Abstract Submitted
for the APR20 Meeting of
The American Physical Society

Searching for ultralight bosons within spin measurements of a population of binary black hole mergers KEN NG, Massachusetts Institute of Technology (MIT), OTTO HANNUKSELA, The National Institute for Subatomic Physics (NIKHEF), SALVATORE VITALE, Massachusetts Institute of Technology (MIT), TJONNIE LI, The Chinese University of Hong Kong (CUHK) — Ultralight bosons can form clouds around rotating black holes if their Compton wavelength is comparable to the black hole size. The boson cloud spins down the black hole through a process called superradiance, lowering the black hole spin to a characteristic value. It has thus been suggested that spin measurements of the black holes detected by ground-based gravitational-wave detectors can be used to constrain the mass of ultralight bosons. Unfortunately, a measurement of the individual black hole spins is often uncertain, resulting in inconclusive results. Instead, we use hierarchical Bayesian inference to combine information from multiple gravitational-wave sources and obtain stronger constraints. We show that tens to hundreds of high signal-to-noise ratio gravitational-wave detections are enough to exclude (confirm) the existence of bosons in the $[10^{-13}, 3 \times 10^{-12}]$ eV mass range. The expected number of detections depends on the distribution of black hole spins at formation and on the mass of the boson. We then apply our method to the 10 binary black hole mergers detected by LIGO and Virgo in their first two observing runs, finding that we cannot draw statistically significant conclusion from the small number of sources.

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Date submitted: 10 Jan 2020 Electronic form version 1.4