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Introduction

The MIT Physics Department has a long and storied history. Over the years, it has accumulated a wealth of resources and opportunities for its students. Its decentralized structure allows for a myriad of fascinating research directions within its nine divisions (which are also referred to as "research areas"). This means that as the Department has evolved and grown, various bits and pieces of information have been published in a variety of places, some of which are not immediately obvious; as a result, finding information about various aspects of the program can often require more work than our day-to-day research!

The MIT Physics Handbook is a **student-led effort** which aims to a) compile pre-existing resources and b) share the wealth of advice from older students. This Handbook aims to collect all aspects of the MIT Physics PhD program in one easy-to-access, searchable document.

A few logistical notes to mention:

- The Physics Handbook is a resource written by students, for students; you should not take this as any kind of official statement from the Physics Department!
- This Handbook is a living document - nothing written here is set in stone, and the content will change as various departmental guidelines and expectations change. We expect to update this document at least annually.
- Responses written by individual students will naturally include observations drawn from their personal experiences. Your own experiences with each facet of this program will likely vary from what you read here, but these experiences may serve as a useful guide.

Finally, we welcome any questions / comments / concerns you have about the Handbook. Our aim is to make your journey through grad school as smooth and easy as possible, and we wouldn't be able to do so without your feedback and support! Please contact PGSC at physics-gsc-23-24@mit.edu.

Sincerely,

Lisa Lin

Editor, 2024

List of acronyms and terms

Things around the Department

ASE: Advanced Standing Examinations - qualifying exams for MIT *undergraduates* to earn credit for an MIT subject without taking the class

APO: Academic Programs Office (4-315)

Breadth classes: Classes outside your area of research specialization (division)

Course 8: All departments at MIT are numbered (as with the buildings); the Physics Department is “Course 8” and its classes are referred to by their numerical representations, e.g. 8.592 is Statistical Physics in Biology.

General Exams: The Written Exams and Oral Exam

GWIP: Graduate Womxn in Physics

NSBP: National Society of Black Physicists

Pappalardo Room (4-349): Where many of the Physics Department events take place, including socials, fancy lunches, and town halls.

PGSC: Physics Graduate Student Council

physREFs: Physics (Department’s) Resources for Easing Friction and Stress

PVC: Physics Values Committee

RA: Research Assistant

Specialty classes: Classes within your research area; you take these before the Oral Exam. Can also be referred to as “Depth” classes in some contexts.

TA: Teaching Assistant

UROP: MIT Undergraduate Research Opportunities Program

UWIP: Undergraduate Womxn in Physics

Divisions

AMO : Atomic, Molecular, and Optical Physics

ASTRO: Astrophysics

BIO: Biophysics

CMT: Condensed Matter Theory

CMX: Condensed Matter Experiment

NUPAT: Nuclear and Particle Theory

NUPAX: Nuclear and Particle Experiment

PLASMA: Plasma Physics

QI: Quantum Information

Research labs

CUA: Center for Ultracold Atoms

CTP: Center for Theoretical Physics

LIGO: Laser Interferometer Gravitational-Wave Observatory

LNS: Laboratory for Nuclear Science

MKI: MIT Kavli Institute for Astrophysics & Space Research

PLS: Physics of Living Systems

PSFC: Plasma Science and Fusion Center

RLE: Research Laboratory for Electronics

Other terms you may hear

CPT: Curricular Practical Training; authorizes international students under F-1 visa status to obtain employment training and work in paid internship positions before graduation

DEI(J): Diversity, Equity, Inclusion (, and Justice) – you may see permutations of this acronym used at other institutions, e.g. EDI

GSC: MIT-wide Graduate Student Council

GSU: MIT Graduate Student Union (affiliated with the United Electrical, Radio, and Machine Workers of America)

IAP: Independent Activities Period (effectively MIT's "winter break")

ISO: MIT's International Students Office

OPT: Optional Practical Training; a type of temporary work authorization for international students under F-1 visa status (i.e. have just graduated or have been studying for over nine months) to legally work in the United States for one year. If you are in a STEM field (Physics included), you can apply for a 2-year STEM OPT extension (so 3 years in total). OPT is typically used post-graduation, but there exists a pre-completion OPT that allows you to work off-campus

during your program. Note that time spent on pre-completion OPT will count towards (i.e. shorten) the time for post-completion OPT.

Part II: Written Exams/Core Courses (*ask an older student what* "Part I" *was, if you're curious*)

Part III: Oral Exam

SoS: School of Science

Conferences and Fellowships

AAS: American Astronomical Society (major conference is the "Winter Meeting")

APS: American Physical Society (major conferences are the "March Meeting" and "April Meeting," each attracting ~10k attendees each year)

DOE CSGF: Department of Energy's Computational Science Graduate Fellowship

NDSEG: Department of Defense National Defense Science and Engineering Graduate Fellowship Program

NSF GRFP: National Science Foundation's Graduate Research Fellowship Program

Administrative Info

How to get around the department

Resources at-a-glance

Within the department, we have the Physics Graduate Student Council (PGSC), which puts on many events throughout the academic year. Examples include fortnightly Cookie Socials (that seldom actually have cookies) and monthly Pizza Socials (free pizza and beer!).

- Physics PhD at a glance [note that some of the information in this particular PDF may be outdated, but in general the offices / resources listed may still be useful]
- PGSC resources doc
- PVC chart of department structure
- Who's who around the department — grad coordinator, grad advocate, DEI officers, APO staff, GradSupport/OGE, department leadership
- Links to newsletters: APO weekly, physics@mit annual, MIT news, The Tech
- Weekly schedule of department events (colloquia, seminars, etc.)
- PhysREFS (REFS = Resources for Easing Friction and Stress): A free, confidential service by peers trained in conflict mediation to listen and discuss any problems you may have (exam stress, culture shock, anything)

The MIT Physics Department (also known as Course 8 at MIT) has a decentralized structure and is broken into independent "divisions" based on research area, e.g. AMO refers to Atomic, Molecular, and Optical physics, NUPAX refers to NUclear and PArticle eXperiment, etc. These acronyms are not listed on the Physics Department website, but are commonly referred to in intradepartmental communications. A more comprehensive list of acronyms you may come across during your time here can be found in Section [List of acronyms and terms].

You were likely admitted by a specific division based on your research interests, but you are not required to stay in this division once you arrive at MIT, so long as there is an advisor in another area who will take you on. If you wish to change divisions, you must first find an advisor who has guaranteed you funding for your program; logistically, you will not formally change divisions until you have committed to a lab/group.

List of people to know

(updated March 13, 2023)

Department head: Deepto Chakraborty

Associate department head: Lindley Winslow. In charge of academic programs within the department, e.g the associate head signs on behalf of the department on theses before they get archived, sits on the graduate admissions committee, and is involved with oral exam discussions.

Academic Office: Sydney Miller, Shannon Larkin

Graduate Student Advocate: Claude Canizares. The advocate is a fully confidential resource, so reach out to them if you need help with anything, e.g. work-life balance, managing difficult situations with advisors, or wanting to anonymously communicate with department leadership. The graduate student advocate works outside of the department leadership bureaucracy, and they can lend their voice as a faculty member to bring student issues to the attention of the department.

Alternative mentors: Outside of your research advisor, your academic advisor can also serve as your mentor for the first year or two of your PhD. Academic advisors are meant to regularly check in with their students regarding progress through qualifying exams, class requirements, and navigating finding a research group.

After passing the oral qualifying exam, you may form your thesis committee. The members of your thesis committee can also act as mentors and research advisors, and you should check in with them at least once a year on your research progress.

General information/facts about the graduate program

Academic requirements

Add-on academic programs

MIT offers a variety of certificate programs open to all MIT graduate students, which can be completed *in addition* to the student's principal area of specialization. Several of these options are listed below:

- Kaufman Teaching Certificate Program: "An interactive workshop series intended for late-program [ed. note: Year 3+, in practice] graduate students and postdocs interested in academic careers or developing skills to support their teaching at MIT"
- Science, Technology & Policy (STP) Certificate Program: "Seeks to complement the outstanding academic experience MIT currently provides to its science and engineering PhD students with a rigorous introduction to the social and policy contexts in which their research is embedded."
- MIT Biophysics Certificate Program: Distinct from the Physics Department's Biophysics specialty area! For students in other disciplines who may find it useful to have biophysics training. To encourage interdisciplinarity, biophysics students in Physics can earn this certificate by completing one graduate Biology course.
- MIT LEAPS Program: The MIT LEAdership and Professional Skills & Training (LEAPS) program offers two half-semester courses on leadership and professional strategies and skills to advance graduate student and postdoc careers in academia and industry.

Alternate degree program: PhD in Physics, Statistics, and Data Science (AKA IDPS or PhysSDS)

Written by Tri Nguyen (03/2023)

Any Physics PhD student is eligible to apply for a doctoral degree in the field of "Physics, Statistics, and Data Science" (PhysSDS). Students are required to take one subject each in Probability, Statistics, Computation & Statistics, and Data Analysis. They must also take the Doctoral Seminar in Statistics (listed as IDS.190), and write their dissertation utilizing statistical methods. For detailed information on the application process, you should refer to the link to the program above or here. You can also talk to Prof. Jesse Thaler and Prof. Michael Williams, who are the current co-chairs of PhysSDS.

