Physics

Graduate work leading to the PhD degree is offered in the Department of Physics. Students may petition for an MA degree on their way to a PhD. Please note that the department will not consider applications from students who intend to work toward the MA degree only. In certain cases, students may petition for a terminal MA degree. Research is a major part of the PhD program, and research opportunities exist across the full spectrum of theoretical and experimental physics in astrophysics and cosmology, atomic, molecular and optical physics, biophysics, condensed matter, elementary particles and fields, fusion and plasma, low temperature physics, mathematical physics, nuclear physics, quantum information, space physics, and statistical mechanics.

At the Lawrence Berkeley National Laboratory, extensive opportunities exist for research in astrophysics, elementary particle and nuclear physics, condensed matter physics and materials science, and plasma and nuclear physics. Space physics, interplanetary studies, solar plasma research, physics of the upper atmosphere, and cosmological problems are pursued both in the Physics Department and at the Space Sciences Laboratory.

Admission to the University

Uniform minimum requirements for admission

The following minimum requirements apply to all programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A minimum grade-point average of B or better (3.0);
3. If the applicant comes from a country or political entity (e.g. Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 570 on the paper-and-pencil test, 230 on the computer-based test, 90 on the iBT test, or an IELTS Band score of at least 7 (note that individual programs may set higher levels for any of these); and
4. Enough undergraduate training to do graduate work in the given field.

Applicants who already hold a graduate degree

The Graduate Council views academic degrees as evidence of broad research training, not as vocational training certificates; therefore, applicants who already have academic graduate degrees should be able to take up new subject matter on a serious level without undertaking a graduate program, unless the fields are completely dissimilar.

Programs may consider students for an additional academic master's or professional master's degree if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may only apply to one single degree program or one concurrent degree program per admission cycle.

Any applicant who was previously registered at Berkeley as a graduate student, no matter how briefly, must apply for readmission, not admission, even if the new application is to a different program.

Required documents for admissions applications

1. **Transcripts:** Upload unofficial transcripts with the application for the departmental initial review. Official transcripts of all college-level work will be required **if admitted**. Official transcripts must be in sealed envelopes as issued by the school(s) you have attended. Request a current transcript from every post-secondary school that you have attended, including community colleges, summer sessions, and extension programs.
   If you have attended Berkeley, upload unofficial transcript with the application for the departmental initial review. Official transcript with evidence of degree conferral ***will not*** be required if admitted.
2. **Letters of recommendation:** Applicants can request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.
3. **Evidence of English language proficiency:** All applicants from countries in which the official language is not English are required to submit official evidence of English language proficiency. This requirement applies to applicants from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, and most European countries. However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a U.S. university may submit an official transcript from the U.S. university to fulfill this requirement. The following courses will not fulfill this requirement: 1) courses in English as a Second Language, 2) courses conducted in a language other than English, 3) courses that will be completed after the application is submitted, and 4) courses of a non-academic nature. If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests.

Admission to the Program

The Department of Physics ordinarily admits only those applicants who have scholastic records well above a B+ average and who have completed the equivalent of the undergraduate major in physics. This program includes upper-division courses in mechanics (4 semester units), electromagnetism and optics (8 semester units), statistical and

thermal physics (4 semester units), quantum mechanics (8 semester units), and advanced undergraduate laboratory (5 semester units). Courses in atomic, nuclear and solid state physics, astronomy and applied mathematics are recommended as electives. Not all courses in the major are required for admission. Some courses required for the major program but not previously taken may have to be made up in the first year of graduate work. Applicants are required to submit a list of courses taken in physics and mathematics with course number, and applicable textbook, as well as a list of courses in progress.

In determining the admissibility of a prospective graduate student the Department attempts to carefully weigh all relevant factors, including transcripts of academic work, scores on the GRE, letters of recommendation, any research experience, and a statement of purpose. We recognize the diverse experiences of our applicants and therefore encourage them to submit supporting materials.

The graduate program in physics is designed for those intending to pursue work leading to the PhD. After completing the necessary course work requirements, an MA degree can be awarded. However, the Department does not consider applications from those intending to work toward the MA degree only.

