

# Physics

The Department of Physics offers **Master of Arts (AM) and Doctor of Philosophy (PhD) programs in Physics**. Research covers a wide area of experimental and theoretical physics, and benefits from close contacts with nuclear and inorganic chemists in the chemistry department, planetary scientists in the earth and planetary sciences department, applied scientists in the School of Engineering & Applied Science 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 and the Institute of Materials Science & Engineering.

Experimental research areas include:

- astrophysics (observations of cosmic rays, gamma rays, X-rays, dark matter detection, high-precision tests of gravity)
- space sciences (laboratory analysis of meteorites, stardust, interplanetary dust particles)
- condensed matter and materials physics (graphene and other two-dimensional atomic crystals, quantum information and atomic physics with condensed matter devices, nanostructured materials, metallic glasses and liquids, magnetism and superconductivity, high-pressure physics, nuclear magnetic resonance)
- biophysics (computational neurophysics, systems cell biology).

Theoretical research areas include:

- biophysics (nonequilibrium dynamics in biological cells, theory of the microbiome)
- condensed matter physics (strongly correlated electron systems, topological phases, excited states of many-electron systems, density functional theory and glasses)
- elementary particle physics (astroparticle physics, dark matter, theoretical cosmology, strong interactions, non-Hermitian Hamiltonians, quark physics beyond the Standard Model)
- nuclear theory (nuclear matter, correlations in nuclei).

Students are usually admitted to the PhD program rather than to the AM. They spend their first two years taking graduate courses, finding a dissertation adviser, and starting research. During that time they 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, 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

**Mark Alford** ([http://physics.wustl.edu/people/alford\\_mark-g](http://physics.wustl.edu/people/alford_mark-g))  
Professor  
PhD, Harvard University  
Nuclear/particle physics

### Endowed Professors

**Ramanath Cowsik** ([http://www.physics.wustl.edu/people/cowsik\\_ramanath](http://www.physics.wustl.edu/people/cowsik_ramanath))  
James S. McDonnell Professor of Space Sciences  
PhD, University of Bombay  
Astrophysics and space sciences

**Kenneth F. Kelton** ([http://www.physics.wustl.edu/people/kelton\\_kenneth-f](http://www.physics.wustl.edu/people/kelton_kenneth-f))  
Arthur Holly Compton Professor of Physics  
PhD, Harvard University  
Condensed matter and materials physics

### Professors

**James H. Buckley** ([http://physics.wustl.edu/people/buckley\\_james-h](http://physics.wustl.edu/people/buckley_james-h))  
PhD, University of Chicago  
Experimental high-energy astrophysics

**Anders E. Carlsson** ([http://physics.wustl.edu/people/carlsson\\_anders-e](http://physics.wustl.edu/people/carlsson_anders-e))  
PhD, Harvard University  
Biophysics

**Willem H. Dickhoff** ([http://www.physics.wustl.edu/people/dickhoff\\_willem-h](http://www.physics.wustl.edu/people/dickhoff_willem-h))  
PhD, Free University, Amsterdam  
Many-body theory

**Martin H. Israel** ([http://www.physics.wustl.edu/people/israel\\_martin-h](http://www.physics.wustl.edu/people/israel_martin-h))  
PhD, California Institute of Technology  
Experimental cosmic-ray physics

**Jonathan I. Katz** ([http://www.physics.wustl.edu/people/katz\\_jonathan-i](http://www.physics.wustl.edu/people/katz_jonathan-i))  
PhD, Cornell University  
Theoretical astrophysics

**Henric Krawczynski** ([http://www.physics.wustl.edu/people/krawczynski\\_henric](http://www.physics.wustl.edu/people/krawczynski_henric))  
PhD, University of Hamburg  
Experimental high-energy astrophysics

**Zohar Nussinov** ([http://www.physics.wustl.edu/people/nussinov\\_zohar](http://www.physics.wustl.edu/people/nussinov_zohar))  
PhD, University of California, Los Angeles  
Theoretical condensed matter physics

**Michael C. Ogilvie** ([http://www.physics.wustl.edu/people/ogilvie\\_michael-c](http://www.physics.wustl.edu/people/ogilvie_michael-c))  
PhD, Brown University  
Theoretical particle physics

