

Investigating Expansion-History Mismatch with Diverse Dark Energy Parametrization Frameworks

jueves, 17 de septiembre de 2026 15:45 (25)

The Λ CDM model successfully explains a wide range of cosmological observations; however, persistent discrepancies most notably the H_0 tension between early and late time measurements challenge its completeness. No proposed extension has yet resolved this tension while retaining the overall success of Λ CDM. We have investigated whether the H_0 tension can be associated with a specific epoch in the cosmic expansion history and identify the redshift range most relevant for understanding its origin. In addition to the cosmological constant, we have considered three phenomenological models based on general parametrizations of key quantities governing cosmic expansion: the dark energy (DE) equation of state, the DE pressure density, and the scale factor. Using early time Planck data and late time Pantheon+ (with and without SH0ES calibration) and DESI measurements, we have constrained model parameters and examined the evolution of the Hubble parameter $H(z)$. We have found that Λ CDM exhibits discrepancies across all redshifts, whereas the other models show them mainly at low redshifts. Further analysis at low redshifts reveals significantly larger deviations in $H(z)$ at $z=0.51$ and 0.706 compared to other ranges. We have also found that the pressure density parametrization alleviates the H_0 tension, reducing it to $\sim 2.7\sigma$, while the other models do not provide significant improvements.

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Clasificación de la sesión : Afternoon Session (Thursday)