

*UNIVERSITY OF
PENNSYLVANIA
DEPARTMENT OF
PHYSICS AND
ASTRONOMY
GRADUATE
HANDBOOK
V1.2*

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Introduction and Overview

Welcome to the graduate program in the University of Pennsylvania's Department of Physics and Astronomy (P&A). There are roughly 100 graduate students at any one time in the P&A grad program. Most work with groups in P&A itself but some work outside the department, for example with faculty in engineering. The time to PhD is on average around 5.75 years, and more than 90% of all students who enter complete the program and earn a PhD. About half of all students who receive a PhD go on to academic post-doctoral positions, a fraction that has been declining in recent years as competition from the tech, healthcare, and financial industries for people with physics PhDs has risen.

This Handbook is intended to provide an overview of what you will need to do in your time here to complete the program, and how to get through the (sometimes annoying) maze of requirements for the PhD. It is not a replacement for direct discussions with actual human beings such as your advisor, the Graduate Coordinator, the Graduate Chair, or other faculty, but serves instead as a first place to go to understand what you need to do and where you can find additional resources.

Other Important Information

In addition to this Handbook, you can find details about student and advisor roles and responsibilities, on the Vice Provost for Education's web pages, under "Advising & Mentoring PhD Students." The link as of this writing can be found at:

<https://catalog.upenn.edu/graduate/academic-resources/advising-mentoring/>

but since the university seems to compulsively change its link addresses, you may need to go directl to the Vice Provost's page within the upenn domain and hunt for this link there.

Also, the Department of Physics and Astronomy lists the Degree Requirements for PhDs on the Department's web page under the "Graduate" tab at the top. The current link can be found

<http://www.physics.upenn.edu/graduate/degree-requirements>

People

There are several people in the department that directly and indirectly affect your time here, and it is good to get to know them. In some cases, the positions rotate and will not always be the same person.

Department Administrator/Graduate Coordinator (Millicent Minnick): The Graduate Coordinator is your first point of contact to get details about things like how to register for classes, how to get paid, what the requirements to become a degree candidate and ultimately graduate are, the myriad forms that need to be filled out at each stage, assigning TA positions, etc. The Graduate Coordinator is the "institutional memory" of the graduate program, and she has many years of experience with all the various things that students encounter. It is good to get to know Ms. Minnick and to be as helpful to her as she is to you.

Associate Chair for Graduate Affairs (“Grad Chair”): The Grad Chair is a faculty member selected by the Department Chair to manage the P&A grad program, for a term of three years. The Grad Chair is responsible for graduate admissions, orientation to incoming graduate students, advising to graduate students as they progress through the program, as well as providing nominations for various internal and external awards and fellowships. The Grad Chair manages the graduate program budget, which includes funding for TA positions. The Grad Chair also chairs the Graduate Committee, which assists with admissions and issues associated with graduate degree requirements and curriculum. The Grad Chair also has final say on whether a course can be waived or not, on the recommendation of the relevant class instructor, and provides the official departmental signature on oral candidacy exam results, PhD dissertations, and PhD defense exam results. In Academic Year (AY) 2018-2019, the Grad Chair is Prof. Josh Klein.

Department Chair: The Department Chair manages the entire P&A Department and is responsible for many things, including providing faculty with their teaching assignments, developing and implementing a faculty hiring plan, chairing faculty meetings and the departmental “planning committee,” and representing the department to the Deans of the School of Arts and Sciences. The Department Chair also meets with and interacts with various graduate student groups and helps to resolve any conflicts that may arise either amongst students or more broadly within the department. The Department Chair is elected by the faculty and has a term of 5 years. In AY 2018-2019 the Chair is Prof. Mark Trodden.

Assistant to the Chair (Michelle Last): The Assistant to the Chair has many responsibilities, including working with the Department Chair, the Graduate Coordinator, and the Grad Chair to provide teaching assignments to students and faculty, organize nominations for awards and fellowships, and provide room assignments for things like seminars and other meetings. Ms. Last is also a good person to get to know and to help whenever she needs assistance.

Graduate Committee: The Graduate Committee is appointed by the Department Chair with input from the Grad Chair and consists of 5-6 faculty members who are responsible for reviewing graduate applications and organizing the graduate Visiting Day, as well as assisting with questions regarding graduate degree requirements and graduate curriculum. The membership of this committee represents the three broad areas of the department (Astronomy, Condensed Matter Physics, and High Energy Physics) and may be different from year to year. The Graduate Coordinator or Graduate Chair can tell you who is on the committee in any year.

Graduate Group: The “Graduate Group” is the set of faculty members who are able to be advisors to students in Physics and Astronomy. It includes all standing faculty in Physics and Astronomy, plus faculty in other departments who have been admitted to the Graduate Group by the faculty members in Physics and Astronomy. The Graduate Chair is technically the “Chair of the Graduate Group” but in the Graduate Group rarely if ever meets as a whole. You can find members of the Graduate Group on the Physics and Astronomy Department’s web pages, or ask the Graduate Coordinator.

Location(s)

Much of your time at Penn will be spent in scenic David Rittenhouse Lab (DRL), located at the corner of 33rd and Walnut streets. DRL is really two connected buildings, a three-story “Old

DRL” which is a red-brick building built in the 1950s, and a four-story “New DRL” built in the 1960s and which is a more...interesting design. Navigating your way through DRL is at best confusing and at worst maddening. The building(s) are arranged in wings named by compass direction: E,W, and N. East is toward Center City, West toward 33rd Street, and North toward Walnut Street. Nearly all of the North (N) wing is New DRL; Old DRL is primarily West and East but includes also a “Central” (C) corridor on each floor. In recent years, signs that are said to be helpful have been added to help you find your way around.

