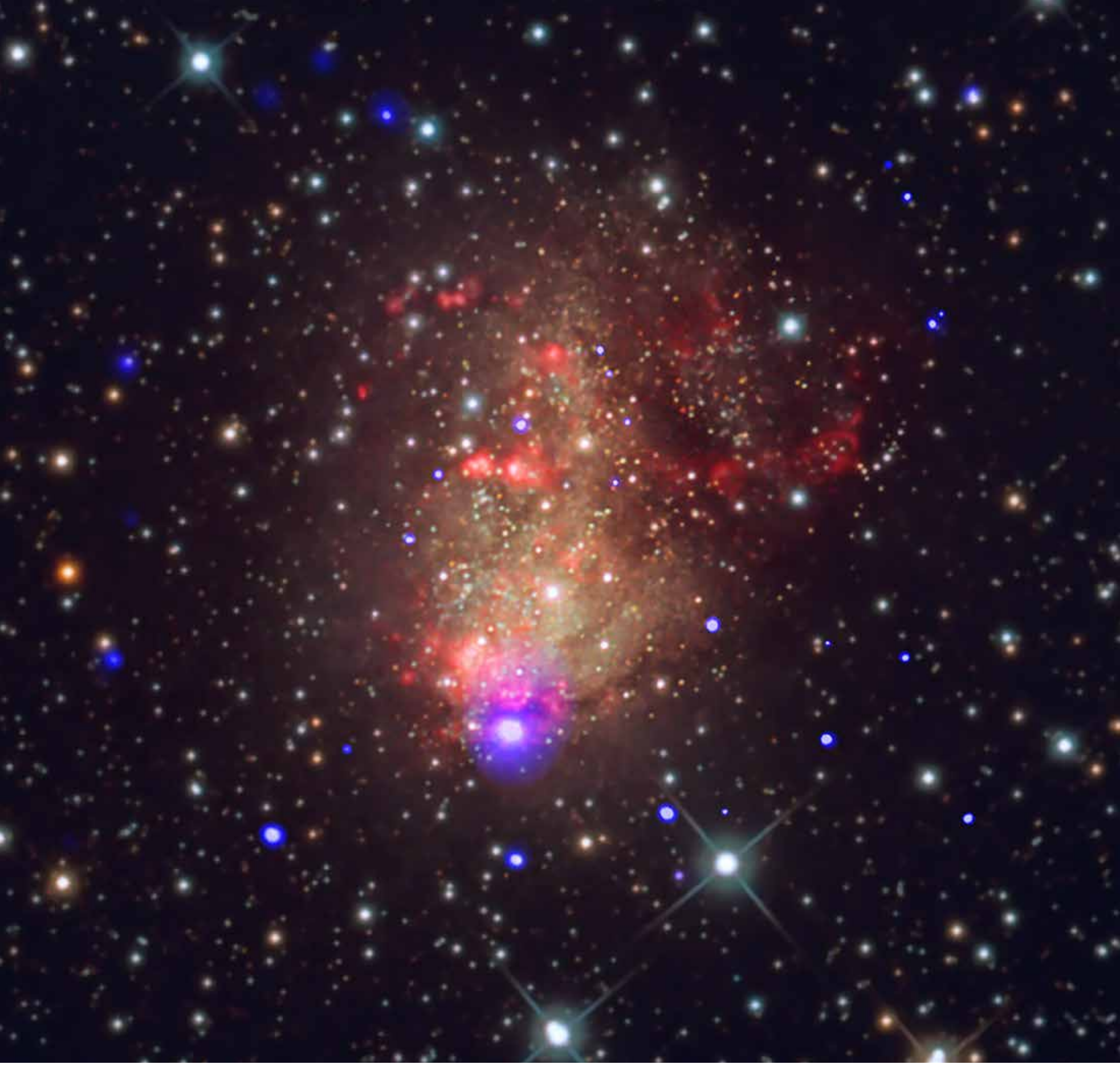
National Aeronautics and
Space Administration

