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Enhancing Phase Transition Calculations through Polynomial Fitting and Neural Network Approximation

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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. In this work, we use polynomial fitting to approximate the action function of temperature, aimed at mitigating the uncertainties inherent in calculation of the nucleation temperature, the percolation temperature, and the inverse transition duration. We find that the sixth-order polynomial can provide an excellent fit for the groomed 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.

Primary author: ZHANG, Yang (Henan Normal University)

Presenter: ZHANG, Yang (Henan Normal University)

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