DEPARTMENT OF PHYSICS

Faculty

James W. Corbett Distinguished Service Professor

Walter M. Gibson, Ph.D. (Emeritae)
University of California, Berkeley

Distinguished Teaching Professor Emeritae/i

Bruce B. Marsh, Ph.D.
University of Rochester

Professors Emeritae/i

Raymond E. Benenson, Ph.D.
University of Wisconsin
Keith F. Ratcliff, Ph.D.
University of Pittsburgh
Wilfried W. Scholz, Ph.D.
University of Freiburg (Germany)
Alfred D. Levitas, Ph.D.
Syracuse University
Laura M. Roth, Ph.D.
Radcliffe College
Jack H. Smith, Ph.D.
Cornell University
Chih-ree Sun, Ph.D.
University of California, Los Angeles

Professors

Mohammad Sajjad Alam, Ph.D.
Indiana University
Hassaram Bakhru, Ph.D.
Calcutta University
Ariel Caticha, Ph.D.
California Institute of Technology
Tara P. Das, Ph.D.
University of Calcutta
Jagadish B. Garg, Ph.D.
University of Paris
Akira Inomata, Ph.D.
Rensselaer Polytechnic Institute
Alain E. Kaloyeros, Ph.D.
University of Illinois at Urbana-Champaign
John C. Kimball, Ph.D.
University of Chicago
Tung-Sheng Kuan, Ph.D.
Cornell University
William A. Lanford, Ph.D.
University of Rochester
Carolyn MacDonald, Ph.D.
Harvard University
Keith F. Ratcliff. Ph.D.
University of Pittsburgh

Associate Professor Emeritae/i

Robert P. Lanni, M.A.
University at Albany

Associate Professors

Robert E. Geer, Ph.D.
University of Minnesota

Assistant Professors

Jesse A. Ernst, Ph.D.
University of Rochester
Susanne M. Lee, Ph.D.
Harvard University
Mengbing Huang
University of Western Ontario, Canada

University Adjuncts (estimated): 12

Teaching Assistants (estimated): 25

The objective of the department is to provide students a solid foundation in both classical and modern physics. Students are prepared either to undertake graduate study in physics, to apply physics principles and techniques successfully for advanced work in other disciplines, to enter industry usefully, or to teach in the secondary schools. Along with courses in classical mechanics, electromagnetic theory, atomic and nuclear physics, and thermal physics, students learn modern experimental techniques, principles of quantum mechanics, and applications. Elective courses in other sciences and independent study and research with faculty members in the active research fields of the department are encouraged as part of the practical emphasis. Courses in environmental problems, astronomy and space physics, applications of nuclear physics, physics in the arts, and physical science for humanists bring physics concepts to the nonmajor.

Careers

Graduates holding the bachelor's degree in physics find employment as laboratory or theoretical research assistants in physics or engineering, high-level medical technicians, science writers and editors, computer programmers, and secondary school teachers. A bachelor's degree in physics can be an ideal background for advanced study in other sciences, engineering, and the business and medical professions. A graduate degree in physics opens a broad spectrum of opportunities in pure and applied research in academia and industry.

Special Programs or Opportunities

One-to-one student-faculty interaction is possible and is encouraged by the department. Computer use at all levels of instruction is afforded by means of terminals in the Joseph Henry Physics Building. Very modern equipment is available in all laboratories. Opportunities for valuable experience, training, and financial support exist in the form of undergraduate assistantships in the research and teaching laboratories. The Society of Physics Students sponsors popular talks, tours to nearby laboratories, and social events. The society offers tutorial services, computer clinics, and has its own library. It conducts tours of our facilities for students and the general public. It also supplies information on opportunities after the B.S. degree. The department has a chapter of Sigma Pi Sigma, the national physics honor society.

For students interested in engineering, there are available 3–2 programs with Rensselaer Polytechnic Institute, Clarkson University, SUNY at New Paltz, and SUNY at Binghamton. Students in these programs spend their first three years at this campus and the last two at the other. The tuition is at the University at Albany rate for the first three years only. Upon successful completion of the programs, students are awarded a B.S. in Physics from the University at Albany and a B.S. in Engineering from the other institution.

