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# N_eff constraints on the Dark Axion Portal

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Axions and dark photons are common in many extensions of the Standard Model. The dark axion portal—an axion coupling to the dark photon and photon—can significantly modify their phenomenology. We study the cosmological constraints on the dark axion portal from Cosmic Microwave Background (CMB) bounds on the energy density of dark radiation, $\Delta N_{eff}$. By computing the axion-photon-dark photon collision terms and solving the Boltzmann equations including their effects, we find that light axions are generally more constrained by $\Delta N_{eff}$ than from supernova cooling or collider experiments. However, with dark photons at the MeV scale, a window of parameter space is opened up above the supernova limits and below the experimental exclusion, allowing for axion decay constants as low as $f_a \sim 10^4$ GeV. This region also modifies indirectly the neutrino energy density, thus relaxing the cosmological upper bound on the sum of ne

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