

Constraining DDE Models with AdS-to-dS and Similar Late-Time Transitions

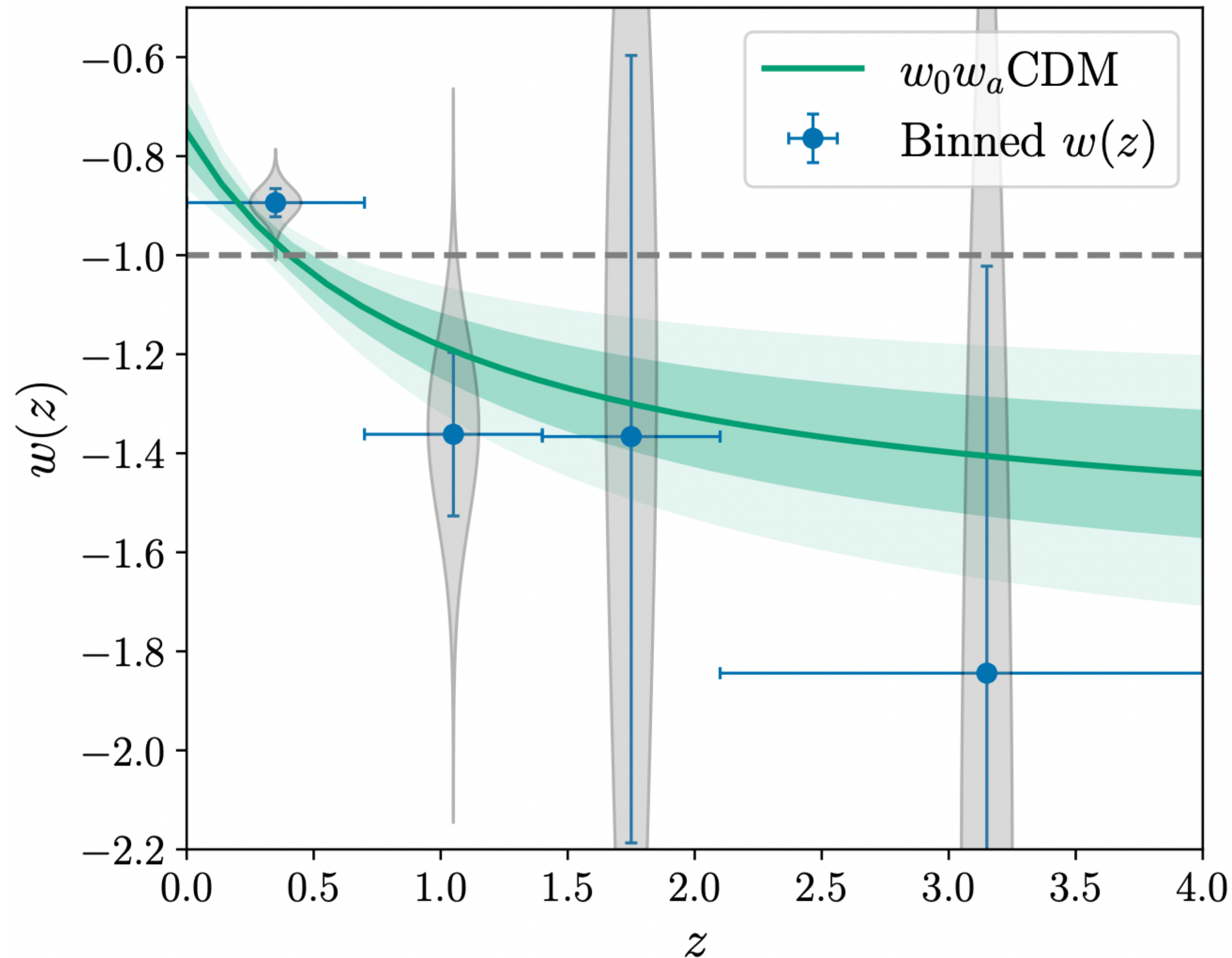
Exploring New Frontiers in Cosmology @ GGI
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Phantom Crossing?



