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Freeze-in sterile neutrino DM in a feebly gauged $B-L$ model

We consider the gauged $\mathrm{U(1)_{B-L}}$ model and examine the situation where the sterile neutrino is a dark matter candidate produced by the freeze-in mechanism. In our model, the dark matter N is mainly produced by the decay of a $\mathrm{U(1)_{B-L}}$ breaking scalar boson ϕ. We point out that the on-shell production of ϕ through annihilation of the $\mathrm{U(1)_{B-L}}$ gauge boson Z' plays an important role. We find that the single production of Z' from the gluon bath in the early Universe can become the main production mode for Z' in some parameter regions. To prevent N from being overproduced, we show that the $\mathrm{U(1)_{B-L}}$ gauge coupling constant g_{B-L} must be as small as 10^{-16}–10^{-10}. We also consider the case where the decay of ϕ into N is kinematically forbidden. In this case, N is generated by the scattering of Z' and the g_{B-L} takes values of 10^{-10}–10^{-6}, which can be explored in FASER, FASER2 and SHiP. We will show the sensitivity of FASER, FASER2, and SHiP. This talk is based on JHEP 05 (2025) 147 and arXiv:2603.28882.

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