A big-data approach to inferring accreting neutron stars' physical properties from X-ray pulsar lightcurves.

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Abstract

A multi-satellite library of X-ray pulse-profiles, derived from all available pointed X-ray observations of the Small Magellanic Cloud (e.g. RXTE-PCA, Chandra ACIS, XMM, NuStar, NICER, etc.) enables new statistical approaches to be applied. These include parameterizing pulse profiles to explore correlations with other observable physical changes in the accretion flow. To each pulse profile we fit a geometric model that incorporates fan-like and pencil-like X-ray emission from both poles, and includes approximate gravitational light-bending. By modeling pulse-profiles for each pulsar on many different occasions, over its full range of luminosity we can quantify and track the pulse shape, and look for what is driving these changes. In parallel, we track energy dependence of the pulse profile, spectral energy distribution, and accretion torques. Leveraging modeling and big data provide a route to measure fundamental neutron star properties, such as magnetic field strength and orientation. Community resources including the library itself, and an interactive modeling interface being developed as part of this project.