# ASTRONOMY

## Overview and Contact Information

Modern astronomy is concerned with understanding the nature of the universe and the various structures—galaxies, stars, planets, atoms—within it. We are interested not only in describing these things, but in understanding how they are formed and how they change, and, ultimately, in reconstructing the history of the universe.

This understanding is always based upon the same set of theories and practices—physics, chemistry, biology, materials science, geology, mathematics, computer science—that we use to understand the earth and its immediate surroundings. Thus, all students are strongly encouraged to base their study of the universe upon a firm grounding in one of these disciplines.

All 100-level courses are taught by Mount Holyoke faculty and staff. Courses at the 200 level and above are staffed collectively by faculty in the Five College Department (as listed above); many of them will be offered off-campus. Students are urged to consult the department to assist in planning a program of study that takes advantage of the rich variety of course opportunities. Through advising, the exact program is always tailored to the student's particular strengths, interests, and plans.

Astronomical facilities at all five institutions are available for student use. The Williston Observatory at Mount Holyoke includes a historic Clark 8″ telescope. The McConnell Rooftop Observatory at Smith College includes two computer-controlled Schmidt Cassegrain telescopes, and the Amherst Observatory has a Clark 18″ refractor.

### Contact Information

**Darby Dyar, Chair**
**Sarah Byrne, Academic Department Coordinator**

206 Kendade Hall
413-538-2238
https://www.mtholyoke.edu/acad/astronomy

## Mount Holyoke Faculty

**This area of study is administered by the Astronomy department and is a collaborative program through the Five College Department of Astronomy (FCAD):**
Darby Dyar, Kennedy-Schelkunoff Professor of Astronomy

Jason Young, Visiting Lecturer in Astronomy

Thomas Burbine, Director of the Observatory

## Five College Faculty

Calzetti, Edwards (Five College chair), Erickson, Follette, Giavalisco, Gutermuth, Hameed, Hanner, Heyer, Katz, Lowenthal, Mo, Narayanan, Pope, Schloerb, Schneider, Snell, Stage, Tripp, Wang, Weinberg, Whitaker, Wilson, Yun

## Requirements for the Major

The astronomy major is designed to provide a good foundation in modern science with a focus on astronomy. Taken alone, it is suited for students who wish to apply scientific training in a broad general context. If coupled with additional course work in related fields, the astronomy major or minor provides the foundation to pursue a career as a professional astronomer or planetary scientist. Thus, advanced courses in geology, mathematics, physics, biology, and/or chemistry, as well as a facility in computer programming, are strongly encouraged.

Students should note that completion of this major will likely require them to travel to other institutions within the Five Colleges.

A minimum of 32 credits:

MATH-101, MATH-102, and PHYS-110 must be completed as prerequisites for the courses in this major.

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|---|---|---|
| Select one of the following: | | 4 |
| ASTR-100 | Stars and Galaxies | |
| ASTR-102 | Solar Systems | |
| ASTR-105 | The Sky | |
| PHYS-201 | Electromagnetism | 4 |
| Two astronomy courses at the 200 level (8 credits) from the offerings of the Five College Astronomy department | | 8 |
| One astronomy course at the 300 level (4 credits) from the offerings of the Five College Astronomy department | | 4 |
| Two additional courses at the 300 level, in astronomy or a related field such as mathematics, physics, geology, biology, computer science, or the history or philosophy of science | | 8 |
| One additional course at any level in astronomy or a related field such as mathematics, physics, geology, biology, computer science, or the history or philosophy of science | | 4 |
| Total Credits | | 32 |

### Additional Specifications

- Students planning graduate study should generally regard this as a minimum program and include additional 300-level work. Advanced course work in physics and mathematics is especially encouraged for students wishing to pursue graduate studies in astronomy.

## Requirements for the Minor

The goal of an astronomy minor is to provide a practical introduction to modern astronomy. If combined with a major in another science or mathematics-related field, such as geology, chemistry, or computer science, it can provide a versatile scientific background that prepares a student for future work as a scientist or technical specialist. Alternatively, the minor may be combined with a major in a nonscientific field, such as history, philosophy, or education, for students who wish to apply their astronomical backgrounds in a broader context that could include history of science, scientific writing or editing, or science education.

