Program Request for Astronomy Minor

Department of Physics

College of Science

March 8, 2006

Astronomy Minor

Sponsoring Department: PHYSICS

Course Listings in Astronomy:
ASTR 1050 (The Solar System)
ASTR 1060 (The Universe)
ASTR 1080 (The Search for ET)
ASTR 2060 (Popular Observational Astronomy)
ASTR 3060 (Intro to Astrophysics)
ASTR 4060 (Observational Astronomy)
ASTR 4080 (Intro to Cosmology)
ASTR 5590 (Intro to Astrophysics Honors)
ASTR 5580 (Intro to Cosmology Honors)

Astronomy Program:

Astronomy is a profound and fundamental science that has never ceased to fascinate the general public and attract the imagination of students. We want to offer our students the opportunity to explore astronomy through a minor degree program. The intent is to provide sufficient background to enable a student with an astronomy minor to pursue graduate work in astrophysics.

Requirements for the minor:

Astronomy minors must complete all general education and College of Science requirements and have a GPA of at least 2.0 in physics, astronomy and mathematics courses combined. All physics, astronomy and mathematics courses must be passed with at least a C- grade. The credit/no credit option may not be elected for any course used to fulfill the degree requirements for an astronomy minor.

To obtain an undergraduate minor in astronomy, a student must complete at least 17 hours of approved course work, consisting of the following required and recommended courses.

Required courses:

ASTR 3060 (3); 4060 (3); 4080 (3)
PHYS 3740 (3) (Intro to Quantum and Relativity)

Recommended courses:

ASTR 5590 (3), 5580 (3)
MATH 2210 (3) (Calculus III), 2250 (3) (Ordinary Differential Equations & Linear Algebra), 3150 (2) ((Partial Differential Equations), 3160 (2) (Complex Variables)
PHYS 2210 (4), 2220 (4) (Physics for Scientists and Engineers), 3730 (4) (Computational Physics), 3760 (3) (Thermodynamics), 4420 (4) (Theoretical Electricity & Magnetism)

Students may obtain proposed minor approval from Lynn Higgs, 201 JFB.

Justification for Number of Credits

The number of credit hours required for the Astronomy Minor, 17, is similar to the number of hours required by other minors already in existence at the University of Utah. In addition, this number of required hours is sufficient to expose the students to current research and techniques in astronomy, but at the same time allow the target student audience for the minor to include it in a complete program of study.

External Review and Accreditation

No external consultants were involved in the development of this program and no professional accreditation is required. The primary goal of this program is to provide students with an understanding of the fundamentals of astronomy and cosmology. It is not intended to prepare students for employment as a professional astronomer. Students wishing to pursue a career as a professional Astronomer or Astrophysicist need to complete the B.S. Degree in Physics that is offered by the Department of Physics, and then follow this degree with a graduate degree in Physics or Astronomy.

Current Astronomy Program at the University of Utah

The University of Utah currently does not offer an undergraduate major in Astronomy, nor a Graduate program in Astronomy, but it does offer a Physics graduate degree with an emphasis in Astrophysics. The University of Utah Department of Physics has a long-term strategic plan to establish an Astronomy Major at the University of Utah, as well as an Astronomy graduate degree program. The proposed Astrophysics Minor is designed with and is consistent with the goals of this long-term strategic plan. As a part of this plan, the University of Utah *Department of Physics* is in the process of changing its name to the *Department of Physics and Astronomy.*

Program Necessity

There are three groups of students that will benefit from the creation of an Undergraduate Minor in Astronomy. These groups include: 1) Physics students interested in pursuing a career in Astrophysics, Astronomy & Cosmology, 2) engineering and science students that have an interest in Astronomy, Astrophysics & Cosmology, and 3) non-science students who have a strong interest in astronomy who seek a strong background in astronomy, without pursing a full Physics major. This category might include individuals intent on teaching science at the high school or community college level.

