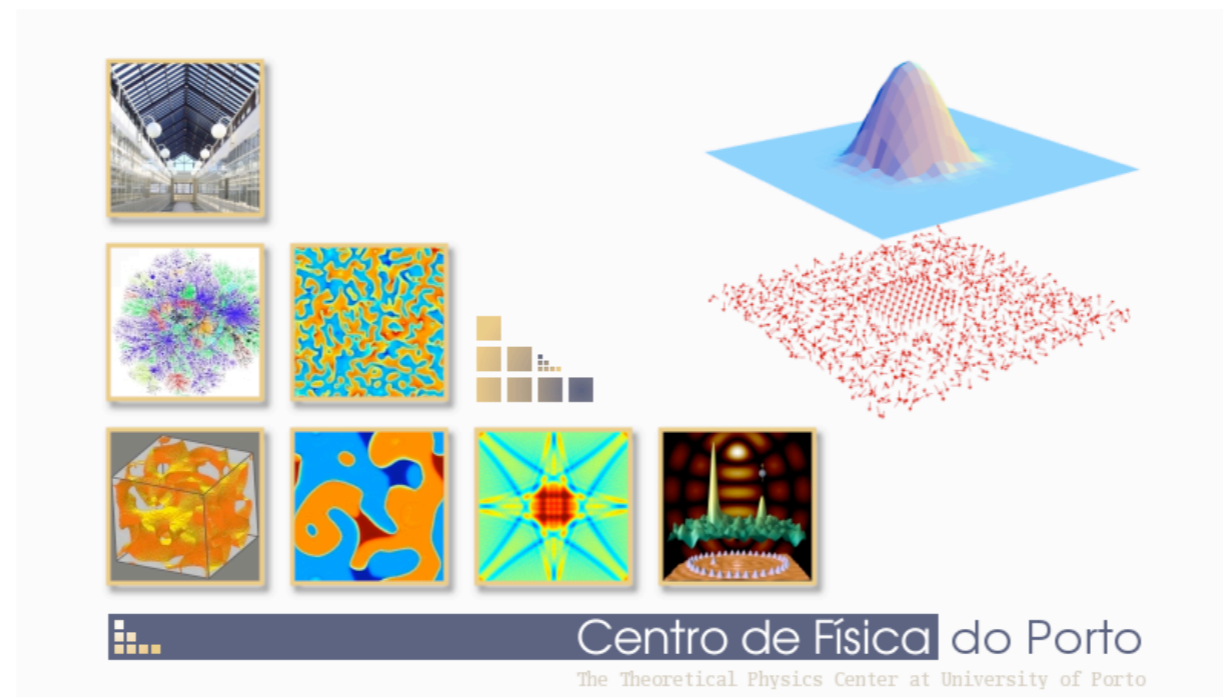


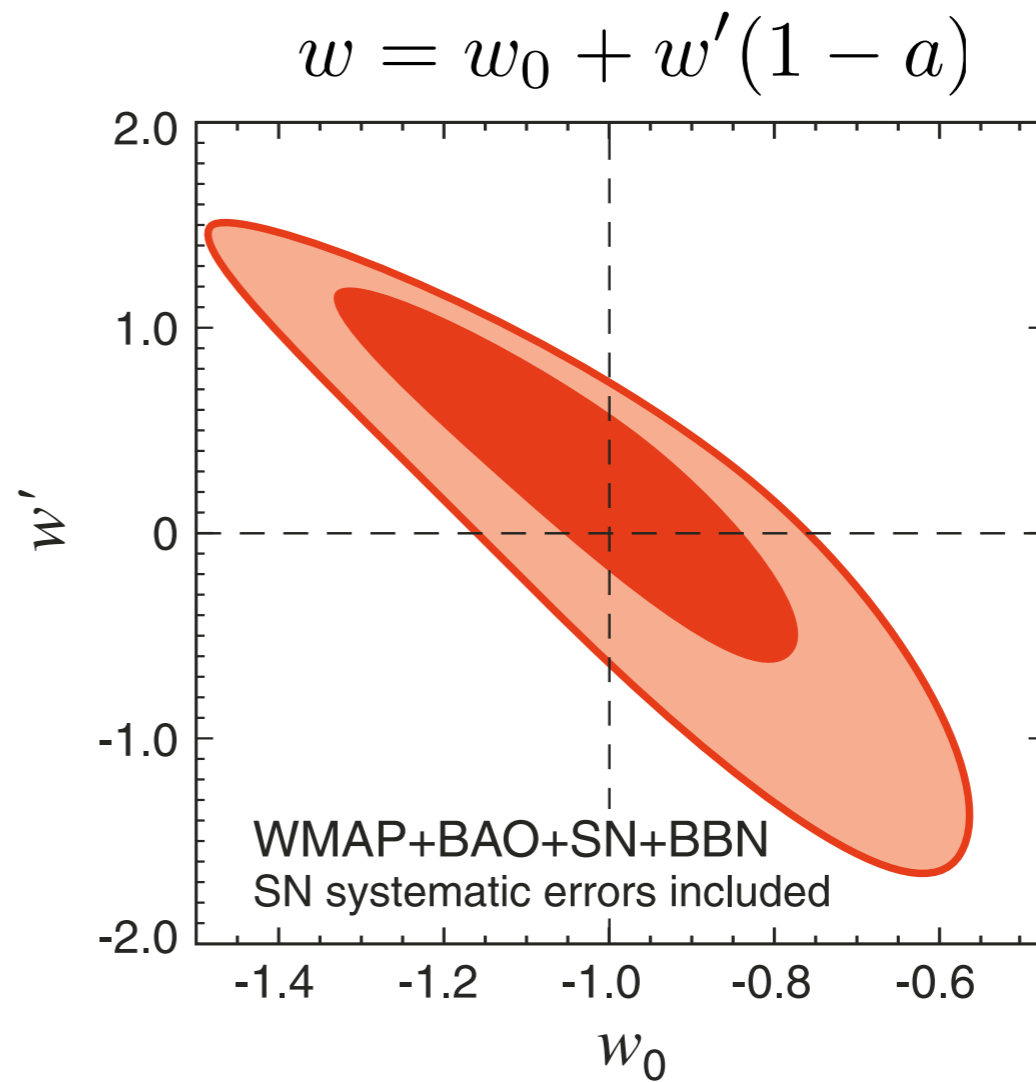