CHANDRA
X-RAY OBSERVATORY

2018



JANUARY 2018

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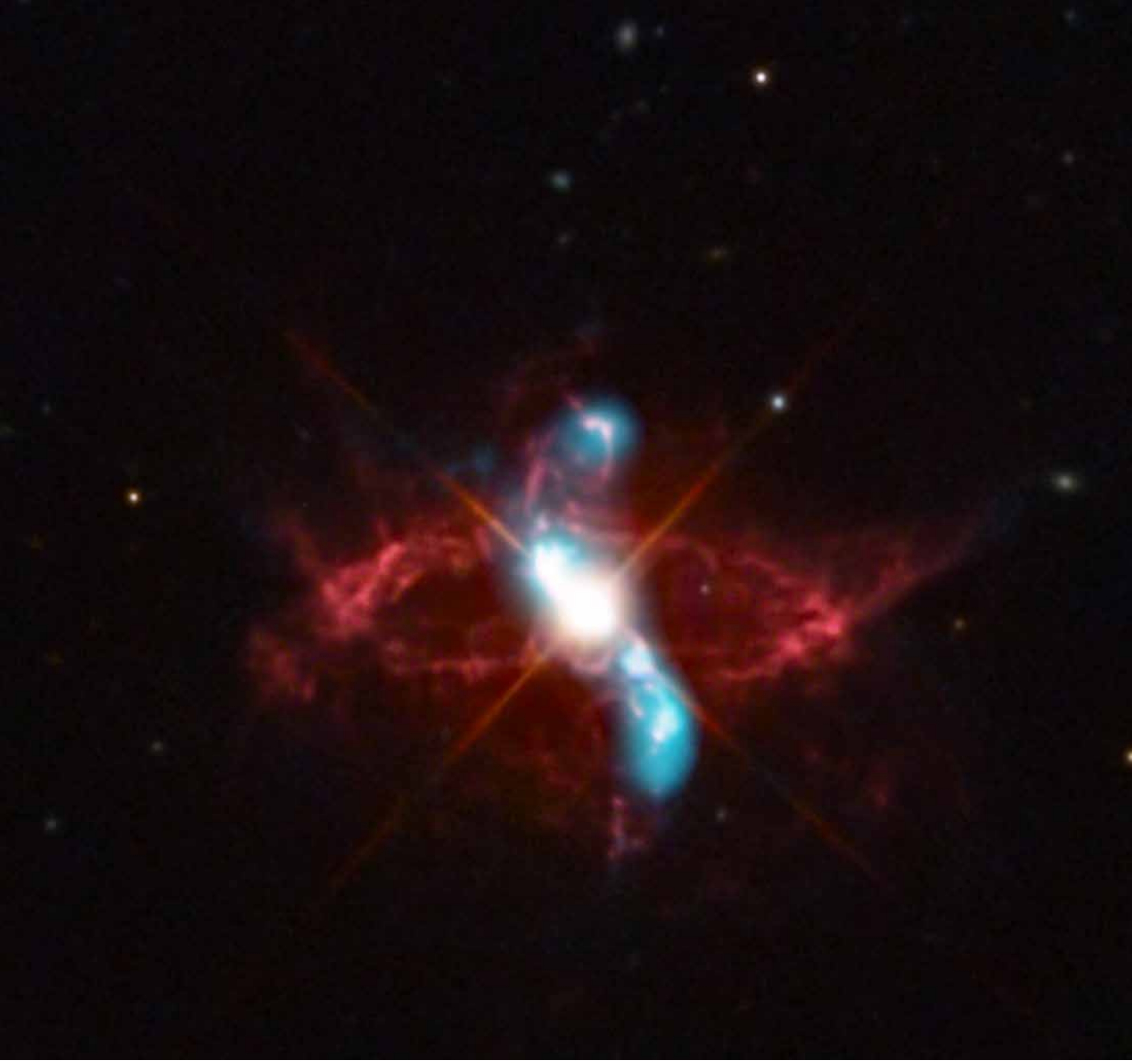
IC 10

IC 10 is a starburst galaxy that has many new stars forming within it. Chandra observations taken over a decade reveal 110 X-ray sources in IC 10, including about a dozen that are black holes and neutron stars feeding off gas from young, massive stellar companions (systems known as “X-ray binaries”). Some of these pairs may eventually form systems that merge and emit gravitational waves. This new composite of IC 10 combines X-ray data from Chandra with an optical image (red, green, blue) taken by amateur astronomer Bill Snyder.

Credit: X-ray: NASA/CXC/UMass Lowell/S.Laycock et al. Optical: Bill Snyder Astrophotography



FEBRUARY 2018

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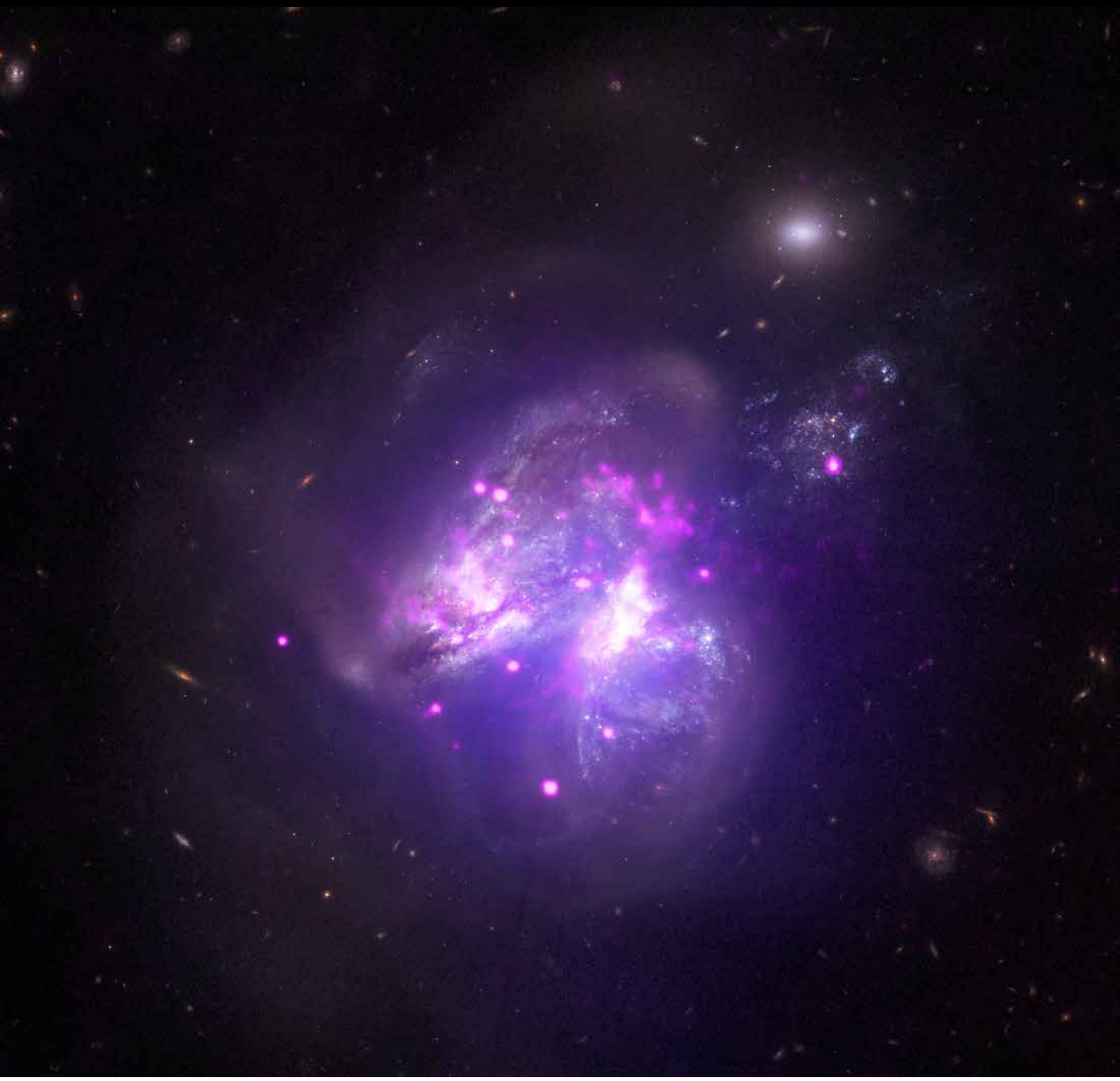
R AQUARII

