Astronomy & Astrophysics

Director of undergraduate studies: Jeff Kenney (jeff.kenney@yale.edu); astronomy.yale.edu

Astronomy and Astrophysics are quantitative physical sciences that apply physics, mathematics, and statistical analysis to observing, describing, and modeling the universe. The courses and degree programs offered by the Department of Astronomy train students in research techniques and quantitative reasoning and develop creative problem solvers. The department offers a B.A. degree in Astronomy and a B.S. degree in Astrophysics. The Astronomy degree is intended for students who plan to continue in adjacent fields such as science policy and science journalism. The Astrophysics degree is intended for students who plan to attend graduate school in related fields. Students who complete either major are sought after by employers in a range of fields from healthcare management to the banking and investment industry.

INTRODUCTORY COURSES

Introductory courses with no prerequisites The department offers a variety of courses without prerequisites that provide an introduction to astronomy with particular attention to recent discoveries and theories. Courses numbered below 1500 are intended for students who desire a broad, nontechnical introduction to astronomy. These courses fulfill the science distributional requirement, and some also fulfill the quantitative reasoning distributional requirement.

Courses with numbers from 1500 to 1999 are topical rather than survey courses. Most of these offerings fulfill both the science and the quantitative reasoning requirements. ASTR 1550 is a laboratory course that provides a hands-on introduction to astronomical observing. ASTR 1600 and ASTR 1700 provide an introduction to frontier topics in modern astrophysics and cosmology.

Introductory courses with high school calculus and physics prerequisites Students who have taken calculus and physics in high school may enroll in quantitative introductory courses. ASTR 2100 and ASTR 2200 focus on fundamental measurements and tools used in astronomy and include an in-depth study of stellar astrophysics (ASTR 2100) or galaxies and cosmology (ASTR 2200). These courses overlap in content, so students should take either ASTR 2100 or ASTR 2200, but not both. ASTR 2550 provides training in data analysis and research techniques, including computer programming and numerical and statistical analysis.

PREREQUISITES

B.A. degree program The prerequisites for the B.A. degree are PHYS 1700 and PHYS 1710, or PHYS 1800 and PHYS 1810, or PHYS 2000 and PHYS 2010, and MATH 1120 and 1150.

B.S. degree program Prerequisites for the B.S. degree include an introductory physics sequence (PHYS 1800 and PHYS 1810, or PHYS 2000 and PHYS 2010, or PHYS 2600 and PHYS 2610); a physics laboratory sequence (PHYS 1650L and PHYS 1660L, or PHYS 2050L and PHYS 2060L); and the mathematics sequence MATH 1120, MATH 1150, and either MATH 1200 or ENAS 1510. ASTR 1550 may be substituted for

one term of the physics laboratory sequence. All prerequisites should be completed by the end of the sophomore year.

Prerequisites for advanced electives Courses numbered 3000 and above are specialized and intensive. The prerequisites for these courses include ASTR 2100 or ASTR 2200, multivariable calculus, and two terms of introductory college physics.

REQUIREMENTS OF THE MAJOR

B.A. degree program The B.A. degree program in Astronomy is designed for students who do not plan to continue in a graduate program in astronomy, but who are interested in the subject as a basis for a liberal arts education or as a physical science background to careers such as medicine, teaching, journalism, business, law, or government. It allows greater flexibility in course selection than the B.S. program because the emphasis is on breadth of knowledge rather than on specialization.

Ten courses are required beyond the prerequisites, including either ASTR 2100 or 2200; ASTR 2550; ASTR 3100; one additional Astronomy elective numbered 1500 or above; and the senior requirement (ASTR 4920). Two of the ten courses must be advanced courses in mathematics, such as MATH 1200 or ENAS 1510, or courses in mathematical methods, including statistics or computer science, such as CPSC 1001, MATH 2000 or above, or ASTR 3560. Three electives can be drawn from any of the natural, applied, or mathematical sciences (including additional astronomy courses); at least two of these must be advanced enough to have college-level prerequisites.