You will have to take up to 5 additional courses (including the seminar IDS.190) on top of your Physics requirement. Some courses can be counted for both Physics requirements and PhysSDS requirements. In general, it'll take you, on average, an additional year to complete. But if you're up to the challenge, there are a few advantages to having this degree:

1. The PhysSDS program may provide more opportunities to make industry connections than in Physics, for students interested in working in industry post-graduation. Participating students will also have more opportunities to interact with others across many departments beyond Physics!
2. It may be helpful in the long run for students who use data science and statistics very frequently in their research to have knowledge of more advanced statistics and data science skills and techniques.
3. A PhysSDS/IDPS degree may be especially valuable **for international students interested in entering the US workforce**. To be able to work off-campus, international students must be granted either a CPT (Curriculum Practical Training) or an OPT (Optional Practical Training) by the MIT ISO. This degree fulfills the MIT ISO's stringent requirement that **"any work/employment related activity (paid or unpaid) on CPT and OPT must be directly related to the student's degree/major field of study,"** because the degree title itself ("Physics, Statistics, and Data Science") includes "data science" (a standard "Physics" PhD would not qualify).
4. This degree program also gives **international students who have already satisfied all of their Physics requirements** (*including* breadth courses) the opportunity to pursue an internship pre-graduation. International students who have *not* taken two breadth classes can use an internship to fulfill one of their breadth requirements (see the "Breadth courses" section under Written Exam/Courses for more info; unfortunately, students cannot give up a breadth course they have already taken). MIT ISO requires any off-campus work be **"a required component of the curriculum, which ALL students (international and domestic students) in the program must complete to earn the degree."** As such, **students who have already satisfied all of their program requirements cannot work off-campus.** However, students who have *not yet* taken the IDPS seminar course requirement (IDS.190) can satisfy it with an internship. Since this external work opportunity would then be a necessary component of their (IDPS) program to graduate, it would be permitted.
    a. Note: The above item is only valid if you are planning to use a CPT for your internship. If you are planning to use a pre-completion OPT, you will not be under the "curriculum restriction" (item 3 will still apply to you, though). However, I would **NOT** recommend using a pre-completion OPT because it will **eat away at your OPT time after graduation**, which I think is more important.

Course registration tips

- Each full-time class generally counts for 12 course hours; first years *must* register for the First-year seminar (8.398, 6 course hours, 2 semesters).
- A full-time class load is 2-3 courses, and students typically take 0-2 per semester. The remainder of your time is usually taken up by research. Students must register for at LEAST 36 course hours each term (a full course load is 36-48 hours); to meet the full course load, students make up the difference using some amount of research credits (8.391/2 or 8.THG; the latter applies if you have finished your oral exam).
- Core requirements should be finished within your first two years, and can be satisfied either by passing the corresponding written exam or taking that class (see section on quals). Elective courses (breadth/depth) can be spaced out more, but it is an unspoken requirement that students in all divisions take their specialty classes before taking the oral exam. In practice, students wrap up their specialty courses during their second year and take their qualifying exam either one or two semesters after their final specialty course (around spring semester second year or fall semester third year; but there is a wide distribution of timings that students have pursued in the past).
- Written exams are offered twice per school year: once at the end of the summer / beginning of Fall term, and once in the Winter (around late January, at the end of MIT's IAP, or Independent Activities Period). All students have four opportunities to take each exam (classical mechanics, E&M, statistical physics, and quantum mechanics), and two chances to take each class.
- Students are expected ("strongly encouraged") to join a research group by the end of their first year, though it is still possible to change advisors after this point - see also Section [advising]. The Physics Department guarantees one semester's worth of funding to students transitioning between research groups.

Academics

Written by Mason Ng, 02/2022

First and foremost, graduate school is a long endeavor. You will be here for, on average, at least five years[1], so think of a PhD as a marathon and not a sprint. Everybody is different, but establishing some sort of routine will likely help you in the long run. When you first arrive, be kind to yourself and give yourself some time to acclimate to your new environment. Do not forget that everyone else is in the same boat, and are likely as eager (and shy) as you when it comes to making new friends. This might be especially true for international students who do not have existing networks in the city or country, and who will encounter cultural differences between their home country and in the US in their interpersonal interactions. Be understanding of one another! As someone once said, everyone here is smart, so distinguish yourself by being kind.

Advice on academic requirements

If you are coming directly from your last semester of university, you might find little differences in your day-to-day life for at least one to two semesters. Your immediate, but not entire, focus will likely be on getting through the first set of required classes while exploring various advisors and finalizing your decision to work with a research group. If you are coming in with a departmental fellowship, you will likely be talking to several professors until late September to identify a research group that fits your initial interests. On the other hand, if you have a research assistantship (RA), you will probably become involved with research relatively quickly. Either way, everyone will still be wrestling with classes. The Academic timeline/Qualifying exams section outlines some possible routes you can take to satisfy the necessary course and exam requirements, but the most important thing to stress is that there is no "right" way to go about tackling the requirements.

If you're transitioning from a full-time position (research Master's, post-bac, industry, etc.) and/or a gap year, you might be feeling rusty about your "problem set/assignment skills." Don't worry! Your peers will be more than happy to work with you in small groups on the assignments. Your fellow graduate students will be the colleagues and friends you will encounter on a day-to-day basis for many years to come – so make sure to treat each other with respect!

In terms of becoming acclimated to your research, graduate school is probably when you are diving deeply into your research field in a way you never really did in your undergraduate career. No matter whether you are continuing in the same field from your undergraduate research career or entering a new one, get into the habit of keeping yourself informed of what is going on in the field. Make it a habit to keep up with recent literature in your field (e.g., reading the arXiv). With these papers, you can gain a lot of information about the latest developments in your field in just a few minutes by skimming abstracts, studying a few figures, and reading the conclusions of new papers. This will give you some knowledge of cutting-edge topics in your field, and provide you with more context as you eventually develop your thesis topic in your third year (or so).

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[1] For statistics on degree to completion (and more), visit https://ir.mit.edu/graduate-education-statistics, and take a look at Figure 1 further down in the document.

Degree milestones

Written by Haochen Wang, 02/2022

Edited by Calvin Leung, 02/2022; Rahul Jayaraman, 03/2023

1. Choose the right program for you

This is more like a "step zero," but it is probably the most important decision to make regarding graduate school. You are going to spend at least five years in the school you choose to attend, so you should think about questions like "Will I be happy if I go there? Is there research matching my interests?" One of the best ways to find out is to attend open house events and talk to current graduate students and potential advisors. It is important to consider whether the school has an academic environment and research programs that motivate and excite you. In addition, you should also consider whether you will enjoy life there outside research. Does the school have activities or clubs that you would like to join? How easy is it to meet other students outside your department?

2. Arrange research projects to try out with potential advisors

This is usually done any time between accepting admission to a program up until the end of your first year of graduate school. If you are admitted to MIT on a fellowship, you will have the option to explore and try out research projects in your first year. If you don't know who to work with yet, it is generally a good idea to reach out to several potential advisors to meet and discuss whether your interests and goals would align well with theirs. These meetings usually occur in the early fall and, in rare cases, the summer before graduate school. Sometimes students do one research project with an advisor in the fall and try another with a different advisor in the spring and finally decide which research group to join at the end of their first year. Pinning down a few research groups of interest and arranging some "trial" projects with one or two professors is an important step in graduate school for students who want to explore their interests.

3. Choose an advisor

If you are admitted to MIT on a research assistantship, it is probably because you have already indicated a strong interest in a particular advisor, or that advisor has determined that you would be a good fit for their work. In that case, you start graduate school already knowing who to work with. Other students will choose an advisor usually by the end of their first year after having explored some options. When choosing an advisor, it is crucial to consider whether the advisor's mentoring style works well for you, in addition to whether or not the research excites you.

4. Publish your first paper in graduate school

This can happen at very different times for different people. Some students might publish papers at the end of a trial project with a potential advisor in their first year, while others don't publish papers until a few years into graduate school. This highly depends on the nature of one's research and the field they work in. Personally, I believe the time when papers are published and the quantity of papers published should not be taken as the only indications of one's academic merits, and **graduate school is not a race to see how many papers you can publish.**

You should be very proud when you publish your first paper. It means that you have made significant contributions to your field and are on the way to even more exciting discoveries!

5. Pass the written exam / Complete course requirements (also see the previous section)

By either passing the written exam or doing well in the core classes (i.e., getting a B+ or above), almost all students can meet the written exam requirements by the end of their second year. Studying for the written exam or trying to get good grades in courses can be a nerve-racking process, but remember that you are not alone! Personally, I made many good friends while taking the core classes and studying for the written exams. With people studying together, you will pass the written exam requirements before you even realize it! Also note that if you feel like your background in a particular core area is weak, you can take the corresponding undergraduate class (e.g., 8.223 for Classical Mechanics, or 8.044/8.08 for Statistical Mechanics). Doing so will also extend your timeline for satisfying the core requirements, so don't worry if you elect to pursue this option!

Besides the core classes, each division at MIT Physics also has its own specific course requirements. In general, each division requires students to take two or three classes within their divisions and two electives outside their divisions. The classes within one's division are usually completed before the end of one's second year because the content in those courses frequently comprises the bulk of the oral exam. The electives can be completed at any point in the program. Some students choose to take them early so they can completely focus on research later on. Others may wait until their last two years to take electives. This is totally up to you!

