

# ASTRONOMY AND ASTROPHYSICS, PHD

## Research and Advising

The principal goal of graduate study is to train the student to conduct original research. Therefore, physics and astronomy graduate students at Johns Hopkins are involved in research starting in their first semester in the program.

### First and Second-Year Research Requirement

By the end of September, the student chooses their first research advisor among the professorial faculty and starts working on the first-semester research project. If the proposed research advisor does not hold a primary appointment as a tenure-track or research faculty member in the Department of Physics and Astronomy, the form must be co-signed by a PHA faculty member, who will provide mentorship (relevant department faculty members list) (<https://physics-astronomy.jhu.edu/people/#filter=faculty>). This requirement holds for all semesters of research. The first-semester project continues through intersession in January. The spring-semester research project continues until the end of the spring semester. The summer semester lasts from June through August. Students may continue with one advisor through the entire first year, or they may choose to cycle through several different research advisers from one semester to the next.

This system of semester projects continues during the first two years of the program, when students also complete required coursework. The nature of these first- and second-year research projects varies from student to student, from advisor to advisor and from one sub-field of physics to another. Some may be self-contained research projects that lead to published scientific papers and may or may not be related to the thesis research in later years. Listing of recent publications by our graduate students (<http://sites.krieger.jhu.edu/pags/academics/graduate-research/>). Others may comprise reading or independent-study projects to develop background for subsequent research. In other cases, they may be first steps in a longer-term research project.

This system accommodates both the students who have chosen the direction of their thesis work before graduate school and those who would like to try a few different things before committing to a long-term project. As students get more familiar with the department and the research opportunities, they zero in on their thesis topic and find a thesis advisor. This may happen any time during the first two years, and students are required to find a thesis advisor by the beginning of the third year.

### Thesis Research and Defense

Securing a mutual agreement with a thesis advisor is one of the most important milestones of our graduate program. Students must find a thesis advisor and submit the thesis advisor form before the first day of their 3rd year. The form represents a long-term commitment and serious efforts in planning and communication between the student and the advisor. If the proposed thesis advisor does not hold a primary appointment as a tenure-track or research faculty member in the Department of Physics and Astronomy, the form must be co-signed by a PHA faculty member, who will serve as the departmental advisor of record (relevant department faculty members list) (<https://physics-astronomy.jhu.edu/people/#filter=faculty>).

Students should start their thesis planning no later than the beginning of the summer after the second year. By this time in the program, many students have identified projects and advisors of interest during their research rotations in the 1st and 2nd years. In these cases, students should discuss with their prospective advisors their mutual expectations for the scope and the timeline of the thesis and when an agreement is reached, submit the thesis advisor form. If by the summer after their 2nd year, the student does not have a clear idea of who they want to work with for their thesis, they should reach out to different faculty of interest, to 1st / 2nd year academic advisors, and/or to the Chair of the graduate program committee (Director of graduate studies). In these cases the student's goal for the summer is to identify a thesis advisor and to reach an agreement regarding a thesis topic. In all cases, the thesis advisor form must be submitted before the 1st day of the 3rd year.

## Admission Requirements

### A complete application will include:

- Statement of purpose. We look for a thoughtful, well-written statement that shows the ability to overcome challenges, dedication to attain chosen goals, a capacity for creativity, an understanding of physics and/or astronomy, and any other indication of potential for research.
- Three letters of recommendation. Recommendation letters should help us evaluate your capacity for research, the most important criterion for admission.
- Transcripts of all previous work. Transcripts submitted with the application may be unofficial transcripts. Successful applicants who accept the offer of admission must supply an official transcript before they can begin the PhD program at JHU. In the case of students in the final year of their bachelors program, the official transcript must show completion of all coursework required for the degree.
- TOEFL or IELTS for international students. A reproduction is acceptable. Johns Hopkins prefers a minimum score of 600 (paper-based) or 250 (computer-based) or 100 (Internet-based) on the Test of English as a Foreign Language (TOEFL).
- \$75 non-refundable application fee. The application fee may be waived (<http://krieger.jhu.edu/graduate-admissions/apply/how-to-apply/#fees>).