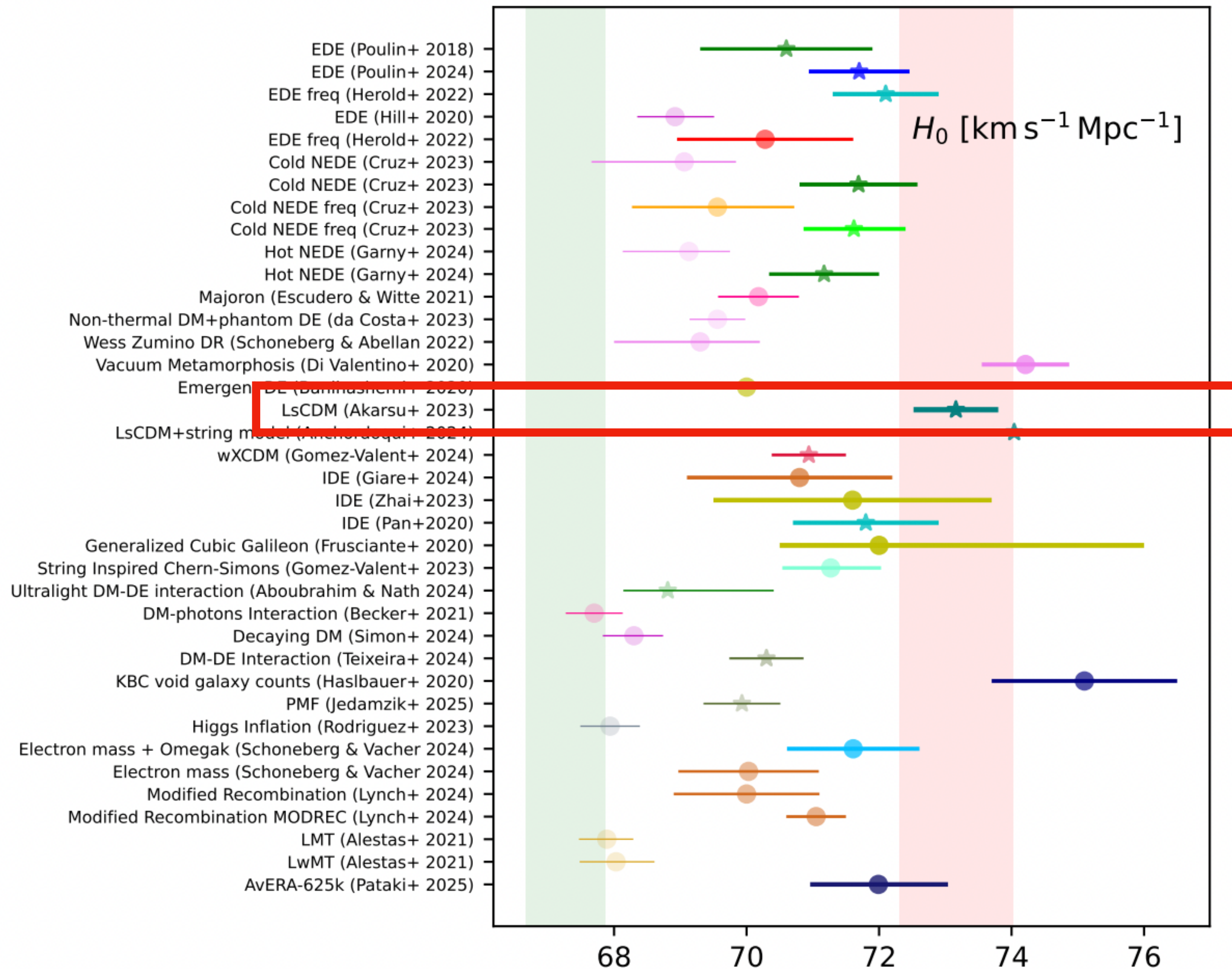
DESI DR2 results for CMB+BAO+DESY5
DESI Collaboration, PRD (2025), arXiv:2503.14738.