Some important places in DRL to know:

- *Room 2E5, P&A Academic Office:* This is where you will find Ms. Minnick, the Graduate Coordinator, and Ms. Last, the Department Administrator. (2E5 means, “Second floor, East Wing, Room 5”). Occasionally, some packages wind up being delivered here and you may receive an e-mail requesting that you pick up your package.
- *Room 2E2, Mail/Copy Room:* Every graduate student is given a mailbox in the mail room for “snail mail” deliveries. The mail boxes are also used sometimes to receive or deliver quizzes or exams that you might be grading. Packages are also often delivered here, and if you are expecting something, you may have to check there for your package. There is also a copy machine in the mail room, which you need a code (20933) to use. The mail room is locked after 5pm and neither students nor faculty have the key to open it.
- *Room 2E7, Business Office:* The people in the business office manage faculty grants and accounts but also are ultimately where your check comes from. They are also the people that process purchase orders, which you may make if you are buying supplies or equipment for your research. Also, if you run into problems with a travel reimbursement, they are the people to talk to.
- *Room 2E15, Chair’s Office:* This is the spacious office of the Department Chair, who also retains his or her faculty office. The Grad Chair has no similar spacious office.
- *Room 2E17, Faculty Lounge:* In reality, the “faculty lounge” is really P&A’s only departmental common space. Here you will find coffee (which, while not very good, is free at the time of this writing), a microwave, and a sink. Occasionally departmental lunches (like the “HEP Lunch” on Mondays) happen here. From time to time other meetings occur in 2E17 (like faculty meetings), but unless some event is scheduled there, you are free to take a break and sit there or chat with colleagues or friends. There are blackboards for discussing ideas. Refreshments are served here before department colloquia. It is one of the nicer spaces in the building, and also tends to be warm even in Winter.
- *Room 3E9, Grad Lounge:* This is space reserved for graduate students to relax, talk, etc., and is currently used for the weekly Grad Student “cookie hour.” It is also used for some department-wide parties.
- *Room 2N38, “The Zoo”:* This is the “bullpen” office space for first-year graduate students. Some first-year students are already integrated into research groups and may have another desk, but for the most part all first-year students have space here.
- *2C Hallway:* You will likely have at least some classes here, and across from those classrooms are offices for graduate students who do not have lab space (ie, theorists) and are past their first year.

- *“A” Lecture Halls:* Few graduate classes are taught in the big lecture halls, all of which have names starting with “A” like A1, A2, etc., but you may act as a TA in a class that meets in one of these rooms, and some departmental seminars take place in them, as well as department colloquia. “A” stands for something that starts with the letter A.
- *East End of 1C Hallway:* The machine shop is at the east end of the 1C hallway, as is the loading dock, both of which you may need from time to time if you are an experimentalist. Also, there is a package receiving room just off the machine shop, but the hours are restricted. Some packages---particularly large ones that come in off the loading dock---are placed in that room.

Depending on your research activities, you may also spend time across Walnut Street in either the Laboratory for Research into the Structure of Materials (LRSM) or the Singh Nanotechnology Center.

When you arrive

Key Collection

You can collect your key to the Zoo and the Graduate Student Lounge from the academic office (2E5) when you arrive in the department. The same key works for the Zoo (2N38) and the adjacent room Zoo prime (2N40). You can claim any unoccupied desk in either the Zoo or Zoo prime. Mark your desk with a name label to show that it is taken.

Paperwork

Not the most exciting task, but pretty important if you want to be paid. You should visit the business office within your first few days at Penn and ask for your paperwork. Return it to them promptly to avoid delays in being paid.

Health insurance and vaccinations (<https://www.vpul.upenn.edu/shs/>)

The Penn Student Insurance Plan (PSIP) is available to all Penn physics graduate students who wish to use it. All students, regardless of their insurance plan, must be compliant with the vaccination requirements by the end of their first semester. Failure to do so will cause your registration for the second semester to be put on hold.

Online Portals

There are many platforms at Penn, each of which have different features. It’s not apparent why there are so many and it can sometimes be confusing knowing what to find where. The following summarizes the main ones you will need to use:

Penn Portal (portal.apps.upenn.edu/penn_portal/portal.php)

This contains lots of useful information and links about all aspects of Penn life. It also contains links to Campus Express and Penn InTouch (see below).

Campus Express (<prod.campusexpress.upenn.edu>)

This is where you go to setup your email address, apply for your PennCard and complete your health forms. You’ll rarely need to visit this site after you have completed these tasks.

Penn InTouch (https://portal.apps.upenn.edu/penn_portal/intouch/splash.html)

This is where you can search courses, register for classes and view your schedule and required textbooks. In your first semester, Millicent will register you for the required classes.

Canvas (<http://canvas.upenn.edu>)

This is the virtual learning environment used by Penn. Lecturers will often post homework and class announcements to the course Canvas page. You will also likely use Canvas as part of your TA work.

Concur (<http://cms.business-services.upenn.edu/penntavel/expense-report.html>)

Concur is the platform used by Penn for reimbursements. **Before using Concur for the first time, you will need to go to the business office to be added to the system.**

International Students

ISSS

The main resource for international students is the International Student and Scholar Services (ISSS) (global.upenn.edu/issv), which is part of Penn Global. Their website contains lots of useful information for international students and you are strongly encouraged to check it out.

All international students must check-in with ISSS upon arrival.

