GRADUATE PROGRAM IN

PHYSICS

Program of Study

Programs of study leading to Programs of study leading to the degrees of Master of Science, Master of Engineering (Engineering Physics), and Doctor of Philosophy are offered through the Department of Physics and Astronomy.

Master of Science

The program of graduate study for the master's degree, which normally requires two years, is developed around an original investigation, the results of which are presented as a thesis. Of the minimum of 30 semester hours required for the Master of Science degree, 24 are devoted to courses in physics and such allied fields as other sciences, mathematics, and engineering. However, the following courses or their equivalents, which are offered every year, must be included: PHY 501 Mechanics; PHY 502 Electrodynamics I, and PHY 503 Quantum Mechanics I.

Master of Engineering (Engineering Physics)

A minimum of 30 semester hours is also required for the Master of Engineering (Engineering Physics) degree. Of the total of 24 required course hours, nine hours must be selected from a meaningful engineering course sequence. In addition, nine hours must be selected from three of the following courses: PHY 501 Mechanics, PHY 502 Electrodynamics I, PHY 503 Quantum Mechanics I, and PHY 510 Graduate Laboratory. A thesis is optional but is strongly encouraged. The thesis may be completed in either the Physics Department or the engineering department in which the engineering course sequence is taken. Satisfactory completion of the non-thesis option requires 36 hours of course credit.

Doctor of Philosophy

Typically a total of 5 years are needed to complete the Ph.D. degree for a student who enters the program with a bachelor's degree. This time is approximately equally divided between course work and thesis research. A thesis presenting the results of an original investigation in a specialized area of physics is an essential feature of the program. Requirements also include passing the comprehensive examination, normally attempted during the third year of study beyond the bachelor's degree. The program of study for each student in the Ph.D. program includes a minimum of 42 course hours. The following courses, or their equivalents, are required of all students: PHY 501 Mechanics; PHY 502 Electrodynamics I; PHY 574 Methods of Theoretical Physics; PHY 503 Quantum Mechanics I; PHY 603 Quantum Mechanics II; PHY 512 Statistical Mechanics; PHY 510 Graduate Laboratory.

Research Areas

Research areas include: biophysics, computational physics and astrophysics; defect chemistry of semiconductors; environmental nuclear radiation; environmental sensors; general relativity; health physics; liquid crystals; microelectronic materials; nonequilibrium statistical mechanics; observational extra-galactic astronomy; pattern formation; phase transitions; physics and astronomy education; statistical mechanics; superconductivity; surface and interface science; thin films; tribology and nanomechanics; variational methods in quantum mechanics.

Several Physics faculty members and their students work on research projects in the Laboratory for Surface Science & Technology, an interdisciplinary research unit located in the Sawyer Research Center. Research opportunities exist in high technology areas related to surfaces, interfaces, and thin film materials. Project topics include microelectronic devices, sensors, nanotechnology, catalysis, composite materials, tribology, paper coatings, and instrument development.

In addition, one of the strengths of our program is the opportunity to do interdisciplinary research. Students receive one of the graduate degrees listed above, but could elect to take courses and to conduct research with faculty in other departments, such as computer science, geology, electrical engineering, biology, chemistry, chemical engineering. Such cooperative research projects have been conducted on topics as diverse as semiconductor devices and solar cell materials, optical and resonance studies of anticancer compounds, polymers on metallic surfaces, glacier flow, properties of nucleic acids, natural radioactivity in the environment, and acid rain.

Financial Aid

Teaching assistantships are available for the calendar year in the amount of $16,000 and include remission of tuition for up to nine credit hours per semester and three credit hours in the summer session. These appointments provide for approximately half-time teaching and half-time study. Teaching assignments usually involve six contact hours per week. Summer support is usually available for students in the program. The University of Maine supports a number of University fellowships and tuition scholarships. Research assistantships also are available in some of the areas of investigation.

