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Unified Origin of Primordial Black Hole Dark Matter and Nanohertz Gravitational Waves

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Recent high-cadence observations by Subaru-HSC have identified a population of ultrashort-timescale microlensing events, providing a compelling window for planet-mass primordial black holes (PBHs) to constitute the entirety of dark matter. In this Letter, we demonstrate that this PBH population and the nanohertz stochastic gravitational-wave (GW) background reported by pulsar timing arrays (PTAs) can be naturally unified by a single primordial origin: a broad, nearly-flat enhancement of the curvature power spectrum with an amplitude of O (1 0 − 2) O(10 −2). The resulting PBH mass function spans the planet-to-solar mass range, while remaining consistent with all current observational constraints. This unified PBH–induced-GW framework makes concrete multi-messenger predictions, which can be decisively scrutinized by forthcoming microlensing surveys, next-generation PTAs, space-borne interferometers, precision astrometry, and laser ranging experiments.

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