

Handbook for Astronomy Majors

September 2019

Department of Astronomy (www.astro.umass.edu)
University of Massachusetts, Amherst

Contact List:

Astronomy Department Main Office:	Cara Iaconi, LGRT 619 E, (413) 545-2194
Department Head:	Professor Daniela Calzetti (413) 545-3556, calzetti@astro.umass.edu
Undergraduate Program Director:	Professor Ronald Snell (413) 545-1949, snell@astro.umass.edu
Chief Undergraduate Advisor and Honors Program Director:	Professor Min Yun (413) 545-2215, myun@astro.umass.edu

Advising and Counseling Resources

Astronomy Department Academic Advisors:

Chief Undergraduate Advisor: Professor Min Yun LGRC 522, 545-2215, myun@astro.umass.edu
Advisor Class of 2023: Professor Daniel Wang LGRC 517 G, 545-2131, wqd@umass.edu
Advisor Class of 2023: Professor Neal Katz LGRC 532, 545-2085, nsk@astro.umass.edu
Advisor Class of 2022: Professor Steve Schneider LGRC 526, 545-2076, schneider@astro.umass.edu
Advisor Class of 2021: Professor Mauro Giavalisco LGRC 520, 545-4767, mauro@astro.umass.edu
Advisor Class of 2020: Professor Alexandra Pope LGRC 618, 545-1769, pope@astro.umass.edu
Transfer Advising: Professor Ronald Snell LGRC 517 K, 545-1949, snell@astro.umass.edu

The College of Natural Sciences Advising Center:

220 Morrill II Science Center, 545-1969

www.cns.umass.edu/students/academic-advising/cns-advising-center

The College of Natural Sciences Career and Professional Development Center:

215 Morrill III Science Center, 545-2238

www.cns.umass.edu/students/academic-advising/cns-career-center

University Career Services:

511 Goodell Building 545-2224

www.umass.edu/careers/

University Counseling Services:

Middlesex House, 545-2337 or 545-0333

www.umass.edu/counseling/

Degree Requirements

University and College Requirements

To receive a bachelor's degree in astronomy, a student must meet the graduation requirement set by (1) the University, (2) the College of Natural Sciences and (3) the Department of Astronomy. The University requirements (total number of credits, number of credits in residence, GPA, general education requirements) are all explained in the *Guide to Undergraduate Programs*, available at www.umass.edu/ug_programguide/. We note that two of the general education requirements (Junior Year Writing and Integrative Experience) are discipline specific and are also summarized under the Department requirements.

The College of Natural Science requirements for graduation are described on the College website at www.cns.umass.edu/academics/cns-degree-requirements/. For a BS degree the College of Natural Science requires 60 credits of coursework in departments within the college. For a BA degree there is a foreign language requirement (see College website for details)..

Department Requirements

The Department offers both B.A. and B.S. degrees in astronomy. For the B.S. degree there are two tracks (Astrophysics track and the Space Science Track). If you are interested in adding an astronomy major or interesting in changing degree tracks, please consult one of our advisors and

they can provide the form needed to make this change. The requirements for these degrees and degree tracks are summarized below.

We note that the requirements for the BA degree has been recently revised. Therefore students declaring the major Summer 2018 or later have difference requirements that students declaring the major before Summer 2018.

B.S. Astrophysics Track

The Astrophysics track is recommended to those students who want to pursue a graduate degree in astrophysics and related fields.

Astronomy Courses:

ASTRON 191A: First Year Seminar (1 credits, Fall semester only)

ASTRON 228: Stars and Galaxies (3 credits, Spring semester only)

ASTRON 301: Writing in Astronomy (3 credits, satisfies Junior year writing requirement – Spring semester only. Students with double majors should take the writing course offered by their primary major department.

ASTRON 339: Astronomy in a Global Context (3 credits, satisfies the integrative experience requirement for those for which this is required - Spring semester only) or PHYSICS 440

ASTRON 335: Modern Astrophysics (4 credits, Fall semester only)

ASTRON 452: Astrophysics II – Galaxies (4 credits, Spring semester only)

One additional astronomy course (at least 3 credits) at the 300 level or higher.
Recommendations:

ASTRON 330: Topics in Astrophysics (3 credits.)

ASTRON 337: Techniques of Optical and Infrared Astronomy (4 credits, fall semester)

Most faculty members in astronomy are engaged in basic research and undergraduate research opportunities are available through independent study, honor research and summer internships. Although not required, we encourage students to get involved in research.

