Astronomy and Astrophysics

Astronomy and Astrophysics are offered in the Department of Physics.

Astrophysicists apply physics and mathematics to the study of planets, stars, galaxies, pulsars, black holes, quasars and the universe, among many other fascinating objects in order to understand their origin, evolution and ultimate fate. Students who major in astronomy or astrophysics usually have very inquisitive minds and a good aptitude for physics and mathematics. The bachelor degree programs in astronomy and astrophysics provide the student with a solid background in laboratory and theoretical astrophysics as well as in the fundamentals of physics and mathematics. Research opportunities are available to supplement classroom instruction.

The bachelor of science degree in astrophysics is designed for students who wish to go on to graduate studies in astrophysics with the goal of becoming professional astronomers. Professional astronomers generally find positions at colleges, and universities, national labs, NASA or its contractors and in various space industries. This degree also prepares you for many jobs in related fields such as computer science, mathematics or physics.

The bachelor of arts degree in astronomy is intended for students who desire a broad background in astronomy, mathematics and physics but do not plan to do graduate work in astrophysics. With this broad background, the student is well prepared in many fields of endeavor, including planetarium and museum work, teaching astronomy at colleges and universities, secondary education, science writing, or in many professions in which the ability to learn is critical.

Both of these degrees can be profitably combined with mathematics and other sciences producing excellent double majors or double degrees.

A minor program in astronomy is also available for students who wish to enlarge their potential for a career choice or who may be eager to learn more about astrophysics than an introductory course can provide.

ASTRONOMY AND ASTROPHYSICS DEGREE PROGRAMS

B.A. with Major in Astronomy Program Requirements

Mathematics		
MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
Basic and Intermediate-Level Science		
ASTR 007 & ASTR 008	Introduction to Astronomy and Introduction to Astronomy Laboratory	4
EES 021	Dynamic Earth	3
PHY 010	General Physics I	4
or PHY 011	Introductory Physics I	
PHY 013	General Physics II	3-4
or PHY 021	Introductory Physics II	
PHY 012	Introductory Physics Laboratory I	1
PHY 022	Introductory Physics Laboratory II	1
PHY 031	Introduction to Modern Physics	3
ASTR 105	Introduction to Planetary Astronomy	3
PHY 220	Advanced Physics Laboratory I	3
Advanced Astronomy and Astrophysics		
ASTR 301	Introduction to Stellar Astrophysics	3
ASTR 302	Introduction to Galactic and Extragalactic Astrophysics	3
Approved Electives		**6**
Select two additional courses from the following list		
ASTR 332	High-Energy Astrophysics	
ASTR 342	General Relativity	
PHY 212	Electricity and Magnetism I	
PHY 213	Electricity and Magnetism II	
PHY 215	Classical Mechanics I	
PHY 340	Thermal Physics	
PHY 362	Quantum Mechanics I	
PHY 364	Nuclear and Elementary Particle Physics	
PHY 366	Introduction to String Theory	
Total Credits		**52-53**

A total of 120 credit hours are required for the Bachelor of Arts in Astronomy.

B.S. in Astrophysics Program Requirements

Mathematics Courses		
MATH 021	Calculus I	4
MATH 022	Calculus II	4
MATH 023	Calculus III	4
MATH 205	Linear Methods	3
MATH 208	Complex Variables	3-4
or MATH 320	Ordinary Differential Equations	
or MATH 322	Methods of Applied Analysis I	
Basic Science Courses		
PHY 011	Introductory Physics I	4
or PHY 010	General Physics I	
PHY 021	Introductory Physics II	0,4
PHY 012	Introductory Physics Laboratory I	1
PHY 022	Introductory Physics Laboratory II	1
PHY 031	Introduction to Modern Physics	3
CHM 030	Introduction to Chemical Principles	4
ASTR 105	Introduction to Planetary Astronomy	3
Laboratory and Computing Courses		
PHY 220	Advanced Physics Laboratory I	3
PHY 221	Advanced Physics Laboratory II	2
CSE 003	Introduction to Programming, Part A	2
or CSE 007	Introduction to Programming	
*Or an equivalent course in scientific computing.		
Intermediate and Advanced Courses		
PHY 212	Electricity and Magnetism I	3
PHY 213	Electricity and Magnetism II	3
PHY 215	Classical Mechanics I	4
PHY 340	Thermal Physics	3
PHY 362	Quantum Mechanics I	3
ASTR 301	Introduction to Stellar Astrophysics	3
ASTR 302	Introduction to Galactic and Extragalactic Astrophysics	3
Elective Courses		**12**
Select four Physics or Astronomy courses numbered higher than 100. Up to two courses in appropriate technical areas offered in other departments may be substituted, when selected with advisor approval. Students planning graduate work in physics are encouraged to include PHY 273 (Research) among their electives.		
Total Credits		**75-80**

A total of 123 credit hours are required for the Bachelor of Science in Astrophysics.

