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A study of the exotic pulsars in the globular cluster NGC 1851

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The exceptionally high stellar densities in the cores of globular clusters (GCs) makes them remarkable hosts for an exotic pulsar population. In this talk, I will discuss the results from the radio timing analysis of a couple of massive binary pulsars in the dense globular cluster NGC 1851, observed with the MeerKAT as a part of the TRAPUM (TRAnsients and Pulsars with MeerKAT) GC Survey. Both systems consist of millisecond pulsars in eccentric orbits with massive companions, suggesting they are the likely products of secondary exchange encounters.

The first binary is very fascinating as the total mass of the system exceeds the heaviest double neutron star known in our Galaxy. Additionally, it is also heavier than the most massive NS-NS merger candidate in LIGO/Virgo data. The derived companion mass places it as a compact object mass-gap candidate, with a mass larger than the largest precisely measured pulsars and smaller than the lightest known stellar-mass black holes (BHs). If the companion is identified as a massive neutron star, it would provide valuable insights into the equation of state of dense nuclear matter, leading to new constraints. On the other hand, if it is identified as a BH, it would signify the discovery of the first millisecond pulsar-BH system. This would offer a unique opportunity to test the properties and formation mechanisms of black holes.

The second one is an eccentric binary pulsar with a massive carbon-oxygen white dwarf companion, and we have obtained precise measurements of three spin frequency derivatives of the pulsar. The second derivative is too large to be accounted for by the cluster and suggests an ongoing encounter with a third mass around the binary. We discuss the nature of this nearby star and address the effects of the frequency derivatives on other timing parameters.

Affiliation

Max Planck Institute for Radio Astronomy, Germany

Current Position

PhD Student

Primary author: DUTTA, Arunima (Max Planck Institute for Radio Astronomy, Germany)

Presenter: DUTTA, Arunima (Max Planck Institute for Radio Astronomy, Germany)

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