Astronomy

Overview

The Department of Astronomy offers undergraduate and graduate instruction in a wide variety of fields, including theoretical and observational astrophysics; infrared, optical, and radio astronomy; galactic structure and dynamics of stellar systems; high-energy astrophysics and cosmology; and star and planet formation. A considerable amount of research and teaching related to astronomy is done in other units at UC Berkeley, including the Physics Department, Earth and Planetary Science, Space Science Laboratory, and the Lawrence Berkeley National Laboratory. Various professors in the Chemistry, Mathematics, Statistics, and Engineering departments have an active interest in astronomy and are available for consultation.

Facilities

Many instruments are available to students and staff, including two 10-meter telescopes at the Keck Observatory on Mauna Kea in Hawaii; 30-inch, 40-inch and 120-inch telescopes at Lick Observatory; the PAPER Array in South Africa; and a 30-inch telescope at Leuschner Observatory (near the campus). Laboratories are available for the development of radio, infrared, and optical instruments, and for the precise measurement of images and spectra. For further information regarding these resources, see the Facilities page on the department's website (https://astro.berkeley.edu/research-facilities/).

Physics-Astronomy Library

The Physics-Astronomy Library (https://www.lib.berkeley.edu/visit/physics-astronomy/) is located in 351 Physics North. The Physics-Astronomy Library has approximately 95,000 volumes available (on campus and at the NRLF) and 700 journal subscriptions.

Organized Research Units

The Radio Astronomy Lab (http://ral.berkeley.edu/) is involved with many instruments and projects including PAPER and HERA.

The Theoretical Astrophysics Center (http://astro.berkeley.edu/tac/) includes faculty, research scientists, postdoctoral researchers, and students working on a wide variety of problems in theoretical astrophysics.

The Center for Integrative Planetary Science (http://cips.berkeley.edu/) is involved in many research projects including the ongoing Extrasolar Planet Search, astrobiology, and research into planetary composition and formation.

Undergraduate Programs

Astrophysics (http://guide.berkeley.edu/undergraduate/degree-programs/astrophysics/): BA, Minor

Graduate Program

Astrophysics (http://guide.berkeley.edu/graduate/degree-programs/astrophysics/): PhD

Astronomy

Expand all course descriptions [+]Collapse all course descriptions [-]

ASTRON 3 Introduction to Modern Cosmology 2 Units

Terms offered: Fall 2015, Spring 2015, Spring 2014
Description of research and results in modern extragalactic astronomy and cosmology. We read the stories of discoveries of the principles of our Universe. Simple algebra is used.
Introduction to Modern Cosmology: Read More [+]

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Bloom, Ma

Introduction to Modern Cosmology: Read Less [-]

ASTRON 7A Introduction to Astrophysics 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022
This is the first part of an overview of astrophysics, with an emphasis on the way in which physics is applied to astronomy. This course deals with the solar system and stars, while 7B covers galaxies and cosmology. Solar system topics include orbital mechanics, geology of terrestrial planets, planetary atmospheres, and the formation of the solar system. The study of stars will treat determination of observations, properties and stellar structure, and evolution. The physics in this course includes mechanics and gravitation; kinetic theory of gases; properties of radiation and radiative energy transport; quantum mechanics of photons, atoms, and electrons; and magnetic fields.
Introduction to Astrophysics: Read More [+]

Rules & Requirements

Prerequisites: Math 1A -1B. Physics 5A, 5B/5BL or Physics 7A/B (5B or 7B can be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Chiang, Kriek, Weisz, Dressing

Introduction to Astrophysics: Read Less [-]

ASTRON 7AB Introduction to Astrophysics: From Planets to Cosmology 4 Units

Terms offered: Summer 2024 Second 6 Week Session, Summer 2023 Second 6 Week Session
This course provides a broad introduction to astrophysics, with an emphasis on the way in which physics is applied to astronomy. The course will cover astrophysics at small and large scales from stars and planets to galaxies and cosmology. Topics include observational astronomy, orbital mechanics, planets, stars, the interstellar medium, degenerate objects, the Milky Way galaxy, galaxies, black holes, quasars, dark matter, the expansion of the universe, the large-scale structure of the universe, cosmology, and the Big Bang. The physics in this course includes mechanics, gravitation, kinetic theory of gases, radiation, energy transport, quantum mechanics, magnetic fields, special relativity, and general relativity.
Introduction to Astrophysics: From Planets to Cosmology: Read More [+]

