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Freeze-in Inelastic Dirac Dark Matter and H0 tension

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The discrepancy in the estimation of the Hubble constant, as measured by the local distance ladder and the Cosmic Microwave Background (CMB) observations, has become a significant concern, reaching a 4σ to 6σ level of significance. In this study, we investigate a particle physics model featuring an inelastic Dirac dark matter framework with a gauged $U(1)_D$ symmetry, aimed at mitigating this tension in a cosmologically consistent manner while maintaining feeble coupling between the dark and visible sectors. Our model proposes the production of dark sector particles through a freeze-in mechanism, with the two sectors retaining distinct temperatures due to minimal kinetic mixing. Leveraging the presence of a light mediator, the dark matter particles undergo late-stage annihilation into these mediators via resonantly enhanced Sommerfeld cross-sections. Subsequently, these mediators annihilate into self-interacting dark radiations, selectively influencing the dynamics during the CMB era without perturbing Big Bang Nucleosynthesis (BBN), thus offering a dual solution by alleviating both the Hubble constant (H_0) and σ_8 tensions concurrently.

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