ASTRONOMY MAJOR

Program Director: Melissa Hayes-Gehrke, Ph.D.

Astronomy is the scientific study of the universe and its contents, including planets, stars, galaxies, and other celestial objects. Astronomers not only study what the universe is like right now, but they seek to understand the origins and evolution of the universe and the objects within it. At the University of Maryland, astronomers use a variety of tools, including telescopes (both ground-based and space-based) for imaging and spectroscopy, and other specialized instruments to study celestial objects as well as creating theoretical and computational models to better understand those objects.

The Astronomy Department offers courses leading to a Bachelor of Science in three specializations: Astrophysics, Astronomy - Data Science, and Astronomy - Physical Science. The department also offers a series of courses of general interest to non-majors. Astronomy majors are given a strong undergraduate preparation in astronomy, mathematics, and physics. Our class sizes are small and all courses are led by our enthusiastic faculty, developing a strong peer community. The degree program is designed to prepare students for positions in government, industry laboratories, science communication, science policy, science education, or for graduate work in Astronomy or related fields.

Program Objectives

The Department of Astronomy B.S. program educates majors toward achieving an understanding of modern astronomical concepts, applying physics and mathematics to astrophysical situations, and gaining experience in gathering and reducing data using astronomical instrumentation and computational tools. Completion of this program provides the opportunity for majors to acquire the knowledge and skills necessary for graduate school or employment after graduation.

Program Learning Outcomes

1. Use and explain fundamental concepts from the many areas of astronomy, including motions in the sky, gravity, electromagnetic radiation, solar system, stars, galaxies, and cosmology.
2. Assess and solve unfamiliar problems in astrophysics using the knowledge and skills acquired in their astronomy, physics, and mathematics courses.
3. Use astronomical telescopes/instruments and reduce astronomical data using modern computational methods.
4. Summarize scientific literature and nuanced concepts, demonstrating in-depth knowledge in specific sub-fields corresponding to upper-level electives.
5. Describe the current demographic composition of people working in the field of astronomy and how this affects its practice and presents barriers to broader inclusion.

REQUIREMENTS

Courses Required for All Specializations

Course	Title	Credits
Required Introductory Astronomy Courses		
ASTR130	Introductory Astrophysics 1 - Foundations (Introductory Astrophysics 1 - Foundations)	3
ASTR131	Introductory Astrophysics 2 - Planets and Stars (Introductory Astrophysics 2 - Planets and Stars)	3
ASTR232	Introductory Astrophysics 3 - The Milky Way and Beyond (Introductory Astrophysics 3 - The Milky Way and Beyond)	4
ASTR310	Observational Astronomy	4
Required Introductory Physics Courses		
PHYS171	Introductory Physics: Mechanics	3
PHYS265	Introduction to Scientific Programming [1]	3
PHYS272	Introductory Physics: Electricity and Magnetism	3
PHYS273	Intermediate Oscillations and Waves	3
PHYS275	Experimental Physics I: Mechanics and Waves	2
PHYS276	Experimental Physics II: Analog Circuits	2
Supporting Mathematics Courses		
MATH140	Calculus I	4
MATH141	Calculus II	4
MATH241	Calculus III	4
MATH243	Introduction to Linear Algebra and Differential Equations [2]	4
Specialization (see below)		**24-29**
Total Credits		**70-75**

Astrophysics Specialization

Course	Title	Credits
Advanced Astronomy Courses		
ASTR320	Theoretical Astrophysics	3
Three of the following:		**9**
ASTR406	Stellar Structure and Evolution	
ASTR410	Radio Astronomy	
ASTR415	Computational Astrophysics	
ASTR421	Galaxies	
ASTR422	Cosmology	
ASTR430	The Solar System	
ASTR435	Astrophysics of Exoplanets	
ASTR450	Orbital Dynamics	
ASTR480	High Energy Astrophysics	
Three credits of: [3]		**3**
ASTR288	Special Projects in Astronomy	
ASTR498	Special Problems in Astronomy	
ASTR399	Honors Seminar	
ASTR086	Experiential Learning (Experiential Learning)	
Advanced Physics Courses		**0**
PHYS313	Electricity and Magnetism I	4
PHYS371	Modern Physics	3
Two of the following:		6-7
PHYS401	Quantum Physics I	
PHYS404	Introduction to Statistical Thermodynamics	
PHYS410	Classical Mechanics	
Total Credits		**28-29**

