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Constraining Preferred-Frame Effects in Gravity with Binary Pulsars

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We constrain Einstein-Aether gravity, a leading alternative to General Relativity that introduces a preferred-frame via a dynamical time-like vector field, using high-precision pulsar timing observations from EPTA. Our analysis incorporates both conservative and dissipative first post-Newtonian corrections and utilizes full times of arrival from multiple pulsars, processed with Vela.jl, a Bayesian tool based on PINT. The model spans many parameters, including binary component masses, Einstein-Aether coupling constants and center-of-mass velocity components. We extract posteriors on post-Keplerian parameters from timing data and employ normalizing flows combined with resampling techniques to map these onto constraints for the fundamental theory parameters. Our results demonstrate the power of pulsar timing to probe deviations from General Relativity and provide insights into the phenomenology of preferred-frame gravity.

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