First Detection of Millisecond Pulsar by FAST Telescope

China's Five-hundred-meter Aperture Spherical radio Telescope (FAST), still under commissioning, has made the first detection of a radio millisecond pulsar (MSP) on February 27, 2018. The event was confirmed by the Fermi-LAT team when reprocessing Fermi data on April 18.

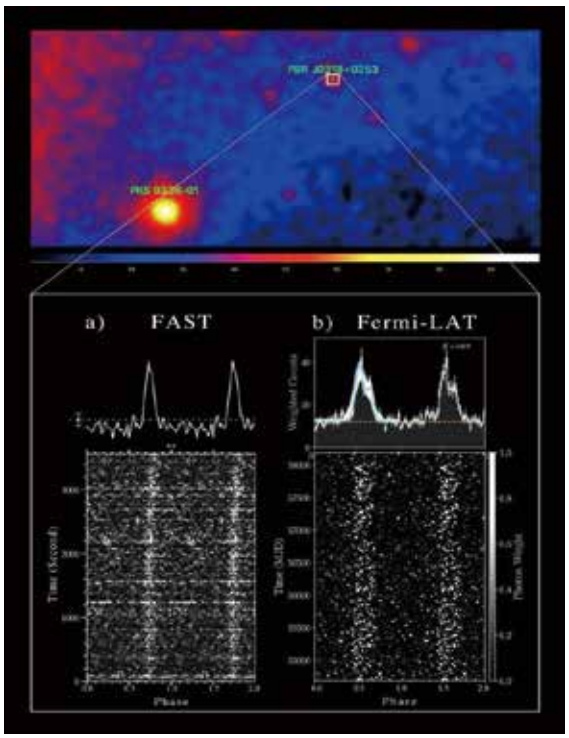
A MSP is a special type of neutron star that rotates hundreds of times per second. It plays an important role in our understanding of the evolution of neutron stars and the equation of state of dense matter. It can also be used to detect low-frequency gravitational waves.

"MSPs rotate at a very stable speed and only get slow by one second over a billion years' time. Its timing accuracy can be compared to that of the most accurate Cesium atomic clocks made on Earth," LI Di from the National Astronomical Observatories of the Chinese Academy of Sciences (NAOC), who is the chief scientist of FAST, told *BCAS*. "And they are rare. About one out of ten pulsars is a MSP," he added.

"This discovery demonstrated the great potential of FAST in pulsar searching and highlights the vitality of the large aperture radio telescope in the new era," said Kejia Lee, an astronomer with the Kavli Institute of Astronomy and Astrophysics, Peking University.

The newly discovered MSP, named as PSR J0318+0253, is the first result from the FAST-Fermi LAT collaboration outlined in a MoU signed between the FAST team and Fermi-LAT team. Radio follow-up of Fermi-LAT unassociated sources is an effective way to detect new pulsars. Previous radio observations, including three epochs with Arecibo Telescope in June 2013, have failed to detect MSPs. In a one-hour tracking observation with the FAST ultra-wide band receiver, the radio pulses toward 3FGL J0318.1+0252 were detected with a spin period of 5.19 milliseconds, an estimated distance of about 4,000 light-years, and as potentially one of the faintest radio MSPs.

The outstanding performance of FAST in detecting pulsars can lead to an important role in Europe's Pulsar Timing Array (PTA) project, which attempts to detect low-frequency gravitational waves from merging supermassive black holes using the long-term timing of a set of stable millisecond pulsars. The planned Commensal Radio Astronomy FAST Survey is expected to discover many millisecond pulsars and will make significant contribution to the PTA experiment.



The Gamma-ray sky map and integrated pulse profiles of the new MSP. Upper panel shows the region of the gamma-ray sky where the new MSP is located. Lower panel a) shows the observed radio pulses in a one-hour tracking observation of FAST. Lower panel b) shows the folded pulses from more than 9 years of Fermi-LAT gamma-ray data. (Image: WANG Pei and LI Di of NAOC)

"The international radio-astronomy community is excited about the amazing FAST telescope, already showing its power in these discoveries. FAST will soon discover a large number of millisecond pulsars and I'm looking forward to seeing FAST's contribution to gravitational wave detection," said George Hobbs, a scientist from the Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia and member of the Gravitational Wave International Committee.

FAST will stay in commissioning until it reaches designed specifications. As the world's largest single-dish radio telescope, it has discovered more than 20 pulsars by far.