Astronomy - Data Science Specialization

Course	Title	Credits
Advanced Astronomy Courses		**9**
Three of the following: [4]		

ASTR320	Theoretical Astrophysics	
ASTR406	Stellar Structure and Evolution	
ASTR410	Radio Astronomy	
ASTR415	Computational Astrophysics	
ASTR421	Galaxies	
ASTR422	Cosmology	
ASTR430	The Solar System	
ASTR435	Astrophysics of Exoplanets	
ASTR450	Orbital Dynamics	
ASTR480	High Energy Astrophysics	
ASTR498	Special Problems in Astronomy [5]	
Advanced Data Science Courses		
DATA320	Introduction to Data Science [4]	3
DATA350	Data Visualization and Presentation [4]	3
NOTE: Prerequisites are required in order to enroll in DATA320 and DATA350 (click on the course to see its prerequisites). The prerequisite courses align with the Data Science minor, although completing the Data Science minor is not required for this specialization.		
Three of the following: [4]		9
MATH416	Applied Harmonic Analysis: An Introduction to Signal Processing	
MATH423	Linear Optimization	
MATH464	Transform Methods	
STAT401	Applied Probability and Statistics II	
STAT430	Introduction to Statistical Computing with SAS	
Total Credits		**24**

Astronomy - Physical Science Specialization

Course	Title	Credits
Advanced Astronomy Courses		**9**
Three of the following: [4]		
ASTR320	Theoretical Astrophysics	
ASTR406	Stellar Structure and Evolution	
ASTR410	Radio Astronomy	
ASTR415	Computational Astrophysics	
ASTR421	Galaxies	
ASTR422	Cosmology	
ASTR430	The Solar System	
ASTR435	Astrophysics of Exoplanets	
ASTR450	Orbital Dynamics	
ASTR480	High Energy Astrophysics	
ASTR498	Special Problems in Astronomy [5]	
Complementary Science Courses		**9**
Three of the following: [4]		
AOSC360	(How to solve the climate change problem?)	
AOSC375	Introduction to the Blue Ocean	
AOSC401	Climate Dynamics and Earth System Science	
AOSC431	Atmospheric Thermodynamics	
AOSC432	Dynamics of the Atmosphere and Ocean	
AOSC433	Atmospheric Chemistry and Climate	
AOSC434	Air Pollution and Environmental Justice	
AOSC475	Carbon Cycle and Climate: Past, Present, and Future	
BSCI331	Cell Biology and Physiology (Cell Biology and Physiology)	
BSCI361	Principles of Ecology	
BSCI464	Microbial Ecology	
ENST333	Ecosystem Health and Protection	
ENST360	Ecosystem Ecology	
ENST405	Energy and Environment	
ENST415	Renewable Energy	
ENST436	Emerging Environmental Threats	
ENST485	Water Management in Urban Environment	
GEOG301	Advanced Geographical Environmental Systems	
GEOG373	Geographic Information Systems	
GEOG415	Land Use, Climate Change, and Sustainability	
GEOG417	Land Cover Characterization Using Multi-Spectral Remotely Sensed Data Sets	
GEOL322	Mineralogy	
GEOL340	Geomorphology	
GEOL341	Structural Geology	
GEOL412	Geology of the Terrestrial Planets	
GEOL446	Geophysics	
GEOL457	Seismology	
GEOL472	Active Tectonics	
Societal Implications/Communication/Science Applications		**6**
Choose one course from two of the following three groups (two courses total): [4]		
Societal Implications (Group 1)		
AREC345	Global Poverty and Economic Development	
AREC365	World Hunger, Population, and Food Supplies	
ENSP360	Every Drop Counts: Water, Food and Global Public Health	
GVPT273	Introduction to Environmental Politics	
GVPT373	Geographic Information Systems for Redistricting	
GVPT392	Introduction to Geographic Information Systems for Social Science Research	
GVPT393		
LARC461	People and the Environment	
PLCY301	Sustainability	
PLCY380	Innovation and Social Change: Do Good Now	
Communication (Group 2)		
COMM341	Environmental Communication	
COMM345	Foundations of Public Dialogue and Deliberation	
COMM365	Social Media & Digital Culture	
COMM385	Influence	
COMM459C	(Special Topics in Science Communication: Misinformation, Society, and Science Communication (3))	
COMM475	Persuasion	
COMM498R	(Risk Communication (3))	
ENGL387	Visual Rhetoric	
ENGL388C	Writing for Change	