Many incoming freshmen that are interested in pursuing a Physics degree are motivated by a general interest in Astronomy, Astrophysics and Cosmology. Many times this interest is sparked by educational science programs (NOVA, Nature), popular magazines (Scientific American, Discover, Popular Science) and visits to local planetariums. Although these students may have a strong interest in Astronomy, the University of Utah does not offer a major in Astronomy. Students interested in pursuing Master's level and PhD work in Astronomy need a solid background in Astronomy upon graduation, typically this requires a three-course junior/senior level sequence in Astrophysics, Observational Astronomy, and Cosmology. In designing this Minor in Astrophysics, we coordinate the existing astrophysics courses offered within the Physics Department to provide this three-course sequence, and provide the student with the

background and certificate recognition necessary to open up new options for graduate level study.

The second group of students that will benefit from the creation of an Undergraduate Minor in Astronomy is engineering and science students that have an interest in Astrophysics and Astronomy. At present there is no incentive for these students to take more than one or two introductory Astronomy courses. However, the existence of an Astronomy Minor would encourage students with a strong interest to continue the pursuit of additional Astronomy courses beyond their initial foray into the field.

The third group of students who may benefit from the creation of the Minor in Astronomy includes non-traditional students, such as individuals majoring in high school science education, or intent on teaching at local community colleges, working at local museums, planetariums, etc. These individuals already have nearly full curriculum requirements in Education; it would be impractical for them to complete their primary degree as well as a Physics Major. The proposed minor in Astronomy provides a complete background in current topics in Astronomy including interesting topics in black holes, neutron stars, star formation, galaxy formation, and cosmology, as well as, practical experience in observational Astronomy. This knowledge is essential preparation for interpreting and understanding new developments in science that are described daily in the newspapers, and which can be applied directly to increase student interest and aptitude in general fields of science, as well as teaching students how to successfully setup their own observations, thereby stimulating the student's natural curiosities.

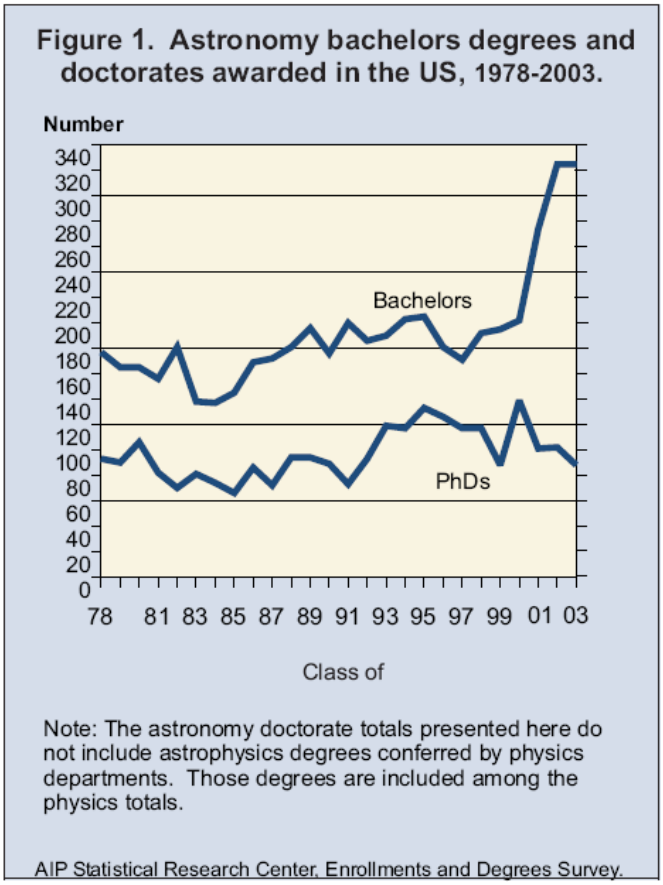
Similar Programs

A total of 574 colleges and universities in the United States offer a B.S. degree in Physics. In terms of Astronomy Departments, there are 62 undergraduate degree-granting programs in Astronomy in the United States; about half of these programs are located within the above Physics Departments, the remaining are programs established within an independent department of Astronomy. In terms of local programs, the nearest Undergraduate programs in Astronomy are located in Flagstaff, AZ; Boulder, CO; and Los Angeles, CA. Consequently, the establishment of an undergraduate Minor degree will provide additional motivation for our best high-school students to remain within the state rather than travel to other states to pursue their science interests.