*Note: submission of General GRE and Physics GRE scores is optional.*

Successful applicants applying in the last year of their Bachelor's program will need to demonstrate the completion of their Bachelor's degree program before they can begin the Ph. D. program at JHU.

## Program Requirements

The Ph.D. program has strong emphasis on early and active involvement in graduate research. Thus, students are required to have a research advisor and file a research summary every semester they are enrolled in the program, starting with the first one. Furthermore, students must complete the required courses with a grade of B- or better; the coursework is typically done over the first two years. In the beginning of the second year, students complete the research examination, and in the beginning of the third year – the University's Graduate Board Oral examination, both of which are based on completed or proposed research. During the first two years, students are typically involved in introductory research projects, which may or may not be related to their thesis work, and sometimes work with several different advisors, but they must identify (and have an agreement with) a thesis advisor no later

than the beginning of their third year in the program, after which point students focus on their thesis research. The thesis is to be completed by no later than the end of the 6th year, ending with an oral presentation of the thesis to a faculty committee.

## Course Requirements

### Ph.D. in Physics

Students must complete the following courses:

Code	Title	Credits
AS.171.603	Electromagnetic Theory	3
AS.171.605 & AS.171.606	Quantum Mechanics and Quantum Mechanics	8
AS.171.703	Advanced Statistical Mechanics	3

### Ph.D. in Astronomy and Astrophysics

Students must complete the following courses:

Code	Title	Credits
AS.171.611	Stellar Structure and Evolution	3
AS.171.612	Interstellar Medium and Astrophysical Fluid Dynamics	3
AS.171.613	Radiative Astrophysics	3
AS.171.627	Astrophysical Dynamics	3
AS.172.633	Language Of Astrophysics	1

Students in both programs must receive at least a B- in each required course, or they will be required to retake the specific course once more and pass it.

The department offers a wide range of graduate physics, astrophysics, mathematical methods and statistics classes, and while only five are required, the students are encouraged to use the flexibility of the graduate program and the available classes to design programs of study that best prepare them for their chosen area of research. In addition to the required courses listed above, below is the list of the graduate courses that have been taught in recent years:

Code	Title	Credits
AS.171.610	Numerical Methods for Physicists	4
AS.171.618	Observational Astronomy	3
AS.171.620	Soft Matter Physics	3
AS.171.621 & AS.171.622	Condensed Matter Physics and Condensed Matter Physics	3
AS.171.622	Condensed Matter Physics	3
AS.171.625	Experimental Particle Physics	3
AS.171.639	Group Theory in Physics	3
AS.171.644	Exoplanets and Planet Formation	3
AS.171.646	General Relativity	3
AS.171.648	Physics of Cell Biology: From Mechanics to Information	3
AS.171.649	Astrophysical Plasmas	3
AS.171.698	Physics Beyond the Standard Model	3
AS.171.701 & AS.171.702	Quantum Field Theory and Quantum Field Theory II	3
AS.171.704	Phase Transitions and Critical Phenomena	3
AS.171.708	Gravitational Waves	3
AS.171.732	Elementary Particle Physics	3

AS.171.749	Machine Learning for Scientists	3
AS.171.750	Cosmology	3
AS.171.752	Black Hole Astrophysics	3
AS.171.755	Fourier Optics and Interferometry in Astronomy	3
AS.171.785	Advanced Particle Theory: Dark Matter	3
AS.171.762	Advanced Condensed Matter	3
AS.171.783	Black Hole Physics	3
AS.171.764	Experimental Techniques in Condensed Matter Physics	3
AS.171.782	Advanced Particle Theory: Quantum Gravity	3

Students in both programs must receive at least a B- in each required course, or they will be required to retake the specific course once more and pass it.