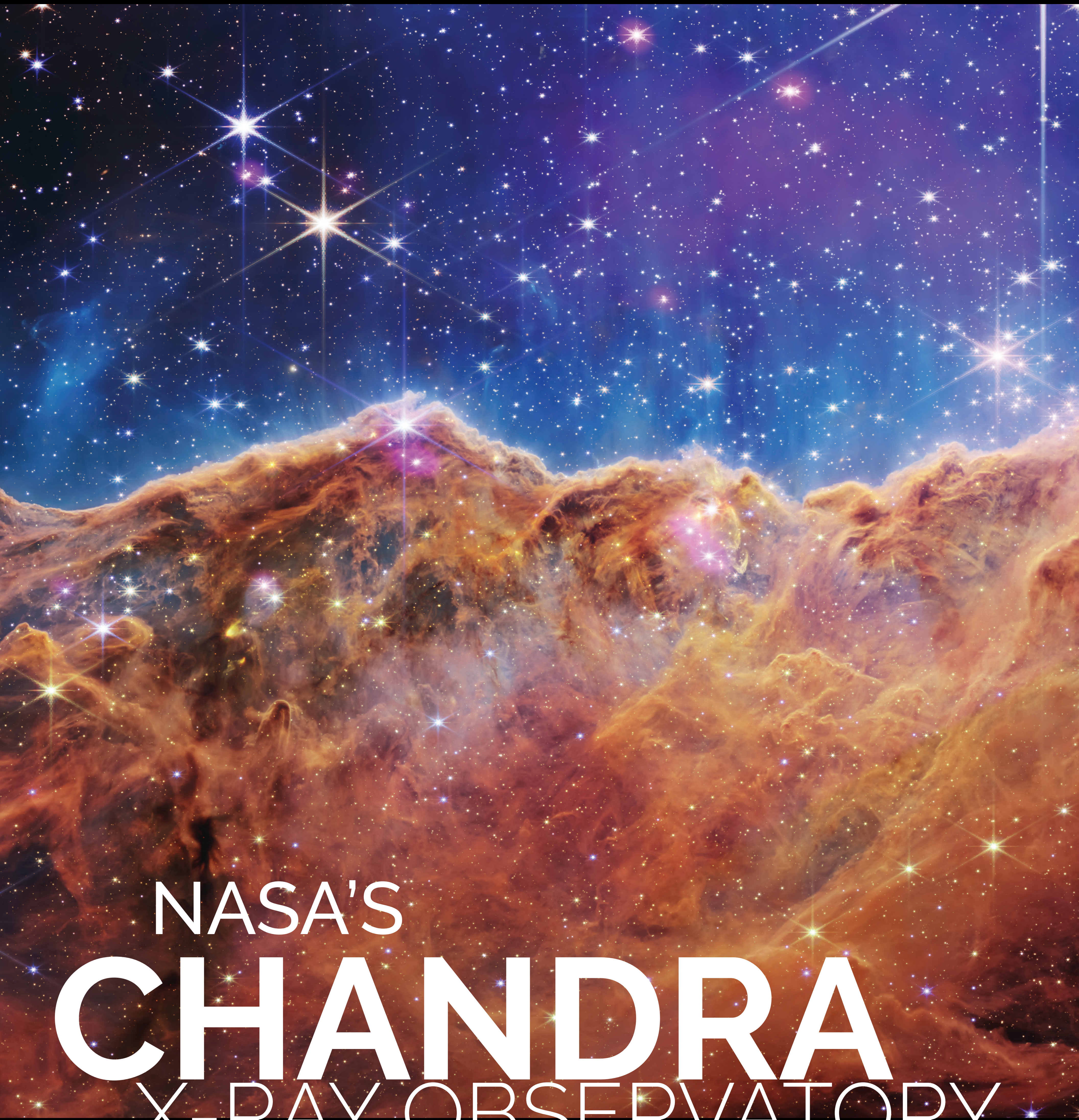
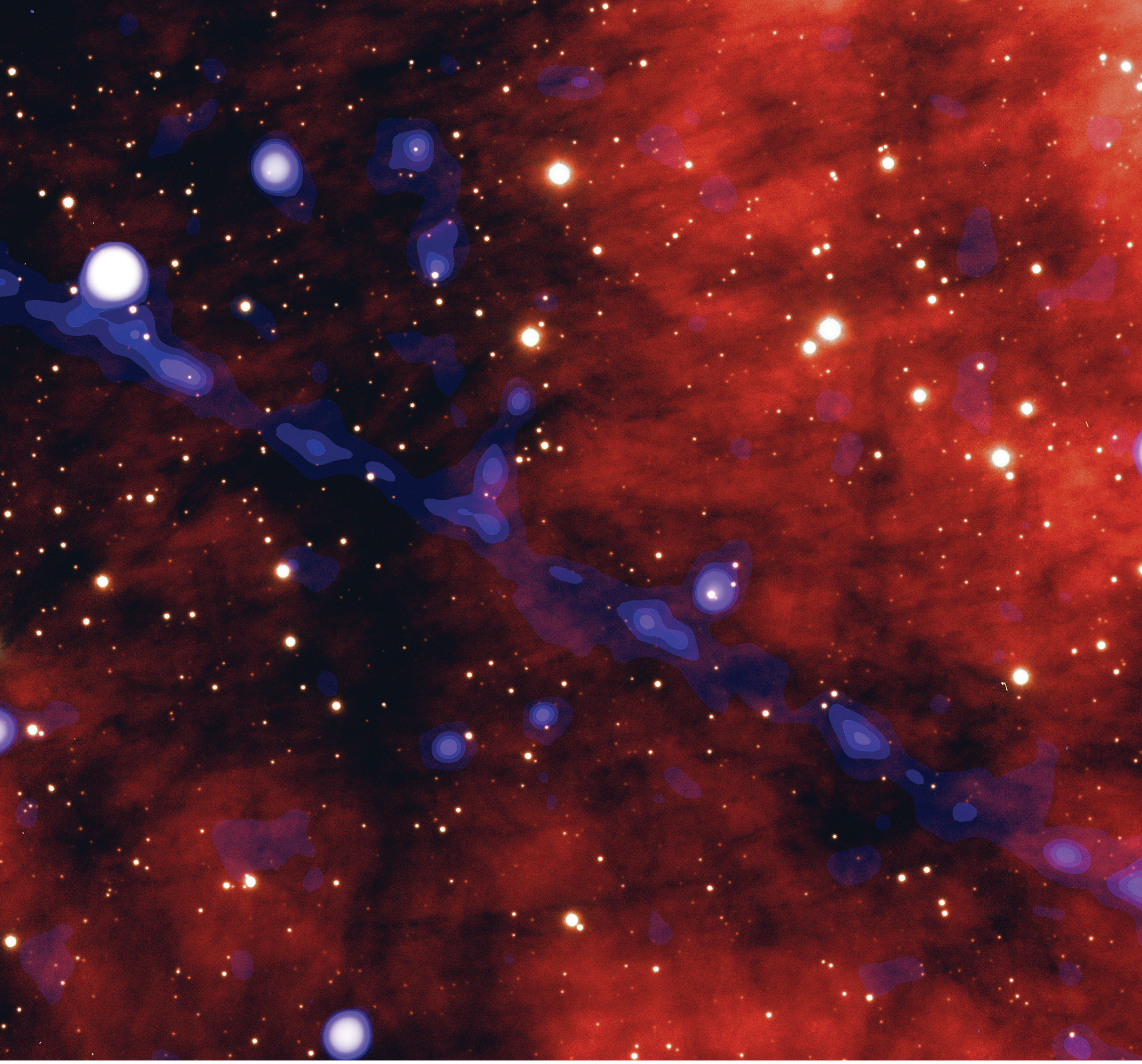
National Aeronautics and
Space Administration