Rules & Requirements

Prerequisites: Knowledge of introductory calculus at the level of Math 1A/1B or Math 16A/16B is strongly recommended. Knowledge of introductory mechanics and gravitation at the level of Physics 7A/5A is strongly recommended. Knowledge of introductory electricity & magnetism at the level of Physics 7B/5B is recommended

Credit Restrictions: Students will receive no credit for ASTRON 7AB after completing ASTRON 7A, or ASTRON 7B.

Hours & Format

Summer: 6 weeks - 8 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Dressing

Introduction to Astrophysics: From Planets to Cosmology: Read Less [-]

ASTRON 7B Introduction to Astrophysics 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
This is the second part of an overview of astrophysics, which begins with 7A. This course covers the Milky Way galaxy, star formation and the interstellar medium, galaxies, black holes, quasars, dark matter, the expansion of the universe and its large-scale structure, and cosmology and the Big Bang. The physics in this course includes that used in 7A (mechanics and gravitation; kinetic theory of gases; properties of radiation and radiative energy transport; quantum mechanics of photons, atoms, and electrons; and magnetic fields) and adds the special and general theories of relativity.
Introduction to Astrophysics: Read More [+]

Rules & Requirements

Prerequisites: Math 1A -1B. Physics 5A, 5B/5BL, 5C/5CL, or Physics 7A/B/C (5C or 7C can be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Bloom, Chiang

Introduction to Astrophysics: Read Less [-]

ASTRON 9 Selected Topics in Astronomy 3 Units

Terms offered: Summer 2024 First 6 Week Session, Summer 2024 Second 6 Week Session, Summer 2023 Second 6 Week Session
This seminar will explore one of a variety of subjects in greater depth than in introductory courses. Possible topics include stars, galaxies, the solar system, the interstellar medium, relativity and cosmology, history of astronomy, observational astronomy, and life in the universe.
Selected Topics in Astronomy: Read More [+]

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3-3 hours of lecture per week

Summer: 6 weeks - 7.5 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Selected Topics in Astronomy: Read Less [-]

ASTRON 10 Introduction to General Astronomy 4 Units

Terms offered: Summer 2024 Second 6 Week Session, Summer 2023 Second 6 Week Session, Summer 2022 Second 6 Week Session
A description of modern astronomy with emphasis on the structure and evolution of stars, galaxies, and the Universe. Additional topics optionally discussed include quasars, pulsars, black holes, and extraterrestrial communication, etc. Individual instructor's synopses available from the department.
Introduction to General Astronomy: Read More [+]
Rules & Requirements

Credit Restrictions: Students will receive no credit for ASTRON 10 after completing ASTRON C10, ASTRON N10, ASTRON S10, or ASTRON 10S. A deficient grade in ASTRON 10 may be removed by taking XASTRON 10, or ASTRON C10.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer:
6 weeks - 8 hours of lecture and 2 hours of discussion per week
8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Bloom

Introduction to General Astronomy: Read Less [-]

ASTRON C10 Introduction to General Astronomy 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022
A description of modern astronomy with emphasis on the structure and evolution of stars, galaxies, and the Universe. Additional topics optionally discussed include quasars, pulsars, black holes, and extraterrestrial communication, etc. Individual instructor's synopses available from the department.
Introduction to General Astronomy: Read More [+]
Rules & Requirements

Credit Restrictions: Students will receive no credit for ASTRON C10 after completing ASTRON N10, ASTRON 10S, ASTRON 7S, or ASTRON 10.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer:
6 weeks - 8 hours of lecture and 2.5 hours of discussion per week
8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Filippenko

Also listed as: L & S C70U

Introduction to General Astronomy: Read Less [-]

ASTRON N10 Introduction to General Astronomy 3 Units

Terms offered: Prior to 2007
The nature and evolution of the universe: history of astronomical knowledge; overall structure of the universe; galaxies, radio galaxies, peculiar galaxies, and quasars; structure and evolution of stars; exploding stars, pulsars, and black holes; exploration of the solar system; the search for extraterrestrial life.
Introduction to General Astronomy: Read More [+]
Rules & Requirements

Prerequisites: High school algebra will be presumed but used sparingly

Credit Restrictions: Students will receive no credit for 10 after taking 7.

