

Discovering new forces with gravitational waves from supermassive black holes

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Supermassive black hole binary mergers generate a stochastic gravitational wave background detectable by pulsar timing arrays. While the amplitude of this background is subject to significant uncertainties, the frequency dependence is a robust prediction of general relativity. We show that the effects of new forces beyond the Standard Model can modify this prediction and introduce unique features into the spectral shape. In particular, we consider the possibility that black holes in binaries are charged under a new long-range force, and we find that pulsar timing arrays are capable of robustly detecting such forces. Supermassive black holes and their environments can acquire charge due to high-energy particle production or dark sector interactions, making the measurement of the spectral shape a powerful test of fundamental physics.

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