Abstract

Any renormalizable, gauge-invariant scalar potential can have terms upto mass dimension 4, and as a result a given multi-dimensional potential which is bounded from below can have multiple minimas. In one dimension, for minimas separated by a small amount, a nice anlytic treatment for tunneling rates from the false vacuum to the true vacuum has been given by Coleman [Col77]. The formalism involves calculation of the least tunneling action from false vacua to true vacua in the thin wall limit, which is analytically easy to do. The value of the tunneling rates gives a measure of decay of false vacuum per unit volume, $\Gamma/V = Ae^{-B/\hbar}(1 + O(\hbar))$ where S is the action and A is a constant, using which we can put constraints on the parameter space of the scalar theory by using the present lifetime of the universe. Specifically, any model needs to have an action of $S > 400$ in order to provide a feasible description of the standard model vacuum as a false minima. For the MSSM, where the scalar potential is multidimensional due to multiple squark and slepton fields along with the Higgses, the estimation of tunneling action requires tunneling methods as the situation is not always solvable analytically. Sarid [Sar98], introduced useful numerical tools for estimating the tunneling action for decay from a false vacuum to a relatively stable vacuum. In his formalism, he provided efficient techniques for calculating the minima to a valid approximation. We take the MSSM scalar potential and use Sarid's mehods to put constraints on the parameter space of MSSM such that the universe can rest in a false vacuum without decaying to any stabler one during its present lifetime and essentially determine the parameter space viable for such a scenario. In our work, a toy model using the top and the bottom superfields coupled to the MSSM Higgses is analysed, and the obtained results are compared to [KLS96]. The stable and unstable regions in the paramter space are pointed out.