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Bayesian model selection of Primordial Black Holes and Dressed Primordial Black Holes with lensed Gravitational Waves

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If particle dark matter (DM) and primordial black holes (PBHs) coexist, PBHs will be surrounded by particle DM, forming celestial objects known as dressed PBHs (dPBHs). These structures suggest a scenario in which PBHs and DM can exist simultaneously. However, in the high-frequency regime, the gravitational lensing effect of bare PBHs is similar to that of dPBHs. Ground-based gravitational wave (GW) detectors are particularly sensitive to high-frequency GW signals. In this regime, the lensing effect of a point-mass lens with a mass in the range of $10^{-1} \sim 10^{2} M_{\odot}$ becomes significant. In this work, we incorporate dPBH models with GW observations and employ Bayesian inference techniques to distinguish PBHs from dPBHs. Using the third-generation ground-based GW detectors, Einstein Telescope (ET) and Cosmic Explorer (CE), as examples, we demonstrate that these detectors can effectively differentiate the lensing effects of dPBHs from those of PBHs across a broad frequency range. Furthermore, we find that with a larger black hole (BH) mass inside the surrounding particle DM, ET and CE can distinguish these two lensed models with even greater precision.

Collaboration you are representing

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