

Decay Rate of Electroweak Vacuum in the Standard Model and Beyond

Thursday 24 May 2018 16:10 (20 minutes)

We perform a precise calculation of the decay rate of the electroweak vacuum in the standard model as well as in models beyond the standard model. We use a recently developed technique to calculate the decay rate of a false vacuum, which provides a gauge invariant calculation of the decay rate at the one-loop level. We give a prescription to take into account the zero modes in association with translational, dilatational, and gauge symmetries. We calculate the decay rate per unit volume, γ , by using an analytic formula. The decay rate of the electroweak vacuum in the standard model is estimated to be $\log \gamma \times \text{Gyr Gpc}^3 = -582$. We also provide errors to γ due to the uncertainties of the Higgs mass, the top quark mass, the strong coupling constant and the choice of the renormalization scale. The analytic formula of the decay rate, as well as its fitting formula given in this paper, is also applicable to models that exhibit a classical scale invariance at a high energy scale. As an example, we consider extra fermions that couple to the standard model Higgs boson, and discuss their effects on the decay rate of the electroweak vacuum.

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Session Classification: Parallel Session on EW Vacuum Stability