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Relaxing Limits from Big Bang Nucleosynthesis on Heavy Neutral Leptons with Axion-like Particles

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Heavy neutral leptons (HNLs) are constrained by requirements of Big Bang Nucleosynthesis (BBN) as their decays significantly impact the formation of the primordial elements. We propose here a model where the primary decay channel for the HNLs is to an axion-like particle (ALP) and a neutrino. Consequently, HNLs can decay earlier and evade the BBN bound for lower masses, provided the ALPs themselves decay considerably later. Further cosmological and astrophysical constraints limit severely the range of validity of the ALP properties. We find that a new parameter region opens up for HNLs with masses between 1 MeV and 1 GeV, and active-sterile neutrino mixing strengths between 10^{-9} and 10^{-6} that is consistent with constraints and can be probed in future searches. In such a scenario, current bounds as well as sensitivities of future direct HNL searches such as at NA62 and DUNE will be affected.

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