Hours & Format

Summer: 8 weeks - 6 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Introduction to General Astronomy: Read Less [-]

ASTRON C12 The Planets 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
A tour of the mysteries and inner workings of our solar system. What are planets made of? Why do they orbit the sun the way they do? How do planets form, and what are they made of? Why do some bizarre moons have oceans, volcanoes, and ice floes? What makes the Earth hospitable for life? Is the Earth a common type of planet or some cosmic quirk? This course will introduce basic physics, chemistry, and math to understand planets, moons, rings, comets, asteroids, atmospheres, and oceans. Understanding other worlds will help us save our own planet and help us understand our place in the universe.
The Planets: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer: 6 weeks - 7.5 hours of lecture and 2.5 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Jeanloz, Dressing

Also listed as: EPS C12/L & S C70T

The Planets: Read Less [-]

ASTRON W12 The Planets 3 Units

Terms offered: Summer 2024 8 Week Session, Summer 2023 8 Week Session, Summer 2022 8 Week Session
A tour of the mysteries and inner workings of our solar system. What are planets made of? Why do they orbit the sun the way they do? How do planets form, and what are they made of? Why do some bizarre moons have oceans, volcanoes, and ice floes? What makes the Earth hospitable for life? Is the Earth a common type of planet or some cosmic quirk? This course will introduce basic physics, chemistry, and math to understand planets, moons, rings, comets, asteroids, atmospheres, and oceans. Understanding other worlds will help us save our own planet and help us understand our place in the universe. This course is web-based.
The Planets: Read More [+]
Hours & Format

Summer: 8 weeks - 6 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Militzer

Formerly known as: Astronomy W12/Earth and Planetary Science W12

Also listed as: EPS W12

The Planets: Read Less [-]

ASTRON C13 Origins: from the Big Bang to the Emergence of Humans 4 Units

Terms offered: Fall 2018, Fall 2016, Fall 2014
This course will cover our modern scientific understanding of origins, from the Big Bang to the formation of planets like Earth, evolution by natural selection, the genetic basis of evolution, and the emergence of humans. These ideas are of great intrinsic scientific importance and also have far reaching implications for other aspects of people's lives (e.g., philosophical, religious, and political). A major theme will be the scientific method and how we know what we know.
Origins: from the Big Bang to the Emergence of Humans: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Marshall, Quataert

Also listed as: INTEGBI C13

Origins: from the Big Bang to the Emergence of Humans: Read Less [-]

ASTRON 24 Freshman Seminars 1 Unit

Terms offered: Fall 2015, Fall 2011, Spring 2011
The Berkeley Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small-seminar setting. Berkeley Seminars are offered in all campus departments, and topics vary from department to department and semester to semester.
Freshman Seminars: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman Seminars: Read Less [-]

ASTRON 39 Seminar 1.5 Unit

Terms offered: Spring 2011, Spring 2008, Spring 2007
A small-size undergraduate seminar exploring one astronomical topic in depth. Students are responsible for much of the presentation.
Seminar: Read More [+]

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Instructors: Basri, Filippenko, Davis

Seminar: Read Less [-]

ASTRON 84 Sophomore Seminar 1 or 2 Units

Terms offered: Spring 2023, Spring 2021, Spring 2020
Sophomore seminars are small interactive courses offered by faculty members in departments all across the campus. Sophomore seminars offer opportunity for close, regular intellectual contact between faculty members and students in the crucial second year. The topics vary from department to department and semester to semester. Enrollment limited to 15 sophomores.
Sophomore Seminar: Read More [+]

Rules & Requirements

Prerequisites: At discretion of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring:
5 weeks - 3-6 hours of seminar per week
10 weeks - 1.5-3 hours of seminar per week
15 weeks - 1-2 hours of seminar per week

Summer:
6 weeks - 2.5-5 hours of seminar per week
8 weeks - 1.5-3.5 hours of seminar and 2-4 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Sophomore Seminar: Read Less [-]

