National Centre for Radio Astrophysics (NCRA-TIFR), Pune
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The uGMRT confirms an unexpected event in millisecond pulsars - the cosmic clocks.

A group of nearly 40 astronomers, under the banner of Indian Pulsar Timing Array (InPTA), have provided first time a clear evidence of unexpected changes in a milli-second radio pulsar using the upgraded Giant Metrewave Radio Telescope (uGMRT). Millisecond pulsars are exotic objects in the sky and are used in efforts for detecting ultra-low frequency gravitational waves due to their extreme stable behaviour. These changes have attracted the attention of astronomers across the globe because the millisecond pulsars are not expected to show such behaviour and this star-clock may not be good enough to search for gravitational waves.

Pulsars (PULSAting Radio Stars) are ultra-dense dead stars that act as celestial lighthouses with a radio flash once every rotation of the star. This flashing radio signal or pulse has unmatched stability in their periods and shapes. The stable shape of their pulses is regarded as their fingerprints and is crucial to extract their clock-like pulse ticks very precisely. Measuring these time ticks for a collection of pulsars is necessary for the momentous detection of nano-Hertz gravitational waves (nHz) in the near future.

Pulsars are bright at lower frequencies and best observed at lower radio frequencies. The uGMRT, located 80 km from Pune, is one of the largest radio telescopes in the world capable of observing at these frequencies. Thus, even minute changes in the pulse shapes can be seen with the uGMRT.

The Indian Pulsar Timing Array(InPTA) has been regularly monitoring a set of pulsars using the uGMRT for the eventual detection of (nHz) nanohertz gravitational waves. The InPTA is a collaboration of Indian and Japanese astronomers from several institutes. Earlier this year, the InPTA became a part of the International pulsar timing array (IPTA) consortium, which is an international collaboration that aims to detect the elusive nanohertz gravitational waves.

Among the set of pulsars being observed, PSR J1713+0747 is one of the most reliable clocks of them all. Ongoing observations between April and May 2021 and thereafter revealed strong evidence of a fingerprint change in this star disturbing its rhythm and clock behaviour. The InPTA team continued to observe this pulsar to track the changes following this event. With the low radio frequency observations that only the uGMRT can provide, the team has established that the change in this event was much larger than ever observed before in any other pulsar clock used in PTA experiments. As these experiments require exquisite timing observations, such a change needs to be accounted for to make reliable detection of nanohertz gravitational waves.

Further uGMRT observations are likely to help in unravelling the mysteries behind this unexpected but interesting event and eventually help in detection of nanohertz gravitational waves.

These results have recently been published as rapid communication in the Journal Monthly

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