This composite image shows Chandra X-ray data (cyan) along with optical data (red, green, blue) of the “symbiotic” system R Aquarii (R Aqr). This system contains a white dwarf star in orbit with a pulsating red giant. Occasionally, the white dwarf pulls enough material from the red giant onto its surface to generate a thermonuclear explosion. Since shortly after Chandra launched in 1999, astronomers have been using the X-ray telescope to monitor the behavior of R Aqr, giving them a better understanding of the behavior of this volatile stellar pair. The image is about 4.2 x 3.4 arcminutes.

Credit: X-ray: NASA/CXC/SAO/R. Montez et al.; Optical: Adam Block/Mt. Lemmon SkyCenter/U Arizona.



MARCH 2018

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ARP 299

Arp 299 contains two galaxies that are merging, creating a partially blended mix of stars from each galaxy in the process. New data from Chandra (pink) reveals 25 bright X-ray sources in Arp 299, fourteen of which are extremely strong emitters of X-rays known as “ultra-luminous X-ray sources,” or ULXs. Such a high concentration of ULXs is rare, but caused by the intense star formation resulting from the galactic collision. This composite also contains data from NuSTAR (purple) and Hubble (red, green, blue). The image is 2.8 arcminutes (about 117,000 light years) across

Credit: X-ray: NASA/CXC/Univ of Crete/K. Anastasopoulou et al., NASA/NuSTAR/GSFC/A. Ptak et al.; Optical: NASA/STScI

APRIL 2018

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CRAB NEBULA

Astronomers have produced a highly-detailed image of the Crab Nebula by combining data from telescopes spanning nearly the entire breadth of the electromagnetic spectrum. This image contains data from five different telescopes: VLA radio (red); Spitzer infrared (yellow); Hubble visible (green); XMM-Newton ultraviolet (blue); and Chandra X-ray (purple). Chandra has observed the Crab Nebula repeatedly since the telescope was launched into space in 1999. Scale: The image is 5 arcminutes (about 10 light years) across.

Credit: X-ray: NASA/CXC/SAO; Optical: NASA/STScI; Infrared: NASA/JPL/Caltech; Radio: NSF/NRAO/VLA; Ultraviolet: ESA/XMM-Newton