6. Pass the oral exam (see also: Exams at-a-glance)

After passing the written exam and completing all the required courses, students are ready to prepare for the oral exam. The exam is usually offered near the end of each semester, and students generally complete it by the end of their third year. The oral exam tests one's knowledge specific to their division, so the format and content of the exam vary among divisions. Students who have passed the oral exam in their divisions usually have study materials and are generally very eager to share them with their peers who are studying for the exam. Because the oral exam tests a wide range of topics in one's field, studying can sometimes feel overwhelming. However, just like the written exam, studying with others can help reduce your stress. It is also often more enjoyable to study for the oral exam than the written exams, since much of this material is more closely related to your broader research area :)

7. Form a thesis committee

Upon completing the oral exam, a student officially becomes a PhD candidate. At this point, the student and their advisor can assemble a thesis committee for the student. This is usually done whenever the student is ready to begin the thesis writing process. The committee consists of three faculty members: the student's own advisor, an additional faculty member (usually in the student's area of research interest) chosen by the student in conjunction with their advisor, and one faculty member chosen by the Department. The purpose of the thesis committee is to mentor the student and supervise the thesis writing process. Once a committee is established, the student

will have an initial meeting with the committee to discuss the plan for writing the thesis. The student will also write a 2-page written thesis proposal to be sent to Sydney Miller for the record.

Expectations for the initial meeting may vary by division. For instance, in the Astro division, the committee gets together and expects the student to prepare ~30 minutes of slides including 1) past work, 2) present and future work, and 3) degree progress timeline. The remainder of the ~1 hour meeting is an informal conversation between the PhD candidate and their committee. During this meeting, advisors (in Astro) will typically help the candidate answer questions from the rest of the committee or provide broader context for the committee.

After the initial meeting, the student usually meets with the committee at least once a year to give updates on their progress and solicit feedback. Remember that the thesis committee is a useful resource for any research-related questions, so feel free to meet with them as often as you need to in order to successfully make meaningful progress on your thesis.

8. Make a post-graduate school plan

By the end of graduate study, students usually have fairly concrete ideas on what they want to do after getting a PhD. Some students want to stay in academia, so they will look for postdoc positions and try to become more competitive in the field by publishing novel work, developing their own research program, and attending conferences. Others want to enter the industry and may also participate in internships. No matter what your plan is, you can almost always get help from your advisor or find other students in similar situations for advice.

9. Defend the thesis

Once a draft of the thesis is accepted by the committee, the student defends their thesis by giving an oral presentation on the thesis. After this is done, the student graduates with a PhD degree (and can finally, officially call themselves Doctor)!

What does success look like/mean to you? (written by Haochen Wang, 02/2022)

Personally, success means that I am content with the current state of my life and actively pursuing goals that I have made for the future. Compared to academic progress and financial success, I believe mental and physical health are more important. That is why, in addition to working on research and other academic responsibilities, I also spend a significant amount of time with close friends and doing activities that I enjoy–like playing the piano and singing in an MIT choir. I feel fortunate to be in a department where the student culture generally values both academic achievement alongside mental/emotional well-being. I spend almost every day in the department working on research that can help me grow into a more mature researcher and building friendships that will support me throughout and beyond graduate school.

Time to graduation

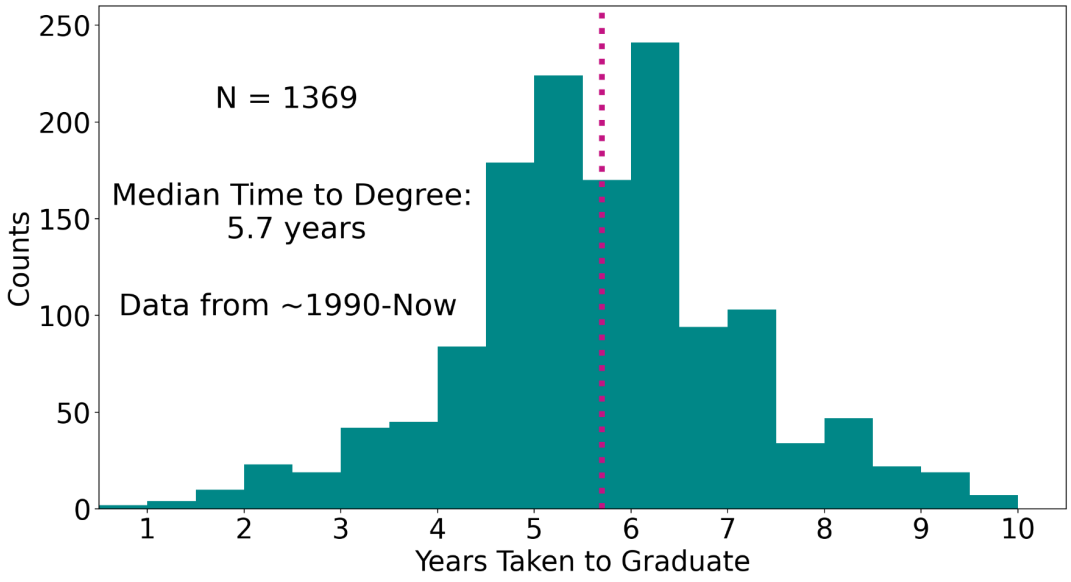

Figure 1. Data for years to degree completion from 1990 until today (2021). 35 outliers – who took >10 years to finish their PhD due to extenuating circumstances – are not shown here.

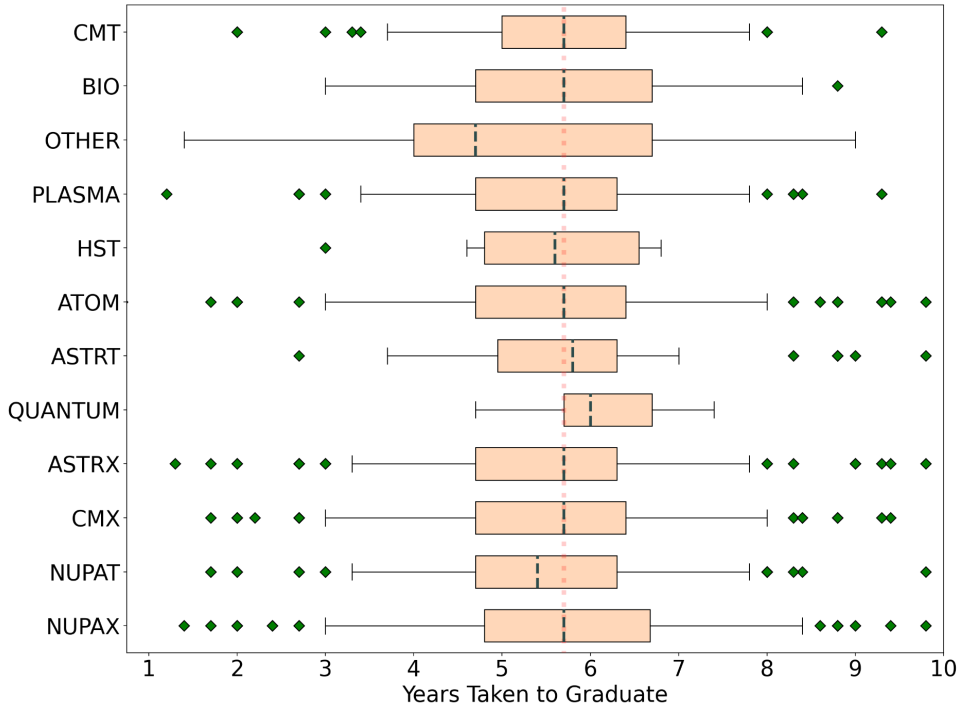

Figure 2. Box and whisker plot of division-level data on time to degree completion. The faint red dotted line represents the overall median completion time (as above), 5.7 years. The y-axis lists all the divisions. This plot, like Figure 1, contains data spanning from 1990 until 2021.

Academic timeline/Qualifying exams

Edited by Lisa Lin, 03/2024

The timeline of the PhD is somewhat, but not particularly flexible, except for two things – the timing of the oral exam, and the semesters in which you take breadth classes. You can choose in which semester (during your second or third year) you take the oral exam, and you can take a breadth course anytime during your PhD.

It may seem intimidating to new students that there are "exams on your first day here." This first round of exams is required for all* incoming students as per the doctoral guidelines, ("Core Requirements Information"). This initial set of written exams is not meant to stress you out for months, but rather is an opportunity for you to get a sense for how exams are given and assessed in the MIT Physics program. Whether or not (and how much) you study is completely up to you, and all approaches to these diagnostic exams are equally valid. The results of this diagnostic will NOT make or break your PhD, and failing an exam absolutely will NOT have a negative effect on the Department's perception of you! Most students do not end up passing any given exam, and students often become close friends by either taking the corresponding core courses or studying for the IAP iteration of the exams together.

*Well, almost all - exceptions are granted on a case-by-case basis. From the Department website: "Entering students must take the exam upon arrival. The Associate Head may approve exceptions due to extenuating circumstances such as Visa issues or the desire to take undergraduate coursework in one of the core areas."

