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Free-streaming and Coupled Dark Radiation Isocurvature Perturbations: Constraints and Application to the Hubble Tension

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Dark radiation (DR) appears as a new physics candidate in various scenarios beyond the Standard Model. While it is often assumed that perturbations in DR are adiabatic, they can easily have an isocurvature component if more than one field was present during inflation, and whose decay products did not all thermalize with each other. In this talk, I will discuss the constraints on both uncorrelated and correlated DR density isocurvature perturbations from the full Planck 2018 data alone, and also in combination with other cosmological data sets. Our work on free-streaming DR (FDR) updates and generalizes the existing bound on neutrino density isocurvature perturbations by including a varying number of relativistic degrees of freedom. In the case of coupled DR (CDR) isocurvature, we derive the first bound. I will also discuss that for isocurvature IC, FDR gives rise to larger CMB anisotropies compared to CDR – contrary to the adiabatic case. More generally, we find that a blue-tilt of DR isocurvature spectrum is preferred from the cosmological data. This gives rise to a larger value of the Hubble constant H_0 compared to the standard ΛCDM+$\Delta N_{\rm eff}$ cosmology with adiabatic spectra and relaxes the Hubble tension.

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