



- [Home](#)
- [About Chandra](#)
- [Education](#)
- [Field Guide](#)
- [Photo Album](#)
- [Press Room](#)
- [Resources](#)
- [Multimedia](#)
- [Podcasts](#)
- [Blog](#)
- [Research](#)

Images by Date

2022	2021	2020	2019
2018	2017	2016	2015
2014	2013	2012	2011
2010	2009	2008	2007
2006	2005	2004	2003
2002	2001	2000	1999

Images by Category

- [Solar System](#)
- [Stars](#)
- [White Dwarfs](#)
- [Supernovas](#)
- [Neutron Stars](#)
- [Black Holes](#)
- [Milky Way Galaxy](#)
- [Normal Galaxies](#)
- [Quasars](#)
- [Galaxy Clusters](#)
- [Cosmology/Deep Field](#)
- [Miscellaneous](#)

Images by Interest

- [Space Scoop for Kids](#)
- [4K JPG](#)
- [Multiwavelength](#)
- [Sky Map](#)
- [Constellations](#)
- [Photo Blog](#)
- [Top Rated Images](#)
- [Image Handouts](#)
- [Desktops](#)
- [Fits Files](#)

Image Tutorials

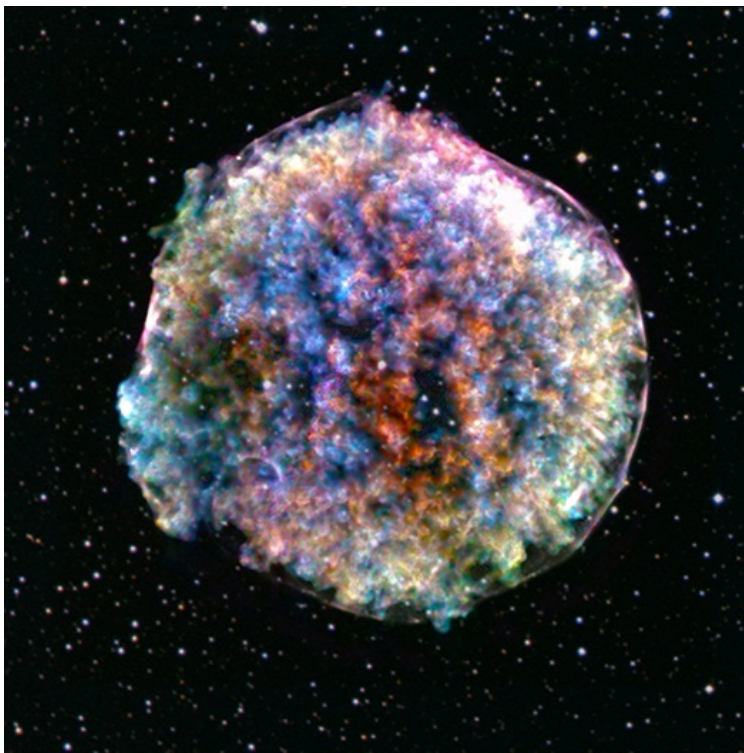
- [Photo Album Tutorial](#)
- [False Color](#)
- [Cosmic Distance](#)
- [Look-Back Time](#)
- [Scale & Distance](#)
- [Angular Measurement](#)
- [Images & Processing](#)
- [AVM/Metadata](#)

[Image Use Policy](#)

Web Shortcuts

- [Chandra Blog](#)
- [RSS Feed](#)
- [Chronicle](#)
- [Email Newsletter](#)
- [News & Noteworthy](#)
- [Image Use Policy](#)
- [Questions & Answers](#)
- [Glossary of Terms](#)
- [Download Guide](#)
- [Get Adobe Reader](#)

The Clumpy and Lumpy Death of a Star



View Wavelengths: [CompositeX-rayOptical](#)

- A new image of the Tycho supernova remnant from Chandra shows a pattern of bright clumps and fainter holes in the X-ray data.
- Scientists are trying to determine if this 'clumpiness' was caused by the supernova explosion itself or something in its aftermath.
- By comparing Chandra data to computer simulations, researchers found evidence that the explosion was likely the source of this lumpy distribution.
- The original supernova was first seen by skywatchers in 1572, including the Danish astronomer Tycho Brahe who the object was eventually named after.

In 1572, Danish astronomer [Tycho Brahe](#) was among those who noticed a new bright object in the constellation Cassiopeia. Adding fuel to the intellectual fire that Copernicus started, Tycho showed this "new star" was far beyond the Moon, and that it was possible for the Universe beyond the Sun and planets to change.