Social security number (SSN)

In order to receive your stipend, you must have a bank account and an SSN. You should apply for an SSN as soon as possible after you arrive at Penn in order to avoid delays in being paid. To apply, see Millicent for assistance in filling out the On-Campus Work Authorization for F-1 students.

Department Climate

The Department of Physics and Astronomy is committed to freedom of thought which, like the University of Pennsylvania as a whole, is founded on trust and respect among all members of the University community. It is the responsibility of every member of the Department to respect the personal dignity and worth of others. We believe in fostering a climate of inclusion for all members of the Department. We include below a statement and resources regarding both sexual harassment and discrimination.

Sexual Harassment Policy and Resources

Our Departmental policy on sexual harassment follows that of the University, and Penn has a clear sexual harassment guide, which can be found here

<http://www.upenn.edu/affirm-action/introsh.html>

We take any issues of harassment extremely seriously.

If anyone is a victim of a violation of these rules, there exist clear reporting paths for students, staff and faculty for sexual harassment, and Penn has multiple places such things can be reported, so that one need not worry about having nowhere to go if the person reporting is uncomfortable with one of the options.

Within the Department, you are encouraged to bring any such events to the attention of the Department Chair, the Graduate Chair or the Undergraduate Chair. You can also speak to anyone on the Graduate Committee, if you feel uncomfortable with the other options. Most importantly though, independently of

whether the person reporting chooses to bring it to the attention of any of these individuals, they are at all times free to report allegations to the Office of Affirmative Action and Equal Opportunity Programs

<http://www.upenn.edu/affirm-action/>

The Department of Physics and Astronomy stands ready to deal with and report any such allegation through the proper channels, and the above makes clear that we have policies in place, and intend to work to ensure that our department and Penn are a welcoming place where faculty students and staff can all feel supported.

Discrimination and Equal Opportunity

Penn has an equal opportunity guide

<http://www.upenn.edu/affirm-action/eoaa.html>

for which there is a clear complaint resolution protocol that is quite similar to the one linked to above regarding sexual harassment

<http://www.upenn.edu/affirm-action/resolcomplaint.html>

Each department Chair is quite well-versed in these procedures, and we invoke them without hesitation when issues arise.

Timeline as a Graduate Student

There are several milestones in the graduate program, which we outline below.

- *Admissions:* Admissions “close” on April 15, the last day when all students who have decided to come to Penn let the Department know that that is their intent. At this point, information about first-year funding is sent to the students as well as information about registration and arrival at Penn. Once you see in the Collegenet system that it knows you are coming, you should be able to get yourself an e-mail address at Penn, which will help with ensuring that you get department-related e-mails and other important information. Usually, students get first an “sas” domain e-mail address (e.g., i.newton@sas.upenn.edu) but you may get other e-mail addresses in other domains within your research group after you arrive.
- *Summer Before First Year:* All matriculating students are strongly encouraged to show up the summer before they begin their first year to work with a research group. There are many advantages to this. In that first summer, you get an opportunity to “ramp up” on research work, learning skills and ideas that will be necessary for doing research, without the time commitment of classes and teaching. You may even be able to begin a research project that will turn into a dissertation project. The group you work with may be a great fit, or it may not be---discovering this in your first summer allows you to explore other options during the academic year.
- *Orientation (late August before Year 1):* Orientation takes place just before classes begin. For students who will be teaching (usually, all first-years), there is an additional orientation about teaching and associated policies.

- First Year:* Your first year is largely taken up by classes and TAing. Usually students try to complete their core classes (these are outlined in a subsequent section but they are Math Methods, E&M, Quantum I and II) in their first year. It is also a good idea to become involved in a research group, even if you don't have a lot of time to do research, for all the reasons stated above. Because in this year you are either funded by the department to teach, or on a fellowship, many potential advisors will be happy to have you sit in on group meetings or get started on a project. Finding a group to do research with is helped by the Physics 501 class that every first-year student is enrolled in. P501 is a series of talks given by various faculty, outlining their research. It is a good time to ask the faculty whether they are taking students and the kinds of projects they might have. Even if you had an idea of what you wanted to do when you came, you might find that a talk by a faculty member changes your thinking, so it is worth listening to the talks with an open mind. With help from the Graduate Coordinator, the P501 classes include some kind of dinner (pizza, etc.) that is picked up by one of the students (this rotates around). You should feel free to eat while the speaker talks (and the speaker may also be eating...). **By the end of your first year, you should have found an advisor and a group to do research with.** This is a critical outcome of that first year, because to graduate in a reasonable time you will need to get started on serious research by your second year. It is also the primary way you will be funded for the summer following your first year and for all your time at Penn thereafter. The Grad Chair is happy to help with this process, as are members of the Grad Committee and other faculty members (even if they are not going to be your advisor). We describe in a subsequent section some further tips on getting an advisor.
- Year 2:* In your second year, you will likely be continuing to take a few classes, including a course outside your primary discipline, as well as any other electives that you find interesting or which your advisor recommends you take. Most students will not be TAing, although some do part time (particularly theorists). In Year 2, you should be planning on becoming focused primarily on your research work, learning needed skills as well as starting to get an idea of potential thesis topics. Part of your course credit requirements will be satisfied by "independent study" supervised by your advisor.
- Year 3:* Nearly all students should have completed coursework, other than potentially independent study credits or, in some cases, advanced topic courses taken as electives. Your focus should be almost entirely on beginning independent, original research projects.
- Oral Candidacy Exam:* **No later than 18 months after you complete your core classes--**so, for most students, sometime in their third year--**you must take an oral "exam."** You can take it multiple times if necessary, but **must pass it before the end of your sixth semester at Penn.** The exam time, place, and committee are all arranged by you, in consultation with your advisor. The explicit details will be provided in a subsequent section, but the idea of the oral candidacy exam is to demonstrate that you have acquired the skills necessary to begin the research that will ultimately form the basis of your dissertation. You do this by presenting both some independent work you have done and its physics context to a committee of three faculty, chosen by you, and this group becomes your "Dissertation Committee" who are charged with monitoring your progress from candidacy to the PhD. Your committee members are also a great group to draw from when you are looking for letters of recommendation for post-doctoral fellowships or