**Ralf Wessel** ([http://www.physics.wustl.edu/people/wessel\\_ralf](http://www.physics.wustl.edu/people/wessel_ralf))  
PhD, University of Cambridge  
Biophysics

## Joint Professors

**Shankar M.L. Sastry** ([http://www.physics.wustl.edu/people/sastry\\_shankar](http://www.physics.wustl.edu/people/sastry_shankar))  
PhD, University of Toronto  
(Mechanical Engineering)

**Lee G. Sobotka** ([http://www.physics.wustl.edu/people/sobotka\\_lee-g](http://www.physics.wustl.edu/people/sobotka_lee-g))  
PhD, University of California, Berkeley  
(Chemistry)  
Experimental nuclear physics

## Associate Professors

**Francesc Ferrer** ([http://www.physics.wustl.edu/people/ferrer\\_francesc](http://www.physics.wustl.edu/people/ferrer_francesc))  
PhD, Universitat Autònoma de Barcelona  
Theoretical astro-particle physics & cosmology

**Kater Murch** ([http://www.physics.wustl.edu/people/murch\\_kater](http://www.physics.wustl.edu/people/murch_kater))  
PhD, University of California, Berkeley  
Quantum information and materials

**Alexander Seidel** ([http://www.physics.wustl.edu/people/seidel\\_alexander](http://www.physics.wustl.edu/people/seidel_alexander))  
PhD, Massachusetts Institute of Technology  
Theoretical condensed matter physics

**Li Yang** ([http://www.physics.wustl.edu/people/yang\\_li](http://www.physics.wustl.edu/people/yang_li))  
PhD, Georgia Institute of Technology  
Condensed matter and materials science

## Assistant Professors

**Bhupal Dev** ([http://physics.wustl.edu/people/dev\\_bhupal](http://physics.wustl.edu/people/dev_bhupal))  
PhD, University of Maryland, College Park  
Theoretical astro-particle physics & cosmology

**Erik Henriksen** ([http://www.physics.wustl.edu/people/henriksen\\_erik](http://www.physics.wustl.edu/people/henriksen_erik))  
PhD, Columbia University  
Condensed matter and materials science

**Shankar Mukherji** ([http://physics.wustl.edu/people/mukherji\\_shankar](http://physics.wustl.edu/people/mukherji_shankar))  
PhD, Massachusetts Institute of Technology/Harvard Medical School  
Systems cell biology

**Ryan Ogliore** ([http://physics.wustl.edu/people/ogliore\\_ryan](http://physics.wustl.edu/people/ogliore_ryan))  
PhD, California Institute of Technology  
Cosmochemistry, planetary science

**Saori Pastore**  
PhD, Old Dominion University  
Theoretical nuclear physics

**Maria Piarulli**  
PhD, Old Dominion University  
Theoretical nuclear physics

**Mikhail Tikhonov** ([http://physics.wustl.edu/people/tikhonov\\_mikhail](http://physics.wustl.edu/people/tikhonov_mikhail))  
PhD, Princeton University  
Microbiome, microbial ecology and evolution

## Lecturers

**Vikram Duvvuri** ([http://www.physics.wustl.edu/people/duvvuri\\_vikram](http://www.physics.wustl.edu/people/duvvuri_vikram))  
PhD, University of Chicago

**Manel Errando** ([http://physics.wustl.edu/people/errando\\_manel](http://physics.wustl.edu/people/errando_manel))  
PhD, Universitat Autònoma de Barcelona, Spain

**Mairin Hynes** ([http://www.physics.wustl.edu/people/hynes\\_kathryn-mairin](http://www.physics.wustl.edu/people/hynes_kathryn-mairin))  
PhD, Washington University

## Research Professors

**Sachiko Amari** ([http://www.physics.wustl.edu/people/amari\\_sachiko](http://www.physics.wustl.edu/people/amari_sachiko))  
PhD, Kobe University

**Robert Binns** ([http://www.physics.wustl.edu/people/binns\\_robert](http://www.physics.wustl.edu/people/binns_robert))  
PhD, Colorado State University

