Physics

The Department of Physics offers Master of Arts (AM) and Doctor of Philosophy (PhD) programs in physics. Research in this department covers a wide area of experimental and theoretical physics and benefits from close contacts with nuclear and inorganic chemists in the Department of Chemistry; planetary scientists in the Department of Earth, Environmental, and Planetary Sciences; applied scientists in the McKelvey School of Engineering and the Institute of Materials Science & Engineering; and biological scientists both on the Danforth Campus and at the School of Medicine. The department is a major participant in the McDonnell Center for the Space Sciences, the Institute of Materials Science & Engineering, and the Center for Quantum Sensors.

Experimental research areas include the following:

- Astrophysics (observations of cosmic rays, gamma rays, X-rays, dark matter detection, and high-precision tests of gravity)
- Space sciences (laboratory analysis of meteorites, stardust, and interplanetary dust particles)
- Condensed matter and materials physics (graphene and other two-dimensional atomic crystals, nanostructured materials, metallic glasses and liquids, magnetism and superconductivity, high-pressure physics, and topological materials)
- Quantum information science (quantum sensing and simulation and computation)
- Biophysics (computational neurophysics and systems cell biology)

Theoretical research areas include the following:

- Biophysics (nonequilibrium dynamics in biological cells and theory of the microbiome)
- Condensed matter physics and quantum materials (strongly correlated electron systems, topological phases, excited states of many-electron systems, density functional theory, glasses, quantum equilibrium and non-equilibrium phenomena, quantum memory, statistical mechanics, and networks and machine learning)
- Elementary particle physics (astroparticle physics, dark matter, theoretical cosmology, strong interactions, non-Hermitian Hamiltonians, and quark physics beyond the Standard Model)
- Nuclear theory (atomic nuclei, infinite neutron and nuclear matter, nuclear structure and reactions, ab initio calculations, nuclear models, quark matter, neutron star mergers, and physics beyond the Standard Model)

Students spend their first two years (four semesters) taking graduate courses. At the end of this time, they will typically have completed requirements for the master's degree. Students planning to complete a PhD will also need to find a dissertation advisor and start their research. PhD candidates will receive a stipend and complete two semesters of mentored teaching experiences. After achieving the required course grades and passing an oral examination at the end of their second year, PhD students are normally paid from research funds while working on their research and writing a dissertation. The PhD program typically takes between five and six years to complete.

Website: http://physics.wustl.edu/graduate

Faculty

Chair

Henric Krawczynski (https://physics.wustl.edu/people/henric-krawczynski/)
Wayman Crow Professor of Physics
PhD, University of Hamburg
Experimental high-energy astrophysics

Associate Chair

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Associate Professor
PhD, Old Dominion University
Theoretical nuclear physics

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James S. McDonnell Professor of Space Sciences
PhD, University of Bombay
Astrophysics and space sciences

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PhD, California Institute of Technology

Degree Requirements

The information below summarizes the Department of Physics' degree requirements. These requirements are in addition to those established by the Office of Graduate Studies, Arts & Sciences. For more information about requirements for doctoral degrees (http://bulletin.wustl.edu/grad/artsci/phd/academic/) or master's degrees (http://bulletin.wustl.edu/grad/artsci/masters/academic/) in the Office of Graduate Studies, Arts & Sciences, please visit the appropriate sections of this *Bulletin*.

Master of Arts in Physics

36-Unit Academic Credit Course Requirement

Courses that count toward academic credit are as follows:

- Any regular 500-level lecture courses in the physics department, including Physics 582 Research Seminar
- Courses outside of the physics department, if approved by the master's program director
- Selected Topics courses, for which students should register: Physics 589 Selected Topics in Physics I/Physics 590 Selected Topics in Physics II
- Supervised research, for which students should register: Physics 593 Introduction to Methods in Physics/Physics 594 Introduction to Methods in Physics (Supervised research may be used for a maximum of 6 units of academic credit.)

Core Course Requirements

For qualification, students must pass five core 500-level physics courses. In those courses, the student must maintain an average of a B (a grade point average of 3.0), with no more than one grade lower than B-. Core courses may be taken only once. If more than five core courses are taken, the GPA will be determined from the best five course grades.