ASTRON 98 Directed Group Study 1 - 4 Units

Terms offered: Spring 2024, Fall 2023, Spring 2023
Topics will vary with instructor.
Directed Group Study: Read More [+]

Rules & Requirements

Prerequisites: Restricted to freshmen and sophomores; consent of instructor

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Study: Read Less [-]

ASTRON 99 Directed Study in Astronomy 1 - 3 Units

Terms offered: Fall 2022, Spring 2022, Fall 2021
Supervised observational studies or directed reading for lower division students.
Directed Study in Astronomy: Read More [+]

Rules & Requirements

Prerequisites: 7A-B, 10 and consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of independent study per week

Summer: 6 weeks - 2.5-7.5 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Study in Astronomy: Read Less [-]

ASTRON 120 Optical and Infrared Astronomy Laboratory 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022
This course requires four to six experiments such as the following: accurate position and brightness measurements of stars; laboratory exploration of the characteristics of two-dimensional charge-coupled devices (CCDs) and infrared detectors; measurement of the distance, reddening, and age of a star cluster; measurement of the Stokes parameters and linear polarization of diffuse synchrotron and reflection nebulae; measurement of the period and pulse shape of the Crab pulsar using Fourier techniques. Professional telescopes will be used such as those at Leuschner Observatory and Lick Observatory. There is a emphasis on error analysis, software development in the IDL language, and high-quality written reports.
Optical and Infrared Astronomy Laboratory: Read More [+]
Rules & Requirements

Prerequisites: Astronomy 7A-7B recommended; Mathematics 54 or Physics 89 (may be taken concurrently); Physics 7A-7B-7C (7C may be taken concurrently) or Physics 5A-5B-5C (5C may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Graham, Duchene

Optical and Infrared Astronomy Laboratory: Read Less [-]

ASTRON 121 Radio Astronomy Laboratory 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
Several basic laboratory experiments that concentrate on microwave electronics and techniques; construction of receiving, observing, and data analysis systems for two radioastronomical telescopes, a single-dish 21-cm line system and a 12-GHz interferometer; use of these telescopes for astronomical observing projects including structure of the Milky Way galaxy, precise position measurement of several radio sources, and measurement of the radio brightness distributions of the sun and moon with high angular resolution. There is a heavy emphasis on digital data acquisition, software development in the Python language, and high-quality written reports.
Radio Astronomy Laboratory: Read More [+]
Rules & Requirements

Prerequisites: Astro 7A-7B recommended; Mathematics 53; Mathematics 54 or Physics 89; Physics 7A-7B-7C or Physics 5A-5B-5C

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of discussion and 1 hour of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Parsons

Radio Astronomy Laboratory: Read Less [-]

ASTRON 128 Astronomy Data Science Laboratory 4 Units

Terms offered: Fall 2024, Spring 2024, Fall 2022
This course features 3 data-centric laboratory experiments that draw on a variety of tools used by professional astronomers. Students will learn to procure and clean data (drawn from a variety of world-class astronomical facilities), assess the fidelity/quality of data, build and apply models to describe data, learn statistical and computational techniques to analyze data (e.g., Bayesian inference, machine learning, parallel computing), and effectively communicate data and scientific results. There is a heavy emphasis on software development in the Python language, statistical techniques, and high-quality communication (e.g., written reports, oral presentations, and data visualization).
Astronomy Data Science Laboratory: Read More [+]
Rules & Requirements

Prerequisites: Astro 7A-7B; Mathematics 53; Mathematics 54 or Physics 89; Astro 160; Astro C161 (may be taken concurrently) and Data C8 or C100 (or equivalent level of fluency of the Python programming language)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

Instructors: Weisz, Bloom

Astronomy Data Science Laboratory: Read Less [-]

ASTRON 160 Stellar Physics 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022
Topics covered include some, but not necessarily all, of the following. Observational constraints on the properties and evolution of stars. Theory of stellar structure and evolution. Stellar atmospheres and stellar spectroscopy. Stellar nucleosynthesis. Supernovae. Degeneracy of matter and structure of collapsed stars. Elements of gas dynamics, accretion onto compact objects, and x-ray sources. Dynamics and evolution of close binary systems. Stellar pulsation.
Stellar Physics: Read More [+]
Rules & Requirements

