

ASTRONOMY

The Wesleyan Astronomy Department provides outstanding opportunities for undergraduates who wish to major in this fascinating subject, either in preparation for graduate school or as an end in itself. Our unique program blends coursework with research opportunity and provides students access to professional-quality telescopes, instrumentation, and computers. A principal strength is our active research faculty who will work one-on-one with undergraduates employing state-of-the-art instrumentation and computers to investigate areas of current astronomical interest.

Our students go on to graduate programs, including the best in the country, or to a variety of rewarding careers in and out of science. Many of our students are co-authors on research papers based on work performed during their undergraduate careers. In addition, we offer a comprehensive range of coursework that will prepare students for a variety of directions in life, including graduate study.

UNDERGRADUATE PROGRAM DEPARTMENTAL ADVISING EXPERTS

William Herbst, Edward Moran, Seth Redfield

- Undergraduate Astronomy Major (<https://catalog.wesleyan.edu/departments/astr/ugrd-astr/>)

Master of Arts in Astronomy (<https://catalog.wesleyan.edu/departments/astr/grad-astr/>)

ASTR102F Planets Near and Far: The Diversity of Worlds in the Solar System and Beyond (FYS)

For the past 4,000 years, ancient and modern astronomers have tracked the motion of the solar system planets across the sky. Thanks to some very recent discoveries and technological innovations, we now know of thousands of additional planets orbiting other stars. With the cumulative knowledge of millennia of solar system research and recent extrasolar breakthroughs, what planetary science questions can we now answer? How do planets form and evolve? Does the solar system look like a typical planetary system? How many planets are similar to Earth and can any support life? Students in this course will explore these questions and more while developing skills vital to scientific inquiry, writing, and communication.

Offering: **Host**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **None**

Prereq: **None**

ASTR103 The Planets

More than 100 planets are now known in the universe, eight of which circle the sun. NASA missions and improved telescopes and techniques have greatly increased our knowledge of them and our understanding of their structure and evolution. In this course, we study those eight planets, beginning with the pivotal role that they played in the Copernican revolution, during which the true nature of the Earth as a planet was first recognized. We will study the geology of the Earth in some detail and apply this knowledge to our closest planetary neighbors--the moon, Venus, and Mars. This is followed by a discussion of the giant planets and their moons and rings. We will finish the discussion of the solar system with an examination of planetary building blocks--the meteorites, comets, and asteroids. Additional topics covered in the course include spacecraft

exploration, extrasolar planetary systems, the formation of planets, life in the universe, and the search for extraterrestrial intelligence.

Offering: **Crosslisting**

Grading: **OPT**

Credits: **1.25**

Gen Ed Area: **NSM-EES**

Identical With: **E&ES151**

Prereq: **None**

ASTR105 Exploring the Cosmos

This introductory course for non-science majors unveils the universe and how we have come to understand our place in it. We will touch on a full range of astronomical topics, including the mechanics of our solar system, the discovery of planets around other stars, the stellar life cycle, the formation and evolution of galaxies, the big bang, and the ultimate fate of the universe. Occasional evening sessions will provide the opportunity to observe celestial objects through Wesleyan's telescopes.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR106 History of Astronomy from Copernicus to the Modern Age

Since the dawn of human consciousness, we have gazed at the sky with wonder and pondered our place amongst the heavens. In this class, we will discuss the key discoveries of astronomy and the people who made them, placing these discoveries in historical context: what was the world like when humans first discovered the size of the Earth or determined the distances to the stars? How did society influence discovery, and how did achievements in astronomy impact society?

Through discussion, telescopic observation, and demonstration of techniques, we will examine the major astronomical achievements from antiquity to the present day, with an emphasis on the past 500 years. We will discuss astronomy's changing role over time, from mystical (astrology and mythology), to practical (time keeping and navigation), to physical (the nature of stars and planets). Finally, we will gaze to the future and discuss the biggest unsolved mysteries in astronomy, and what we will need to achieve to solve them.