MAY 2018

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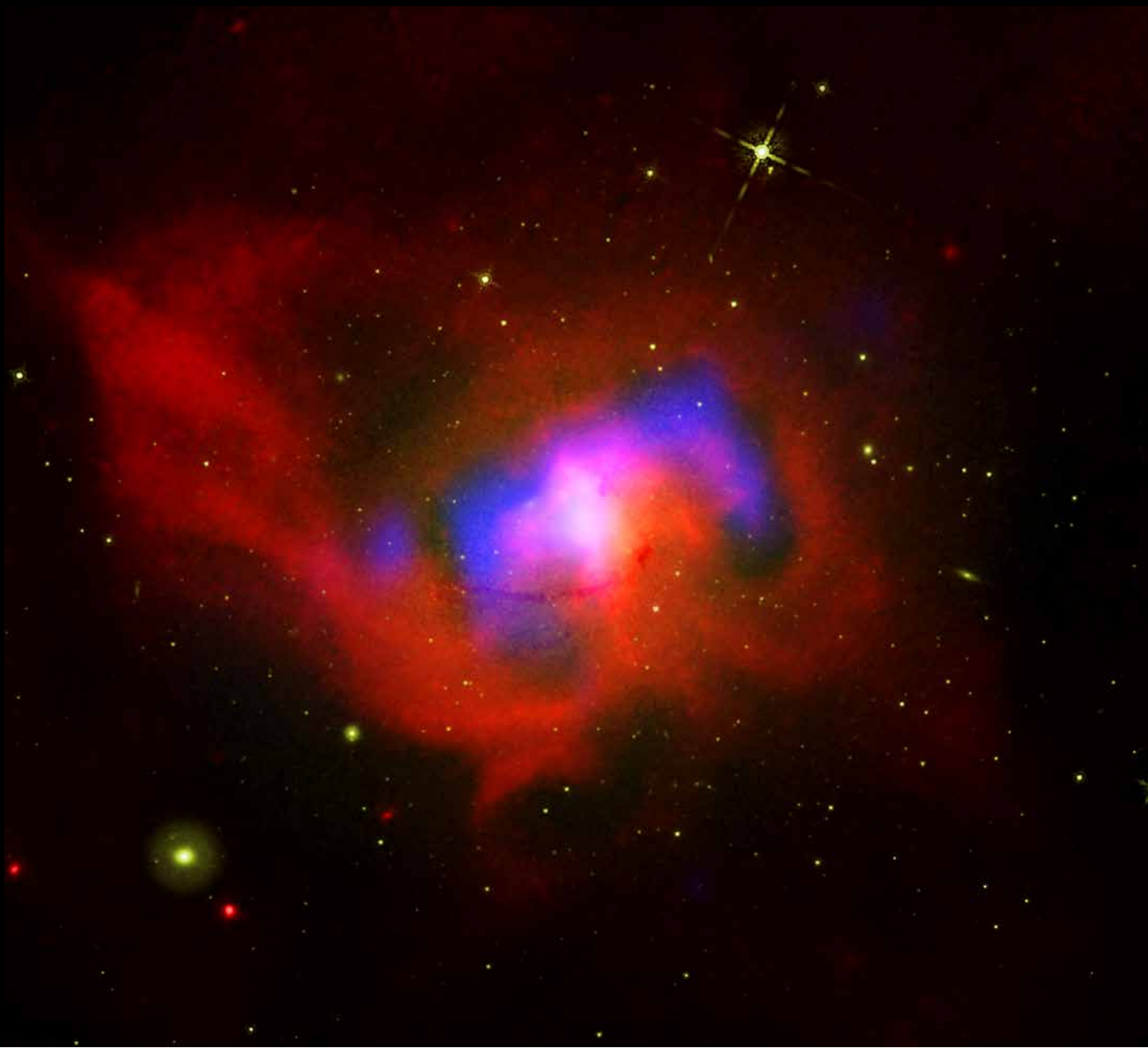
PERSEUS CLUSTER

Using NASA’s Chandra X-ray Observatory, scientists have found a vast wave of hot gas in the Perseus galaxy cluster, about 250 million light years from Earth. Spanning some 200,000 light years, the wave is about twice the size of the Milky Way galaxy. Researchers think the wave formed billions of years ago after a small galaxy cluster grazed Perseus and caused its vast supply of gas to slosh around in an enormous volume of space. Researchers combined a total of 10.4 days of high-resolution Chandra data with 5.8 days of wide-field observations. This X-ray image of the hot gas in the Perseus galaxy cluster was made from those observations. Researchers
then filtered the data in a way that brightened the contrast of edges in order to make subtle details more obvious.

Credit: X-ray: NASA/CXC/SAO; Optical: NASA/STScI; Radio: NRAO/VLA



JUNE 2018

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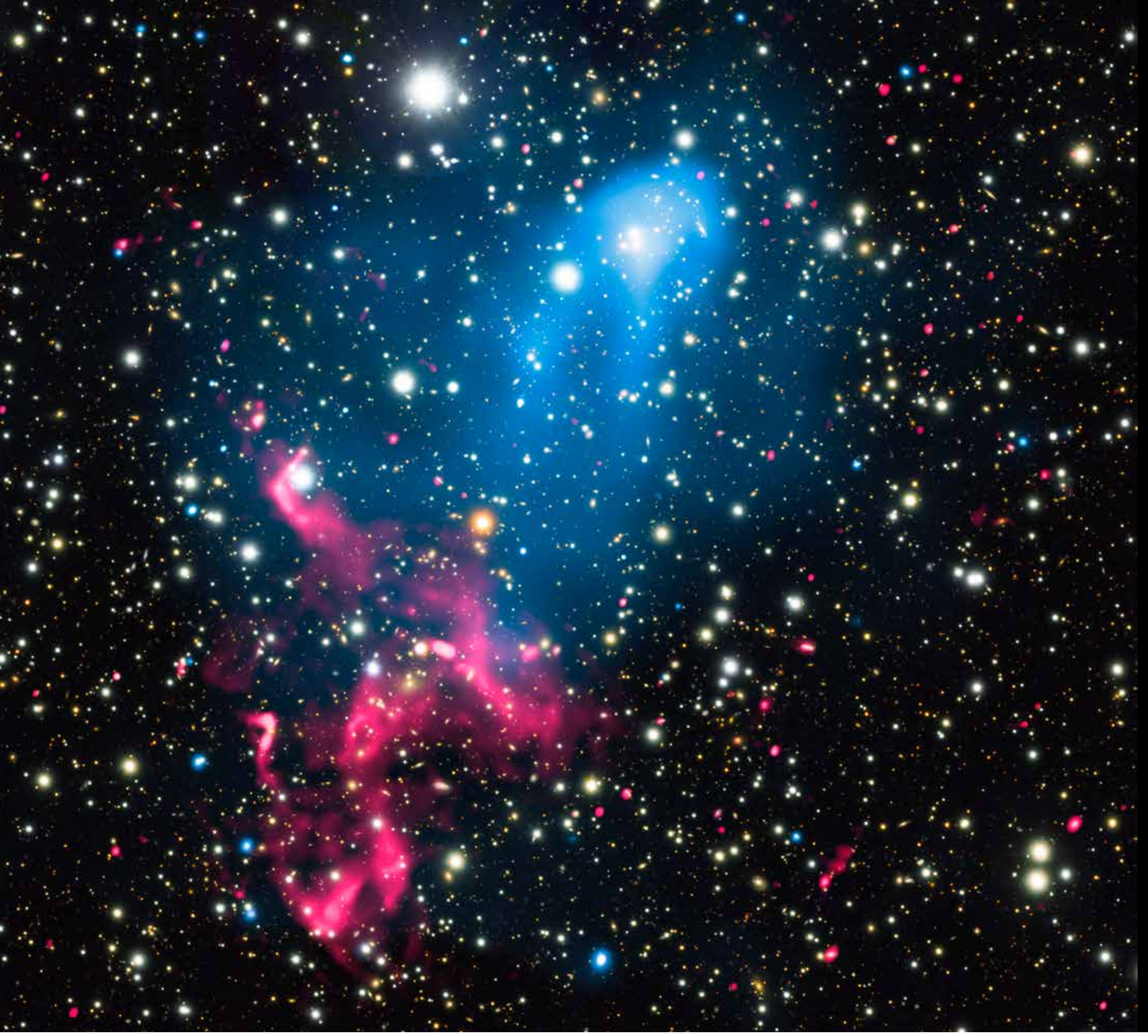
NGC 4696