Physics Courses:

PHYSICS 181: Physics I – Mechanics (4 credits with lab, Fall semester only)

PHYSICS 182: Physics II – Electricity and Magnetism (4 credits with lab, Spring semester only)

PHYSICS 281: Computational Physics (3 credits, Fall semester only)

PHYSICS 282: Techniques of Theoretical Physics (3 credits., Spring semester only)

PHYSICS 284 (and associated lab PHYSIC 286): Modern Physics I (4 credits., Spring semester only)

PHYSICS 287 (and associated lab PHYSIC 289): Physics III – Waves and Thermodynamics (4 credits, Fall semester only)

PHYSICS 421: Mechanics I (3 credits, Fall semester only)

PHYSICS 422: Intermediate Electricity and Magnetism (3 credits., Spring semester only)

PHYSICS 423: Statistical Physics (3 credits., Spring semester only)

PHYSICS 424: Quantum Mechanics (3 credits, Fall semester only)

Math Courses:

MATH 131: Calculus I (4 credits., fall or spring semesters)

MATH 132: Calculus II (4 credits., fall or spring semesters)

MATH 233: Multivariate Calculus (3 credits., fall or spring semesters)

MATH 331: Ordinary Differential Equations for Scientists and Engineers (3 credits., fall or spring semesters)

Suggested Course Schedule:

Freshman Year:

Fall: ASTRON 191A, PHYSIC 181, MATH 131

Spring: ASTRON 228, PHYSIC 182, MATH 132

Sophomore Year:

Fall: PHYSIC 281, PHYSIC 287/289, MATH 233

Spring: PHYSIC 282, PHYSIC 284/286, MATH 331

Junior/Senior Years:

Fall: ASTRON 335, PHYSIC 421, PHYSIC 424

Spring: ASTRON 301, ASTRON 339, ASTRON 452, PHYSIC 422, PHYSIC 423,

Either Fall or Spring: one elective 300+ course

B.S. Space Science Track

The Space Science track is recommended for students pursuing an astronomy-related professional career after graduation.

Astronomy Courses:

ASTRON 191A: First Year Seminar (1 credits, Fall semester only)

ASTRON 228: Stars and Galaxies (3 credits, Spring semester only)

ASTRON 301: Writing in Astronomy (3 credits, satisfies Junior year writing requirement – Spring semester only. Students with double majors should take the writing course offered by their primary major department.

ASTRON 339: Astronomy in a Global Context (3 credits, satisfies the integrative experience requirement for those for which this is required - Spring semester only). Students with double majors should take the integrative experience course offered by their primary major department.

ASTRON 335: Modern Astrophysics (4 credits, Fall semester only)

Three additional courses (at least 3 credits each) all at the 200 level or higher and one of these three courses must be at the 300 level or higher. The 300+ level course could be in related fields such as Geoscience or Physics, however need Department Advisor Approval. Some options for 200+ and 300+ level astronomy courses:

ASTRON 220: Special Topics in Astronomy (3 credits)

ASTRON 223: Planetary Science (3 credits, usually in spring semester)

ASTRON 224: Stellar Astronomy (4 credits, usually in fall semester)

ASTRON 225: Galactic and Extragalactic Astronomy (4 credits,
usually in fall semester)

ASTRON 330: Topics in Astrophysics (3 credits.)

ASTRON 337: Techniques of Optical and Infrared Astronomy (4
credits, fall semester only)

Most faculty members in astronomy are engaged in basic research and undergraduate research opportunities are available through independent study, honor research and summer internships. Although not required, we encourage students to get involved in research.

Physics Courses:

PHYSICS 151: General Physics I (4 credits, fall or spring semesters) or PHYSIC 181 Physics I – Mechanics (4 credits with lab, Fall semester only)

PHYSICS 152: General Physics II (4 credits, fall or spring semesters) or PHYSICS 182: Physics II – Electricity and Magnetism (4 credits with lab, Spring semester only)

PHYSICS 281: Computational Physics (3 credits, Fall semester only)

PHYSICS 284 (and associated lab PHYSIC 286): Modern Physics I (4 credits., Spring semester only)

PHYSICS 287 (and associated lab PHYSIC 289): Physics III – Waves and Thermodynamics (4 credits, Fall semester only)

One additional elective Physics course (at least 3 credits) at the 400+ level

Math Courses:

MATH 131: Calculus I (4 credits., fall or spring semesters)

MATH 132: Calculus II (4 credits., fall or spring semesters)

MATH 233: Multivariate Calculus (3 credits., fall or spring semesters)

Concentration Requirement:

Three courses (each at least 3 credits) in a related field. The courses used to satisfy the concentration requirement cannot be used to satisfy any of the requirements listed above. Students should consult with their Department Advisor to formulate a plan. Each student will need to submit a 1 page proposal outlining the 3 courses and the rational behind them. This proposal will need to approved a Department Advisor (the advisor should enter the approved plan in the SPIRE notes).