other jobs. The work you present need not be part of your ultimate dissertation work. You also should have a brief write-up of what you will talk about, approved by both your advisor and the Grad Chair. It need not be long; 3-5 pages is a pretty common length. While there may be physics questions that are collateral to the candidacy exam as well as some that will explore more general physics topics, the primary goal is to ensure that you are ready to become a “degree candidate.” University rules say that if you have not moved on to degree candidacy by the end of your fifth year, you must be dropped from the graduate program, but this should not be a problem given that the candidacy exam is taken by most students before Year 3.5. For several years, the 18-month deadline was treated quite loosely, but that often led to students being at risk of being dropped by the university rules on 5th year candidacy or in some cases taking a very long time to finish. Beginning in AY2017-18, the 18-month deadline is followed.

- *Meetings with your Dissertation Committee and Progress Reports:* The three-member committee you pick for your oral candidacy exam also serves as your “dissertation committee” and they are charged with **meeting with you annually** to monitor your progress toward graduation. Those meetings should be arranged by you, although your advisor may prod you to set them up. They are not formal in any way---simply a discussion of how things have been going and where you stand on dissertation work---but they are an important way for you and your advisor to get feedback on your progress towards graduation, and a way for you to cultivate mentors and letter writers for the future. You must submit an **annual progress report each year**, and it would be good to have this in hand when you speak to your dissertation committee. You should submit the progress report **after** you have your meeting with the dissertation committee. Talk to Ms. Minnick to find out how to submit the progress report.
- *Years 4-5:* These are the primary years you spend on your dissertation work, exploring an original physics topic on your own, with guidance from your advisor, and ending with the written document describing your work. In some cases, students may take slightly longer than 5 years to finish the work and write-up.
- *Dissertation Defense:* The dissertation defense will be described in detail in a subsequent section, but it is primarily a presentation to a five-member committee (three of which are your dissertation committee from your oral candidacy exam, and usually including someone from outside your area of expertise). Passing your dissertation defense, and submission of your dissertation to the Dean’s office according to guidelines included in this handbook, means you have completed all requirements for receiving a PhD from the Department of Physics and Astronomy.

Requirements to Complete the PhD

You can find the information below anytime at:

<http://www.physics.upenn.edu/graduate/degree-requirements>

A grade of B+ or higher in each of the following courses:

Math Methods (Physics 500)

Electrodynamics (Physics 516)

Quantum I (Physics 531)
Quantum II (Physics 532)

1. Successful completion of 20 graduate-level course credits (including no more than 11 course credits for research and reading courses). These courses must include the four courses listed above, Statistical Mechanics (611), and one course outside the student's field of specialization.
2. Students may receive credit for graduate courses taken at other institutions, though no more than 8 credits may be transferred. To get credit for such courses and therefore be exempt from having to re-take them, the student should first go to the current instructor for that course for a standardized evaluation of the instructor's design. If the instructor determines that the student knows the course material, then he or she will make a recommendation to the Grad Chair that course will be waived and then, if appropriate, credit will be given.
3. An Oral Candidacy Exam must be taken within 18 months of the successful completion of the four required courses in requirement 1.
 - Before this exam can be scheduled, the student's advisor and the graduate chair must approve a short, written statement describing the student's research topic.
 - The exam, which need not be public is administered by a three-person committee. Typically, the thesis advisor is one of the committee members, with the others drawn from among the members of the Physics Graduate Group. If you want a committee member who is not part of the Graduate Group, you should talk to the Grad Chair: this can be done but requires approval.
 - The oral part of the exam will include a presentation by the student followed by a question and answer session on the student's general field of study by the three-person committee.
 - **Students who have not taken this exam by the 18-month deadline will not be allowed to register for the following term.**
4. Annual progress reports. From the time of successful completion of the Candidacy exam, until successful defense of the Ph.D. dissertation, the student and the three-member committee must provide annual progress reports to the Associate Chair for Graduate Affairs.
5. A dissertation based on original and significant research in physics, astronomy or a related field.
 - The dissertation must be written in English and presented and defended in public. While the thesis itself may be written in absentia, there is a one-year residency requirement. There is no additional language requirement for the Ph.D. degree.
 - Prior to public presentation, the written dissertation will be examined by a committee consisting of five members of the Physics and Astronomy Graduate Group. Three of the five members are usually the same faculty members who served on the candidate's three-member committee during the oral candidacy exam. One of the two additional members

should be chosen from among those active in the candidate's subfield while the remaining member is expected to be from a different subfield. If the candidate's advisor is not a member of the Physics Graduate Group, he/she will serve as the sixth member of the committee. The committee must also attend the public presentation, which serves as an oral examination.

- The committee members should be given adequate time to read the dissertation (at least 14 days) and the defense should be announced to the department about one week in advance. For that purpose, the candidate should advise the Graduate Assistant of the proposed composition and chair of the five-member dissertation committee, the date, time and place of the defense, and the title of the dissertation, for approval by the Associate Chair for Graduate Affairs. Upon approval, the Graduate Assistant will prepare a notice announcing the defense to the department.