Exams at-a-glance

Written exams:

Students can choose one of three options to satisfy each core requirement (CM, SM, QM, EM). For any incomplete core requirement, they must

- take the corresponding graduate class and get at least a B+;
- take the corresponding written exam; or
- take the corresponding *undergraduate* class, and then take the appropriate exam or graduate-level class the next time they are able to. This option also provides students an extension of the timeline for their core requirements.

The PGSC and GWIP websites contain studying tips, links to other universities' qualifying exams, MIT OCW courses, previous MIT written exams, and a melange of other resources. Note that "Part II" in the latter refers to the Written Exam (for a list of other acronyms used in the Physics Department, please see the glossary at the start of this document).

The physREFS website contains a list of available previous exams from the last 20-odd years, largely with solutions. The department also holds review sessions for specific exams during the summer term and IAP, and has committed to offering mock exams to help students prepare.

Oral exams:

The oral exam has a more limited selection of resources, and its details are highly division-specific. The PVC website (bottom) has a general list of resources for each division's oral exam, and the PGSC wiki contains additional information about them. Both of these websites are a bit outdated, but we are working on improving the information and resources available for these exams.**!**

The following (longer) section is split into two parts dealing with the ***Written Exam/Courses*** *and* ***Oral Exam****.*

Written exam / Core courses

Written by Rahul Jayaraman (02/2022) and Tri Nguyen (03/2023)

All students are required to attempt all sections of the written exams right after they set foot on campus in August of their first year. Some students pass all four exams, some pass none; others pass exams that they barely studied for, and still others fail exams they studied intensively for. Though there's no way to predict exactly what will be on the exams, a fairly extensive database of past exams is publicly available, and the Department website offers a syllabus of topics and concepts that exam takers are expected to know. The results of the written exams from that first August will inform your course schedule for the next two (or, in some cases, three) semesters. Here are a few examples of real-life course plans:

Exam Result (Aug)	Pass all 4 exams	Pass none of the exams	Pass 1 of 4 exams	Pass none of the exams
Semester 1	· Specialty course 1 · Breadth course	· Stat Mech · Quantum	· Stat Mech · Quantum	· Stat mech · Specialty course 1
Exam Result (Jan)	N/A	Pass 0 of 2 remaining	Pass remaining exam	Pass 1 of 4 exams
Semester 2	· Specialty course 2 · Breadth course/ another one you are interested in *(or start intensive*	· Specialty course 1 · E&M	· Specialty course 1 · Breadth course	· Specialty course 2 · E & M

	research / rotation)			
Exam Result (Aug)	N/A	Pass 0 of 1 remaining	N/A	Passes 0 of 1 remaining
Semester 3	N/A, or oral exam	· Specialty course 2 · Classical Mechanics	· Specialty course 2	· Quantum · Specialty course 3/Breadth course

As you can see, there are a variety of ways in which you can complete these requirements. In a small number of cases, students take E & M in their fourth semester – i.e., their last possible chance to take the class. **There is nothing wrong with the schedule that you end up taking**. Nobody will judge you for taking all four courses or failing an exam multiple times. The culture in our department is extremely welcoming in that regard and closely hews to the Physics Values Statement – "There are a multitude of ways and routes to becoming a physicist." And, you may be stressed about the exam itself (which is very reasonable) – but something to keep in mind is that since the exam structure was revamped in 2015, *nobody has failed out of the program due to not being able to complete the core requirements*. The department is willing to extend students' timelines for fulfilling these requirements, if absolutely necessary. That means **hundreds of students have taken the same path as you, gone through the core courses or exams, and have successfully earned their doctorates**. You're not alone, and you will get through this!

There are two guidelines, though, that you should abide by when scheduling courses:

1. The unspoken expectation is that you should **complete specialty course requirements as soon as you can**. Most people wrap them up either in their second or third semester, by taking the highest-level specialty course (e.g., Astro II, AMO II, QFT 3).
2. **If it is your last opportunity to take a core course, you must do so**. For example, if you did not pass the classical mechanics exam after three attempts, you **must** take that course during your third semester. This is a departmental guideline and policy to make sure people are still making satisfactory progress toward their eventual degree.

Breadth courses: Most students take one breadth during their first couple of years, and their second during Years 3 and 4. There have been students who waited till their last semester to take a breadth; I do not endorse this path, as that takes valuable time away from thesis writing! My advice here is to just find a course you're interested in, find the semester that works best with your schedule (research and other commitments), and discuss your thoughts with your advisor. Everyone's prioritization of breadth courses is different, but the goal is to **just get it done**.

In addition to coursework, the Physics Department offers a research externship (listed as 8.995), which lets students use a semester at a national lab or industry to satisfy the second

breadth requirement. Students considering the pursuit of a career in industry may find this option particularly useful, and it can also be used for CPT (Curricular Practical Training), a program allowing international students under **F-1 visa status** to work off-campus. The MIT International Students Office (ISO) requires that "the work is a required component of the curriculum, which ALL students (international and domestic students) in the program must complete to earn the degree". International students who want to participate in paid internships *must* use 8.995 for their second breadth requirement. If an international student has already satisfied both breadth requirements, they *cannot* work off-campus under this restriction (and no, sadly you cannot give up a breadth course you have already taken). If you have taken both breadth requirements and want to do an internship, there are two options that I (Tri) know of:

1. Apply for a pre-completion OPT (Optional Practical Training), which can also be used to obtain off-campus work authorization. However, OPT takes much longer to process (5 months instead of 2 weeks) because you will have to apply directly to the U.S. Citizenship and Immigration Services (USCIS). More importantly, the pre-completion OPT will **use up your post-completion OPT time**, which allows you to stay in the US and work after graduation for a period of time. So I (Tri) do NOT recommend you utilize this option unless you feel that the internship is ***extremely*** useful and/or beneficial.

2. If you are using statistical and data science methods "in a substantial way" in your research, you can apply to the PhD in Physics, Statistics, and Data Science program (aka IDPS or PhysSDS), which has some additional requirements. One of the requirements, the Doctoral Seminar in Statistics course (or IDS.190), can be satisfied with an internship (basically an 8.995 equivalent). However, this requires you to take up to 5 additional courses (including IDS.190) on top of the Physics requirements. Refer to the PhysSDS program in Alternate degree program for more info.

As of March 2023, the GSU has been actively working with the administration as part of our contract negotiations to standardize CPT/OPT requirements across departments and make them more flexible (to the extent allowed by federal law) and more competitive with peer institutions.

[*Editor's note: The above discussion on research externships for international students applies to F-1 visas only, which cover most MIT international students. The J-1 visa is another common type of visa (which often covers postdocs), and has a corresponding work authorization called Academic Training (AT). If you know anyone on a J-1 visa, let us know! We'd love to update this section with relevant information for such individuals.*]

Anecdotally…: My (Rahul's) personal path closely mirrored the third column in the above table, as I passed E&M (luckily) on my first try, took quantum + stat mech that semester (along with 8.701 – Intro to Particle – as a breadth course; I do **not recommend taking three courses in a single semester**. It was a mistake). I then passed the classical mechanics qual in January and took a breadth course and Astro I that spring (ah, spring 2020…). I wanted to finish my course requirements as soon as possible, and I was able to do that by taking Astro II my third semester.

Sometimes, your advisor may ask you to take another class that they feel will be useful to your degree. However, since this does not count for any requirements, you can take it either pass/fail or register to audit the course. After all, they care that you *learn* the content, and diligently doing p-sets and assignments for the class may detract from the time you have to research for them. I

was in this situation; I opted to take the class pass/fail and knew that I had the flexibility to pick and choose assignments that interested me and/or were very relevant to my research at the time. Once you've gotten the requirements out of the way, it's best to be judicious with your time and make sure that you're prioritizing research most of the time, as opposed to taking every class you possibly can. After all, this is a research-focused degree and is not the same as undergrad.

Oral Exams

Written by Rahul Jayaraman, 02/2022

Edited by Rahul Jayaraman, 03/2023

Most students first attempt to take the exam between spring of second year and fall of third year; however, this timeline may be accelerated or extended in some circumstances (e.g., injury, a delay in the written exam requirements, etc.). You may only take the oral exam once you have fulfilled every component of the written exam. The parameters of this exam will be arranged by your research area; the exam will (in normal times) take place a week or two before finals period (think first ten days of December, or early- to mid-May). Most students opt to take this exam **immediately after finishing the last specialty course in their research area,** when the content is still fresh in their memory. The content and format of the oral exam varies by research area.

If you are prepared and have no other significant commitments, there is a *very* slight advantage to attempting the oral exam during your second year, as you can have uninterrupted years of research after this. However, if you still have outstanding specialty course requirements, it's best to wait until you are finished with these courses to fully devote yourself to the oral. This exam may appear terrifying (spoiler alert: it is), but the professors on the committee want you to succeed and will give you hints if you get stuck or aren't sure where to start. The oral exam is also a good way to dive deep into a subfield and practice your speaking skills, as a portion of it (in some divisions) is a "chalk talk" about a specific topic (chosen by you or the committee).

Many divisions have a study guide that has been prepared by prior graduate students or faculty. This will be your most valuable resource; if you study most of the topics on these study guides, you will set yourself up for success in this exam. Before you start studying, you should reach out to older students and your committee to make sure you know all the resources available to you.

