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Higgs inflation puts lower and upper bounds on tensor-to-scalar ratio and on Higgs-portal-dark-matter mass

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We find a theoretical lower bound on the tensor-to-scalar ratio r from a premise that extrapolation of the Higgs-field direction plays the role of the inflaton at high scales. We assume that all the non-minimal couplings are not particularly large so that the renormalizable low-energy effective field theory is reliable up to 10^17GeV. This framework includes the so-called critical Higgs inflation. In our analysis, we take into account the Higgs-portal scalar dark matter and the heavy right-handed neutrinos. The resultant bounds are rather stringent. In particular in the absence of the right-handed neutrinos, namely, when the right-handed-neutrino masses are smaller than 10^13GeV, the Planck bound r<0.09 implies that the dark-matter mass must be smaller than 1.1TeV. On the other hand, the PandaX-II bound on the dark-matter mass m_DM>750GeV leads to r>4x10^-3. Both are within the range of near-future detection. When we include the right-handed neutrinos of mass M_R=10^14GeV, the allowed region becomes wider, but we still predict r>10^-3 in the most of the parameter space. The most conservative bound becomes r>10^-5 if we allow three-parameter tuning of m_DM, M_R, and the top-quark mass.

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