PHYSICS, PH.D.

DEPARTMENT OVERVIEW

The Department of Physics has a strong tradition of graduate study and research in astrophysics; atomic, molecular, and optical physics; condensed matter physics; cosmology; elementary particle physics; nuclear physics; phenomenology; plasmas and fusion; quantum computing; statistical and thermal physics; string theory.

EXPERIMENTAL PHYSICS

Astrophysics; atomic, molecular, and optical physics; biophysics; condensed matter physics; cosmology; elementary particle physics; neutrino physics; experimental studies of superconductors; medical physics; nuclear physics; plasma physics; quantum computing; spectroscopy.

PH.D. DEGREE DETAILS

The Ph.D. degree requires successful completion of advanced coursework in physics (required core coursework), completion of a minor, and passage of the qualifying and preliminary examinations. However, the Ph.D. is primarily a research degree, awarded only upon completion of substantial original research. This broad range of research opportunities makes the department especially attractive to beginning students who have not yet chosen a field of specialization. The program provides the background, experience, and credentials needed for employment as a professional physicist in research or education. All admitted Ph.D. students receive financial support in the form of teaching or research assistantships and fellowships.

ADMISSIONS

Please consult the table below for key information about this degree program's admissions requirements. The program may have more detailed admissions requirements, which can be found below the table or on the program's website. Graduate admissions is a two-step process between academic programs and the Graduate School. Applicants must meet the minimum requirements (https://grad.wisc.edu/apply/requirements/) of the Graduate School as well as the program(s).

Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/apply/).

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
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<tbody>
<tr>
<td>Fall Deadline</td>
<td>December 15</td>
</tr>
<tr>
<td>Spring Deadline</td>
<td>This program does not admit in the spring.</td>
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<tr>
<td>Summer Deadline</td>
<td>This program does not admit in the summer.</td>
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<tr>
<td>GRE (Graduate Record Examinations)</td>
<td>Required.</td>
</tr>
<tr>
<td>English Proficiency Test</td>
<td>Every applicant whose native language is not English or whose undergraduate instruction was not in English must provide an English proficiency test score and meet the Graduate School minimum requirements (<a href="https://grad.wisc.edu/apply/requirements/#english-proficiency">https://grad.wisc.edu/apply/requirements/#english-proficiency</a>).</td>
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<tr>
<td>Other Test(s) (e.g., GMAT, MCAT)</td>
<td>n/a</td>
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<tr>
<td>Letters of Recommendation Required</td>
<td>3</td>
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</table>

Admission is competitive. All applicants are reviewed and evaluated on the basis of previous academic record, three letters of recommendation, statement of purpose for graduate studies, resume, and Graduate Record Exam (GRE) general and subject scores. The physics subject GRE exam is required. For applicants whose native language is not English, the department requires a minimum score of 580 (paper-based), 237 (computer-based) or 92 (internet-based) on the Test of English as a Foreign Language (TOEFL) exam, or 7 on the International English Language Testing System (IELTS) exam. All eligible applicants with complete files are considered for teaching or research assistantships and fellowships. To be considered for admission, students must submit all application materials (including test scores) via the Graduate School electronic application site (https://www.gradsch.wisc.edu/eapp/eapp.pl) by December 15.

FUNDING

GRADUATE SCHOOL RESOURCES

Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding/) is available from the Graduate School. Be sure to check with your program for individual policies and restrictions related to funding.

PROGRAM RESOURCES

FINANCIAL SUPPORT FOR PHD STUDENTS IN PHYSICS

All admitted Ph.D. students are provided with a guarantee of financial support. Typically, a graduate student is first appointed as a teaching assistant. Teaching assistants assist faculty members in the introductory physics courses, generally by teaching discussion and laboratory sections. Later, as a research assistant, the student works with a major professor on a mutually agreed research program. Tuition is remitted for teaching assistant and research assistant appointments greater than one-third time or greater. However, all students must still pay the segregated fees, which are about $600 per semester for full-time students, and any additional university fees.

