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Constraints on Ultralight Scalar and Dark photon Dark Matter from PPTA-DR3 and EPTA-DR2

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The cold dark matter (CDM) model successfully describes the Universe on large scales, yet faces challenges at sub-galactic scales. Ultralight dark matter (ULDM), with particle masses around 10^{-22} eV, offers a promising solution to these small-scale issues. Pulsar timing arrays (PTAs), originally designed to detect nanohertz gravitational waves, also provide a sensitive probe for ULDM signals. In this work, we perform a Bayesian search for ULDM using PTAs, focusing on two types of signals: the oscillatory gravitational potential from scalar ULDM and the fifth-force interaction mediated by dark photon dark matter (DPDM). Both signals are searched for using the PPTA-DR3 dataset, while the EPTA-DR2 data are employed to constrain the DPDM. No statistically significant evidence for ULDM is found, and we place 95% confidence-level upper limits on the relevant parameters. For scalar ULDM, our constraints show improved sensitivity over PPTA-DR1 at low frequencies, are comparable to those from the NANOGrav 15-year dataset, but are weaker than the latest EPTA-DR2 limits. For DPDM, the obtained bounds are comparable to existing constraints.

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