NASA'S CHANDRA X-RAY OBSERVATORY

2023



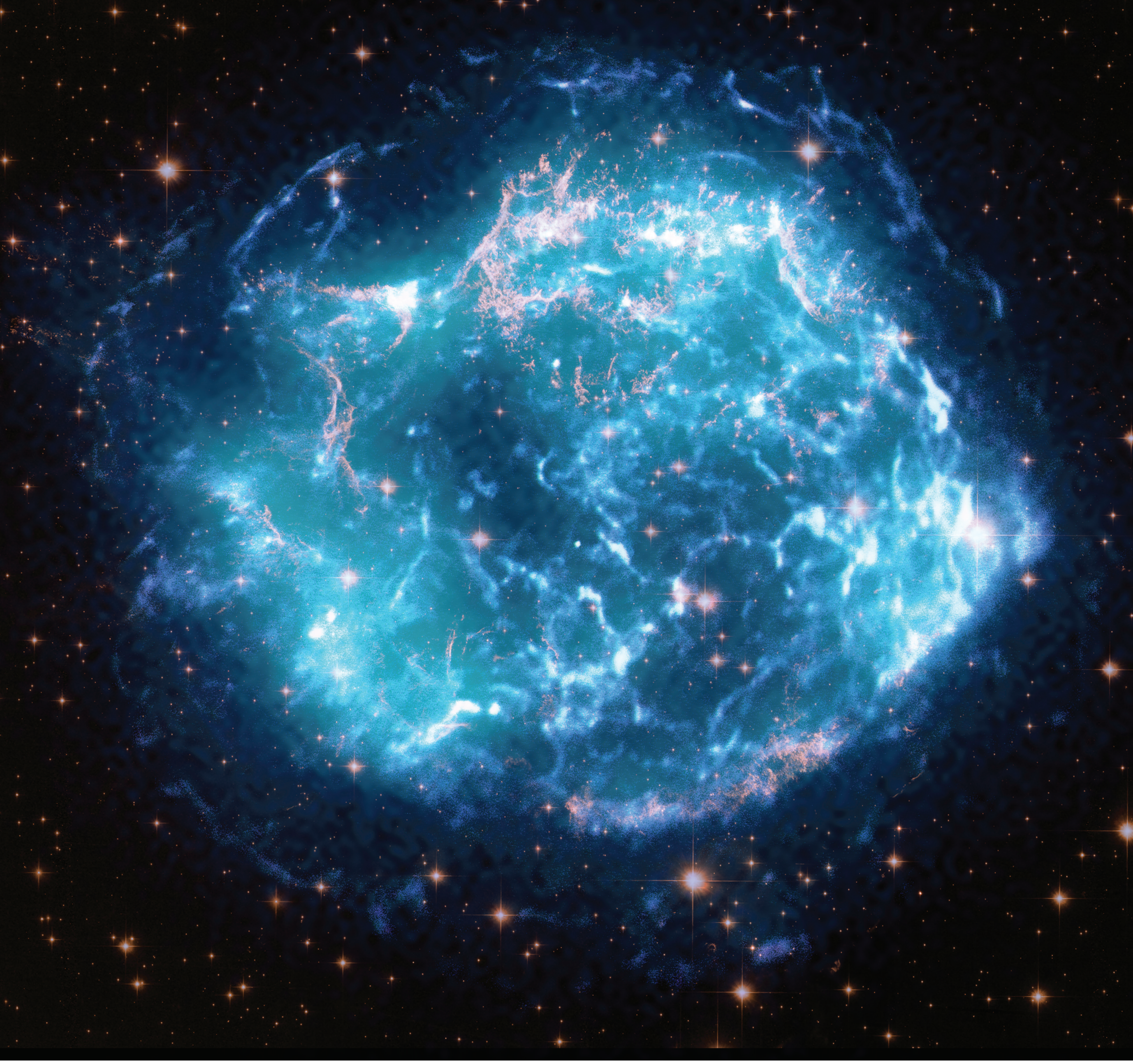
JANUARY 2023

S	M	T	W	Th	F	Sa
1 New Year's Day	2	3	4	5	6 ○	7
8	9	10	11	12	13	14 ◗
15	16 Martin Luther King, Jr.	17	18	19	20	21 ●
22	23	24	25	26	27	28 ◖
29	30	31				

J2030

This image shows the pulsar known as PSR J2030+4415 in X-rays from Chandra (blue) and optical light from the Gemini telescope in Hawaii (appearing as red, brown, and black). The left panel shows about one third the length of an extremely long filament, or beam, from the pulsar detected in Chandra data. The right panel contains a close-up where the X-rays are created by particles flying around the pulsar itself. As the pulsar moves through space at about half a million miles an hour, some of these particles escape and create the long filament. This beam may help explain the surprisingly large numbers of positrons, the anti-matter counterparts to electrons, scientists have detected at Earth.

Credit: X-ray: NASA/CXC/Stanford Univ./M. de Vries; Optical: NSF/AURA/Gemini Consortium

