PHYSICS AND ASTRONOMY

Department Website (http://www.physics.sc.edu/)

The Department of Physics and Astronomy offers strong traditional curricula at the graduate level with additional courses in research. Comprehensive experimental research programs are available in high-energy physics, nuclear/intermediate energy physics, condensed matter physics/nanoscience, and astrophysics. There are broad efforts in theoretical research with programs in the foundations of quantum theory, nuclear and particle physics, statistical/condensed matter physics, cosmology and astrophysics, and computational physics.

The Department of Physics and Astronomy offers the degrees of Master of Science, Professional Science Master (area of emphasis: modeling for corporate applications[1]), and Doctor of Philosophy. In cooperation with the College of Education, the department also offers the Master of Arts in Teaching in Sciences (Physics Option) and the Interdisciplinary Master of Arts in Sciences (Physics Option).

[1] The Professional Science Master program is not currently accepting applicants into the modeling for corporate applications emphasis.

Admissions

Adequate preparation for graduate study ordinarily presupposes a bachelor's degree in physics or an allied field. Prior to admission to this department, entering graduate students are expected to have passed with a grade of C or better the following courses or their equivalent: modern physics, mechanics, electromagnetic theory, kinetic theory and statistical mechanics, nuclear physics, and solid state physics. Mathematics through advanced calculus, including ordinary and particle differential equations and vector analysis, should also have been completed in the undergraduate program. Students with deficiencies in these courses must make them up during their initial two years of graduate studies.

Requests for further information should be addressed to:

Director of Graduate Studies
Department of Physics and Astronomy
University of South Carolina
Columbia, SC 29208

Programs

- Physics, M.S. (https://academicbulletins.sc.edu/graduate/arts-sciences/physics-astronomy/physics-ms/)
- Physics, Ph.D. (https://academicbulletins.sc.edu/graduate/arts-sciences/physics-astronomy/physics-phd/)

Courses

ASTR 510 - Observational Astronomy (3 Credits)
Observational techniques, scientific method application, and astronomical data analysis taken from international telescopes.
Prerequisites: A minimum grade of C in CSCE 106 (Python) and ASTR 101 or ASTR 201; or graduate student standing.

ASTR 533 - Advanced Observational Astronomy (1-3 Credits)
Development of a combination of observational techniques and facility at reduction of data. A maximum of eight hours per week of observation, data reduction, and consultation. Offered each semester by arrangement with the department.

ASTR 534 - Advanced Observational Astronomy (1-3 Credits)
A continuation of ASTR 533. Up to eight hours per week of observation, data reduction, and consultation.

ASTR 599 - Topics in Astronomy (1-3 Credits)
Readings and research on selected topics in astronomy. Course content varies and will be announced in the schedule of classes by title.

PHYS 501 - Quantum Physics I (3 Credits)
A self-contained treatment of quantum theory and its applications, beginning with the Schrodinger equation.
Prerequisites: C or better in PHYS 307 and MATH 242 or MATH 520.

PHYS 502 - Quantum Physics II (3 Credits)
Advanced topics in quantum physics, plus topics in special relativity, high-energy physics, and cosmology.
Prerequisites: C or better in PHYS 501.

PHYS 503 - Mechanics (4 Credits)
Classical mechanics of particles, systems, and rigid bodies; discussion and application of Lagrange's equations, introduction to Hamiltonian formulation of mechanics.
Prerequisites: C or better in PHYS 306 or PHYS 307 and MATH 242 or MATH 520.

PHYS 504 - Electromagnetic Theory (4 Credits)
Field theory of electric and magnetic phenomena; Maxwell's equations applied to problems in electromagnetism and radiation.
Prerequisites: C or better in PHYS 503.

PHYS 506 - Thermal Physics and Statistical Mechanics (3 Credits)
Principles of equilibrium thermodynamics, kinetic theory, and introductory statistical mechanics.
Prerequisites: C or better in PHYS 306, PHYS 307, MATH 241 and MATH 242 or MATH 520.

PHYS 511 - Nuclear Physics (4 Credits)
An elementary treatment of nuclear structure, radioactivity, and nuclear reactions. Three lecture and three laboratory hours per week.
Prerequisites: C or better in PHYS 501.

PHYS 515 - Mathematical Physics I (3 Credits)
Analytical function theory including complex analysis, theory of residues, and saddlepoint method; Hilbert space, Fourier series; elements of distribution theory; vector and tensor analysis with tensor notation.
Prerequisites: C or better in MATH 242 or MATH 520.