Offering: **Host**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR107 The Universe

This course focuses on the modern scientific conception of the universe, including its composition, size, age, and evolution. We begin with the history of astronomy, tracing the development of thought that led ultimately to the big bang theory. This is followed by a closer look at the primary constituent of the universe--galaxies. We end with consideration of the origin and ultimate fate of the universe.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR108 Conceptual Astronomy: Science Fact vs. Science Fiction

Our conceptual understanding of the world around us is shaped by our experiences, often in subtle ways. In this media-dominated world, the public's predominant exposure to science comes from science fiction in popular culture,

especially TV and movies. In this course, we will examine the ways in which popular culture has influenced our collective knowledge about astronomy: the good, the bad, and the really bad. Wide-ranging topics will include asteroids and comets threatening the earth, travel through space and time, and life in the universe. Through lecture, discussion, and laboratory exercises, we will examine these topics through the lens of science to expose the reality of the universe that is our home.

Offering: **Host**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR109 Worlds Beyond: The Search for Life in the Universe

We are living through a unique time with the recent discovery of other worlds, planets orbiting nearby stars, and the capability to obtain detailed observations of those planets in the coming decades. This makes tangible the age-old question of whether we are alone in the universe, as the only known life-bearing planet. This introductory course for non-science majors will explore the fundamental concepts that are needed to place life into a cosmic context. We will discuss planetary systems near and far, stars as the integral hosts of planets, and prospects for finding and identifying life elsewhere in the universe. Occasional evening sessions will provide the opportunity to observe celestial objects through Wesleyan's telescopes.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR111 The Dark Side of the Universe

The physical world we experience is one of normal matter, energy, and--if one looks up at night--stars. But on larger scales, the universe has an exotic and much-less-well-understood side dominated by things we call dark matter, dark energy, and black holes. What are these mysterious components, and what is the relationship between them and the world that is familiar to us? The answers lie at the frontier of modern astrophysics. In this course, we explore the evidence for the existence of these dark components and the current debates regarding their nature and origin. In different ways, each of them has a vital role in the evolution of the universe and its ultimate fate.

Offering: **Host**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR112Z The Dark Side of the Universe

The physical world we experience is one of normal matter, energy, and--if one looks up at night--stars. But on larger scales, the universe has an exotic and much-less-well-understood side dominated by things we call dark matter, dark energy, and black holes. What are these mysterious components, and what is the relationship between them and the world that is familiar to us? The answers lie at the frontier of modern astrophysics. In this course, we explore the evidence for the existence of these dark components and the current debates regarding their nature and origin. In different ways, each of them has a vital role in the evolution of the universe and its ultimate fate.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR155 Introduction to Astrophysics

The fundamentals of astronomy will be covered. This course serves as an introduction to the subject for potential majors and as a survey for non-majors who have a good high school preparation in math and science. We will cover selected topics within the solar system, galaxy, local universe, and cosmology, including the Big Bang Theory of the origin of the universe and the discovery of planets around other stars.

Offering: **Host**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR210 Fundamentals of Scientific Computing in Astronomy

Computing is essential to the practice of modern astrophysics, from the visualization and analysis of large observational datasets to the numerical simulation of complex physical processes. This course develops the computational skills necessary for astronomical research and prepares students for advanced coursework. Through hands-on tutorials and exercises, students will learn to read, manipulate, and visualize astronomical datasets using basic UNIX and Python programming. The course will also include an introduction to data analysis using statistical techniques.

Offering: **Host**

Grading: **A-F**

Credits: **0.50**

Gen Ed Area: **NSM-ASTR**

Prereq: **None**

ASTR211 Observational Astronomy

This course introduces the techniques of observational astronomy. Students will acquire a basic knowledge of the sky and become familiar with the use of Van Vleck Observatory's telescopes and instruments. Acquisition and analysis of astronomical data via modern techniques are stressed. Topics include celestial coordinates, time, telescopes and optics, astronomical imaging, and photometry. Some basic computer and statistical analysis skills are developed as well. The concepts discussed in lecture are illustrated through observing projects and computer exercises.

