Why study physics and astronomy at the University of Denver?

The Department of Physics and Astronomy at the University of Denver combines a tradition of individualized instruction with a contemporary research focus. We have a dynamic faculty with innovative, interdisciplinary research programs. We provide an attentive, hands-on research and learning environment up to the PhD level. The department also offers a low student-to-faculty ratio in all advanced and graduate physics and astronomy courses and stresses individualized attention to each student.

The department has major research thrusts in stellar astronomy/astrophysics, biophysics, and condensed matter physics. Our faculty members are internationally recognized and accomplished researchers. The department is a part of two major interdisciplinary centers that were recently founded at the University of Denver: the Molecular and Cellular Biophysics program and the Center for Nanoscale Science and Engineering. Major state-of-the-art instrumentation is available in the department and through collaborations with nearby national institutes in the region (NIST, NREL, and NCAR), where several of our faculty hold associate appointments. Also, the Division of Natural Sciences and Mathematics maintains our own Linux cluster for in-house high-performance computational needs.
DEGREE REQUIREMENTS

Examinations
Before registering, new graduate students must take a diagnostic examination covering undergraduate physics. This examination serves to identify undergraduate deficiencies and helps to determine the student’s initial program.

A comprehensive examination is given to assess whether students have attained the standards set by the department to continue their pursuit of the degrees sought. All students are required to pass the comprehensive examination at an appropriate level (MS or PhD) upon completing the core course requirements in order to advance their candidacy status. All students pursuing a PhD are required to pass an oral dissertation research proposal in order to be promoted to PhD candidacy.

Master of Science Degree Requirements

• Option I (Research Thesis)
  45 quarter hours in an approved course of study; comprehensive examinations; an acceptable thesis; oral final examination (primarily a thesis defense). Two departmental faculty members and an outside chair are required for the oral examination.

• Option II (No thesis)
  45 quarter hours in an approved course of study; comprehensive examinations; oral final examination covering course work. Two departmental faculty members are required for the oral examination.

Doctor of Philosophy
A minimum of three years of full-time study beyond the baccalaureate degree, with at least 90 quarter hours of approved graduate credit; comprehensive examination; and acceptable dissertation. There is no departmental foreign language requirement. Enrollment as a graduate student at the University of Denver for at least six quarters, including at least two consecutive quarters of full-time attendance, is required to meet residency standards.

See the department of physics’ website (www.physics.du.edu/) for more information.

Other Degrees

Molecular and Cellular Biophysics
This interdepartmental PhD degree was recently established. See the molecular and cellular biophysics’ website http://www.du.edu/nsm/departments/molecularandcellular/index.html for more information.
Faculty

Davor Balzar
Associate Professor and Chair
PhD, University of Zagreb, Croatia
Research interests: condensed matter physics; materials science

Maria M. Calbi
Associate Professor
PhD, University of Buenos Aires, Argentina
Research interests: condensed matter physics, carbon nanotubes

Kingshuk Ghosh
Assistant Professor
PhD, University of Massachusetts, Amherst
Research interest: biophysics

Jennifer L. Hoffman
Assistant Professor
PhD, University of Wisconsin-Madison
Research interests: stellar astronomy and astrophysics

Dinah Loerke
Assistant Professor
PhD, University of Goettingen, Germany
Research interest: biophysics

Sean E. Shaheen
Associate Professor
PhD, University of Arizona
Research interests: condensed matter physics; biophysics

Mark Siemens
Assistant Professor
PhD, University of Colorado, Boulder
Research interests: ultrafast lasers, condensed matter physics

Robert E. Stencel
Professor, Womble Professor of Astrophysics PhD,
University of Michigan
Research interests: stellar astronomy and astrophysics

Toshiya Ueta
Associate Professor
PhD, University of Illinois at Urbana-Champaign
Research interests: stellar evolution; mass loss; astronomical solids (dust); radiative transfer through dusty media

Barry L. Zink
Associate Professor
PhD, University of California, San Diego
Research interests: condensed matter physics; materials science

RESEARCH PROFESSORS

Robert C. Amme
PhD, Iowa State University
Research interests: atomic and molecular physics; environmental materials; pure and applied mechanics; condensed matter physics

Jonathan F. Ormes
PhD, University of Minnesota
Research interests: high-energy astrophysics

LABORATORY MANAGER

Peter Hallam
MS, Colorado State University

ADJUNCT PROFESSORS

Ronald Mickle
MS Certificate, Swinburne University
PROFESSORS EMERITI

Aaron Goldman
Professor
DSc., Technion-Israel Institute of Technology

Herschel Neumann
Professor
PhD, University of Nebraska, Lincoln

Alwyn van der Merwe
Professor
PhD, University of Bern, Switzerland

RESEARCH PROFESSORS EMERITI

John R. Olson
PhD, Iowa State University

Bert Van Zyl
PhD, University of Washington
PHYS 3111 Quantum Physics I (4 qtr. hrs.)
First of a two-quarter sequence. The Schrödinger equation: interpretation of wave functions; the uncertainty principle; stationary states; the free particle and wave packets; the harmonic oscillator; square well potentials. Hilbert space: observables, commutator algebra, eigenfunctions of a Hermitian operator; the hydrogen atom and hydrogenic atoms. Prerequisites: PHYS 2252, 2260, 2556, 3612; MATH 2070.