Here is some brief (un)solicited advice, based on things I've heard:

- In some of the divisions, the questions you get asked in the oral exam may mirror the research interests of the professors on the committee. This will hopefully no longer be the case soon, as the department has been working to ensure consistency in the fairness of the oral exam and the content it tests across all divisions.
- **It is perfectly okay to not pass the oral exam on the first attempt**. Students (including myself) have been advocating for a department-wide "conditional pass", where a student will be re-tested on material they struggled with during the exam within a reasonable timeframe (a few weeks), rather than waiting an entire semester (or semester + summer) to be tested on the entirety of the material again. **Keep in mind that studying for the**

oral exam may stymie your research progress. Make sure you and your advisor are clear about the expectations surrounding this.

Candidacy: Yay, you passed your oral exam! Now what? Well, you have a couple of things that stand between you and that sweet, sweet doctorate. You need to make sure you've finished all your breadth classes, and then you just have to write your thesis. Easy, right? You got this!

Advice on advising

Written by Anonymous, 02/2022

Edited by Rahul Jayaraman, 03/2023; Lisa Lin, 03/2024

[*Editor's note: the Physics Values Committee wrote an advisory report on advisor-advisee relationships in the Department in 2022, offering suggestions and worksheets on effective communication and conflict resolution with your advisor. It's a great resource in addition to the advice below!*]

Some good advice I heard at the first-year seminar[2] (paraphrased): "Getting along with your advisor is more important than your interest in the research - it's easy to get interested in many scientific questions." This has been true for me - I'm in a different field than what I initially intended to pursue. Despite a learning curve to get acquainted with the field, I have found the research to be meaningful and rewarding. In fact, you might find that the best advisor for you and your research interests may very well be located outside the Physics Department!

Different advisors have very different working styles, and it's important to make sure your styles are compatible. You can find out about advising styles by talking to other students in your division (I wish I did this more early on!), but you can only know for sure with firsthand experience. Advising styles are varied: some advisors are more hands-on, while others mostly provide high-level guidance. They may also have different expectations in terms of research output. Group culture and dynamics also vary: some advisors keep small groups, and you may get to interact a lot with them. At the same time, there may be fewer people you can consult if you get stuck. Conversely, other advisors may keep larger groups, and your advisor may be less directly involved with your research. In this case, it's important to get to know the postdocs and other students in the group and assess the group culture.

In my case, I thought my first group wasn't a good fit: the advising style was different from my preferred research style. I reached out to a few of the senior grad students in the group to see if they shared my experience, or if I was doing something wrong (or if it was a COVID-era development). It turned out that my experience was fairly common, both among grad students who thrived in the group and those who were less happy. I decided it would not be a good fit and simply told my advisor I was looking to work with someone else - he was understanding and suggested we wrap up our current project (full disclosure, it did not get wrapped up).

In general, transitioning between research groups is a difficult decision. It's naturally easier if you're on a fellowship. If you're on an RA-ship, there are department resources available to ease your transition (e.g., transitional TA funding), as well as Institute transitional funding (in the specific case of unhealthy/toxic advising – see here for info). It's best to reach out to the Academic Programs Office or department resources (such as PhysREFS) if you are struggling with anything research- or group-related. It's certainly not too late to switch groups in your first few years, as it's in everyone's best interest if you are in an environment in which you can thrive!

[2] A course specifically designed for first-year students to get them up to speed on grad school – there are discussions about how to find advisors, set goals, and introductions to research within the department. Course number: 8.398.

Life at MIT

As we mentioned above, the PhD is a marathon, not a sprint, so be sure to work sustainably in a way so that you are able to take care of yourself and not burn out! Be aware of your capacity and do not overestimate your capacity for new things in your life.

- Health & wellness
    - Your graduate appointment will come with the MIT extended student health insurance plan, which includes many services (see here for more information)
    - As of March 2023, the GSU is currently negotiating with the administration to see if we can expand access to dental and vision coverage, and lock in co-pay rates for prescriptions and other specialty services as part of our insurance plan.
- For when you have a problem
- For cultural & social identity (scroll to the bottom of the page) + for students from underrepresented/ marginalized groups
- For being a better teacher or mentor
- MIT funding sources for conferences, travel, events

Living in the Boston area

Written by Mason Ng, 02/2022

Edited by Rahul Jayaraman, 03/2023

Here is a list of tips/unsolicited advice (mainly designed for international students). There is also a list of other resources later on in the section.

- **As soon as** you get your I-20 form from the International Students Office, start the process of applying for your F-1 (or J-1) visa. Interview appointments at your nearest consulate might not be available as soon as you might like.
- Be up-to-date with your vaccinations (including COVID-19!), as you will need to get them *before* coming to the US, and you will need to report them to MIT Medical
- If you are looking for a SIM plan, the writer recommends Mint Mobile (the writer finds it fuss-free and value-for-money)
- The writer went with the MIT Federal Credit Union when they first got to the US; it is a good starting point for your banking needs to build your credit score
- Your health insurance will only start on September 1, while you will likely be in Cambridge by mid-August (for Orientation) - be sure to get some form of health insurance that covers you for that period of time! (Note that having sufficient insurance coverage throughout your time as a state resident is required by Massachusetts state law.)

- Off-campus housing: There are many housing posts for sublets, leases, etc. on various Facebook groups (e.g. MIT Housing, Harvard MIT Housing, Cambridge Housing, etc.), and you can usually request virtual room tours if you are unable to check out the housing market in-person!
- On-campus housing: There are a variety of room styles (2-3 bedroom apartments, efficiencies, etc.) available in MIT's various graduate dorms. A few things to note:
    - Unless you really want to, or are sharing with someone/a partner, or can afford it, avoid Site 4 (it is very pricey!)
    - All graduate dorms are furnished except for Edgerton, and utilities are included in the monthly rent
    - Xfinity on Campus: If you live on campus, you can get access to live TV with over 90 channels!
- Grocery shopping: several of the options listed below are also available on Instacart, for those who prefer grocery delivery
    - MIT offers shuttles on certain days to some places!
    - Budget option: Daily Table
        - The "Too Good to Go" app (unrelated to Daily Table) aims to help reduce food waste by allowing you to get very affordable meals and groceries from local restaurants and stores. Keep in mind, however, that the options currently available may not always accommodate certain dietary restrictions - the app is adding options for vegetarians, etc., but these are few and far between at the moment
    - Cheap(er): Trader Joe's, Market Basket, Star Market, Stop & Shop
    - Pricier: Whole Foods, H-Mart, Wegmans
    - Gourmet: Brothers Marketplace
    - East Asian: Super 88 (Allston / BU campus), H-mart (Cambridge), C-mart (Chinatown), 99 Ranch (Quincy)
        - Online options: Weee, Yamibuy
    - South Asian: Foodland (Porter Square), Little India (Union Square, next to Market Basket), Patel Brothers (Waltham), India Mart (Quincy)
    - There are also Eastern European grocery stores near UMass Boston (off the MBTA Red Line), a couple of Latin American grocery stores in Allston, and African and Caribbean stores in Nubian Square, Roxbury, and Hyde Park
    - Other options: Hello Fresh (prepared meal kits), Imperfect Foods (sells boxes of slightly misshapen produce at discounted rates)

- If you are moving from a tropical climate, invest in some winter shoes (plus rain boots potentially) and coats (good, high-quality insulating parkas can cost up to hundreds of dollars) and brace for the cold! Winter is coming!

Congressional offices are also available to help Massachusetts residents with any problems that relate to a federal government service. For example, the Graduate Student Council has worked with Senator Markey's office on individual international student visa cases. However, it is emphasized that the case workers can only **find out** more information about the status of your case, and **cannot alter the outcome** of any individual case.

Here is a non-exhaustive list of resources and some suggestions of what graduate students can do in their leisure time:

- Clubs/groups at MIT
    - There are over 500 groups!
    - To see a listing, click on "Groups" at the top, followed by "+ All Groups"
    - Some examples: MIT Puppy Lab, MIT Science Policy Initiative, MITvote, MIT Concert Band
- Fitness/sports/activities
    - MIT Recreation has wide-ranging, modern facilities, including an indoor golf driving range, an ice rink, indoor track, sailing pavilion, and swimming pools
    - Intramural sports are also available every season; contact the PGSC Intramurals Officer (2022-23: Patrick Oare; poare@mit.edu to learn more

    - MIT Outing Club (MITOC) organizes day trips for, e.g., hiking and ice climbing. They also offer equipment rental and discounts on other activities (including memberships at local rock climbing gyms).