Degree Requirements for the Major in Physics

General Program B.S. A combined major and minor sequence totaling 66 credits: An introductory physics sequence of A Phy 140N or 141, 145, 150N or 151, 155, 240 or 241, 245, and 250; followed by the main core sequence of A Phy 320, 330, 440, 450 460, 335, or 335Z and A Phy 315 or A Mat 315. Requirements in mathematics are A Mat 112 or 118, 113 or 119, 214, 220, and 314; in chemistry A Chm 120N or 130, 121N or 131; in computer science A Csi 201N. With departmental approval, A Phy 105N and 108N may be substituted for A Phy 140N and 150N. Students who do not foresee pursuing a graduate degree in physics may, with departmental approval, take 6 credits at the 300-level or higher instead of A Phy 450 and 460.

Honors Program

The honors program in physics is designed for outstanding students enrolled in the general program.

Students may apply for admission to the honors program by submitting a letter of request to the department chair no later than April 15 of the sophomore year (for admission in the fall) or November 15 of the junior year (for admission in the spring). Junior transfers may apply at the time of their admission to the University. Primary emphasis will be placed on indications of academic ability and maturity sufficient for applicants to pursue with distinction a program involving independent research.

The minimum requirements for admission follow:

1. Completion of A Phy 140N or 141, 150N or 151, 240 or 241, 250 or their equivalents;

2. An overall grade point average of 3.30;

3. A grade point average of 3.60 in physics courses required for the major;

4. Written recommendations from at least three faculty members, one of whom, preferably, should be from outside the Department of Physics.

Students in the program must maintain both a minimum grade point average of 3.30 overall and of 3.60 in physics courses taken to satisfy major requirements during the junior and senior years. The progress of participants in the honors program will be reviewed at the end of the junior year by the Departmental Honors Committee. Students not meeting the standards above at

that time may be precluded from continuing in the program during their senior year.

Students in the honors program are required to complete a minimum of 72 credits as follows: the 66 credits specified for the general program in physics; 3 credits of Honors Seminar in Physics (A Phy 498); and 3 credits of Research and/or Independent Study in Physics (A Phy 497). The independent study must include an honors research project culminating in a written report by the end of the student's last semester.

After completion of the requirements above, the records of candidates will be reviewed by the Departmental Honors Committee. After consideration of overall academic record, performance and accomplishments in the independent study project(s), the quality of the Honors Seminar, and the evaluations of departmental faculty members who have supervised these activities, a recommendation for or against a degree with honors will be made by the committee to the departmental faculty. The final recommendation will be made by the departmental faculty and transmitted by the chair.

Combined B.S./M.S. Program

The combined B.S./M.S. program in physics provides an opportunity for students of recognized academic ability and educational maturity to fulfill integrated requirements of undergraduate and master's degree programs at the beginning of the junior year. A carefully designed program can permit a student to earn the B.S. and M.S. degrees within nine semesters.

The combined program requires a minimum of 138 credits, of which at least 30 must be graduate credits. In qualifying for the B.S., students must meet all University and college requirements including the requirements of the undergraduate major described previously, the minimum 60-credit liberal arts and sciences requirement, general education requirements, and residency requirements. In qualifying for the M.S., students must meet all University and college requirements as outlined in the Graduate Bulletin, including completion of a minimum of 30 graduate credits and any other conditions such as a research seminar, thesis, comprehensive examination, professional experience, and residency requirements. Up to 12 graduate credits may be applied simultaneously to both the B.S. and M.S. programs.

A Phy 519 may be substituted for A Phy 335 or 335Z in meeting the B.S. requirements, enabling Phy 519 to be one of the graduate courses applied simultaneously to the undergraduate and graduate programs.

Students are considered as undergraduates until completion of 120 graduation credits and satisfactory completion of all B.S. requirements. Upon meeting B.S. requirements, students are automatically considered as graduate students.

