Title

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1 Objectives

For LCDM, interacting models, and CPL, calculate

- ξ range for varying EoS while fixing $\Omega m0$
- ξ range for varying $\Omega m0$ or r, while fixing ω
- Does $\xi < 0$ means energy transfer to dark energy in this method?

2 Background

Deceleration parameter reads

$$q(z) = -1 + \frac{1+z}{H}\frac{\mathrm{d}H}{\mathrm{d}z} \tag{1}$$

For interaction models, the Friedmann equaitons,

$$\dot{\rho}_c + 3H\rho_c = Q_c \tag{2a}$$
$$\dot{\rho}_d + 3H(1+w)\rho_d = -Q_c \tag{2b}$$

$Q_c = \xi H \rho_c$ Background equations,

$$\Omega m = \Omega m0(1+z)^{3-\xi} \tag{3a}$$
$$\Omega d = (\Omega d0 + \frac{\xi}{3w+\xi}\Omega m0)(1+z)^{3(1+w)} + \frac{-\xi}{\xi+3w}\Omega m = \bar{\Omega d}0(1+z)^3 + \frac{-\xi}{\xi+3w}\Omega m \tag{3b}$$

$Q_c = \xi H \rho_d$

$$\Omega m = (\Omega m0 + \frac{\xi}{\xi+3w}\Omega d0)(1+z)^3 + \frac{-\xi}{\xi+3w}\Omega d = \omega\bar{m}0(1+z)^3 + \frac{-\xi}{\xi+3w}\Omega d \tag{4a}$$
$$\Omega d = \Omega d0(1+z)^{3(1+w)+\xi} \tag{4b}$$

Eqn 3 and eqn 4 shows that the coupling constant has two effects,

1. Change the amplitude of the evolution of matter or dark energy energy density.
2. Transfer energy between DE and DM.