PALFA survey reveals eight new millisecond pulsars

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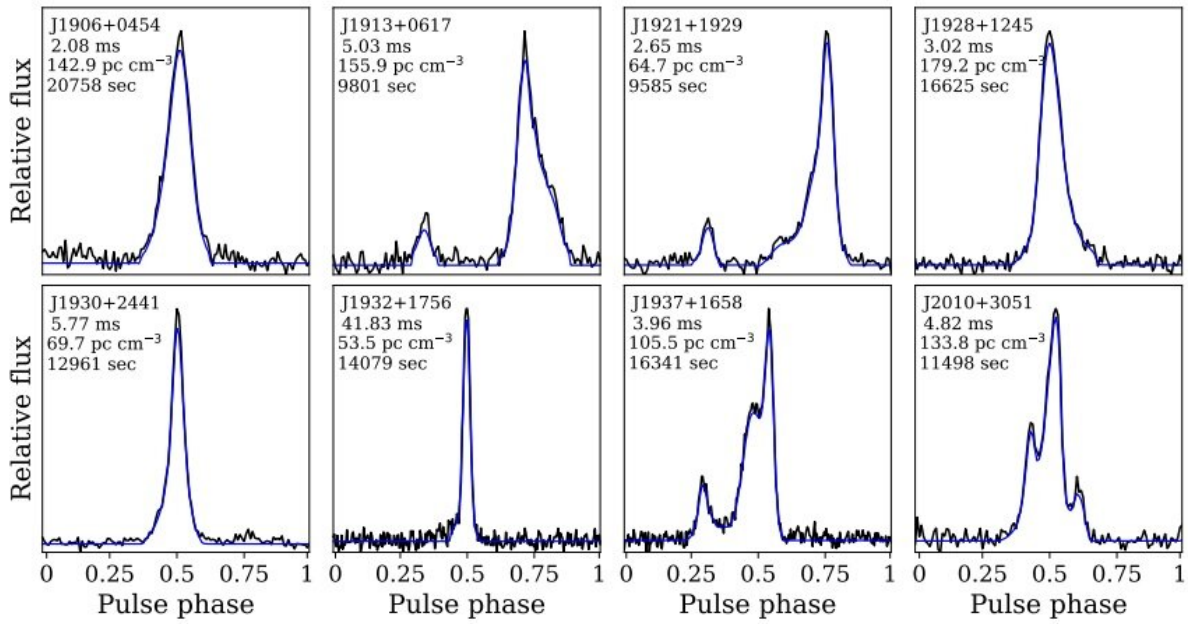

Pulse profiles at 1.4 GHz of the eight pulsars presented in the paper. Credit: Parent et al., 2019.

An international team of astronomers has reported the discovery of eight new millisecond pulsars in the PALFA (Pulsar Arecibo L-band Feed Array) survey. All of the newly detected pulsars were found to have orbiting companions. The finding is detailed in a paper published August 26 on arXiv.org.

Pulsars are highly magnetized, rotating neutron stars emitting a beam of electromagnetic radiation. The most rapidly rotating pulsars, with rotation periods below 30 milliseconds, are known as millisecond pulsars (MSPs).

Astronomers believe that MSPs are formed in binary systems when the initially more massive component turns into a neutron star that is then spun-up due to accretion of matter from the secondary star. Observations conducted so far seem to support this theory, as more than a half of known MSPs have been found to have stellar companions.

Now, a group of astronomers led by Emilie Parent of McGill University in Montreal, Canada, has announced the discovery of eight new MSPs existing as binary systems. The objects were found in the PALFA survey, which utilizes the seven-beam L-band feed array on the Arecibo Observatory's William E. Gordon 305-meter telescope. Afterward, the pulsar nature of the newly identified sources was confirmed by follow-up observations using the 76-m Lovell Telescope at Jodrell Bank Observatory (JBO) and also the Arecibo Observatory.

"We report on eight millisecond pulsars in binary systems discovered with the Arecibo PALFA survey. Phase-coherent timing solutions derived from 2.5 to 5 years of observations carried out at Arecibo and Jodrell Bank observatories are provided," the astronomers wrote in the paper.

With a period of about 2.08 ms, PSR J1906+0454 is the fastest-spinning MSP among the newly detected pulsars and the second-most rapidly rotating object found by PALFA. The slowest spinning pulsar reported in the paper turns out to be PSR J1932+1756, with a period of approximately 41.83 ms. The remaining six MSPs have spin periods between 2.64 and 5.76 ms.

All eight pulsars were found at galactic longitudes between 39 and 68 degrees, and within 3.0 degrees of the galactic plane. When it comes to dispersion measure, this value is at a level between 53 to 179 parsecs/cm^3 for all the pulsars described in the study.

According to the authors of the paper, the most interesting MSPs out of the eight are: PSR J1928+1245, PSR J1921+1929 and PSR J1932+1756.

PSR J1928+1245 is a "black widow" pulsar for which no eclipses were detected. The so-called "black widows" are a class of extreme binary pulsars with semi-degenerate companion stars dubbed "spider pulsars," distinguished by an extremely low-mass companion (with mass less than 0.1 solar masses).

PSR J1921+1929 is a gamma-ray MSP with a relatively low dispersion measure (64.76 parsecs/cm^3) and rapid rotation (2.64 ms). The properties of this pulsar make it an interesting target of observations for pulsar timing array (PTA) projects—regular, high-precision timing observations of a widely distributed array of MSPs.

The slowest spinning pulsar out of the newfound MSPs, PSR J1932+1756, turns out to be an intermediate-mass binary pulsar (IMBP) in a low-eccentricity orbit with a massive white dwarf. PSR J1932+1756 has the longest orbital period of all the known IMBPs.

More information: E. Parent, et al. Eight Millisecond Pulsars Discovered in the Arecibo PALFA Survey, arXiv:1908.09926v1 [astro-ph.HE]: arxiv.org/abs/1908.09926.

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