PHYSICS AND ASTRONOMY

Department of Physics, Astronomy, Geology, and Environmental Science Room 2023 Ward Beecher Hall (330) 941-3616 Fax: (330) 941-2131 Department Chairperson: Dr. W. Gregg Sturrus (wgsturrus@ysu.edu) Academic Operations Specialist: Jill Mogg (jmmogg@ysu.edu)

Welcome

Welcome to the Physics and Astronomy program at YSU! We are proud of the unique opportunities we provide for our students. We are dedicated to the idea that students learn best by doing the activities considered to be the work of physicists and astronomers. Our Ward Beecher Planetarium sports a 40-foot projection dome, a Chronos GOTO Star Projector, and a SciDome HB full-dome digital projector, all of which are maintained and operated by our students. Our physics students also have access to state-of-the-art research equipment in our research labs. This equipment includes an atomic force microscope and an x-ray photoemission spectrometer for surface studies; a photolithography semiconductor mask aligner; magnetron sputtering deposition system and a HeCd laser photoluminescence spectrometer for developing and testing new semiconductor materials and devices; and a Vibrant OPOTek optical parametric oscillator; an x-ray photoemission spectrometer for surface composition studies; and several pulsed YAG lasers for non-linear optics studies of layered polymer materials.

The astronomy research students learn to use the latest data analysis tools and work with imaging data from telescopes around the world. Students have access to the Ohio Supercomputer Facility do perform simulations studies on solid state systems. Furthermore, the department has an endowment specifically for use to pay students who work as assistants in our research labs. We strive to include students in all our research projects and our planetarium shows, and we are happy to discuss these opportunities with interested students.

Ward Beecher Planetarium general and programming information may be found by calling (330) 941-1370 or on the website at https://www.wbplanetarium.org/

Mission Statement

The Physics and Astronomy program strives to provide a high quality educational experience for its majors by involving undergraduate students in significant research activities to embody its philosophy of teaching through research; to continue and expand the research footprint of the department and the University; to serve the undergraduate population by offering challenging and essential course work; and to establish connections between the public and the scientific community and between the public and the University through outreach programs.

Courses are organized with the following aims:

- To provide well-rounded training in physics and astronomy for those needing it for graduate study, industry, or for secondary school teaching.
- To provide basic training for engineering and pre-professional students.
- To acquaint students from non-science programs with the methods, applications, and theories of physics and astronomy in the modern world.

The program curricula, four-year plan, and minimum requirements for the degrees of Bachelor of Arts and Bachelor of Science with a major in physics and a Bachelor of Science degree with a combined major in physics and astronomy are available through the links under the *Programs of Study* tab. These degrees may be earned in eight semesters if students average 15 hours per semester.

Degree Options

The BA degree program in physics is designed for students who are interested in fields that benefit from a strong background in physics or for students planning to terminate their education at the bachelor's degree level. The BS degree program in physics is designed for students who plan to pursue graduate studies in physics or technical positions in an industrial setting. The BS degree program with a combined physics and astronomy major is designed for students who plan to pursue graduate studies in astronomy or space science. For advising questions, please contact us at (330) 941-3616 or email Dr. Sturrus at wgsturrus@ysu.edu.

Students pursuing the BA degree must complete Foreign Language through the 2600 level.

A student desiring to teach physics or astronomy in secondary schools should consult the dean of the Beeghly College of Liberal Arts, Social Sciences, and Education.

Students are urged to come to the department office early in their first year for advising by the department chair.

For more information, visit the **Department of Physics, Astronomy, Geology, and Environmental Sciences.**

Department Program Directors:

Ward Beecher Planetarium Director: Dr. Patrick Durrell (Email: prdurrell@ysu.edu) (330)-941-7107

Chair

William Gregg Sturrus, Ph.D., Professor, Chair

Professor

Snjezana Balaz, Ph.D., Associate Professor

Michael J. Crescimanno, Ph.D., Professor

Patrick R. Durrell, Ph.D., Professor

John J. Feldmeier, Ph.D., Professor

Donald Priour, Ph.D., Associate Professor

Majors

- BS in Physics with a Minor in Mathematics (http://catalog.ysu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-physics-astronomy/bs-physics-minor-mathematics/)
- BA in Physics with a Minor in Mathematics (http://catalog.ysu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-physics-astronomy/ba-physics-minor-mathematics/)
- BS with a Combined Major in Physics and Astronomy and a Minor in Mathematics (http://catalog.ysu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-physics-astronomy/bs-combined-major-physics-astronomy-minor-mathematics/)

Minors

- Physics Minor (http://catalog.ysu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-physics-astronomy/physics-minor/)
- Astronomy Minor (http://catalog.ysu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-physics-astronomy/astronomy-minor/)

Physics

PHYS 1500 Conceptual Physics 3 s.h.
A conceptual treatment of selected theories and laws of classical and modern physics and their application to the understanding of natural phenomena. The evolution of these laws from hypotheses to functional relationships examined in a historical context. Not applicable to the major in Physics or to the combined major in Physics and Astronomy.
Gen Ed: Natural Science.

