Data-Driven Approaches to Pulsar Glitch Triggers, Evolution, and Universality

Ye, Christine (School: Eastlake High School)

Observations of the rotation of pulsars, highly magnetized rotating neutron stars, have revealed a mysterious type of rotation anomaly: glitches, discontinuous events where the pulsar suddenly begins rotating faster. I study the substructure and population properties of pulsar physics through Bayesian methods in order to probe the microphysics of the superfluid and the behavior of matter at and beyond nuclear densities. I place upper limits on glitch sizes in 47 millisecond pulsars used for gravitational wave science, and find that there is a substantial minimum glitch size in these pulsars. Using a hierarchical approach, I infer best-fit parameters and overall evidence for models directly encoding information about the triggers of glitches, and find substantial support for mixed trigger models and limited dynamic range of scale invariance. Finally, I look at the substructure of pulsar glitch behavior as a function of age, and find good agreement with an evolutionary picture informed by vortex creep and avalanche dynamics. These findings constrain possible mechanisms for glitch build-up, trigger, and recovery, and will not only serve to improve our understanding of the fundamental microphysics in the superfluids and crusts of neutron stars, but also improve the accuracy of pulsar timing measurements for use in gravitational waves, general relativity, exoplanet searches, and other fundamental astrophysics.

Awards Won:

Third Award of $1,000