

# ASTR - ASTRONOMY

## ASTR406 Stellar Structure and Evolution (3 Credits)

Study of stellar internal structure, nuclear reactions, and energy transport. Study of stellar evolution of both low-mass and high-mass stars, including the stellar end states of white dwarfs, neutron stars, and black holes.

**Prerequisite:** ASTR320; or permission of CMNS-Astronomy department.

**Credit Only Granted for:** ASTR498N or ASTR406.

**Formerly:** ASTR498N.

## ASTR410 Radio Astronomy (3 Credits)

Introduction to current observational techniques in radio astronomy. The radio sky, radiophysics, coordinates and catalogs, antenna theory, Fourier transforms, interferometry and arrays, aperture synthesis, and radio detectors.

**Prerequisite:** ASTR121; and (PHYS271 and PHYS270; or PHYS273). Or permission of CMNS-Astronomy department.

## ASTR415 Computational Astrophysics (3 Credits)

Introduction to the most important computational techniques being used in research in astrophysics. Topics include modern high performance computer architectures, scientific visualization and data analysis, and detailed descriptions of numerical algorithms for the solution to a wide range of mathematical systems important in astrophysics.

**Prerequisite:** ASTR121; and (PHYS271 and PHYS270; or PHYS273). Or permission of CMNS-Astronomy department. Jointly offered with ASTR615.

**Credit Only Granted for:** ASTR415 or ASTR615.

## ASTR421 Galaxies (3 Credits)

Introduction to structure, kinematics, and dynamics of normal and peculiar galaxies. Quantitative descriptions of normal spiral galaxies (like our Milky Way) and elliptical galaxies will be followed by more exotic considerations such as interacting and merging galaxies, and active galactic nuclei.

**Prerequisite:** ASTR121; and (PHYS271 and PHYS270; or PHYS273). Or permission of CMNS-Astronomy department.

## ASTR422 Cosmology (3 Credits)

Introduction to modern cosmology. Topics include large scale structure of universe, the intergalactic medium, the nature of dark matter cosmological models and galaxy formation.

**Prerequisite:** Must have completed or be concurrently enrolled in ASTR320; or permission of CMNS-Astronomy department.

## ASTR430 The Solar System (3 Credits)

Formation and evolution of the Solar System. Planetary surfaces, interiors, atmospheres, and magnetospheres. Asteroids, comets, planetary satellites, and ring systems. Emphasis on using basic physics to understand observed properties of the Solar System. Intended for students majoring in the physical sciences.

**Prerequisite:** ASTR121; and (PHYS271 and PHYS270; or PHYS273). Or permission of CMNS-Astronomy department.

## ASTR435 Astrophysics of Exoplanets (3 Credits)

Introduction to exoplanets. Topics include historical development, advantages, and limitations of detection methods, the statistics of exoplanet characteristics, the bulk properties of known exoplanets, and remote sensing for characterization of exoplanets.

**Prerequisite:** ASTR121; and (PHYS273; or (PHYS270 and PHYS271)). Or permission of CMNS-Astronomy department.

**Credit Only Granted for:** ASTR498X or ASTR435.

**Formerly:** ASTR498X.

## ASTR450 Orbital Dynamics (3 Credits)

Vectorial mechanics, motion in a central force field, gravitational and non-gravitational forces, the two-body and three-body problems, orbital elements and orbital perturbation theory, resonances in the solar system, chaos. Intended for students majoring in any of the physical sciences.

**Prerequisite:** Must have completed or be concurrently enrolled in ASTR320; or permission of CMNS-Astronomy department.

## ASTR480 High Energy Astrophysics (3 Credits)

The structure, formation, and astrophysics of compact objects, such as white dwarfs, neutron stars, and black holes, are examined. Phenomena such as supernovae and high-energy particles are also covered.

**Prerequisite:** Must have completed or be concurrently enrolled in ASTR320; or permission of CMNS-Astronomy department.

## ASTR498 Special Problems in Astronomy (1-6 Credits)

Research or special study. Credit according to work done.

**Restriction:** Must be in one of the following programs (Physics; Astronomy); and permission of CMNS-Astronomy department.