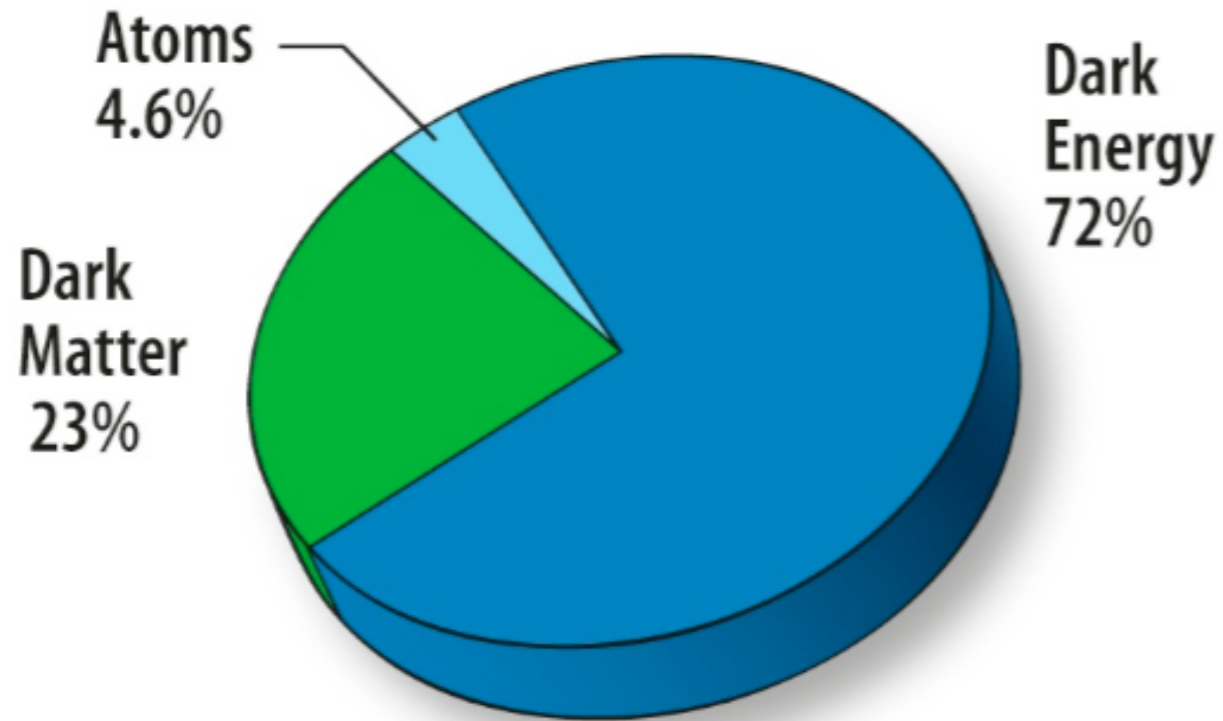
The impact of the matter density uncertainty on the dark energy reconstruction