- Preference for CPL-parametrized dynamical dark energy

$$w_{\text{CPL}}(a) = w_0 + (1 - a)w_a$$

- Worsens the H0 tension
- Phantom ($w = -1$) crossing $\rightarrow$ theoretically non-trivial
- Could be an indication of null energy condition violation in DE

$$\rho_{\text{DE}} + p_{\text{DE}} = \rho_{\text{DE}}(1 + w_{\text{DE}}) > 0$$



- Λ CDM $\rightarrow \Lambda + \text{CDM}$
- Λ_s CDM $\rightarrow \Lambda_s + \text{CDM}$

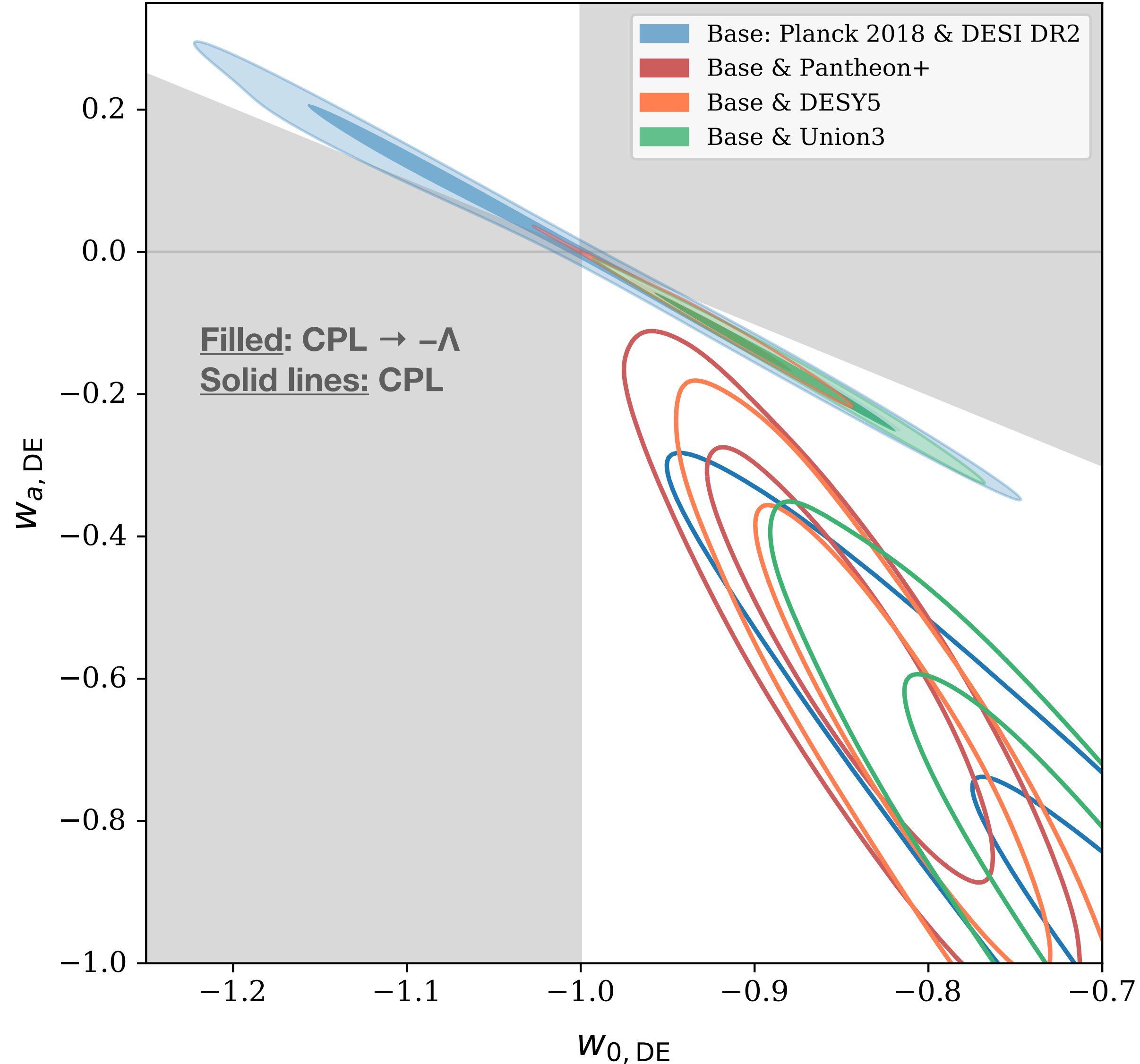
$$\Lambda_s \equiv \Lambda_{s0} \text{sgn}(z_{\dagger} - z)$$

