CHANDRA
X-RAY OBSERVATORY CENTER
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CRAB NEBULA

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CRAB NEBULA

The Crab Nebula consists of the Crab pulsar surrounded by a diffuse cloud, or nebula. It was created in a supernova explosion seen on Earth in 1054 AD. The supernova was described by Yang Wei-te, the court astronomer (astrologer) to the Chinese Sung emperor, and may be the basis of two petroglyphs found in the US southwest.

We now see the Crab Nebula as it appeared 945 years after the supernova. The Crab Nebula is 6000 light years away and lies in the constellation Taurus. Its name derives from the resemblance of the optical nebula to a claw of a crab. The pulsar, which was discovered by radio astronomers in 1968, emits periodic flashes of radiation 30 times a second. These flashes are produced by a beam of radiation from a rapidly rotating neutron star.

The Neutron Star in the Crab Nebula

Neutron stars are extremely dense, with a mass slightly greater than the sun compressed into a sphere only 20 km across. The strong gravity of the star packs the neutrons in its core more tightly than neutrons are packed in the nucleus of an atom.

The neutron star in the Crab spins one full revolution each 33 milliseconds. This means that a point on the equator of the neutron star travels at roughly 4 million miles per hour. The star was spun up when it collapsed from a normal, large and relatively slowly rotating, star down to the compact size of the neutron star. The effect is the same as when a twirling ice skater pulls in her arms and spins faster.

The neutron star's rotation powers the radiation we see from the pulsar and the nebula. The neutron star has a strong magnetic field, 10 trillion times as strong as the magnetic field of the Earth. Because the star is rotating, the magnetic field acts like a gigantic electric power generator. The Crab neutron star produces a total power equal to 100,000 times the power output by our sun. Generating this power slows down the neutron star; the period of rotation of the Crab pulsar is increasing by 15 microseconds per year.

NASA's Chandra X-ray Observatory Reveals Details of Crab Powerhouse

The Chandra X-ray Observatory image of the Crab Nebula shows the central pulsar, or neutron star, surrounded by tilted rings or waves of high-energy particles that appear to have been flung outward over the distance of more than light year from the pulsar. Jet-like structures produced by high-energy particles blasting away from the pulsar in a direction perpendicular to the rings are also visible.

The diameter of the inner ring is more than 200 times the diameter of our solar system. The X rays from the Crab Nebula are produced by high energy particles spiraling around magnetic field lines in the Nebula. The bell-shaped appearance of the Nebula could be due to the interaction of this huge magnetized bubble with clouds of gas and dust in the vicinity.

The radiation Chandra observes from the Crab Nebula is produced mainly by high-energy particles accelerated by the neutron star. These energetic particles, which near the neutron star are thought to include anti-matter positrons as well as electrons, spiral around magnetic field lines in the nebula and give off radiation by the synchrotron process.

Chandra's X-ray image of the Crab Nebula traces the most energetic particles being produced by the pulsar. This amazing image reveals an unprecedented level of detail about the highly energetic particle winds and will allow scientists to probe deep into the dynamics of this cosmic powerhouse.

Chandra X-ray Observatory image made with the Advanced CCD Imaging Spectrometer (ACIS)/ High Energy Transmission Grating (Credit: NASA/CXC/SAO)

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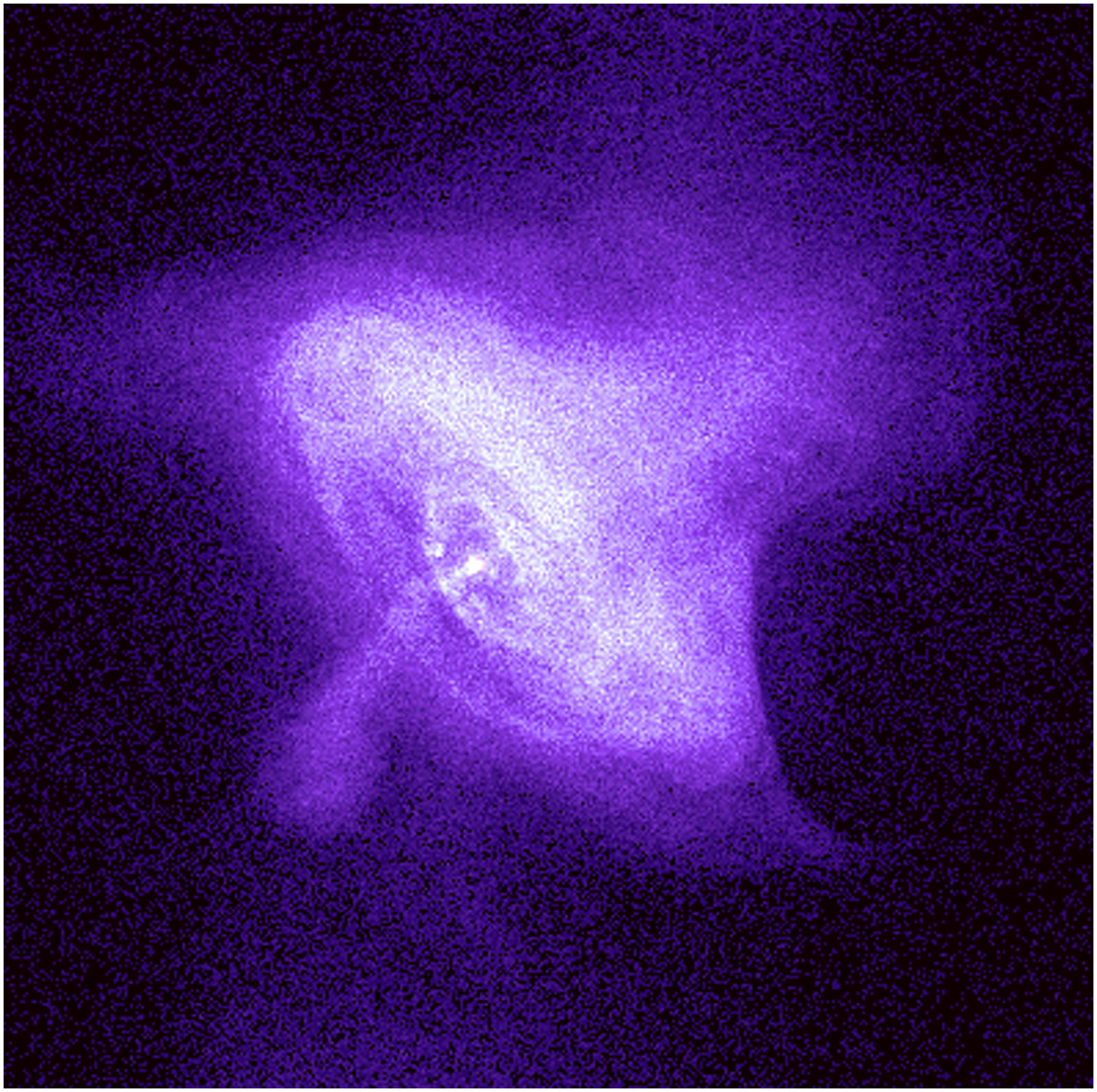
Supernova Remnant & Pulsar



Chandra image made with the Advanced CCD Imaging Spectrometer (ACIS)/High Energy Transmission Grating

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