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Superradiant Bosons Driving Supermassive Black Hole Mergers

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Ultralight bosons, predicted in scenarios beyond the Standard Model and viable dark matter (DM) Candidates can form superradiant clouds around spinning black holes, influencing their dynamics. Using century-long monitored OJ287 supermassive black hole binary, we set the first DM–DM-independent, dynamical constraints on their masses $\mu = (8.5–22)\times10–22$ eV. These dynamical constraints, driven by boson cloud friction, are robust against DM-model uncertainties and offer a novel ultralight boson probe. We show that analogous superradiant dynamics across the cosmic population of supermassive black hole systems could help resolve the final-parsec evolution stalling problem and imprint a detectable suppression and break in the gravitational wave background.

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