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Gravitational Wave Sourced by Decay of Massive Particle from Primordial Black Hole evaporation

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I will discuss the stochastic gravitational waves (GWs) spectrum, resulting from the emission of gravitons through bremsstrahlung, in the decay of particles produced by Hawking radiation. Although particle decays inevitably entail the emission of graviton due to bremsstrahlung, the associated decay width is notably suppressed due to the Planck scale suppression in the coupling of matter fields to gravitons. Consequently, the relic abundance of such GWs constituted of these gravitons undergoes a corresponding reduction. However, we demonstrate that super-heavy particles, reaching masses as high as Planck scale, can emerge naturally in the Hawking radiation of evaporating primordial black holes (PBHs) and can compensate for this suppression. In addition, we also discuss the stochastic gravitational waves constituted out of the gravitons directly radiated from such evaporating PBHs. When the super-heavy particle decays promptly after its production, then the corresponding GW spectrum remains subdominant to the one arising from direct PBH evaporation. However, if this particle is long-lived and decays after PBH evaporation, then the resulting GWs produced in these two processes have two distinct spectra with their peaks at extremely high frequencies, providing avenues for proposed ultra-high frequency gravitational wave detectors. We also show that such gravitational waves contribute significantly to substantial dark radiation, well within the anticipated sensitivity thresholds of future experiments like CMB-S4 and EUCLID.etic field is significantly smaller than its equipartition estimation.

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