Examples of Concentration Programs

1. Astrobiology
 - a. Bio 151,152+153(lab), 285 (cell and molecular biology)
2. Astro-Chemistry
 - a. Chem 111, 112, and 261 (Orgo 1): The combination of inorganic and organic chemistry 1 will allow students to get a better handle on chemistry as a whole to then apply this basic understanding to spectroscopic results of pre-biotic molecules. Having organic chemistry 1 will open the doors to begin building a better knowledge of the synthesis of molecules, why molecules form in regio-specific manners and adopt certain isomers. It will serve as a foundation for insight into what molecules cannot be found on Earth but why they may be found in interstellar space.
3. Astronomy and Math
 - a. Math 235, 331, and 551 (Int Scientific Computing)

- b. Math 235, 331, and Statistics 515
- 4. Astronomy and Geo-science
 - a. Geology 311 (Mineralogy), 321 (Petrology), and 445 (Structural Geology): These courses focus on the chemical and physical properties of minerals, rocks and the larger structures rock make up like tectonic plates. These courses are vital for understanding the formation, dynamics, and possible environments of, not only Earth, but also all bodies composed of similar materials.
 - b. Geology 321 (Petrology), 441 (Structural Geology), 445 (Sedimentology): These classes will provide knowledge that is crucial to understanding the geologic history and evolution of planetary bodies, and by extension the history and possible future for our home planet
- 5. Astronomy and Computer Science
- 6. Astronomy and Mechanical Engineering
 - a. M&I-ENG 230 (Thermodynamics), 340 (Fluid Mechanics), 354 (Heat Transfer)

Suggested Course Schedule:

Freshman Year:

Fall: ASTRON 191A, PHYSICS 151/181, MATH 131
Spring: ASTRON 228, PHYSICS 152/182, MATH 132

Sophomore Year:

PHYSICS 281 (fall), PHYSICS 287/289 (fall), PHYSICS 284/286 (spring semester). MATH 233 (fall or spring semester), and two additional 220+ level astronomy courses (fall or spring semester), concentration courses

Junior/Senior Years:

ASTRON 301 (spring semester), ASTRON 335 (fall semester), ASTRON 339 (spring semester), one additional 400+ level physics courses (fall or spring) and one additional 300+ level astronomy course (fall or spring), concentration courses

B.A. Degree (for students declaring the major before summer 2018)

The B.A. degree is designed for students seeking careers in teaching, museum work, science writing, pre-med, etc.

Astronomy Courses:

ASTRON 191A: First Year Seminar (1 credits, Fall semester only)

ASTRON 224: Stellar Astronomy (4 credits, usually in spring semester) or ASTRON 225: Galactic and Extragalactic Astronomy (4 credits, usually offered in spring semester)

ASTRON 228: Stars and Galaxies (3 credits, Spring semester only)

ASTRON 301: Writing in Astronomy (3 credits, satisfies Junior year writing requirement – Spring semester only. Students with double majors should take the writing course offered by their primary major department.

ASTRON 339: Astronomy in a Global Context (3 credits, satisfies the Integrative Experience requirement for those for which this is required - Spring semester only). Students with double majors should take the writing course offered by their primary major department.

ASTRON 335: Modern Astrophysics (4 credits, Fall semester only)

Three additional astronomy courses (at least 3 credits each) and one of these three additional course must be at the 300 level or higher. The 300+ level course can also be in closely related subjects such as Geoscience or Physics, but need approval by Department Advisor. Some options for 200+ and 300+ level astronomy courses:

ASTRON 220: Special Topics in Astronomy (3 credits)

ASTRON 223: Planetary Science (3 credits, usually in spring semester)

ASTRON 330: Topics in Astrophysics (3 credits.)

ASTRON 337: Techniques of Optical and Infrared Astronomy (4 credits, fall semester)

Physics Courses:

PHYSICS 151: General Physics I (4 credits with lab, fall or spring semesters)

PHYSICS 152: General Physics II (4 credits, fall or spring semesters)

PHYSICS 281: Computational Physics (3 credits, Fall semester only)

PHYSICS 284 (and associated lab PHYSIC 286): Modern Physics I (4 credits., Spring semester only)

Math Courses:

MATH 131: Calculus I (4 credits., fall or spring semesters)

MATH 132: Calculus II (4 credits., fall or spring semesters)

Suggested Course Schedule:

Freshman Year:

Fall: ASTRON 191A, PHYSICS 151, MATH 131

Spring: PHYSICS 152, MATH 132

Sophomore Year:

ASTRON 224/225 (spring semester), ASTRON 228 (spring semester), and two additional 220+ level astronomy courses, PHYSICS 281, PHYSICS 284/286

Junior/Senior Years:

ASTRON 301 (spring semester), ASTRON 335 (fall semester), ASTRON 339 (spring semester), one additional 300+ level astronomy.