Other Programs: Five to ten percent of our students work towards a Ph.D. in physics or astronomy by doing research outside the department, under the joint supervision of a member of the Graduate Group in Physics and Astronomy and a faculty member in another department.

Courses

As described above, the core courses, plus Statistical Mechanics and one class outside of your field of discipline must be taken as part of your requirements for the PhD. You will also need to take Physics 501, the “research seminar” in your first year, as described in the section on your timeline and on finding an advisor. Usually the core courses are completed in your first year, but bear in mind that you are likely to be TAing (which takes real time) and you will hopefully also be getting integrated into a research group, or at least working to find an advisor. Therefore planning on taking additional courses in your first year should be evaluated carefully in light of your available time. It is far worse to fail a class than to postpone taking it. That being said, if you either are able to get some classes waived because you have taken a graduate-level class elsewhere that the Penn instructor feels is similar the course here, or because you are not TAing, it may make sense to get as many class requirements out of the way as possible so that you can focus more on research in your second year.

As a reminder, to get classes waived you need to talk to the relevant instructor first, who will then make a recommendation to the Graduate Chair. That instructor may simply review materials from a previous course you have taken, or ask you to do a sample homework set, or even a previous final exam, in order to determine whether you know the material well enough to not take the course.

Please note: **no matter how many classes you have waived, you still need to have at least 3 total credit units each semester until you have taken your oral candidacy exam, in order to be considered a full-time student. This is particularly important for international students who must be considered full-time for visa purposes.** This may mean that if you’ve waived a lot of courses when you arrive, you will need to find relevant courses outside of the Physics and Astronomy Department to take, or already have an advisor with whom you can take independent study credits.

The 11 credits of “independent study” typically are credits awarded for work you are doing with your advisor. Students usually register for these in their second year and as they continue working with their advisor they continue to sign up for them, until they have received all 11.

Grading

In the Department of Physics and Astronomy, graduate courses are typically graded on a compressed scale. Passing grades are assigned between B and A+: a B- or lower is given for poor performance.

Funding

Understanding how funding works can seem like a remote issue to a new graduate student: having just gone through being an undergraduate where you were paying tuition (whether you received financial aid or not) may mean that you haven't thought much about how as a grad student you will ensure that you will receive a stipend and that someone will be paying tuition for you. On top of that, it is sometimes hard to understand where your funding comes from and how what you want to do may be affected by that.

Graduate students are funded in three ways in P&A: a small block of funds from the School of Arts and Sciences intended primarily for students who are TAing; research grants obtained by the students' advisors; and through external and internal fellowships---the NSF Graduate Research Fellowship being an example of the former and the Penn Dissertation Completion Fellowship an example of the latter.

If you are a first-year student, you will most likely be funded by the "TA block" grant that comes from the School of Arts and Sciences, and you will be expected to be a Teaching Assistant (TA). Some first-year students will have external fellowships and can decide not to be TAs (but as it is a critical part of your training to do so, it is recommended that you do when an opportunity arises). Some first-year students may be in a lab that has research funding and wants to use it to "buy" the student's TA time so that they have more time for research, and in some of those cases the student will TA in a later year instead.

After your first year, your funding is expected to come primarily from research grants obtained by your advisor. For those on a fellowship, this may not be the case, although usually fellowships do not extend for the duration of your time in graduate school and therefore some of your funding probably will come from your advisor. A very small number of students may receive half their funding by teaching for one semester each year beyond Year 1, because some external grants will only cover 50% of a student (this is almost always theory students). Your first year ends June 30, so you need an advisor who will fund you by then (i.e., starting in July after your first year), hence the importance of spending time finding a research group to do research with during Year 1. Some students beyond their first year also TA a class or two to earn extra cash (if their advisor signs off on this!) but they are not *supported* as a TA---their tuition and their stipend is paid for by their advisor. An important point here is that **you cannot be supported as a TA past your first year if you do not have an advisor**. Even in the rare 50% support cases mentioned above, students have advisors with whom they are doing research toward their candidacy and eventually dissertation.

External funding obtained by your advisor likely comes from either federal or private sources (there may also be some state funding available). In either case, most grants are for three years, and federal grants are often "renewable" meaning your advisor can re-apply for new funding after three years to continue a research program. That means that it is a near certainty that during

your time doing research as a grad student your advisor's grant will expire and a new one will have to be successfully reviewed in order for you to continue being funded. In the vast majority of cases this is what happens, but it is worth understanding that the success of a proposal requesting funding for an existing graduate student will depend in part on what your advisor can say about your research: if they can make a case that you are indispensable to the research program and have done creative and interesting and important research to date, the likelihood of funding is much higher. It is therefore a good idea to keep in mind that your research progress will affect your funding, and in fact this is your introduction to the way scientific research is done in the United States---research is reviewed competitively, and the best proposals get funded (where "best" can have a very complex and nuanced meaning), but most do not.

There are opportunities for students to receive direct funding themselves. The most common example of this is the NSF Graduate Research Fellowship, which you can apply for in your first or second year, but there are also Department of Energy Graduate Research Fellowships, Graduate Instrumentation Research Awards, etc. Talk to your advisor or the Grad Chair for ideas of things to apply for if you are interested. With the exception of the NSF GRF, most of these require you to already have an advisor or to be planning on doing research somewhere else (like at a National Lab). These are all very competitive, but an advantage of getting such a fellowship is that it comes with a certain prestige that is good when you are applying for post-doc positions or other jobs, and it also gives you some flexibility in finding an advisor: you can do research with someone who does not necessarily have funding for a new student, and so your options are broader.