Prerequisites: Astro 7A recommended; Physics 7A-7B-7C (7C may be taken concurrently) or Physics 5A-5B-5C (5C may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Filippenko, Quataert, Lu

Stellar Physics: Read Less [-]

ASTRON C161 Relativistic Astrophysics and Cosmology 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022
Elements of general relativity. Physics of pulsars, cosmic rays, black holes. The cosmological distance scale, elementary cosmological models, properties of galaxies and quasars. The mass density and age of the universe. Evidence for dark matter and dark energy and concepts of the early universe and of galaxy formation. Reflections on astrophysics as a probe of the extrema of physics.
Relativistic Astrophysics and Cosmology: Read More [+]
Rules & Requirements

Prerequisites: Astro 7B recommended; Physics 7A-7B-7C (7C may be taken concurrently) or Physics 5A-5B-5C (5C may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Lee, Ma, Kasen

Also listed as: PHYSICS C161

Relativistic Astrophysics and Cosmology: Read Less [-]

ASTRON C162 Planetary Astrophysics 4 Units

Terms offered: Spring 2024, Spring 2022, Fall 2020
Physics of planetary systems, both solar and extra-solar. Star and planet formation, radioactive dating, small-body dynamics and interaction of radiation with matter, tides, planetary interiors, atmospheres, and magnetospheres. High-quality oral presentations may be required in addition to problem sets and a final exam.
Planetary Astrophysics: Read More [+]
Rules & Requirements

Prerequisites: Mathematics 53, 54; Physics 7A-7B-7C

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Chiang, Dressing, Militzer

Also listed as: EPS C162

Planetary Astrophysics: Read Less [-]

ASTRON C180 Order-Of-Magnitude Physics 4 Units

Terms offered: Fall 2024
Learn how to understand the world around you to within a factor of 10, how to solve real-life problems from physical first principles, how to make ill-posed questions well-posed, and how to sketch solutions quickly and avoid long and formal derivations. These skills build physical intuition and are crucial for all lines of work, especially research. You will learn how to guess intelligently, how to follow your hunches while guided by the laws of physics, and how to maximize understanding from just a modicum of information --- how to reason inductively and quantitatively. All of undergraduate physics --- mechanics, E&M, quantum mechanics, statistical mechanics --- will be covered in useful, memorable, and entertaining ways.
Order-Of-Magnitude Physics: Read More [+]
Rules & Requirements

Prerequisites: Physics 7A, 7B, 7C (or 5 equivalent) + preferably at least 1 upper-division course in the physical sciences. Suitable also for graduate students

Credit Restrictions: Students will receive no credit for PHYSICS C101 after completing PHYSICS 101. A deficient grade in PHYSICS C101 may be removed by taking PHYSICS 101.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required, with common exam group.

Formerly known as: Physics C101/Astronomy C101

Also listed as: PHYSICS C180

Order-Of-Magnitude Physics: Read Less [-]

ASTRON 190 Undergraduate Special Topics 3 Units

Terms offered: Prior to 2007
Rotating astronomy topics for undergraduate students. This course meets for three hours per week. The focus will be not only on the formal subject matter, but also on the nature of scientific inquiry itself.
Undergraduate Special Topics: Read More [+]
Rules & Requirements

Prerequisites: Upper division standing

Repeat rules: Course may be repeated for credit without restriction. Students may enroll in multiple sections of this course within the same semester.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Undergraduate Special Topics: Read Less [-]

ASTRON H195 Special Study for Honors Candidates 2 - 4 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023
Individual project of research or study.
Special Study for Honors Candidates: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2-4 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Special Study for Honors Candidates: Read Less [-]

ASTRON 198 Directed Group Study 1 - 4 Units

Terms offered: Spring 2022, Fall 2021, Fall 2020
Topics will vary with instructor.
Directed Group Study: Read More [+]
Rules & Requirements

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Study: Read Less [-]

ASTRON 199 Supervised Independent Study and Research 1 - 4 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023
Supervised Independent Study and Research: Read More [+]
Rules & Requirements

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study and Research: Read Less [-]

