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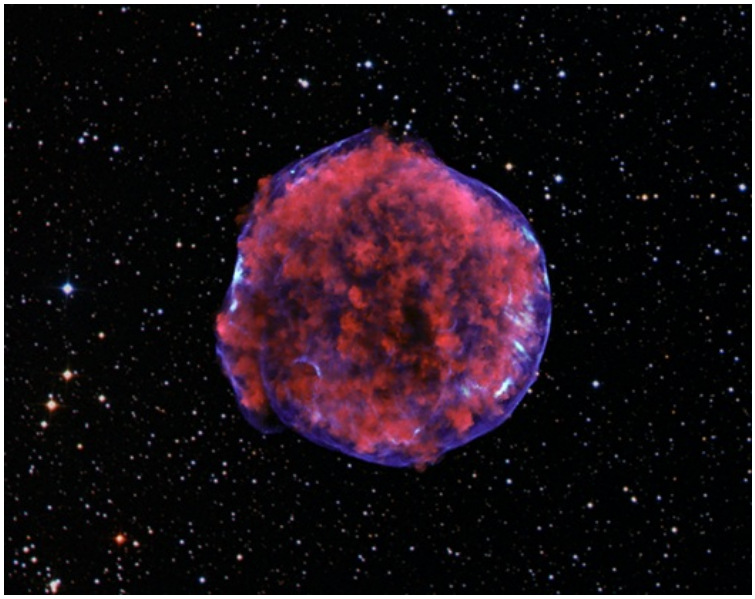
Tycho's Supernova Remnant: Exploding Stars and Stripes

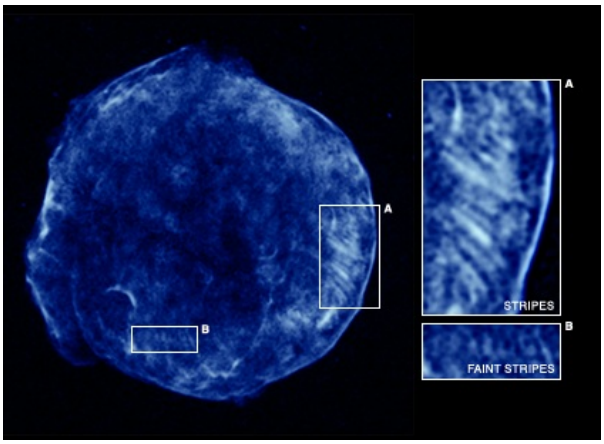


View Wavelengths CompositeX-rayOptical

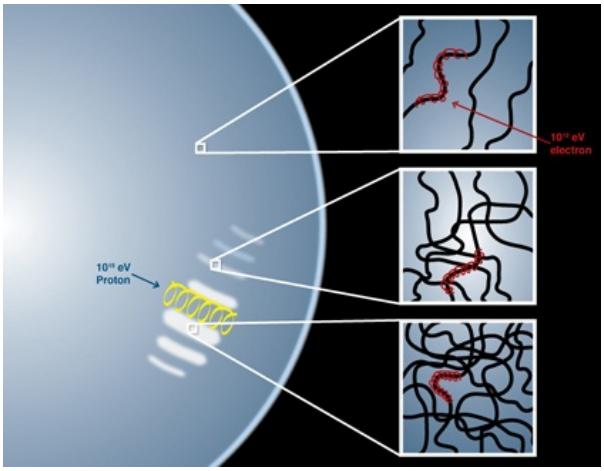
- A long Chandra observation of Tycho has revealed a pattern of X-ray "stripes" never seen before in a supernova remnant.
- This result could explain how some of the extremely energetic particles bombarding the Earth, called cosmic rays, are produced.
- Tycho is a supernova remnant that was first observed in 1572 by a famous Danish astronomer who became its namesake.

This image comes from a very deep Chandra observation of the Tycho supernova remnant, produced by the explosion of a white dwarf star in our Galaxy. Low-energy X-rays (red) in the image show expanding debris from the supernova explosion and high energy X-rays (blue) show the blast wave, a shell of extremely energetic electrons . These high-energy X-rays show a pattern of X-ray "stripes" never previously seen in a supernova remnant. By rolling the mouse over the color image above, two regions containing stripes in the high energy image can be seen superimposed on the full color version. Some of the brightest stripes can also directly be seen in the full color image, on the right side of the remnant pointing from the outer rim to the interior. The stellar background is from the Digitized Sky Survey and only shows stars outside the remnant. We have also produced an image showing all of the stars.

These stripes may provide the first direct evidence that supernova remnants can accelerate particles to energies a hundred times higher than achieved by the most powerful particle accelerator on Earth, the Large Hadron Collider. The results could explain how some of the extremely energetic particles bombarding the Earth, called cosmic rays, are produced, and they provide support for a theory about how magnetic fields can be dramatically amplified in such blast waves.



