

# ASTRONOMY

Degree Types: PhD

The Northwestern Astronomy PhD (<https://www.physics.northwestern.edu/graduate/doctoral-program/astronomy-phd-degree-requirement.html>) is designed to provide students with a broad training in astronomy while enabling them to get started quickly with their graduate research. The Astronomy PhD is a flexible program that allows students to complement their astronomy training with a selection of physics courses or courses from other quantitative disciplines such as applied mathematics, statistics, computer science or engineering relevant to their research.

Students pursuing astronomy or astrophysics research in our department will benefit from the vibrant environment and opportunities offered by the Center for Interdisciplinary Research and Exploration in Astrophysics (<https://ciera.northwestern.edu/>) (CIERA).

## Additional resources:

- Department website (<https://www.physics.northwestern.edu/>)
- Program handbook(s)

## Degrees Offered

- Astronomy PhD (<https://catalogs.northwestern.edu/tgs/astronomy/astronomy-phd/>)

In their graduate courses, students will learn the fundamentals of astronomy and astrophysics. They will also develop more specialized knowledge related to a variety of areas of current research.

## Astronomy Courses

### ASTRON 405-0 Basics of Radio Astronomy (1 Unit)

Survey of radio astronomy, emphasizing technical aspects; radiation, antennas, receivers, radio spectroscopy, interferometer arrays and aperture synthesis; radio emission mechanisms and cosmic rays.

### ASTRON 410-0 Astrophysical Radiative Processes and Transport (1 Unit)

Astrophysical Radiative Processes and Transport. Radiative processes important in astrophysics and the methods to model the propagation of radiation. Synchrotron and bremsstrahlung emission. Compton scattering. Plasma effects. Basic atomic and molecular processes. Example astronomical applications.

### ASTRON 414-0 Planetary Astrophysics (1 Unit)

Planetary Astrophysics Methods of exoplanet detection. The observed architecture of exoplanetary systems. The formation and evolution of planetary systems. Modeling exoplanet interiors and atmospheres. Exoplanet habitability and the search for biosignatures.

### ASTRON 416-0 Astrophysical Fluid Dynamics (1 Unit)

Astrophysical Fluid Dynamics. Dynamics of fluids as applied to astrophysical bodies. Topics include hydrostatics, shocks, waves, instabilities, and magnetohydrodynamics. Applications include atmospheres, stars, accretion disks, stellar winds, and galactic disks.

### ASTRON 421-0 Observational Astrophysics (1 Unit)

Geometric optics applied to design of optical and x-ray telescopes; diffraction and the Airy disk; radio and optical interferometry and aperture synthesis; adaptive optics; recent developments in detector technology;

quantum and thermal noise in astronomy. Independent research projects using the CCD camera and 18-inch refractor in Dearborn Observatory.

Prerequisite: ASTRON 220-1 or ASTRON 220-2.

### ASTRON 425-0 Stellar Astrophysics (1 Unit)

Physics of stellar interiors, stellar atmospheres, and star formation.

Specific topics include simple stellar models, nuclear energy generation, overview of evolutionary phases, white dwarfs, neutron stars, interstellar gas and dust grains, gravitational collapse.

Prerequisite: ASTRON 220-1 or ASTRON 220-2.

### ASTRON 429-0 Extragalactic Astrophysics and Cosmology (1 Unit)

Big bang cosmology, Friedman model, thermal history of the Universe, primordial nucleosynthesis, microwave background, dark matter, inflation, large-scale structure, galaxy formation, spiral and elliptical galaxies, and groups and clusters of galaxies.

### ASTRON 441-0 Advanced Topics in Astrophysics (1 Unit)

Specialized lectures on current research topics.

### ASTRON 443-0 Stellar Structure and Evolution (1 Unit)

Stellar interiors, structure, and atmospheres; thermonuclear reactions, stellar stability, and evolution of binaries. Special topics such as supernovae or brown dwarfs may be included.

Prerequisites: ASTRON 425-0 or permission of instructor.

### ASTRON 448-0 Interstellar Matter and Star Formation (1 Unit)

Overview of interstellar gas, absorption and emission lines, synchrotron radiation, excitation of atoms and molecules, shocks, supernova remnants, gravitational collapse, and protostars.

Prerequisites: ASTRON 425-0 or permission of instructor.

### ASTRON 449-0 Stellar Dynamics (1 Unit)

Gravitational potential theory, regular and chaotic orbits, galactic nuclei and supermassive black holes, galactic disk dynamics and spiral structure, evolution of galaxies and star clusters, and dark matter.

### ASTRON 450-0 Special Topics in Astronomy (1 Unit)

### ASTRON 451-0 High Energy Astrophysics (1 Unit)

High Energy Astrophysics Detectors for high-energy photons and particles. Formation and evolution of compact objects in isolation and in binaries. Supernova types. Gamma-ray bursts. Cosmic rays and particle acceleration.

### ASTRON 499-0 Independent Study (1-3 Units)

SEE DEPT FOR SECTION AND PERMISSION NUMBERS May be repeated for credit. Permission of instructor and department required.

### ASTRON 590-0 Research (1-3 Units)

SEE DEPT FOR SECTION AND PERMISSION NUMBERS Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.