Promising for
addressing the H_0
tension.

Can a negative
density phase also
better explain the
recent DESI BAO
observations?

The CosmoVerse Network, Di Valentino, Levi Said et al., Phys. Dark Univ. (2025), arXiv:2504.01669.

FIG. 3: Summary of models proposed to solve the H_0 tension in this White Paper following the order of the different sections.



CPL $\rightarrow -\Lambda$

$$w_{\text{CPL}}(a_c) \equiv -1 \quad \Rightarrow \quad a_c = 1 + \frac{1 + w_0}{w_a} \quad w_a \neq 0$$

$$w_{\text{DE}}(a) = \begin{cases} w_0 + (1 - a)w_a, & a > a_c, \\ -1, & a \leq a_c. \end{cases}$$

$$\rho_{\text{DE}}(a) = \begin{cases} \rho_{\text{CPL}}(a), & a > a_c, \\ -\rho_{\text{CPL}}(a_c), & a \leq a_c. \end{cases}$$

- Toy model to compare different mechanisms of phantom behavior. Not the best way to implement sign-switch.
- Negative DE phase derives $w_0 \rightarrow -1$ and $w_a \rightarrow 0$ (towards the CC limits) !!

Ph- Λ_s CDM

Akarsu, Perivolaropoulos, Tsikoundoura, Yükselci, Zhuk, arXiv:2502.14667.

$$S_\phi = \int d^4x \sqrt{-g} \left[\frac{\xi}{2} g^{\mu\nu} \partial_\mu \phi \partial_\nu \phi - V(\phi) \right]$$

