Goals of the Berkeley Undergraduate Program in Astrophysics

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The Department of Astronomy offers a program of instruction that is designed to ground students in the theory and practice of modern astrophysics. Students are exposed to a rich phenomenology spanning the birth and fate of stars, the origin and evolution of planetary systems, high-energy processes in the vicinity of black holes and neutron stars, structure formation in the universe a large, and the geometry and evolution of spacetime. They are taught the fundamental physics underlying these diverse phenomena. The curriculum provides formal training in quantitative reasoning, teaching students to work from first principles. Furthermore, undergraduate majors acquire extensive hands-on experience collecting and analyzing astronomical data.

A primary goal of the Astrophysics major is to prepare students for graduate work in astrophysics and related fields (physics, math, earth & planetary science). Another goal is to train a scientific and technically literate workforce (e.g., teachers, field engineers, hardware/software developers, and science writers).

Our Methods:

The Astrophysics major consists of (a) one lab class: Astro120 (Optical/Infrared), 121 (Radio); (b) two out of the three core upper-division classes: Astro 160 (Stellar Physics), Astro C161 (Relativistic Astrophysics & Cosmology), and Astro C162 (Planetary Astrophysics); and five additional upper-division electives. Majors are encouraged - but not required - to take the two-semester lower division Introduction to Astrophysics classes, Astro 7A and 7B, as preparation for the above courses (most majors do). Highly recommended upper division electives include physics and math classes.

The required load of 3 "in-house" astronomy classes is light by design; we encourage students to study more physics and math. The rationale is that astrophysics is, to a large extent, a field of applied physics: astronomers use physics and math to quantitatively understand astronomical phenomena. Double majoring in physics is encouraged, and nearly one half do.

A key feature of the Astrophysics major, and one that has garnered recognition and commendations at the National level, is its heavy emphasis on laboratory work. This emphasis reflects the nature of astronomy as an empirical, observation-driven science. Each lab is extremely demanding (median of 20 hours per week), and teaches the full complement of skills in observational astronomy: instrument design, data acquisition, data analysis, technical writing, and oral presentation. The instructional techniques employed by the labs adopt

educational "best practices": peer instruction and inquiry-based learning. The rewards of the lab classes commensurate with the intensity of the experience; though only one lab is required, some students take more. The skills learned in hardware/software development and error analysis are directly portable to a variety of technical fields other than astronomy. The most capable and motivated undergraduates matriculate from the lab classes into research groups.

In recent years, the increasing cross-talk between astrophysicists and geophysicists, spurred by spacecraft missions, the discovery of extrasolar planets, and the possibility of detecting life on other worlds,has motivated the major program to develop a "Planetary Science Track." The electives of this track are chosen from Physics, Earth & Planetary Sciences (EPS), and Chemistry Department offerings.

Finally, a hallmark of a degree in astrophysics is the ability to make order-of-magnitude estimates. The ability of this skill - which is necessary in astronomy partly because the systems is interest cannot be manipulated and are too remote to permit detailed characterization - extends far beyond the confines of astronomy (e.g., consultants must routinely make educated guesses about complex markets). Here the Astronomy Department arguably fills a gap left open by a traditional education in Physics.