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Searching for dark radiation at the LHC

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There is an interesting connection between early universe cosmology and searches for long-lived particles (LLPs) at the LHC. Light particles can be produced via freeze-in and act as dark radiation, contributing to the effective number of relativistic species $N_{\rm eff}$. The parameter space of interest for future CMB missions points to LLP decay lengths in the mm to cm range. These decay lengths lie at the boundary between prompt and displaced signatures at the LHC and can be comprehensively explored only by combining searches for both. We consider a model where the LLP decays into a charged lepton and a (nearly) massless invisible particle. By reinterpreting searches for promptly decaying sleptons and for displaced leptons at both ATLAS and CMS we can then directly compare LHC exclusions with cosmological observables. Our results show how in this model the target value of CMB-S4 is already excluded by current LHC searches.

In-person participation

Yes

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