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A Unique Multi-Messenger Signal of QCD Axion Dark Matter

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We propose a multi-messenger probe of the natural parameter space of QCD axion dark matter (DM) based on observations of black hole-neutron star binary inspirals. It is suggested that a dense DM spike may grow around intermediate mass black holes. The presence of such a spike produces two unique effects: a distinct phase shift in the gravitational wave strain during the inspiral period and an enhancement of the radio emission from the resonant axion-photon conversion occurring in the neutron star magnetosphere. Remarkably, the observation of the gravitational wave signal can be used to infer the DM density and, consequently, to predict the radio emission. Given a sufficiently nearby detection with the LISA interferometer and next-generation radio telescope Square Kilometre Array, I will show that such observations can explore the QCD axion in the mass range 10^{-7}eV to 10^{-5}eV, potentially providing a striking multi-messenger signature of QCD axion DM.

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