PHYSICS

The department of physics offers programs leading to both the master of science and doctor of philosophy degrees. The master's degree can be earned with either a thesis or non-thesis option.

Most physics graduate students are supported by teaching or research assistantships, although some fellowships are available for exceptionally promising students. Most new graduate students start as teaching assistants in the introductory physics laboratory. Later, they are often supported as research assistants on external research grants. Entering graduate students usually have a physics undergraduate degree; however inquiries from students with other technical degrees and a good mathematics background are encouraged, since the program allows minor background deficiencies to be made up.

Each student's graduate degree program is designed around a set of core graduate courses (classical mechanics, electrodynamics, quantum mechanics, and statistical mechanics) and two graduate physics electives. After their second year, Ph.D. students must take a qualifying examination based on the material taken from the undergraduate courses and the graduate core courses. Details of the program and course offerings can be found on the department's web page at http://physics.mst.edu/ or requested via email to physics@mst.edu.

The department's research emphasis includes three areas of physics: condensed matter and materials physics; atomic, molecular, and optical physics; as well as astrophysics. Experimental and theoretical research opportunities are available in each of these areas. Graduate students in the department work with faculty on a wide range of problems, including the characterization of magnetic materials, predicting the properties of quantum and classical phase transitions, investigating electrical and thermal transport, determining electron-atom scattering events, computing the electronic structure of new materials, measuring and imaging ion-atom collisions, growing and characterizing exotic quantum materials, studying wave propagation in complex media, exploring quantum electrodynamics' descriptions of few-electron atoms and ions, studying gravitational waves emitted by black holes and neutron stars; and exploring the expansion history of the universe.

Most research is performed in the Physics Building, but several research studies are carried out in the Materials Research Center on campus as well as in national laboratories and other national facilities such as LIGO, the Laser Interferometer Gravitational-Wave Observatory. Special instrumentation in the physics department includes a unique ion-atom accelerator and energy-loss spectrometer, an optical atom trap, custom ultra-high vacuum systems, Auger and XPS surface characterization spectrometers, facilities for the growth of exotic materials, low temperature transport measurement instruments, and high-performance computer systems for modelling and simulation.

Marco Cavaglia, Professor
PHD International School for Advanced Studies, Trieste, Italy
Experimental and theoretical gravitational physics.

Aleksandr Chernatynskiy, Associate Professor
PHD University of Louisville
Theoretical condensed matter physics. Mechanical and transport properties of materials.

Mina Esmaeelpour, Assistant Professor
PHD Lehigh University

Daniel Fischer, Associate Professor
PHD Heidelberg University
Experimental investigations of atomic fragmentation processes.

Halyna Hodovanets, Assistant Professor
PHD Iowa State University

Yew San Hor, Associate Professor
PHD Rutgers University
Growth and characterization of exotic materials.

Ulrich Jentschura, Professor
PHD Dresden University of Technology
QED bound-state calculations, relativistic quantum dynamic process in laser fields, analysis of high-precision experiments.

Hyunsoo Kim, Assistant Professor
PHD Iowa State University

Ioulia Y. Medvedeva, Professor
PHD Russian Academy of Science
Theoretical condensed matter physics. First principles computational methods.

Symeon Mystakidis, Assistant Professor
PHD University of Hamburg

Jerry L Peacher, Professor
PHD Indiana University Bloomington
Theoretical atomic and molecular collisions.

Shun Saito, Assistant Professor
PHD University of Tokyo, Japan
Observational cosmology.

Steffen Thomas Vojta, Curators Distinguished Professor
PHD Chemnitz University of Technology, Germany
Theoretical condensed matter and statistical physics. quantum and classical phase transitions, transport, and disorder.

Alexey Georgiyevich Yamilov, Professor
PHD The City University of New York
Theoretical optical Physics. Wave propagation in complex media.

PHYSICS 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

PHYSICS 5001 Special Topics (IND 0.0 and LAB 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

PHYSICS 5333 Subatomic Physics (LEC 3.0)
An introduction to elementary particles. Topics include particle properties, nuclear forces, particle interactions, the Standard Model for quarks and leptons, fundamental forces in gauge field theory models, and the role of elementary particle interactions in cosmology. Prerequisite: Physics 3311.

PHYSICS 5403 Computational Physics (LAB 1.0 and LEC 3.0)
An introduction to modern computer simulations for solving physics problems. The course will be project-oriented with examples including planetary motion, chaotic dynamics, quantum scattering, structure of atoms and clusters, molecular dynamics, and Monte-Carlo simulations. Prerequisites: Physics 2305 or Physics 2311; Math 3304; programming experience.

PHYSICS 5409 Computational Physics Laboratory (LAB 3.0)
Computational project-based studies in the areas of fundamental, applied, and data-driven physics and astronomy with connections to chemistry and materials science. Topics include atomistic and ab-initio computer simulations for quantum materials, semiconductors, extreme-environment ceramics, alloys, etc. The course covers algorithms, interpolations, experimental or theoretical data processing, analysis and visualization as well as an introduction to Linux, bash-scripting and parallel computing at an HPC cluster. Prerequisites: Physics 2305.