PHYS 1500L Conceptual Physics Laboratory 1 s.h.
Experimental work designed to supplement PHYS 1500. Three hours per week.
Prereq. or Coreq.: PHYS 1500.

PHYS 1501 Fundamentals of Physics 1 4 s.h.
Topics include kinematics, forces, energy, momentum, rotational kinematics, torque, angular momentum, simple harmonic motion, and mechanical waves. Not recommended for mathematics, chemistry, physics, or engineering majors.

Prereq.: C or better in MATH 1507 or MATH 1510 and MATH 1511, or readiness for MATH 1571 or equivalent, or at least level 40 on the Mathematics Placement Test.
Gen Ed: Natural Science.

PHYS 1501L Fundamentals of Physics Laboratory 1 1 s.h.
Experimental work designed to supplement the PHYS 1501, PHYS 1502 sequence. Three hours per week.
Prereq. or Coreq.: PHYS 1501.

PHYS 1501R Fundamentals of Physics 1 Recitation 1 s.h.
Discussion and problem solving based on current material in PHYS 1501. Concurrent with: PHYS 1501.

PHYS 1502 Fundamentals of Physics 2 3 s.h.
Study of electricity, magnetism, and light. Topics include electric charge, electric forces and fields, electric potential, capacitance and resistance in direct current circuits, basic circuit analysis, magnetic forces and fields, induced emf, inductance, reflections, refraction, geometric optics as applied to lenses and mirrors, interference, and diffraction.
Prereq.: PHYS 1501 or equivalent.
Gen Ed: Natural Science.

PHYS 1502L Fundamentals of Physics Laboratory 2 1 s.h.
Experimental work designed to supplement the PHYS 1501, PHYS 1502 sequence. Three hours per week.
Prereq. or Coreq.: PHYS 1502.

PHYS 1506 Physics for Health Care 3 s.h.
The basic laws of physics applied to various biological and physiological problems. Designed for majors in the allied health fields, e.g., Respiratory care. Not applicable to the major in Physics or to the combined major in Physics and Astronomy.

PHYS 2607 Physical Science for Middle and Secondary Education 4 s.h.
Selected topics in physical science appropriate to the middle- and secondary-level curriculum. Emphasis on diverse hands-on classroom activities, and multiple approaches to communicating basic concepts in physical science. Topics include simple machines, light and sound, batteries and bulbs, physical properties of solids, liquids and gases.
Prereq.: MATH 1501 or at least level 3 on the Mathematics Placement Test and admission to TELS Upper Division Status.
Gen Ed: Natural Science.

PHYS 2608 Sound 3 s.h.
The physical principles accounting for the production, propagation, and perception of sound waves. The relevance of these principles to phenomena ranging from hearing to the operation of various musical instruments. Introduction to auditorium acoustics. This course is designed for Music majors. Not applicable to the Physics major or to the combined Astronomy and Physics major.
Gen Ed: Natural Science.

PHYS 2610 General Physics 1 4 s.h.
A course in mechanics; the kinematics and dynamics of masses in translation and rotation; Newton's Laws; gravity; the conservation laws of energy and momentum; simple harmonic motion and introduction to wave motion and sound.
Prereq.: High school physics or PHYS 1501.
Prereq. or Coreq.: MATH 1571.
Gen Ed: Natural Science.

PHYS 2610L General Physics Laboratory 1 1 s.h.
Experimental work designed to supplement the PHYS 2610, 2611 sequence. Three hours per week.
Prereq. or Coreq.: PHYS 2610 or PHYS 2601 for PHYS 2610L.

PHYS 2610R General Physics 1 Recitation 1 s.h.
Discussion and problem solving based on current material in PHYS 2610. Concurrent with: PHYS 2610.

PHYS 2611 General Physics 2 4 s.h.
Study of electric and magnetic fields and their effects; introduction to electric circuits; light as an electromagnetic wave; introduction to geometrical and physical optics.
Prereq.: PHYS 2610.
Prereq. or Coreq.: MATH 1572.
Gen Ed: Natural Science.

PHYS 2611L General Physics laboratory 2 1 s.h.
Experimental work designed to supplement the PHYS 2610, 2611 sequence. Three hours per week.
Prereq. or Coreq.: PHYS 2611 or PHYS 2602.