The study program outlined in this proposal is consistent with Astronomy Minor programs offered by the majority of United States collegiate and university Astronomy Programs offering a Minor Degree in Astronomy. The typical program requires three junior/senior level Astronomy courses: one semester in Stellar Astrophysics, one semester in Observational Techniques, and one semester in Modern Cosmology.

Benefits

The University of Utah and the USHE benefit by offering an Astronomy Minor program because it responds to the needs of our undergraduate student population. When students have options such as this open to them they will be more likely to stay in state for their Bachelor's Degree program.



Female undergraduate students will also strongly benefit from this program. The number of undergraduate astronomy majors has been growing remarkably over the past few years (Figure 1). This renewed interest in astronomy among undergraduates is particularly strong among female undergraduates; 41% of all astronomy majors in the US are now awarded to female students, compared to 23% of all Physics undergraduate degrees. Astronomy appears to appeal to female undergraduate students as being substantially more accessible and interesting compared to the standard Physics program. Consequently, offering the Astronomy Minor provides the University of Utah with a unique opportunity for strongly increasing the participation of underrepresented minorities in the physical sciences.

Consistency with Institutional Mission

The proposed Astronomy Minor program is consistent with and appropriate to the University of Utah mission toward undergraduate and graduate education, research and scholarship. This undergraduate program will provide high quality academic, professional, and applied learning opportunities designed to advance the intellectual well-being of the students who enroll in it. In doing so, the Astronomy Minor will be consistent with the institutional mission of the university.

Institutional Impact

Projected Enrollment

The projected enrollment of students interested in the astronomy minor would be about 10 students/year. This number is based upon current enrollment in the core courses of the Astronomy Minor. The student mix is approximately 50% from Physics and 50% from engineering and other sciences. The enrollment in the program is likely to be in the same range for the first few years and increase to 20-25 students/year as the availability of the program becomes better known.

Expansion of Existing Program

The Astronomy Minor is not an expansion of any existing program and will not require any additional courses.

Faculty

No additional faculty will be required; current faculty, materials and facilities can absorb the additional student load.

Staff

No additional staff will be required; current staff can meet the needs of the additional student load.

Library

The University of Utah's Marriott Library currently has all of the materials required to offer an Astronomy minor program as described in this proposal.

Other Learning Resources

No additional learning resources are required to support this program.

Finances

Budget

No additional resources are required, either as new funding or reallocation of existing budgets.

Course descriptions:

1050 The Solar System (3) Fulfills Physical/Life Science Exploration.
Astronomy--from ancient to modern times. Central theme will be the attempt to understand the nature and origin of our solar system starting with early ideas of the cosmos, proceeding through investigations that led to the scientific revolution of the 17th century and culminating with the observations and discoveries made by the 20th-century space program. Topics will include apparent motions of the sun, moon, planets, and stars; seasons and eclipses; principles of light and telescopes. Films of the Mariner, Viking, Voyager, Galileo, and Pathfinder missions and the latest Hubble images will be included.

1060 The Universe (3) Fulfills Physical/Life Science Exploration.
Modern astronomy--central theme will be modern science's attempt to understand the nature and origin of the universe at large, including the matter and radiation that make it up. Specific topics include stars, exotic stellar objects (white dwarfs, red giants, neutron stars and black holes), supernova explosions, the origin of atomic elements, galaxies, giant radio sources, quasars, clusters of galaxies, the fabric of space and time, and Big Bang cosmology.