Teaching Assistantships

The typical first appointment for a beginning graduate student is a teaching assistantship (TA). A teaching assistantship is both a teaching
position and a means of support for graduate study. It is normally advantageous for a graduate student to hold a TA position for at least a semester during graduate studies, since the teaching activity solidifies and deepens the teaching assistant’s undergraduate education in physics and also helps prepare for a possible career in teaching.

TA appointments are granted for a semester at a time. Based on a 50% appointment at the standard rate, a TA earns approximately $11,000 per semester.

Research Assistantships
Research assistantships are made available by individual professors to students who have decided on their field of research. Most departamental RA appointments are made for an annual (12 months) period. Students who wish to be considered for an RA appointment should contact the faculty directly.

Fellowships
Fellowships, including University Fellowships and Advanced Opportunity Fellowships, are awarded by the College of Letters & Science and the Graduate School upon recommendation of the Department of Physics. In addition, the department may have additional fellowships—funded by endowments from physics department alumni—available for first-year graduate students.

REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/#policiesandrequirementstext), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION

<table>
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<tr>
<th>Mode of Instruction Definitions</th>
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<tr>
<td><strong>Face to Face</strong></td>
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<tr>
<td><strong>Evening/Weekend</strong></td>
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<tr>
<td><strong>Online</strong></td>
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<tr>
<td><strong>Hybrid</strong></td>
</tr>
<tr>
<td><strong>Accelerated</strong></td>
</tr>
</tbody>
</table>

Yes No No No No

**Mode of Instruction Definitions**

**Accelerated**: Accelerated programs are offered at a fast pace that condenses the time to completion. Students are able to complete a program with minimal disruptions to careers and other commitments.

**Evening/Weekend**: Courses meet on the UW–Madison campus only in evenings and/or on weekends to accommodate typical business schedules. Students have the advantages of face-to-face courses with the flexibility to keep work and other life commitments.

**Face-to-Face**: Courses typically meet during weekdays on the UW-Madison Campus.

**Hybrid**: These programs combine face-to-face and online learning formats. Contact the program for more specific information.

**Online**: These programs are offered 100% online. Some programs may require an on-campus orientation or residency experience, but the courses will be facilitated in an online format.

CURRICULAR REQUIREMENTS

<table>
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<tr>
<th>Requirements Detail</th>
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<tr>
<td>Minimum Credit Requirement</td>
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<tr>
<td>Minimum Residence Credit Requirement</td>
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<tr>
<td>Minimum Graduate Coursework Requirement</td>
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<tr>
<td>Overall Graduate GPA Requirement</td>
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<tr>
<td>Other Grade Requirements</td>
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<tr>
<td>Assessments and Examinations</td>
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<tr>
<td>Language Requirements</td>
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<td>Doctoral Minor/Breadth Requirements</td>
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REQUIRED COURSES

All graduate degree candidates are required to take five core courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 711</td>
<td>Theoretical Physics-Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 715</td>
<td>Statistical Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 721</td>
<td>Theoretical Physics-Electrodynamics</td>
<td>3</td>
</tr>
</tbody>
</table>
Each course must be repeated until a grade of at least a B is earned. Most entering students take two of these core courses in the fall semester and two in the spring semester. All core courses must be completed by the end of the fourth semester of the student’s program. All first year graduate students are required to enroll in and attend PHYSICS 701 Graduate Introductory Seminars held each fall.

Entering graduate students should check that their undergraduate work was equivalent to a complete physics major. Students without the experience of a senior advanced laboratory course should consider PHYSICS 507. PHYSICS 623 and PHYSICS 625 are important for an understanding of experiments in most research areas and should be taken as soon as possible. The remaining 500 and 600 level courses in the student’s area of interest should also be taken as early as possible.

PHYSICS 551 should be taken by students interested in Condensed Matter Physics or related areas such as spectroscopy. Students interested in space physics or astrophysics should take courses in astrophysics which are at least equivalent to the requirements for a minor in Astronomy. PHYSICS 545 gives a good general introduction to atomic physics. Those interested in plasma physics should begin the sequence of plasma courses with PHYSICS/E C E/N E 525. PHYSICS 535 and/or PHYSICS 735 should be taken by students interested in high energy physics.