A minimum of 16 credits:

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|---|---|
| One 300-level astronomy, physics, or geology course | 4 |
| Three additional 200-level or 300-level courses in astronomy | 12 |
| Total Credits | 16 |

## Five College Course Offerings

Astronomy students will probably take multiple courses off-campus as part of the integrated curriculum of the Five College Astronomy Department. In addition to the courses listed in the Mount Holyoke course catalogue, the following courses are offered at other institutions. Students should consult these course listings at the home institution where they are offered. Enrollment is done through the Five College Interchange.

**220 Special Topics in Astronomy**
*Fall*
Intermediate-level classes designed to introduce special topics in astronomy such as comets and asteroids, meteorites, and science and public policy, generally without prerequisites. Special offerings vary from year to year. See listings at individual institutions for more information.

**223 Planetary Science**
*Spring*
This intermediate-level course covers fundamentals of spectroscopy, remote sensing, and planetary surfaces. Discussions will include interiors, atmospheres, compositions, origins, and evolution of terrestrial planets; satellites, asteroids, comets, and planetary rings.
*Offered at the University of Massachusetts.*
*Prereq. 1 physical science course and MATH-100 or MATH-101.*

**224 Stellar Astronomy**
*Spring*
The basic observational properties of stars will be explored in an experimental format relying on both telescopic observations and computer programming exercises. No previous computer programming experience is required.
*S. Edwards (offered at Smith College).*
*Prereq. Physics 110, Mathematics 102 and one astronomy course; alternates with Astronomy 225.*

**225 Galaxies and Dark Matter**
*Spring*
The role of gravity in determining the mass of the universe will be explored in an interactive format making extensive use of computer simulations and independent projects.
*S. Edwards (offered at Smith College).*
*Prereq. Physics 110, Mathematics 102 and one astronomy course; alternates with Astronomy 224.*

**226 Cosmology**
*Fall*
The course introduces cosmological models and the relationship between models and observable parameters. Topics in current astronomy that bear upon cosmological problems will be covered, including background electromagnetic radiation, nucleosynthesis, dating methods, determinations of the mean density of the universe and the Hubble constant, and tests of gravitational theories. We will discuss questions concerning the foundations of cosmology and its future as a science.
*Offered at Amherst College.*
*Prereq. Mathematics 101 and a physical science course*

**228 Astrophysics I: Stars and Galaxies**
*Spring*
This course is a calculus-based introduction to the properties, structure, formation, and evolution of stars and galaxies. The laws of gravity, thermal physics, and atomic physics provide a basis for understanding observed properties of stars, interstellar gas, and dust. We apply these concepts to develop an understanding of stellar atmospheres, interiors, and evolution, the interstellar medium, and the Milky Way and other galaxies.
*Offered at Hampshire, Smith, the University of Massachusetts, and Mount Holyoke Colleges.*
*Prereq. Physics 110, Physics 201 or concurrent enrollment, and Math 102*

**301 Writing about Astronomy**
*Fall and Spring*
The goal of this course is to teach the writing techniques and styles that are appropriate for the types of careers that might be pursued by an astronomy major. The course will be composed of both a set of short writing assignments and longer assignments, and some of these assignments will be orally presented to the class. All students will critique the talks, and some written assignments will be exchanged between students for peer editing and feedback. Some papers will require analysis of astrophysical data.
*Offered at the University of Massachusetts.*
*Prereq. completion of 200-level or higher astronomy class, an English writing course, and at least the first two semesters of physics.*

**330 Seminar: Topics in Astrophysics**
*Fall and Spring*
In-class discussions will be used to formulate a set of problems, each designed to illuminate a significant aspect of the topic at hand. The problems will be difficult and broad in scope: their solutions, worked out individually and in class discussions, will constitute the real work of the course. Student will gain experience in both oral and written presentation. Topics vary from year to year.
*See listings at individual institutions for more information.*

**335 Astrophysics II: Stellar Structure**
*Fall*
How do astronomers determine the nature and extent of the universe? Centering around the theme of the "Cosmic Distance Ladder," we explore how astrophysics has expanded our comprehension to encompass the entire universe. Topics include: the size of the solar system; parallactic and spectroscopic distances of stars; star counts and the structure of our galaxy; Cepheid variables and the distances of galaxies; the Hubble Law and largescale structure in the universe; quasars and the Lyman-Alpha Forest.
*Offered at the University of Massachusetts.*
*Prereq. Astronomy 228 or instructor approval.*