Offering: **Host**

Grading: **OPT**

Credits: **1.25**

Gen Ed Area: **NSM-ASTR**

Prereq: **ASTR108 OR ASTR111 OR ASTR105 OR ASTR107 OR E&ES151 OR**

ASTR155 OR ASTR210

ASTR221 Galactic Structure and Formation

The fundamentals of astrophysics are applied to galaxies and the objects contained therein. Topics include galaxy formation and evolution, the Milky Way, galaxy scaling relations, stellar populations, morphology and kinematics, clusters and dark matter halos, and the interstellar and circumgalactic media. In addition, we cover some of the basic numerical methods commonly used in astronomy, such as interpolation, numerical integration, and curve-fitting, and apply them to observational and theoretical problems.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR521**

Prereq: **(ASTR155 AND ASTR211)**

ASTR222 Modern Observational Techniques

This course reviews the practices of modern observational astronomy, focusing primarily on techniques employed in the optical and x-ray bands. Topics will include a description of the use of digital detectors for imaging, photometry, and spectroscopy in a wide variety of applications. Data acquisition, image

processing, and data analysis methods will be discussed. In particular, students will gain hands-on experience with the analysis of data obtained from both ground- and satellite-based observatories. An introduction to relevant error analysis methods is included. Students will also become familiar with the fundamental techniques that will be necessary when "big data" projects like LSST come online in the near future: database querying, metadata handling, and modern programming techniques.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR522**

Prereq: **ASTR211**

ASTR224 Exoplanets: Formation, Detection, and Characterization

Our ability to place the earth into a cosmic context has dramatically improved in recent decades with the discovery of planets around other stars (exoplanets). The study of exoplanets has quickly become a dominant field in astronomy. This course will focus on the fundamentals of exoplanet formation, detection, and characterization (interiors and atmospheres) based on astronomical observables. We will also discuss the assessment of habitability for Earth-like exoplanets and the prospects for the detection of biosignatures.

Offering: **Host**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR524**

Prereq: **(ASTR155 AND ASTR211)**

ASTR231 Stellar Structure and Evolution

As the principal source of light in galaxies today and as drivers of chemical evolution, stars play a critical role in the universe. It is important to understand their structure and evolution. Fortunately, we have a fairly well-developed and tested theory of stellar structure covering both their interiors and atmospheres. In this course, we will provide an introduction to that theory and examine its key results, including a basic description of how stars evolve.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR531**

Prereq: **(PHYS213 AND PHYS214 AND ASTR155 AND ASTR211)**

ASTR232 Galaxies, Quasars, and Cosmology

This course introduces modern extragalactic astronomy, blending established practices in the field and important recent discoveries. Three major themes will be developed. First, the basics of Newtonian and relativistic cosmologies will be discussed, including modern determinations of the Hubble Law and the observations that have led to the currently favored cosmological model. Next, the universe of galaxies will be investigated: their constituents, structure and kinematics, and multiwavelength properties. Finally, the nature of galactic nuclei will be explored, including the observational consequences of black-hole accretion and the coordinated growth of galaxies and their central black holes. Outstanding research questions related to the topics covered will be highlighted throughout the course.

Offering: **Host**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR532**

Prereq: **(ASTR155 AND ASTR211)**

ASTR240 Radio Astronomy

This course will introduce students to the origins, theory, and practice of radio astronomy. It will cover theory of antennas and interferometers, as well as signal detection and measurement techniques. Particular emphasis will be placed on the theory and applications of Fourier transforms. A practical laboratory component will provide experience working with single-dish and interferometric data.