Students may apply to the Graduate Committee for admission to the combined degree program in physics at the beginning of their junior year or after the successful completion of 56 credits, but no later than the accumulation of 100 credits. A cumulative grade point average of 3.20 or higher and three supportive letters of recommendation from faculty are required for consideration.

Courses

A Phy 100N Contemporary Astronomy—The Cosmic Connection (3)
Modern developments in astronomy, the birth and death of stars, solar and planetary science, neutron stars and black holes, galactic structure, cosmology, theories of the origin and future of the universe. [NS]

A Phy 102N Applications of Modern Physics in Art History and Archaeology (3)
Twentieth century physics has greatly increased our knowledge of the structure of matter and the natural laws that lead to that structure. This course discusses our modern understanding of the structure of matter at an introductory level and then illustrates how this knowledge can be applied to the study of objects of interest in art history or archaeology. The goals of such studies include learning about the age of an object, the technology used to fabricate the object, and how an object should be stored in order to preserve it for future generations.[NS]

A Phy 103N Exploration of Space (3)
The solar system, modern developments in planetary and space science; human exploration of space; space travel and future colonization.. [NS]

A Phy 104N Physical Science for Humanists (3)
How the universe works. A historical approach to the development of the laws of physics from the classical physics of Newton to the present. Emphasizes the people and events of the revolution in physics in the 20th century. Unraveling of the structure and properties of the nuclear atom or from raisin pudding to quarks. Intended for nonmajors. [NS]

A Phy 105N General Physics I (3)
Vectors, kinematics, dynamics, vibrations and waves, sound, fluids, and thermodynamics. Three class periods each week. May not be taken for credit by students with credit for A Phy 140N or 141. Prerequisite(s): three years of high school mathematics. [NS]

A Phy 106 General Physics Lab (1)
Laboratory experiments to complement the topics being studied in A Phy 105N. One laboratory each week. Corequisite(s): A Phy 105N.

A Phy 107 Problem Solving: General Physics (1)
Applications of the principles and methods studied in general physics. Assignments selected with the aim of aiding the student in developing a more thorough understanding of the subject matter of general physics. Individual assignments can be arranged for students with special needs or interests. Corequisite: A Phy 105N.

A Phy 108N General Physics II (3)
Electrostatics, circuit electricity, magnetism, geometrical and physical optics, atomic and nuclear phenomena. Three class periods each week. May not be taken for credit by students with credit for A Phy 150N or 151. Prerequisite(s): A Phy 105N. [NS]

A Phy 109 General Physics Lab (1)
Laboratory experiments to complement the topics in A Phy 108N. One laboratory period each week. Corequisite(s): A Phy 108N.

A Phy 110 Problem Solving: General Physics (1)
Applications of the principles and methods studied in general physics. Assignments selected with the aim of aiding the student in developing a more thorough understanding of the subject matter of general physics. Individual assignments can be arranged for students with special needs or interests. Corequisite(s): A Phy 108N.

A Phy 122 Problem Solving: Introductory Physics I (1)
Application of the principles and methods studied in Introductory Physics I (A Phy 140N or 141). Assignments selected with the aim of aiding the student in developing a more thorough understanding of the subject matter in A Phy 140N or 141. Individual assignments can be arranged for students with special needs or interests. Corequisite: A Phy 140N or 141.

A Phy 126 Problem Solving: Introductory Physics II (1)
Application of the principles and methods studied in Introductory Physics II (A Phy 150N or 151). Assignments selected with the aim of aiding the student in developing a more thorough understanding of the subject matter in A Phy 150N or 151. Individual assignments can be arranged for students with special needs or interests. Corequisite(s): A Phy 150N or 151.

