Novel Surveys of Substructure in Pulsar Glitch Morphology and Glitching Pulsar Populations

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Observations of pulsars, whose pulses are produced by a beam of coherent radio emission, has revealed two rotation anomalies: timing noise and glitches. I undertake a comprehensive survey of glitch substructure and investigate potential sources of substructure, to constrain population characteristics and physical parameters. Single glitch analysis using clustering reveals two novel populations, whose statistics and mechanisms are explored by analyzing prolific glitching pulsars. A study of invariant residuals demonstrates that recoveries themselves form a continuum, with prolific pulsars experiencing similar recoveries. Considering glitching pulsars, classification techniques reveal a separation boundary; however, considering glitches as state-dependent Poisson processes and recent glitches in MSPs, all pulsars may glitch. To understand population parameters and potential substructure, especially early behavior, I simulate rises (~0-100s) using a recently proposed three-component superfluid model, sampling parameter space and comparing to pulse-for-pulse glitches in order to understand rise times, lags, and fractional moments. This, along with pulse shape variability analysis and anti-glitch/micro-glitch methods, reveals potential for improved substructure studies with high-cadence observations. My findings directly constrain glitch population and phenomenology, improving precision timing and pulsar-based observations (exoplanets, gravitational waves, general relativity, etc.). In addition, it reveals new knowledge about pulsar interiors, with applications in timing noise analysis and superfluidity. Future work includes superfluid simulation of long-term recovery (10-1000d) and constraints on the equation of state, as well as in-depth timing of J0537-6910’s glitches.