Offering: **Host**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR540**

Prereq: **ASTR155 ASTR211**

ASTR401 Individual Tutorial, Undergraduate

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR402 Individual Tutorial, Undergraduate

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR407 Senior Tutorial (downgraded thesis)

Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.

Offering: **Host**

Grading: **A-F**

ASTR408 Senior Tutorial (downgraded thesis)

Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.

Offering: **Host**

Grading: **A-F**

ASTR409 Senior Thesis Tutorial

Topic to be arranged in consultation with tutor.

Offering: **Host**

Grading: **OPT**

ASTR410 Senior Thesis Tutorial

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR411 Group Tutorial, Undergraduate

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR412 Group Tutorial, Undergraduate

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR420 Student Forum

Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.

Offering: **Host**

Grading: **Cr/U**

ASTR421 Undergraduate Research, Science

Individual research projects for undergraduate students supervised by faculty members.

Offering: **Host**

Grading: **OPT**

ASTR422 Undergraduate Research, Science

Individual research projects for undergraduate students supervised by faculty members.

Offering: **Host**

Grading: **OPT**

ASTR423 Advanced Research Seminar, Undergraduate

Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR424 Advanced Research Seminar, Undergraduate

Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR430 Seminar on Astronomical Pedagogy

Methods for effectively teaching astronomy at all levels from general public outreach to college level will be discussed.

Offering: **Host**

Grading: **Cr/U**

Credits: **0.25**

Gen Ed Area: **NSM-ASTR**

Prereq: **ASTR155 OR ASTR211**

ASTR431 Research Discussion in Astronomy

Current research topics in astronomy will be presented and discussed by astronomy staff and students.

Offering: **Host**

Grading: **Cr/U**

Credits: **0.25**

Gen Ed Area: **NSM-ASTR**

Prereq: **ASTR155 OR ASTR211**

ASTR491 Teaching Apprentice Tutorial

The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member's course for academic credit.

Offering: **Host**

Grading: **OPT**

ASTR492 Teaching Apprentice Tutorial

The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member's course for academic credit.

Offering: **Host**

Grading: **OPT**

ASTR500 Graduate Pedagogy

The elements of good teaching will be discussed and demonstrated through lectures, practice teaching sessions, and discussions of problems encountered in the actual teaching environment. The staff consists of faculty and experienced graduate students. An integral part of the course is a required one-day workshop BEFORE the first day of formal classes.

Training in pedagogy in the first semester of attendance is required for all incoming Wesleyan MA and PhD students who have not already fulfilled this requirement at Wesleyan. BA/MA students are not required to get training in pedagogy but may choose to do so.

Offering: **Host**

Grading: **Cr/U**

Credits: **0.50**

Gen Ed Area: **None**

Identical With: **CHEM500, BIOL500, E&ES500, MB&B500, MUSC500, PHYS500, PSYC500, MATH500**

Prereq: **None**

ASTR501 Individual Tutorial for Graduates

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR502 Individual Tutorial for Graduates

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR503 Selected Topics, Graduate Sciences

Topic to be arranged in consultation with the tutor. A seminar primarily concerned with papers taken from current research publications designed for, and required of, graduate students.

Offering: **Host**

Grading: **OPT**

ASTR504 Selected Topics, Graduate Sciences

Topic to be arranged in consultation with the tutor. A seminar primarily concerned with papers taken from current research publications designed for, and required of, graduate students.

Offering: **Host**

Grading: **OPT**

ASTR512 Group Tutorial, Graduate

Topic to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR521 Galactic Structure and Formation

The fundamentals of astrophysics are applied to galaxies and the objects contained therein. Topics include galaxy formation and evolution, the Milky Way, galaxy scaling relations, stellar populations, morphology and kinematics, clusters and dark matter halos, and the interstellar and circumgalactic media. In addition, we cover some of the basic numerical methods commonly used in astronomy, such as interpolation, numerical integration, and curve-fitting, and apply them to observational and theoretical problems.

