

Astronomy

Chair: Andrea K. Dobson

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Courses are concerned with the planets, stars, and galaxies which compose the physical universe, and with the techniques for investigating the nature of these objects. The introductory courses contribute to a general understanding of our place in the universe. The advanced courses have frequent relevance for students in physics, chemistry, and other sciences.

Students interested in graduate work in astronomy are encouraged to major in physics-astronomy or in physics with an astronomy minor, since most graduate schools look for the equivalent of an undergraduate degree in physics. Some students with other interests also have designed individual combined majors such as astrobiology.

Distribution: Some courses completed in astronomy apply to the science and quantitative analysis distribution areas.

Learning goals: Upon graduation, a student will be able to:

- **Major-Specific Areas of Knowledge**
 - Accurately articulate in qualitative terms how the laws of physics explain observations of the universe and its constituents. Better understand how scientists ask questions about the universe and its constituents.
- **Accessing Academic Community/Resources**
 - Read and comprehend astronomical literature, progressing from popular level work as beginning students to technical articles as senior majors.
- **Communication**
 - Clearly describe orally the properties of the universe and its constituents. Clearly describe in writing the properties of the universe and its constituents.
- **Quantitative Skills**
 - Using mathematics and statistics through at least second-year calculus, accurately express in quantitative terms how the laws of physics explain observations of the universe and its constituents.
- **Research Experience**
 - Better understand how scientists take data, develop and evaluate models to explain the data, and present those models for scrutiny by others.
- **After College**
 - Intellectually capable students with combined or double majors in Physics-Astronomy or Astronomy-Geology who are interested in further study will be well prepared for graduate work in Astrophysics or Planetary Science.

The Astronomy major: Astronomy 177, 178, 179, 310, 320, 330, at least four credits from 350, 360, 380, 391, 392, and at least four credits from 490, 498; Physics 145 or 155 or 165, 156 or 166, 245, 246, 255, 256; Mathematics 125, 126, 225; introductory courses in geology and computer programming are strongly recommended. In the final semester the student must pass a senior assessment consisting of a comprehensive written examination and an approximately one-hour oral exam.

The astronomy major requires coursework in astronomy, physics, and mathematics and statistics. A student who enters Whitman with no prior college-level work in any of these areas would need to complete 32 credits in astronomy, 16 credits in physics, and 10 credits in mathematics and statistics.

The Astronomy minor: A minimum of 18 credits in astronomy, to include Astronomy 177, 178, 179, and six additional credits to be chosen from courses numbered 200 or above. Courses taken P-D-F may not be used to satisfy course or credit requirements for the minor after the minor has been declared.

The Astronomy-Geology combined major: Astronomy 177, 178, 179, two credits of 490, one of the following: 310, 320, 330, 350, 360, 380, and at least two additional credits in courses numbered 310-392; either Geology 110 and 111, 120 and 121, or 125 and 126; and Geology 227, 270, 350, 470 and a minimum of one credit in 358, two credits of 490, and two of the following: 310, 405, or 420; Physics 145 or 155, 156, Mathematics 125, 126, and Chemistry 125, 135 are also required. Computer Science 167; Mathematics 225, 244, Chemistry 126, 136, and Physics 245, 246, 255, 256 are strongly recommended. In the final semester, the student must pass a senior assessment consisting of a two-part comprehensive written examination and an approximately one-hour oral exam conducted jointly by astronomy and geology faculty.

The astronomy-geology combined major requires coursework in astronomy, geology, chemistry, physics, and mathematics. A student who enters Whitman with no prior college-level work in any of these areas would need to

complete 20 credits in astronomy, 27 to 28 credits in geology, four credits in chemistry, eight credits in physics, and six credits in mathematics

The Physics-Astronomy combined major: Astronomy 177, 178, 179, 310, and 320 or 330; at least two credits in any of the following: 320, 330, 350, 360, 380, 391, 392 or 490; Physics 145 or 155 or 165, 156 or 166, 245, 246, 255, 256, 325, 339, and one additional physics course numbered from 300-480 or BBMB 324; Mathematics 225 and 244. Additional physics courses, Computer Science 167, Mathematics 240, 367, and 368 are strongly recommended. In the final semester the student must pass a senior assessment consisting of a two-part comprehensive written examination and an approximately one-hour oral exam conducted jointly by physics and astronomy faculty.

The physics-astronomy combined major requires coursework in astronomy, physics, and mathematics and statistics. A student who enters Whitman with no prior college-level work in any of these areas would need to complete 22 credits in astronomy, 24 credits in physics, and 13 credits in mathematics and statistics.

110 Principles of Astronomy

Fall, Spring

Paust

4 credits

This course offers an introduction to our present knowledge of the universe and the historical development of humanity's changing understanding of the cosmos. Emphasis not only on the nature of planets, stars, and galaxies, but also on the evolutionary processes which occur in the universe, including cosmology and the origin of the elements, the formation and life cycles of stars, and the development of planetary systems. Three lecture/lab sessions per week. Not open to physical science majors.

177 Sky and Planets

Fall

A. Dobson

4 credits

A survey of planets and their motions, planetary satellites, comets, meteorites, and interplanetary material. Several problem sets and exams, short research paper, and one evening lab session each week. Offered in rotation with Astronomy 178, 179. *Prerequisites:* three years of high school mathematics and one year of high school physics, or consent of instructor; *Recommended prerequisite:* Mathematics 125 or 126.