Data from Chandra and other telescopes have provided evidence for repeated bursts of energetic particles generated by the supermassive black hole at the center of the Centaurus Cluster. This composite image contains X-ray data from Chandra (red) that reveals the hot gas in the cluster, and radio data from the VLA (blue) that shows high-energy particles produced by jets powered by the black hole. Visible light data from Hubble (green) show galaxies in the cluster as well as galaxies and stars outside the cluster. The image is about 2.2 arcminutes (about 14 million light years) across.

Credit: X-ray: NASA/CXC/MPE/J.Sanders et al.; Optical: NASA/STScI; Radio: NSF/NRAO/VLA



JULY 2018

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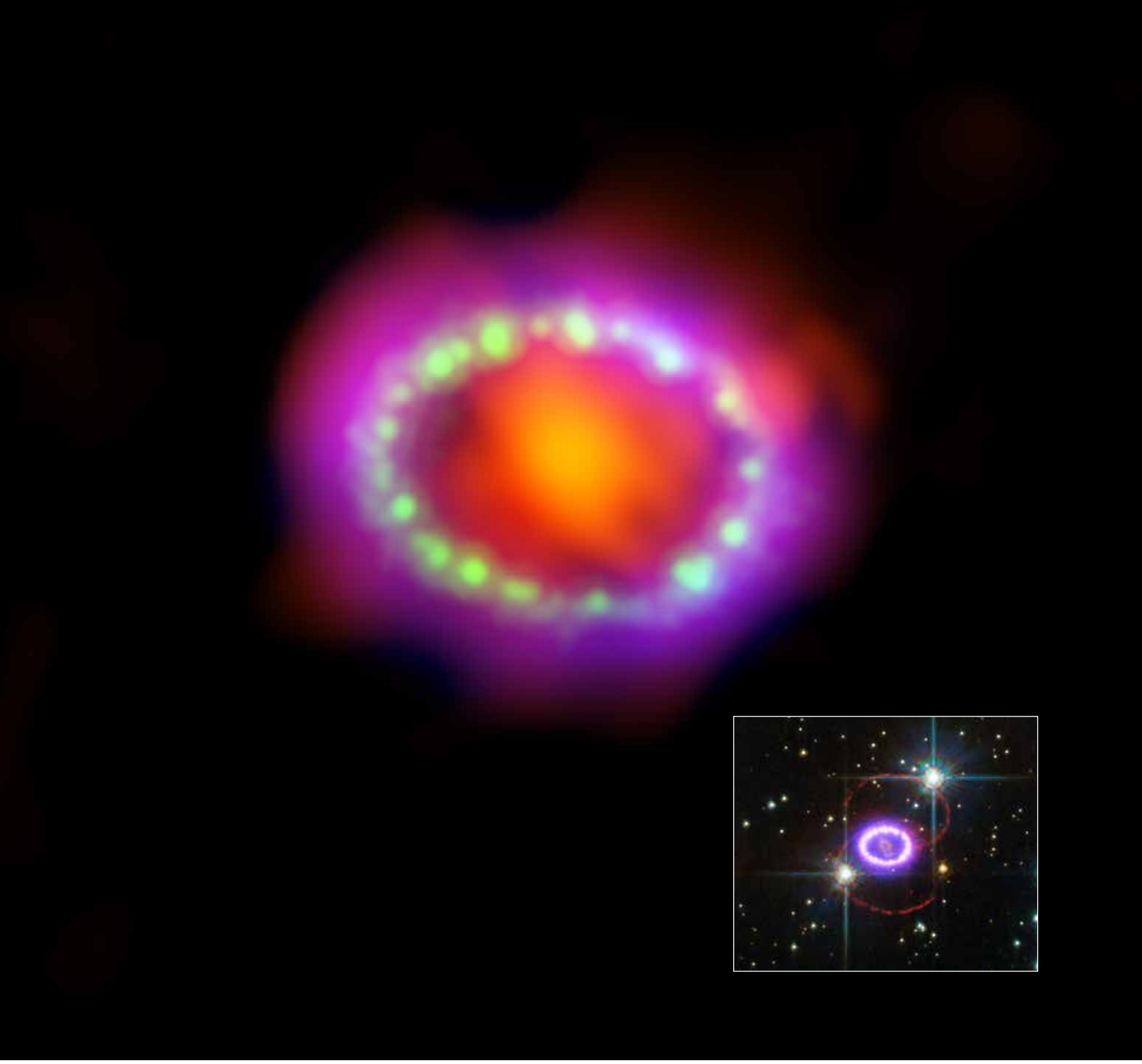
ABELL 3411/3412

