Contribution ID: **13** Type: **Talk**

Testing Dynamical Dark Energy Models with Novel Cosmological Data

Wednesday 25 June 2025 10:05 (25 minutes)

We explore an extension of the ΛCDM model that introduces a time-dependent evolution of the pressure parameter p in the dark energy fluid. In this process, the corresponding energy density ρ is derived by a continuity equation. Consequently, the equation of state $w \equiv p/\rho$ evolves during the late-time expansion of the Universe. We model the pressure parameter using a Taylor expansion within the dynamical dark energy (DDE) framework. Initially, we truncate the expansion at first order, introducing a single additional parameter that allows the equation of state to deviate from the cosmological constant value. We then extend the analysis to second order, demonstrating that observational data can constrain both these additional parameters. Since no significant deviation from ΛCDM was detected for the relevant cosmological parameters, we did not include higher-order terms. To examine the parameter space of this extended model, we modified the publicly available CAMB code and performed a Markov Chain Monte Carlo analysis, extending the ΛCDM parameter space to incorporate the pressure parameterizations.

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Session Classification: Morning session 1