

PHYSICS, PHD

Admission Requirements

To obtain admission, a student is expected to submit evidence that they have a good chance to succeed.

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.

Advising

All entering students are assigned to a first-year advisor who works closely with the student through the first two years of graduate study, or until a thesis advisor is found. The first-year advisor advises the student on courses of study, helps familiarize them with the department and provides guidance in finding research opportunities. In the beginning of each fall semester, the department holds a "research jamboree" where incoming students are introduced to the research in the department through a series of brief talks, lab tours, and research group open houses. Thus, the students are familiar, immediately upon their arrival, with the scope of research in the department and can identify prospective research advisors they may wish to work with.

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	
AS.171.605 & AS.171.606	Quantum Mechanics and Quantum Mechanics	
AS.171.703	Advanced Statistical Mechanics	

Ph.D. in Astronomy and Astrophysics

Students must complete the following courses:

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

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	
AS.171.618	Observational Astronomy	
AS.171.620	Soft Matter Physics	
AS.171.621	Condensed Matter Physics	
AS.171.625	Experimental Particle Physics	
AS.171.639	Group Theory in Physics	
AS.171.644	Exoplanets and Planet Formation	
AS.171.646	General Relativity	
AS.171.648	Physics of Cell Biology: From Mechanics to Information	
AS.171.649	Astrophysical Plasmas	
AS.171.701	Quantum Field Theory	
AS.171.704	Phase Transitions and Critical Phenomena	
AS.171.708	Gravitational Waves	
AS.171.732	Elementary Particle Physics	
AS.171.750	Cosmology	

AS.171.752	Black Hole Astrophysics
AS.171.753	String Theory
AS.171.755	Fourier Optics and Interferometry in Astronomy
AS.171.762	Advanced Condensed Matter
AS.171.783	Black Hole Physics
AS.171.749	Machine Learning for Scientists
AS.171.764	Experimental Techniques in Condensed Matter Physics

First and Second-Year Research Requirement

First-year students must find, by the end of the third week of class in the fall semester, and by the end of the first week of class the second semester, as well as before the summer term begins, a member of the professorial faculty to advise them in some type of 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 student must select a co-advisor who is a PHA faculty member. The students are required to submit a short written summary of that research experience at the end of the semester. Students may continue with one advisor through all three semesters, or they may choose to cycle through several different research advisors. In some cases, one of these first-year research advisors may become a thesis advisor, but in others, the thesis advisor may change. This research requirement continues until the end of the second year, or until the student finds a thesis advisor.

The nature of these first-year research projects may vary from student to student, from one advisor to another, and from one sub-field of physics to another. In some cases they lead to published research. In other cases, they may be first steps in a longer-term research project. And in some cases, they may comprise reading or independent-study projects to develop background for subsequent research. It is left to the individual advisor to determine what the written summary should entail. These research projects are not research assistantships and are performed in addition to other graduate student responsibilities (teaching and graduate classwork), although they are typically merged with RA-supported research for those students supported by RAs.

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>).

After the student chooses a thesis advisor, the student forms their Thesis Committee consisting of the advisor and two other faculty members (all Thesis Committees contain at least two full-time faculty from the department). These committees function as extended advisory bodies; students have the opportunity to discuss their progress and problems with several faculty. They also conduct one formal annual review of each student's progress. Research leading to the dissertation can be carried out not only within the Department of Physics and Astronomy, but with appropriate arrangements, either partly or entirely at other locations if necessitated by the project goals. At the conclusion of thesis research,

the student presents the written dissertation to the faculty committee and defends the thesis in an oral examination.

Requirements for the M.A. Degree

Although the department does not admit students who intend to pursue the master's degree exclusively, students in the department's Ph.D. program and students in other Ph.D. programs at Johns Hopkins may apply to fulfill the requirements for the M.A. degree in the Department of Physics and Astronomy. Students from other JHU departments must seek approval from their home department and from the Department of Physics and Astronomy.

Before beginning their M.A. studies, students must have mastered the undergraduate physics material covered by the following courses:

Code	Title	Credits
AS.171.204	Classical Mechanics II	4
AS.171.303 & AS.171.304	Quantum Mechanics I and Quantum Mechanics II	8
AS.171.312	Statistical Physics/Thermodynamics	4

Courses taken elsewhere may qualify at the discretion of the Graduate Program Committee (normally this requirement is satisfied by the Ph.D.-track students before they arrive at JHU as they have completed a B.A. or B.Sci. in Physics at another institution).

To qualify for the M.A. degree in Physics, students must complete eight one-semester 3-credit graduate-level courses in the Department of Physics and Astronomy and pass the departmental research exam. For the M.A. degree in Astronomy, students must complete eight one-semester 3-credit graduate-level courses in the Department of Physics and Astronomy, plus the seminar "Language of Astrophysics" and pass the departmental research exam. The student must receive a grade of B- or above in each of the courses; graduate courses can be retaken once in case of failure.

Of the eight one-semester courses, four must be the core courses listed above in the Ph.D. requirements and two must be Independent Graduate Research courses. The remaining two course requirements for the M.A. degree may be fulfilled either by 3-credit graduate electives or by additional Independent Graduate Research. The research courses must include an essay or a research report supervised and approved by a faculty member of the Department of Physics and Astronomy.

Under most circumstances students pursuing their Ph.D. qualify for the M.A. degree by the end of their second year if they have taken all four core courses in their discipline at JHU, the "Language of Astrophysics" seminar (for M.A. in Astronomy), four semesters of Independent Graduate Research, and passed the research exam. Graduate courses taken at another institution or in another department at JHU in most cases do not count toward the M.A. requirements (therefore, students who are interested in the M.A. degree, but are planning to waive any graduate courses because they have passed a comparable graduate course at another institution, should discuss their eligibility for the M.A. degree with the Academic Program Administrator as soon as they arrive at JHU). Students should expect that no M.A. requirements can be waived; that the minimal research requirement is two semesters; and that at most one of the core courses can be substituted by another (non-research) graduate course in exceptional circumstances. Any requests for M.A. course substitutions must be made to the Graduate Program Committee

at least a year before the expected M.A. degree so that the committee can recommend an appropriate substitution.