## POLICIES

### GRADUATE SCHOOL POLICIES

The Graduate School’s Academic Policies and Procedures (https://grad.wisc.edu/acadpolicy/) provide essential information regarding general university policies. Program authority to set degree policies beyond the minimum required by the Graduate School lies with the degree program faculty. Policies set by the academic degree program can be found below.

### MAJOR-SPECIFIC POLICIES

#### PRIOR COURSEWORK

**Graduate Work from Other Institutions**

Prior coursework from other institution may count toward any graduate degree in physics as allowed by the Graduate School policy on prior coursework.

**UW–Madison Undergraduate**

Up to 7 credits in courses numbered 500 or above may be used to satisfy minimum degree requirements.

**UW–Madison University Special**

With program approval and payment of difference in tuition (between Special and graduate tuition), students are allowed to count no more than 15 credits of coursework numbered 500 or above taken as a UW-Madison University Special student. Coursework earned five or more years prior to admission to a doctoral degree is not allowed to satisfy requirements.

### PROBATION

Grade of B or better in all coursework and a minimum cumulative graduate GPA of 3.0 are required.

### ADVISOR / COMMITTEE

All students are assigned a temporary advisor upon matriculation. The responsibility to acquire (choose and be accepted by) a major professor (permanent advisor) is entirely with the student. Acceptance for Ph.D. research by a professor depends on the professor’s appraisal of the student’s potential for research and on the ability of the professor to accept a student at that time. Usually the major professor will be able to offer support in the form of a research assistantship, but this is not always the case, and occasionally a student may need to work as a teaching assistant while performing thesis research.

Graduate students should begin research work as early as possible. Students are encouraged to acquire a major professor (advisor) and begin research by the end of the second semester. Summer is the ideal time to begin research unencumbered by coursework or teaching. Students who do not acquire a research advisor and begin research by the end of their third semester may be subjected to a review of their status in the program.

At the time of the preliminary examination (the student’s fifth semester), the major professor and three additional faculty members will form a committee that will evaluate and advise the student. This committee will meet regularly with the student from the time the preliminary examination is passed to the time of the final oral defense. The committee will report the student’s progress annually to the director of graduate studies.

At the time of the final oral defense, a fifth member will be added to the Preliminary Examination Committee. All Final Oral Defense Committee members will serve as readers of the student’s thesis.

### GRIEVANCES AND APPEALS

These resources may be helpful in addressing your concerns:

- Bias or Hate Reporting (https://doso.students.wisc.edu/bias-or-hate-reporting/)
- Graduate Assistantship Policies and Procedures (https://hr.wisc.edu/policies/gapp/#grievance-procedure)
- Hostile and Intimidating Behavior Policies and Procedures (https://hr.wisc.edu/hib/)
  - Office of the Provost for Faculty and Staff Affairs (https://facstaffprovost.wisc.edu/)
- Dean of Students Office (https://doso.students.wisc.edu/) (for all students to seek grievance assistance and support)
- Employee Assistance (http://www.eao.wisc.edu/) (for personal counseling and workplace consultation around communication and conflict involving graduate assistants and other employees, post-doctoral students, faculty and staff)
- Employee Disability Resource Office (https://employeedisabilities.wisc.edu/) (for qualified employees or applicants with disabilities to have equal employment opportunities)
- Graduate School (https://grad.wisc.edu/) (for informal advice at any level of review and for official appeals of program/departmental or school/college grievance decisions)
- Office of Compliance (https://compliance.wisc.edu/) (for class harassment and discrimination, including sexual harassment and sexual violence)
• Office of Student Conduct and Community Standards (https://conduct.students.wisc.edu/) (for conflicts involving students)
• Ombuds Office for Faculty and Staff (http://www.ombuds.wisc.edu/) (for employed graduate students and post-docs, as well as faculty and staff)
• Title IX (https://compliance.wisc.edu/titleix/) (for concerns about discrimination)

Students should contact the department chair or program director with questions about grievances.

OTHER
Typical funding is through 50% assistantships. Virtually 100% of enrolled PhD students are funded for the duration of their degree. All programs are full time and require full-time student enrollment during fall and spring terms.

PROFESSIONAL DEVELOPMENT

GRADUATE SCHOOL RESOURCES
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PROGRAM RESOURCES
Students are encouraged to attend Graduate School sponsored Professional Development events and participate in Graduate School Professional Development resources, such as the Individual Development Plan (IDP).

