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Plenary — Antonio De Felice: From Data to Dynamics: A Simple Phantom-Crossing Dark Energy Parametrization

Monday, 16 November 2026 11:00 (1 hour)

Is the time dependence of dark energy genuinely complicated, or can current observations be described by a much simpler expression?

I will present a data-driven approach to this question within VCDM, a minimally modified theory of gravity that allows a consistent treatment of cosmological perturbations even when the effective dark-energy equation of state crosses the phantom divide.

We begin by reconstructing the dark-energy equation of state using Bayesian splines constrained by cosmic microwave background, baryon acoustic oscillation, and Type Ia supernova observations. The reconstruction favors relatively smooth histories, while Bayesian evidence does not justify introducing excessive functional complexity. We then employ exhaustive symbolic regression to identify compact and interpretable analytic expressions compatible with the reconstructed evolution.

A particularly interesting outcome is the one-parameter form $w(a) = w_0/\sqrt{a}$, which provides a competitive fit compared with conventional two-parameter parametrizations, including CPL.

Its simplicity leads to concrete predictions: the phantom-crossing redshift is determined by the single parameter w_0 , the effective dark-energy density is suppressed at early times, and the phantom phase is transient, avoiding a future big-rip singularity.

I will discuss the observational implications of this result and explain how the underlying VCDM dynamics can accommodate phantom crossing without introducing an additional propagating scalar degree of freedom.