The X-ray stripes are thought to be regions where the turbulence is greater and the magnetic fields more tangled than surrounding areas. Electrons become trapped in these regions and emit X-rays as they spiral around the magnetic field lines. Regions with enhanced turbulence and magnetic fields were expected in supernova remnants, but the motion of the most energetic particles -- mostly protons -- was predicted to leave a messy network of holes and dense walls corresponding to weak and strong regions of magnetic fields, respectively. Therefore, the detection of stripes was a surprise.



Schematic Illustration of the Tycho Stripes

The size of the holes was expected to correspond to the radius of the spiraling motion of the highest energy protons in the supernova remnant. These energies equal the highest energies of cosmic rays thought to be produced in our Galaxy. The spacing between the stripes corresponds to this size, providing evidence for the existence of these extremely energetic protons.

The Tycho supernova remnant is named for the famous Danish astronomer Tycho Brahe, who reported observing the supernova in 1572. It is located in the Milky Way, about 13,000 light years from Earth. Because of its proximity and intrinsic brightness, the supernova was so bright that it could be seen during the daytime with the naked eye.

Fast Facts for Tycho's Supernova Remnant:

Credit	X-ray: NASA/CXC/Rutgers/K.Eriksen et al.; Optical: DSS
Release Date	March 24, 2011
Scale	Image is 19 arcmin across (about 55 light years)
Category	Supernovas & Supernova Remnants
Coordinates (J2000)	RA 00h 25m 17s | Dec +64° 08' 37"
Constellation	Cassiopeia
Observation Date	9 pointings between April 13 and May 3, 2009
Observation Time	207 hours 15 min (8 days 15 hours 15 min)
Obs. ID	10093-10097; 10902-10904; 10906
Instrument	ACIS
Also Known As	G120.1+01.4, SN 1572
References	K.Eriksen et al. 2011, ApJL, 728:L28; arXiv:1101.1454
Color Code	Energy: Red 1.6-2.15 keV, Green 7.15-9.3 keV, Blue 4-6 keV

Distance Estimate	About 13,000 light years

Visitor Comments (9)

Where can I find more in-depth information on the research of the Tycho stripe formation?

Posted by Paul on Monday, 08.20.12 @ 14:25pm

If explosions ripped the star, pole to pole. That explains the stripes emanating from near equator to opposed polar areas. Natl Geo July 2004 p. 19 shows solar stripes angled to left and are EM lines whose magnetics attract pos. protons out to loop's rise to corona. Protons are stripped by gravity, forming the lower level sluggish return to equator dynamo.
With that, spaces between tycho remnant stripes are from asymptotic freedom. One pole of atoms are pos energy. Opposed pole are neg energy. Protons are basic positive energy.

Posted by Ed McCarvill on Monday, 02.6.12 @ 13:40pm

Were the X-ray and optical data taken at the same time? Why is there no optical data of the explosion?

Posted by Nate on Friday, 11.4.11 @ 17:56pm

Do you have any info like these about SNR IC 443?

Posted by Graziano Chiaro on Wednesday, 08.3.11 @ 12:17pm

Dear Sir,
Will you give me exact location, Deg. of that supernova?
Can it be visible?
Thanks
Jacob

Posted by Jacob Shulami on Friday, 06.17.11 @ 10:51am

Seems to be some variation in its location.
This post says 7500 ly from us.
http://www.solstation.com/x-objects/tycho-s.htm

Posted by Martin on Monday, 05.9.11 @ 13:15pm

Dear Marvin L.S.,
Thanks for your question. Undoubtedly searches will be made for similar phenomena in other supernova remnants, but deeper images might be needed before other examples will be found. Very few observations of supernova remnants are as deep as the Chandra one of Tycho.
P. Edmonds, CXC

Posted by P. Edmonds on Monday, 05.2.11 @ 14:21pm

Another great first for Chandra. Are you looking into other super nova remnants for the same phenomena?

Marvin L. S.

Posted by Marvin L. S. on Saturday, 04.16.11 @ 22:55pm

I look at many NASA sites, but Chandra is my favorite. The colors are quite impressive on this remnant. These combination representations really bring out the best of all available data. Thanks

Posted by Kevin Morrison on Thursday, 03.24.11 @ 14:12pm

The Basics

What is it?

How Far Away is it?

In the constellation Cassiopeia, visible from Northern Hemisphere.

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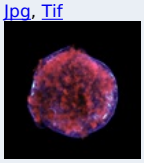

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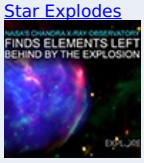

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