ASTRON 201 Radiation Processes in Astronomy 4 Units

Terms offered: Spring 2012, Fall 2011, Fall 2010
An introduction to the basic physics of astronomy and astrophysics at the graduate level. Principles of energy transfer by radiation. Elements of classical and quantum theory of photon emission; bremsstrahlung, cyclotron and synchrotron radiation. Compton scattering, atomic, molecular and nuclear electromagnetic transitions. Collisional excitation of atoms, molecules and nuclei.
Radiation Processes in Astronomy: Read More [+]
Rules & Requirements

Prerequisites: Physics 105, 110A; 110B concurrently; open to advanced undergraduates with GPA of 3.70

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Chiang, Quataert

Radiation Processes in Astronomy: Read Less [-]

ASTRON C202 Astrophysical Fluid Dynamics 4 Units

Terms offered: Fall 2024, Fall 2023, Spring 2023
Principles of gas dynamics, self-gravitating fluids, magnetohydrodynamics and elementary kinetic theory. Aspects of convection, fluid oscillations, linear instabilities, spiral density waves, shock waves, turbulence, accretion disks, stellar winds, and jets.
Astrophysical Fluid Dynamics: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Chiang, Kasen, Ma, Quataert, White

Also listed as: PHYSICS C202

Astrophysical Fluid Dynamics: Read Less [-]

ASTRON 203 Astrophysical Techniques 3 Units

Terms offered: Spring 2021, Spring 2019, Spring 2018
Introduction to the flow of astronomical signals through telescope optics and into detectors; subsequent calibration, deconvolution of instrumental artifacts, and analysis. A broad wavelength approach is maintained with focus on shared fundamental concepts. Students "adopt a wavelength band" for assignments and presentations. Analysis and simulation of astronomical signals, noise, and errors.
Astrophysical Techniques: Read More [+]
Rules & Requirements

Prerequisites: 201 and 290A; 290B must be taken concurrently

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructor: Graham

Astrophysical Techniques: Read Less [-]

ASTRON 204 Numerical Techniques in Astronomy 3 Units

Terms offered: Fall 2011, Spring 2010, Spring 2008
Methods of data analysis, model fitting, and data display, all oriented towards the detailed analysis of astronomical observation data and/or numerical results from simulations. Specific topics include probability density functions, error propagation, maximum likelihood, least squares, data and function fitting, Fourier transforms, wavelets, principal components analysis, color images. The software language used is the Interactive Data Language (IDL).
Numerical Techniques in Astronomy: Read More [+]
Rules & Requirements

Prerequisites: Mathematics 54

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructor: Heiles

Numerical Techniques in Astronomy: Read Less [-]

ASTRON C207 Radiation Processes in Astronomy 4 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021
An introduction to the basic physics of astronomy and astrophysics at the graduate level. Principles of energy transfer by radiation. Elements of classical and quantum theory of photon emission; bremsstrahlung, cyclotron and synchrotron radiation. Compton scattering, atomic, molecular and nuclear electromagnetic transitions. Collisional excitation of atoms, molecules and nuclei.
Radiation Processes in Astronomy: Read More [+]
Rules & Requirements

Prerequisites: Physics 105, 110A; 110B concurrently; open to advanced undergraduates with GPA of 3.70

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Chiang, Kasen, Quataert

Also listed as: PHYSICS C207

Radiation Processes in Astronomy: Read Less [-]

ASTRON 218 Stellar Dynamics and Galactic Structure 3 Units

Terms offered: Fall 2023, Fall 2021, Fall 2019
A basic course. Structure and kinematics of the galaxy; stellar population concepts; dynamics of stellar systems with and without encounters.
Stellar Dynamics and Galactic Structure: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Blitz, Davis, Graham

Stellar Dynamics and Galactic Structure: Read Less [-]

ASTRON C228 Extragalactic Astronomy and Cosmology 3 Units

Terms offered: Fall 2024, Fall 2022, Spring 2021, Fall 2016
A survey of physical cosmology - the study of the origin, evolution, and fate of the universe. Topics include the Friedmann-Robertson-Walker model, thermal history and big bang nucleosynthesis, evidence and nature of dark matter and dark energy, the formation and growth of galaxies and large scale structure, the anisotropy of the cosmic microwave radiation, inflation in the early universe, tests of cosmological models, and current research areas. The course complements the material of Astronomy 218.
Extragalactic Astronomy and Cosmology: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Holzapfel, Lee, Ma, Seljak, White