Self-funding---where a student pays his or her own tuition and does not receive a stipend, is no longer allowed by the School of Arts and Sciences in PhD programs.

Finding an Advisor

Given how important it is to find an advisor by the end of your first year, you might think there was a fixed or written procedure for doing it, or some matching service that put advisors and students together. But across nearly all Departments of Physics and Astronomy, this is not the case (in some departments or at other universities students are "accepted" into a particular group rather than to the program as a whole, and the students are then forced to work with that group and advisor for their entire graduate time).

So, how does one do this? There are many ways. In some cases, students are fairly certain about what they want to do and who they want to work with when they arrive, and they have already spoken to a prospective advisor. For these students it is very important to begin work with that group either in the summer before they arrive, or during their first year. Having an idea of what you want to do and who you want to work with is a great advantage in getting into a research group, but once there you may change your mind. It is best to go through that process sooner rather than later, so you can begin acquiring the skills and experience you will need to start your own research project for your dissertation. During your first year it is of course hard to get a lot of research done (although some students do) but even a small project, or just attending group meetings, can be helpful in deciding whether your choice is a good one. In such cases, regardless of whether you are happy, you will want to have a chat with your prospective advisor sometime around the middle of your second semester (if not sooner), to understand the funding

situation in the group: is there funding for a new student? Your advisor will be happy to talk to you about this, and the Grad Chair will be happy to answer questions as well.

If you have been accepted to Penn P&A and are not certain what you want to do, there are several things to do to help you decide. The first is to pick *something* that you think might be interesting and contact a prospective advisor before your first summer, and to offer to work in that group for the summer. Funding for this typically comes from the Department, not the advisor's grant, and thus the advisor can say yes without having the funding available immediately. If you decide not to do this---or are so uncertain that you can't even a guess at what you might want to do yet---you can begin to investigate possibilities once you arrive for classes in your first year. One of the classes you must take in your first year is Physics 501 which has a title like "introduction to research." The class is a series of talks by faculty---often faculty who are interested in taking on new students---that describe their research. After the talk, if you find a particular faculty member's research to be interesting, you can arrange to chat with them to see if indeed they are interested in new students. Another possibility is to attend one or more of the departmental seminars in a field or fields that you have an interest. In these seminars you will get an idea of what people in that area are interested in (based on who they invite) and what the major topics are. You can get an idea of what you find interesting this way. You also get to see various faculty members "in action" and how they interact with the speakers and students and post-docs in attendance.

Probably the most common approach, however, is simply to knock on the doors of a faculty member in whose work you are interested and ask them whether they have space for a student. If they do, they may be willing to take you on for a semester (while you are first-year) or the summer after your first year, so that both of you can decide whether it is a good fit. After that, in most cases, they will be happy to have you continue doing research with them and will agree to fund your research. You also need not restrict your investigations to faculty members in P&A; students can also be advised (and funded) by faculty in other departments. These faculty are members of the "Graduate Group" which includes anyone who can advise a student in P&A through to the end of their PhD.

The Grad Chair usually meets with all first-year graduate students about halfway through the Spring semester, at which point you can describe your progress on finding an advisor, ask for help in doing so or ask questions about the next year of your graduate study.

In some cases, after a summer or even a year of research in a group, it becomes clear that the group is not a good fit: either you are not interested or not happy with the science you are doing, or you are not making enough progress to go through an oral candidacy exam on schedule. And in some rare cases, your advisor's grant may not be renewed or comes in with less funding than anticipated (or you may be returning from a leave to find your advisor's grant has expired). In these cases, changing advisors or research groups is possible, and it is important to talk to the Grad Chair as soon as possible to explore possibilities. It is not a good idea to plan on "shopping around" by trying several groups, because each switch to a new group means a delay to your overall graduate school timeline and runs the risk of an interruption in your funding.

Remaining in Good Academic Standing

To complete the program (and to continue being funded) graduate students need to remain in “good academic standing.” To this, you need to:

- Maintain an average of B+ or better in your core courses, and do not get below a B+ in any course more than once
- Complete the 20 credits of course work, with no more than 11 credits coming from research (“independent study” courses).
- Find an advisor with funding for you, with whom you can do research, and make enough progress in that research as determined by your advisor that you are able to take your Oral Candidacy Exam
- Take the Oral Candidacy exam no more than 18 months after you complete your core courses, and successfully pass it no later than your sixth term
- Advance to candidacy by the end of your 5th year
- Make satisfactory progress on your dissertation after advancing to candidacy, as determined by your advisor and your three-member dissertation committee.
- Complete and defend your dissertation.

Oral Exam Candidacy Preparations

As discussed above, within 18 months of completing the required coursework, and not later than their sixth term in the program, all physics students are required to pass the oral candidacy examination. It is strongly recommended that you take the exam well in advance of the 18-month deadline.

The exam is administered by the 3-member committee. You are expected to find committee members yourself---faculty are usually quite happy to participate if they are available---as well as set up the time and place. You can get help from the academic office in getting a room reserved. The exam typically lasts 90 minutes. At least one week prior to the exam, you should provide each committee member with a short document of sufficient length (for some students, one page may be enough; for others, 8-10 pages might be needed) to summarize your research.

There are several goals of the oral candidacy exam: to see that you have developed the skills necessary to begin dissertation work; to determine whether you understand the “big picture” physics concepts that you will need for the context of your work; to get you and your advisor to think carefully about possible dissertation topics and timeline. The written statement you submit as part of the candidacy exam is expected to include things like a brief physics context for your work, a summary of previous work (a “warm-up” problem, for example) and preliminary results if any, and references. Your presentation should cover these things as well.

