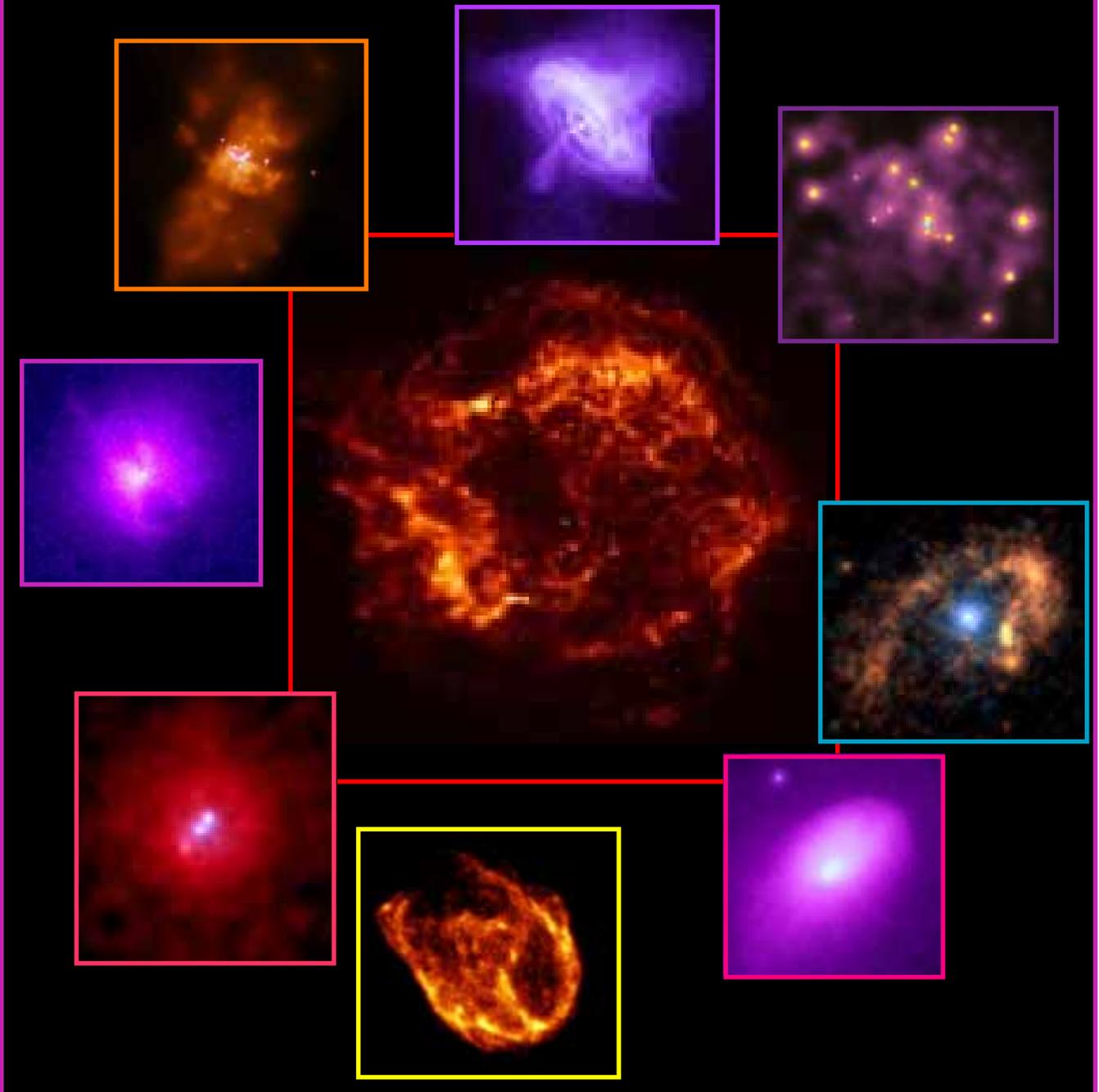




The Chandra
X-Ray Center

Chandra X-Ray Observatory

Early Images



NASA
Marshall Spaceflight Center



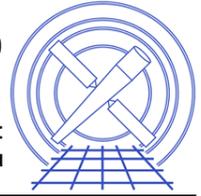
Smithsonian
Astrophysical Observatory

CHANDRA X-RAY CENTER

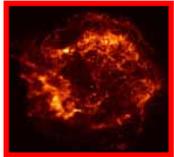
Harvard-Smithsonian Center for Astrophysics
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Early Images

For more information, visit:
<http://chandra.harvard.edu>



The Chandra X-Ray Observatory, launched on July 23, 1999, has taken its place with the Hubble Space Telescope and Compton Gamma Ray Observatory in NASA's fleet of Great Observatories. As the world's premier X-ray observatory, Chandra gives astronomers a powerful new tool to investigate the hot regions of the universe where black holes, exploding stars, and colliding galaxies hold sway.



