Astronomy at Indiana University

General Information

The Astronomy Department at Indiana University, Bloomington, maintains a full program of activities in teaching, research and outreach. The department offers both an undergraduate major program leading to the B.S. degree in Astronomy & Astrophysics and a graduate program leading to the M.A. and Ph.D. degrees in Astronomy or Astrophysics. In addition, the department has range of introductory astronomy courses designed for students majoring outside of the sciences. There is also an Astronomy undergraduate minor program.

Education and research in astronomy at Indiana University has a long and proud history, beginning with Professor Daniel Kirkwood in 1856. His pioneering studies of asteroid orbits in the solar system are still widely recognized. The historic Kirkwood Observatory on campus dates from 1900 and is used for public viewing. Undergraduate Astronomy & Astrophysics majors use two computer-controlled 14" telescopes on the roof of Swain Hall. The doctoral program began in 1950 and has produced over 100 Ph.D. astronomers now engaged in teaching and research worldwide. The department has a wide range of powerful computing facilities for analyzing astronomical data from ground- and space-based telescopes, and for simulating astrophysical systems from planetary rings to distant clusters of galaxies.

WIYN Observatory

Indiana University is a founding member of the WIYN consortium which operates modern 3.5-meter and 0.9-meter telescopes at Kitt Peak, about 50 miles southwest of Tucson, Arizona. IU has 17% of the observing time on WIYN, which can be used both by traveling to Kitt Peak and by remote observing from Bloomington. WIYN is designed so that the 3.5-meter telescope produces superb image quality over a wide field. The One Degree Imager program is currently developing a camera that will maintain the WIYN 3.5-meter as one of the world's premier wide-field imaging telescopes. In addition to this imaging capability, WIYN is also equipped with a multiple object spectrograph that can obtain the spectra for nearly 100 objects simultaneously. Projects currently being pursued by Indiana University astronomers at WIYN include work on cataclysmic variable stars, dynamical studies of star clusters, stellar abundance determinations that bear on stellar interior theory and Big-Bang nucleo-synthesis, and studies of galaxy evolution.

What is Astronomy?

Astronomy is the study of the entire universe—its past, present and future. It seeks to answer the most fundamental questions humans ask about the nature of our universe and our place in it. One of the most exciting aspects of this field is the extraordinary discoveries of new objects and processes in the universe that are made on a daily basis. Powerful space-based observatories, such as the Hubble Space Telescope, the Chandra X-ray Observatory, and the Spitzer Infrared Space Telescope, allow us to peer even further out from Earth and back in time from the present to observe the origins of galaxies, stars, and planets. The rapidly advancing power of computers makes it possible to apply astrophysical principles to simulate the evolution of these objects and thus develop an understanding of their internal processes.

The topics covered in astronomy courses and research programs include: the solar system (Sun, planets, asteroids, and comets), the life cycles of stars, our Milky Way galaxy, other galaxies, clusters of galaxies, and the large-scale distribution of both luminous and dark matter in the universe.

Careers in Astronomy

There are a number of possible career paths in the field of astronomy. Since most professional positions in astronomy require graduate-level education, the Astronomy & Astrophysics undergraduate major at IU is designed to prepare students for graduate study leading to a Masters and/or Ph.D. degree. Most astronomy research is done at either universities or national facilities such as NASA centers (e.g. the Goddard Space Flight Center near Washington, DC) and the national and private observatories (e.g. the National Optical Astronomy Observatory in Tucson, Arizona or the Carnegie Observatory in Pasadena, California). Astronomers at universities typically spilt their time between carrying out research projects and teaching at the undergraduate and graduate levels. In addition to these research positions, other careers in astronomy involve teaching at the college of high school level, and working at planetariums and science museums, and working in computer support positions for NASA contractors. Related careers that build on an astronomical background include scientific writing, various positions in the aerospace, defense, surveillance, and environmental fields, and military work (particularly with the Air Force).