PHYS 3112 Quantum Physics II (4 qtr. hrs.)
Second of a two-quarter sequence. Angular momentum and spin; identical particles; the Pauli exclusion principle; atoms and solids: band theory; perturbation theory; the fine structure of hydrogen; the Zeeman effect; hyperfine splitting; the variational principle; the WKB approximation; tunneling; time dependent perturbation theory; emission and absorption of radiation. Scattering: partial wave analysis; the Born approximation. Prerequisite: PHYS 3111.

PHYS 3270 Workshop: Practical Astronomy (1 to 5 qtr. hrs.)
Capstone coursework featuring studies in experimental, computational, and/or theoretical work in astronomy and astrophysics.

PHYS 3311 Advanced Laboratory I (1 qtr. hrs.)
First of a three-quarter sequence. Advanced experimental techniques in physics. Meets with PHYS 2311. Prerequisite: instructor’s permission.

PHYS 3312 Advanced Laboratory II (1 qtr. hrs.)
Second of a three-quarter sequence. Advanced experimental techniques in physics. Meets with PHYS 2312. Prerequisite: instructor’s permission.

PHYS 3313 Advanced Laboratory III (1 qtr. hrs.)
Third of a three-quarter sequence. Advanced experimental techniques in physics. Meets with PHYS 2313. Prerequisite: instructor’s permission.

PHYS 3510 Analytical Mechanics I (4 qtr. hrs.)
Lagrangian and Hamiltonian mechanics. Prerequisites: PHYS 1113, 1213, or 1214; MATH 2070; consent of instructor.

PHYS 3611 Electromagnetism I (4 qtr. hrs.)
First of a two-quarter sequence. Vector algebra; differential vector calculus (gradient, divergence and curl); integral vector calculus (gradient, divergence and Stokes’ Theorems); line, surface and volume integrals; Electrostatics: the electric field, electric potential, work and energy in electrostatics; method of images, boundary value problems and solutions to Laplace’s equation in Cartesian, spherical and cylindrical coordinates; multipole expansion of the electric potential; electric fields in matter: polarization; the electric displacement vector; boundary conditions, linear dielectrics. Magnetostatics: magnetic fields and forces. Prerequisites: PHYS 1113, 1213, or 1214; MATH 2070.

PHYS 3612 Electromagnetism II (4 qtr. hrs.)
Second of a two-quarter sequence. Magnetic vector potential; magnetic fields in matter: magnetization; fields of magnetized objects; linear and nonlinear magnetic materials; electromotive force, Ohm’s law; electromagnetic induction; Faraday’s law; Maxwell’s equations; the displacement current; boundary conditions; the Poynting theorem; momentum and energy density of the fields; the Maxwell stress tensor; the wave equation and electromagnetic waves in vacuum and matter; absorption and dispersion; wave guides; the potential formulation and gauge transformations; retarded potentials; dipole radiation. Prerequisite: PHYS 3611.

PHYS 3700 Advanced Topics: General (3 qtr. hrs.)
Offered irregularly, depending on demand. May be taken more than once for credit. Prerequisite(s): instructor’s permission.

PHYS 3711 Optics I (4 qtr. hrs.)
First of a two-quarter sequence. Gaussian optics and ray tracing; matrix methods and application to optical design; elementary theory of aberrations; light as electromagnetic wave, diffraction and interference; interferometers and their applications. Elementary theory of coherence; selected topics. May include laboratory work as appropriate. Prerequisites: PHYS 1113, 1213 or 1214, MATH 2070.
PHYS 3841 Thermal Physics I (4 qtr. hrs.)
First of a two-quarter sequence. Laws of thermodynamics; thermal properties of gases and condensed matter; kinetic theory of gases, classical and quantum statistics. Prerequisites: PHYS 1113, 1213 or PHYS 1214; MATH 2070.

PHYS 3991 Independent Study (1 to 8 qtr. hrs.)

PHYS 3992 Directed Study (1 to 10 qtr. hrs.)

PHYS 3995 Independent Research (1 to 10 qtr. hrs.)

PHYS 4001 Introduction to Research I (1 or 2 qtr. hrs.)
This course is the first of the 3-course sequence designed to provide the opportunity of learning fundamental skills to conduct independent research in any physical science discipline. In this course, students review essential material in mathematical physics, learn basic programming techniques and improve upon their skills in literature search and scientific writing, especially proposal writing. Special in-class seminars in collaboration with the Penrose Library and Writing and Research Center are scheduled. Students are introduced to research conducted by Physics and Astronomy faculty so that they can choose a faculty member with whom to take on a Winter Research Project during the winter interterm and winter quarter as part of Introduction to Research II. Students must prepare and submit a research proposal before the end of the fall quarter.

