Portorož 2025: Particle Physics from Early Universe to Future Colliders

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## False Vacuum Decay Rate of a Scalar Field at One Loop

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We investigate the false vacuum decay rate of a real scalar field theory in 2, 3, and 4 spacetime dimensions, incorporating quantum corrections at the one-loop level. This process, crucial for understanding phenomena such as metastable states in quantum field theory, phase transitions in the early universe, and critical behavior in condensed matter systems, is typically described using semiclassical methods. Here, we go beyond the leading-order approximation by including quantum fluctuations through the functional determinant. We compute the bounce action and analyze the functional determinant, providing numerical results across the full parameter range and analytic expressions in the thin-wall limit.

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