B.A. Degree (for students declaring the major summer 2018 or later)

The B.A. degree is designed for students seeking careers in teaching, museum work, science writing, pre-med, etc.

Astronomy Courses:

ASTRON 191A: First Year Seminar (1 credits, Fall semester only)

ASTRON 228: Stars and Galaxies (3 credits, Spring semester only)

ASTRON 301: Writing in Astronomy (3 credits, satisfies Junior year writing requirement – Spring semester only. Students with double majors should take the writing course offered by their primary major department.

ASTRON 339: Astronomy in a Global Context (3 credits, satisfies the Integrative Experience requirement for those for which this is required - Spring semester only). Students with double majors should take the writing course offered by their primary major department.

ASTRON 335: Modern Astrophysics (4 credits, Fall semester only)

Three additional astronomy courses (at least 3 credits each) and one of these three additional course must be at the 300 level or higher. The 300+ level course can also be in closely related subjects such as Geoscience or Physics, but need approval by Department Advisor. Some options for 200+ and 300+ level astronomy courses:

ASTRON 220: Special Topics in Astronomy (3 credits)
ASTRON 224: Stellar Astronomy (4 credits, spring semester)
ASTRON 225: Galactic and Extragalactic Astronomy (4 credits, spring semester)
ASTRON 223: Planetary Science (3 credits, usually in spring semester)
ASTRON 330: Topics in Astrophysics (3 credits.)
ASTRON 337: Techniques of Optical and Infrared Astronomy (4 credits, fall semester)

Physics Courses:

PHYSICS 151: General Physics I (4 credits with lab, fall or spring semesters) or Physics 181

PHYSICS 152: General Physics II (4 credits, fall or spring semesters) or Physics 182

PHYSICS 281: Computational Physics (3 credits, Fall semester only)

PHYSICS 284 (and associated lab PHYSIC 286): Modern Physics I (4 credits., Spring semester only)

PHYSICS 287 (and associated lab PHYSIC 289): Physics III – Waves and Thermodynamics (4 credits, Fall semester only)

Math Courses:

MATH 131: Calculus I (4 credits., fall or spring semesters)

MATH 132: Calculus II (4 credits., fall or spring semesters)

MATH 233: Multivariate Calculus (3 credits., fall or spring semesters)

Suggested Course Schedule:

Freshman Year:

Fall: ASTRON 191A, PHYSICS 151, MATH 131

Spring: PHYSICS 152, MATH 132

Sophomore Year:

ASTRON 228 (spring semester), and two additional 200+ level astronomy courses,
PHYSICS 281, PHYSICS 284/286, PHYSICS 287/289, MATH 233

Junior/Senior Years:

ASTRON 301 (spring semester), ASTRON 335 (fall semester), ASTRON 339
(spring semester), one additional 100+ level astronomy course and one additional
300+ level astronomy course

Minor in Astronomy

Requirements for a Minor in astronomy consists of taking ASTRON 228 and four additional courses at the 200+ level.

Honors in Astronomy

Departmental Honors is an Advanced Scholarship track of Commonwealth Honors College. Students may complete Departmental Honors as part of the full Commonwealth Honors College curriculum, which includes Honors General Studies, or they may complete Departmental Honors alone.

Students who are not already members of Commonwealth Honors College must apply to Departmental Honors via the online application using the following link: <http://www.honors.umass.edu/admissions/>. Admission to Departmental Honors will be at the discretion of the Honors Program Director. Minimally, to be eligible to apply for Departmental Honors, students must have (1) an overall GPA of 3.40 or higher earned after one fulltime semester of UMass Amherst coursework, (2) the ability to complete the Departmental Honors-Track requirements, and (3) the ability to complete the Commonwealth Honors College residency requirement of 45-graded credits (not pass/fail) earned at UMass Amherst (not transferred).

The Astronomy requirements for the completion of Departmental Honors are the following:

One honors course chosen from ASTRON 224, 225, 335 or 337

One additional astronomy honors course 300-level or higher

Honors Thesis or Project (students will need to sign up for ASTRON 499Y and 499T and file a proposal with the Commonwealth Honors College)

For more information about Departmental Honors in Astronomy, speak with our Honors Program Director Professor Min Yun.