Offering: **Crosslisting**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR221**

Prereq: **(ASTR155 AND ASTR211)**

ASTR522 Modern Observational Techniques

This course reviews the practices of modern observational astronomy, focusing primarily on techniques employed in the optical and x-ray bands. Topics will include a description of the use of digital detectors for imaging, photometry, and spectroscopy in a wide variety of applications. Data acquisition, image processing, and data analysis methods will be discussed. In particular, students will gain hands-on experience with the analysis of data obtained from both ground- and satellite-based observatories. An introduction to relevant error analysis methods is included. Students will also become familiar with the fundamental techniques that will be necessary when "big data" projects like LSST come online in the near future: database querying, metadata handling, and modern programming techniques.

Offering: **Crosslisting**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR222**

Prereq: **ASTR211**

ASTR524 Exoplanets: Formation, Detection, and Characterization

Our ability to place the earth into a cosmic context has dramatically improved in recent decades with the discovery of planets around other stars (exoplanets). The study of exoplanets has quickly become a dominant field in astronomy. This course will focus on the fundamentals of exoplanet formation, detection, and characterization (interiors and atmospheres) based on astronomical observables. We will also discuss the assessment of habitability for Earth-like exoplanets and the prospects for the detection of biosignatures.

Offering: **Crosslisting**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR224**

Prereq: **(ASTR155 AND ASTR211)**

ASTR531 Stellar Structure and Evolution

As the principal source of light in galaxies today and as drivers of chemical evolution, stars play a critical role in the universe. It is important to understand their structure and evolution. Fortunately, we have a fairly well-developed and tested theory of stellar structure covering both their interiors and atmospheres. In this course, we will provide an introduction to that theory and examine its key results, including a basic description of how stars evolve.

Offering: **Crosslisting**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR231**

Prereq: **(PHYS213 AND PHYS214 AND ASTR155 AND ASTR211)**

ASTR532 Galaxies, Quasars, and Cosmology

This course introduces modern extragalactic astronomy, blending established practices in the field and important recent discoveries. Three major themes will be developed. First, the basics of Newtonian and relativistic cosmologies will be discussed, including modern determinations of the Hubble Law and the observations that have led to the currently favored cosmological model. Next, the universe of galaxies will be investigated: their constituents, structure and kinematics, and multiwavelength properties. Finally, the nature of galactic nuclei will be explored, including the observational consequences of black-hole accretion and the coordinated growth of galaxies and their central black holes. Outstanding research questions related to the topics covered will be highlighted throughout the course.

Offering: **Crosslisting**

Grading: **A-F**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR232**

Prereq: **(ASTR155 AND ASTR211)**

ASTR540 Radio Astronomy

This course will introduce students to the origins, theory, and practice of radio astronomy. It will cover theory of antennas and interferometers, as well as signal detection and measurement techniques. Particular emphasis will be placed on the theory and applications of Fourier transforms. A practical laboratory component will provide experience working with single-dish and interferometric data.

Offering: **Crosslisting**

Grading: **OPT**

Credits: **1.00**

Gen Ed Area: **NSM-ASTR**

Identical With: **ASTR240**

Prereq: **ASTR155 ASTR211**

ASTR549 Advanced Research Seminar, Graduate

Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR550 Advanced Research Seminar, Graduate

Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: **Host**

Grading: **OPT**

ASTR555 Planetary Science Seminar

This course will examine topics and methods in the interdisciplinary field of planetary science. Students will join several faculty members in the planetary science group to discuss the origin, evolution, and habitability of planets in this and other solar systems. This class is intended for graduate students who are pursuing or who intend to pursue the planetary science concentration. Other graduate and undergraduate students may request admission to the course.

Offering: **Crosslisting**

Grading: **Cr/U**

Credits: **0.25**

Gen Ed Area: **NSM-EES**

Identical With: **E&ES555**

Prereq: **None**