Mapping the Pulsar Environment with Pulsed Fraction Spectroscopy

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Abstract

Pulsed fraction spectra-the energy dependence of the fractional amplitude of coherent X-ray pulsations-provide a powerful yet largely unexplored diagnostic of the emission and reprocessing mechanisms in accreting X-ray pulsars. In this contribution, I will present a novel analysis framework that extends beyond conventional phase-averaged and phase-resolved spectroscopy by combining timing and spectral information into a unified physical picture. I will introduce our newly developed pipeline, which combines NuSTAR, XMM-Newton/EPIC-pn, and INTEGRAL/ISGRI observations to produce broadband pulsed fraction spectra. By quantifying how spectral features such as cyclotron resonant scattering features (CRSFs) and fluorescent emission lines suppress or enhance the pulsed signal, this approach provides new constraints on the geometry, radiative transfer, and emission processes in strongly magnetized accreting neutron stars. Finally, I will show how the extensive INTEGRAL archive of high-mass X-ray binaries can be revisited with this methodology, revealing new scientific potential in one of the mission's richest legacy datasets.

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