A Phy 140N (formerly A Phy 120N) Physics I: Mechanics (4)
An introduction to the fundamentals of physics: Classical Mechanics. Topics include the concepts of force, energy and work applied to the kinematics and dynamics of particles and rigid bodies and an introduction to special relativity. Pre/corequisite: A Mat 111 or 112 or 118. [NS]

A Phy 141 Honors Physics I: Mechanics (4)
Course content will follow A Phy 140N. However, topics will be covered in more depth and at a somewhat more advanced level. Students with a strong interest in physical sciences should consider taking A Phy 141 instead of A Phy 140N. Only one of A Phy 140N or 141 may be taken for credit. Offered in fall semester only. Prerequisite(s): A Mat 111 or 112 or 118. [NS]

A Phy 145 (formerly A Phy 221) Physics Lab I (1)
Experiments in mechanics, electricity, and optics. One laboratory period each week. Offered fall semester. Pre/corequisite: A Phy 140N or 141.

A Phy 150N (formerly A Phy 124N) Physics II: Electromagnetism (3)
An introduction to the fundamentals of physics: Electrostatics and magnetism, including the concepts of the electric and magnetic fields, electric potential and basic circuits. The laws of Gauss, Ampere, and Faraday: Maxwell's equations. Geometrical optics. Pre/corequisite: A Mat 113 or 119; prerequisite: A Phy 140N or 141. [NS]

A Phy 151 Honors Physics II: Electromagnetism (3)
Course content will follow A Phy 150N. However, topics will be covered in more depth and at a somewhat more advanced level. Students with a strong interest in physical sciences should consider taking A Phy 151 instead of A Phy 150N. Only one of A Phy 150N or 151 may be taken for credit. Offered in spring semester only. Pre/corequisite(s): A Mat 113 or 119; prerequisite(s): A Phy 140N or 141 and permission of instructor. [NS]

A Phy 155 (formerly A Phy 225) Physics Lab II (1)
Experiments in electricity and magnetism, circuits, and optics. One laboratory period each week. Offered spring semester. Pre/corequisite: A Phy 150N or 151.

A Phy 202N Environmental Physics (3)
Study of the collection, evaluation, and interpretation of data and the modeling and analysis of urban and environmental problems. Topics include population, pollution, mass transportation systems, comparison of various energy sources such as solar, nuclear, and fossil fuel, and effective utilization of natural resources. Three class periods each week. Prerequisite(s): algebra. [NS]

A Phy 229 Mathematics in Physics (3)
A survey of mathematical techniques use in physics. Topics include complex numbers and functions of a complex variable, power series, Fourier analysis, vectors and linear algebra, calculus of variations, ordinary and partial differential equations, and special functions. Course offered only in the spring semester. Physics majors may substitute this course for A Mat 314. Prerequisite(s): A Phy 150N or 151. Co-requisite(s): A Mat 214.

A Phy 240 (formerly A Phy 220) Physics III: Structure of Matter (3)
An introduction to the fundamentals of physics: Thermodynamics and kinetic gas theory. Quantum theory of photons, atoms, nuclei and solids. Pre/corequisite: A Mat 214; prerequisite: A Phy 150N or 151.

A Phy 241 Honors Physics III: Structure of Matter (3)
Course content will follow A Phy 240N. However, topics will be covered in more depth and at a somewhat more advanced level. Students with a strong interest in physical sciences should consider taking A Phy 241 instead of A Phy 240N. Only one of A Phy 240N or 241 may be taken for credit. Offered in fall semester only. Pre/corequisite(s): A Mat 214; prerequisite(s): A Phy 150N or A Phy 151 and permission of instructor. [NS]

A Phy 245 Physics Lab III (1)
Experiments in modern physics. One laboratory period each week. Offered fall semester. Pre/corequisite: A Phy 240 or 241.

A Phy 250 (formerly A Phy 224) Physics IV: Waves (3)
Waves and oscillations in optics, in classical and in quantum mechanics. An introduction to physical concepts (wave packets, normal modes, interference and diffraction) and mathematical techniques (Fourier series, transforms, complex numbers, eigenvectors). Pre/corequisite: A Mat 220; prerequisite: A Phy 240 or 241.

A Phy 305 Physics Principles in Nuclear Medicine (3)
Basic physics in nuclear medicine, radioactive nuclides, radionuclide scanning, radiation chemistry, biological effects of radiation and radio-pharmaceuticals, clinical radiation pathology, radiation hazards and safety, waste disposal. Three class periods a week. Offered fall semester only. Prerequisite(s): A Phy 108N or A Phy 250 or equivalent. May not be offered in 2004-2005.