Also listed as: PHYSICS C228

Extragalactic Astronomy and Cosmology: Read Less [-]

ASTRON C249 Solar System Astrophysics 3 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017
The physical foundations of planetary sciences. Topics include planetary interiors and surfaces, planetary atmospheres and magnetospheres, and smaller bodies in our solar system. The physical processes at work are developed in some detail, and an evolutionary picture for our solar system, and each class of objects, is developed. Some discussion of other (potential) planetary systems is also included.
Solar System Astrophysics: Read More [+]
Rules & Requirements

Prerequisites: 149, 169, C160A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Chiang, de Pater

Also listed as: EPS C249

Solar System Astrophysics: Read Less [-]

ASTRON 250 Special Topics in Astrophysics 3 Units

Terms offered: Spring 2024, Spring 2022, Fall 2021
Topics will vary from semester to semester. See department for announcements.
Special Topics in Astrophysics: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Special Topics in Astrophysics: Read Less [-]

ASTRON 252 Stellar Structure and Evolution 3 Units

Terms offered: Spring 2022, Spring 2020, Fall 2017
Equations of stellar structure, radiative transfer and convection, thermonuclear reactions and stellar energy generations; stellar models, degenerate configurations, evolutionary sequences, supernovae, neutron stars, black holes, nucleosynthesis.
Stellar Structure and Evolution: Read More [+]

Rules & Requirements

Prerequisites: Physics 110A-110B, 112, 137A-137B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructor: Filippenko

Stellar Structure and Evolution: Read Less [-]

ASTRON C254 High Energy Astrophysics 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022, Fall 2018
Basic physics of high energy radiation processes in an astrophysics environment. Cosmic ray production and propagation. Applications selected from pulsars, x-ray sources, supernovae, interstellar medium, extragalactic radio sources, quasars, and big-bang cosmologies.
High Energy Astrophysics: Read More [+]

Rules & Requirements

Prerequisites: 201 or consent of instructor. 202 recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructors: Boggs, Quataert

Formerly known as: Physics C254, Astronomy C254

Also listed as: PHYSICS C254

High Energy Astrophysics: Read Less [-]

ASTRON 255 Computational Methods in Theoretical Astrophysics 3 Units

Terms offered: Spring 2020, Spring 2018, Spring 2016
A broad in-depth survey of state-of-the-art numerical approaches to astrophysical self-gravitational gas dynamics with application to large scale simulation of coupled non-linear astrophysical flows. Finite-difference approaches for Lagrangian and Eulerian astrophysical hydrodynamics and coupled radiation-hydrodynamics. N-body gravitation techniques including direct N-body, P-M, P3M, and hierarchical Tree. Particle gas dynamics methods such as smooth particle hydrodynamics (SPH), adaptive SPH and unification of SPH, and gravity tree hierarchies (TREE-SPH). Advanced techniques such as higher order Godunov finite difference methods with adaptive mesh refinement (AMR). Applications of these approaches in three broad areas: cosmology, high energy astrophysics, and star formation and the interstellar medium.
Computational Methods in Theoretical Astrophysics: Read More [+]

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructor: Klein

Computational Methods in Theoretical Astrophysics: Read Less [-]

ASTRON 256 Astronomy Data Science Laboratory 4 Units

Terms offered: Fall 2024, Fall 2022, Spring 2021
This course features 3 data-centric laboratory experiments that draw on a variety of tools used by professional astronomers. PhD students will learn to procure and clean data (drawn from a variety of world-class astronomical facilities), assess the fidelity/quality of data, build and apply models to describe data, learn statistical and computational techniques to analyze data (e.g., Bayesian inference, machine learning, parallel computing), and effectively communicate data and scientific results. There is a heavy emphasis on software development in the Python language, statistical techniques, and high-quality communication (e.g., written reports, oral presentations, and data visualization).
Astronomy Data Science Laboratory: Read More [+]
Rules & Requirements