Astronomers have discovered what happens when the eruption from a supermassive black hole is swept up by the collision and merger of two galaxy clusters. This composite image contains X-rays from Chandra (blue), radio emission from the GMRT (red), and optical data from Subaru (red, green, blue) of the colliding galaxy clusters called Abell 3411 and Abell 3412. These and other telescopes were used to analyze how the combination of these two powerful phenomena can create an extraordinary cosmic particle accelerator. The image is 17 arcminutes (about 10 million light years) across.

Credit: X-ray: NASA/CXC/SAO/R. van Weeren et al; Optical: NAOJ/Subaru; Radio: NCRA/TIFR/GMRT



AUGUST 2018

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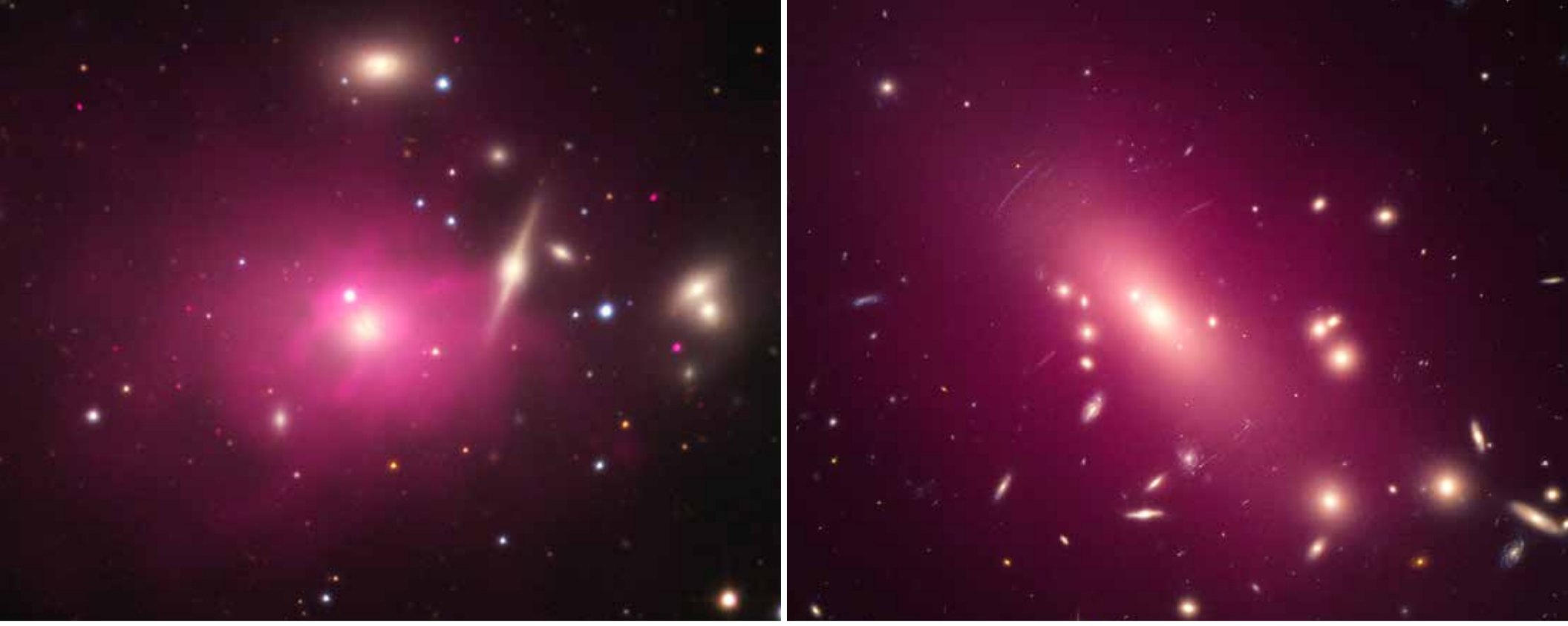
SUPERNOVA 1987A

Thirty years have passed since Supernova 1987A (SN 1987A) was first seen. Since then, telescopes around the world and in space have observed this remarkable object, including Chandra. The main panel contains X-rays from Chandra (blue), visible light data from Hubble (green), and submillimeter wavelength data from ALMA (red). The latest data indicate the supernova shock wave is moving beyond the dense ring of gas produced late in the life of the pre-supernova star, an important milestone. The inset to the lower right is a wide-field composite with Chandra (blue) and Hubble data. The main image is about 20 arcseconds (about 14 million light years) across.

