you're ready to essentially be an indentured servant for the next six years, go for it! It's really exciting and it's really fun.

So now i'll take questions. I see some things have just shown up in the chat.

If you're listed as a senior but extra credits are there, or running start ? - nobody cares whether your transcript says you're a junior or senior or whatever. They care that you took the courses that are going to be the solid ones that get you ready for graduate school.

The other question is work life balance. You can build your work-life balance the way you want it to be. I remember, I had one grad student who was married and his wife was a grad student in geophysics. He came in and told me, "you know i'm ready to work like crazy from eight to six, but after six, I'm married." And he went through and he got his degree in five years, and did great. He's now a manager at Applied Materials and has in fact hired other students who came out of my lab. Meanwhile, there was another student who was in the lab at the same time, who basically just lived and breathed the lab. He didn't really know what else to do with his life, so he hung out in the basement all the time, and he actually took about seven or eight years to get through.

So yes, you do have time to do all kinds of things, if you are an organized person. Time management skills are important, but we drill that into you from 121 on up, so hopefully by the time you graduate from our department you're pretty good at being able to to manage your time and build in time for your life. Because, yes, you can't spend six years not doing anything else, and we don't expect you to.

Are there other questions, either in the chat or if anybody wants to unmute and ask? In that case, thank you for coming and for asking questions. and we will get Shane to put this on the department YouTube channel and get this ready to be shared. I appreciate that you guys came and stayed and ask your questions. You asked great questions.

I look forward to meeting you guys. Come in for advising please come in. Paula, Catherine and I are all ready to talk to you about graduate school and the earlier you come in, the earlier you can start making changes in what you need to do in order to be getting ready for graduate school. Thank you all for coming, and I will turn off the recording now.