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On the fate of electroweak vacuum and order of phase tran- sition in Beyond Standard Model Scenarios

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The extension of SM with inert doublet and right-handed neutrinos is being studied. The inert doublet which is odd under Z_2 does not take part in the electroweak symmetry breaking (EWSB) and thus provides a viable dark matter candidate. The light neutrino mass is generated by the seesaw mechanism. It is observed that vacuum stability is rescued by the addition of scalars i.e. doublet and triplet scalars and the bounds only come from perturbativity (where any of the coupling in the theory hits 4π constraint) while the effect of fermions to the running of SM-Higgs quartic coupling is negative and therefore, the Planck scale stability is compromised.
Next, we observed that SU(2) charged fermion shows a drastic change in the running behaviour of gauge coupling g 2 and contributes positively giving completely stable scenario. In case of Type-III inverse seesaw scenario (fermionic triplet with SU(2) charge), we observed that the only bound comes from perturbativity and the number of generations of fermionic triplet are restricted to two from Planck scale perturbativity due to large positive contribution.

For further extensions with doublet and triplet leptoquark with all three gauge charges, the positive contribution to the running of gauge couplings is even more. Therefore, R_2 + S_3 are restricted from Planck scale perturbativity because of the large positive contribution.
Dark matter constraints from relic density, Direct detection experiments like XENONIT, LUX and Indirect cross-section constraints for domiant modes from HESS and Fermi-Lat experiments are studied in case of inert Higgs doublet (IDM) and inert Higgs triplet (ITM). The lower bound on DM mass from relic density is M DM > 700 GeV and 1200 GeV for IDM and ITM respectively.
In case of Standard Model, the order of electroweak phase transition is second-order. The electroweak baryogenesis and the Gravitational wave signatures requires strongly first-order phase transition which also motivates the beyond Standard Model fields. However, in extensions of the Standard Model such as minimal supersymmetric standard model(MSSM), a sizeable CP violation can occur through an extended Higgs sector. The contribution from additonal degrees of freedom in the cubic term of the effective potential enhances the strength of phase transition. We observed that the upper bound will come on the mass parameter from strongly first order phase transition consistent with current Higgs boson mass of 125.5 GeV and Planck scale stability and perturbativity. We also studied the parameter space for the Gravitational wave frequency detectable by Laser Interferometer Space Antenna (LISA) experiment.

Session

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