Astronomers now know that Tycho's new star was not new at all. Rather it signaled the death of a star in a [supernova](#), an explosion so bright that it can outshine the light from an entire galaxy. This particular supernova was a [Type Ia](#), which occurs when a [white dwarf](#) star pulls material from, or merges with, a nearby companion star until a violent explosion is triggered. The white dwarf star is obliterated, sending its debris hurtling into space.

As with many [supernova remnants](#), the Tycho supernova remnant, as it's known today (or "Tycho," for short), glows brightly in X-ray light because shock waves — similar to [sonic booms](#) from supersonic aircraft — generated by the stellar explosion heat the stellar debris up to millions of degrees. In its two decades of operation, [NASA's Chandra X-ray Observatory](#) has captured unparalleled [X-ray images of many supernova remnants](#).

Chandra reveals an intriguing pattern of bright clumps and fainter areas in Tycho. What caused this thicket of knots in the aftermath of this explosion? Did the explosion itself cause this clumpiness, or was it something that happened afterward?

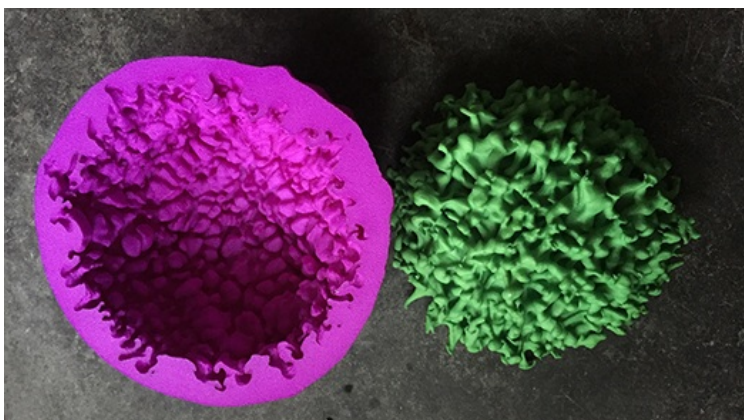
This latest image of Tycho from Chandra is providing clues. To emphasize the clumps in the image and the three-dimensional nature of Tycho, scientists selected two narrow ranges of X-ray energies to isolate material (silicon, colored red) moving away from Earth, and moving towards us (also silicon, colored blue). The other colors in the image (yellow, green, blue-green, orange and purple) show a broad range of different energies and elements, and a mixture of directions of motion. In this new composite image, Chandra's [X-ray](#) data have been combined with an optical image of the stars in the same field of view from the Digitized Sky Survey.

By comparing the Chandra image of Tycho to two different computer simulations, researchers were able to test their ideas against actual data. One of the simulations began with clumpy debris from the explosion. The other started with smooth debris from the explosion and then the clumpiness appeared afterwards as the supernova remnant evolved and tiny irregularities were magnified.

A statistical analysis using a technique that is sensitive to the number and size of clumps and holes in images was then used. Comparing results for the Chandra and simulated images, scientists found that the Tycho supernova remnant strongly resembles a scenario in which the clumps came from the explosion itself. While scientists are not sure how, one possibility is that star's explosion had multiple ignition points, like dynamite sticks being set off simultaneously in different locations.

Understanding the details of how these stars explode is important because it may improve the reliability of the use of Type Ia supernovas "standard candles" — that is, objects with known inherent brightness, which scientists can use to determine their distance. This is very important for studying the expansion of the universe. These supernovae also sprinkle elements such as iron and silicon, that are essential for life as we know it, into the next generation of stars and planets.

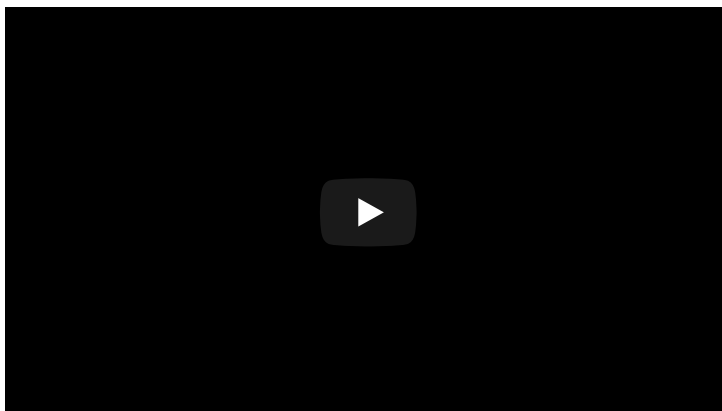
A paper describing these results appeared in the July 10th, 2019 issue of The Astrophysical Journal and is [available online](#). The authors are Toshiki Sato (RIKEN in Saitama, Japan, and NASA's Goddard Space Flight Center in Greenbelt, Maryland), John (Jack) Hughes (Rutgers University in Piscataway, New Jersey), Brian Williams, (NASA's Goddard Space Flight Center), and Mikio Morii (The Institute of Statistical Mathematics in Tokyo, Japan).