PHYS 516 - Mathematical Physics II (3 Credits)
Group theory, linear second-order differential equations and the properties of the transcendental functions; orthogonal expansions; integral equations; Fourier transformations.
Prerequisites: C or better in PHYS 515.

PHYS 517 - Computational Physics (3 Credits)
Application of numerical methods to a wide variety of problems in modern physics including classical mechanics and chaos theory, Monte Carlo simulation of random processes, quantum mechanics and electrodynamics.
Prerequisites: C or better in PHYS 212 and MATH 142.

PHYS 520 - Introduction to Biological Physics (3 Credits)
An introduction to the physical principles that underlie a variety of important biological and biophysical phenomena. Combines both physical and biological perspectives to explore a wide range of topics not possible in stand-alone undergraduate physics- or biological-science courses. Designed to be suitable for both bio-oriented and physics-oriented students.
Prerequisites: C or better in PHYS 201 or PHYS 211; C or better in MATH 141; C or better in BIOL 101.

PHYS 541 - Advanced Experimental Physics I (4 Credits)
Continuation of PHYS 310. Optical apparatus (telescope, microscope, interferometer) and advanced project planning including equipment design and budgeting.
Prerequisites: C or better in PHYS 310.

PHYS 542 - Advanced Experimental Physics II (4 Credits)
Continuation of PHYS 541. Study of topics from advanced optics, astronomy, biophysics, digital electronics, nuclear/particle physics, or solid state physics, plus conduction of a physics experiment, including a written paper and an oral presentation.
Prerequisites: C or better in PHYS 541.

PHYS 546 - Introduction to Astrophysics (3 Credits)
An astrophysics course for physics students. Covers the basics of observational techniques, structure and evolution of stars, interstellar medium and star formation, structure and properties of the Milky Way and nearby galaxies, and generation and transfer of radiation in astrophysical environments.
Prerequisites: C or better in PHYS 307.

PHYS 599 - Topics in Physics (1-3 Credits)
Readings and research on selected topics in physics. Course content varies and will be announced in the schedule of classes by title.

PHYS 700 - Seminar on Teaching & Learning in Physics & Astronomy (1 Credit)
Understanding physics students; current teaching methods supported by research in physics, physics education, education, psychology, and cognitive science.

PHYS 701 - Classical Mechanics (3 Credits)
Generalized coordinates, Lagrangian and Hamiltonian formulations, variational principles, transformation theory, and Hamilton-Jacobi equation.

PHYS 703 - Classical Field Theory I (3 Credits)
Development of classical fields; Maxwell's equations; boundary value problems; radiation theory.

PHYS 704 - Classical Field Theory II (3 Credits)
A continuation of PHYS 703.

PHYS 706 - Statistical Thermodynamics (3 Credits)
Statistics of Boltzmann, of Fermi and Dirac, and of Bose and Einstein, with applications.

PHYS 708 - General Relativity and Cosmology (3 Credits)
Introduction to the basic concepts of general relativity and a discussion of problems of current interest.
Prerequisite or Corequisite: PHYS 701, PHYS 704.

PHYS 711 - Quantum Mechanics I (3 Credits)
A development of non-relativistic quantum mechanics.

PHYS 712 - Quantum Mechanics II (3 Credits)
A continuation of PHYS 711.

PHYS 713 - Advanced Quantum Theory (3 Credits)
Second Quantization. Relativistic formulations of quantum mechanics.
Prerequisites: PHYS 712.

PHYS 714 - Quantum Field Theory (3 Credits)
Theory of quantized fields. Introduction to renormalization. A continuation of PHYS 713.
Prerequisites: PHYS 713.

PHYS 715 - Many-Body Quantum Theory (3 Credits)
Effective field theory, particle -hole, quasiparticles.
Prerequisite or Corequisite: PHYS 713.

PHYS 721 - Subatomic Physics (3 Credits)
Nuclear physics, mainly from the experimental standpoint.

PHYS 723 - Elementary Particles I (3 Credits)
Introduction to elementary particles. The quark model. Symmetry principles and conservation laws. Calculation of cross sections and decay rates using Feynman rules. Accelerators, particle detectors, and experiments.
Prerequisites: PHYS 701, PHYS 703, PHYS 711.

Corequisite: PHYS 712.

PHYS 724 - Elementary Particles II (3 Credits)
Experimentally accessible processes and their description using the framework developed in PHYS 723. Gauge theories and the standard model. Particle experiments for the next decade and their underlying physics descriptions.
Prerequisites: PHYS 723.