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Dark energy constraints



WMAP5year + BAO + SN :

$$w_{\text{eff}} = -1^{+0.12}_{-0.14} \quad (2\sigma)$$

Dark energy reconstruction limitations [1]

$$w \equiv \frac{p}{\rho} = \frac{w_\phi}{1 + \Omega_m/\Omega_\phi} = w_\phi(1 - \Omega_m)$$

Taking $\Delta\Omega_m = 0$:

$$\Delta w_\phi = \Delta w \left(1 + \frac{\Omega_m}{\Omega_\phi} \right) = \frac{\Delta w}{1 - \Omega_m}$$

If $\Omega_{m0} = 0.27$ and $\Omega_{\Lambda 0} = 1 - \Omega_{m0}$:

$$1 + \frac{\Omega_m}{\Omega_\phi} = 1 + \frac{\Omega_{m0}(1+z)^3}{\Omega_{\Lambda 0}} \sim 1 + 0.37(1+z)^3$$

Dark energy reconstruction limitations [11]

$$w = -\frac{2}{3} \frac{H'}{H} - 1 = w_\phi (1 - \Omega_m)$$

where $' \equiv d/d \ln a$. Taking $\Delta w = 0$:

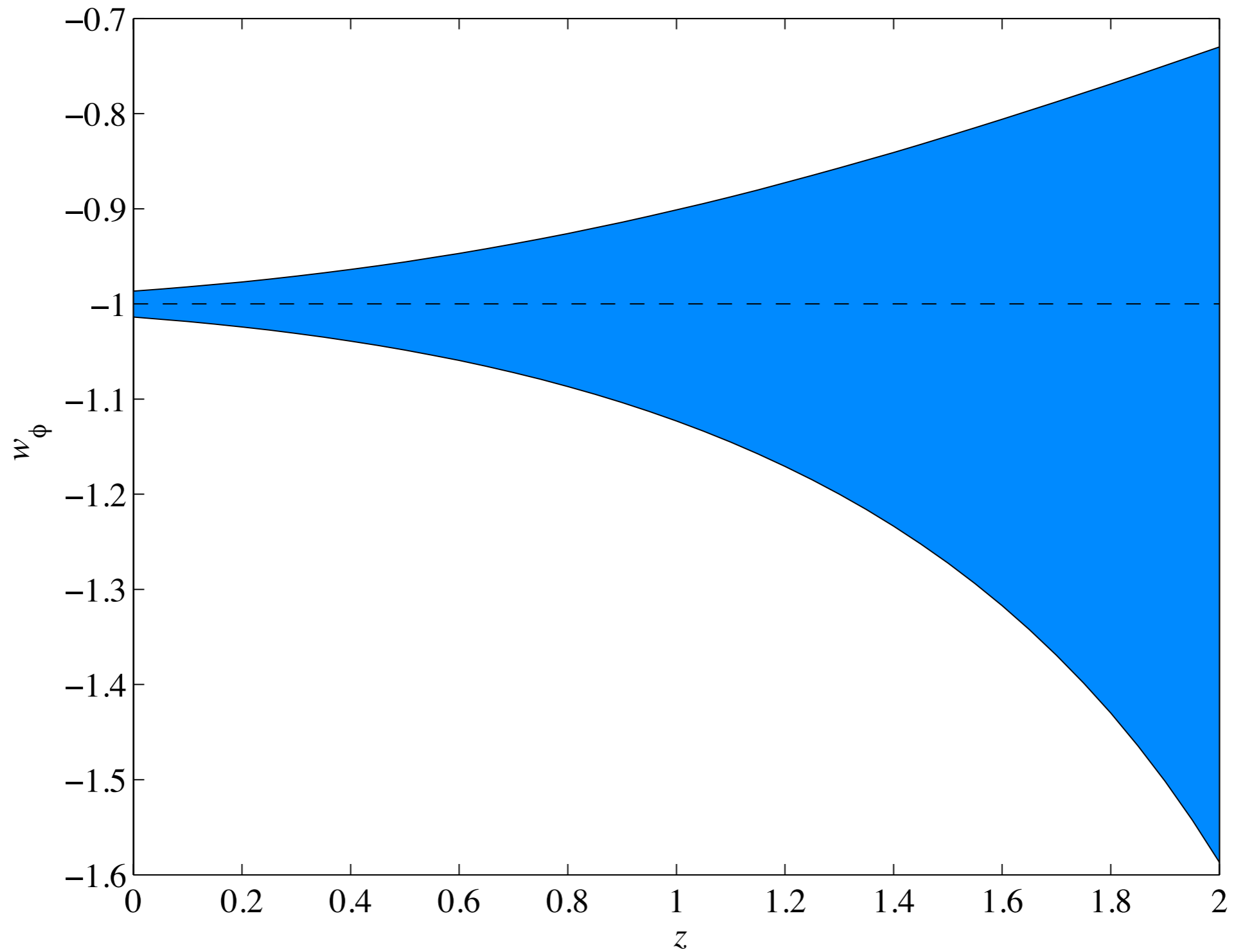
$$\Delta w_\phi \sim \frac{|w| \Delta \Omega_m}{(1 - \Omega_m)^2} = \frac{|w_\phi| \Delta \Omega_m}{1 - \Omega_m}$$

If $w_\phi \sim -1$ then :

$$\Delta w_\phi \sim \frac{\Delta \Omega_m}{1 - \Omega_m}$$

but $\Omega_m \rightarrow 1$ at high redshift.

Dark energy reconstruction uncertainty (using standard methods)



Varying couplings method

Assumptions :

$$\mathcal{L}_\phi = \frac{1}{2} \partial_\mu \phi \partial^\mu \phi - V(\phi)$$

$$\frac{\delta \alpha}{\alpha} = \zeta \delta \phi$$

WEP constraints imply that $\zeta \leq 1.8 \times 10^{-4}$

Coupling to electromagnetically interacting matter has negligible impact on the dynamics of α

Spatial variations of α are negligible in this model

Dynamics of varying couplings

If $\sigma = \rho_\phi / (\rho_0 \Omega_{m0})$ then :

$$\sigma' = \frac{\sigma'_0}{\sigma_0 + 1} \left(\frac{\phi'}{\phi'_0} \right)^2 (\sigma + a^{-3})$$

where :

