

EXPLORING *the* EXTREME:

20 YEARS OF CHANDRA

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.

- 1** NASA's Chandra X-ray Observatory was launched aboard the Space Shuttle Columbia on July 23, 1999.
- 2** Eileen Collins commanded that mission, known as STS-93, the first woman to be in charge of a Shuttle.
- 3** Chandra's oval-shaped orbit takes it tens of thousands of miles away from Earth – 1/3 the distance to the Moon – at its farthest point.
- 4** Chandra is NASA's premier X-ray telescope, belonging to a special class called the "Great Observatories" (along with Hubble, Spitzer, and Compton).
- 5** The Great Observatories took decades to plan, develop, and build. Each has given astronomers a unique view of the Universe in different types of light.
- 6** Chandra is a black hole finder and explorer. It has observed black holes of all sizes, from nearby to the edge of the known Universe.
- 7** When matter swirls around a black hole, it is superheated to millions of degrees. This makes it glow brightly in X-ray light that Chandra can detect.
- 8** Chandra has seen giant eruptions from the supermassive black holes that reside at the centers of most galaxies – including our own.
- 9** Black holes can rip apart stars that approach too close, and Chandra has observed the aftermath of these violent events.
- 10** Chandra has helped to reveal the fundamental properties – spin and mass – of black holes.



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Galaxy clusters are the largest objects in the Universe held together by gravity. Most of their normal matter is in hot gas between the galaxies that emit X-rays.

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Chandra sees the hot gas in clusters in more detail than any other telescope, making discoveries like the deepest known note in the Universe within the Perseus Cluster.

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Studies of galaxy clusters with Chandra have given scientists clues about the nature of dark matter and dark energy, two of the biggest mysteries in astrophysics.

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Many of the elements necessary for life are forged inside stars and blasted into space in supernovas. Chandra has tracked these elements with exceptional accuracy.

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The study of these debris fields, known as supernova remnants, gives astronomers a way to understand the life cycle of star life, death, and rebirth.

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Chandra can study stars of different ages and sizes, enabling a better understanding of the past, present, and future of our own Sun and nearby stars

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Astronomers have used Chandra to learn about how exoplanets are affected by X-rays from their host stars.

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X-rays from Chandra have told us new things about planets, comets, moons and other objects within our own Solar System.

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Chandra observed X-rays resulting from a merger between two neutron stars that generated gravitational waves, the birth of a new era in studying the Universe.

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In 2018, Chandra became the longest running astronomy mission in space without maintenance or repair from astronauts. Here's to another 20 years.