Five College Interchange

The undergraduate curriculum is shared among the Five Colleges, therefore you may want or need to take an astronomy course at one of the other campuses. Enrollment for these off-campus classes are handled by the Five College Interchange office located in 613 Goodell. Steps for registration are the following:

- 1) Identify courses from the Five College Course Catalog (or from the Department website). No more than 8 credits can be taken at any one of the other four institutions per semester.

- 2) Locate the Five College Enrollment Request Form **on your SPIRE account**. Log on to Spire and under “Enrollment” follow the link for Five College Enrollment Request. Read the two pages of instructions and **enter you course information onto the form** (handwritten forms will not be accepted).
- 3) Print out TWO copies of the form.
- 4) Acquire instructor signatures:
During pre-registration: If the course has limited enrollment, requires prerequisites, or requires instructor's permission.
During the Add/Drop registration - All courses require the instructor's signature.
- 5) If you want the course to fulfill a requirement for you major or minor have your major or minor advisor sign the appropriate line on the Five College Enrollment Request Form.
- 6) Bring both copies (with signatures) to the Five College Interchange Office in 613 Goodell before the end of the registration deadline.

For additional information go to the following website:

<http://www.umass.edu/fivecollegeinterchange/>

Independent Study

Students may wish to concentrate on topics or research outside to the classroom. Opportunities for this type of investigation exist through the Independent Study courses (ASTRON 196, 296, 396 and 496). These courses are arranged on a semester basis between a student and a professor. Depending on the type of activity, these classes generally range from 1 to 3 credits.

There are also many summer intern programs in astronomy. A list of these Research Experiences for Undergraduates can be found on the American Astronomical Society's website:

<http://aas.org/learn/internships-scholarships>.

In addition to the REU programs funded by the National Science Foundation and listed on the AAS website, the Five College Astronomy Department runs a summer research intern program each summer for astronomy students within the Five Colleges. Details of this program can be found at: <http://www.astro.umass.edu/academics/five-college-astronomy-undergraduate-internship-program>. We encourage students to take advantage of these intern programs.

Scholarships, Internships, and Career Information

[The College of Natural Sciences](#) is your primary source of general scholarships. You have access to additional general scholarships if you are a member of the [Commonwealth Honors College](#). The list of outside scholarships and fellowships are highly incomplete, and they will be updated with new information (let me know if you come across others). For the Internships and Career Information/Advice, I strongly recommend starting on the [AAS Career](#) and [AstroBetter](#) pages to educate yourself first. Most of the national and international opportunities are found there, but some of the major programs of interest are listed below, including some international programs that you might not easily find elsewhere.

Scholarships and Fellowships

- [CNS Scholarships](#)
- [Commonwealth Honors College Scholarships](#)
- [Office of National Scholarship Advisement](#)
- [Universities Space Research Association \(USRA\) Scholarships](#)
- [StudySoup Future Innovator Scholarship](#)
- [NSF Graduate Research Fellowship Program](#): graduating seniors can apply for this fellowship that will support the applicant through his/her graduate education.

Internships and Career Information

UMass Resources

- [Five-College Astronomy Undergraduate Internship Program](#)
- [Physics Department Undergraduate Research Opportunities](#)
- [CNS Internship Information](#)

Resources Outside UMass

- [Internship Advice and Opportunities at AstroBetter](#) **START HERE!**
- [AAS Career Resources](#) (Resources for a broader job searches and advices)
- [AAS Internships and Scholarships](#) (both REU and non-REU programs)
- [NASA Internships and Fellowships](#)
- [NASA/JPL Internship Programs](#)
- [Space Telescope Science Institute Summer Program](#)
- [Department of Energy Science Undergraduate Laboratory Internship \(SULI\) Program](#)
- [Caltech Summer Undergraduate Research \(SURF\) Program](#)
- [MIT/Lincoln Lab Undergraduate Research Program and Internships](#)
- [Nakatani RIES: an undergraduate research fellowship in Japan](#)
- [UTRIP: The University of Tokyo Research Internship Program](#)
- [ASIAA Summer Student Program](#)

Careers in Astronomy

Below is a list of websites that provide information about careers in astronomy:

American Astronomical Society (AAS) has general information on careers in astronomy:
<http://aas.org/jobs/career-profiles> see also <http://aas.org/careers>

AAS also has some career profiles
<http://aas.org/learn/careers-astronomy>

National Optical Astronomical Observatories' FAQs about a career in astronomy:
<http://www.noao.edu/education/being-an-astronomer.php>

The following website produced by Nick Strobel has more information on astronomy careers and a list of useful web sites with additional information
<https://www.astronomynotes.com/careers.htm>