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
Loryn Engelbrecht, Academic Department Coordinator
206 Kendade Hall
413-538-2238
https://www.mtholyoke.edu/academics/find-your-program/astronomy

Learning Goals
Learning goals for introductory-level astronomy classes:

- Understand fundamental concepts in astronomy such as gravity, the nature of light, the origin of the universe, and physical characteristics of matter.
- Demonstrate skills for quantitative analyses, including the ability to form a hypothesis, graphically represent and interpret data, estimate error and understand sampling bias.
- Critically evaluate representations of science in all types of media.

Learning goals for advanced astronomy classes:

- Demonstrate proficiency in fundamental concepts in each of the major areas of astronomy: cosmology, planetary science, galaxies, stellar structure, and the universe.
- Show a working knowledge of a broad array of physical phenomena that are based upon fundamental concepts.
- Gain familiarity with instrumentation, computational methods and software resources utilized by professional astronomers.
- Understand the variety of career paths and opportunities that are open to students who have majored in astronomy.
- Exhibit a proficiency in the methods of scientific inquiry in laboratory and/or research projects.
- Demonstrate use of critical thinking skills in well-organized, logical and scientifically sound oral and written scientific reports.

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, Teaching Spring Only
Thomas Burbine, Visiting Lecturer in Astronomy
Manbir Kaur, Visiting Lecturer in Astronomy and Physics

Five College Faculty
Burbine, Calzetti, Erickson, Follette, Giavalisco, Gutermuth, Hameed, Hanner, Heyer, Katz, Lowenthal, Mo, Narayanan, Offner, Pope(Five College chair), Schneider, Stage, Tripp, Wang, Weinberg, 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:

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MATH-101, MATH-102, and PHYS-110</td>
<td>must be completed as prerequisites for the courses in this major.</td>
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<tr>
<td>ASTR-100</td>
<td>Stars and Galaxies</td>
<td>4</td>
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<tr>
<td>ASTR-102</td>
<td>Solar Systems</td>
<td>4</td>
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<tr>
<td>ASTR-104</td>
<td>Planet Earth</td>
<td>4</td>
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<tr>
<td>ASTR-105</td>
<td>The Sky</td>
<td>4</td>
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<tr>
<td>PHYS-201</td>
<td>Electromagnetism</td>
<td>4</td>
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<tr>
<td>Two astronomy courses at the 200 level (8 credits) from the offerings of the Five College Astronomy department</td>
<td>8</td>
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<tr>
<td>One astronomy course at the 300 level (4 credits) from the offerings of the Five College Astronomy department</td>
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<tr>
<td>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</td>
<td>8</td>
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<tr>
<td>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</td>
<td>4</td>
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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, scientific writing or editing, or science education.

A minimum of 16 credits:

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<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tr>
<td></td>
<td>One 300-level astronomy, physics, or geology course</td>
<td>4</td>
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<tr>
<td></td>
<td>Three additional 200-level or 300-level courses in astronomy</td>
<td>12</td>
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<tr>
<td></td>
<td><strong>Total Credits</strong></td>
<td><strong>16</strong></td>
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Course Offerings

**ASTR-100 Stars and Galaxies**  
*Spring. 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*  
The department

**ASTR-104 Planet Earth**  
*Not Scheduled for This Year. Credits: 4*  
This course traces the evolution of the universe, our solar system, and Earth and provides an introduction to the field of planetary science. It follows the evolution of terrestrial planets and asteroids through geologic processes. Topics include planetary origins, atmospheres, interiors, and magnetic fields; plate tectonics; volcanism, weathering, earthquakes, faults and folding on terrestrial planets; distribution and limitations of resources on Earth and other bodies; and the search for the origins of life.  
*Applies to requirement(s): Math Sciences*  
The department

**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

**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 interior, atmospheres, compositions, origins, and evolution of terrestrial planets; satellites, asteroids, comets, and planetary rings.  
*Applies to requirement(s): Math Sciences*  
T. Burbine  
*Prereq: 1 physical science course. MATH-100 or 101 is also suggested but not required as a prerequisite.*

**ASTR-226 Cosmology**  
*Fall. 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*  
M. Kaur  
*Prereq: ASTR-100, ASTR-101, ASTR-102, or ASTR-115; one semester of physics; and one semester of calculus at high school or college level.*

**ASTR-228 Astrophysics I: Stars and Galaxies**  
*Spring. 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*  
The department  
*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 Planetary Science**  
*Not Scheduled for This Year. Credits: 4*  
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-330MA Topics in Planetary Science: ‘Mars’
Not Scheduled for This Year. Credits: 4
This course will survey the past, present, and future of Mars exploration and science. We will focus on the evolution of Mars as a paradigm for terrestrial planets, with specific units on missions, formation, volcanism, impacts, glaciers and water, spectroscopy and mineralogy, climate, and issues pertaining to the possibilities of life on Mars. This is a discussion-based, interactive seminar with students and faculty reading current papers from the literature, supported by many outside speakers. Weekly writing assignments focus on critical thinking.
Applies to requirement(s): Math Sciences
M. Dyar
Prereq: Any intermediate-level Astronomy or Geology course.
Advisory: ASTR-223 recommended.

ASTR-330ME Topics in Planetary Science: ‘Mercury’
Not Scheduled for This Year. Credits: 4
This course will survey the past, present, and future of the exploration and science of the planet Mercury. 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
Other Attribute(s): Writing-Intensive
E. McGowan
Prereq: Any intermediate-level Astronomy or Geology course.

ASTR-330MN Topics in Planetary Science: ‘Moon’
Not Scheduled for This Year. Credits: 4
This course will survey the past, present, and future of the exploration and science of the Earth’s Moon. 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
M. Dyar
Prereq: Any intermediate-level Astronomy or Geology course.
Advisory: Astronomy 223 recommended.

ASTR-335 Astrophysics II
Not Scheduled for This Year. Credits: 4
This is a course in applied physics with the ultimate goal of describing how stars work. Topics include gravitation, stellar mass determination, stellar structure, stellar atmospheres, stellar evolution, and the physics of pulsating stars. We will approach each of these topics from fundamental concepts and we will work our way to a detailed understanding. On the way we will review the structure of the atom, radiative processes, and some basic principles of thermodynamics.
Applies to requirement(s): Math Sciences
The department
Prereq: ASTR-228.

ASTR-352 Astrophysics III
Not Scheduled for This Year. 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 virial 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
The department
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.