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Shedding light on the small-scale crisis with CMB spectral distortions

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The small-scale crisis, discrepancies between observations and N-body simulations, may imply suppressed matter fluctuations on subgalactic distance scales. Such a suppression could be caused by some early-universe mechanism (e.g., broken scale-invariance during inflation), leading to a modification of the primordial power spectrum at the onset of the radiation-domination era. Alternatively, it may be due to nontrivial dark-matter properties (e.g., new dark-matter interactions or warm dark matter) that affect the matter power spectrum at late times, during radiation domination, after the perturbations re-enter the horizon. We show that early- and late-time suppression mechanisms can be distinguished by measurement of the μ distortion to the frequency spectrum of the cosmic microwave background. This is because the μ distortion is suppressed, if the power suppression is primordial, relative to the value expected from the dissipation of standard nearly-scale-invariant fluctuations. We emphasize that the standard prediction of the μ distortion remains unchanged in late-time scenarios even if the dark-matter effects occur before or during the era (redshifts 5×10^4 $lesssim z$ $lesssim 2 \times 10^6$) at which μ distortions are generated.

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