$\xi = +1 \quad \Rightarrow$ Quintessence

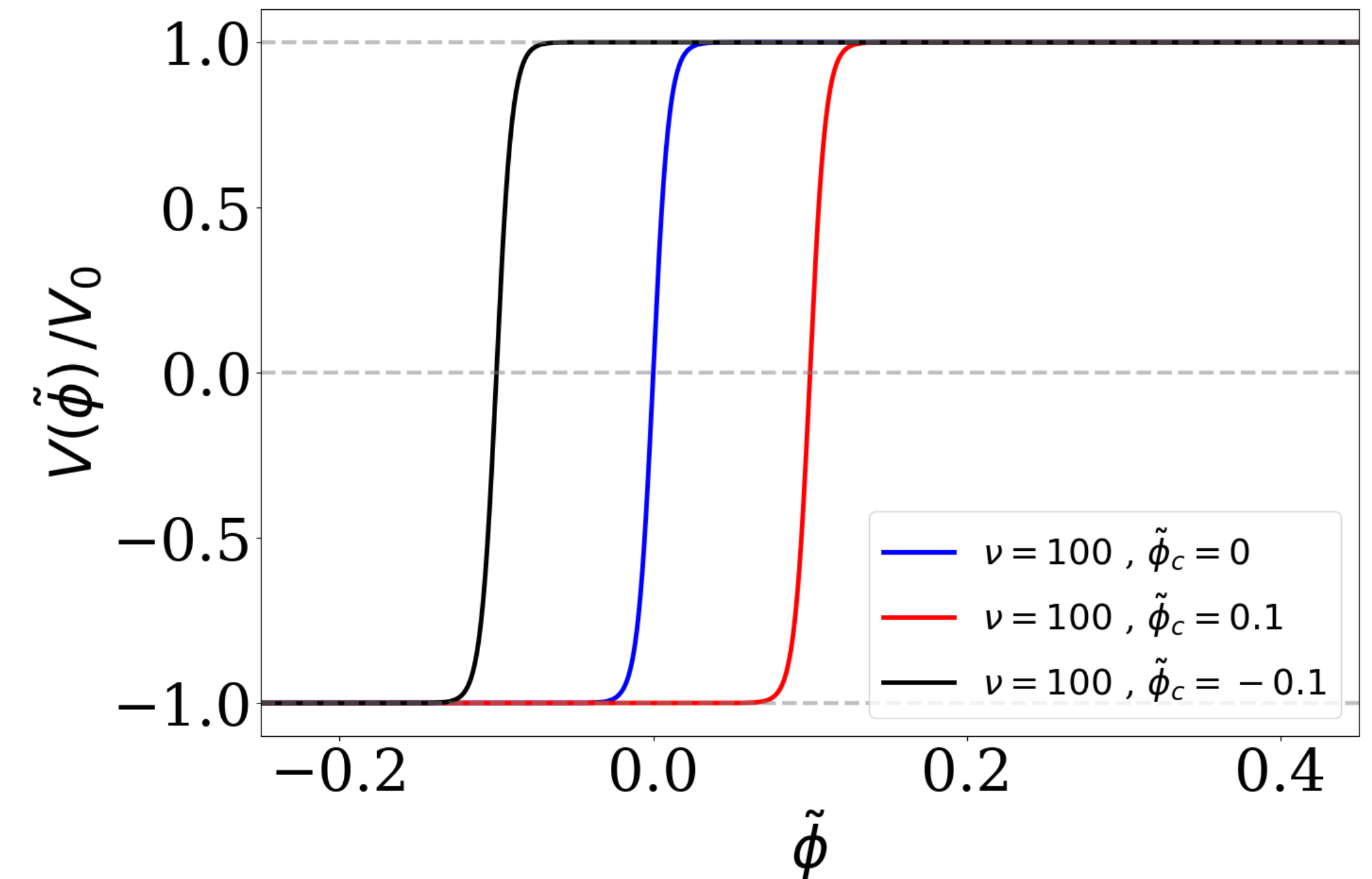