Prerequisites: This class assumes that you have completed introductory astrophysical instruction (at the Astro 7A and 7B level) as well as knowledge of calculus (e.g. similar to Math 53) and linear algebra (e.g., similar to Math 54 or Physics 89).You should have proficiency or fluency in the Python programming language. This class heavily emphasizes software development, and is not the place to learn Python for the first time

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Instructor: Bloom

Astronomy Data Science Laboratory: Read Less [-]

ASTRON C285 Theoretical Astrophysics Seminar 1 Unit

Terms offered: Fall 2024, Spring 2024, Fall 2023, Fall 2022
The study of theoretical astrophysics.
Theoretical Astrophysics Seminar: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Quataert

Also listed as: PHYSICS C285

Theoretical Astrophysics Seminar: Read Less [-]

ASTRON 290A Introduction to Current Research 2 Units

Terms offered: Fall 2021, Fall 2020, Fall 2019
Professional Skills and Directed Reading (a.k.a. "how to be a professional astronomer")
Introduction to Current Research: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Lu

Introduction to Current Research: Read Less [-]

ASTRON 290B Introduction to Current Research 1 Unit

Terms offered: Spring 2020, Spring 2019, Spring 2018
Continuation of 290A. Study of a research topic with an individual staff member.
Introduction to Current Research: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: de Pater

Introduction to Current Research: Read Less [-]

ASTRON C290C Cosmology 2 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023, Spring 2023, Spring 2022
Cosmology: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: White, Cohn

Formerly known as: Physics C290C, Astronomy C290C

Also listed as: PHYSICS C290C

Cosmology: Read Less [-]

ASTRON 292 Seminar 1 - 2 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023
In addition to the weekly colloquium, the Department offers seminars in advanced topics, several of which are announced at the beginning of each semester. A maximum of 5 units may be taken per semester with a limitation of 2 in any one section.
Seminar: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Seminar: Read Less [-]

ASTRON C292 Planetary Science Seminar 1 Unit

Terms offered: Fall 2024, Spring 2024, Fall 2023
The departments of Astronomy and Earth and Planetary Science offer a joint research seminar in advanced topics in planetary science, featuring speakers drawn from graduate students, postdoctoral researchers, faculty, and visiting scholars. Topics will span planetary interiors; surface morphology; atmospheres; dynamics; planet formation; and astrobiology. Speakers will vary from semester to semester. Meetings will be held once a week for 1 hour each, and the schedule of speakers will be determined on the first day of class. To pass the class, participants will be required to give a 30-minute presentation, either on their own research or on recent results from the literature.
Planetary Science Seminar: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-1 hours of seminar per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Also listed as: EPS C292

Planetary Science Seminar: Read Less [-]

ASTRON 298 Directed Group Study 1 - 4 Units

Terms offered: Fall 2021, Fall 2020, Fall 2019
Tutorial for groups of two or three students.
Directed Group Study: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Directed Group Study: Read Less [-]

ASTRON 299 Advanced Study and Research 2 - 12 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023
Advanced Study and Research: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2-12 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Graduate

Grading: Letter grade.

Advanced Study and Research: Read Less [-]

ASTRON 301 Undergraduate Astronomy Instruction 1 - 2 Units

Terms offered: Fall 2004, Fall 2003, Fall 2002
Open to a limited number of highly qualified undergraduate students interested in astronomy teaching at the college level. Students will participate in a seminar on educational methods and engage in tutorial or laboratory teaching under supervision of a faculty member.
Undergraduate Astronomy Instruction: Read More [+]
Rules & Requirements

Prerequisites: An elementary astronomy course and consent of instructor

Repeat rules: Course may be repeated for credit up to a total of 4 units.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 3-6 hours of laboratory per week

Additional Details

Subject/Course Level: Astronomy/Professional course for teachers or prospective teachers

Grading: Offered for pass/not pass grade only.

Undergraduate Astronomy Instruction: Read Less [-]

ASTRON 602 Individual Study for Doctoral Students 1 - 8 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013
Individual study in consultation with the major field adviser, intended to provide an opportunity for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D. (and other doctoral degrees). May not be used for unit or residence requirement for the doctoral degree.
Individual Study for Doctoral Students: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-8 hours of independent study per week

Additional Details

Subject/Course Level: Astronomy/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.

Individual Study for Doctoral Students: Read Less [-]