Another team of astronomers, led by Gilles Ferrand of RIKEN in Saitama, Japan, has constructed their own three-dimensional computer models of a Type Ia supernova remnant (shown above) as it changes with time. [Their work](#) shows that initial asymmetries in the simulated supernova explosion are required so that the model of the ensuing supernova remnant closely resembles the Chandra image of Tycho, at a similar age. This conclusion is similar to that made by Sato and his team.

A paper describing the results by Ferrand and co-authors appeared in the June 1st, 2019 issue of The Astrophysical Journal and is [available online](#).

NASA's Marshall Space Flight Center manages the Chandra program. The Smithsonian Astrophysical Observatory's Chandra X-ray Center controls science and flight operations from Cambridge, Massachusetts.

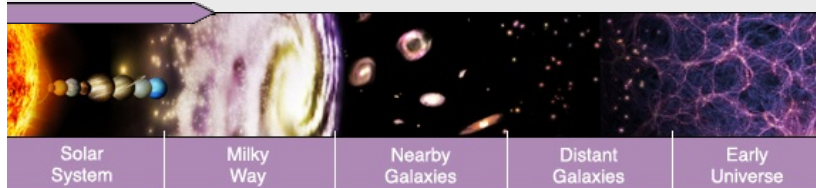


Fast Facts for Tycho's Supernova Remnant:

Credit	X-ray: NASA/CXC/RIKEN & GSFC/T. Sato et al; Optical: DSS
Release Date	October 17, 2019
Scale	Image is about 12 arcmin (45 light years) across.
Category	Supernovas & Supernova Remnants
Coordinates (J2000)	RA 00h 25m 17s Dec +64° 08' 37"
Constellation	Cassiopeia
Observation Date	14 pointings between Oct 1, 2001 & April 22, 2016
Observation Time	336 hours 2 minutes (14 days 0 hours 2 minutes)
Obs. ID	115, 3837, 7539, 8551, 10093-10097; 10902-10904; 10906, 15998
Instrument	ACIS
Also Known As	G120.1+01.4, SN 1572
References	Sato, T. et al. 2019, ApJ, 879, 64; arXiv:1903.00764
Color Code	X-ray Broadband: Red: 0.3-1.2 keV, Yellow: 1.2-1.6 keV, Cyan: 1.6-2.26 keV, Navy: 2.2-4.1 keV, Purple: 4.4-6.1 keV; X-ray Motion Shift Orange: 1.7666-1.7812 keV, Blue: 1.9564-1.971 keV; Optical: Red, Blue



Distance Estimate About 13,000 light years



The Basics

[What is it?](#)

[How Far Away is it?](#)

In the constellation Cassiopeia.

Rate This Image

★ ★ ★ ★ ★
Rating: **3.9/5**
(506 votes cast)



Download & Share

[JPEG \(530.4 kb\)](#)
[Large JPEG \(2.3 MB\)](#)

[Tiff \(47.3 MB\)](#)

[Handout \(pdf\)](#)

[Image Feed](#)

Share This  

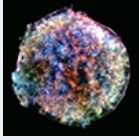
More Information

Blog: [Tycho Remnant](#)

More Images

X-ray Image of
the Tycho's Supernova
Remnant

[Jpg, Tif](#)



[More Images](#)

Animation & Video

A Tour of Tycho's Supernova
Remnant



[More Animations](#)

More Releases



[Tycho's Supernova Remnant](#)
(12 May 16)



[Tycho's Supernova Remnant](#)
(22 Jul 14)



[Tycho's Supernova Remnant](#)
(26 Apr 11)



[Tycho's Supernova Remnant](#)
(24 Mar 11)



[Tycho's Supernova Remnant](#)
(18 Feb 09)



[Tycho's Supernova Remnant](#)
(05 Sep 05)



[Tycho's Supernova Remnant](#)
(06 Sep 02)

Related Images



[Cassiopeia A](#)
(26 Aug 19)



[Crab Nebula](#)
(10 May 17)

Related Information

**Supernovas & Supernova
Remnants**

[X-ray Astronomy Field Guide](#)

[Questions and Answers](#)

[Chandra Images](#)

Related Podcast

[Quick Look: When a Stable Star Explodes](#)



Top Rated Images



M51



Data Sonification



Planetary Nebula Collection



[Help](#) | [Site Map](#) | [Image Use Policy](#) | [Privacy](#) | [Accessibility](#) | [Downloads & Plugins](#) | [Glossary](#) | [Q & A](#) | [New & Noteworthy](#) | [CXC Science](#)

cxcpub@cfa.harvard.edu



Select Language ▾

Powered by [Google Translate](#)

[Tweet](#)