- Events around Boston
    - The Boston Calendar keeps track of events happening around the area
    - Find It Cambridge has a similar listing for Cambridge
- Free or discounted access to museums / arts programs museums
    - MIT students (with valid ID) get free access to the Museum of Fine Arts, Institute for Contemporary Art, the Isabella Stewart Gardner Museum, and discounted student passes to the Aquarium from the MIT Activities Committee
        - MITAC also provides discounted movie tickets for certain theaters!
    - Students can purchase a BSO college card ($5) for the whole season, and Celebrity Series of Boston and Broadway in Boston have student rush tickets
- Shuttles
    - MIT provides free shuttles around the Cambridge area (with valid ID)! The EZRide Shuttle, for instance, can get you from Sidney-Pacific/Ashdown graduate housing to just outside the MIT Kavli Institute for Astrophysics and Space Research (McNair Building; or "37"), very convenient!
- Software Licenses
    - As MIT community members, you will have access to premium versions of software – e.g., Adobe Creative Cloud, Mathematica, Microsoft Office, and more!
- Newspapers (via the MIT Libraries)
    - You get access to digital subscriptions to national newspapers such as the New York Times and the Wall Street Journal
    - You can also get limited access to *articles* of other news sites such as the Boston Globe or the Washington Post
- Libraries
    - Access to Harvard Libraries (through Ivy Plus and BorrowDirect)
        - As an MIT student, you can request access to libraries on the Harvard campus (e.g., Widener Library)
    - Boston Public Library: All you need to get a (free) library card is show any document (physical or electronic) with proof of Massachusetts residency and an ID!

- Cambridge Public Library: Same as above - your school ID works as an ID as well here.

Graduate appointments and funding

Written by Wenzer Qin and Ari Liu, 03/28/22

First-year students are guaranteed a full year of funding. All graduate students are paid the same base stipend; if you have fellowships/awards that total more than this base amount, your stipend will be 'topped up' to match this amount by either an RA or internal fellowship.

In addition, the flexibility of your research direction may depend on the type of appointment you hold. As of March 2023, students on RA and TA will be covered by the contract that the GSU is negotiating with the administration. The inclusion of Fellows in the contract is under appeal.

Research assistantship (RA): RAs are given by specific research groups/principal investigators. If you are supported on an RA, the expectation is that you will work with the group so long as they continue to fund you.

Fellowships: If you are funded on fellowship, you may use this time to rotate with different groups. Departmental fellowships also cover the summer following the academic year of your fellowship appointment. Certain fellowships may also come with additional discretionary funding. For example, if you hold a fellowship from an institution outside of MIT, you will also be given an 'External Fellowship Award' in the amount of $1100 by the department to be used towards education-related materials.

Teaching assistantship (TA): Graduate students hold TA positions for various reasons, including when their group does not have resources to support them full time, if the student desires teaching experience, or if the student needs transitional funding while switching between research groups. See the link below for past information on the process of getting assigned a TA position.

2020 TA information: https://physvals.mit.edu/sites/default/files/documents/grad-ta.pdf

Additional income / Taxes: There are multiple opportunities by which you can supplement your income from the department. For less taxing TA positions, graduate students may be paid a 10-20% TA—this cannot replace a full time appointment. There are also often 1-2 day offers to grade or proctor exams for general undergraduate physics classes for additional income.

Finally, the process of paying taxes also differs depending on funding type. The amount of your appointment that goes towards tuition is not taxed, but your salary/stipend is. If you are on RA or TA, this tax can be automatically withheld from your monthly paycheck. If you are on fellowship, taxes will not be withheld from your stipend or reported on a W-2; however, you are still required to pay *quarterly estimated taxes* on these earnings.

MIT withholds taxes from international students who are non-resident aliens (< 5 years in the US) regardless of your funding type (TA, RA or fellowship), so you don't need to pay taxes by

yourself. On the other hand, once you become a resident alien (5+ years in the US), your fellowship earnings are *not* taxed by MIT and you will need to pay quarterly estimated taxes.

An additional complication is when your external fellowship is meant to fund your full-time appointment but does not cover all of your tuition (e.g. NSF GRFP). In this case, you will be paid a supplemental RA appointment/**tuition shortfall** to cover the remaining amount. NSF Graduate Research Fellows in particular are supplemented by either an institute or department partial fellowship. Their student life fee and health insurance are also supplemented, making the NSF GRFP a full fellowship at MIT.

Tax-filing resources

Nonresident aliens: Nonresident aliens can use Sprintax to file tax returns. You can file federal tax returns on Sprintax for free through MIT (see hyperlink), though you will have to pay an additional fee to file your state income tax return forms through Sprintax. Sprintax offers free webinars on the tax filing process. Do complete your tax filing on time because you may get some of the taxed money back, depending on the tax treaties the US has with your home country!

Resident aliens / Domestic students: Resident aliens can use the same tax preparation software as domestic students, TurboTax. Note that TurboTax will not allow you to file for free if you have additional non-standard income (e.g., via contracting); TaxAct allows for free filing. Almost every single grad student is eligible for the FreeFile program (run by the Internal Revenue Service), because our adjusted gross income (AGI) is lower than $73,000/year.

Division culture

AMO

Written by Yoo Kyung (Eunice) Lee, 02/2022

The atomic, molecular, and optical (AMO) physics division at MIT is part of the MIT-Harvard Center for Ultracold Atoms (CUA), a joint research effort funded by the NSF. Groups within AMO use platforms including, but not limited to, ultracold atoms in electromagnetic traps, cavities, ultracold molecules, and nitrogen-vacancy (NV) centers in diamond for applications to quantum simulation, quantum information science, probes of fundamental physics, precision measurement, and more.

The outstanding event of the year is the AMO retreat. Every winter, the entire CUA heads out to New Hampshire for three days of talks, poster presentations, skiing, a wine and cheese night – basically, getting to know your colleagues in a more relaxed setting. Due to the pandemic the 2021 retreat was canceled, but these retreats have since resumed.

In addition to the retreat, there are weekly colloquia given by visiting speakers who are leaders in their field. The community gets to enjoy a catered lunch with the speaker as well as their talk that evening. Seminars held (via Zoom) by the Interdisciplinary Quantum Information Science and Engineering (iQuISE) are also commonly attended by members of the AMO community. Pizza is provided before the talk.

It is common practice to share paper preprints on the arXiv. Job opportunities and faculty openings are often shared via a CUA-wide email address.

Astro

Written by Wenzer Qin, Mason Ng, and Ellie Rath, 02/2022

Edited by Rahul Jayaraman, 03/2023

The Astrophysics division is often synonymous with the MIT Kavli Institute for Astrophysics and Space Research (MKI), although MKI has a separate funding structure from the Physics department and includes members from the Physics; Earth, Atmospheric, and Planetary Sciences; Aeronautics and Astronautics; and other departments. A useful distinction is to consider things pertaining to academics (classes, academic requirements, etc) under the sphere of the Astrophysics Division, and things pertaining to research and grants under the sphere of MKI. LIGO students are generally considered part of the Astrophysics Division, though their offices are in a different building from the MKI offices (NW22, next to Ashdown House).

Research at MKI includes observations across wavelengths studying phenomena including (but not limited to) AGNs, exoplanets, galaxy clusters, stars and star formation, radio transients, and 21 cm cosmology; experiment and instrumentation; and theory (black holes and gravitational waves, cosmology, dark matter–note that some of this research is also affiliated with CTP).

MKI is very active and hosts a variety of social events. Regular events include a weekly graduate student lunch, annual holiday bake-off and Winter Party, graduate student Secret Santa, and table tennis tournaments. Students are also often tapped for service work, such as running the Friday journal clubs, serving on faculty search committees, and taking part in the MKI Anti-Racism Task Force. Graduate students in MKI have desks in one of four communal office spaces, making it easy to interact with students in other research groups. Pranks between graduate students are also not unheard of. LIGO grad students who work on laser instrumentation may choose to take either the Astro or AMO oral qualifying exam, but are generally considered members of the astrophysics community and participate in MKI social events regardless of which division's qualifying exam they choose to take.

Within astrophysics, it is common practice to share paper preprints over the arXiv, while the ADS Abstract Service is more official for literature searches (but some researchers swear by inspire-hep instead) . Rumors about job offers (both for postdoc and faculty positions) are posted at the AstroBetter rumor mill.

Biophysics

Written by Dan Swartz, 02/2022

Edited by Lisa Lin, 03/2022

Biophysics (BIO) is also known as the Physics of Living Systems (PLS) group at MIT. PLS is formally located in MIT building 4 on the 3rd floor (recently relocated from NE46!), but many of the labs affiliated with PLS are in other spaces. The research in PLS spans a diverse set of topics including immunology, ecology, single cell biophysics, development, and pattern formation. Different groups in PLS address these questions using varying mixtures of wet-lab experiments, data analysis, numerical simulation, and analytic theory.

The PLS group is known for hosting short talks every Friday throughout the semester where students, post-docs, and faculty can gather to hear about new advancements in research (followed by snacks + drinks). Additionally, PLS graduate students are encouraged to organize lunches to build a strong community within the division.

CMX

Written by Caolan John, 02/2022

The Condensed Matter experiment (CMX) division lives on the second floor of Building 13, a building it shares with research divisions in the EECS and Materials Science and Engineering (MSE) Departments, and other groups within the Materials Research Laboratory (MRL). Research is focused primarily on strongly correlated and topological materials; we study these systems with a variety of techniques ranging from materials synthesis, magnetotransport in devices, and optical or spectroscopic probes, among others.

A more formal research seminar shared with the Condensed Matter Theory (CMT) division is the Monday Chez Pierre Seminar, where pizza is provided. A fantastic component of the program is the division-wide journal club at 3 PM on Fridays, where a graduate student, postdoc, or faculty

member shares their insights on a recent publication in a pedagogical chalk talk. These are well worth attending and are a great opportunity to get to know your peers in other labs.

Preprints are shared on the arXiv.

