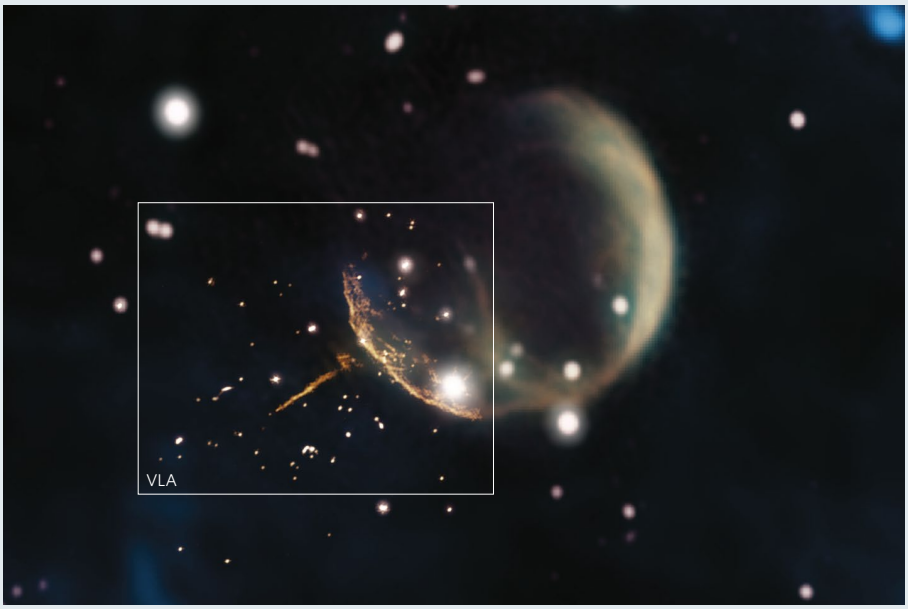
PULSARS

Breaking out of the bubble

Pulsars are usually discovered in blind radio surveys, using large, sensitive telescopes to cover sizeable portions of the sky. This generates substantial amounts of data that are searched for periodic signals that might indicate the presence of a pulsar. For instance, the ongoing PALFA survey using the Arecibo telescope has discovered almost 200 new pulsars in 15 years using this technique. However, some pulsars are only known to emit radiation in the form of gamma rays. Direct detection of such objects requires the use of space-based observatories, such as NASA's Fermi telescope. This is the aim of the Einstein@Home Gamma-ray Pulsar Survey, named after the distributed volunteer computing system used to process the Fermi data.

Pulsar PSR J0002+6216 is one of the 13 new gamma-ray pulsars discovered in the first results of the citizen-science-powered survey (C. J. Clark et al. *Astrophys. J.* **834**, 106; 2017). The pulsar lies about 2 kpc away, and pulses roughly nine times per second. Because the pulsar had no known counterpart at other wavelengths, it was flagged for radio-wavelength follow-up observations in order to investigate the source of the gamma-ray emission (see F. K. Schinzel et al. *Astrophys. J.* **838**, 139; 2017). That follow-up, performed using the Karl G. Jansky Very Large Array (VLA), resulted in the impressive image presented here, which also includes a background image taken from the Canadian Galactic Plane Survey. The pulsar itself is not particularly evident in this radio image, but its position is indicated by a golden, needle-like trail of shocked particles shooting out of the supernova remnant bubble in the centre.



Credit: composite by Jayanne English, University of Manitoba; F. Schinzel et al.; NRAO/AUI/NSF; DRAO/Canadian Galactic Plane Survey; NASA/IRAS

The pulsar is moving at more than 1,000 km s^{-1}, and tracking the pulsar's motion backwards puts it at the centre of the supernova remnant some 10,000 years ago. The pulsar is likely to have experienced a kick during the supernova explosion itself, which saw it catch up with the supernova shock front after about 5,000 years, before punching through it and continuing out the other side. The very high speed of the pulsar — some 4–5 times faster than usual — will see it escape the Milky Way eventually. ❐

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