**Alexander Meshik** ([http://www.physics.wustl.edu/people/meshik\\_alex](http://www.physics.wustl.edu/people/meshik_alex))  
PhD, Vernadsky Institute of Cosmochemistry

**Michael Nowak**  
PhD, Stanford University

## Research Associate Professor

**Olga Pravdivtseva** ([http://physics.wustl.edu/people/pravdivtseva\\_olga](http://physics.wustl.edu/people/pravdivtseva_olga))  
PhD, Vernadsky Institute, Russian Academy of Sciences

## Research Assistant Professors

**Viatcheslav Bugaev** ([http://www.physics.wustl.edu/people/bugaev\\_viatcheslav](http://www.physics.wustl.edu/people/bugaev_viatcheslav))  
PhD, Altai State University

**Nan Lui** ([http://physics.wustl.edu/people/liu\\_nan](http://physics.wustl.edu/people/liu_nan))  
PhD, University of Chicago

**Brian Rauch** ([http://www.physics.wustl.edu/people/rauch\\_brian](http://www.physics.wustl.edu/people/rauch_brian))  
PhD, Washington University

## Professors Emeriti

**Carl M. Bender** ([http://physics.wustl.edu/people/bender\\_carl](http://physics.wustl.edu/people/bender_carl))  
Wilfred R. and Ann Lee Konneker Professor of Physics  
PhD, Harvard University

**Claude W. Bernard** ([http://physics.wustl.edu/people/bernard\\_claude](http://physics.wustl.edu/people/bernard_claude))  
PhD, Harvard University

**Thomas Bernatowicz** ([http://physics.wustl.edu/people/bernatowicz\\_thomas-j](http://physics.wustl.edu/people/bernatowicz_thomas-j))  
PhD, Washington University

**John W. Clark** ([http://www.physics.wustl.edu/people/clark\\_john-w](http://www.physics.wustl.edu/people/clark_john-w))  
Wayman Crow Professor of Physics  
PhD, Washington University

**Mark S. Conradi** ([http://www.physics.wustl.edu/people/conradi\\_mark-s](http://www.physics.wustl.edu/people/conradi_mark-s))  
PhD, Washington University

**Peter A. Fedders** ([http://www.physics.wustl.edu/people/fedders\\_peter](http://www.physics.wustl.edu/people/fedders_peter))  
PhD, Harvard University

**Michael W. Friedlander** ([http://www.physics.wustl.edu/people/friedlander\\_michael-w](http://www.physics.wustl.edu/people/friedlander_michael-w))  
PhD, University of Bristol

**Patrick C. Gibbons** ([http://www.physics.wustl.edu/people/gibbons\\_patrick-c](http://www.physics.wustl.edu/people/gibbons_patrick-c))  
PhD, Harvard University

**Charles M. Hohenberg** ([http://physics.wustl.edu/people/hohenberg\\_charles-m](http://physics.wustl.edu/people/hohenberg_charles-m))  
PhD, University of California, Berkeley

**Kazimierz Luszczyński** ([http://www.physics.wustl.edu/people/luszczyński\\_kazimierz](http://www.physics.wustl.edu/people/luszczyński_kazimierz))  
PhD, University of London

**James G. Miller** ([http://www.physics.wustl.edu/people/miller\\_james-g](http://www.physics.wustl.edu/people/miller_james-g))  
Albert Gordon Hill Professor of Physics  
PhD, Washington University

**Peter R. Phillips** ([http://www.physics.wustl.edu/people/phillips\\_peter-r](http://www.physics.wustl.edu/people/phillips_peter-r))  
PhD, Stanford University

**John H. Scandrett** ([http://www.physics.wustl.edu/people/scandrett\\_john-h](http://www.physics.wustl.edu/people/scandrett_john-h))  
PhD, University of Wisconsin-Madison

**James S. Schilling** ([http://www.physics.wustl.edu/people/schilling\\_james-s](http://www.physics.wustl.edu/people/schilling_james-s))  
PhD, University of Wisconsin-Madison

**Stuart A. Solin** ([http://www.physics.wustl.edu/people/solin\\_stuart](http://www.physics.wustl.edu/people/solin_stuart))  
Charles M. Hohenberg Professor of Experimental Physics  
PhD, Purdue University

