



INSTITUTO DE FÍSICA
DE PARTÍCULAS Y DEL COSMOS

IPARCOS



Preprint Series in Particles and Cosmos Physics

n° IPARCOS-UCM-24-043

Scalar Dark Matter Production through the Bubble Expansion Mechanism: The Boosting Role of Non-Renormalizable Interactions

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July 2024

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Abstract

We consider a Bubble Expansion mechanism for the production of scalar dark matter during a first-order phase transition in the early Universe. Seeking for a dark matter energy density in agreement with observations, we study different non-renormalizable interactions between the dark matter species and the field undergoing the transition. The resulting relic abundance is shown to display a strong dependence on the Lorentz boost factor associated to the bubble wall motion, with this dependence becoming more significant the higher the dimension of the non-renormalizable interaction. This allows for observational compatibility across a wide range of dark matter masses and transition temperatures, typically excluded in renormalizable scenarios. For a transition around the electroweak scale, the associated gravitational wave spectrum is also within the reach of future detectors.

