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Vacuum (meta?)stability, Higgs inflation and physics beyond the Standard Model

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The measurements of the Higgs mass and top quark Yukawa coupling indicate that we live in a very special Universe, at the edge of the absolute stability of the electroweak vacuum. The most precise theoretical computations combined with the most recent LHC experiments do not allow us to decide with certainty whether our vacuum is absolutely stable or metastable. In any event, the Standard Model (SM) can be extended all the way up to the Planck scale M_P in a self-consistent manner. Still, the SM cannot be a complete theory below M_P as it cannot explain the flatness and homogeneity of the Universe at large scales, existence of structures such as clusters or galaxies, its matter-antimatter asymmetry, the presence of dark matter and neutrino masses. The first set of problems can be solved within the SM if the Higgs field has a non-minimal coupling to gravity. I will discuss the Higgs inflation for both stable and metastable vacuum and show that it can take place even if the scalar Higgs self-coupling crosses zero at the energy scale much below the inflationary one. The second set of problems can be solved by extending the SM by three relatively light right-handed neutrinos. I will overview shortly the predictions of the model and discuss accelerator and astrophysical experiments which can be capable to test it.

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