CMT

Written by Ali Ghorashi, 02/2022

In a sense, each group has its own culture. Some are more amenable to close faculty-student collaborations, whereas others are geared towards a more hands-off advising approach. There are weekly condensed matter seminars with pizza–though one must be timely to ensure sufficient caloric intake.

Areas of research span everything from photonics/AI to more condensed matter-related topics like strongly correlated systems and topological phases. In more interdisciplinary areas of research, like photonics, opportunities abound to work with PhD students in other departments like EECS and Mechanical Engineering.

NUPAX

Written by Nick Kamp and Will Kitouni 02/2022

The Nuclear and Particle Experiment (NUPAX) research division sits within the Laboratory for Nuclear Science (LNS). The groups within NUPAX focus on a variety of research areas, including but not limited to, hadronic physics, neutrino physics and dark matter physics (NuDM), fundamental nuclear physics, particle astrophysics, and machine learning applications. Similar research divisions tend to have offices on the same floor, e.g., most of the NuDM group offices are located on the fifth floor of building 26.

There are two main talk series relevant for the NUPAX community: the Monday LNS Colloquium and the Tuesday LNS Lunchtime Seminar. There is also a lunchtime seminar series specifically for graduate students that is held on Fridays. There are more informal social activities within NUPAX which tend to be area-specific, such as semi-regular journal clubs. Papers are usually shared using the arXiv or InspireHEP; the latter tends to have more official citation information. Students and postdocs (and sometimes faculty) also often gather for lunch.

NUPAT

Written by Wenzer Qin, 02/2022

The Center for Theoretical Physics (CTP) is part of the Laboratory for Nuclear Science (LNS), which encompasses both NUPAT and NUPAX (described above), and is generally divided into three research areas:

- Phenomenology: This area covers topics such as collider physics, effective field theory, dark matter, lattice QCD, and includes the groups of Jesse Thaler, Iain Stewart, Tracy Slatyer, Krishna Rajagopal, Will Detmold, and Phiala Shanahan.

- Formal theory: This area covers string theory, quantum gravity, quantum information, and includes the groups of Dan Harlow, Netta Engelhardt, Hong Liu, Wati Taylor, and Barton Zwiebach.
- Quantum information: This includes the groups of Aram Harrow and Soonwon Choi.

While there are talks and social events that include all research areas, such as the Graduate Student Lunch Club and LNS Colloquium, there are also several events and seminars that are specific to each area. It is also common for students, postdocs, and professors to eat lunch together; this usually takes place in the seminar rooms, or outdoors, if weather permits.

In terms of research culture, the arXiv is used for sharing paper preprints, while InspireHEP is a more official hub for information such as paper citations and job openings. There are also two "rumor mills" for discussing postdoc and faculty job offers:

- Postdoc rumor mill: https://sites.google.com/site/postdocrumor/
- Faculty rumor mill: http://particle.physics.ucdavis.edu/rumor/doku.php

Plasma

Written by Ben Reichelt, 02/2022

Most of the work pertaining to plasma physics at MIT is contained within the Plasma Science and Fusion Center (PSFC), a multidisciplinary center that mostly takes on students in the Physics and Nuclear Science & Engineering Departments, but also has a smattering of mechanical and aerospace engineers, as well as researchers from a few other disciplines. Plasma physics is a discipline that spans many orders of magnitude in time and length scales, so there is a very wide breadth of research that takes place, including:

- Magnetic Confinement Fusion (MCF): All sorts of phenomena that affect MCF schemes, like disruptions, hot electrons, instabilities, magnet technology, etc. Compact, high field tokamaks are especially studied, given MIT's historical work with Alcator C-Mod and ongoing work with Commonwealth Fusion Systems and SPARC
- High Energy Density Physics (HEDP): Broadly speaking, HEDP works to study plasma physics phenomena at short timescales, high densities, and high energies using big lasers. Research topics include inertial confinement fusion, laboratory astrophysics, and basic physics at high energy densities.
- Atmospheric, space, and basic plasma physics: Studying questions of plasma physics at more moderate regimes than the HEDP group (although often there is overlap)– magnetic reconnection, solar wind, and turbulence are a few examples.
- Science and technology: Plasma is really ubiquitous in a lot of technologies that enable modern science and civilization– particle accelerator physics, semiconductor manufacturing, and some medical imaging techniques are among those that are researched at the PSFC and associated Francis Bitter Magnet Laboratory.

There is a PFSC-wide weekly seminar series with a wide variety of plasma physics topics. Within each group there may also be additional talk series; e.g., within the HEDP group, we have a weekly physics talk where one or two people within the group will share recent results in their research. Additionally, the HEDP group has strong ties to collaborators at other institutions and national labs, and there are several recurring weekly and monthly meetings where results about more specific topics will be covered.

Though there are certainly some researchers in the field that use arXiv, generally arXiv'ed papers tend to be on the theoretical side. For the more experimentally-focused papers, you're much more likely to see a preprint or outline of a paper before it is published by directly talking to and collaborating with the authors, either privately or through one of the many recurring meeting series. Our group heavily emphasizes interaction with scientists at other HEDP facilities (especially the NIF and OMEGA), and each student typically takes on the role of a diagnostic research scientist for a few diagnostics at these facilities, meaning all setup and data analysis for other users of these diagnostics will go through you. This gives you an opportunity to closely work with many different scientists at the labs and get a feel for the direction of their research, as well as pick up some co-authorships– it is not unheard of for PhD students in our group to graduate with > 40 co-authorships, if data from your diagnostic is in high demand.

As far as social events go, there's usually one or two PSFC-wide holiday parties each year. Additionally, when traveling to laser user facilities like NIF and OMEGA to support or PI experiments, there are commonly large group meals to celebrate successful experiments (or mourn failed ones).

QIS

Written by Daniel Mark, 03/2022

Quantum Information Science, variously abbreviated as QI, QIS, QUIS, or EQUIS and TQUIS (but never QUIT), is a vibrant collection of groups spanning departments including physics, math, EECS, and Mechanical Engineering, as well as significant overlap with the AMO division.

There are broad experimental and theoretical efforts to build and use quantum devices, develop new algorithms, or simply better understand the underlying physics. Of note are the Center for Quantum Engineering (CQE) and the Interdisciplinary Quantum Information Science and Engineering (iQuISE), a student-run organization that runs a weekly ~~pizza service~~ seminar series. There are many relevant regular seminars, including the quantum information theory group and the Center for Ultracold Atoms (CUA, see AMO section above). I have personally found everyone here to be very friendly, and have thoroughly enjoyed the opportunity to interact with people spanning many divisions! Relevant faculty rumor mills include the condensed matter/AMO rumor mill at http://www.cmamorumors.org/.

Life beyond MIT

A few general resources (physics-related and not) to keep in mind as you explore career options:

- The Office of Career Advising and Professional Development (CAPD) offers a variety of career resources, including lists of job posting websites, professional development opportunities for graduate students, and tools for writing resumes, cover letters, and CVs (among many other things!). They also organize a fall career fair every year - keep an eye out for their newsletters (which you should already receive if you've signed up for Handshake, another online resource that helps students connect with employers)

- MIT Alumni network (https://alum.mit.edu/directory/#/) is a way to connect with MIT alumni across all sectors and network / ask for advice regarding your own career path!

- The American Physical Society (APS) offers units (divisions, topical groups, and forums) that members can join for free to keep up with the latest developments in their fields. Unit offerings range from industrial physics (FIAP) and early career scientist forums (FECS) to divisions for condensed matter (DSOFT, DCMP), all of which receive regular posts advertising various positions and opportunities within those communities. APS also offers career and industry mentoring programs that pair students with physicists working in all industries. If you're interested in non-academic career tracks that don't involve physics, the next section is for you!

Figure 3. A word cloud showing the (self-reported) occupations/titles of MIT physics graduates over the past few decades. The variety in career choice is quite clear!

Non-academic career advising

Written by Alyssa Rudelis, 02/2022

Beyond academia, there are many career options that PIs often haven't heard of or don't know how to advise graduate students about, especially if they've spent their entire career in academia.

First, there's the option of going into STEM industry. Physicists can work in R&D across engineering fields from silicon manufacturing to renewable energy, automotive industries, and even medical physics. Often, software companies are also looking for scientists to fill their software engineer roles. I am paraphrasing a Google recruiter when I say that they would prefer to hire a scientist who knows no programming than a programmer who knows no science and

logical reasoning. I worked in silicon manufacturing (at Applied Materials, Inc.) in Silicon Valley as a systems engineer before graduate school. I had a bachelor's degree in Physics but was able to convince the company that I could do the work of an engineer. Sometimes a little bit of convincing is required during the interview process because there is a preconception that physicists can't do practical work on a practical timescale.

For those whose PhD work is mainly computational, there is an abundance of opportunities in finance. Many physicists join large trading firms and work on creating faster algorithms to buy and sell stocks.

Similar in culture to finance, consulting firms also recruit scientists heavily. There are general consulting firms like Boston Consulting and McKinsey, but there are also consulting firms that specialize in STEM issues, like Exponent.

In contrast to the above career paths, the options of going into education or science policy are more general in scope and focused on impacting society at large rather than on solving specific technical problems.