PHYS 4002 Introduction to Research II (1 to 3 qtr. hrs.)
This is the second of the 3-course sequence to provide the opportunity of learning fundamental skills to conduct independent research in any physical science discipline. In this course, students conduct an independent research or study project that they have outlined in the research proposal they submitted as part of Introduction to Research I under supervision of a faculty advisor of their choosing. At the same time, students have time to review issues that we face as researchers. Prerequisite: PHYS 4001 and consent of a faculty research advisor.

PHYS 4003 Introduction to Research III (1 or 2 qtr. hrs.)
This is the third of the 3-course sequence to provide students with the opportunity of learning fundamental skills to conduct independent research in any physical science discipline. In this course, students complete their Winter research project conducted as part of Introduction to Research II and present the results in writing as a term paper and in oral presentation as part of the Departmental Colloquium. Special in-class sessions in collaboration with the Writing and Research Center are included. Prerequisite: PHYS 4002.

PHYS 4100 Foundations of Biophysics (3 qtr. hrs.)
Focus of the course is on application of basic physics principles to the study of cells and macromolecules. Topics include diffusion, random processes, thermodynamics, reaction equilibriums and kinetics, computer modeling. Must be admitted to the MCB PhD program or related graduate program with instructor approval.

PHYS 4111 Quantum Mechanics I (3 qtr. hrs.)

PHYS 4112 Quantum Mechanics II (3 qtr. hrs.)

PHYS 4251 Intro to Astrophysics I (3 qtr. hrs.)

PHYS 4252 Intro to Astrophysics II (3 qtr. hrs.)

PHYS 4253 Intro to Astrophysics III (3 qtr. hrs.)

PHYS 4411 Advanced Condensed Matter I (3 qtr. hrs.)
Materials structure; structure analysis; elastic properties; defects; plastic mechanical properties; thermal properties and phonons; free electron gas; energy bands and Fermi surfaces; crystalline and amorphous semiconductors; quasiparticles and excitations; electrical properties and ferroelectrics; magnetic properties and ferromagnetics; classical and high-Tc superconductors; other advanced materials. Co-requisite: PHYS 4111.
COURSE DESCRIPTIONS (CONTINUED)

PHYS 4412 Advanced Condensed Matter II (3 qtr. hrs.)
Materials structure; structure analysis; elastic properties; defects; plastic mechanical properties; thermal properties and phonons; free electron gas; energy bands and Fermi surfaces; crystalline and amorphous semiconductors; quasiparticles and excitations; electrical properties and ferroelectrics; magnetic properties and ferromagnetics; classical and high-Tc superconductors; other advanced materials. Co-requisite: PHYS 4112.

PHYS 4413 Advanced Condensed Matter III (3 qtr. hrs.)
Materials structure; structure analysis; elastic properties; defects; plastic mechanical properties; thermal properties and phonons; free electron gas; energy bands and Fermi surfaces; crystalline and amorphous semiconductors; quasiparticles and excitations; electrical properties and ferroelectrics; magnetic properties and ferromagnetics; classical and high-Tc superconductors; other advanced materials. Co-requisite: PHYS 4113.

PHYS 4511 Advanced Dynamics I (4 qtr. hrs.)

PHYS 4611 Adv Electricity & Magnetism I (3 qtr. hrs.)

PHYS 4612 Adv Electricity & Magnetism II (3 qtr. hrs.)

PHYS 4750 Seminar in Physics (1 qtr. hrs.)

PHYS 4811 Statistical Mechanics I (4 qtr. hrs.)
Fundamentals of thermodynamics, microcanonical and canonical ensemble, quantum formulation noninteracting particle systems.

PHYS 4910 Special Topics Physics (1 to 5 qtr. hrs.)

PHYS 4991 Independent Study (M.S.) (1 to 10 qtr. hrs.)

PHYS 4992 Directed Study (M.S.) (1 to 10 qtr. hrs.)

PHYS 4995 Independent Research (M.S.) (1 to 10 qtr. hrs.)

PHYS 6991 Independent Study (PhD) (1 to 10 qtr. hrs.)

PHYS 6995 Independent Research (PhD) (1 to 10 qtr. hrs.)

For More Information
A complete description of the program’s official offerings and requirements is available from the department at http://www.du.edu/nsm/departments/physicsandastronomy/.

The University of Denver is an Equal Opportunity institution. We admit students of any race, color, national and ethnic origin to all the rights, privileges, programs and activities generally accorded or made available to students at the University. The University of Denver does not discriminate on the basis of race, color, national and ethnic origin in administration of our educational policies, admission policies, scholarship and loan programs, and athletic and other university-administered programs. University policy likewise prohibits discrimination on the basis of age, religion, disability, sex, sexual orientation, gender identity, gender expression, marital status or veteran status. Inquiries concerning allegations of discrimination based on any of the above factors may be referred to the University of Denver, Office of Diversity and Equal Opportunity.