Normative Time Requirements

Students enter the program with different training and backgrounds and because thesis research by its very nature is unpredictable, the time-frame for individual students will vary. Nevertheless, failure to meet the goals set forth here without appropriate justification may indicate that the student is not making adequate progress towards the PhD, and will therefore prompt consideration by the Department and possibly by Graduate Division of the student's progress, which might lead to probation and later dismissal. See the Physics Department's website (http://physics.berkeley.edu/academics/graduate-degrees/phd-program) for more information on the expectations for the progress of a typical graduate student from admission to award of a PhD.

Time to Advancement

Curriculum

Courses Required

PHYSICS 209	Classical Electromagnetism	5
PHYSICS 211	Equilibrium Statistical Physics	4
PHYSICS 221A/221B	Quantum Mechanics	5
Physics electives:		
Graduate		11
Graduate/Upper Division		8

Preliminary Exams

The preliminary examination (http://physics.berkeley.edu/academics/graduate-degrees/phd-program/preliminary-examinations) is a written examination and is designed to ensure that students command a broad spectrum of undergraduate physics prior to engaging in graduate research. The written exam is composed of four sections, and all four sections of the preliminary exam are offered at the beginning of both Fall and Spring semesters. Additional information can be found on our website (http://physics.berkeley.edu/sites/default/files/_/prelim_policy.pdf) .

QE

After the beginning of research and no later than completion of four semesters of research, the student is expected to take an oral qualifying examination covering his or her research field and related areas. The examination is administered by a four-member committee (consisting of three physics and one outside faculty member) approved by the Graduate Council.

Further details can be found on our website (http://physics.berkeley.edu/sites/default/files/_/qualifying_exam_infosheet.pdf) .

Students who meet the December deadline will automatically be considered for GSI positions. Additional information is available on the department's website (http://physics.berkeley.edu/index.php?option=com_content&task=view&id=102&Itemid=155) .

Non-native speakers of English must prove their proficiency in spoken English before they can hold GSI positions. Additional information is available on the department's website (https://gsi.berkeley.edu/lpp) .

Physics

PHYSICS C201 Introduction to Nano-Science and Engineering 3 Units
A three-module introduction to the fundamental topics of Nano-Science and Engineering (NSE) theory and research within chemistry, physics, biology, and engineering. This course includes quantum and solid-state physics; chemical synthesis, growth fabrication, and characterization techniques; structures and properties of semiconductors, polymer, and biomedical materials on nanoscales; and devices based on nanostructures. Students must take this course to satisfy the NSE Designated Emphasis core requirement.
Rules & Requirements

Prerequisites: Major in physical science such as chemistry, physics, etc., or engineering; consent of advisor or instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

Instructors: Gronsky, S.W. Lee, Wu

Also listed as: BIO ENG C280/MAT SCI C261/NSE C201

PHYSICS C202 Astrophysical Fluid Dynamics 4 Units
Principles of gas dynamics, self-gravitating fluids, magnetohydrodynamics and elementary kinetic theory. Aspects of convection, fluid oscillations, linear instabilities, spiral density waves, shock waves, turbulence, accretion disks, stellar winds, and jets.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

Instructors: Chiang, Kasen, Ma, Quataert, White

Also listed as: ASTRON C202

PHYSICS C203 Computational Nanoscience 3 Units
A multidisciplinary overview of computational nanoscience for both theorists and experimentalists. This course teaches the main ideas behind different simulation methods; how to decompose a problem into "simulatable" constituents; how to simulate the same thing two different ways; knowing what you are doing and why thinking is still important; the importance of talking to experimentalists; what to do with your data and how to judge its validity; why multiscale modeling is both important and nonsense.
Rules & Requirements

Prerequisites: Graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

Also listed as: NSE C242

PHYSICS 205A Advanced Dynamics 4 Units
Lagrange and Hamiltonian dynamics, variational methods, symmetry, kinematics and dynamics of rotation, canonical variables and transformations, perturbation theory, nonlinear dynamics, KAM theory, solitons and integrable pdes.
Rules & Requirements

