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Hydrodynamic sound shell model and bubble wall velocity

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For a cosmological first-order phase transition in the early Universe, the associated stochastic gravitational wave background is usually dominated by sound waves from plasma fluid motions, which have been analytically modeled as a random superposition of freely propagating sound shells but with the force by the scalar field that produces the self-similar profile removed. Recently, we proposed a new analytic sound shell model by focusing on the forced propagating contribution from the initial collision stage of sound shells while the moving bubble walls still maintain their self-similar profiles. We reproduce the causal k^3 scaling in the infrared consistent with numerical simulations, and also recover the broad dome in the power spectrum first observed in numerical simulations. We also provided a new method to estimate the bubble wall velocity from the junction condition given by the conservation of particle number density flow.

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