Contribution ID: **222** Type: **Contributed Poster Presentation**

Exploring neutron star crusts, cores, and magnetic fields using the mass-radius relation

Neutron stars possess extremely high surface magnetic fields and densities of mass. The neutron star's densities can far exceed those found in atomic nuclei. Studying their structure provides insights into the behavior of fundamental particles, particularly neutrons, under extreme conditions that are very hard to recreate in terrestrial laboratories. Although the precise equation of state governing the neutron star matter remains an open question, simultaneous observations of their masses and radii provide valuable constraints. By modeling the mass-radius relationship and thereby the density of neutron stars, key properties such as the moment of inertia, surface magnetic field strength, and the radii of the core and crust can be inferred for neutron stars with known masses. While the composition of the neutron star crusts is relatively well characterized, the nature of their cores remains an area of active research. Furthermore, the superfluid and superconducting properties of the core complicate the characterization of the properties of their surface magnetic fields. This presentation will explore the mass-radius relationship, density modeling, core and crust structure, and the contributions of magnetic fields in shaping neutron star properties.

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Session Classification: Poster Session

Track Classification: Nuclear Astrophysics