Contribution ID: **83** Type: **Talk**

Constraining Pressure-Based Dark Energy Models with Latest Cosmological Data

Friday, July 11, 2025 4:50 PM (25 minutes)

In this talk, I explore an extension of the standard cosmological model by introducing a dynamical dark energy (DDE) scenario, where the pressure evolves with cosmic time. Instead of assuming a constant dark energy component, we expand the pressure around the present epoch to capture possible deviations from a cosmological constant. This approach introduces one or two new parameters, depending on the order of the expansion, which quantify how dark energy evolves over time. Using recent observational data, including Planck CMB, DESI galaxy clustering, and DESY5 supernovae, I present constraints on both first- and second-order DDE models. The results show significant evidence for dynamical behavior: a 2.7σ preference for the first-order model and over 4σ for the second-order case. In particular, the second-order reconstruction reveals a non-monotonic evolution of dark energy, including phantom-crossing behavior. Importantly, the inferred trends are consistent across datasets and align well with other dynamical parametrizations, stressing the robustness of this pressure-based framework. Based on 2505.02932 and ongoing work.

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Session Classification: Contributions