Credit: X-ray: NASA/CXC/SAO/PSU/K.Frank et al.; Optical: NASA/STScI; Millimeter: ESO/NAOJ/NRAO/ALMA



SEPTEMBER 2018

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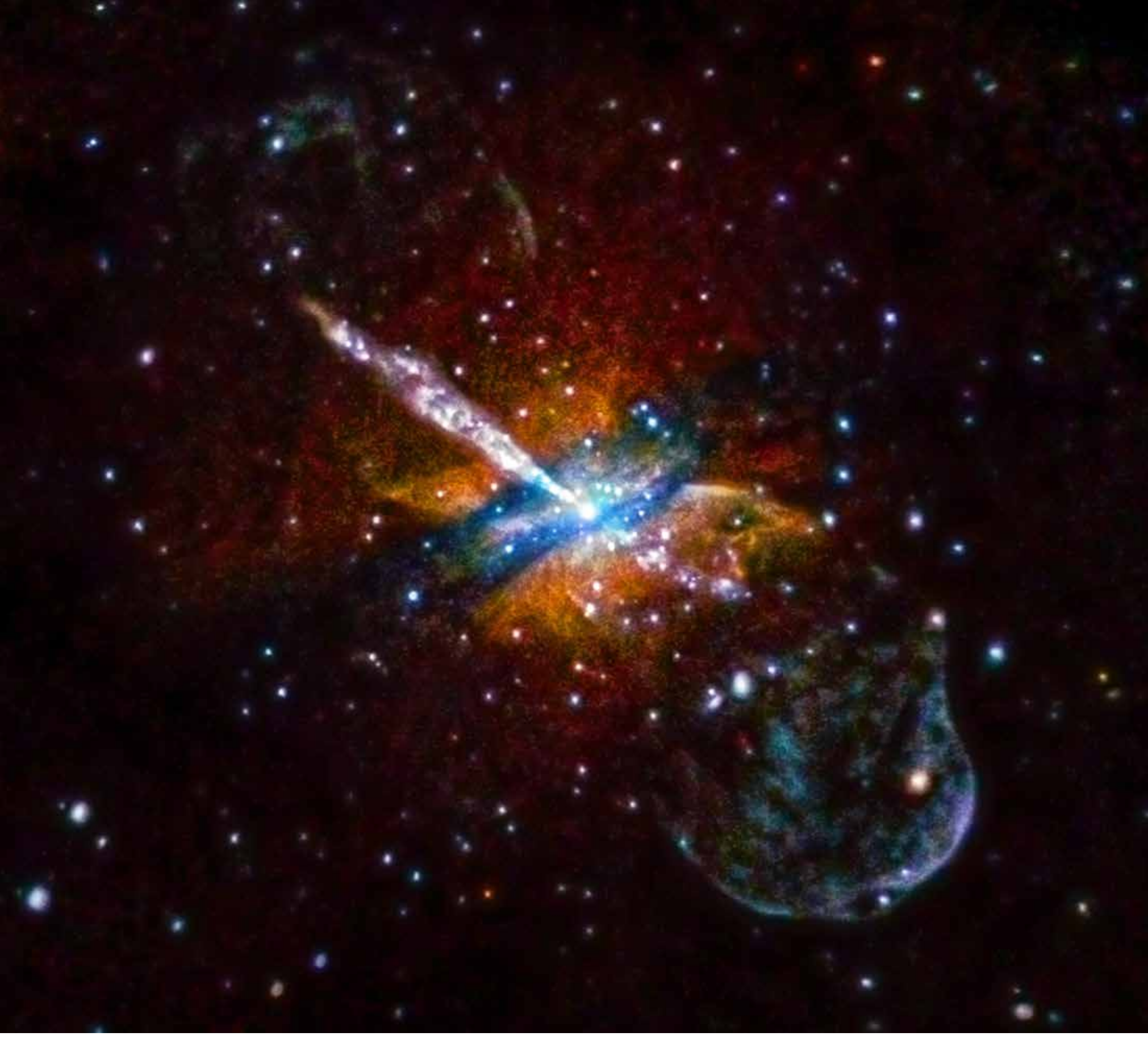
ABELL 262, ABELL 383, ABELL 1413, AND ABELL 2390

Astronomers used Chandra observations of 13 galaxy clusters to study the properties of dark matter. Specifically, researchers tested a model using a principle in quantum mechanics that each subatomic particle has a wave associated with it. To an observer at a great distance, the interaction of these waves with dark matter would make the particles appear fuzzy, if they could be directly observed. Although the simplest fuzzy dark matter model did not match the Chandra data, a version where the particles had different amounts of energy – the “excited states” – did give good agreement with the data, thus providing promise for theoreticians trying to better understand dark matter.

Credit: X-ray: NASA/CXC/Cinestav/T.Bernal et al.; Optical: Adam Block/Mt. Lemmon SkyCenter/U. Arizona