B.S. degree program The B.S. degree program in Astrophysics is designed to provide a strong foundation in astrophysics for students interested in graduate study or a career in astronomy, physics, or a related science.

Beyond the prerequisites, twelve courses are required in astronomy, physics, and mathematics. Students complete at least six courses in astronomy, including either ASTR 2100 or 2200; ASTR 2550; ASTR 3100; ASTR 3200; and a two-term senior project (ASTR 4900 and 4910). Students also complete three physics courses numbered 4000 or above, normally PHYS 4010, PHYS 4020, and PHYS 4390. In addition, majors choose either one additional 4000-level course in physics or an astronomy elective numbered 3000 or higher. In mathematics, students complete a course in differential equations selected from MATH 2460, PHYS 4000, or ENAS 1940, and either an additional mathematics course numbered 2000 or above or a course in statistics or computing such as CPSC 1001, CPSC 2010, or ASTR 3560.

Credit/D/Fail No course taken Credit/D/Fail may be applied toward the major requirements of either degree program.

Outside credit Courses taken at another institution or during an approved summer or term-time study abroad program may count toward the major requirements with DUS approval.

SENIOR REQUIREMENT

B.A. degree program The senior requirement consists of a senior essay or independent research project carried out for one term in ASTR 4920 under the supervision of a faculty member.

B.S. degree program The senior requirement consists of an independent research project in astronomy carried out for two terms in ASTR 4900 and ASTR 4910 under the supervision of a faculty member.

ADVISING

Before entering the junior year, students must obtain approval of a course of study from the director of undergraduate studies (DUS).

Graduate work Graduate courses in astronomy are open to qualified undergraduates who already have a strong preparation in mathematics, physics, and astronomy. Students wishing to take a graduate course must first obtain the permission of the instructor and of the director of graduate studies.

SUMMARY OF MAJOR REQUIREMENTS

ASTRONOMY, B.A.

Prerequisites PHYS 1700, PHYS 1710, or PHYS 1800, PHYS 1810, or PHYS 2000, PHYS 2010; MATH 1120, MATH 1150

Number of courses 10 courses beyond prereqs, incl senior req

Specific courses required ASTR 2100 or ASTR 2200; ASTR 2550; ASTR 3100

Distribution of courses 1 astronomy elective numbered 1500 or above; 2 advanced math courses; 3 science electives (may include addtl astronomy courses), at least 2 with college-level prereqs

Senior requirement Senior essay or senior research project (ASTR 4920)

ASTROPHYSICS, B.S.

Prerequisites PHYS 1800, PHYS 1810, or PHYS 2000, PHYS 2010, or PHYS 2600, PHYS 2610; PHYS 1650L, PHYS 1660L, or PHYS 2050L, PHYS 2060L; MATH 1120, MATH 1150; MATH 1200 or ENAS 1510

Number of courses 12 courses beyond prereqs, incl senior req

Specific courses required ASTR 2100 or 2200; ASTR 2550; ASTR 3100; ASTR 3200

Distribution of courses 3 courses in physics numbered 4000 or above; 1 addtl course in astronomy numbered 3000 or above or in physics numbered 4000 or above; 2 courses in math or mathematical methods, as specified

Substitution permitted ASTR 1550 for 1 term of physics lab prereq

Senior requirement Senior independent research project (ASTR 4900 and ASTR 4910)

FACULTY OF THE DEPARTMENT OF ASTRONOMY

Professors Hector Arce, Charles Bailyn, †Charles Baltay, Sarbani Basu (*Chair*), Paolo Coppi, Pierre Demarque (*Emeritus*), Debra Fischer, Marla Geha, Jeffrey Kenney, Richard Larson (*Emeritus*), Priyamvada Natarajan, †C. Megan Urry, William van Altena (*Emeritus*), Frank van den Bosch, Pieter van Dokkum, Robert Zinn

Associate Professors †Daisuke Nagai, †Nikhil Padmanabhan

Assistant Professors Earl Bellinger, Malena Rice

Lecturer Michael Faison

†A joint appointment with primary affiliation in another department.