Students must take the following three courses:

Code	Title	Units
Physics 505	Classical Electrodynamics I	3
Physics 523	Quantum Mechanics I	3
Physics 529	Statistical Mechanics	3

They must also take at least two of the following:

Code	Title	Units
Physics 501	Theoretical Physics	3
Physics 506	Classical Electrodynamics II	3
Physics 507	Classical Mechanics	3
or Physics 509	Nonlinear Dynamics	
Physics 524	Quantum Mechanics II	3

PhD in Physics

Outline of Requirements

- Complete 36 units of academic credit (detailed below), maintaining an average grade of at least a B (3.0 GPA).
- Pass the PhD qualification procedure. This requirement must be completed before a student can formally join a research group and is normally completed before the start of the third year.
- Complete the teaching requirements.
- Write a thesis (doctoral dissertation (https://wustl.app.box.com/s/16rx96n2hupwg7uuepwsjerzafer36pl/)).
- Pass an oral dissertation defense examination.

36-Unit Academic Credit Course Requirement

Courses that count toward academic credit are as follows:

- Any regular 500-level lecture courses in the physics department, including Physics 597 Supervised Teaching of Physics and Physics 582 Research Seminar
- Courses outside of the physics department, if approved by the student's advisor and the director of graduate studies
- Special topics courses, for which students should register: Physics 589 Selected Topics in Physics I/Physics 590 Selected Topics in Physics II
- Supervised research, for which students should register: Physics 593 Introduction to Methods in Physics/Physics 594 Introduction to Methods in Physics (Supervised research may be used for a maximum of 6 units of academic credit.)

PhD Qualification: Course Requirements

For qualification, students must pass six core 500-level physics courses. In those courses, the student must maintain an average of a B (3.0 GPA), with no more than one grade lower than B-. A given core course may be taken only once. If more than six core courses are taken, the GPA will be determined from the best six course grades.

Students must take the following four courses:

Code	Title	Units
Physics 501	Theoretical Physics	3
Physics 505	Classical Electrodynamics I	3
Physics 523	Quantum Mechanics I	3
Physics 529	Statistical Mechanics	3

They must also take at least two of the following:

Code	Title	Units
Physics 502	Methods of Theoretical Physics II	3
Physics 506	Classical Electrodynamics II	3
Physics 507	Classical Mechanics	3
or Physics 509	Nonlinear Dynamics	
Physics 524	Quantum Mechanics II	3

These requirements can be modified for students who have completed equivalent courses while working toward a master's degree in physics at other universities.

PhD Qualification: Oral Examination Requirement

To qualify, the student must give a presentation to a committee of three physics faculty members (i.e., the prospective research advisor and two others). The student should demonstrate a basic understanding of a major topic of current research in the selected area of study, chosen in consultation with the student's prospective thesis advisor. One week before the oral exam, the student must prepare a written paper (approximately 1500-3000 words) summarizing the content of the presentation and give it to the committee. The student's responses to questions raised by the examination committee are graded as adequate or not. Students have a chance to respond to inadequately answered questions in writing within 48 hours after the examination. The student is not allowed to receive assistance in preparing the written response from any other individuals. The answers should either be given in person to the chair of the examination committee or emailed to the chair as a PDF file so that it is time stamped. The committee will determine whether the written answers are sufficient.

The committee must be chosen and approved by the department chair by the end of a student's third semester (typically in December of the second year). The oral examination should be taken by the end of a student's fourth semester (typically in May of the second year). If the student fails the oral examination, they can take it again one additional time.

Teaching Requirements

These requirements must be completed before the student submits their doctoral dissertation to the Office of Graduate Studies, Arts & Sciences:

- **Complete L31 Physics 597:** Graduate students are required to take Physics 597 Supervised Teaching of Physics prior to serving as an assistant in instruction. Students typically take this course during their first fall semester.
- **Complete at least two semesters of mentored teaching experiences**
- **Complete four hours of oral presentations:** Graduate students must complete a total of four hours of specialized oral presentations. Examples of such presentations include teaching a class (e.g., when substituting for a professor); giving seminars, such as the weekly graduate seminar; or giving oral presentations at conferences, journal clubs, and the like.

Dissertation Requirements

Please refer to the Doctoral Dissertation Guide (PDF) (https://wustl.app.box.com/s/16rx96n2hupwg7uuepwsjerzafer36pl/) of the Office of Graduate Studies, Arts & Sciences, for more information.