No separate application for financial support is necessary. All students are admitted with support. Currently about one-half are supported by Teaching Assistantships and one-half are supported by Research Assistantships.

Research Facilities

The Department's machine shop, electronic shop, and many specialized facilities essential to the experimental research programs listed above, are available. In addition, the University's Mainframe Computer with vector processing in conjunction with the national Supercomputer Network is available for suitable research activities. A network Linux PC workstations for data reduction and numerical simulation is available to students working in the area of astrophysics, particularly (but not exclusively) in the construction of realistic models of galactic dynamics. There is a cluster of computers in the department available for student use and individual computers in most graduate student offices.

The Laboratory for Surface Science and Technology has facilities for thin film synthesis, processing, and characterization; scanning probe microscopies; optical and electron spectroscopies; X-ray and electron diffraction; nanomechanical testing systems; sensor device testing and electronic characterization; gas absorption and desorption analysis; Class 1000 clean room for microelectronic device fabrication.

Students

Total graduate student enrollment ranges between 25 and 30. Approximately one third are in a Master's program and two thirds in the Ph.D. program. Class size is small, on the order of 5-10 students and faculty have an open door policy. Travel support to present research results at regional and national meetings is available through the department and the graduate student association.

Applying

In addition to satisfying the general admission requirements of the Graduate School, candidates for advanced degrees in physics should normally have received a Bachelor's degree in physics, in which they should have completed at least 16 semester hours in physics beyond the introductory course and studied mathematics at least through differential equations. Typically the following undergraduate preparation is assumed: Modern Physics: Beiser, *Concepts of Modern Physics*; Mechanics: Fowles and Cassiday, *Analytical Mechanics*; Electricity and Magnetism: Griffiths, *Introduction to Electrodynamics*; Mathematics: Paul, *Differential Equations for Mathematics, Science, and Engineering*. Candidates who have majored in other physical sciences or mathematics are encouraged to apply. A candidate's preparation for graduate study in physics or astronomy can be strengthened by taking selected undergraduate courses for graduate credit.

The GRE General and Subject tests are required but no minimum GRE scores or undergraduate GPA are required for admission. Applications are accepted at any time for admission in the Fall (September), the Spring (January), or the Summer (June) semester. Early submission (by January 15) for Fall admission is encouraged.

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Graduate Faculty

Susan R. McKay, Ph.D. (M.I.T., 1987), Professor and Chair. Condensed matter theory, phase transitions and critical phenomena, systems with quenched disorder, spin glasses, random-field ferromagnets, systems far from equilibrium, pattern formation, non-linear systems, and chaos. (e-mail: susan_mckay@umit.maine.edu)

R. Dean Astumian, Ph.D. (Texas-Arlington, 1983), Professor. Design of microscopic mechanical and electrical pumps and motors powered by non-equilibrium isothermal chemical reactions. (e-mail: astumian@maine.edu)

David J. Batuski, Ph.D. (New Mexico, 1986), Professor. Observational cosmology, large-scale structure in the universe, dynamics of galaxy clusters, interacting galaxies and radio sources. (e-mail: batuski@maine.edu)

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Charles W. Smith, Ph.D. (Ohio, 1968), Professor. Low temperature experimental physics, superconductivity, point contact spectroscopy, and condensed matter physics. (e-mail: charless@maine.edu)

John Thompson, Ph.D. (Brown, 1998), Assistant Professor. Member of Center for Science and Mathematics Education Research. Co-director, Physics

Education Research Laboratory. Physics Education: student conceptual understanding of physics topics including thermal physics, sound and longitudinal waves,

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Michael C. Wittmann, Ph.D. (Maryland, 1998), Assistant Professor. Director of the Laboratory for Research in Physics Education (LRPE). Investigating student learning (wave physics, quantum mechanics, electricity and magnetism), research-based curriculum development and dissemination, modeling student reasoning in physics. (e-mail: wittmann@maine.edu)