**Wai-Mo Suen** ([http://www.physics.wustl.edu/people/suen\\_wai-mo](http://www.physics.wustl.edu/people/suen_wai-mo))  
PhD, California Institute of Technology

**Clifford Will** ([http://www.physics.wustl.edu/people/will\\_clifford-m](http://www.physics.wustl.edu/people/will_clifford-m))  
PhD, California Institute of Technology

## Degree Requirements

### Master of Arts (AM) and PhD in Physics

This document summarizes the physics department's degree requirements. These are in addition to the requirements established by the Graduate School. For more information regarding requirements for doctoral degrees (<http://bulletin.wustl.edu/grad/gsas/phd/academic>) or master's degrees (<http://bulletin.wustl.edu/grad/gsas/masters/academic>) in the Graduate School, please visit the appropriate sections of this *Bulletin*.

Students are normally accepted for graduate work toward the PhD, and students are occasionally accepted to work toward the AM. For more information about degree requirements (<http://physics.wustl.edu/graduate/about-the-program/handbook/degree-requirements>), please visit the physics department website.

### Requirements for AM in Physics

1. 36 semester hours of course credits, of which at least 30 semester hours must be in classroom or seminar courses at the 400 level or higher.
2. The student must get permission from their adviser and the director of graduate studies to take courses outside the physics department.
3. The student must maintain an overall grade average of B (GPA 3.0) or better.
4. Among the student's courses there must be at least 12 semester-hours of the "core" courses (detailed below), passed with an average grade of B (GPA 3.0) or better.

### Requirements for PhD in Physics

#### Outline of requirements

- Complete 36 units of academic credit (detailed below), maintaining an average grade of at least B (GPA 3.0).
- Pass the PhD qualification procedure. This must be done before a student can formally join a research group, and is normally completed before the start of the third year.

- Teaching requirements.
- Write a thesis ("doctoral dissertation").
- Pass an oral dissertation defense examination.

### 36 unit academic credit course requirement

Courses that count toward academic credit:

- Any regular 400- or 500-level lecture courses in the physics department, including Physics 597/598 Supervised Teaching of Physics and Physics 582 Research Seminar
- Courses outside the physics department, if approved by the student's adviser and the director of graduate studies
- Reading courses, for which students should register for Physics 589/590 Selected Topics in Physics
- Supervised research, for which students should register for Physics 593/594 Introduction to Methods in Physics. This can be used for a maximum of 6 units of academic credit.

Students can take up to four 400-level physics classes toward their academic credit without special permission from the graduate studies committee. However, they should discuss the merits of doing so with their adviser.

### 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 (GPA 3.0) with no more than one grade lower than B-. A given core course may be taken only once.

**Must take:**

Required	Units
Theoretical Physics	3
Classical Electrodynamics I	3
Quantum Mechanics I	3
Statistical Mechanics	3

**plus at least two of:**

Required	Units
Methods of Theoretical Physics II	3
Classical Electrodynamics II	3
Classical Mechanics <b>or</b> Nonlinear Dynamics	3
Quantum Mechanics II	3

These requirements can be modified or waived for students with previous graduate experience, e.g., a master's degree in physics.

### PhD qualification: oral examination requirement

After completing courses, the student must give a presentation to a committee of three physics faculty members (the prospective

research adviser and two others), to qualify for admittance to the PhD program. A written summary is also required.

### Teaching requirements

These requirements must be completed before the student submits their doctoral dissertation to the Graduate School:

- **Take L31 Physics 597:** Graduate students are required to take L31 Physics 597 Supervised Teaching of Physics prior to serving as an assistant in instruction. Students typically take Physics 597 in their first fall semester.
- **At least two semesters of mentored teaching experiences**
- **Four hours of oral presentations:** Graduate students must give a total of 4 hours of "specialized oral presentation." For example, 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, etc.

### For dissertation requirements, including the oral defense of the dissertation:

Please refer to the Graduate School's Doctoral Dissertation Guide on the Graduate School website (<http://graduateschool.wustl.edu/guides-0>).