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.

### FACULTY

**William Herbst**  
BA, Princeton University; MAA, Wesleyan University; MSC, University of Toronto;  
PHD, University of Toronto  
John Monroe Van Vleck Professor of Astronomy; Professor of Astronomy;  
Professor, Integrative Sciences

**Meredith Hughes**  
BS, Yale University; PHD, Harvard University  
Associate Professor of Astronomy; Associate Professor, Integrative Sciences

**Roy E. Kilgard**  
BA, Valdosta St University; PHD, University of Leicester  
Associate Professor of the Practice in Astronomy; Associate Professor of the Practice, Integrative Sciences

**Edward C. Moran**  
BS, Pennsylvania State University; MA, Columbia University; MPHIL, Columbia University;  
PHD, Columbia University  
Professor of Astronomy; Director, Van Vleck Observatory; Professor, Integrative Sciences; Co-Coordinator, Planetary Science

**Seth Redfield**  
BM, New Eng Consv Music; BS, Tufts University; MS, University of Colorado Boulder;  
PHD, University of Colorado Boulder  
Associate Professor of Astronomy; Chair, Astronomy Department; Associate Professor, Integrative Sciences; Co-Coordinator, Planetary Science

### UNDERGRADUATE PROGRAM

#### DEPARTMENTAL ADVISING EXPERTS

William Herbst, Edward Moran, Seth Redfield

- Undergraduate Astronomy Major (catalog.wesleyan.edu/departments/astr/ugrd-astr/)

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

### ASTRONOMY

#### Undergraduate Astronomy Major

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:** A-F  
**Credits:** 1.25  
**Gen Ed Area:** NSM-ASTR  
**Identical With:** NSM-ASTR

**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:** Host  
**Grading:** A-F  
**Credits:** 1.00  
**Gen Ed Area:** NSM-ASTR  
**Identical With:** NSM-ASTR

**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  
**Identical With:** NSM-ASTR

**Prereq:** None

#### ASTR107 The Universe

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  
**Identical With:** 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:** A-F  
**Credits:** 1.00  
**Gen Ed Area:** NSM-ASTR
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: A-F
Credits: 1.00
Gen Ed Area: NSM-ASTR
Prereq: None

ASTR111Z 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 astrophysics will be covered. This course serves as an introduction to the subject for potential majors and as a survey for nonmajors 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: 1.25
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: A-F
Credits: 1.50
Gen Ed Area: NSM-ASTR
Prereq: ASTR108 OR ASTR111 OR ASTR105 OR ASTR107 OR E&ES151 OR ASTR155

ASTR221 Galactic Astronomy
The fundamentals of astrophysics are applied to the galaxy and objects therein. Topics include the interstellar medium, stellar populations, galactic structure, formation, and evolution.
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 dramatically improved in the past 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 mult wavelength 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:** A-F

**Credits:** 1.00

**Gen Ed Area:** NSM-ASTR

**Identical With:** ASTR540

**Prereq:** ASTR155

**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.
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: Crosslisting
Grading: Cr/U
Credits: 0.50
Gen Ed Area: None
Identical With: E&ES500, CHEM500, BIOL500, 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

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 dramatically improved in the past 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: A-F
Credits: 1.00
Gen Ed Area: NSM-ASTR
Identical With: ASTR240
Prereq: ASTR155

**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 mean 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&ESS555
Prereq: None