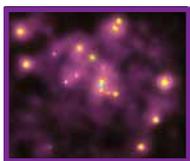
Cassiopeia A: Located in the constellation Cassiopeia, supernova remnant Cassiopeia A (Cas A) is 10 light years across and 10,000 light years from Earth. This image is the official first light image of the Chandra X-ray Observatory. Two shock waves are visible: a fast outer shock and a slower inner shock. The inner shock wave is believed to be due to the collision of the ejecta from the supernova explosion with a circumstellar shell of material, heating it to a temperature of ten million degrees. The outer shock wave is analogous to an awesome sonic boom resulting from this collision. The bright object near the center may be the long sought neutron star or black hole that remained after the explosion that produced Cas A. (NASA/CXC/SAO)

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Crab Nebula: The explosion from this supernova remnant and pulsar in the constellation Taurus was seen on Earth in 1054 AD. At the center of the nebula is a rapidly spinning neutron star, or pulsar that emits pulses of radiation 30 times a second. The image shows the central pulsar surrounded by tilted rings of high-energy particles that appear to have been flung outward over a distance of more than a light year from the pulsar. Perpendicular to the rings, jet-like structures produced by high-energy particles blast away from the pulsar. The diameter of the inner ring in the image is about a tenth of a light year, 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. (NASA/CXC/SAO)

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Andromeda Galaxy (M31): This image shows the central portion of the Andromeda Galaxy, our nearest neighbor spiral galaxy at a distance of two million light years. The blue dot in the center of the image is a "cool" million degree X-ray source where a supermassive black hole with the mass of 30 million suns is located. The X-rays are produced by matter funneling toward the black hole. Numerous other hotter X-ray sources are also apparent. Most of these are probably due to X-ray binary systems, in which a neutron star or black hole is in a close orbit around a normal star. (NASA/CXC/SAO)

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Eta Carinae: This image shows the complex nature of the region around Eta Carinae, a massive supergiant star that is 7,500 light years from Earth in the constellation Carina. The outer horseshoe shaped ring has a temperature of about 3 million degrees Celsius. It is about two light years in diameter and was probably caused by an outburst that occurred more than a thousand years ago. The blue cloud in the inner core is three light months in diameter and is much hotter; the white area inside the blue cloud is the hottest and may contain the superstar which is vigorously blowing matter off its surface. (NASA/CXC/SAO)

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Abell 2142: This image shows the merger of two sub-clusters of galaxies. The sub-clusters are embedded within Abell 2142, a gigantic galaxy cluster that is one of the most massive objects in the universe. The smoothness of the elongated cloud in the Chandra image suggests that these sub-clusters have collided two or three times in a billion years or more, and have nearly completed their merger. The bright source in the upper left is an active galaxy in the cluster. Abell 2142 is a cluster of galaxies in the constellation Corona Borealis. (NASA/CXC/SAO)

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N132D: This image shows a highly structured remnant, or shell, of 10 million degree gas that is 80 light years across. It is located in the Large Magellanic Cloud, about 180,000 light years from Earth. The estimated age of the remnant is about 3000 years. The N132D supernova remnant appears to be colliding with a giant molecular cloud, which produces the brightening on the southern

rim of the remnant. The relatively weak X-radiation on the upper left shows that the shock wave is expanding into a less dense region on the edge of the molecular cloud. A number of small circular structures are visible in the central regions and a hint of a large circular loop can be seen in the upper part of the remnant. (NASA/CXC/SAO)



3C295: 3C295 is a large distant galaxy in the center of a cluster of galaxies located in the constellation Boötes. This image shows an explosive galaxy enveloped by a vast cloud of fifty million degree gas. The gas cloud, which is visible only with an X-ray telescope, contains more than a hundred galaxies and enough material to make a thousand more. The galaxies are too cool to be visible in X rays. Roughly two million light years in diam-

eter, the cloud and its cluster of galaxies are among the most massive objects in the universe. It is so distant that we see it as it was five billion years ago. (NASA/CXC/SAO)



Hydra A: The galaxy cluster Hydra A is 840 million light years from Earth. The image shows the complex inner structure of the large cloud of multimillion degree gas. Long strands of hot gas are seen expanding away from the center of the cluster. They may be deflected by magnetic fields produced by explosions, from the vicinity of a supermassive black hole at the core of the central

galaxy. As the largest gravitationally bound objects in the universe, galaxy clusters provide crucial clues for understanding the origin and fate of the universe. (NASA/CXC/SAO)



M82: M82, at a distance of 11 million light years from Earth, is the nearest starburst galaxy. Massive stars are forming and expiring in M82 at a rate ten times higher than in our galaxy. The bright spots in the center are supernova remnants and X-ray binaries. These are some of the brightest such objects known. The luminosity of the X-ray binaries suggests that most contain a black hole.

The diffuse X-ray light in the image extends over several thousand light years, and is caused by multimillion degree gas flowing out of M82. A close encounter with a large galaxy, M81, in the last 100 million years is thought to be the cause of the starburst activity. (NASA/CXC/SAO/PSU/CMU)