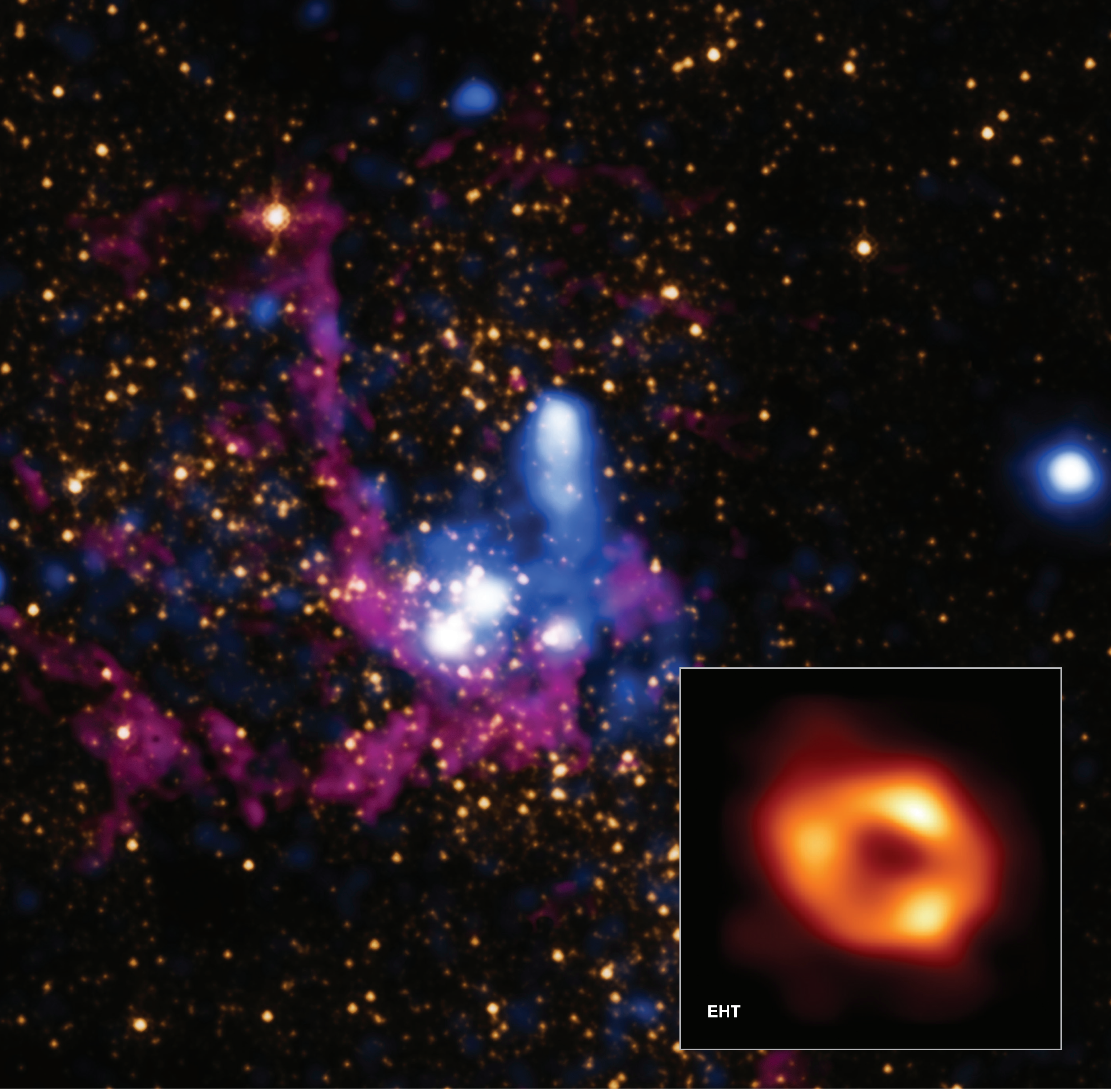


FEBRUARY 2023

S	M	T	W	Th	F	Sa
			1	2	3	4
5 ○	6	7	8	9	10	11
12	13 ◗	14 Valentine's Day	15	16	17	18
19	20 Presidents' Day ●	21	22	23	24	25
26	27 ◖	28				

CASSIOPEIA A WITH IXPE

NASA's Imaging X-Ray Polarimetry Explorer (IXPE) was launched into space December 9, 2021, and looks at "polarimetry" of X-rays, or how X-ray light is oriented as it travels through space. Like Chandra, one of the first objects IXPE focused on was the supernova remnant Cassiopeia A (Cas A). The shock waves from the explosion have swept up surrounding gas, heating it to high temperatures and accelerating cosmic ray particles to make a cloud that glows in X-ray light. The image combines X-ray data from both IXPE and Chandra data of Cas A. The saturation of the green color corresponds to the intensity of X-ray light observed by IXPE, which has been overlaid on high-energy X-rays from Chandra (blue) and optical light from Hubble (gold). Credits: NASA/CXC/SAO/IXPE



MARCH 2023

S	M	T	W	Th	F	Sa
			1	2	3	4
5	6	7 ○	8	9	10	11
12	13	14 ◗	15	16	17	18
19	20	21 ●	22	23	24	25
26	27	28 ◖	29	30	31	

SAGITTARIUS A*

The main panel of this graphic contains X-ray data from Chandra (blue) showing hot gas that was blown away from massive stars near the Milky Way's central supermassive black hole known as Sagittarius A* (Sgr A*). Two infrared images at different wavelengths from Hubble reveal stars (orange) and cool gas (purple). An image of Sgr A* from the Event Horizon Telescope, a network of radio telescopes around the globe, is in the inset. This shows the area close to the "event horizon," the boundary of a black hole from which nothing can escape. By combining EHT data with those from NASA telescopes and others on the ground, astronomers are learning more about Sgr A* and how it interacts with its environment.

Credt: X-ray: NASA/CXC/SAO; IR: NASA/HST/STScI. Inset: Radio (EHT Collaboration)

APRIL 2023

S	M	T	W	Th	F	Sa
						1
2	3	4	5	6 ○	7	8
9	10	11	12	13 ◗	14	15
16	17	18	19	20 ●	21	22
23	24	25	26	27 ◖	28	29
30						

SNR 0519-69.0

Astronomers combined X-ray data from Chandra with those from other telescopes to determine how long ago the star in the supernova remnant called SNR 0519-69.0 exploded and learn about the environment the supernova occurred in. This composite image contains X-ray data from Chandra (green, blue and purple with some appearing as white) and Hubble's optical data of the remnant's perimeter (red) and surrounding stars (white). Astronomers concluded that the white dwarf that created this remnant exploded no more than about 670 years ago as seen from Earth.

