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Pair-production of dark particles in meson decays

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Rare decays of K, B mesons provide a powerful probe of dark sectors with light new particles. We show that the pair production of O(100 MeV) dark states can be probed with the decays of K_L mesons, owing to the enhanced two-body kinematics, $K_L \rightarrow X_1 X_2$. If either or these two particles is unstable, {em e.g.} $X_2 \rightarrow X_1 \pi^0$ or $X_{1,2} \rightarrow \gamma \gamma$, such decays could easily mimic $K_L \rightarrow \pi^0 \nu \overline{\nu}$ signatures, while not being ruled out by the decays of charged kaons. We construct explicit models that could account for the KOTO excess events, and pass all other constraints from collider searches and meson decays. The lightest of $X_{1,2}$ particles, in some models, could constitute the entirety of dark matter.

Summary

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