Astronomers find unexpected 'heartbeats' in star

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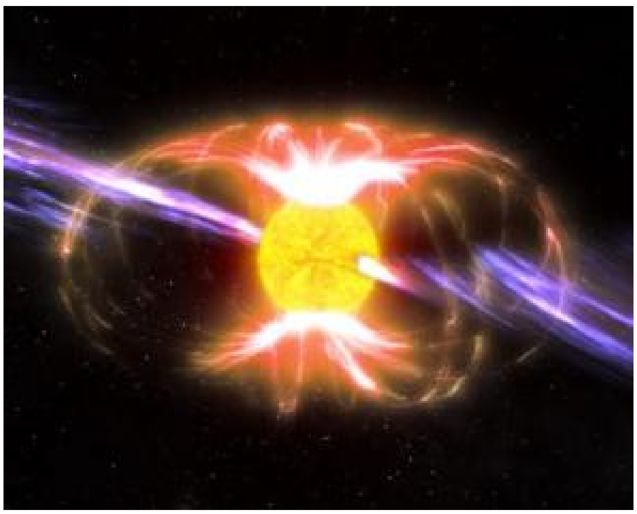

An artist's impression of magnetar XTE J1810-197showing the radio emissions and the magnetic field. Credit: CSIRO

Astronomers using CSIRO's Parkes telescope in eastern Australia have detected radio "heartbeats" from a star that was not expected to have them. A US-Australian research team found that a "magnetar" -- a kind of star with the strongest magnetic fields known in the Universe -- is giving off extraordinary radio pulses, which links this rare type of star with the much more common "radio pulsars."

The findings will be published in the journal *Nature* on 24 August, and are also being presented at the International Astronomical Union General

Assembly taking place in Prague (14-25 August).

The research team, led by Dr Fernando Camilo of Columbia University in New York, includes staff of the CSIRO Australia Telescope National Facility and the US National Radio Astronomy Observatory. The discovery observations were made on 17 March 2006 by CSIRO scientist John Sarkissian. Further observations at Parkes were made by the Observatory's officer-in-charge, John Reynolds.

"We hoped to detect a radio pulse if we were lucky," Mr Sarkissian says. "But we were genuinely surprised at how strong it actually was."

Dr. Reynolds says the unexpected strength of the pulsar puts it in a category of its own.

"The pulsar was so strong we could easily see and hear individual pulses of emission at the discovery frequency, which is rare enough," Dr Reynolds says. "But we were stunned to find that as we tuned to higher and higher frequencies the single pulses kept booming in."

The object in question is a neutron star – a small star made of extremely dense "neutron matter" – called XTE J1810-197. It lies about 10,000 light-years away in the constellation Sagittarius. The Parkes observations found it to be emitting radio pulses at every turn of the star, or every 5.54 seconds. These pulses have now been confirmed and studied with other telescopes in Australia, the USA and Europe. Radio pulsars are neutron stars that put out regular pulses of radio waves. In almost all cases these pulses are easiest to detect at low frequencies (long radio wavelengths), and get fainter and much harder to detect at higher frequencies (short wavelengths).

"But this object is extraordinary," Dr Camilo says. "Its brightness is essentially the same over a factor of 100 in frequency. For wavelengths less than about a centimetre, it is brighter than every other known neutron star." XTE J1810-197 was discovered in 2003 as an X-ray source and is one of a handful of unusual objects called "anomalous X-ray pulsars" or AXPs: slowly rotating neutron stars with bright and variable pulsing X-ray emission.

Debate raged for many years over the nature of AXPs. They are now thought to be magnetars, of which only a dozen are known in our Galaxy – very young neutron stars with magnetic fields a hundred million million times stronger than Earth's (10exp14 gauss, as compared with the Earth's 0.5 gauss).

Radio pulsars are another, much more common, type of neutron star. More than 1700 are known. Their magnetic fields, while strong by terrestrial standards, are typically about 100 times weaker than those of magnetars. Radio pulsars also generally spin much faster than magnetars.

Because the physical conditions in the "atmosphere" of magnetars are very different from those in normal pulsars, it was not clear whether magnetars should emit radio waves.

"Clearly we've found that you can get radio emission from a magnetar, but whether any models for it are correct in detail remains to be seen," Dr Camilo says.

"In any case, this discovery connects the rare magnetars to the much more common radio pulsars, and helps put some order and understanding into the zoo of neutron stars."

But much is still unexplained. Co-author Scott Ransom, of NRAO, says: "The brightness of the radio emission detected from XTE J1810-197 varies day-by-day in a way that is inconsistent with what we know about ordinary pulsars." While XTE J1810-197 was born a few thousand years ago, it became visible only in early 2003, when it produced a bright outburst of X-rays. Archival X-ray data from the previous 24 years shows no such strong emission.

Following the 2003 outburst, the Very Large Array telescope in the USA detected radio emission from the source in January 2004. The Parkes observations showed that this emission was, in fact, pulsed.

Archived Parkes observations from the late 1990s don't reveal any radio sources in the vicinity of the magnetar. The radio emission was probably turned on by the X-ray outburst of 2003.

The X-ray brightness of the magnetar is decreasing rapidly, and within the next year it should fade to pre-2003 levels. The same will probably happen to the radio emission, according to Dr Camilo, but "we have no idea whether this will happen in six months or 50 years".

Citation: Fernando Camilo, Scott M. Ransom, Jules P. Halpern, John Reynolds, David J. Helfand, Neil Zimmerman & John Sarkissian. "Transient pulsed radio emission from a magnetar". *Nature* vol 442, pp 892-895 (24 August 2006).

Source: CSIRO Australia