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Nonperturbative study of the electroweak phase transition in the real scalar singlet extended Standard Model

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In this talk, we explore the electroweak phase transition in the real singlet scalar extension of the Standard Model through a nonperturbative lattice study. We examine both heavy and light singlet-like scalar scenarios, focusing on non-zero singlet-doublet mixing angles.

The presentation begins with an overview of the lattice methods relevant to phase transition analysis. We then analyze how thermodynamic properties depend on order parameters. In the heavy scalar regime, we find that the transition is a crossover for small mixing angles, despite an energy barrier in the potential, while it becomes first order for larger mixing angles.

We also discuss the strong agreement between two-loop perturbation theory and our lattice results for critical thermodynamic quantities when the transition is strongly first order. For the light scalar regime, pertinent to exotic Higgs decays, we update previous one-loop results using two-loop effective field theory and present lattice simulations at specific benchmark parameters. Our findings indicate that the transition shifts to a crossover with small Higgs-singlet portal couplings.

This work enhances our understanding of the electroweak phase transition and its implications in high-energy physics.

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