Credit: X-ray: NASA/CXC/GSFC/B. J. Williams et al.; Optical: NASA/ESA/STScI

MAY 2023

S	M	T	W	Th	F	Sa
	1	2	3	4	5 ○	6
7	8	9	10	11	12 ◗	13
14	15	16	17	18	19 ●	20
21	22	23	24	25	26	27 ◖
28	29 Memorial Day	30	31			

CARTWHEEL GALAXY

The Cartwheel galaxy gets its shape from a collision with another smaller galaxy – located outside the field of this image – about 100 million years ago. When this smaller galaxy punched through the Cartwheel, it triggered star formation that appears around an outer ring and elsewhere throughout the galaxy. X-rays seen by Chandra (blue) come from superheated gas, individual exploded stars, and neutronstars and black holes pulling material from companion stars. NASA's James Webb Space Telescope's infrared view shows the Cartwheel galaxy plus two smaller companion galaxies – not part of the collision -- against a backdrop of many more distant galactic cousins.

Credit: X-ray: NASA/CXC; IR: NASA/ESA/CSA/STScI

JUNE 2023

S	M	T	W	Th	F	Sa
				1	2	3 ○
4	5	6	7	8	9	10 ◗
11	12	13	14	15	16	17
18 ●	19 Juneteenth	20	21	22	23	24
25	26 ◖	27	28	29	30	

CARINA NEBULA: NGC 3324: THE COSMIC CLIFFS

Data from Chandra of the "Cosmic Cliffs" (pink) reveal over a dozen individual X-ray sources. These are mostly stars located in the outer region of a star cluster in the Carina Nebula with ages between 1 and 2 million years old, which is very young in stellar terms. Young stars are much brighter in X-rays than old stars, making X-ray studies an ideal way to distinguish stars in the Carina Nebula from the many stars of different ages from the galaxy along our line of sight to the nebula. The diffuse X-ray emission likely comes from hot gas from the three hottest, most massive stars located in the star cluster that are outside the field of view of the Webb image.

Credit: X-ray: NASA/CXC/Univ. Observ. Munich/T. Preibisch et al.; IR: NASA/ESA/CSA/STScI

JULY 2023

S	M	T	W	Th	F	Sa
						1
2	3 ○	4 Independence Day	5	6	7	8
9 ◗	10	11	12	13	14	15
16	17 ●	18	19	20	21	22
23	24	25 ◖	26	27	28	29
30	31					

SMACS 0723.3–7327

Webb brilliantly shows how the galaxy cluster SMACS J0723, located about 4.2 billion light-years away, contains hundreds of individual galaxies. Galaxy clusters, however, contain much more. As some of the largest structures in the universe, they are filled with vast reservoirs of superheated gas that is seen only in X-ray light. In this image, the Chandra data (blue) reveals gas with temperatures of tens of millions of degrees, possessing a total mass of about 100 trillion times that of the Sun, several times higher than the mass of all the galaxies in the cluster. Invisible dark matter makes up an even larger fraction of the total mass in the cluster.

Credit: X-ray: NASA/CXC/Durham Univ./G. Mahler; IR: NASA/ESA/CSA/STScI

AUGUST 2023

S	M	T	W	Th	F	Sa
			1 ●	2	3	4
5	6	7	8 ◗	9	10	11
12	13	14	15	16 ●	17	18
19	20	21	22	23	24 ◖	25
26	27	28	29	30 ○		

STEPHAN'S QUINTET

The four galaxies within Stephan's Quintet are undergoing an intricate dance choreographed by gravity. (The fifth galaxy is an interloping galaxy at a different distance.) Webb's image of this object features never-seen-before details of the results of these interactions, including sweeping tails of gas and bursts of star formation. The Chandra data (light blue) of this system has uncovered a shock wave that heats gas to tens of millions of degrees, as one of the galaxies passes through the others at speeds of around 2 million miles per hour. This composite also includes data from NASA's now-retired Spitzer Space Telescope (yellow-green).