$$\sigma_0 = 1/\Omega_{m0} - 1$$

$$\sigma'_0 = -3\sigma_0(w_{\phi 0} + 1)$$

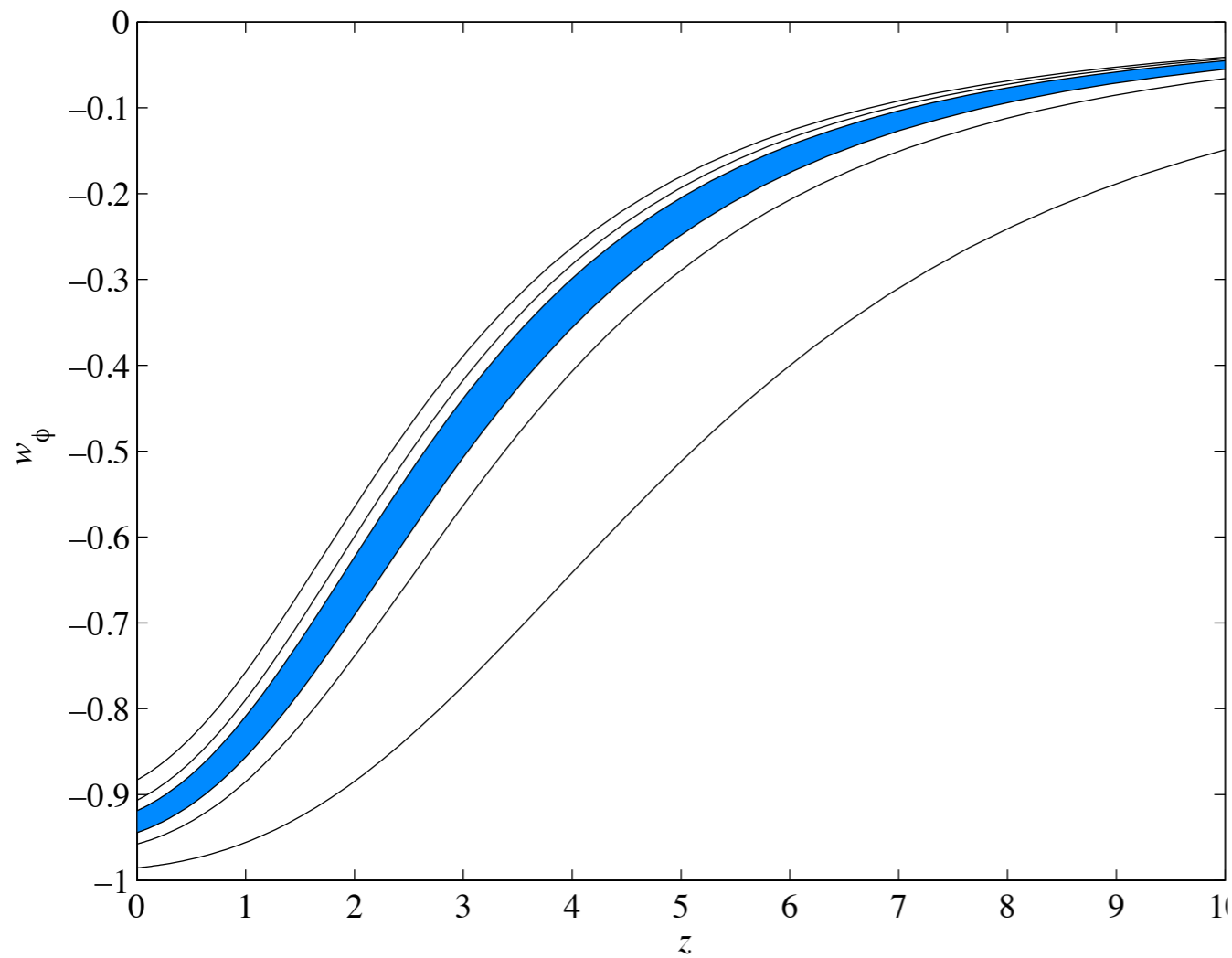
and :