PHYS 2617 Physical Science for Middle and High School Teachers 3 s.h.
Selected topics in physical science appropriate to the middle- and secondary-level curriculum. Emphasis on diverse hands-on classroom activities, and multiple approaches to communicating basic concepts in physical science. Topics include motion, forces, simple machines, light and sound, batteries and bulbs, physical properties of solids, liquids and gases.
Prereq.: At least level 35 on the Mathematics Placement Test (ALEKS 46-60) and admission to TELS Upper Division Status.
Gen Ed: Natural Science.

PHYS 2617L Laboratory Physical Science for Middle School and High School Teachers 1 s.h.
Laboratory course to accompany PHYS 2617 Physical Science for Middle School and Secondary Teachers.
Coreq.: PHYS 2617.
Gen Ed: Natural Science.

PHYS 3703 Classical Mechanics and Dynamics 4 s.h.
Kinematics and dynamics of particles and rigid bodies in inertial and non-inertial reference systems. Linear and non-linear oscillations and oscillating systems. Conditions for chaotic motion. Gravitational and central forces. Langrangian and Hamiltonian mechanics.
Prereq.: PHYS 2611 or ECEN 2633 and prerequisite or concurrent with MATH 3705.

PHYS 3704 Modern Physics 4 s.h.
Special Theory of Relativity. Quantum phenomena related to electromagnetic radiation and material particles. The Bohr model of the hydrogen atom; the Schroedinger equation; the Heisenberg Uncertainty Principle. Wave mechanics of single particles in one-dimensional potentials. Selected topics in atomic, nuclear and condensed matter physics.
Prereq.: PHYS 2611 or ECEN 2633 and prerequisite or concurrent with MATH 2673.

PHYS 3704L Modern Physics Laboratory 1 s.h.
Experimental work designed to supplement PHYS 3704. Three hours per week.
Prereq. or Coreq.: PHYS 3704.

PHYS 3705 Thermodynamics and Classical Statistical Dynamics 3 s.h.
Principles and theorems of thermodynamics derived from the observable macroscopic properties related to temperature, heat, and the underlying statistical origins of thermodynamic processes. Includes the laws of thermodynamics, entropy, state functions, differential equations of state, Maxwell relations, and Maxwell-Boltzmann statistics.
Prereq.: PHYS 2611 or ECEN 2633 and prerequisite or concurrent with MATH 2673.

PHYS 3705L Thermodynamics and Classical Statistical Mechanics Laboratory 1 s.h.
Experimental work designed to supplement PHYS 3705. Three hours per week.
Prereq. or Coreq.: PHYS 3705.

PHYS 3741 Electromagnetic Field Theory 1 3 s.h.
Intermediate theory of electric and magnetic fields. Topics include electric field, scalar potential, techniques for calculating scalar potential (method of images, Laplace's and Poisson's equations, multipole expansion, Green's Function approach), dielectrics and polarization, Maxwell's equations and their application to the propagation of electromagnetic waves including reflection, refraction, transmission, and absorption; guided waves, retarded potentials, radiating systems, special relativity. Must be taken in sequence, before PHYS 3742.
Prereq.: MATH 3705 and either PHYS 2611 or ECEN 2633.

PHYS 3742 Electromagnetic Field Theory 2 3 s.h.
Intermediate theory of electric and magnetic fields. Topics include electric field, scalar potential, techniques for calculating scalar potential (method of images, Laplace's and Poisson's equations, multipole expansion, Green's Function approach), dielectrics and polarization, Maxwell's equations and their application to the propagation of electromagnetic waves including reflection, refraction, transmission, and absorption; guided waves, retarded potentials, radiating systems, special relativity.
Prereq.: PHYS 3741.

PHYS 3750 Mathematical Physics 3 s.h.
The mathematics techniques required in the study of classical, statistical, and quantum mechanics, and field theory.
Prereq.: MATH 3705 and either PHYS 2611 or ECEN 2633.

PHYS 4805 Undergraduate Physics Research 3 s.h.
Research conducted under the direction of a faculty member. The grading is Traditional/PR.
Prereq.: PHYS 3703 and PHYS 3704.
Gen Ed: Capstone.

PHYS 5810 Quantum Mechanics and Quantum Statistical Mechanics 1 3 s.h.
The postulates of wave mechanics, Matrix mechanics, angular momentum coupling, scattering, perturbation theory, intrinsic spin, emission and absorption of radiation. Fermi-Dirac and Bose-Einstein statistics with applications in quantum theory. Must be taken in sequence before PHYS 5811.

Prereq.: PHYS 3703 and PHYS 3704 and MATH 3705.