RECOMMENDED SEQUENCE OF COURSES FOR THE FIRST TWO YEARS

B.A. with Major in Astronomy

First Year

Fall	CR	Spring	CR
WRT 001	3	WRT 002	3
Big Questions Seminar	3-4	PHY 010 or 011	4

MATH 021 or 031	4	PHY 012	1
ASTR 007 & ASTR 008	4	MATH 022 or 032	4
		Disciplinary Perspectives*	4
	14-15		**16**

Second Year

Fall	CR	Spring	CR
PHY 013 or 021	3-4	ASTR 105	3
PHY 022	1	EES 021	3
MATH 023	4	PHY 031	3
Disciplinary Perspectives*	6-8	Disciplinary Perspectives*	3-4
		Free elective	3-4
	14-17		**15-17**

Total Credits: 59-65

B.S. Astrophysics

First Year

Fall	CR	Spring	CR
WRT 001	3	WRT 002	3
Big Question Seminar*	3-4	CHM 030	4
PHY 011 or 010	4	MATH 022 or 032	4
PHY 012	1	Disciplinary Perspectives*	4
MATH 021 or 031	4		
	15-16		**15**

Second Year

Fall	CR	Spring	CR
PHY 021	4	PHY 031	3
PHY 022	1	MATH 205	3
MATH 023 or 033	4	Disciplinary Perspectives*	8
CSE 003 or 007	2-4	ASTR 105	3
Disciplinary Perspectives*	4		
	15-17		**17**

Total Credits: 62-65

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Students may choose to select ASTR 007 by deferring a distribution requirement (though it is not required for the BS in Astrophysics).

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Or an equivalent course in scientific computing.

Departmental Honors in Astronomy or Astrophysics

Students receiving a BA in Astronomy or a BS in Astrophysics may earn Departmental Honors by satisfying the following requirements:

1. Academic Performance: Minimum grade point average of 3.50 in astronomy and physics courses used to satisfy the major degree requirements.
2. Research or Project-Based/Creative Activity: completion of approved[1] special topics courses in astronomy that include written reports, or completion of 6 credits of ASTR 273 (research) or equivalent, or completion of a summer research project with written report and oral presentation
3. Additional Course Work: Completion of at least one approved[1] 300-level course in either physics or astronomy beyond those required in the student's degree program. This course may not be selected from special topics or research courses.

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Specific approvals are granted by the Program Director.

The Minor Program in Astronomy

The minor in astronomy consists of 15 credits of astronomy and physics courses, at least 6 credits of which must be astronomy courses at or above the 100-level. No more than one course required in a student's major program may be included in the minor program. The minor program should be designed along a coherent intellectual theme in consultation with the Physics Department Chair. Examples of course sequences for the minor program can be found on the Physics Department Web Site.

Courses

ASTR 007 Introduction to Astronomy 3 Credits
Introduction to planetary, stellar, galactic, and extragalactic astronomy. An examination of the surface characteristics, atmospheres, and motions of planets and other bodies in our solar system. Properties of the sun, stars, and galaxies, including the birth and death of stars, stellar explosions, and the formation of stellar remnants such as white dwarfs, neutron stars, pulsars, and black holes. Quasars, cosmology, and the evolution of the universe. May not be taken by students who have previously completed ASTR 105, PHY 105,.
Attribute/Distribution: NS, NW, Q

ASTR 008 Introduction to Astronomy Laboratory 1 Credit
Laboratory to accompany ASTR 007. Must be enrolled concurrently in ASTR 007.
Corequisites: ASTR 007
Attribute/Distribution: LS, NS, NW

ASTR 091 Special Topics in Astrophysics 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

