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Resolving cosmological tensions with a sign-switching cosmological constant

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In this talk, inspired by the recent conjecture originated from graduated dark energy (gDE) that the universe has transitioned from anti-de Sitter vacua to de Sitter vacua in the late universe, we will discuss the superior features of the Λ_s CDM model, which extends the standard Λ CDM model by a cosmological constant (Λ_s) that switches sign at a certain redshift z_{\dagger} , over the standard Λ CDM model in the light of observational data. We will first discuss that, when the consistency of Λ_s CDM with the CMB data is ensured, H_0 and M_B values are inversely correlated with z_{\dagger} and reach $H_0 \approx 73.4 \text{ km s}^{-1} \text{ Mpc}^{-1}$ and $M_B \approx -19.25 \text{ mag}$ for $z_{\dagger} = 1.6$, in agreement with the SH0ES measurements, and H(z) exhibits an excellent fit to the Ly- α data. We will then show that the CMB alone is not able to well constrain z_{\dagger} and thus discriminate between Λ_{s} CDM and Λ CDM models, but the CMB+BAO data set favors the sign switch of Λ_s providing the constraint: z_{\dagger} = 2.44 ± 0.29 . The further observational analysis using more data sets reveals that Λ_s CDM is significantly favored over Λ CDM, and it resolves various tensions that prevail within Λ CDM; for instance, the CMB+Pan data set with M_B prior gives $z_{\dagger} = 1.784^{+0.14}_{-0.18}$ along with $H_0 \approx 72.38^{+0.98}_{-1.10}$ km s⁻¹ Mpc⁻¹, $S_8 = 0.785 \pm 0.012$, and $M_B = -19.290^{+0.026}_{-0.029}$, all of which are consistent with their local measurements, and moreover that the physical baryon density value, ω_b , better agrees with the BBN constraints on it and H(z) exhibits excellent fit to the Ly- α data. While using the CMB+Pan+Ly- α data set provides us with the similar constrains, inclusion of the low-redshift BAO data, i.e., using CMB+Pan+BAO data set, leads to some compromise in these improvements. We will close the talk with a discussion on some other observational aspects and theoretical implications of the Λ_s CDM model. This talk is based on the works Graduated dark energy: Observational hints of a spontaneous sign switch in the cosmological constant" [Akarsu, Barrow, Escamilla, and Vazquez, PRD 101 (2020) 063528], Relaxing cosmological tensions with a sign switching cosmological constant" [Akarsu, Kumar, Ozulker, and Vazquez, PRD 104 (2021) 123512], and "Relaxing cosmological tensions with a sign switching cosmological constant: Improved results with Planck, BAO and Pantheon data" [Akarsu, Kumar, Ozulker, Vazquez, and Yadav, arXiv:2211.05742] and several ongoing works by an extended group of leading researchers in the field of cosmology.

Presenter(s): OZGUR AKARSU