## ASTR601 Radiative Processes (3 Credits)

Emission, absorption, and scattering of radiation by matter, with astrophysical applications. Thermodynamics and statistical mechanics: LTE, Boltzmann, and Saha equations; radiative transfer; atomic and molecular radiation; plasma radiation and transfer: bremsstrahlung, synchrotron emission, Compton scattering.

**Restriction:** Permission of CMNS-Astronomy department.

## ASTR606 Stellar Structure and Evolution (3 Credits)

Models of stellar atmospheres, methods of determining properties of stars, physical principles governing stellar interior processes, observational data for determining stellar evolution, nuclear processes, stellar modeling.

**Restriction:** Permission of CMNS-Astronomy department.

## ASTR610 Astronomical Instrumentation and Techniques (3 Credits)

Review of Maxwell's equations; designs of telescopes, spectrographs, modern detectors; basic concepts for radio detectors and telescopes; interferometry and data processing.

**Restriction:** Permission of CMNS-Astronomy department.

## ASTR615 Computational Astrophysics (3 Credits)

Introduction to computational techniques used in astrophysical research. Topics include modern high performance computer architectures, scientific visualization and data analysis, and detailed descriptions of numerical algorithms for the solution to a wide range of mathematical systems important in astrophysics.

**Restriction:** Permission of CMNS-Astronomy department.

**Credit Only Granted for:** ASTR415 or ASTR615.

## ASTR620 Galaxies (3 Credits)

Galaxy classifications; Milky way: basic data, distribution of stars, gas, dust and relativistic particles, large-scale structure and rotation; Spiral galaxies: stellar dynamics and stability, density waves, star bursts, galactic center; Elliptical galaxies: stellar dynamics, cannibalism; galaxy formation.

**Restriction:** Permission of CMNS-Astronomy department.

## ASTR622 Cosmology (3 Credits)

Introduction to modern cosmology. Topics include the large scale structure of the universe, cosmological models, the Big Bang, the cosmic microwave background, the nature of dark matter, and galaxy formation.

**Restriction:** Permission of CMNS-Astronomy department.

**ASTR630 Planetary Science (3 Credits)**

The science of our planetary system with an emphasis on the aspects of it, that help us understand the origin of the system and thus the relevance to other planetary systems. Topics will include planetary atmospheres, surfaces, and interiors and the small bodies of the solar system (asteroids, comets, Kuiper-belt objects). We will consider the dynamics of these bodies and the physics and chemistry of these bodies.

**Restriction:** Permission of CMNS-Astronomy department.

**ASTR635 Exoplanetary Astrophysics (3 Credits)**

Introduces students to the current state of the exoplanetary field, at a graduate level. Topics covered will include exoplanet detection, exoplanet demographics, planet formation and evolution, planetary atmospheres and interiors, and habitability.

**Restriction:** Permission of CMNS-Astronomy department.

**Credit Only Granted for:** ASTR635 or ASTR688E.

**Formerly:** ASTR688E.

**ASTR670 Interstellar Medium and Gas Dynamics (3 Credits)**

Content of phases of the interstellar medium: physical processes in the ISM: ionization equilibrium, heating and cooling, interstellar dust; gas dynamics: fluid motions, instabilities, shock waves; magnetohydrodynamics.

**Restriction:** Permission of CMNS-Astronomy department.

**ASTR680 High Energy Astrophysics (3 Credits)**

The structure, formation, and astrophysics of compact objects, such as white dwarfs, neutron stars, and black holes, are examined.

**Restriction:** Permission of CMNS-Astronomy department.

**Formerly:** ASTR688M.

**ASTR688 Special Topics in Modern Astronomy (1-3 Credits)**

Special topics such as extragalactic radio sources, plasma astrophysics, the H.R. diagram, chemistry of the interstellar medium, radiophysics of the sun.

**Restriction:** Permission of instructor.

**ASTR690 Research Project I (3 Credits)****ASTR695 Introduction to Research (1 Credit)**

Provides an introduction to research programs in the Department of Astronomy and a forum to explore possible research projects. Aimed at incoming graduate students.

**ASTR699 Special Problems in Advanced Astronomy (1-6 Credits)****ASTR788 Selected Topics in Modern Astronomy (1-3 Credits)****ASTR799 Master's Thesis Research (1-6 Credits)****ASTR898 Pre-Candidacy Research (1-8 Credits)****ASTR899 Doctoral Dissertation Research (1-8 Credits)**