$$w_\phi = -1 - \frac{1}{3} \frac{\sigma'}{\sigma}$$

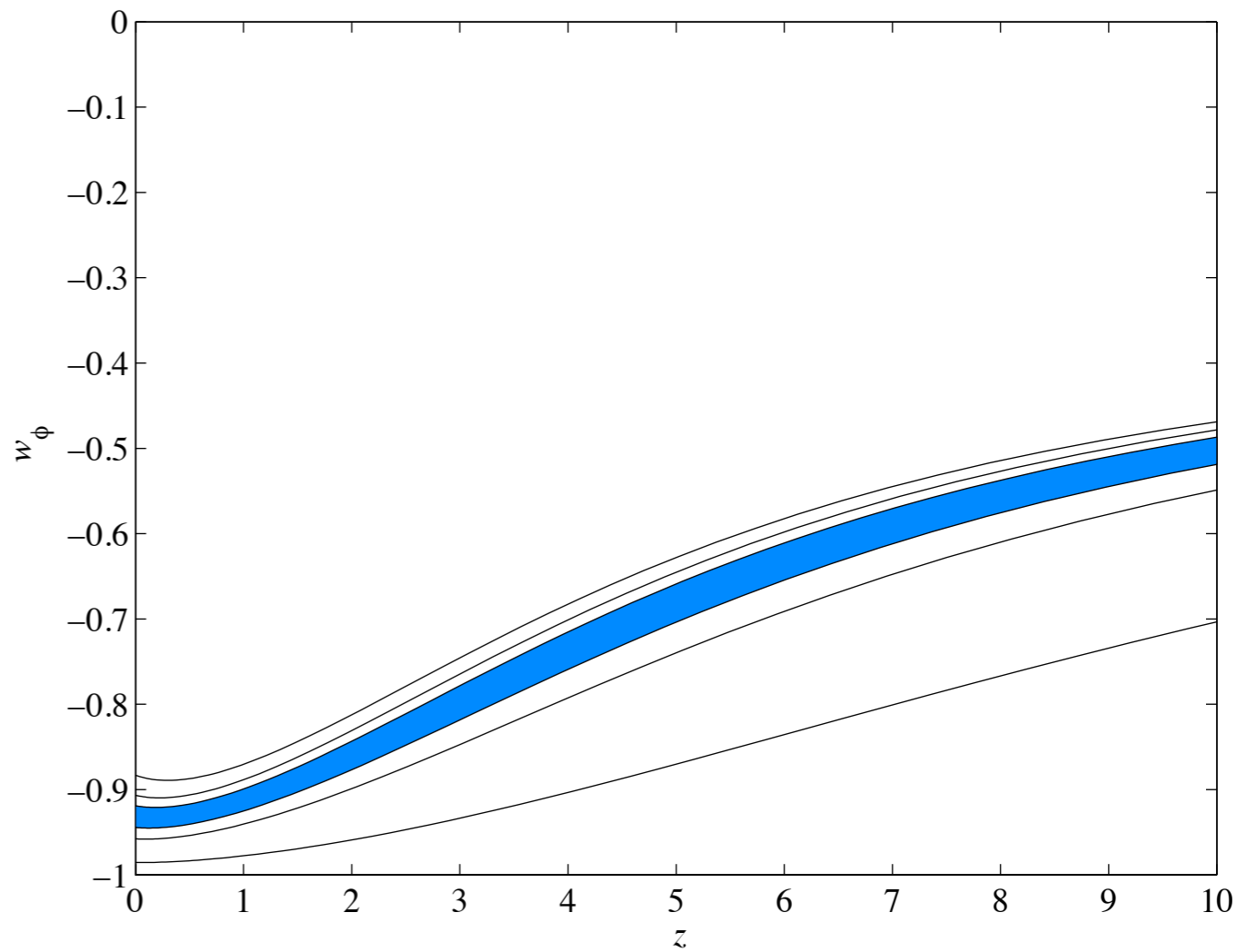
with $' \equiv d/d \ln a$.

Dark energy reconstruction uncertainty (varying couplings method)

$d\phi/d\ln a = \text{constant}$



$d\phi/d\ln a \propto a^{1/2}$



$w_0 = -0.68, \Omega_{m0} = 0.27 + \delta\Omega_{m0}$ with $\delta\Omega_{m0} = -0.04, -0.02, -0.01, 0.01, 0.02, 0.04$ ($\Omega_{\phi 0} = 1 - \Omega_{m0}$)

Conclusion

Dark energy reconstruction using varying couplings is much less sensitive to the matter density uncertainty than standard methods

But:

- I. Is dark energy a standard quintessence scalar field ?
- II. Do fundamental couplings evolve with cosmic time and are such variations observable ?
- III. Are those linearly coupled to the quintessence field ?

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