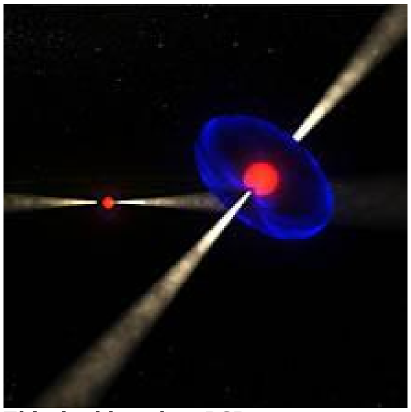
# Rare Double-Pulsar System Provides More Support for General Relativity

**Posted by Guy Pirro on 7/7/2008 10:11 PM**



**This double pulsar PSR J0737-3039A/B is the only known pulsar-pulsar system, that is, two neutron stars orbiting each other and both visible as radio pulsars. (Image Credit: Daniel Cantin, DarwinDimensions, McGill University)**

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Taking advantage of a unique cosmic configuration, astronomers have measured an effect predicted by Albert Einstein's theory of General Relativity in the extremely strong gravity of a pair of superdense neutron stars. Essentially, the famed physicist's 93-year-old theory passed yet another test.

Scientists at McGill University used the National Science Foundation's Robert C. Byrd Green Bank Telescope (GBT) to do a four-year study of a double-star system unlike any other known in the Universe. The system is a pair of neutron stars, both of which are seen as pulsars that emit lighthouse-like beams of radio waves.

Pulsars are small, ultradense stellar objects left behind after massive stars die and explode as supernovae. They typically have a mass greater than that of our Sun, but compressed to the size of a large city. They spin at staggering speeds, generate huge gravity fields and emit powerful beams of radio waves along their magnetic poles. These illuminate Earth-based radio-telescopes like rotating lighthouse beacons as the pulsar spins. More than 1,700 pulsars have been discovered in our galaxy, but PSR J0737-3039A/B, discovered in 2003, is the only known double-pulsar system; that is, two pulsars locked into close orbit around one another. The two pulsars are so close to each other, in fact, that the entire binary could fit within our Sun. PSR J0737-3039A/B lies about 1,700 light years from Earth.

"Of about 1700 known pulsars, this is the only case in which two pulsars orbit around each other," said Rene Breton, a graduate student at McGill University in Montreal, Canada. In addition, the stars' orbital plane is aligned nearly perfectly with their line of sight to the Earth. This causes the signal of one to be blocked, or eclipsed, as it circles the other.

"Those eclipses are the key to making a measurement that could never be done before," Breton said.

Einstein's 1915 theory predicted that in a close system of two very massive objects, such as neutron stars, one object's gravitational tug, along with an effect of its spinning around its axis, should cause the spin axis of the other to wobble, or precess.

Studies of other pulsars in binary systems had indicated that such wobbling occurred, but could not produce precise measurements of the amount of wobbling.

"Measuring the amount of wobbling is what tests the details of Einstein's theory and gives a benchmark that any alternative gravitational theories must meet," said Scott Ransom of the National Radio Astronomy Observatory.

The eclipses allowed the astronomers to pin down the geometry of the double-pulsar system and track changes in the orientation of the spin axis of one of them. As one pulsar's spin axis slowly moved, the pattern of signal blockages as the other passed behind it also changed. The signal from the pulsar in back is absorbed by the ionized gas in the other's magnetosphere.

Pulsars, first discovered in 1967, are the "corpses" of massive stars that have exploded as supernovae. What is left after the explosion is a superdense neutron star that packs more than the mass of our Sun into the size of an average city. Beams of radio waves stream outward from the poles of the star's intense magnetic field and sweep around as the star rotates, as often as hundreds of times a second.