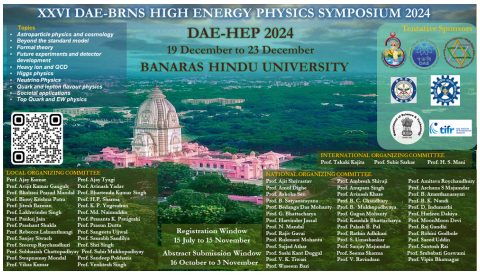

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Effective theory of light Dirac neutrino portal dark matter with observable ΔNeff

Inspired by the null detection of dark matter from direct search experiments, we propose a ν_R-philic dark matter (DM) using an effective field theory (EFT) framework. Specifically, we focus on a dimension-6 operator $\overline{\chi}\chi\overline{\nu_R}\nu_R$, where ν_R represents the right-handed Dirac partner of standard model (SM) neutrinos. In the early Universe, the annihilation of DM to ν_R establishes the relic density. We also introduce another dimension-6 operator, $\overline{\nu_R}\nu_R\overline{f}f$, such that ν_R acts as a portal between the DM and standard model (SM) fermions to provide a signature of DM through direct detection. We estimate the $\Delta N_{\rm eff}$ considering the interactions of ν_R with SM thermal bath and constraint the effective scale from the latest data from PLANCK and DESI. To this end, We also explore UV-complete realizations, including the Left-Right Symmetric Model (LRSM) and U(1)B-L extensions of the SM. Our results offer updated perspectives on the interplay between Dirac neutrinos, dark matter, and cosmological observations, highlighting the implications of recent DESI findings for particle physics models beyond the Standard Model.

Field of contribution

Phenomenology

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