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Evaluation of Dynamic Dark Energy Model

In this work we reviewed parametrizations of Dark Energy (DE) models focusing on potential late-time physics effects that could alleviate the Hubble Tension. We present a preliminary evaluation of the DE models proposed by Pan et. al. 2019, which consist of phenomenological parametrizations of the DE equation of state, $w = P/\rho$, in terms of the current value, w_0. In addition, we include in this evaluation a proposed DE model consisting of a sigmoid function of FLRW scale factor, a, and w_0.

Our analysis indicates that the Pan et. al. 2019 DE models yield H_0 values that are all within 0.6σ from each other, which renders them effectively equivalent, and highlights the weak discriminatory power of these DE parametrizations. These results are in part due to the shape of the functions proposed for $w(a)$, which in all cases define the dynamic variation of DE spread smoothly across redshift space. In contrast, our sigmoid model provides a stronger constraining of redshift and w_0 parameter space, by explicitly localizing the transition redshift point where the equation of state changes values from the past, $w = -1$ (consistent with CMB), to the present value w_0. Using the recent (Scolnic et. al., 2022) Pantheon+ SN Ia data, our sigmoid-DE model (Rueda-Blanco, et al., 2023) gives a best fit value for H_0 of $73^{+0.2}_{-0.6}$ km s^{-1} Mpc^{-1} (\emph{statistical}). Later on, we analyzed the issue of parameter degeneracy and discuss strategies to lessen their impact in our analysis. Finally, our findings indicate that the results depend critically on the treatment of the Ω_M parameter in the fits. Due to the known parameter degeneracy between H_0 and Ω_M, if the Ω_M parameter is left as a floating parameter in the fit, then the values for w_0 resulting from the fit tend towards the phantom sector ($w_0 < -1$). However, when the Ω_M parameter is held fix during the fit (which we claim should be the case in order to leave early CMB physics unperturbed) then the values of w_0 delivered by the fits tend towards values greater than -1. This work is part of a more extensive study of late-time physics models in the context of the Hubble Tension.

Authors: RUEDA BLANCO, Sebastian (Universidad Nacional de Colombia); Dr DELGADO CORREAL, Camilo (Universidad Distrital Francisco José de Caldas); Dr HIGUERA GARZÓN, Mario Armando (Universidad Nacional de Colombia); Dr TORRES ARZAYUS, Sergio (International Center for Relativistic Astrophysics Network)

Presenter: RUEDA BLANCO, Sebastian (Universidad Nacional de Colombia)