In addition, Ph.D. students in Physics have multiple opportunities for professional development throughout their graduate careers. As an integral part of the research experience, students regularly work at places such as CERN, national laboratories (Argonne, FermiLab), and the IceCube Neutrino observatory at the South Pole to name a few.

Students are encouraged to travel to relevant conferences across the U.S. and around the world. Students regularly attend the annual American Physical Society (APS) March Meeting and are encouraged to attend APS meetings in their sub-field throughout the year. Often students attend summer schools at various host institutions to expand their knowledge and to interact with fellow scientists in the field.

LEARNING OUTCOMES
1. Demonstrate mastery of the core physical concepts (Classical Mechanics, Electricity & Magnetism, Quantum Mechanics, and Statistical Mechanics).
2. Evaluates or synthesizes information pertaining to questions or challenges in physics.
3. Engages appropriately and communicates clearly with other research professionals in physics.
4. Formulates and plans original research.
5. Creates research, scholarship, or performance that makes a substantive contribution to the field of physics.
6. Gains a broad awareness of the status of contemporary research beyond the student’s area of specialization.

PEOPLE

FACULTY
More detail about each faculty member (https://www.physics.wisc.edu/people/faculty/) and the research areas (https://www.physics.wisc.edu/research/areas/) can be found on the Physics website.

Yang Bai, Associate Professor
Baha Balantekin, Eugene P. Wigner Professor
Vernon Barger, Vilas Professor and Van Vleck Professor
Keith Bechtol, Assistant Professor
Kevin Black, Professor
Stanislav Boldyrev, Professor
Tulika Bose, Professor
Victor Brar, Assistant Professor
Duncan Carlsmith, Professor
Daniel Chung, Professor
Susan Coppersmith, Robert E. Fassnacht Professor and Vilas Professor
Sridhara Dasu, Department Chair & Professor
Jan Egedal, Professor
Mark Eriksson, Vilas Distinguished Achievement Professor
Lisa Everett, Professor
Cary Forest, Prager Professor of Experimental Physics
Pupa Gilbert, Vilas Distinguished Achievement Professor
Francis Halzen, Gregory Breit Professor and Hilldale Professor
Kael Hanson, Professor, WIPAC Director
Aki Hashimoto, Professor
Matthew Herndon, Professor
Lev Ioffe, Professor
Robert Joynt, Professor
Albrecht Karle, Professor, IceCube Associate Director, Science & Instrumentation
Shimon Kolkowitz, Assistant Professor
James Lawler, Arthur and Aurelia Schawlow Professor
Alex Levchenko, Associate Professor
Dan McCammon, Professor
Robert McDermott, Professor
Marshall Onellion, Professor
Kimberly Palladino, Assistant Professor
Yibin Pan, Associate Professor
Brian Rebel, Associate Professor
Mark Rzchowski, Associate Chair and Professor
Mark Saffman, Professor
John Sarff, Professor
Gary Shiu, Professor
Paul Terry, Professor
Peter Timbie, Professor
Justin Vandenbroucke, Associate Professor
Maxim Vavilov, Professor
Thad Walker, Professor
Sau Lan Wu, Enrico Fermi Professor and Vilas Professor
Deniz Yavuz, Professor
Ellen Zweibel, William L Kraushaar Professor of Astronomy & Physics

AFFILIATED FACULTY
David Anderson, Professor, Electrical & Computer Engineering
Paul Campagnola, Professor, Biomedical Engineering
Jennifer Choy, Assistant Professor, Engineering Physics
Elena D’Onghia, Associate Professor, Astronomy
Chang-Beom Eom, Professor, Materials Science & Engineering
Chris Hegna, Professor, Engineering Physics
Sebastian Heinz, Professor, Astronomy
Mikhail Kats, Associate Professor, Electrical & Computer Engineering
Jason Kawasaki, Assistant Professor, Materials Science & Engineering
Alexandre Lazarian, Professor, Astronomy
Oliver Schmitz, Professor, Engineering Physics
Carl Sovinec, Professor, Engineering Physics