Credit: X-ray: NASA/CXC; IR(Spitzer): NASA/JPL-Caltech; IR(JWST): NASA/ESA/CSA/STScI

SEPTEMBER 2023

S	M	T	W	Th	F	Sa
					1	2
3	4 Labor Day	5	6 ◗	7	8	9
10	11	12	13	14 ●	15	16
17	18	19	20	21	22 ◖	23
24	25	26	27	28	29 ○	30

ABELL 2146

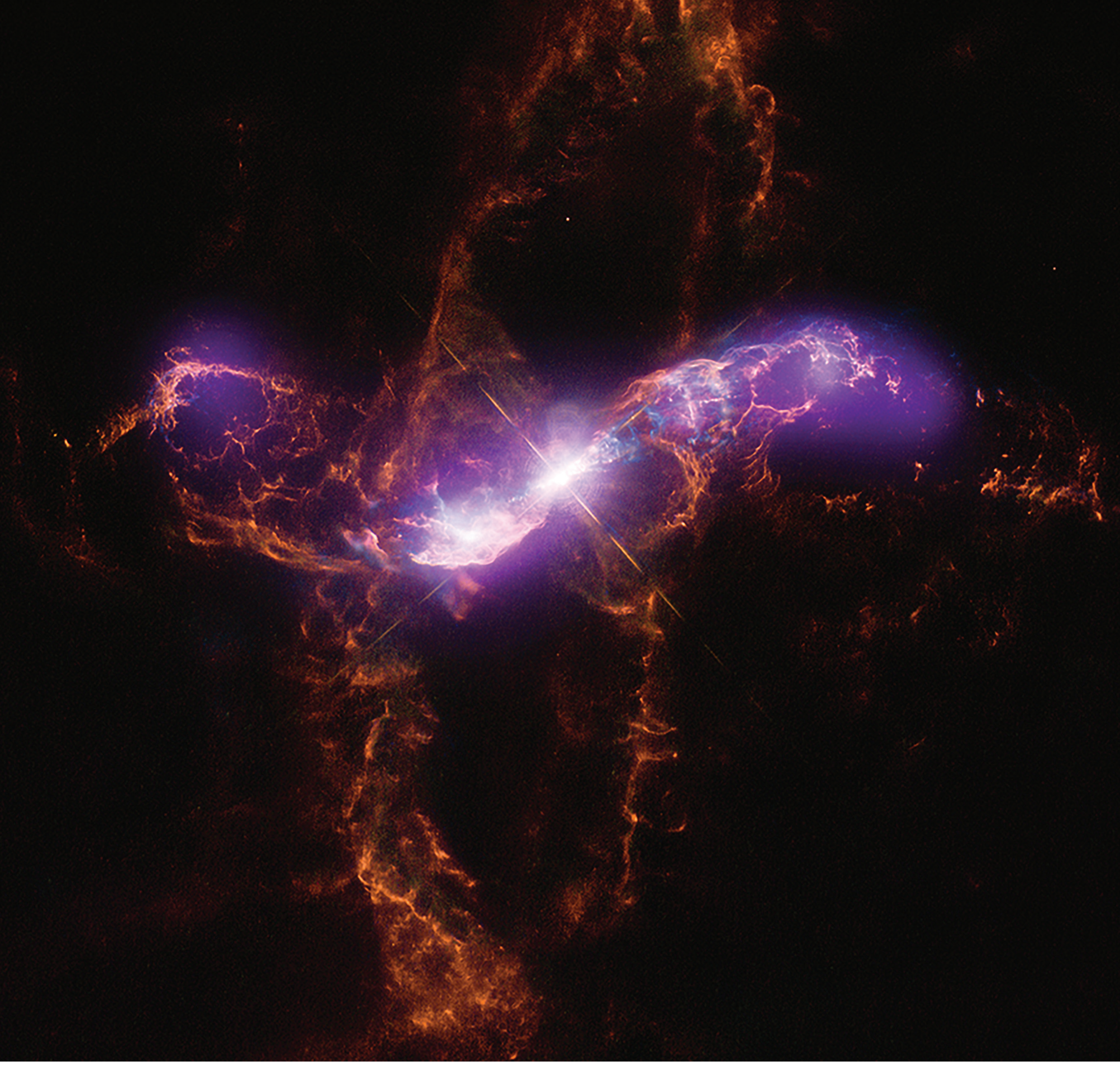
In this composite image of two merging galaxy clusters known as Abell 2146, X-rays from Chandra (purple) show hot gas while optical data from the Subaru telescope in Hawaii reveal individual galaxies (red and white). One cluster is moving towards the bottom left and plowing through the other cluster. The hot gas in the former is pushing out a shock wave, like a sonic boom generated by a supersonic jet, as it collides with the hot gas in the other cluster. A study shows a deep connection between this galaxy cluster collision — which is among the largest, most energetic events in the Universe — and much smaller, weaker ones powered by our own Sun. Credit: X-ray: NASA/CXC/Univ. of Nottingham/H. Russell et al.; Optical: NAOJ/Subaru

OCTOBER 2023

S	M	T	W	Th	F	Sa
1	2	3	4	5	6 ◗	7
8	9 Columbus Day	10	11	12	13	14 ●
15	16	17	18	19	20	21 ◖
22	23	24	25	26	27	28 ○
29	30					

