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Cosmic superstrings, metastable strings and ultralight primordial black holes: from NANOGrav to LIGO

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Recent observations of nHz stochastic gravitational waves (GW) by Pulsar Timing Arrays (PTA), such as NANOGrav, have disfavored the existence of topologically stable cosmic strings. However, cosmic metastable strings and superstrings remain viable candidates. Gravitational waves from all classes of strings generally span a wide range of frequencies, which conflicts with LIGO's non-observation of stochastic gravitational waves at the ~ 10 Hz band for a substantial string-parameter space favored by PTA data. The existence of ultralight primordial black holes ($M_{\rm BH} < 10^9$ g) in the early universe could mitigate this conflict by reducing the amplitude of GWs at higher frequencies through an early matter-dominated phase. This would alleviate the tension between LIGO observations and PTA data. We demonstrate that recent PTA data, complemented by future LIGO-Virgo-Kagra (LVK) runs and detectors such as LISA and ET, could elucidate the properties and search strategies for these ultralight primordial black holes, which are otherwise elusive due to their early evaporation via Hawking radiation.

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