Astronomers Discover Fastest Intergalactic Space Traveller

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A speeding, superdense neutron star somehow got a powerful "kick" that is propelling it completely out of our Milky Way Galaxy into the cold vastness of intergalactic space.

Its discovery is puzzling astronomers who used the National Science Foundation's Very Long Baseline Array (VLBA) radio telescope to directly measure the fastest speed yet found in a neutron star.

The neutron star is the remnant of a massive star born in the constellation Cygnus that exploded about two and a half million years ago. Ultra-precise VLBA measurements of its distance and motion show that it is on course to inevitably leave our Galaxy.

"We know that supernova explosions can give a kick to the resulting neutron star, but the tremendous speed of this object pushes the limits of our current understanding," said Shami Chatterjee, of the National Radio Astronomy Observatory (NRAO) and the Harvard-Smithsonian Center for Astrophysics. "This discovery is very difficult for the latest models of supernova core collapse to explain," he added.

Chatterjee and his colleagues used the VLBA to study the pulsar B1508+55, about 7700 light-years from Earth. With the ultrasharp radio "vision" of the continent-wide VLBA, they were able to precisely measure both the distance and the speed of the pulsar, a spinning neutron star emitting powerful beams of radio waves.

Plotting its motion backward pointed to a birthplace among groups of giant stars in the constellation Cygnus -- stars so massive that they inevitably explode as supernovae.

"This is the first direct measurement of a neutron star's speed that exceeds 1,000 kilometers per second," said Walter Brisken, an NRAO astronomer.

"Most earlier estimates of neutron-star speeds depended on educated guesses about their distances. With this one, we have a precise, direct measurement of the distance, so we can measure the speed directly," Brisken said.

The VLBA measurements show the pulsar moving at nearly 1100 kilometers (more than 670 miles) per second -- about 150 times faster than an orbiting Space Shuttle. At this speed, it could travel from London to New York in five seconds.

In order to measure the pulsar's distance, the astronomers had to detect a "wobble" in its position caused by the Earth's motion around the Sun. That "wobble" was roughly the size of a baseball bat as seen from the Moon. Then, with the distance determined, the scientists could calculate the pulsar's speed by measuring its motion across the sky.

"The motion we measured with the VLBA was about equal to watching a home run ball in Boston's Fenway Park from a seat on the Moon," Chatterjee explained. "However, the pulsar took nearly 22 months to show that much motion. The VLBA is the best possible telescope for tracking such tiny apparent motions."

The star's presumed birthplace among giant stars in the constellation Cygnus lies within the plane of the Milky Way, a spiral galaxy. The new VLBA observations indicate that the neutron star now is headed away

from the Milky Way's plane with enough speed to take it completely out of the Galaxy.

Since the supernova explosion nearly 2 and a half million years ago, the pulsar has moved across about a third of the night sky as seen from Earth.

"We've thought for some time that supernova explosions can give a kick to the resulting neutron star, but the latest computer models of this process have not produced speeds anywhere near what we see in this object," Chatterjee said. "This means that the models need to be checked, and possibly corrected, to account for our observations," he said.

"There also are some other processes that may be able to add to the speed produced by the supernova kick, but we'll have to investigate more thoroughly to draw any firm conclusions," said Wouter Vlemmings of the Jodrell Bank Observatory in the UK and Cornell University in the U.S.

The observations of B1508+55 were part of a larger project to use the VLBA to measure the distances and motions of numerous pulsars. "This is the first result of this long-term project, and it's pretty exciting to have something so spectacular come this early," Brisken said.

Chatterjee, Vlemmings and Brisken worked with Joseph Lazio of the Naval Research Laboratory, James Cordes of Cornell University, Miller Goss of NRAO, Stephen Thorsett of the University of California, Santa Cruz, Edward Fomalont of NRAO, Andrew Lyne and Michael Kramer, both of Jodrell Bank Observatory. The scientists presented their findings in the September 1 issue of the Astrophysical Journal Letters.

The VLBA is a system of ten radio-telescope antennas, each with a dish

25 meters (82 feet) in diameter and weighing 240 tons. From Mauna Kea on the Big Island of Hawaii to St. Croix in the U.S. Virgin Islands, the VLBA spans more than 5,000 miles, providing astronomers with the sharpest vision of any telescope on Earth or in space.