178 Sun and Stars

Spring

A. Dobson

4 credits

An introduction to the properties of stars, their motions, and their distributions in space. Several problem sets and exams, short research paper, and one evening lab session each week. Offered in rotation with Astronomy 177, 179. *Prerequisites:* three years of high school mathematics and one year of high school physics, or consent of instructor; Mathematics 125/126 recommended.

179 Galaxies and Cosmology

Not offered 2018-19

4 credits

An introduction to the structure of galaxies and to the large-scale structure and evolution of the universe. Several problem sets and exams, short research paper, and one evening lab session each week. Offered in rotation with Astronomy 177, 178. *Prerequisites:* three years of high school mathematics and one year of high school physics, or consent of instructor; Mathematics 125/126 recommended.

227 Finding Our Place in the Universe

Not offered 2018-19

3 credits

A survey of cosmological discoveries and their impact on our understanding of our location in space and time. Several problem sets and exams, short research paper and oral presentation, and occasional outdoor labs. This course applies to the science distribution area, but not science with a laboratory. *Prerequisites:* three years of high school math and one year of high school physics, one previous college course in astronomy, or consent of instructor.

228 Exoplanets and the Search for Life in the Universe

Fall

A. Dobson

3 credits

A survey of planetary systems around other stars and current research into the possibilities for life elsewhere in the universe. Several problem sets and exams, short research paper and oral presentation, and occasional outdoor labs. This course applies to the science distribution area, but not science with a laboratory. *Prerequisites:* three years of

high school math and one year of high school physics, one previous college course in astronomy, or consent of instructor.

270 Astronomical Computing

Fall

Paust

1 credit

Astronomical study and research is heavily dependent on the use of computers for analyzing data as well as communicating that data to collaborators, other scientists, and the public. We regularly carry powerful computers in our pockets, ostensibly to make telephone calls, but the normal course of education does not teach how to undertake technical tasks on the computer. In this class, students will gain proficiency in many areas required for professional proficiency in astronomy. Namely, this will include Linux use and file management using a variety of desktop managers, typesetting documents in LaTeX, construction of scientific figures, and an introduction to astronomical programming in FORTRAN and python. *Prerequisite:* one of the following: Astronomy 177, 178, or 179.

310 Stellar Astrophysics

Not offered 2018-19

4 credits

Of interest to majors in physics or physics-astronomy, this course considers the application of the principles of atomic structure and the radiation laws to the interpretation of the spectra of stars and nebulae; the physical principles underlying the study of the structure of stars, energy generation by thermonuclear reactions, and nucleosynthesis; and theoretical and observational aspects of stellar evolution. Several problem assignments and a midterm examination. *Prerequisites:* Astronomy 178 and Physics 156 or 166, or consent of instructor. *Recommended prerequisite:* Physics 245. Offered in alternate years with Astronomy 320.

320 Galactic Astronomy

Fall

Paust

4 credits

Intended for physics-astronomy majors but also open to majors in related sciences. The constituents and structure of our own and other galaxies, the nature of quasars and active galaxies, and the large-scale structure of the universe itself. Reading assignments will be made in various books and scientific journals. Several problem assignments and a mid-term test. *Prerequisites:* Astronomy 179, Mathematics 225 and Physics 156 or 166, or consent of instructor. Offered in alternate years with Astronomy 310.

330 Cosmology

Spring

A. Dobson

4 credits

Intended for majors in physics-astronomy and related sciences. The study of the universe: how it originated, the formation and evolution of structures, the curvature of space and time. Several problem sets, exams, research paper. *Prerequisites:* Astronomy 179 and Physics 245, or consent of instructor. Offered in alternate years.

350 Planetary Science

Not offered 2018-19

4 credits

Intended for majors in astronomy, astronomy-geology, and related sciences. The study of solar system objects: interiors, surfaces, atmospheres, and orbital mechanics. Several problem sets, exams, research paper. *Prerequisites:* Astronomy 177, Physics 155 or 165, and Geology 110 or 120, or consent of instructor.

360 Observational Astronomy

Spring

Paust

4 credits

Intended for majors in astronomy, physics-astronomy, and related sciences. The study of observational astronomy across the full electromagnetic spectrum as well as gravitational waves. Specifically looking at detector technologies, telescope design, data reduction, the current state of the art in both ground-based and space-based observational astronomy missions, and the physics governing emission across the spectrum. Several problem sets, exams, project. *Prerequisites:* Astronomy 177, 178, and 179, or consent of instructor.

380 Special Topics in Astronomy

4 credits

Selected topics in contemporary astronomy and astrophysics; the precise area of study will be designated prior to registration for the semester in which the course is offered. *Prerequisite:* consent of instructor. Any current offerings follow.

391, 392 Directed Project

Fall, Spring

A. Dobson, Paust

1-4 credits

Discussion and directed reading and/or observational work on a topic of interest to the individual student.

Prerequisite: consent of instructor.

482 Astronomy Seminar

Spring

A. Dobson

1 credit

Oral reports by students on reading and research projects. Faculty and visiting scientist guest lectures. Discussion of recent works of importance to the field and problem-solving exercises. No examinations. One meeting per week.

May be repeated for a maximum of two credits. *Prerequisite:* consent of instructor.

490 Senior Research

Fall, Spring

A. Dobson, Paust

1-4 credits

An advanced interdisciplinary independent study project for astronomy or astronomy-combined majors; students wishing to do a senior research project should choose project advisers and propose an interdisciplinary topic during the second semester of their junior year. *Prerequisite:* consent of instructor.

498 Honors Thesis

Fall, Spring

A. Dobson, Paust

2-4 credits

Preparation of an honors thesis. Required of and limited to senior honors candidates in astronomy. *Prerequisite:* admission to honors candidacy.