Welcome to Astronomy 45 – Fall 2002
Introduction to Astrophysics
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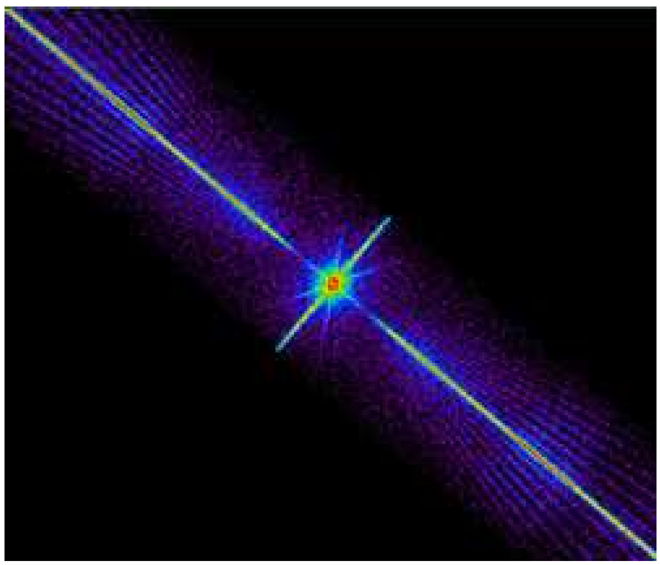
This brochure introduces you to some basic concepts that will be discussed in the course.

Chandra image of edge of accretion disk around black hole XTE J1118+480 in constellation Ursa Major.

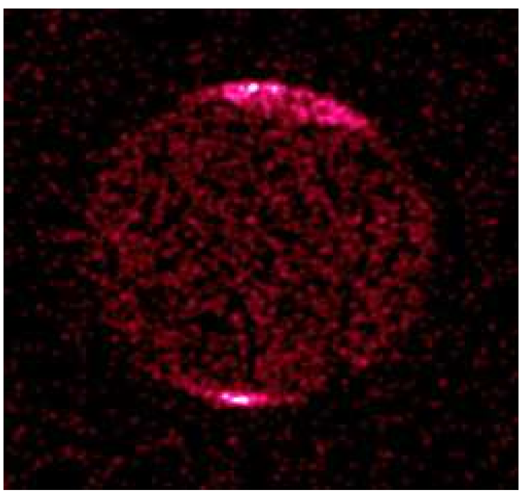


Introduction to Astrophysics
Formal Course Description

An introduction to the concepts and methods of astrophysics, including a discussion of astronomical measurements and stellar magnitudes, and a systematic account of the astrophysical nature of radiation, planetary motion, tidal interactions, binary stars, galactic dynamics and cosmology.

Astrophysics is the science of understanding the universe by investigating its physical processes and principles. These are exciting times in modern astrophysics. Space observatories such as Hubble Space Telescope (HST – http://hubble.stsci.edu/) and our own Chandra X-ray Observatory (Chandra - http://chandra.harvard.edu/) are opening up clear windows into the vast and distant Universe. While HST "sees" the Universe in the infrared to soft ultraviolet (2400 – 200 nanometer) wavelengths (our eyes see in the 700-400 nm range), Chandra uncovers the X-ray universe (hot and "unseen" matter- neutron stars and black holes and the like) in the 10 nm and less wavelength range.

Jupiter image from Chandra, showing the auroral X-rays near the north and south magnetic poles on February 27, 2001. Courtesy of NASA/CXC/SAO.

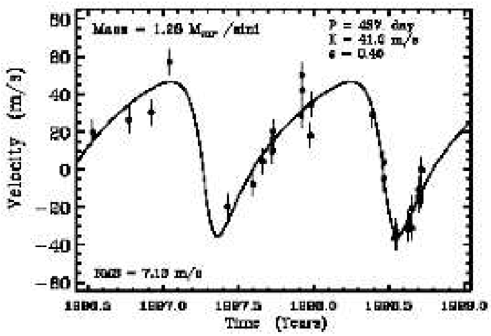


Deployment of Chandra satellite on July 23,1999. Courtesy of NASA/CXC/SAO

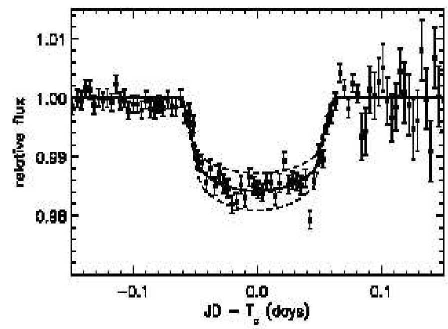
These remarkable images come to us in bits of light (i. e. electromagnetic radiation) from far corners of our solar system and galaxy, the interstellar medium, and extragalactic space. It is the understanding the basic concepts and principles of astrophysics (distance, velocity, brightness and color, and temperature measurements, emission and absorption of radiation and its extinction by the medium, orbiting motion and dynamics of motion of planets around a central star- be it our own solar system or other planetary systems, transfer of matter from one orbiting object onto another, stellar structure and interstellar gases, and the expansion of the Universe) that comprises the material in this course.

A couple of examples:

In this course, we study the concepts of energy density and radiation flux from an illuminating object and their relations to distance to the observer, temperature, size and mass. In another context, we learn about binary systems under the influence of gravitational forces. Relations between radial velocity and mass for the binary system are obtained. It turns out that these concepts are used in detection of extrasolar planets and/or brown dwarfs about main-sequence stars to learn about size, mass, period of the orbit, and distance to Earth (http://cfa-www.harvard.edu/planets/).



Radial velocity measurement of extrasolar planet HD210277



Transit of extrasolar planet HD209458

The concept of redshift is central to understanding astronomical spectra (absorption or emission of light from heavenly objects). Because the speed of light is finite, albeit very large, and objects move also with some finite velocity, the frequency and wavelength of light changes. The redshift refers to the increase in wavelength (corresponding decrease in frequency) of the light emitted by an object in time. One such example is the absorption of light by neutral hydrogen and singly-ionized helium in the spectra of quasars. Quasars are incredibly luminous objects that shine with the brightness of hundred galaxies and have very large redshifts. Quasar HE2347-4342 has recently been observed to absorb at a wavelength of 1181 Angstrom (ultraviolet wavelength), see spectrum below. This corresponds to a redshift of approximately z~ 2.9 (He II transition) which translates to a distance of roughly 12 billion light years- Science, 293, 1112(2001).