High Energy Physics - Phenomenology

Strong Electroweak Phase Transitions in the Standard Model with a Singlet

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It is well known that the electroweak phase transition (EWPhT) in extensions of the Standard Model with one real scalar singlet can be first-order for realistic values of the Higgs mass. We revisit this scenario with the most general renormalizable scalar potential systematically identifying all regions in parameter space that develop, due to tree-level dynamics, a potential barrier at the critical temperature that is strong enough to avoid sphaleron wash-out of the baryon asymmetry. Such strong EWPhTs allow for a simple mean-field approximation and an analytic treatment of the free-energy that leads to very good theoretical control and understanding of the different mechanisms that can make the transition strong. We identify a new realization of such mechanism, based on a flat direction developing at the critical temperature, which could operate in other models. Finally, we discuss in detail some special cases of the model performing a numerical calculation of the one-loop free-energy that improves over the mean-field approximation and confirms the analytical expectations.

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