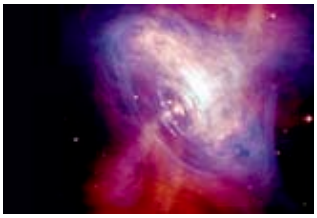


Smallest Deep Space Structures Detected, Study Claims

By Robert Roy Britt
Senior Science Writer
posted: 02:00 pm ET
12 March 2003

With sensitive new equipment, astronomers studying radio emissions from a fast-spinning star have detected what they say are the smallest structures found so far in deep space.

The star is called a pulsar because it pulses with energy. It is known as the Crab Pulsar because it anchors a cloudy batch of gas in space called the Crab Nebula.

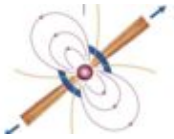
The Crab Pulsar is a neutron star -- a very dense star composed entirely of neutrons -- whose spin has entered overdrive. It rotates 33 times each second.

The newfound structures are little more than aspects of a magnetic field near the pulsar, but scientists hope to use knowledge of them to spin new ideas about how pulsars generate robust and largely mysterious radio bursts.

The pulsar, an aged corpse of a star that exploded centuries ago, Earth time, is about 6,000 light-years away. It emits a powerful beacon of energy that can be detected with each rotation, like the beam of a lighthouse sweeping around the heavens.

The observations were made with the National Science Foundation's radio telescope at Arecibo, in Puerto Rico. Tim Hankins of the New Mexico Institute of Mining and Technology, along with colleagues, hung special equipment on the 1,000-foot-diameter telescope that allowed them to break down the Crab

Images



Anatomy of a pulsar.

A composite image of the Crab Nebula showing the X-ray (blue), and optical (red) images superimposed. The size of the X-ray image is smaller because the higher energy X-ray emitting electrons radiate away their energy more quickly than the lower energy optically emitting electrons as they move.

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pulsar's primary bursts of energy into tiny time segments.

They found subpulses that last no more than two nanoseconds. A nanosecond is a billionth of a second. The embedded mini-bursts must be generated in a region no bigger than about two feet (61 centimeters) across -- the distance light can travel in two nanoseconds -- the scientists said.

"The small size of these regions is inconsistent with all but one proposed theory for how the radio emission is generated," Hankins said.

Here's what he thinks is happening:

The radio waves are generated in powerful mangnetospheres that exist above the pulsar's two magnetic poles. There, superheated gas called plasma contains electrically charged particles that respond to the strong electric and magnetic fields.

The embedded nanopulses must be created by a strange process whereby so-called density waves in the plasma interact with their own electrical field, becoming progressively denser until they reach a point at which they "collapse explosively," Hankins and his colleagues said.

All radio pulsars might behave similarly, the researchers speculate, but others will need to be studied to determine if that's the case.

The results will be reported in the March 13 issue of the journal *Nature*.

The Crab Nebula is the result of a star that exploded on July 4, 1054 and was recorded by Chinese astronomers. The nebula -- a giant cloud of gas -- was discovered by John Bevis in 1731 and independently rediscovered in 1758 by French astronomer Charles Messier, who made it the first entry -- M1 -- in his now famous catalog of objects.

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