UQFF Prediction P13: DESI Y5 Dark Energy w(z) Second-Derivative Strict-Static Test

2026-05-11

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1. Setup

DESI 2024 BAO + SN Ia + CMB combined analysis reports a possible drift in the dark-energy equation of state, parametrized as

$$w(z) = w_0 + w_a \cdot \frac{z}{1+z}, \qquad (w_0, w_a) = (-0.827 \pm 0.063,\ -0.75 \pm 0.29).$$

P7 (PAPER_1170) already constrains the *first* derivative: UQFF predicts $w_0 = -1$, $w_a = 0$ because the R26 vacuum energy is strictly static.

P13 extends to the *second* derivative.

2. UQFF Closed Form (P13)

Because $\rho_\Lambda = (V(0) + \rho_{R26} + \rho_{KK} + \rho_{BSFG})$ is *strictly* time-independent in the closed Lagrangian (PAPER_1167, PAPER_1170), all derivatives of $w(z)$ vanish identically:

$$\boxed{\left.\frac{d^n w}{dz^n}\right|_{\text{UQFF}} = 0 \quad \text{for all } n \geq 1.}$$

In particular, the second derivative

$$\frac{d^2 w}{dz^2} = 0 \pm 0$$

is a *zero-parameter* prediction — UQFF has no freedom to evade it.

3. Numerical Comparison

Standard $w_0 w_a$CDM has $d^2w/dz^2 = 2w_a/(1+z)^3$. At $z = 0.5$:

Model	d^2w/dz^2 at $z = 0.5$
ΛCDM	0
DESI 2024 best fit ($w_a = -0.75$)	-0.444
UQFF (P13)	**0**

4. Falsifiable Prediction (P13)

DESI Y5 (2028) is forecast to constrain w_a at the ± 0.05 level after BAO + SN + CMB combination. The implied second-derivative bound at $z = 0.5$ is

$$|d^2w/dz^2| < 0.030 \quad \text{(DESI Y5 1-}\sigma\text{)}.$$

Falsifier: if DESI Y5 confirms w_a deviating from 0 at the $\geq 3\sigma$ level (equivalently $|d^2w/dz^2| > 0.030$ at $z = 0.5$ at $\geq 3\sigma$), UQFF static-vacuum is excluded.

5. Cross-Check with CP4 #262

CP4 calculator `UQFFDarkEnergySecondDerivativeCalculator` returns $d^2w/dz^2 = 0.0$ at all z for default inputs, with the DESI Y5 bound included for comparison.

6. Status

CLOSED. P13 added to predictions table alongside P6–P12. P13 is unique among the predictions for being a **strict zero with no UQFF freedom**.