**337 Observational Techniques in Optical and Infrared Astronomy**
*Fall*
This course is an introduction to the techniques of gathering and analyzing astronomical data, particularly in the optical and infrared. Telescope design and optics will be discussed, along with instrumentation for imaging, photometry, and spectroscopy. Topics will include astronomical detectors, computer graphics and image processing, error analysis and curve fitting, and data analysis and astrophysical interpretation, with an emphasis on globular clusters.
*J. Lowenthal (offered at Smith College).*
*Prereq. at least one 200-level astronomy course.*

**352 Astrophysics III: Galaxies and the Universe**
*Spring*
Advanced course covering physical processes in the gaseous interstellar medium, including photoionization in HII regions and planetary nebulae, shocks in supernova remnants and stellar jets, and energy balance in molecular clouds. Dynamics of stellar systems, star clusters, and the viral theorem will also be discussed, along with galaxy rotation and the presence of dark matter in the universe, as well as spiral density waves. The course concludes with quasars and active galactic nuclei, synchrotron radiation, accretion disks, and supermassive black holes.
*Offered at the University of Massachusetts.*
*Prereq. Astronomy 335 or two physics courses at the 200 or 300 level.*

# Mount Holyoke Course Offerings

**ASTR-100 Stars and Galaxies**
*Fall. Credits: 4*
Discover how the forces of nature shape our understanding of the cosmos. Explore the origin, structure, and evolution of the earth, moons and planets, comets and asteroids, the sun and other stars, star clusters, the Milky Way and other galaxies, clusters of galaxies, and the universe as a whole.
*Applies to requirement(s): Math Sciences*
*M. Dyar, J. Young*

**ASTR-102 Solar Systems**
*Spring. Credits: 4*
Travel through our solar system using results of the latest spacecraft. Explore the origins of our worlds through the study of planet formation, meteorites, asteroids, and comets. Discover the processes that shape planetary interiors, surfaces, and atmospheres. Compare our solar system to others by learning about newly discovered exoplanets. Trace the conditions that may foster life throughout the solar system and beyond.
*Applies to requirement(s): Math Sciences*
*D. Dyar, J. Young*

**ASTR-105 The Sky**
*Fall and Spring. Credits: 4*
A hands-on introduction to observing and understanding the extraterrestrial sky. Daily and annual motions of the sun, moon, planets, and stars; celestial coordinate systems; apparent brightnesses and colors of the stars; time; calendars. Observations at the Williston Observatory with the unaided eye, visually with the eight-inch telescope, and by electronic camera with computer-controlled telescopes.
*Applies to requirement(s): Math Sciences*
*T. Burbine, J. Young*

**ASTR-115 Introduction to Astronomy**
*Not Scheduled for This Year. Credits: 4*
A comprehensive introduction to the study of modern astronomy, covering planets--their origins, orbits, interiors, surfaces and atmospheres; stars -- their formation, structure and evolution; and the universe -- its origin, large-scale structure and ultimate destiny. This introductory course is for students who are planning to major in science or math.
*Applies to requirement(s): Math Sciences*
*The department*

**ASTR-223 Planetary Science**
*Not Scheduled for This Year. Credits: 4*
This intermediate-level course covers fundamentals of spectroscopy, remote sensing, and planetary surfaces. Discussions will include interiors, atmospheres, compositions, origins, and evolution of terrestrial planets; satellites, asteroids, comets, and planetary rings.
*Applies to requirement(s): Math Sciences*
*The department*
*Prereq: 1 physical science course and MATH-100 or MATH-101.*

**ASTR-226 Cosmology**
*Not Scheduled for This Year. Credits: 4*
Cosmological models and the relationship between models and observable parameters. Topics in current astronomy that bear upon cosmological problems, including background electromagnetic radiation, nucleosynthesis, dating methods, determinations of the mean density of the universe and the Hubble constant, and tests of gravitational theories. Discussion of questions concerning the foundations of cosmology and its future as a science.
*Applies to requirement(s): Math Sciences*
*J. Young*
*Prereq: ASTR-100 or ASTR-101, one semester of physics, and one semester of calculus at high school or college level.*