A Phy 315 Electronics (3)
Transistors and their characteristics; electronic circuits, field effect transistors and applications, amplifiers, low and high frequency response; operational amplifiers; consideration of control-circuit design; fast-switching and counting devices; integrated circuits and their designs. Two class periods and one three-hour laboratory each week. Offered fall semester only. Prerequisite:

A Phy 150N or 151).

A Phy 316 Electronics: Projects (3)
Independent projects involving laboratory work in the study of electronic circuits using linear and/or digital devices. (Each student is expected to undertake a project that requires originality and broadens knowledge of the area.) Special attention is paid to counters, registers, encoders, decoders, and digital applications. Offered spring semester only.

A Phy 320 (formerly A Phy 321) Classical Mechanics (3)
Fundamentals of Newtonian mechanics: conservation theorems, central forces, motion in non-inertial frames, rigid-body motion. Lagrange's and Hamilton's equations. Offered fall semester. Prerequisite: A Phy 250, or permission of the instructor.

A Phy 330 (formerly A Phy 332) Electromagnetism (4)
Electrostatics and magnetostatics in vacuum and in material media. Maxwell's equations. Energy and momentum in the electromagnetic field. Electromagnetic waves. Special relativity. Offered spring semester. Prerequisites: A Phy 250, A Mat 314.

A Phy 335 (formerly A Phy 403) Advanced Physics Lab (3)
Introduction to the techniques of experimental research in the areas of electronics, electromagnetism and modern physics. Measurement technique and error analysis are emphasized. Two three-hour lab periods each week. Prerequisite: A Phy 250 or permission of instructor.

A Phy 335Z (formerly A Phy 403Z) Advanced Physics Lab (3)
A Phy 335Z is the writing intensive version of A Phy 335; only one may be taken for credit. Prerequisite: A Phy 250 or permission of instructor. [WI]

A Phy 353 Microprocessor Applications (3)
Applications of microprocessors to data collection and process control; the capabilities of typical microprocessors and the techniques used to interface them to external devices; input/output programming, use of the data and address busses; interrupt handling, direct memory access, and data communications; characteristics of peripheral devices such as keyboards, printers, A/D and D/A converters, sensors, and actuators. Three class periods each week. Prerequisite(s): A Csi 201N or 204 or equivalent. An elementary knowledge of electricity is helpful.

A Phy 360 Modern Optics (3)
Matrix methods of geometrical optics, diffraction theory, optical Fourier transforms, lasers, holography, Brillouin scattering, and an introduction to nonlinear optics. The course includes frequent demonstrations. Prerequisite(s): A Phy 250.

A Phy 408 (= A Chm 408) Polymer Chemistry and Physics (3)
Structure, synthesis, and morphology of polymers; polymerization reactions; molecular weight determination; introduction to thermal, mechanical, and electrical properties; design of polymers, graft, and copolymers; processing and selected applications including adhesion, coatings, and films. A term paper is required. Only one of A Phy 408 & A Chm 408 may be taken for credit. Prerequisite(s): A Chm 340B or permission of instructor.

A Phy 440 (formerly A 344) Quantum Physics I (3)
Introduction to non-relativistic quantum mechanics; wave functions, amplitudes and probabilities; the superposition of quantum states, the Heisenberg uncertainty principle. Time evolution: the Schroedinger equation, stationary states, two-state systems. Motion in one-dimensional potentials: tunneling, particle in a box, harmonic oscillator. Offered fall semester. Prerequisite: A Phy 250.

A Phy 450 (formerly A Phy 421) Quantum Physics II (3)
Quantum motion in central potentials; angular momentum and spin; the hydrogen atom. Identical Particles. The structure of atoms and molecules, the periodic table. Stationary-state and time-dependent perturbation theory. Scattering theory. Offered spring semester. Prerequisite: A Phy 440.

