uGMRT Discovers Rare Pulsar and Puts Einstein to Test

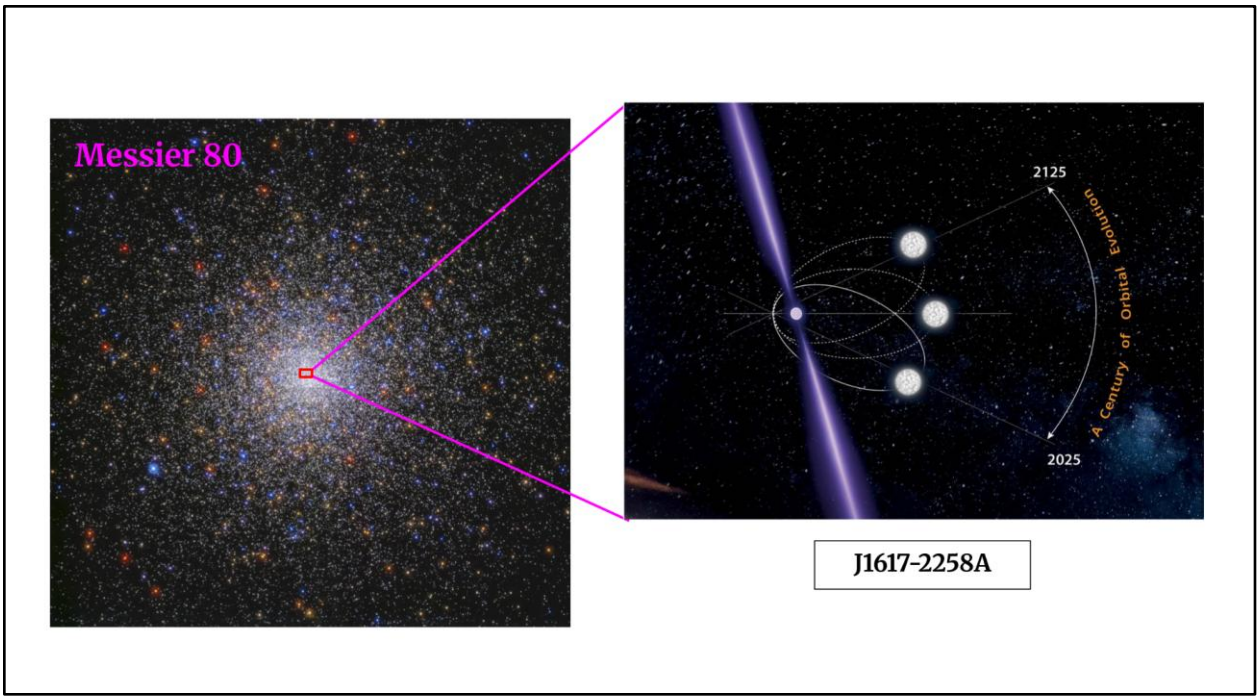
A team of astronomers led by a graduate student from NCRA-TIFR, Jyotirmoy Das, using India's upgraded Giant Metrewave Radio Telescope (uGMRT), has discovered the first pulsar in the ancient star cluster Messier 80 (M80), also known as NGC 6093. The newly discovered one, PSR J1617–2258A, is a millisecond pulsar, spinning 232 times a second, and sits just three-quarters of a core radius from the crowded heart of the cluster. Its unusual orbit, combined with a low-mass companion, makes it a rare system and an important laboratory for testing Einstein's theory of general relativity. It is the first discovery from the new Globular Clusters GMRT Pulsar Search (GCGPS) project. The GCGPS project is an international collaboration uniting scientists from NCRA–TIFR (India), the Max Planck Institute for Radio Astronomy (Germany), the National Radio Astronomy Observatory (USA), and the University of Oxford (UK). This result was recently published on 22 July 2025 in the Astrophysical Journal.

Millisecond pulsars are tiny, city-sized stellar remnants that spin hundreds of times per second, sweeping radio beams across space like cosmic lighthouses. A newly discovered millisecond pulsar from the GCGPS project circles a small companion roughly every 19 hours, but instead of a neat circle, its path is stretched into a long oval, unusually 'lopsided' for such a tight system. In the crowded bustle of a globular cluster, close gravitational fly-bys can kick orbits into odd shapes, forming a PSR J1617-2258A-like system (its orbital 'eccentricity' is about 0.54).

Because the compact orbit is so stretched, the team could actually watch the ellipse itself slowly turn in space, a drift called the *advance of periastron*, predicted by Einstein's general relativity due to spacetime curvature. According to Jyotirmoy Das, the lead author of the paper, "This precision is about half a degree per year. To put that in perspective, this pulsar's orbit shifts in a single day by roughly as much as Mercury's perihelion shifts in an entire decade." That precise measurement lets astronomers 'weigh' the system. Together, the pulsar and its companion have a mass of about 1.67 times that of the Sun.

According to Jayanta Roy, a scientist from NCRA-TIFR and author of the paper, "That mix, a tight orbit, a highly stretched path, and a lightweight companion, makes this system a rarity. Among known binary millisecond pulsars, only a few are both more compact and more eccentric, and those all have heavier partners. PSR J1617–2258A sits in a nearly empty corner of the millisecond-pulsar family portrait, hinting at an unusual evolutionary history."

This system gives researchers a clean laboratory to test gravity with a brand-new object in a dense stellar environment. Another scientist from NCRA-TIFR, Bhaswati Bhattacharyya, a member of the GCGPS collaboration, indicated that the continued monitoring with the GMRT can sharpen the mass estimates and may spot additional relativistic quirks, offering fresh tests of Einstein's theory and new clues to how close stellar encounters shape pulsars in globular clusters.



Messier 80 (NGC 6093) optical image credit: **Gladys Kober**

Publication:

“Globular Clusters GMRT Pulsar Search (GCGPS). I. Survey Description, Discovery and Timing of the First Pulsar in NGC6093 (M80)”

Jyotirmoy Das, Jayanta Roy, Paulo C. C. Freire, Scott M. Ransom, Bhaswati Bhattacharyya, Karel Adámek, Wes Armour, Sanjay Kudale, and Mekhala V. Muley, 2025, The Astrophysical Journal, Volume 988, Number 2. DOI 10.3847/1538-4357/ade052

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