NGC 4490

When two galaxies are in the process of merging, the gravitational interaction can trigger waves of star formation. This is the case for NGC 4490, a spiral galaxy that has collided with a smaller galaxy to the upper right but not seen in this image. Scientists think that these two galaxies have already had their closest approach and are now separating from one another. Some of the point-like sources of X-rays represent stellar-mass black holes and neutron stars within the galaxy. In this image of NGC 4490, X-rays from Chandra (purple) have been combined with an optical image from Hubble (red, green, and blue). X-ray: NASA/CXC/SAO; Optical: NASA/STScI

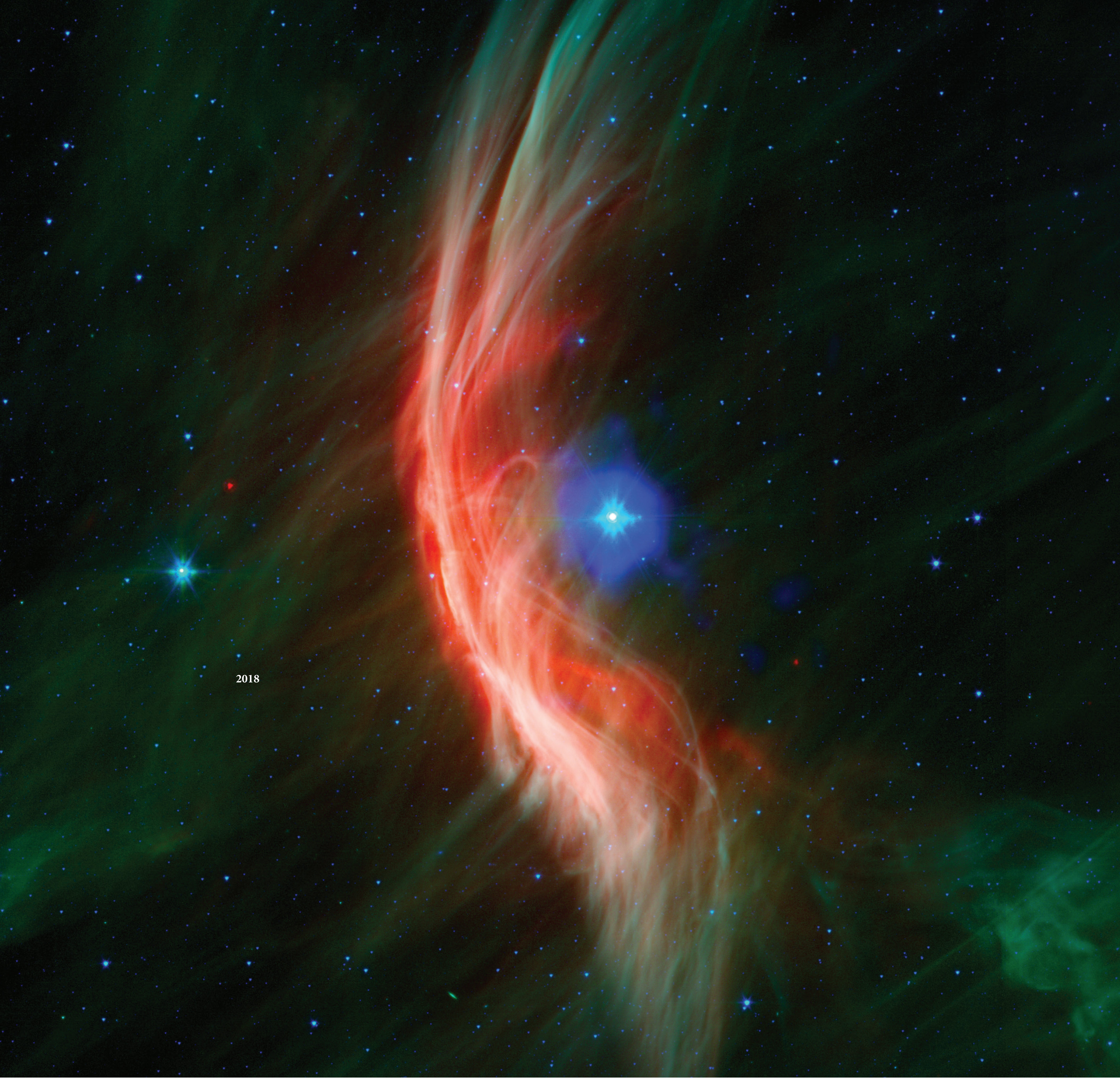


NOVEMBER 2023

S	M	T	W	Th	F	Sa
			1	2	3	4
5	6	7	8	9	10	11 Veterans Day
12	13	14	15	16	17	18
19	20	21	22	23 Thanksgiving Day	24	25
26	27	28	29	30		

