

# PHYSICS, MS

The Physics Department exhibits exceptional strength in several areas. We invite applications from able students interested in experimental and theoretical surface physics and condensed matter physics; in structural biophysics and protein dynamics and function; in quantum field theory, cosmology, relativistic astrophysics, and gravitational-wave/multimessenger astronomy; in medical imaging. The primary goal of our graduate education is the training of creative research scientists.

Our research in gravitational physics is in several areas: In gravitational-wave astronomy, we play a leading role in LIGO, extracting signals of gravitational-waves from the coalescence of binary neutron stars and black holes, as well as searching for electromagnetic counterparts. We play a leading role in the use of pulsars to measure gravitation waves from supermassive black holes. In relativistic astrophysics we have established limits on the spin and mass of rotating neutron stars, and develop computational techniques to model merging stars. Astronomy efforts include studying early galaxy formation and evolution, and phenomenology of neutron stars and white dwarfs.

Experimental work in condensed matter and surface physics includes electron microscopy, electron and x-ray diffraction, atomic force microscopy, infrared spectroscopy, synchrotron radiation, molecular beam epitaxy, and atomic layer deposition. Experimental work is also being done in the areas of low-temperature physics, unconventional superconductivity (including high  $T_c$ ), heavy fermions, topological insulators, materials synthesis and floating zone single crystal growth, oxides, magnetism, ultrasonics, and neutron diffraction. These efforts are all aimed at creating and analyzing novel materials.

Theoretical work in condensed matter physics and surface physics includes research in quantum transport phenomena, superconductivity, magnetism, novel states of matter, and first-principles electronic structure calculations.

Experimental work in biophysics includes advanced optical and electrical methods for probing protein-protein interactions and protein complex structure and dynamics in vivo. Other efforts are in structural biophysics, static and time-resolved macromolecular crystallography, and XFEL-based femtosecond crystallography. Molecular biophysics studies include protein mechano-chemistry and single-molecule force spectroscopy.

Theoretical and computational work in biophysics includes advanced algorithms for signal extraction in the presence of extreme noise and timing uncertainty (XFEL and cryo-electron microscopy data) for protein crystallography, biostructure, dynamics, and function.

Experimental and theoretical efforts in medical imaging revolve around image reconstruction using Radon transformations, and novel imaging modalities such as thermo/opto-acoustic tomography.

## Graduate Minor in Physics

A doctoral student in another department wishing to minor in Physics must choose a minor professor from among the Physics Graduate Faculty. The student and the minor professor plan a program of study consisting of 9 to 12 graduate credits in Physics and complete a Graduate Minor Program Plan for the Physics Department files.

## Requirements

### Admission Requirements

#### Application Deadlines

Application deadlines vary by program, please review the application deadline chart (<http://uwm.edu/graduateschool/program-deadlines>) for specific programs. Other important dates and deadlines can be found by using the One Stop calendars (<https://uwm.edu/onestop/dates-and-deadlines>).

#### Admission

An applicant must meet Graduate School requirements (<http://uwm.edu/graduateschool/admission>) plus these departmental requirements to be considered for admission to the program:

1. Letters of Recommendation. Three letters of recommendation are required from persons familiar with the applicant's academic work.
2. Graduate Record Examinations (<http://uwm.edu/graduateschool/admission/#gre>). Both the General Test and the Subject Test in Physics are strongly encouraged but are not required.
3. Undergraduate major in physics or related fields. Applicants may be admitted with specific program-defined course deficiencies provided that the deficiencies amount to no more than two courses.

The student is expected to satisfy deficiency requirements within three enrolled semesters. The deficiencies are monitored by the Graduate School and the individual graduate program unit. No course credits earned in making up deficiencies may be counted as program credits required for the degree.

## Credits and Courses

### Option 1: Thesis Option

Minimum degree requirement is 30 graduate credits, 18 of which must normally be in physics and 12 of which may be in related fields. Of the 18 credits earned in the Department, at least 6 must be in physics courses numbered above 700, with the remainder in courses at least above 500; research, seminar, and independent study credits do not satisfy the 700 requirement. Six credits are earned through the thesis.

Code	Title	Credits
Physics Courses		18
At least 6 numbered above 700		
Remainder at least above 500		
Physics or Related Fields		12
Total Credits		30

### Option 2: Non-Thesis Option

Minimum degree requirement is 30 graduate credits, 18 of which must normally be in physics and 12 of which may be in related fields. Of the 18 credits earned in the Department, at least 6 must be in physics courses numbered above 700, with the remainder in courses at least above 500; research, seminar, and independent study credits do not satisfy the 700 requirement.

Code	Title	Credits
Physics courses		18
At least 6 numbered above 700 *		
Remaining 12 at least above 500		

Related Fields	12
Total Credits	30

\* Not including research, seminar, and independent study

### Comprehensive Examination

The student must pass a comprehensive written or oral examination. The non-thesis master's Oral Examination should evaluate the student's achievements in graduate courses and fulfillment of the goals of the student's program of study. In particular, students should be familiar with the materials in the "core" courses:

Code	Title	Credits
PHYSICS 515	Statistical Mechanics	3
PHYSICS 531	Principles of Quantum Mechanics I	3
PHYSICS 532	Principles of Quantum Mechanics II	3
PHYSICS 711	Theoretical Physics-Dynamics	3
PHYSICS 720	Electrodynamics I	3

## Program Requirement

### Major Professor as Advisor

The student must have a major professor to advise and supervise the student's studies as specified in Graduate School regulations. The newly admitted student is assigned to a temporary advisor.

Students in the master's program who are planning to terminate their physics studies with a master's degree should plan and prepare a program of study with the Department Master's Program Advisor.

### Option 1: Thesis Option

#### Thesis

The student must write an acceptable thesis.

### Comprehensive Examination

The student must pass a comprehensive oral examination, in part a defense of the thesis.

#### Time Limit

The student must complete all degree requirements within five years of initial enrollment.

### Option 2: Non-Thesis Option

#### Thesis

Not required.

### Comprehensive Examination

The student must pass a comprehensive written or oral examination

#### Time Limit

The student must complete all degree requirements within five years of initial enrollment.