Astronomy Courses at IU

Of the following courses, the 100-level courses are designed for both non-science majors and students intending to minor in Astronomy. The 200, 300, 400-level courses are designed for students intending to major in Astronomy & Astrophysics and other science majors. The designation N & M indicates that a course counts for Natural & Mathematical Sciences-Natural Sciences distribution credit. The designation P indicates a prerequisite.

- **A100 The Solar System (3 cr.) N & M** Celestial sphere, constellations, apparent motions of celestial objects, eclipses, history of astronomy, astronomical observations, the Earth as a planet, the Moon, the planets and their satellites, comets, meteors, theories of the origin of the solar system. Credit not given for both A100 and A110.
- **A102 Gravity the Great Attractor: Evolution of Planets, Stars, and Galaxies (3 cr.) N & M (TOPICS/Freshman Seminar Credit)** The fundamental role of gravity in shaping the evolution of planets, stars, and other astrophysical systems is the underlying theme. Topics include planetary systems, white dwarfs, neutron stars, black holes, binary X-ray sources, gamma-ray bursts, galaxies, and the large scale structure of the Universe.
- **A103 The Search for Habitable Planets (3 cr.) N & M** The search for life and life-friendly environments in the universe is an interdisciplinary focus of modern science. This course explores the origin, nature, and history of other planetary systems, extrasolar planet detection, and the possibility of other technological civilizations.
- **A105 Stars and Galaxies (3 cr.) N & M** Introduction to the physical universe. Topics include constellations, gravity, radiation, the Sun, structure and evolution of stars, neutron stars and black holes, the Milky Way galaxy, normal galaxies, active galaxies, quasars, cosmology, and the search for extraterrestrial life. Credit not given for both A105 and A110.
- **A110 Introduction to Astronomy (3 cr.) N & M** Earth as a planet, satellites, and comets. The Sun. Properties of stars, stellar systems. Extragalactic objects. The nature of the observable universe. Credit not given for both A100 and A110, nor for both A105 and A110.
- **A115 Birth and Death of the Universe (3 cr.) N & M** Introduction to cosmology. Traces the ideas describing the origin and evolution of the universe from ancient geocentric cosmologies to the Big Bang cosmology. Labs will concentrate on observational astronomy. A115 will not be counted with A110.
- **A221-A222 General Astronomy I-II (4-4 cr.) N & M** P: College algebra and trigonometry or high school equivalent. For physical science majors. Introduction to modern astronomy and astrophysics, including basic principles of mechanics, optics, and radiation. Topics include solar system, stars, interstellar matter, galaxies, cosmology, and observational astronomy from radio to gamma rays.

- **A305 Modern Observational Techniques (4 cr.)** P: A221-A222, calculus, PHYS P201-P202 or P221-P222, consent of instructor. Telescopes, astronomical imaging, spectroscopic and photometric observations, and reductions.
- **A390 Reading Course (1-3 cr.)** P: A221, A222, consent of instructor. May be taken for a maximum of 6 credits.
- **A451 Stellar Astrophysics (3cr.)** This is a one semester course offered every other year in which basic physical principles are applied to investigation of the solar system, stars, and the Milky Way galaxy. The prerequisites are calculus and Physics P301 or equivalent.
- **A452 Extragalactic Astrophysics (3 cr.)** This is a one semester course offered every other year in which basic physical principles are applied to investigation of galaxy formation, galaxy evolution, large scale structure, and cosmology. The prerequisites are calculus and Physics P301 or equivalent.
- **A453 Topical Astrophysics (3 cr.)** P: Calculus, P301, or equivalent. Topics in astrophysics not covered extensively by other courses. The celestial mechanics, astrobiology, stellar interiors, stellar atmosphere, stellar populations, galaxy dynamics, and cosmology. May be repeated with a different topic for a maximum of 6 credit hours.
- **S499 Honors Research (3-6 cr.)** P: Consent of director of undergraduate studies. Students will carry out astronomical research closely supervised by a faculty member in the department. Students will write a research report and given an oral presentation during the second semester of their senior year. May be taken two semesters for a maximum of 6 credit hours.