**ASTR-228 Astrophysics I: Stars and Galaxies**
*Not Scheduled for This Year. Credits: 4*
A calculus-based introduction to the properties, structure, formation, and evolution of stars and galaxies. The laws of gravity, thermal physics, and atomic physics provide a basis for understanding observed properties of stars, interstellar gas, and dust. We apply these concepts to develop an understanding of stellar atmospheres, interiors, and evolution, the interstellar medium, and the Milky Way and other galaxies.
*Applies to requirement(s): Math Sciences*
*J. Young*
*Prereq: PHYS-110 and MATH-102.*
*Advisory: PHYS-201 and MATH-203 strongly suggested.*

**ASTR-295 Independent Study**
*Fall and Spring. Credits: 1 - 4*
*The department*
*Instructor permission required.*

**ASTR-330 Topics in Astrophysics**
In-class discussions will be used to formulate a set of problems, each designed to illuminate a significant aspect of the topic at hand. The problems will be difficult and broad in scope: their solutions, worked out individually and in class discussions, will constitute the real work of the course. Students will gain experience in both oral and written presentation. Topics vary from year to year.

**ASTR-330AC Topics in Astrophysics: 'Asteroids and Comets'**
*Spring. Credits: 4*
This course is an introduction to asteroids and comets from both an astronomical and geological point of view. Topics that will be covered will include how these objects are discovered, their orbits, the mineralogies of asteroids and meteorites, how these objects are classified, impact hazard scales, and space missions. This course is appropriate for any student interested in the properties of these small bodies.
*Applies to requirement(s): Math Sciences*
*T. Burbine*

**ASTR-330MN Topics in Astrophysics: 'Moon'**
*Fall. Credits: 4*
This course will survey the past, present, and future of lunar exploration and science. We will focus on the evolution of the Moon as a paradigm for terrestrial planets, with specific units on interiors, heat flow, thermal evolution, magnetism, volcanism, volatiles, impacts, crustal composition and mineralogy, regoliths, and spectroscopy of its surface. This is a discussion-based, interactive seminar with students and faculty reading current papers from the literature.
*Applies to requirement(s): Math Sciences*
*M. Dyar*
*Prereq: Any intermediate-level Astronomy or Geology course.*
*Advisory: Astronomy 223 recommended.*

**ASTR-330VE Topics in Astrophysics: 'Venus'**
*Not Scheduled for This Year. Credits: 4*
This course will survey the past, present, and future of the exploration and science of the planet Venus. We will focus on the evolution of Venus as a paradigm for Earth's possible future. We will have specific units on interiors, heat flow, thermal evolution, magnetism, volcanism, impacts, crustal composition and mineralogy, and spectroscopy of its surface. This is a discussion-based, interactive seminar with students and faculty reading current papers from the literature.
*Applies to requirement(s): Math Sciences*
*J. Young*
*Prereq: Any intermediate-level Astronomy or Geology course.*
*Advisory: Astronomy 223 recommended.*

**ASTR-335 Astrophysics II**
*Fall. Credits: 4*
How do astronomers determine the nature and extent of the universe? Centering around the theme of the "Cosmic Distance Ladder," we explore how astrophysics has expanded our comprehension to encompass the entire universe. Topics include: the size of the solar system; parallactic and spectroscopic distances of stars; star counts and the structure of our galaxy; Cepheid variables and the distances of galaxies; the Hubble Law and large-scale structure in the universe; quasars and the Lyman-Alpha Forest.
*Applies to requirement(s): Math Sciences*
*J. Young*
*Prereq: ASTR-228.*

**ASTR-352 Astrophysics III**
*Spring. Credits: 4*
Advanced course covering physical processes in the gaseous interstellar medium, including photoionization in HII regions and planetary nebulae, shocks in supernova remnants and stellar jets, and energy balance in molecular clouds. Dynamics of stellar systems, star clusters, and the viral theorem will also be discussed, along with galaxy rotation and the presence of dark matter in the universe, as well as spiral density waves. The course concludes with quasars and active galactic nuclei, synchrotron radiation, accretion disks, and supermassive black holes.
*Applies to requirement(s): Math Sciences*
*J. Young*
*Prereq: ASTR-335 or two physics courses at the 200 or 300 level.*

**ASTR-395 Independent Study**
*Fall and Spring. Credits: 1 - 8*
*The department*
*Instructor permission required.*