PHYS 5811 Quantum Mechanics and Quantum Statistical Mechanics 2 3 s.h.
The postulates of wave mechanics, Matrix mechanics, angular momentum coupling, scattering, perturbation theory, intrinsic spin, emission and absorption of radiation. Fermi-Dirac and Bose-Einstein statistics with applications in quantum theory. Must be taken in sequence.
Prereq.: PHYS 5810.

PHYS 5830 Condensed Matter Physics 3 s.h.
Selected topics in condensed matter physics: mechanical, thermal, electrical, and magnetic properties of amorphous and crystalline materials; crystal structures.
Prereq.: PHYS 3704.

PHYS 5835 Spectroscopy 3 s.h.
Treatment of atomic, molecular, and nuclear structure based on the analysis of electromagnetic and other spectra.
Prereq.: PHYS 3704.

PHYS 5835L Spectroscopy Laboratory 1 s.h.
Experimental work designed to supplement PHYS 5835. Three hours per week.
Prereq. or Coreq.: PHYS 5835.

PHYS 5850 Special Topics in Physics 2-4 s.h.
The study of a standard topic at greater depth, of the development of a correlated background for areas of physical knowledge, or the physical and educational experimentation necessary to develop new physics courses. May be repeated twice.
Prereq.: Senior standing in Physics, Electrical Engineering, or Education.

PHYS 5890 Physics and Astronomy for Educators 1-4 s.h.
Intensive study of selected topics of current interest in Physics education. Not applicable to the major in Physics or the combined Astronomy and Physics major. May be repeated for different topics.
Prereq.: Admission to upper-division status in the College of Education or to the Graduate School.

Astronomy

ASTR 1504 Descriptive Astronomy 3 s.h.
Scientific method, introduction to modern understanding of the universe, astronomy and society, humanity's place in the universe. Astronomical observing methods, the solar system, stars and star systems, galaxies, cosmology. Recent astronomical discoveries.
Gen Ed: Natural Science.

ASTR 1504L Astronomy Laboratory 1 s.h.
Telescope and Planetarium laboratory work designed to supplement ASTR 1504. Measurement techniques and deductive methods to determine distance and size of astronomical objects. Three hours per week.
Prereq. or Coreq.: ASTR 1504.

ASTR 2609 Moon and Planets 3 s.h.
A detailed discussion of the moon and planets, with particular emphasis on the geology of the moon.
Prereq.: ASTR 1504 or GEOL 1505.

ASTR 3711 Astrophysics 1 3 s.h.
The application of physical principles to the study of stars and stellar structure; stellar distances and dimensions; stellar spectra and chemical composition; nuclear reactions and the evolution of stars; star formation and the end states of stars.
Prereq.: PHYS 2611 and MATH 2673.

ASTR 3712 Astrophysics 2 3 s.h.
The application of physical principles to the study of the Milky Way and other galaxies; including stellar populations; galactic structure; galaxy interactions; galactic distances and large scale structure of the universe; introduction to cosmology.
Prereq.: ASTR 3711.

ASTR 4811 Observational Astronomy 1 3 s.h.
Photoelectric photometry, photographic and CCD imaging techniques, spectroscopy, methods of data reduction. Some night observatory work included.
Prereq.: PHYS 2611 and MATH 2673.

ASTR 4812 Observational Astronomy 2 3 s.h.
Photoelectric photometry, photographic and CCD imaging techniques, spectroscopy, methods of data reduction. Some night observatory work included.
Prereq.: PHYS 2611 and MATH 2673.

ASTR 4815 Undergraduate Astronomy Research 3 s.h.
Research conducted under the direction of a faculty member. The grading is Traditional/PR.
Prereq.: PHYS 3703 and PHYS 3704.
Gen Ed: Capstone.

Learning Outcomes

The Department of Physics and Astronomy helps students in the departmental programs develop skills to acquire and demonstrate knowledge in classical mechanics, modern physics, electricity and magnetism, thermodynamics, quantum mechanics, and astrophysics. The learning outcomes for the BA Program in Physics are:

- Students will learn to model physical systems and interpret experimental and theoretical results.
- Students will learn how to measure the physical properties of systems using a variety of test equipment and defend the results of their measurements using the associated accuracy and precision of these measurements.
- Students will learn to apply the concepts of classical physics, modern physics, thermodynamics, and electrostatics to solve problems and predict numerical results.

In addition to the learning outcomes for the BA program in physics, students of the BS program in physics will further learn to apply the concepts of electrodynamics and quantum mechanics to solve problems and predict numerical results.

In addition to the learning outcomes for the BA program in physics, students of the BS program in physics and astronomy will learn to apply the concepts of astrophysics to solve problems and predict numeric results.