Prerequisites: 105 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 205B Advanced Dynamics 4 Units
Nonlinear dynamics of dissipative systems, attractors, perturbation theory, bifurcation theory, pattern formation. Emphasis on recent developments, including turbulence.
Rules & Requirements

Prerequisites: 205A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS C207 Radiation Processes in Astronomy 4 Units
An introduction to the basic physics of astronomy and astrophysics at the graduate level. Principles of energy transfer by radiation. Elements of classical and quantum theory of photon emission; bremsstrahlung, cyclotron and synchrotron radiation. Compton scattering, atomic, molecular and nuclear electromagnetic transitions. Collisional excitation of atoms, molecules and nuclei.
Rules & Requirements

Prerequisites: PHYSICS 105, 110A; 110B concurrently; open to advanced undergraduates with GPA of 3.70

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

Instructors: Bower, Chiang, Kasen, Quataert

Also listed as: ASTRON C207

PHYSICS 209 Classical Electromagnetism 5 Units
Maxwell's equations, gauge transformations and tensors. Complete development of special relativity, with applications. Plane waves in material media, polarization, Fresnel equations, attenuation, and dispersion. Wave equation with sources, retarded solution for potentials, and fields. Cartesian and spherical multipole expansions, vector spherical harmonics, examples of radiating systems, diffraction, and optical theorem. Fields of charges in arbitrary motion, radiated power, relativistic (synchrotron) radiation, and radiation in collisions.
Rules & Requirements

Prerequisites: 110A-110B or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 211 Equilibrium Statistical Physics 4 Units
Foundations of statistical physics. Ensemble theory. Degenerate systems. Systems of interacting particles.
Rules & Requirements

Prerequisites: 112 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 212 Nonequilibrium Statistical Physics 4 Units
Time dependent processes. Kinetic equations. Transport processes. Irreversibility. Theory of many-particle systems. Critical phenomena and renormalization group. Theory of phase transitions.
Rules & Requirements

Prerequisites: 112 and 221A-221B, or equivalents

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 216 Special Topics in Many-Body Physics 4 Units
Quantum theory of many-particle systems. Applications of theory and technique to physical systems. Pairing phenomena, superfluidity, equation of state, critical phenomena, phase transitions, nuclear matter.
Rules & Requirements

Prerequisites: 221A-221B or equivalent recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 221A Quantum Mechanics 5 Units
Basic assumptions of quantum mechanics; quantum theory of measurement; matrix mechanics; Schroedinger theory; symmetry and invariance principles; theory of angular momentum; stationary state problems; variational principles; time independent perturbation theory; time dependent perturbation theory; theory of scattering.
Rules & Requirements

Prerequisites: 137A-137B or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 221B Quantum Mechanics 5 Units
Many-body methods, radiation field quantization, relativistic quantum mechanics, applications.
Rules & Requirements

Prerequisites: 221A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 226 Particle Physics Phenomenology 4 Units
Introduction to particle physics phenomena. Emphasis is placed on experimental tests of particle physics models. Topics include Quark model spectroscopy; weak decays; overview of detectors and accelerators; e+e- annihilation; parton model; electron-proton and neutrino-proton scattering; special topics of current interest.
Rules & Requirements

Prerequisites: 221A-221B or equivalent or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS C228 Extragalactic Astronomy and Cosmology 3 Units
A survey of physical cosmology - the study of the origin, evolution, and fate of the universe. Topics include the Friedmann-Robertson-Walker model, thermal history and big bang nucleosynthesis, evidence and nature of dark matter and dark energy, the formation and growth of galaxies and large scale structure, the anisotropy of the cosmic microwave radiation, inflation in the early universe, tests of cosmological models, and current research areas. The course complements the material of Astronomy 218.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

Instructors: Davis, Holzapfel, Lee, Ma, Seljak, White

Also listed as: ASTRON C228

PHYSICS 229 Advanced Cosmology 3 Units
Advanced topics in physical and early-universe cosmology. Topics include the expanding Universe, evidence and nature of dark matter and dark energy, relativistic perturbation theory, models of cosmological inflation, the formation and growth of large scale structure and the anisotropy of the cosmic microwave background, and current research areas. The course extends the material of C228.
Rules & Requirements