Many physicists graduate with a PhD and then teach in some capacity. Those inclined to follow this path often try to get a professorship at a small, liberal arts college that prides itself primarily in how well it teaches (as opposed to R1 universities) or teach at the high school level or below. Staying in academia at an R1 university will also require some teaching, but usually there is little incentive to spend a significant amount of your time on tasks other than research.

Physicists also go into science policy at the federal, state, or local levels. There are several postdoc fellowships that train PhD scientists how to work in policy at these different levels and provide an entry-level job in executive or legislative branches of different levels of government. For example, this one trains and pays you to work in the California state legislature for a year and this one pays and trains you to work in the federal US government for one to two years. Often, these types of programs are restricted to US citizens and permanent residents (especially at the federal level), but some local and state governments are happy for non-citizens/non-residents to work with them. If these opportunities sound interesting to you, make sure to check out the MIT Science Policy Initiative. They host many policy-oriented events and trips, and their website has invaluable information on policy opportunities for scientists during and after your time at MIT. For non-profit work, the Priscilla King Gray (PKG) center on campus is also a great resource for information. If you have an idea for a volunteer project you would like to do as a student, you can apply for funding from the PKG center for it.

Regardless of which type of career you're looking for after graduation, it's a good idea to start thinking about your options and what you're most excited about early. Go to a variety of events on campus related to your interests gradually over time. At some point, you'll narrow down your goal and can focus on getting information about what it takes to enter that career. Don't be afraid to ask professionals you meet at networking events/panels/other activities for an informational interview. Ask them how they got where they are now and take notes!

To improve your chances at getting that first job, consider doing an internship over IAP (if your schedule is tight) or even over an entire summer. Put career-related activities on your CV. Start going to career fairs early to get your resume in the system and ask questions, even if you're not

yet ready to apply for a job. Of course, taking classes that teach you skills necessary for the career you want is also a good idea (~0.5-1 classes/semester AFTER you've finished your physics course and qualifying requirements is reasonable from my experience).

Lastly, the APS has great resources on careers for physicists. Check it out to learn more!

Advising for careers in academia

Contributed by Anonymous
Edited by Lisa Lin, 03/2024

A wide variety of faculty and staff academic job postings can be found on academicjobsonline.org - this might be a good place to start looking for positions post-graduation. Rumor mills are also great resources for academic job searches, and many serve the dual function of listing both job postings and job recipients:

Condensed matter / AMO: http://www.cmamorumors.org/

ASTRO:

- Postdoc rumor mill: https://www.astrobetter.com/wiki/Rumor+Mill
- Faculty/Staff rumor mill: https://www.astrobetter.com/wiki/Rumor+Mill+Faculty-Staff

NUPAT:

- Postdoc rumor mill: https://sites.google.com/site/postdocrumor/
- Faculty rumor mill: http://particle.physics.ucdavis.edu/rumor/doku.php

Teaching-focused jobs

Written by Emily Crabb, 02/2022

The key to surviving the academic job search is remembering that everyone's path is unique. Many stories, especially from current professors, will seem unreproducible: the job environment was completely different when they were applying, they applied to only one job, etc. Also, some professors at MIT may not have a great sense of what other types of schools (especially primary undergraduate institutions) are looking for. I received what seemed to be both too positive and too negative feedback about searching for a tenure-track position at an undergraduate institution during my final year of graduate school.

I recommend starting to explore academic jobs through the New England Future Faculty Workshop or the Path of Professorship program. They are quite similar (the latter is only for women) and provide details on every step of the academic job search process. The MIT Career Advising and Professional Development is a great resource and will help with revising statements and practicing interviews. Their website details all the pieces of the application and has sample statements. Your research supervisor is also a good resource for reviewing your

research statement. Even if you are not ready to apply, you may want to start drafting statements and use these resources while you are at MIT.

To find job postings, I recommend setting up alerts on the Chronicle of Higher Education, Inside Higher Ed, and Physics Today websites. Most jobs seem to be posted in early fall and due anytime from late September to January with a start date the following fall, but off-cycle hiring happens too. You can receive a job offer from one school before the application deadline for another school. I started preparing my materials and asking for letters of recommendation the summer before I would apply and then applied to almost any school that met my basic requirements. I ended up submitting over 30 applications and would have submitted more if I had not received an offer with a one-week decision deadline. I would generally recommend applying broadly; job postings and websites did not give me a great sense of which schools I would like the most.

Undergraduate institutions vary wildly. Some (especially very prestigious ones) care a lot about research, while others put much more focus on teaching. Some explicitly require a postdoc, while others do not. I would recommend trying to get some teaching and/or mentoring experience before applying, which could include being a TA or supervising a UROP, but I have also met professors at prestigious undergraduate colleges who had never taught before starting. You can often get some sense of what a school values through its website and through the wording of the job posting, but you may not really know until you get to an interview. Also think about what you value and whether your research can be done at a smaller school with fewer resources. Undergraduate institutions are very different from a school like MIT (e.g. different balance of research, teaching, and service; fewer on-campus research facilities; smaller startup packages; and different goals and values), and your application should reflect that.

Postdoc/research positions

Written by Jinghui Liu, 02/2022

I've always leaned more towards academia than industry, but didn't start seriously looking into postdocs until the spring of G5 (with a planned PhD duration of 6 years), when the earliest fellowships in my field (biophysics) started their selection processes. I'd recommend starting to apply for positions at least one semester earlier if you're interested in industry opportunities. Though I decided not to apply for any, I found it quite helpful to attend booth chats with companies at MIT's career fairs - usually held at the beginning of each semester - to gather information about available options. *[Editor's note: Some people also choose to pursue a postdoc even if they don't know what they want to do career-wise, just to keep the academia route open!]*

A postdoc position is a temporary, sponsored research appointment. It is as such important to understand the objectives behind each position's sponsorship - who funds the research, how expectations are communicated, what evaluations will be made to ensure the progress, etc. - ideally before applying, but definitely before accepting any offers. For instance, the expectations associated with a postdoc funded by a specific grant program will differ greatly from those provided by a research center focusing on junior scientist careers.There is nothing inherently good or bad about either experience, but it may be useful to keep this distinction in mind as you apply; one of the limited advantages of the lengthy postdoc application process is that (ideally) it

gives you time to compare options and assess which would be a better fit for you, e.g. to optimize your chance at the academic job market after the postdoc stage.

While the transition from a full-time grad student to a prospective professor can be intimidating, you should realize that at this stage, you are not alone! It is often a tradition for research groups to help their members prepare interviews and job talks on varying levels; your closest research colleagues, collaborators, and (in particular) advisors often best understand your strengths, weaknesses and academic ambitions. Don't be afraid to reach out - for the most part, they'll already have gone through the same process and will be more than willing to help you through; after all, it is the same group of people with whom you eventually pop the champagne :-) While assembling applications and advocating for interviews is your own responsibility, using those around you as a sounding board can yield candid feedback and job-searching advice, as well as help identify pre-screening opportunities (e.g., which fellowships your research theme is relevant to) and/or obtain insider information (e.g., whether a specific PI has funding for a wide range or a limited selection of topics).

The most useful piece of advice that I got at the start of my postdoc search was from my advisor, which is to have "a will of steel" in self-advocating and competitive fellowship applications. Having reached the light at the end of the tunnel six months later, I will also suggest that you try to appreciate the introspective and unpredictable nature of the process. I found that my open-ended job search fueled a deeper investigation of what I really wanted, both science- and career-wise. It's totally fine to not know the answer a priori, and enjoy the ride :-)

A note on postdocs and fellowships

There are generally three different types of postdoc positions (this distinction is typically more important for theorists than experimentalists):

- **Postdocs funded by a specific group:** These positions are funded off of a professor's grant and typically require you to work on a specific research project or area. These types of positions can be posted any time during the year, though many fields have a typical application cycle or offer deadline.
- **Postdocs funded by prize fellowships:** A prize fellowship from a department or institution provides greater flexibility and freedom to pursue your own research, and may offer a higher salary (or greater benefits).
- **Postdocs funded by national fellowships:** Fields offering postdoctoral fellowships at the national level can have job postings throughout the year. Fellowship deadlines are usually in early fall and often require either an advisor's nomination or a self-nomination. The earliest deadline is typically the Harvard Junior Fellowship on August 1, so start looking early!

Some examples of postdoc fellowships include:

Universities

- MIT Pappalardo Fellowship
- Harvard Junior Fellowship

- Stanford Science Fellowship
- Berkeley Miller Fellowship
- Cornell Klarman Fellowship
- Yale Mossman Fellowship
- Simons Junior Fellows (NYC area)
- Etc.

Labs

- LANL Director's and Distinguished Fellowships
- LBNL Chamberlain Fellowship (experiment)
- Brookhaven Goldhaber Fellowship
- Fermilab Lederman Fellowship (experiment)
- Etc.

National

- NASA Einstein, Hubble, and Sagan Fellowships
- NSF MPS-Ascend Fellowships
- Marie Curie Fellowships (Europe)
- Etc.

Diversity oriented

- Presidential Postdoc Fellowship Program (Many partner institutions: U of California campuses, Michigan, Colorado, Maryland, Carnegie Mellon, etc.)
- Princeton Future Faculty in Physics
- Stanford PRISM
- SUNY IDEA Fellows
- UChicago Provost's Fellows
- Argonne Massey Fellowship
- Fermilab Gates Fellowship
- Etc.