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Probing spin-2 ultralight dark matter with PTA and space-based GW Detectors

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Spin-2 ultralight dark matter (ULDM) is a viable dark matter candidate, and it can be constrained using gravitational wave (GW) observations. The pulsar timings are sensitive to both the nanohertz gravitational-wave background and the oscillation of ultralight dark matter. We study the angular correlation of the timing residuals induced by spin-2 ultralight dark matter, which differs from the usual Hellings-Downs correlation for stochastic gravitational-wave backgrounds. We also investigate the detectability of spin-2 ULDM by space-based GW interferometers. By considering a direct coupling between spin-2 ULDM and ordinary matter, we derive the corresponding response functions and sensitivity curves for various time-delay interferometry channels and calculate the optimal sensitivity curves for future millihertz GW detectors. Thus, the GW detectors can serve as powerful tools not only for detecting GWs but also for probing fundamental properties of ultralight dark matter.

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