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Distinguishing between Warm Dark Matter and Late Kinetic Decoupling using CMB spectral distortions.

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The damping of perturbations in the early universe produces a distortion in the energy spectrum of the CMB photons which depends intimately on the properties of the photon temperature transfer functions. Here we propose a new method for probing dark matter models on extremely small-scales \(1 \, \textrm{Mpc}^{-1}\lesssim k \lesssim 10^{4} \, \textrm{Mpc}^{-1}\) by looking at how these models affect the evolution of the photon transfer functions. We explore the dependance of the distortion on different dark matter models including warm dark matter and dark matter with elastic scattering off a relativistic species (we consider both photons and neutrinos). The photon temperature transfer functions are determined for each model and used to calculate the heating rate of the CMB photons and the distortion signatures in each case. We place constraints on the dark matter-radiation elastic scattering cross-sections and show the projected constraints for future experiments. We show that the distortion signal differs between all 3 dark matter models under consideration and can thus shed light on the small-scale problems associated with conventional Cold Dark Matter models.

Authors: DIACOUMIS, James (University of New South Wales); WONG, Yvonne (The University of New South Wales)

Presenter: DIACOUMIS, James (University of New South Wales)

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