ENGL398N	Writing for Non-Profit Organizations
ENGL398R	Writing Non-Fictional Narratives
ENGL398V	Writing About the Environment
ENGL491	Digital Rhetoric
ENGL493	Writing Genres as Social Action
Science Applications (Group 3)	
AOSC424	Remote Sensing of the Atmosphere and Ocean
AOSC447	Machine Learning in Earth Science
BSCI374	Mathematical Modeling in Biology
GEOG377	Artificial Intelligence for Spatial Data
GEOG440	Polar Remote Sensing
GEOG472	Remote Sensing: Digital Processing and Analysis
GEOG473	Geographic Information Systems and Spatial Analysis
GEOG475	Geographic Visualization and Digital Mapping
GEOL447	Observational Geophysics
MATH401	Applications of Linear Algebra
MATH462	Partial Differential Equations
STAT426	Introduction to Data Science and Machine Learning
Total Credits	**24**

- All of the above courses must be completed with a C- or better.
- Astronomy majors may not minor in Physics. Astronomy majors who choose the BS Astrophysics Specialization may double-major in one of the Physics specializations.
- Astronomy majors who choose the BS Astrophysics Specialization or the BS Astronomy - Physical Science Specialization may double-major in Computer Science.
- Once a student has begun the Astronomy major at the University of Maryland, no more than one course at the 300/400-level from a "study abroad" type program may be used in place of a ASTR-prefix course required for the major.

[1] For students with extensive experience with computer programming, this course can be replaced by PHYS474 (Computational Physics) or ASTR415 (Computational Astrophysics). If students complete ASTR415 for this requirement, it cannot be counted as an Advanced Astronomy Course requirement.

[2] MATH240 and MATH246 may be substituted for MATH243.

[3] ASTR399 and ASTR086 require special permission of the Astronomy advisor. ASTR086 may be used if a student has completed a suitable paid summer internship. In this case, the student must complete an additional 300/400-level Astronomy or Physics major course, since ASTR086 is 0 credits.

[4] Students are required to adhere to the prerequisites for all courses.

[5] ASTR498 for the Astronomy - Data Science Specialization and for the Astronomy - Physical Science Specialization must be approved by the Astronomy advisor. At least 3 credits must be completed over 1 or more semesters.

GRADUATION PLANS

Click here (https://cmns.umd.edu/undergraduate/advising-academic-planning/academic-planning/four-year-plans/four-year-plans-gened/) for roadmaps for graduation plans in the College of Computer, Mathematical, and Natural Sciences.

Additional information on developing a graduation plan can be found on the following pages:

- http://4yearplans.umd.edu
- the Student Academic Success-Degree Completion Policy (https://academiccatalog.umd.edu/undergraduate/registration-academic-requirements-regulations/academic-advising/#success) section of this catalog