Holographic dark energy In Non-minimal coupling theory

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Holographic dark energy model

- It is vacuum energy in low-energy level (IR cutofff)

$$\rho_\Lambda = \frac{3b^2}{8\pi G L^2}$$

- Apparent horizon as IR cutoff

$$\boxed{\rho_\Lambda = \frac{3b^2}{8\pi G}(H^2 + \frac{k}{a^2})}$$

- Equation of state parameter

$$w_\Lambda = 0$$

Dust behavior

- Non-minimal coupling (NMC) NMC (Horndeski-G4 term)

$$S = \int \mathrm{d}^4x \sqrt{-g} \left[\frac{R}{16\pi G} - \frac{1}{2}\xi\phi^2 R - \frac{1}{2} g^{\mu\nu} \nabla_\mu \phi \nabla_\nu \phi + V(\phi) + \mathcal{L}_\mathrm{m} \right]$$

- Friedmann equation

$$\begin{aligned} 3H^2 + \frac{3k}{a^2} &= 8\pi G_\mathrm{eff} \left(\rho_\phi + \rho_\mathrm{NMC} + \rho_\mathrm{m} + \rho_\mathrm{HDE} \right) \\ 2\dot{H} + 3H^2 + \frac{k}{a^2} &= -8\pi G_\mathrm{eff} \left(P_\phi + P_\mathrm{NMC} + P_\mathrm{m} + P_\mathrm{HDE} \right) \end{aligned}$$

$$G_\mathrm{eff}(\phi) = \frac{G}{1 - 8\pi G \xi \phi^2}. \qquad \rho_\mathrm{HDE} = \frac{3b^2}{8\pi G_\mathrm{eff}(\phi)} \left(H^2 + \frac{k}{a^2} \right)$$