

Ultralight Bosons Explain the Mass–Spin Correlations in the Merging Binary Black Hole Population

Ultralight bosons could trigger superradiant instabilities in rapidly spinning black holes, forming oscillating clouds while extracting rotational energy.

We consider an extended, superradiance-informed spin distribution model that characterizes possible environment-induced spin variations and compare its predictions with the observed population of merging black hole binaries in the Gravitational-Wave Transient Catalogs (GWTCs). We find that the mass-spin relation predicted by a scalar boson with mass $m_b \sim 10^{-12}$ eV is consistent with the GWTCs, with increasing significance from GWTC-3.0 to 5.0. The Bayes factor reaches $\ln \mathcal{B} \approx 7.8$ for GWTC-5.0. Intriguingly, this mass range largely coincides with a previous study based on a waveform analysis of the GW190728 gravitational wave event. Our findings provide compelling evidence that a superradiance-informed spin distribution model is highly compatible with the expanding binary black hole population dataset.

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