Prerequisites: Physics/Astronomy C228 or equivalent or consent of instructor

Hours & Format

Fall and/or spring:
15 weeks - 3 hours of lecture per week
15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 231 General Relativity 4 Units
An introduction to Einstein's theory of gravitation. Tensor analysis, general relativistic models for matter and electromagnetism, Einstein's field equations. Applications, for example, to the solar system, dense stars, black holes, and cosmology.
Rules & Requirements

Prerequisites: 209 or equivalent, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 232A Quantum Field Theory I 4 Units
Introduction to quantum field theory: canonical quantization of scalar, electromagnetic, and Dirac fields; derivation of Feynman rules; regularization and renormalization; introduction to the renormalization group; elements of the path integral.
Rules & Requirements

Prerequisites: 221A-221B or equivalent or consent of instructor (concurrent enrollment in 226 is recommended)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 232B Quantum Field Theory II 4 Units
Renormalization of Yang-Mills gauge theories: BRST quantization of gauge theories; nonperturbative dynamics; renormalization group; basics of effective field theory; large N; solitons; instantons; dualities. Selected current topics.
Rules & Requirements

Prerequisites: 232A or equivalent or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 233A Standard Model and Beyond I 4 Units
Introduction to the Standard Model of particle physics and its applications: construction of the Standard Model; Higgs mechanism; phenomenology of weak interactions; QCD and the chiral Lagrangian; quark mixing and flavor physics.
Rules & Requirements

Prerequisites: 232A or equivalent or consent of instructor (concurrent enrollment in 232B is recommended)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 233B Standard Model and Beyond II 4 Units
Advanced topics in the Standard Model and beyond, selected from: open problems in the Standard Model; supersymmetric models; grand unification; neutrino physics; flat and warped extra dimensions; axions; inflation; baryogenesis; dark matter; the multiverse; other current topics.
Rules & Requirements

Prerequisites: 233A or equivalent or consent of instructor

Repeat rules: Course may be repeated for credit with consent of instructor. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 234A String Theory I 4 Units
Perturbative theory of the bosonic strings, superstrings, and heterotic strings: NSR and GS formulations; 2d CFT; strings in background fields; T-duality; effective spacetime supergravity; perturbative description of D-branes; elements of compactifications and string phenomemology; perturbative mirror symmetry.
Rules & Requirements

Prerequisites: 232A or equivalent or consent of instructor. 232B is recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 234B String Theory II 4 Units
Nonperturbative apsects of string theory. Topics selected from black holes; black branes; Bekenstein-Hawking entropy; D-branes; string dualities; M-theory; holographic principle and its realizations; AdS/CFT correspondence; gauge theory/gravity dualities; flux compactifications; cosmology in string theory; topological string theories. Selected current topics.
Rules & Requirements

Prerequisites: 234A or equivalent or consent of instructor

Repeat rules: May be repeated for credit with consent of instructor. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 238 Advanced Atomic, Molecular, and Optical Physics 4 Units
Contemporary topics in atomic, molecular, and optical physics are presented at an advanced level. These topics may include one or several of the following, at the discretion of the instructor: mechanical effects of light-atom interactions, ultra-cold atomic physics, molecular physics, resonance optics of multi-level atoms, and probing particle physics with atoms and molecules.
Rules & Requirements

Prerequisites: 110A, 130, 137A-137B, and 138; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 240A Quantum Theory of Solids 4 Units
Excitations and interactions in solids; crystal structures, symmetries, Bloch's theorem; energy bands; electron dynamics; impurity states; lattice dynamics, phonons; many-electron interactions; density functional theory; dielectric functions, conductivity and optical properties.
Rules & Requirements

Prerequisites: 141A-141B and 221A-221B or equivalents, or consent of instructor; 240A is prerequisite to 240B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 240B Quantum Theory of Solids 4 Units
Optical properties, excitons; electron-phonon interactions, polarons; quantum oscillations, Fermi surfaces; magnetoresistance; quantum Hall effect; transport processes, Boltzmann equation; superconductivity, BCS theory; many-body perturbation theory, Green's functions.
Rules & Requirements