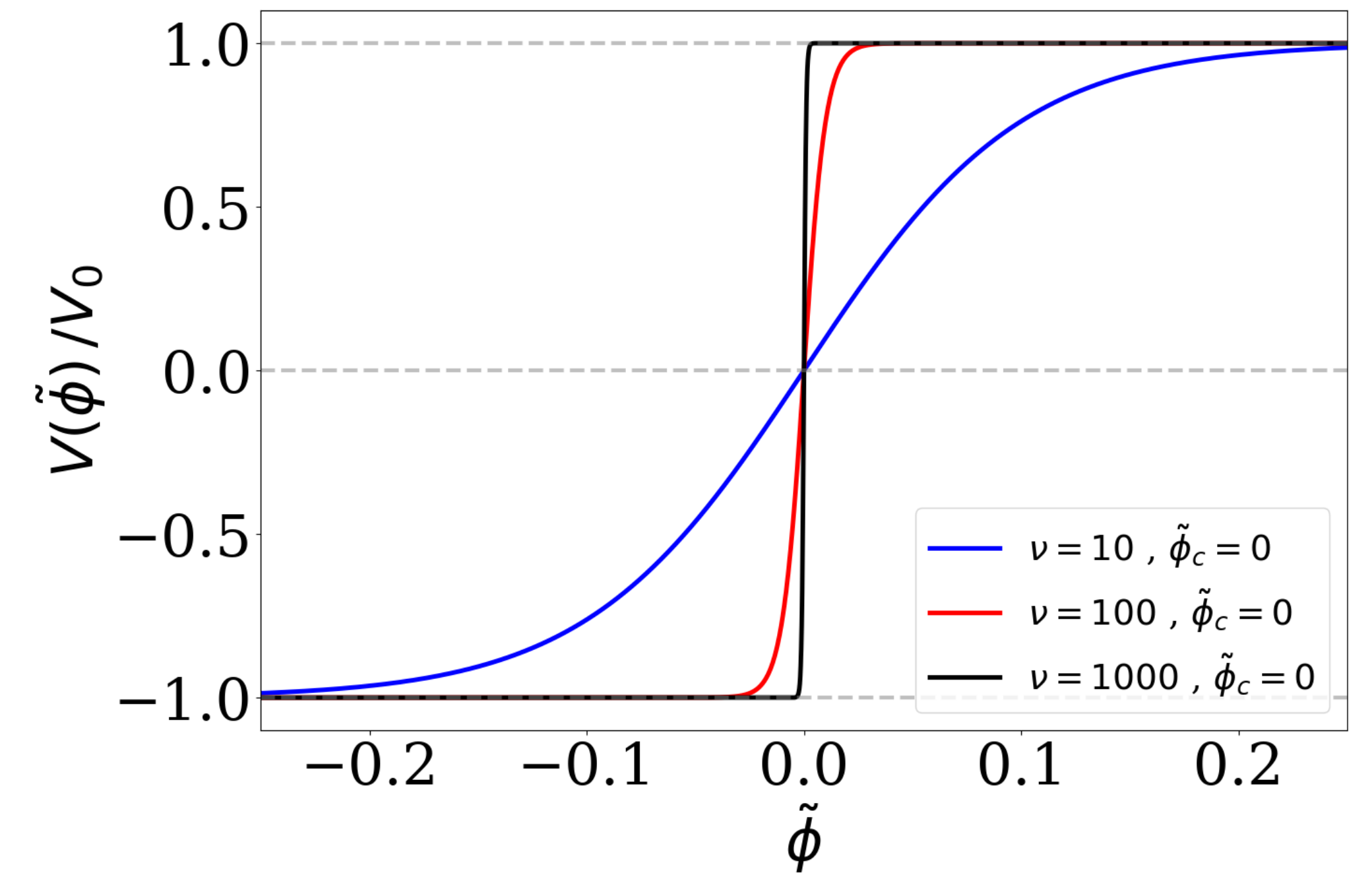
$\xi = -1 \quad \Rightarrow$ Phantom

