

# PHYSICS (PHYS)

## Degrees Offered: Ph.D., M.S.

*These programs are offered in Durham.*

Physics is concerned with the properties of matter and the laws that describe its behavior. As a fundamental science, its discoveries and laws are basic to understanding in nearly all areas of science and technology. Advances in such diverse fields as medical instrumentation, solid state electronics, and space research have relied heavily on the application of basic physical laws and principles.

The mission of the Department of Physics is two-fold: to prepare students for a variety of career opportunities in business, industry, government and education/academia, and to conduct world-class research in various fields, including space and astrophysics, nuclear physics, high-energy physics, gravity, and solid state physics. The department has currently 28 teaching faculty, 11 research faculty, 105 undergraduate students and 60 graduate students. It houses state-of-the-art educational and laboratory facilities; the affiliated UNH Observatory is open to the public.

The Department of Physics offers the degrees of Master of Science and Doctor of Philosophy. Interested students are encouraged to contact the department for further information. More detailed information is also on the physics department web page at [www.physics.unh.edu](http://www.physics.unh.edu).

## Admission Requirements

Applicants to the master of science and doctor of philosophy programs are expected to have a bachelor's degree in science, with at least 24 credits in physics and closely allied fields. Applicants must submit current scores (within five years) from the general test of the Graduate Record Examination (GRE), and from the GRE physics subject test.

## Interdisciplinary Research

The department encourages research in areas related to physics or applied physics. If students desire to do research in a field related to physics, special provisions may be made. Contact the department chairperson or graduate adviser for details.

<https://ceps.unh.edu/physics-astronomy>

## Programs

- [Physics \(Ph.D.\)](#)
- [Physics \(M.S.\)](#)

## Courses

## Physics (PHYS)

### PHYS 805 - Experimental Physics

**Credits:** 4

Experiments in nuclear, solid-state, and surface physics. Includes discussion of laboratory techniques, data analysis, and data presentation. Special projects assigned to individual students.

**Repeat Rule:** May be repeated up to 1 time.

**Grade Mode:** Letter Grading

### PHYS 806 - Introduction to Physics Research and Teaching

**Credits:** 1

This course introduces new graduate students to both research and teaching. The teaching portion focuses on facilitating group work, problem solving, and deeper student thinking. The research portion focuses on research currently conducted at UNH, library resources, responsible conduct in research, how research differs from coursework, and how research results are presented in the research community.

**Grade Mode:** Graduate Credit/Fail grading

### PHYS 810 - Astrophysics I

**Credits:** 4

A comprehensive review of modern astrophysics. Topics covered include the celestial sphere, celestial mechanics, the tools of the modern astronomer (including different types of telescopes for studying the electromagnetic radiation from space), stellar spectra, stellar atmospheres, stellar interiors, the formation of stars, stellar evolution, and the stellar graveyard (white dwarfs, neutron stars, and black holes).

**Equivalent(s):** EOS 810

**Grade Mode:** Letter Grading

### PHYS 812 - Introduction to Space Plasma Physics

**Credits:** 4

Introduction to the subject of space plasma physics including solar physics, heliospheric physics, magnetospheric physics, and ionospheric physics. The course provides an overview of the basic phenomena and processes (e.g. particle acceleration and transport, shock formation, magnetic structures and reconnection, wave propagation, wave-particle interactions, instabilities), theoretical techniques (e.g. single-particle orbits, kinetic and fluid descriptions), and experimental techniques. (Alternate years only.)

**Equivalent(s):** EOS 812

**Grade Mode:** Letter Grading

### PHYS 818 - Introduction to Solid-State Physics

**Credits:** 4

Crystal structure, diffraction, lattice vibrations, electronic and optical properties of metals and semiconductors; selected topics in modern condensed matter physics. Coursework in statistical mechanics and quantum mechanics required. (Normally offered every other year.)

**Grade Mode:** Letter Grading

### PHYS 820 - Nuclear Physics

**Credits:** 4

Nuclear phenomenology, reactions, models, radiation, interaction of radiation with matter; accelerators; properties and interactions of elementary particles; symmetries and symmetry breaking standard model. Introductory coursework in quantum mechanics, electricity and magnetism required.

**Grade Mode:** Letter Grading

### PHYS 864 - General Relativity and Cosmology

**Credits:** 4

Review of special relativity, and the motivation for considering gravity in terms of curvature of space time. Introduction to Riemannian geometry, general relativity and Einstein's equations. Application of general relativity in the study of black holes, gravitational waves, cosmology, as well as recent results on inflation and quantum gravity. (Alternate years only.)

**Grade Mode:** Letter Grading

### PHYS 895 - Independent Study

**Credits:** 1-8

Individual project under direction of a faculty adviser.

**Grade Mode:** Letter Grading

**PHYS 899 - Master's Thesis****Credits:** 1-6

Master's Thesis.

**Repeat Rule:** May be repeated for a maximum of 6 credits.**Grade Mode:** Graduate Credit/Fail grading**PHYS 931 - Mathematical Physics****Credits:** 3

Complex variables, differential equations, asymptotic methods, integral transforms, special functions, linear vector spaces and matrices, Green's functions, and additional topics selected from integral equations, variational methods, numerical methods, tensor analysis, and group theory.

**Equivalent(s):** MATH 931**Grade Mode:** Letter Grading**PHYS 935 - Statistical Physics****Credits:** 3

Review of thermodynamics and kinetic theory, followed by an introduction to classical and quantum statistical mechanics. Microcanonical, canonical, and grand canonical ensembles; ideal Fermi and Bose gases and applications of statistical mechanics to selected physical problems.

