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Enhancing Phase Transition Calculations with Action Curve Fitting

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The computation of bounce action in a phase transition involves solving partial differential equations, inherently introducing non-negligible uncertainty. Deriving characteristic temperatures and properties of this transition necessitates both differentiation and integration of the action, thereby exacerbating the uncertainty. We fit the action curve as a function of temperature to mitigate the uncertainties inherent in the calculation of the nucleation temperature, percolation temperature, and inverse transition duration. We find that, after extracting a factor, the sixth-order polynomial yields an excellent fit for the action in the toy model. In a realistic model, the singlet extension of the Standard Model, this method performs satisfactorily across most of the parameter space after trimming the fitting data. This approach not only enhances the accuracy of phase transition calculations but also systematically reduces computation time and facilitates error estimation, particularly in models involving multiple scalar fields.

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