ASTR 105 Introduction to Planetary Astronomy 3 Credits
This course is an introduction to the solar system. Topics include observations of the sky, transition from the geocentric to the heliocentric paradigm, gravitational interactions, formation and evolution of the solar system, the structure of and energy production in the Sun, survey of the planets in the solar system, including their dynamics, interiors, atmospheres, composition, and moons, the nature of asteroids, comets, and the Kuiper belt, and the study of exoplanets. Instructor permission required in lieu of Phy 5/10/11.
Prerequisites: PHY 005 or PHY 010 or PHY 011
Attribute/Distribution: NS, NW, Q

ASTR 191 Special Topics in Astrophysics 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

ASTR 273 Research 2-3 Credits
Participation in current research projects being carried out within the department.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS, Q

ASTR 291 Special Topics in Astronomy 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

ASTR 300 Apprentice Teaching 1-4 Credits
Apprentice Teaching.

ASTR 301 Introduction to Stellar Astrophysics 3 Credits
This course will take an observational, theoretical, and computational perspective to investigate the physics of stars. Students will learn how to measure fundamental stellar properties (distance, brightness, mass, radius, and temperature). Students will combine astronomical data analysis with physical modeling, including applications from classical mechanics, quantum mechanics, thermodynamics, electromagnetism, and nuclear physics, to describe the atmosphere, internal structure, energy generation, and evolution of stars. Additional topics include: binary stars, variable stars, supernovae, white dwarfs, neutron stars, pulsars, and black holes.
Prerequisites: (PHY 010 or PHY 011) and (PHY 013 or PHY 021 or PHY 023) and PHY 031 and (MATH 022 or MATH 032 or MATH 052)
Attribute/Distribution: NS, Q, W

ASTR 302 Introduction to Galactic and Extragalactic Astrophysics 3 Credits
This course covers the astrophysics of the universe from stars to cosmological structure. We explore star clusters and stellar populations, and examine the components, structure, and dynamics of the Milky Way Galaxy. We investigate galactic morphology, classification, and evolution, including active galaxies and quasars. The course concludes with a short introduction to cosmology and an overview of galaxy clusters and intergalactic structure.
Prerequisites: (PHY 010 or PHY 011) and (PHY 013 or PHY 021 or PHY 023) and (MATH 022 or MATH 032 or MATH 052) and ASTR 301
Attribute/Distribution: NS, Q

ASTR 332 (PHY 332) High-Energy Astrophysics 3 Credits
Observation and theory of X-ray and gamma-ray sources, quasars, pulsars, radio galaxies, neutron stars, black holes. Results from ultraviolet, X-ray and gamma-ray satellites. Generally offered in the spring of odd-numbered years.
Prerequisites: PHY 021 and (MATH 023 or MATH 033) and PHY 031 and PHY 215
Can be taken Concurrently: MATH 023, MATH 033
Attribute/Distribution: NS, Q

ASTR 342 (PHY 342) General Relativity 3 Credits
An introduction to Einstein's theory of general relativity. Topics covered: the geometry of spacetime; curvature and the gravitational field equations; the Schwarzschild and Kerr black holes and more general spacetime geometries; black hole thermodynamics; gravitational waves; the Friedmann–Robertson–Walker geometry and inflationary cosmology; dark energy and the cosmological constant problem.
Prerequisites: (PHY 021) and (MATH 023 or MATH 033) and PHY 215
Can be taken Concurrently: MATH 023, MATH 033, PHY 215
Attribute/Distribution: NS, Q

ASTR 344 Cosmology 3 Credits
This course covers the large-scale evolution of our universe from the big bang until today and into the far future. Topics covered: Hubble expansion, Friedman equations, Einstein's biggest blunder, dark energy, dark matter, the standard model of cosmology (the so-called #CDM model), the cosmic microwave background, nucleosynthesis and inflation.
Prerequisites: PHY 021 and (MATH 023 or MATH 033) and PHY 215
Can be taken Concurrently: MATH 023, MATH 033, PHY 215
Attribute/Distribution: NS

ASTR 389 Honors Project 1-6 Credits
Repeat Status: Course may be repeated.

ASTR 391 Special Topics in Astronomy 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.
Attribute/Distribution: NS

ASTR 491 Special Topics in Astronomy 1-4 Credits
Selected topics not sufficiently covered in other courses.
Repeat Status: Course may be repeated.