R AQUARII

R Aquarii is a pair of objects: a white dwarf star that steadily burns at a relatively cool temperature and a highly variable red giant. As they orbit each other, the white dwarf pulls material from the red giant onto its surface. Over time, enough of this material accumulates and triggers an explosion. Astronomers have seen such outbursts over recent decades. Evidence for much older outbursts is seen in the spectacular structures observed by Hubble (red and blue). X-ray data from Chandra (purple) shows how a jet from the white dwarf is striking material surrounding it and creating shock waves, similar to sonic booms from supersonic planes. *Credit:X-ray: NASA/CXC/SAO/R. Montez et al.; Optical: Data: NASA/ESA/STScI, Enhanced processing by Judy Schmidt (CC BY-NC-SA). X-ray/Optical composite processing by CXC*



DECEMBER 2023

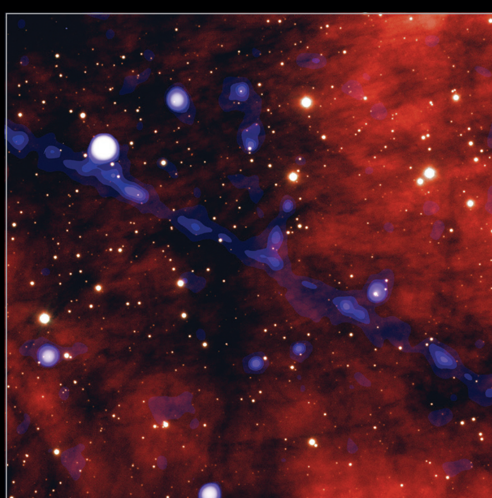
S	M	T	W	Th	F	Sa
					1	2
3	4	5 ◗	6	7	8	9
10	11	12 ●	13	14	15	16
17	18	19 ◖	20	21	22	23
24	25 Christmas Day	26 ○	27	28	29	30

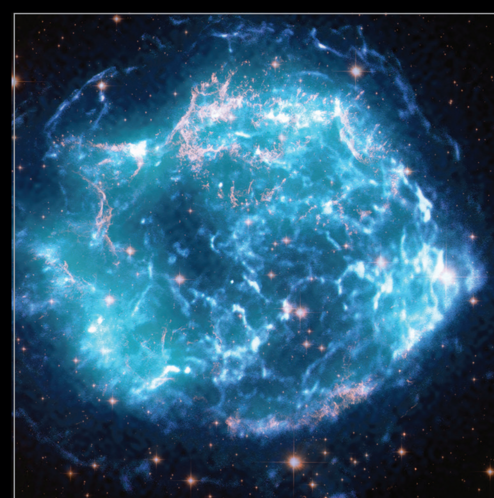
ZETA OPHIUCHI

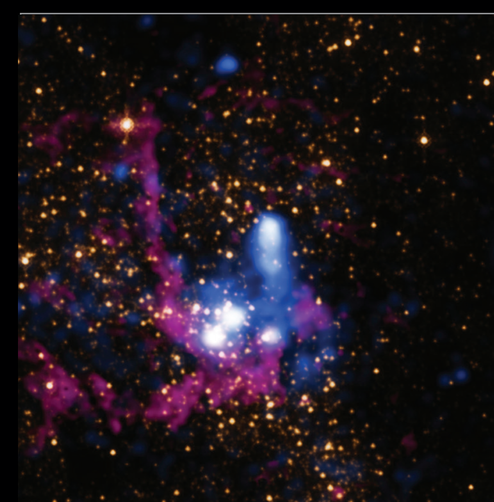
Zeta Ophiuchi was once in close orbit with another star, before being ejected when this companion was destroyed in a supernova explosion. Infrared data from Spitzer, seen in this composite image, reveal a spectacular shock wave (red and green) that was formed by matter blowing away from the star's surface and slamming into gas in its path. Data from Chandra show a bubble of X-ray emission (blue) located around the star, produced by gas that has been heated by the shock wave to tens of millions of degrees. The Chandra data help tell more of the story of this runaway star. X-ray: NASA/CXC/Dublin Inst. Advanced Studies/S. Green et al.; Infrared: NASA/JPL/Spitzer

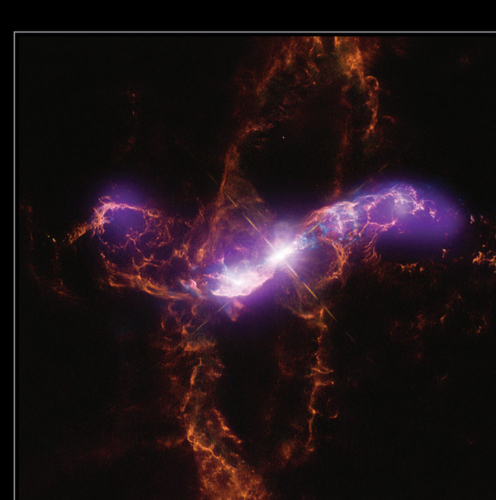
Since its launch on July 23, 1999, the Chandra X-ray Observatory has been NASA's flagship mission for X-ray astronomy, taking its place in the fleet of "Great Observatories."

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.









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