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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 $\Lambda_{\rm s}$CDM model, which extends the standard ΛCDM model by a cosmological constant ($\Lambda_{\rm s}$) that switches sign at a certain redshift $z_\dagger$, over the standard ΛCDM model in the light of observational data. We will first discuss that, when the consistency of $\Lambda_{\rm s}$CDM with the CMB data is ensured, H_0 and M_B values are inversely correlated with $z_\dagger$ and reach $H_0 \approx 73.4\,{\rm km\,s^{-1}\,Mpc^{-1}}$ and $M_B \approx -19.25\,{\rm mag}$ 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 $\Lambda_{\rm s}$CDM and ΛCDM models, but the CMB+BAO data set favors the sign switch of $\Lambda_{\rm s}$ providing the constraint: $z_\dagger = 2.44 \pm 0.29$. The further observational analysis using more data sets reveals that $\Lambda_{\rm s}$CDM is significantly favored over ΛCDM, and it resolves various tensions that prevail within ΛCDM; for instance, the CMB+Pan data set with M_B prior gives $z_\dagger = 1.784^{+0.14}_{-0.18}$ along with $H_0 \approx 72.38^{+0.98}_{-1.10}\,{\rm km\,s^{-1}\,Mpc^{-1}}$, $S_8 = 0.785 \pm 0.012$, 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 $\Lambda_{\rm s}$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.

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