

Visualizing Invisible Dark Matter Annihilation with the CMB and Matter Power Spectrum

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We study the cosmological signatures of Invisibly Annihilating Dark Matter (IAnDM) where DM annihilates into dark radiation particles that are decoupled from the Standard Model (SM). In a large class of dark sector models such invisible annihilation determines the relic abundance of DM via dark thermal freezeout. We demonstrate that IAnDM may reveal itself through observable, novel signatures that are correlated: scale-dependent ΔN_{eff} (number of extra effective neutrinos) in the Cosmic Microwave Background (CMB) spectrum due to DM residual annihilation, while the phase of acoustic peaks shift towards the opposite direction relative to that due to SM neutrinos, resembling the effect due to scattering (fluid-like) thermal dark radiation. In addition, IAnDM induces modifications to the matter power spectrum that resemble yet are distinct from that due to warm dark matter. Current data is sensitive to IAnDM with masses up to ~ 200 keV, while future observations will improve the reach, especially if the late-time DM annihilation cross-section is enhanced relative to the standard thermal value, which can be realized in a variety of scenarios.

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