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Induced gravitational waves from a smooth crossover and their implications on the PBH scenario

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The induced gravitational wave signal can be affected by the modification of the sound speed c_s^2 and the equation of state parameter w at horizon reentry. Inspired by the occurrence of phase transitions in various theories beyond the Standard Model (SM), we conducted numerical simulations to assess the induced gravitational waves generated by a hypothetical smooth transition beyond the SM, that softens the sound speed and equation of state while considering the case of a flat scale-invariant power spectrum. We find that if the amplitude of the power spectrum is $\mathcal{A} \sim \mathcal{O}(10^{-3})$: i) future gravitational wave space-based detectors can detect the signal, ii) the signal is differentiated from the pure radiation case, and iii) compatibility with the hypothesis that primordial black holes constitute the entirety of dark matter. Specifically, we observe a mass function that exhibits a sharp peak at the maximum point of the crossover's softening.

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