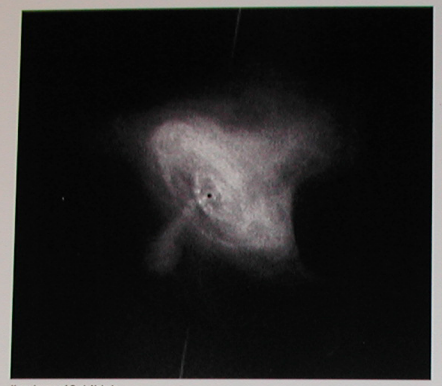
The Chandra X-ray Observatory, launched into Earth orbit in 1999, is designed to observe X rays from high-energy regions of the universe such as the remnants of exploded stars, or supernovas. X rays provide information about events and processes in deep space that cannot be seen in visible light, for one reason because of intervening dust. The spacecraft is in an unusually high, elliptical orbit, reaching one third of the distance to the moon's orbit at its farthest and swooping down to 10,000 km (6,200 miles) from Earth. The Chandra control center is on the MIT campus.



X-ray Image of Crab Nebula
NASA/CXC/SAO
This is Chandra's raw image of the most studied object outside the solar system-the Crab Nebula, remnant of a supernova that Chinese astronomers observed in 1054 A.D. At its center is a pulsar, a neutron star spinning 30 times a second and flinging particles into space at nearly the speed of light, forming rings that emit X rays. The bell shape is caused by synchrotron radiation from a huge bubble of high-energy electrons several light years in diameter. The nebula (the term arose when such fuzzy objects were not understood) producing energy at the rate of 100,000 suns. The Crab is about 6,000 light years from Earth.

X-ray Image of Crab Nebula Adaptively Smoothed
NASA/CXC/SAO
Smoothing can bring out more detailed structural information from raw data. Essentially, the process replaces the value of the intensity of each pixel with the average of its neighbors. Smoothing techniques vary in how many neighboring pixels are included. Here the ring structure is made easier to see. False color was added. The lighter, the more intense the X-ray emissions.

Crab Nebula Through Different Eyes
The same object can look quite different depending on the wavelength being observed and the nature of the signal processing. All four images here are of the Crab Nebula as seen on Aug. 29, 1999. At the upper left is a version of the Chandra image with less smoothing than in the big image above. (This is the version originally released to the media.) The next three images show the Crab at progressively longer wavelengths (and lower energies) of the electromagnetic spectrum. At the upper right is a ground-based optical telescope observation. At the lower left is an infrared image, showing radiation not only from the hot gases but from dust particles in the supernova's expanding cloud. Finally, a radio image. Radio waves come from the lowest energy electrons. They can travel the greatest distance and define the full extent of the nebula.

Upper Left:
X-Ray Image
NASA/CXS/SAO

Upper Right:
Optical Image
Palomar Observatory

Lower Left:
Infrared Image
W.M. Keck Observatory

Lower Right:
Radio Image
VLA/NRAO