1080 Does Extraterrestrial Intelligence Exist? (3) Fulfills Physical/Life Science Exploration.
Most arguments for the existence of extraterrestrial intelligence (ETI) rest on the Principle of Mediocrity, which asserts that on the cosmic scale there is nothing special about either the earth or the human beings who inhabit it- so intelligent extraterrestrials ought to exist. We will discuss the possibility of finding them by radio searches currently in progress, or by direct contact via future space exploration. If we're nothing special, then ETIs should have developed millions of solar systems long before ours did and the presence should already be known to us. Yet, we've never seen a single shred of evidence to support the existence of ETI, so where are they? This seemingly innocuous question represents a paradox whose scientific and philosophical implications will be fully explored. We will make reasonable estimates of the number of ETIs that co-inhabit our galaxy based upon our current understanding of cosmology, stellar and planetary evolution, anthropology, the nature of life, and evolutionary processes that have produced the human species, the probable sociology and philosophy of intelligent civilizations, and the possible evolution of noncarbon-based ETI. If we conclude that the number of ETIs is small then we must explain the uniqueness of our existence, given the Principle of Mediocrity. But, if we conclude that the number is large, then we must ask the question, so where are they? Either conclusion has profound consequences for the continued existence of the human species. All speculation is based on sound scientific principles and current theories and facts drawn from a highly diverse set of scientific principles.

2060 Popular Observational Astronomy (3) Prerequisites: Elementary Algebra, PHYS 1060 or 1070.
This course will serve as an introduction to the tools and techniques used in optical and radio astronomy. Using the facilities at the University of Utah Observatory, we will explore the cosmos and study the Sun, planets, asteroids, stars and galaxies. Measurements of basic properties of astronomical objects will be performed. Quantitative analysis of these measurements will enable us to determine such things as the mass of jupiter as well as the ages of stars.

3060 Introduction to Astrophysics (3) Prerequisites: PHYS 2220, or equivalent. Recommended Prerequisite: PHYS 3760, 4420, 3740, or equivalent.

A core course in astrophysics including observational astronomy (celestial coordinates, astronomical instruments), stellar astrophysics (radiation and energy transport, stellar evolution, star formation), compact objects and black holes.

4060 Observational Astronomy for Scientists (3) Prerequisites: ASTR 3060. Recommended prerequisites: Familiarity with computers, PHYS 2220.

This course will serve as an introduction to the tools and techniques used in optical and radio astronomy. Using the facilities at the University of Utah Observatory, we will explore the cosmos and study the Sun, planets, asteroids, stars and galaxies. Measurements of basic properties of astronomical objects will be performed. Quantitative analysis of these measurements will enable us to determine such things as the mass of Jupiter as well as the ages of stars.

4080 Introduction to Cosmology (3) Prerequisite: PHYS 3740, ASTR 3060, or equivalent.

A core course that explores modern cosmological ideas explaining the expansion and age of the Universe, the existence and properties of the cosmic microwave background radiation, the origin of the light elements in the Universe, and the formation of large scale structures in it, such as galaxies and clusters of galaxies. The course also reviews the properties of the very early universe and the motivation for the cosmological inflation theory. Although this course focuses on theoretical rather than observational aspects, it is based on a physical approach to cosmology instead of detailed mathematical one.

5590 Introduction to Astrophysics (Honors) (3) Prerequisites: PHYS 2220, or equivalent. Recommended Prerequisite: PHYS 3760, 4420, 3740, or equivalent.

Meets with ASTR 3060. This is the honors version of ASTR 3060. Completion of additional material and/or assignments will be required for credit. A core course in astrophysics including observational astronomy (celestial coordinates, astronomical instruments), stellar astrophysics (radiation and energy transport, stellar evolution, star formation), compact objects and black holes.

5580 Introduction to Cosmology (Honors) (3) Prerequisite: PHYS 3740, 3760, 4410, 4420 and MATH 2250 or equivalent.

Meets with ASTR 4080. This is the honors version of ASTR 4080. Completion of additional material and/or assignments will be required for credit. A core course that explores modern cosmological ideas explaining the expansion and age of the Universe, the existence and properties of the cosmic microwave background radiation, the origin of the light elements in the Universe, and the formation of large scale structures in it, such as galaxies and clusters of galaxies. The course also reviews the properties of the very early universe and the motivation for the cosmological inflation theory. Although this course focuses on theoretical rather than observational aspects, it is based on a physical approach to cosmology instead of detailed mathematical one.