The format of the exam is as follows:

-You give a short (15-20 minutes) presentation which describes the physical concepts that will be the context for your dissertation research, the research you’ve done to date, and a notional level of what you plan for your dissertation, including if possible a timeline.

-During and following the presentation, the committee members may ask questions, both about the presentation and the research and about the physics context in which the research is being done. There may also be questions outside your research area. Typically, it is assumed that you are familiar with your chosen subfield at the level of Physics 518, 622, or Astronomy 503.

This exam is not just an evaluation of your completed and proposed dissertation research; the purpose here is to determine your grasp of the fundamentals in the area of concentration (bio-physics, condensed-matter, particle, or astrophysics), and to assess your preparation for research in this area.

The exam may be taken more than once, but it must be passed within the sixth term in the program. A student who fails twice will be assessed by the Graduate Committee and/or the entire physics and astronomy graduate group before a third attempt is granted. In such cases, the thesis supervisory committee might be enlarged and/or reconstituted.

A form reporting the outcome of the exam must be signed and submitted to the Graduate Assistant within one week of the completion of the exam. If a student has any course work deficiencies at the time of the exam, then a passing grade on the exam is only provisional until the deficiencies are corrected.

Each student who has completed the required coursework is also expected to have begun research with an advisor. The student has the responsibility of promptly forming a three-member thesis supervisory committee. This committee administers the Ph.D. Oral Candidacy Exam and will serve as the core of the Ph.D., defense committee.

One member of the committee will be the thesis advisor (even if the advisor is outside the department). The other two members will be members of the Graduate Group. If possible, each committee should consist of at least one theorist and one experimentalist. Any member of the physics and astronomy graduate group is eligible as the third member, although the third member is usually in the same research subfield as the thesis project. Conversations between the student and prospective committee members regarding their willingness to serve are appropriate and encouraged. Whereas the selection of committee members should be done by the student with the advice and consent of the thesis advisor, the committee is actually appointed by the graduate group chair in consultation with the student and advisor.

The student has the further responsibility of meeting with each member of this committee once a year to review his/her progress. This meeting need not be as a group, but it is mandatory: the Graduate Assistant will not register the student unless all three members of the committee have signed a form acknowledging they have met with the student within 13 months of their previous meeting.

During the fifth year, and each year thereafter, the Graduate Chair will request the three-member committee to meet to discuss the student's status. The student will be informed of the outcome of the meeting, and a brief written summary of the meeting will be placed in the student's file.

Preparation for the Dissertation Defense

Degrees are only granted at certain times during the year, and so if you want a degree by a certain date (for example, to start a job that requires the degree) you need to check when your defense must be done in order to get that degree. Below is a link to the calendar for degree-granting dates, and link to sign up to get that degree granted.

Calendar for May, August, and December Degree Dates (see GAS for updates)

https://provost.upenn.edu/uploads/media_items/graduation-calendar-15c-18a.original.pdf

Sign Up for the Degree: <https://fission.sas.upenn.edu/sso/gas/degree/app-start.php>.

Dissertation Manual Guidelines:

Dissertation Manual: http://guides.library.upenn.edu/dissertation_manual

Committee

- The thesis defense committee must contain 5 members of the Physics and Astronomy Graduate Group. Additional committee members may be added at the discretion of the PhD candidate and their research advisor (see academic office for a list of members of the Graduate Group).
- Three of the five members are usually the faculty members who served on the candidate's three-member committee during the oral candidacy exam. One of the two additional members should be chosen among people active in the candidate's subfield while the remaining member is selected from a different subfield. If the candidate's advisor is not a member of the Physics Graduate Group, he/she may serve as the sixth member of the committee, or, in consultation with the Grad Chair, the requirement that they be in the Graduate Group can be waived (or they can be admitted to the Graduate Group).
- A member of the committee should be selected to Chair the defense (excluding the Advisor). The committee must attend the public presentation. In addition, an oral examination is required. The oral examination may be public and part of the oral presentation, or may be private (including only the candidate and the committee).
- The committee members should be given adequate time to read the candidate's dissertation (about 14 days) and the defense should be announced to the department about one week in advance.
- The candidate should advise our Department Coordinator of all the details that are part of the announcement, i.e., the composition and the chair of the dissertation committee, the date, time, place of the defense, and the title of the dissertation. You should email the department to reserve a room.

- There will be a notice announcing the defense to the department and posted to the website. All arrangements, including the selection of all five committee members, its chair, and the date and time of the defense are subject to approval by the Associate Chair for Graduate Affairs.

Title Page: Include the year you turn in your dissertation on the title page and copyright notice, even if you defended the previous year. The year printed on the dissertation must match the year of publication. This will avoid reprinting and obtaining new signatures.

Rule: Committee Members Outside faculty (i.e., not in the graduate group, whether at Penn or at another institution) may serve as reader and even as dissertation supervisor. But the Chair of the Committee must always hold an appointment on the standing faculty in the graduate group (see following list).

Final Step

Check the degree calendar for deposit dates. Contact Graduate School Arts & Sciences to set up an appointment to deposit the dissertation. Degree Assistant (215-898-7445).

Requirements for the Master's Degree

Grades of B or higher in each of Math Methods (Physics 500), Electrodynamics (Physics 516), and Quantum I and II (Physics 531/532).

Satisfactory completion of four additional graduate-level courses with scores of B or better, at least one of which must be offered by the Physics and Astronomy Department. Up to three courses may be from other departments, provided the Grad Chair agree that they are in subjects related to Physics and Astronomy.

