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 either teaching or research assistantships, although some fellowships are available for exceptionally promising students. Most entering graduate students are supported on teaching assistantships, and teach in the introductory physics laboratory. Thereafter, they are usually 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 graduate two 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 may be obtained by calling 573-341-4702, or emailing the department chairman at physics@mst.edu. Additional information may also be found on the department’s web page at http://physics.mst.edu/.

The department’s research emphasis includes both fundamental and applied studies in three areas of physics: condensed matter, solid state, and materials physics; cloud, aerosol and environmental physics; and atomic, molecular, and optical physics. Experimental and theoretical research opportunities are available for study in each of these areas. Following their core coursework, graduate students in the department are able to work with faculty on a wide range of problems, including the characterization of magnetic materials, predicting the properties of quantum and classical phase transitions, establishing the structure and properties of atmospheric aerosols, investigating electron transport in polymers, determining electron-atom scattering events, characterizing the particulate in rocket engine exhaust, exploring the structural properties of thin magnetic films, computing the electronic structure of new materials, measuring and imaging ion-atom collisions, investigating water and sulfuric acid cluster interactions, analyzing and characterizing nanostructures on surfaces, ascertaining the properties of charged particles and atoms, studying the nucleation of vapors into droplets, growing and characterizing exotic materials, studying wave propagation in complex media, and exploring quantum electrodynamics’ descriptions of few-electron atoms and ions.

Most research facilities are in the Physics Building, but several research studies are being carried out in cloud and aerosol laboratories housed in Schrenk Hall. Several faculty working on condensed matter projects make use of extensive instrumentation and materials characterization facilities available in the Materials Research Center. Special facilities include a unique ion-atom accelerator and energy-loss spectrometer, custom UHV systems for preparing and characterizing in situ spin properties of magnetic films, state-of-the-art cloud simulation chambers developed to study nucleation of vapors and droplets, Auger and XPS surface characterization spectrometers, specially developed instrumentation for use in aircraft to study rocket and aircraft exhaust characteristics, high performance computer systems for computational physics studies, facilities for the growth of exotic materials, and low temperature transport measurement instruments.

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

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

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.

Cihan Kurter, Assistant Professor
PHD Illinois Institute of Technology
Unconventional superconductivity, topological systems, and meta materials.

Don H Madison, Curators Professor
PHD Florida State University
Theoretical studies of electron-atom collisions.

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

Paul E Parris, Professor
PHD University of Rochester

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

Michael Schulz, Curators Professor
PHD University of Heidelberg
Experimental atomic and molecular collisions.

John G Story, Associate Professor
PHD University of Southern California
Experimental atomic and molecular physics. Laser excitation of atoms.

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.

George D Waddill, Professor
PHD Indiana University Bloomington
Experimental solid state physics. Surface physics and nano-scale magnetism.
**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 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 5201 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, Physics 3201.

**PHYSICS 5211 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 5301 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 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** (LEC 3.0 and LAB 1.0) 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 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 both Physics 2401 and 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 5603 Advanced Physics Laboratory Teaching Methods** (LEC 3.0) Objectives, methods and problems related to teaching of introductory physics, with an emphasis on laboratory instruction, the development of educational laboratory experiments and techniques, student learning styles, student assessment, student work groups, computer-based data acquisition, and communication techniques. Prerequisite: Graduate standing.

**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 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

**PHYSICS 6022 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 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, Fermi-Dirac and Einstein-Bose distribution laws, application to some simple physical systems. Prerequisites: Physics 4563, 4301.

PHYSICS 6323 Quantum Statistical Mechanics (LEC 3.0)
Techniques for calculation of the partition function with examples drawn from interacting Fermi gas, interacting Bose gas, superconductors, and similar sources. Prerequisites: Physics 6311 and 6301.

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 6353 Atomic And Molecular Structure (LEC 3.0)
Applications of quantum mechanics to the structure of atoms and molecules; perturbation and variational calculations, self-consistent field, multiplets, angular momenta, Thomas-Fermi model, diatomic molecules, spectral intensities. 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).

PHYSICS 6413 Mathematical Physics II (LEC 3.0)
Green’s functions in three dimensions, integral equations, complex variable theory and contour integration, group theory with applications to quantum mechanics, solid state and molecular physics. Prerequisite: Math 6802 or Physics 6403. (Co-listed with Math 6803).