PHYSICS 5413 Chaos, Fractals, and Nonlinear Dynamics (LEC 3.0)
An introduction into nonlinear dynamics, deterministic chaos, and fractals. Topics covered include phase plane analysis, iterated maps, routes to chaos, Lyapunov exponents, strange attractors and pattern formation with applications to chaotic vibrations, population dynamics, chemical oscillations and lasers. Prerequisites: Math 3304; Physics 2135 or Physics 2111.

PHYSICS 5503 Fourier Optics (LEC 3.0)
Applications of Fourier analysis and linear system theory to optics. Topics include scalar diffraction theory, Fourier transforming properties of lenses, optical information processing, and imaging systems. Prerequisites: Both Elec Eng 3430 and Elec Eng 3600 or Physics 4211. (Co-listed with ELEC ENG 5210).

PHYSICS 5513 Fiber And Integrated Optics (LEC 3.0)
Introduction to optical waveguides and their applications to communication and sensing. Topics include dielectric waveguide theory, optical fiber characteristics, integrated optic circuits, coupled-mode theory, optical communication systems, and photonic sensors. Prerequisite: Elec Eng 3600 or Physics 4211. (Co-listed with Elec Eng 5220).

PHYSICS 6000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department Consent of instructor required.

PHYSICS 6001 Special Topics (LEC 0.0 and RSD 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

PHYSICS 6002 Coop Registration (IND 0.0-1.0)
Doctoral candidates participating in a cooperative program with another UM campus must enroll for one hour of credit for their first semester in the program and zero hours of credit for successive registration periods until degree is completed. Failure to do so may invalidate candidacy. Billing is automatic as is registration upon payment.

PHYSICS 6010 Seminar (RSD 0.0-6.0)
Discussion of current topics.

PHYSICS 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

PHYSICS 6050 Continuous Registration (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

PHYSICS 6099 Research (IND 0.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

PHYSICS 6101 Classical Mechanics I (LEC 3.0)
Methods of Newton, Lagrange, and Hamilton applied to the motion of particles and rigid bodies. Introduction to canonical transformations and Poisson brackets. Classical scattering and small oscillations. Prerequisites: Math 3304 and Physics 3201.

PHYSICS 6111 Electrodynamics I (LEC 3.0)
A rigorous development of the fundamentals of electromagnetic fields and waves. Electrostatics, magnetostatics, Maxwell's equations--Green's function, boundary value problems, multipoles, conservation laws. Prerequisites: Physics 4211.

PHYSICS 6201 Quantum Mechanics I (LEC 3.0)
Basic formalism applied to selected problems. Schroedinger equation and one dimensional problems, Dirac notation, matrix mechanics, harmonic oscillator, angular momentum, hydrogen atom, variational methods, introduction to spin. Prerequisite: Physics 4301 or equivalent.

PHYSICS 6211 Electrodynamics II (LEC 3.0)
A continuation of Physics 5211+D1067. Applications of time-dependent Maxwell's equations to such topics as plasmas, wave guides, cavities, radiation; fields of simple systems and multipoles. Relativity; covariant formulation of Maxwell's equations and conservation laws, fields of uniformly moving and accelerated charges. Prerequisite: Physics 5211.

PHYSICS 6301 Quantum Mechanics II (LEC 3.0)
Perturbation theory, treatment of spin, angular momentum addition, Wigner-Eckart theorem; scattering theory including partial wave analysis, born approximation, and formal scattering theory; identical particles, introduction to second quantization, and structure of complex atoms. Prerequisite: Physics 5301.

PHYSICS 6311 Statistical Mechanics (LEC 3.0)
A study of statistical ensembles; Maxwell-Boltzmann, FermiDirac and Einstein-Bose distribution laws, application to some simple physical systems. Prerequisites: Physics 4311, Physics 5301.

PHYSICS 6333 Condensed Matter Physics (LEC 3.0)
A course in the physics of hard and soft matter including solids, liquids, and complex materials. Topics: atomic structure, mechanical properties, phonons, electronic structure, energy band theory, electronic correlations, transport properties, magnetism, superconductivity. Prerequisite: Physics 5301.

PHYSICS 6363 Atomic Collisions (LEC 3.0)
Basic quantum mechanical concepts involved in atomic scattering theory. Topics include the Born approximation elastic collisions, and inelastic collisions. Other specific topics will be chosen from the general areas of electron, ion, and atom collisions with atoms and molecules. Prerequisite: Physics 6353 or 6301.

PHYSICS 6403 Mathematical Physics I (LEC 3.0)
Vector spaces, generalized coordinate transformations, vector analysis, tensors, partial differential equations in physics and boundary value problems, orthogonal functions and solutions to ordinary differential equations, hypergeometric, confluent hypergeometric, Legendre, Laguerre, and Bessel functions, Hermite polynomials, Green's functions in one dimension. (Co-listed with Math 6802).