PHYS 725 - Solid State Physics (3 Credits)
The crystalline state of matter and its main characteristics. Electric and magnetic properties of metals, semiconductors, and insulators.

PHYS 726 - Superconductivity (3 Credits)
Theory and description of conventional and high temperature superconductors and their properties.

PHYS 727 - Magnetic Resonance (3 Credits)
Basic theory. Electron spin resonance. High resolution and wideline nuclear magnetic resonance. MÃƒÂ¶ssbauer effect. Magnetic resonance and dielectric relaxation.

PHYS 728 - Quantum Optics - Understanding Light-Matter Interactions (3 Credits)
Semi-classical and fully quantum-mechanical treatments of interactions between matter and electromagnetic fields on the microscopic level.
Prerequisites: Undergraduate quantum mechanics.

PHYS 729 - Applied Group Theory (3 Credits)
Groups and representations. Full rotational group. Angular momentum. Ligand field theory. Application to atomic, molecular, and nuclear physics.

PHYS 730 - Graduate Seminar (1 Credit)
Presentation by the student of a designated topic. May be repeated for credit.

PHYS 731 - Extragalactic Astrophysics (3 Credits)
Extragalactic astrophysics, including nearby and distant galaxies, active galaxies, galaxy clusters, large-scale structure, galaxy formation/evolution, scale structure, galaxy formation/evolution, basics of cosmology, cosmic radiation backgrounds, and observation constraints on cosmological models.
Prerequisites: PHYS 701, PHYS 703, and ASTR 211 or equivalent.

PHYS 739 - Graduate Research Laboratory (3 Credits)
Obtain necessary skills and habits needed to work in any research group by performing hands-on experiments including finding a collaborator, researching the literature, performing the experiment, analyzing data, interpreting/understanding the results, and writing a report.

PHYS 740 - Selected Topics in Physics (1-3 Credits)
Course content varies and will be announced in the schedule of classes by title.

PHYS 743 - Quantum Computer Science (3 Credits)
Fundamentals of quantum information processing, including quantum computation, quantum algorithms, quantum cryptography, and basic quantum information theory. Topics include: the quantum circuit model, alternative models, qubits, unitary operators, measurement, entanglement, quantum algorithms for factoring and search, quantum cryptographic key distribution, simulation of physical systems, error-correction and fault-tolerance, quantum channels, complexity of quantum computation, near-term implementations, quantum computer programming.
Prerequisites: C or better in MATH 344, MATH 544, or MATH 700, or the equivalent, or instructor permission.

Cross-listed course: CSCE 785, MATH 763

PHYS 745 - Topics in Nuclear Physics (1-3 Credits)
Course content varies and will be announced in the schedule of classes by title.

PHYS 746 - Principles of Astrophysics (3 Credits)
This is an astrophysics course for physics graduate students. The course will cover the basics of observational techniques, structure and evolution of stars, interstellar medium and star formation, structure and properties of the Milky Way and nearby galaxies, and generation and transfer of radiation in astrophysical environments.
Prerequisites: C+ or better in PHYS 307, PHYS 503, PHYS 506.

PHYS 750 - Topics in Solid State Physics (1-3 Credits)
Course content varies and will be announced in the schedule of classes by title.

PHYS 755 - Topics in Theoretical Physics (1-3 Credits)
Course content varies and will be announced in the schedule of classes by title.

PHYS 760 - Research (1-6 Credits)
Introduction to and the application of the methods of research.

PHYS 761 - Research (1-6 Credits)
Introduction to and the application of the methods of research.

PHYS 764 - Quantum Information (3 Credits)
Fundamentals of quantum information theory and quantum communications. Topics include: Postulates of quantum mechanics, classical information and entropy, compression of classical information and classical typical sets, quantum entropy and quantum relative entropy, quantum states discrimination, Schumacher's theory of quantum compression and quantum typical subspace, communicating classical information using quantum channels, the Classical Capacity Theorem of a quantum channel.
Prerequisites: C or better in MATH 344 or MATH 544 or equivalent, or permission by the instructor; and C or better in MATH 511 or STAT 511 or equivalent, or permission by the instructor; knowledge of quantum mechanics is not required.

Cross-listed course: CSCE 764, MATH 764

PHYS 799 - Thesis Preparation (1-9 Credits)
CL: 2020.

PHYS 899 - Dissertation Preparation (1-12 Credits)
CL: 2020.