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Adiabatic renormalization for modified dispersion relations in cosmology

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Abstract

We investigate the behavior of scalar quantum fields in cosmological backgrounds under modified dispersion relations, specifically focusing on how ultraviolet asymptotics influence field quantization. We establish the conditions for both the validity of the adiabatic approximation and the unitary equivalence between quantizations defined via different time variables. Our analysis reveals that while superluminal modified dispersion relations consistently yield unitarily equivalent quantizations, asymptotically subluminal behaviors can lead to inequivalent physical descriptions. By applying adiabatic regularization to the two-point correlation function, we demonstrate that the ultraviolet scaling of the frequency uniquely dictates the required subtraction order. These results are illustrated through applications to standard, superluminal Corley--Jacobson, and Unruh dispersion relations.

