

Vela Pulsar

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Credit: X-ray: NASA/CXC/Univ of Toronto/M.Durant et al; Optical: DSS/Davide De Martin

(Phys.org)—This movie from NASA's Chandra X-ray Observatory shows a fast moving jet of particles produced by a rapidly rotating neutron star, and may provide new insight into the nature of some of the densest matter in the universe.

The star of this movie is the Vela pulsar, a neutron star that was formed when a massive star collapsed. The Vela pulsar is about 1,000 [light years](#) from Earth, spans about 12 miles in diameter, and makes over 11 complete rotations every second, faster than a helicopter rotor. As the pulsar whips around, it spews out a jet of charged [particles](#) that race out along the pulsar's [rotation axis](#) at about 70% of the [speed of light](#). In this still image from the movie, the location of the pulsar and the 0.7-light-year-long jet are labeled.

The Chandra data shown in the movie, containing eight images obtained between June and September 2010, suggest that the pulsar may be slowly wobbling, or precessing, as it spins. The

shape and the motion of the Vela jet look strikingly like a rotating helix, a shape that is naturally explained by precession, as shown in this animation [[link to mathematica animation from Oleg K](#)]. If the evidence for precession of the Vela pulsar is confirmed, it would be the first time that a jet from a neutron star has been found to be wobbling, or precessing, in this way.

One possible cause of precession for a spinning neutron star is that it has become slightly distorted and is no longer a perfect sphere. This distortion might be caused by the combined action of the fast rotation and "glitches", sudden increases of the pulsar's rotational speed due to the interaction of the superfluid core of the neutron star with its crust.

A [paper describing these results](#) will be published in *The Astrophysical Journal* on January 10, 2013.

This is the second Chandra movie of the Vela pulsar, with the original having been released in 2003. The first Vela movie contained shorter, unevenly spaced observations so that the changes in the jet were less pronounced and the authors did not argue that precession was occurring. However, based on the same data, Avinash Deshpande of Arecibo Observatory in Puerto Rico and the Raman Research Institute in Bangalore, India, and the late Venkatraman Radhakrishnan, argued in a 2007 paper that the Vela pulsar might be precessing.

The Earth also precesses as it spins, with a period of about 26,000 years. In the future Polaris will no longer be the "north star" and other stars will take its place. The period of the Vela precession is much shorter and is estimated to be about 120 days.

The supernova that formed the Vela pulsar exploded over 10,000 years ago. This optical image from the Anglo-Australian Observatory's UK Schmidt telescope shows the enormous apparent size of the supernova remnant formed by the explosion. The full size of the remnant is about eight degrees across, or about 16 times the angular

size of the moon. The square near the center shows the Chandra image with a larger field-of-view than used for the movie, with the Vela pulsar in the middle.

More information:

chandra.si.edu/photo/2013/vela/

[www.flickr.com/photos/nasamars ...](http://www.flickr.com/photos/nasamars...)

[s/72157606205297786/](https://www.flickr.com/photos/nasamars/72157606205297786/)

Provided by Chandra X-ray Center

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