$$w_\phi = \frac{p_\phi}{\rho_\phi} = \frac{\xi X - V(\phi)}{\xi X + V(\phi)}, \quad X \equiv \frac{(\dot{\phi})^2}{2c^2}$$

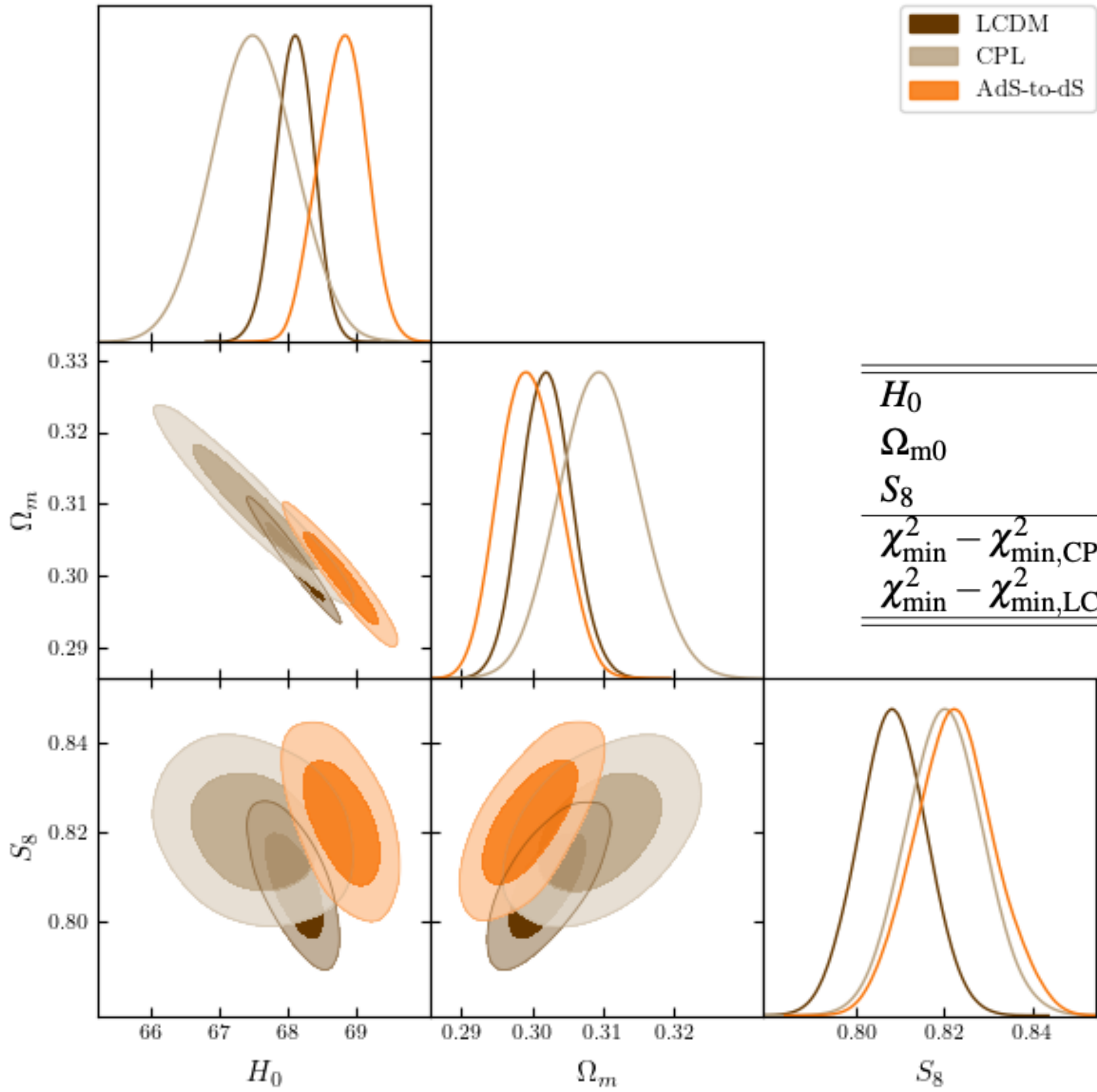
$$V(\tilde{\phi}) = \Lambda \tanh \left[\nu(\tilde{\phi} - \tilde{\phi}_c) \right], \quad \Lambda > 0$$



extra two free parameters compared to LCDM



[in prep.] Akarsu, Di Valentino, **Gökçen**, Smith, van de Bruck, Zhuk, (2026).



- Planck 2018 + DESI DR2 + PantheonPlus
- For fixed $\nu = 1000$ (rapid transition limit)

	Ph- Λ_s CDM	CPL	LCDM
H_0	68.80 ± 0.34	67.51 ± 0.60	68.11 ± 0.28
Ω_{m0}	$0.2997^{+0.0040}_{-0.0044}$	0.3096 ± 0.0057	0.3021 ± 0.0036
S_8	0.8223 ± 0.0091	0.8201 ± 0.0088	0.8083 ± 0.0077
$\chi^2_{\min} - \chi^2_{\min, \text{CPL}}$	-4.11	0	3.25
$\chi^2_{\min} - \chi^2_{\min, \text{LCDM}}$	-7.35	-3.25	0

Ph-LsCDM fits significantly better than reference models

and

H_0 tension is reduced to 5.4σ (from 6.3σ for LCDM) compared to the consensus report value of $73.50 \pm 0.81 \text{ km/s/Mpc}$.