**Prerequisite(s):** PHYS 931 with a minimum grade of B- and PHYS 939 with a minimum grade of B- and PHYS 943 with a minimum grade of B-.**Grade Mode:** Letter Grading**PHYS 939 - Classical Mechanics****Credits:** 3

Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies. Topics that serve as background for the study of modern physical theories are emphasized.

**Grade Mode:** Letter Grading**PHYS 941 - Electromagnetic Theory I****Credits:** 3

The formulation and detailed application of electromagnetic theory to physical problems. The material covered is at the level of the text by J.D. Jackson, "Classical Electrodynamics".

**Grade Mode:** Letter Grading**PHYS 942 - Electromagnetic Theory II****Credits:** 3

The formulation and detailed application of electromagnetic theory to physical problems. The material covered is at the level of the text by J.D. Jackson, "Classical Electrodynamics".

**Grade Mode:** Letter Grading**PHYS 943 - Quantum Mechanics I****Credits:** 3

Introduces non-relativistic quantum theory, covering wave mechanics, Dirac notation, angular momentum, the use of perturbation theory to calculate atomic energy levels, the interaction of atoms with radiation, and various approaches to calculating the differential scattering cross-section.

**Grade Mode:** Letter Grading**PHYS 944 - Quantum Mechanics II****Credits:** 3

See description for PHYS 943.

**Grade Mode:** Letter Grading**PHYS 951 - Plasma Physics****Credits:** 3

Kinetic theory of plasmas; plasma waves, instabilities, turbulence, diffusion, adiabatic motion of charged particles, nonlinear plasma phenomena. (Normally offered every other year.)

**Prerequisite(s):** PHYS 935 with a minimum grade of B- and PHYS 941 with a minimum grade of B- and PHYS 942 with a minimum grade of B-.**Grade Mode:** Letter Grading**PHYS 953 - Magnetohydrodynamics of the Heliosphere****Credits:** 3

Introduction to solar physics, with emphasis on gas dynamics and magnetic fields. Interior structure, the theory of convection, wave motions in the presence of magnetism and gravity, coronal heating theories, steady and nonsteady flows, dynamo theory, and the theory of solar flares and other transient phenomena. Salient observational data are reviewed. (Normally offered every other year.)

**Grade Mode:** Letter Grading**PHYS 954 - Heliospheric Physics****Credits:** 3

The solar wind and its effects on cosmic rays. The basic equations of the solar wind: mass, momentum, angular momentum, and energy balance. Transport processes. Waves, shocks, and instabilities in the solar wind. The basic equations of energetic particle transport. Solar modulation of solar and galactic cosmic rays. Interaction of energetic particles with shock waves. Salient data are reviewed. (Normally offered every other year.) Also offered as EOS 954.

**Equivalent(s):** EOS 954**Grade Mode:** Letter Grading**PHYS 961 - Advanced Quantum Mechanics I****Credits:** 3

Relativistic wave equations, propagator theory and Feynman diagrams, quantum theory of radiation, second quantization, introduction to quantum field theory and related topics. (Normally offered every other year.)

**Prerequisite(s):** PHYS 939 with a minimum grade of B- and PHYS 944 with a minimum grade of B-.**Grade Mode:** Letter Grading**PHYS 965 - Advanced Solid-State Physics****Credits:** 3

Theory of crystalline metals, semiconductors, and insulators. Selected topics from the following: surfaces, films, quantum dots, clusters, solid-state devices. (Normally offered every other year.)

**Prerequisite(s):** PHYS 935 with a minimum grade of B- and PHYS 941 with a minimum grade of B- and PHYS 943 with a minimum grade of B-.**Grade Mode:** Letter Grading**PHYS 987 - Magnetospheres****Credits:** 3

Introduces plasma physics of the interaction of solar and stellar winds with planets having internal magnetic fields, most predominately, the Earth. Both MHD and kinetic descriptions of internal and boundary processes of magnetospheres as well as treatment of the interaction with collisional ionospheres. Flow of mass, momentum, and energy, through such systems. (Normally offered every other year.)

**Prerequisite(s):** PHYS 951 with a minimum grade of B- and PHYS 952 with a minimum grade of B-.**Equivalent(s):** EOS 987**Grade Mode:** Letter Grading

**PHYS 988 - High Energy Astrophysics****Credits:** 3

One-semester course on the physical principles underpinning the field of high energy astrophysics. The first part of the course covers the underlying physical concepts, including radiation processes, particle acceleration processes, and accretion physics. The second part of the course includes more detailed discussion of the various astrophysical sources that can generate high energy radiations, including pulsars, X-ray binaries, active galactic nuclei, and gamma-ray bursts. An overview of important aspects of experimental methods is also provided.

**Prerequisite(s):** PHYS 810 with a minimum grade of B-.**Grade Mode:** Letter Grading**PHYS 995 - Special Topics****Credits:** 1-3

Any special fields of study not covered by the above courses may be included. Topic choices in previous years: astrophysics; elementary particles; lasers/masers; many-body theory; general relativity and cosmology; group theory; atomic physics; quantum theory of light; nonlinear equations, and chaos. May be repeated barring duplication of subject. (Not offered every year.)

**Repeat Rule:** May be repeated up to unlimited times.**Grade Mode:** Letter Grading**PHYS 999 - Doctoral Research****Credits:** 0

Doctoral Research.

**Grade Mode:** Graduate Credit/Fail grading**Special Fee:** Yes

## Faculty

[Physics and Astronomy Department Faculty](#)