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The Equilibrium Spectrum of Stochastic Gravitational Wave Background and Its Role in Cosmic Evolution

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The properties of the stochastic gravitational wave background are crucial for our understanding of cosmic evolution. With the release of data from major pulsar timing arrays, the existence of an extremely low-frequency stochastic gravitational wave background has been widely acknowledged. In this work, based on the theory of general relativity and stochastic dynamics, we have established the fluctuation and dissipation mechanisms of matter in the presence of a classical stochastic gravitational wave background, as well as the fluctuation-dissipation relation. Through a generalized Langevin model, we demonstrate the constraints imposed by the matter equilibrium assumption on the strain power spectrum function of the stochastic gravitational wave background, which is essentially a result of the backreaction of matter on the stochastic background. By fitting our derived strain power spectrum (equilibrium spectrum) to the pulsar timing array data released by NG15, we obtain a Bayesian factor of 48±3.8 (relative to SMBHB), which provides strong evidence for the existence of the equilibrium spectrum.

Collaboration you are representing

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