There is no language requirement, but there is a one-year residency requirement.

Physics and Astronomy Graduate Program Policies

All students must follow the *Penn Code of Student Conduct* (to be found in the Pennbook). Any student who violate the Code of Student Conduct will not be considered in good standing. Students must follow all guidelines for ethical conduct, research and publication

- Please see *Penn's Code of Academic Integrity (in the PennBook)*
- Consult the *Penn Handbook for Students: Ethics and Original Research*

Students receiving a stipend either as a TA may not take any employment outside of your full-time graduate student research without having prior approval of the Physics and Astronomy Graduate Chair and the Dean of the Graduate School of Arts and Sciences. This includes students on external or department fellowships.

Graduate Division of Arts & Sciences: <http://www.sas.upenn.edu/graduate-division/>

Provost Academic Rules for PhDs and Research Master's Degrees:
<https://provost.upenn.edu/policies>

SECTIONS:

- Academics
- Campus Resources & Community
- Conduct & Personal Responsibility
- Employment / Research
- Facilities & Transportation
- Student Groups
- Ethics and Original Research
- Graduate Supervision Guidelines
- PhD Dissertation Manual
- Fairness of Authorship Credit in Collaborative Faculty-Student Publications
- Family Friendly Policies for PhD Students
- Curriculum
- Evaluations and Examinations
- Dissertation
- Public Presentation and Defense Examination
- Acceptance
- Publication and Submission
- Regarding Tutoring Students for Compensation
- Research Abroad
- Time Limits
- Petition for Readmission After Reaching the Maximum Time to Degree
- Recertification
- Tuition
- Transfer Credit
- Continuous Registration
- Extramural Research
- Copyright and Patent Policies
- New Parent Accommodation
- Family Leave of Absence Policy
- Graduate Grades and Academic Standing
- Auditors
- Change of a Graduate Group
- Institutional Courtesy/Exchange Programs

Beyond Research and Studying

Penn Recreation (<https://recreation.upenn.edu>)

Access to [Pottruck Health & Fitness, Fox Fitness, and the Ringe Squash Courts](#) is included as part of the general fee, which is paid for by the department (if you are in first year) or your advisor (after first year) along with your tuition.

Graduate Student Center (<http://www.gsc.upenn.edu>)

The graduate student center's core purpose is to 'encourage the development of Penn's graduate and professional student community through academic and social initiatives'. They provides a range of resources for graduate students as well as running events throughout the year.

Graduate and Professional Student Association (GAPSA)

(<http://www.gapsa.upenn.edu>)

GAPSA is a coalition of graduate students that represents the interests of graduate students in all 12 schools at the University of Pennsylvania. They are the highest level of organized graduate student representation in the university, making them an excellent resource for all things relating to graduate student welfare (anything from communicating with university executives to advocate for graduate student needs to providing funding for graduate student-run activities). There are any number of ways that one can pursue involvement with GAPSA operations, ranging from volunteering for a specific event to pursuing becoming a member of the GAPSA general assembly board. See the GAPSA website or contact the Physics department SASGov representative (Stephen Hackler, shackler@sas.upenn.edu) for more information.

School of Arts and Sciences Government (SASGov)

(<http://www.sasgov.sas.upenn.edu>)

SASGov is the School of Arts and Sciences graduate student government organization. They deal exclusively with issues of concern to SAS graduate students and coordinate with university representatives and with GAPSA to resolve SAS graduate student concerns. Every department in SAS has at least one representative to SASGov which brings issues of concern to members of that department to the attention of SASGov as a whole. That representative sits on the general board and discusses/votes on various issues. The other main function of SASGov is to provide funding, both to individual SAS graduate students and to graduate student groups. This comes in the form of various specific funds (travel reimbursements, professional development, etc.) for which individuals may apply, or event funding for which student groups may apply. See the SASGov website or contact the Physics department SASGov representative (Stephen Hackler, shackler@sas.upenn.edu) for more information.

Diversity and Inclusion in Physics at Penn (DIP) (sites.google.com/view/dip-penn/)

DIP is a group run by graduate students within the department with the aim of making the physics community more inclusive and welcoming to all people by raising awareness of the

forms of discrimination minorities in physics and STEM often face and creating a supportive community within the department for those who may encounter any of these issues. DIP holds monthly lunch meetings during the semester, as well as hosting guest speakers or workshops once per semester.

Penn Education and Public Outreach in Physics & Astronomy (PEPOPA)
(<https://www.physics.upenn.edu/outreach/scientists>)

The Penn Education and Public Outreach in Physics & Astronomy (PEPOPA) group organizes outreach efforts within the department including annual participation in the Philadelphia Science Festival. PEPOPA also manages an email listserv to recruit volunteers for outreach opportunities that arise, such as the need for a speaker at a high school career day or volunteers to perform a demo at local event. PEPOPA frequently communicates with Jane Horwitz and Kristen Coakley of the Science Outreach Initiative (whose offices are located in the north hallway of DRL) to communicate with the Franklin Institute and to find new outreach partnerships. Students, faculty, and staff from all fields related to physics and astronomy are all welcome to join. To be added to the listserv to be updated about meetings and upcoming outreach opportunities, or ask for more information, please email penn.phys.astro.epo@gmail.com.

Other Campus Resources

Counseling and Psychological Services (CAPS) <https://www.vpul.upenn.edu/caps/>

Penn Women's Center <https://www.vpul.upenn.edu/pwc/>

Career Services <https://www.vpul.upenn.edu/careerservices/>

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