A Phy 454 Microprocessor Applications Laboratory (3)
Complements the theoretical development presented in A Phy 353. Centers around practical laboratory applications in both hardware and software of a particular microprocessor. Students prototype a minimum system and expanded system. Applications include keyboard, printer, display, A/D, D/A, and control functions. A knowledge of a microprocessor and digital logic functions is desirable. Prerequisite(s): A Phy 315 or permission of instructor or A Phy 353.

A Phy 460 (formerly A Phy 431) Thermodynamics and Statistical Physics (3)
Thermodynamic systems and variables; the laws of thermodynamics. Thermodynamic potentials and applications, ideal and real gas relations; changes of phase, introduction to probability theory; elementary kinetic theory of gases; micro and macro-states of simple quantum-mechanical systems; Fermi-Dirac, Bose-Einstein, and Maxwell-Boltzmann statistics. Three class periods each week. Pre/co-requisite: A Phy 440. Prerequisite(s): A Mat 214 and A Phy 250.

A Phy 462 (formerly A Phy 362) Physics of Materials (3)
The physics of real materials: the structure of crystalline and amorphous solids; x-ray diffraction and electron microscopy; the thermodynamics and kinetics of phase transformations; crystallographic defects and their relation to mechanical properties. Prerequisite(s): A Phy 250.

A Phy 464 Materials Characterization (3)
A laboratory and lecture course designed to give students experience with modern methods of materials characterization such as electron microscopy, x-ray diffraction, optical absorption, nuclear magnetic resonance, neutron activation, Auger spectroscopy, particle induced x-ray emission, Rutherford backscattering and nuclear reaction analysis. Prerequisite(s): A Phy 362 or permission of instructor. May not be offered in 2004-2005.

A Phy 465 Materials Fabrication (3)
A laboratory and lecture course designed to give students experience in modern methods of materials fabrication and modification such as thin-film evaporation, sputtering, chemical vapor deposition, electrodeposition, doping by ion implantation and diffusion, and ion beam mixing. Prerequisite(s): A Phy 464 or permission of instructor. May not be offered in 2004-2005.

A Phy 466 X-ray Optics, Analysis and Imaging (3)
A broad survey of x-ray optics and their uses. Introduction to the theory of x-ray interaction with matter, including refraction, diffraction, total reflection, image formation, fluorescence, absorption spectroscopy, and the effects of Compton scattering, photo-electric absorption, and surface roughness. Applications include x-ray astronomy, microscopy, lithography, materials analysis and medical imaging. Prerequisite: A Phy 330.

A Phy 467 Physics of Semiconductor Devices (3)
A survey of state-of-the art semiconductor device manufacture and usage in the electronics industry. Topics covered include basic semiconductor physics (band structure, electron transport, phonon, optical, thermal, and high magnetic field properties) and the operating principles and current manufacturing techniques of various devices (p-n junctions, transistors, CCD's, photonic devices, and superlattices). Prerequisite(s): A Phy 330 and A Phy 460; corequisite: A Phy 450.

A Phy 468 Introduction to Particle Physics (3)
Particle interactions and symmetries. Introduction to classification and the quark model. Calculation of elementary processes using Feynman diagrams. Prerequisite(s): Corequisite of A Phy 440 or equivalent or permission of instructor. (Note ONLY for Registrar's: This course is to be a shared-resources course with A Phy 568.)

A Phy 469 Physics of Nuclei (3)
This course will deal with basic properties of nuclei such as size, shape, and nuclear force. Nuclear structure based upon shell and collective models, nuclear reactions induced by nucleons including nuclear fission, nuclear fusion, and nuclear energy. Prerequisite(s): A Phy 330 or permission of instructor.

A Phy 497 Research and/or Independent Study (1-3)
Research and/or independent study under the direct supervision of a faculty member with whom the student has made an arrangement. Ambitious students are encouraged to engage in an activity that broadens their experience considerably beyond that of conventional course work. A written report is submitted on the work of each semester. May be repeated for credit. *S/U* graded.

A Phy 498 Honors Seminar in Physics (3)
A seminar specifically designed for students admitted to the department's honors program. Topics are determined by the Departmental Honors Committee. Prerequisite(s): admission to honors program.