Major in Astronomy and Astrophysics

Students must complete the following fundamental skills and distribution requirements for the B.S. in Astronomy and Astrophysics.

- Writing, same as the general requirements for the B.A. degree.
- Foreign language, 3 credit hours (or the equivalent) at or above the second-year level.
- Two courses in arts and humanities
- Two courses in social and historical studies
- Two courses in natural and mathematical sciences, fulfilled by major.

Concentration Requirements

Students must complete the following:

- Astronomy A221-A222, A305, and two of A451, A452, or A453.
- Physics P221-P222, P301, P331-P332, and two of P441, P442, P453, or P454.
- Mathematics M211, M212, M311, and M343.

Students must also complete the requirements and procedures listed under General Requirements for Bachelor's Degrees in this Bulletin.

Recommendations

The following additional physics courses are highly recommended for students planning graduate study in astronomy and astrophysics: P321, P340, and an additional 400-level sequence (P441-P442 or P453-P454). Other suggested courses are Physics P309, P350, P400, P410; Mathematics M312, M344, M365; Computer Science A221-A222 or C211-C212; Geological Sciences G121.

Minor in Astronomy and Astrophysics

A program leading to a minor in astronomy and astrophysics is provided for students who have a serious interest in the field but do not plan to major in the subject. To obtain a minor in astronomy and astrophysics, a student must take the following courses: two 100-level astronomy courses (all combinations are acceptable except A100 and A110, or A105 and A110), A221, A222, and one of A305, A320, A451, A452, or A453. Altogether, these provide at least 15 credit hours. A student must take all necessary prerequisites, including some mathematics and physics classes. Substitution of other astronomy courses may be made with the permission of the department. Replacement of 100-level astronomy courses by 300- or 400-level astronomy courses is encouraged. The cumulative GPA of all courses taken for the minor must be at least 2.0.

Astronomy Honors

The honors program is designed for superior students who plan to pursue graduate studies in astronomy and astrophysics. Students wishing to pursue the honors program should contact the undergraduate advisor in the Department of Astronomy during the second semester of their sophomore year or first semester of their junior year. To be admitted to the honors program, students must have a minimum overall GPA of 3.3 and a minimum GPA of 3.3 in their astronomy, mathematics, and physics courses. Students must maintain these GPAs to receive a degree with honors in astronomy and astrophysics.

In the honors program, students complete the same requirements as the regular B.S. in astronomy and astrophysics and in addition take Astronomy S499 Honors Research. Astronomy S499 is to be taken one or both semesters during the senior year, and counts for 3 credits each time it is taken. Students will carry out research supervised by a faculty member in the department. During the second semester of the senior year, the student will write a research report and make an oral presentation describing the work to the Department of Astronomy in a mini-colloquium.

Recommended Schedule for Honors Astronomy and Astrophysics Program

Freshman

- Astronomy A221-A222 (Students with good high school preparation in physics and mathematics are encouraged to take A221-A222 during the freshman year.)
- Mathematics M211-M212
- Physics P221-P222

Sophomore

- Astronomy A221-A222 (if not taken during freshman year)
- Mathematics M311 and M343
- Physics P301

Junior

- Astronomy A305 and one of A451, A452, A453 (A305 is offered in alternative years)
- Physics P331-P332 and P453 (if taking the P453-P454 sequence; P453 is taught in the spring semester, and P454 is taught in the fall semester.)

Senior

- Astronomy A305 (if not taken during junior year), one of A451, A452, A453, and S499
- Physics P441-P442 or P454

Contact Information

For information on Astronomy Department courses and the graduate and undergraduate programs, please contact the, Christina Lirot, at (812) 855-6911 or by email at clirot@indiana.edu. General astronomy questions may be directed to astdept@indiana.edu. The IU Astronomy Department website is: www.astro.indiana.edu and the Indiana University Bloomington website is: www.iub.edu. More specialized questions regarding the department should be sent to the appropriate individual listed below:

Chair of the Department
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