Prerequisites: 141A-141B and 221A-221B or equivalents, or consent of instructor; 240A is prerequisite to 240B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 242A Theoretical Plasma Physics 4 Units
Analysis of plasma behavior according to the Vlasov, Fokker-Planck equations, guiding center and hydromagnetic descriptions. Study of equilibria, stability, linear and nonlinear waves, transport, and laser-plasma interactions.
Rules & Requirements

Prerequisites: PHYSICS 142, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 242B Theoretical Plasma Physics 4 Units
Analysis of plasma behavior according to the Vlasov, Fokker-Planck equations, guiding center and hydromagnetic descriptions. Study of equilibria, stability, linear and nonlinear waves, transport, and laser-plasma interactions.
Rules & Requirements

Prerequisites: PHYSICS 142, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 250 Special Topics in Physics 2 - 4 Units
Topics will vary from semester to semester. See Department of Physics announcements.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit with consent of instructor. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2-4 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

PHYSICS 251 Introduction to Graduate Research in Physics 1 Unit
A survey of experimental and theoretical research in the Department of Physics, designed for first-year graduate students. One regular meeting each week with supplementary visits to experimental laboratories. Meetings include discussions with research staff.
Rules & Requirements

Prerequisites: Graduate standing in Department of Physics or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS C254 High Energy Astrophysics 3 Units
Basic physics of high energy radiation processes in an astrophysics environment. Cosmic ray production and propagation. Applications selected from pulsars, x-ray sources, supernovae, interstellar medium, extragalactic radio sources, quasars, and big-bang cosmologies.
Rules & Requirements

Prerequisites: 201 or consent of instructor. 202 recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Letter grade.

Instructors: Boggs, Quataert

Also listed as: ASTRON C254

PHYSICS C285 Theoretical Astrophysics Seminar 1 Unit
The study of theoretical astrophysics.
Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Quataert

Also listed as: ASTRON C285

PHYSICS 290A Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290B Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290D Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290E Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290F Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290G Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290H Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290I Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290J Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290K Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290L Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290N Seminar in Non-Neutral Plasmas 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290P Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290Q Seminar in Quantum Optics 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290R Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290S Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290T Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290X Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290Y Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 290Z Seminar 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS C290C Cosmology 2 Units
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: White, Cohn

Also listed as: ASTRON C290C

PHYSICS 295 Special Study for Graduate Students 1 - 4 Units
This course is arranged to allow qualified graduate students to investigate possible research fields or to pursue problems of interest through reading or non-laboratory study under the direction of faculty members who agree to give such supervision.
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Summer:
6 weeks - 1-4 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 299 Research 1 - 12 Units
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Summer:
6 weeks - 1-12 hours of independent study per week
8 weeks - 1-12 hours of independent study per week

Additional Details

Subject/Course Level: Physics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 301 Advanced Professional Preparation: Supervised Teaching of Physics 1 - 2 Units
Discussion, problem review and development, guidance of physics laboratory experiments, course development.
Rules & Requirements

Prerequisites: 300

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of independent study per week

Additional Details

Subject/Course Level: Physics/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

PHYSICS 375 Professional Preparation: Supervised Teaching of Physics 2 Units
Mandatory for first time GSIs. Topics include teaching theory, effective teaching methods, educational objectives, alternatives to standard classroom methods, reciprocal classroom visitations, and guided group and self-analysis of videotapes.
Rules & Requirements

Prerequisites: Graduate standing or consent of instructor; may be taken concurrently with 301

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Physics/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Formerly known as: Physics 300

PHYSICS 602 Individual Study for Doctoral Students 1 - 8 Units
Individual study in consultation with the major field adviser intended to provide an opportunity for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D.
Rules & Requirements

Prerequisites: For qualified graduate students

Credit Restrictions: Course does not satisfy unit or residence requirements for doctoral degree.

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-8 hours of independent study per week

Summer:
6 weeks - 1-8 hours of independent study per week
8 weeks - 1-8 hours of independent study per week

Additional Details

Subject/Course Level: Physics/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.