OCTOBER 2018

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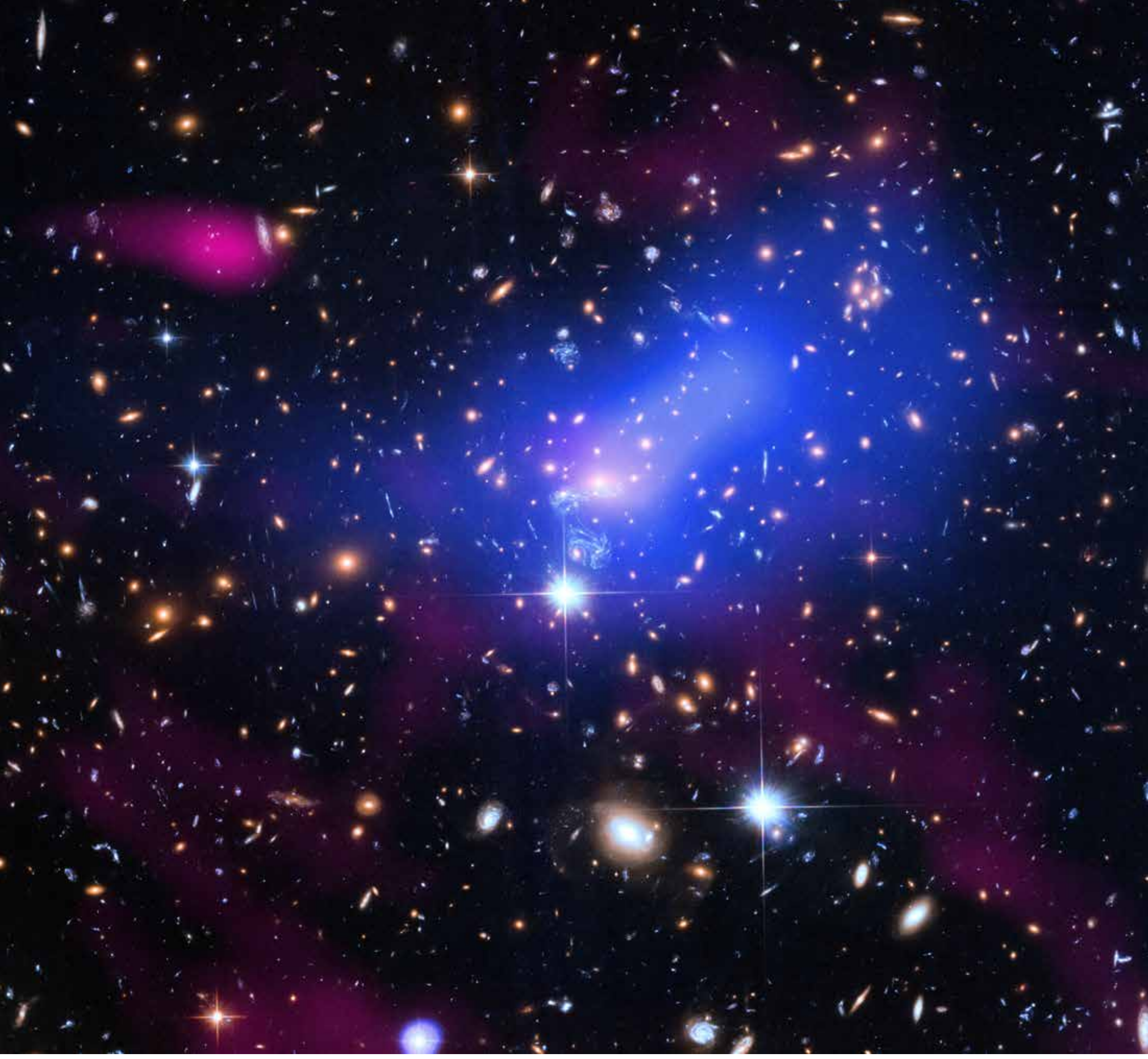
CENTAURUS A

Centaurus A is a galaxy well known for a gargantuan jet blasting away from a central supermassive black hole, which is seen in this new Chandra image. This image - where red, green, and blue colors represent low, medium, and high-energy X-rays respectively - has been processed with new techniques and contains data from observations equivalent to over nine and a half days' worth of observing time taken between 1999 and 2012. The data housed in Chandra's extensive archive on Centaurus A provide a rich resource for a wide range of scientific investigations, including a recent study that examines the population and characteristics of black holes and neutron stars throughout the galaxy. The image is 16.7 arcminutes (about 58,000 light years) across.

Credit: X-ray: NASA/CXC/U.Texas/S.Post et al, Infrared: 2MASS/UMass/IPAC-Caltech/NASA/NSF



NOVEMBER 2018

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MACSJ 1149.5+2223

Galaxy clusters are enormous collections of hundreds or even thousands of galaxies and vast reservoirs of hot gas embedded in massive clouds of dark matter. One galaxy cluster project, called the “Frontier Fields”, has focused long observations from very powerful telescopes, including Chandra, on various galaxy clusters to learn more about them. One such galaxy, MACSJ 1149.5+2223, features X-ray data from Chandra (blue), radio data from the VLA (pink), and optical data from Hubble (red, green, blue).

Credit: X-ray: NASA/CXC/SAO; Optical: NASA/STScI; Radio: NSF/NRAO/AUI/VLA

DECEMBER 2018

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NGC 6357

This composite image captures the star formation region NGC 6357, located in the Milky Way galaxy. X-rays from Chandra and ROSAT (purple) reveal hundreds of point sources, which are the young stars in NGC 6357, as well as diffuse X-ray emission from hot gas. These have been combined with infrared data from Spitzer (orange) and optical data from the SuperCosmos survey (blue) to complete this spectacular cosmic vista. The image is about 44 arcminutes (70 light years) across.

Credit: X-ray: NASA/CXC/PSU/L.Townsley et al; Optical: UKIRT; Infrared: NASA/JPL-Caltech

Since its launch on July 23, 1999, the Chandra X-ray Observatory has been NASA's flagship mission for X-ray astronomy, taking its place in the fleet of "Great Observatories."

NASA's Chandra X-ray Observatory is a telescope specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes. Because X-rays are absorbed by Earth's atmosphere, Chandra must orbit above it, up to an altitude of 139,000 km (86,500 mi) in space.

CHANDRA WEB SITES

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For Scientists
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NASA's Marshall Space Flight Center in Huntsville, Alabama, manages the Chandra program for NASA's Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, controls Chandra's science and flight operations.