LSST-PL/turnaround epoch

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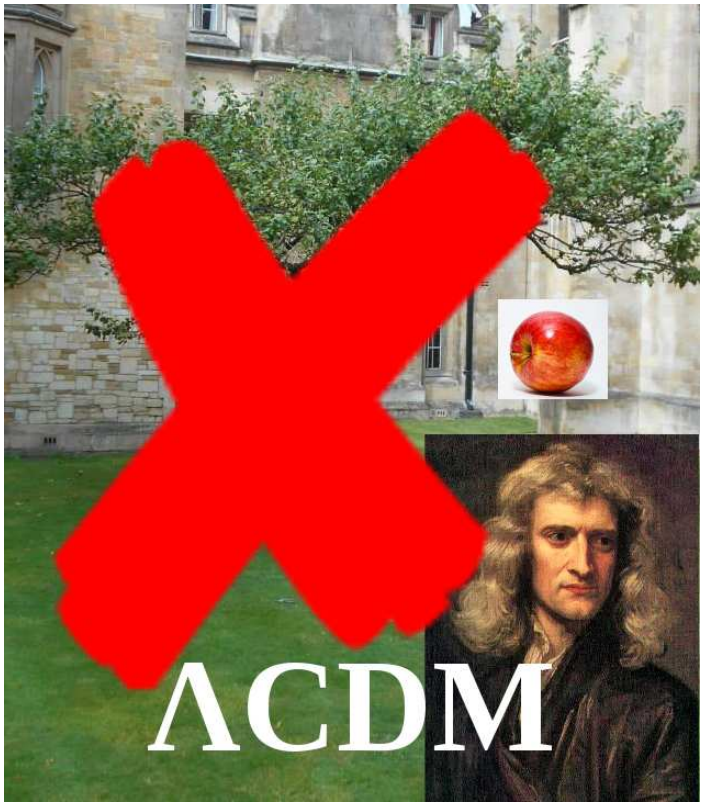
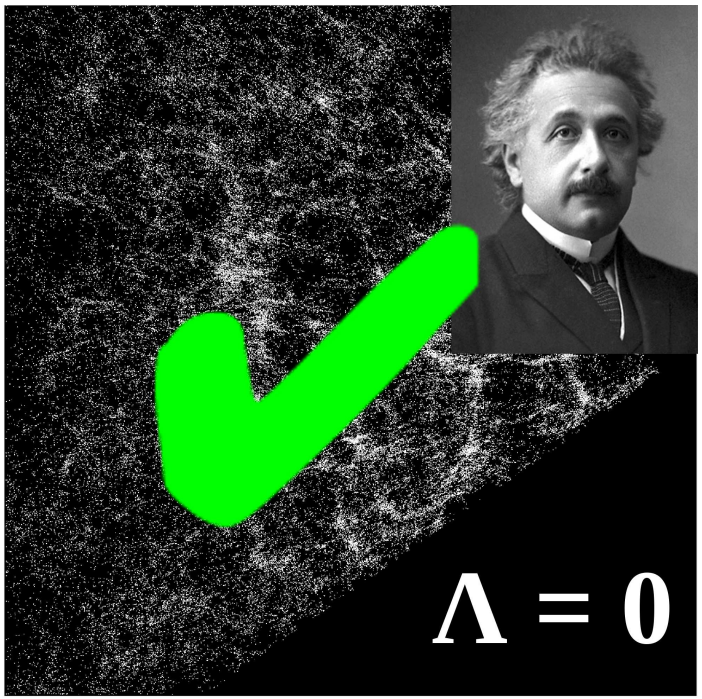
LSST-PL/turnaround epoch

space–time = Universe





?

Gpc-scale galaxy distribution + SNe Ia/LSST $\Rightarrow$ Einstein ?

local 100 Mpc/h^{eff} + "local" H_0 vs "global" H_0 $\Rightarrow$ Einstein ?

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Einstein Eqn time–time part gives (pointwise):

$$\frac{1}{3}\Theta^2 = 8\pi G\rho + \sigma^2 - \frac{1}{2}\mathcal{R} + \Lambda$$

Buchert (2000a) — Hamiltonian constraint

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Buchert (2000a) — Hamiltonian constraint

$$3\,H^2 = 3\,H^2\Omega_{\mathrm{m}} + 0 + 3\,H^2\Omega_{\mathrm{k}} + 3\,H^2\Omega_{\Lambda}$$

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Buchert (2000a) — Hamiltonian constraint

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- turnaround: $\Theta = 0 \Rightarrow \mathcal{R} > 0$
- primordial overdensity must have $\mathcal{R} > 0$ to turn around

  arXiv:0902.09064 (ROMV19)

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averaged Hamiltonian constraint

$$\frac{1}{3}\left\langle\Theta\right\rangle_{\mathcal{D}}^{2} = 8\pi G\left\langle\rho\right\rangle_{\mathcal{D}} + \left\langle\sigma^{2}\right\rangle_{\mathcal{D}} - \frac{1}{3}\left\langle\left(\Theta - \left\langle\Theta\right\rangle_{\mathcal{D}}\right)^{2}\right\rangle_{\mathcal{D}} - \frac{1}{2}\left\langle\mathcal{R}\right\rangle_{\mathcal{D}} + \Lambda$$

$$\mathcal{Q}_{\mathcal{D}} := \frac{2}{3}\left\langle\left(\Theta - \left\langle\Theta\right\rangle_{\mathcal{D}}\right)^{2}\right\rangle_{\mathcal{D}} - 2\left\langle\sigma^{2}\right\rangle_{\mathcal{D}}$$

RZA2

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averaged Hamiltonian constraint

$$\Omega_{\mathrm{m}}^{\mathcal{D}} + \Omega_{\mathcal{Q}}^{\mathcal{D}} + \Omega_{\mathcal{R}}^{\mathcal{D}} + \Omega_{\Lambda}^{\mathcal{D}} = \frac{H_{\mathcal{D}}^2}{H_{\mathrm{eff}}^2} \,,$$

- turnaround: strong expansion variance term $\left\langle \left(\Theta - \left\langle \Theta \right\rangle_{\mathcal{D}}\right)^2 \right\rangle_{\mathcal{D}}$ might allow flat ($\mathcal{R} = 0$) turnaround ($\Theta = 0$)
- non-perturbative: $\mathcal{Q}_{\mathcal{D}}$ relativistic Zel'dovich approximation (QZA)

  arXiv:0902.09064 (ROMV19)

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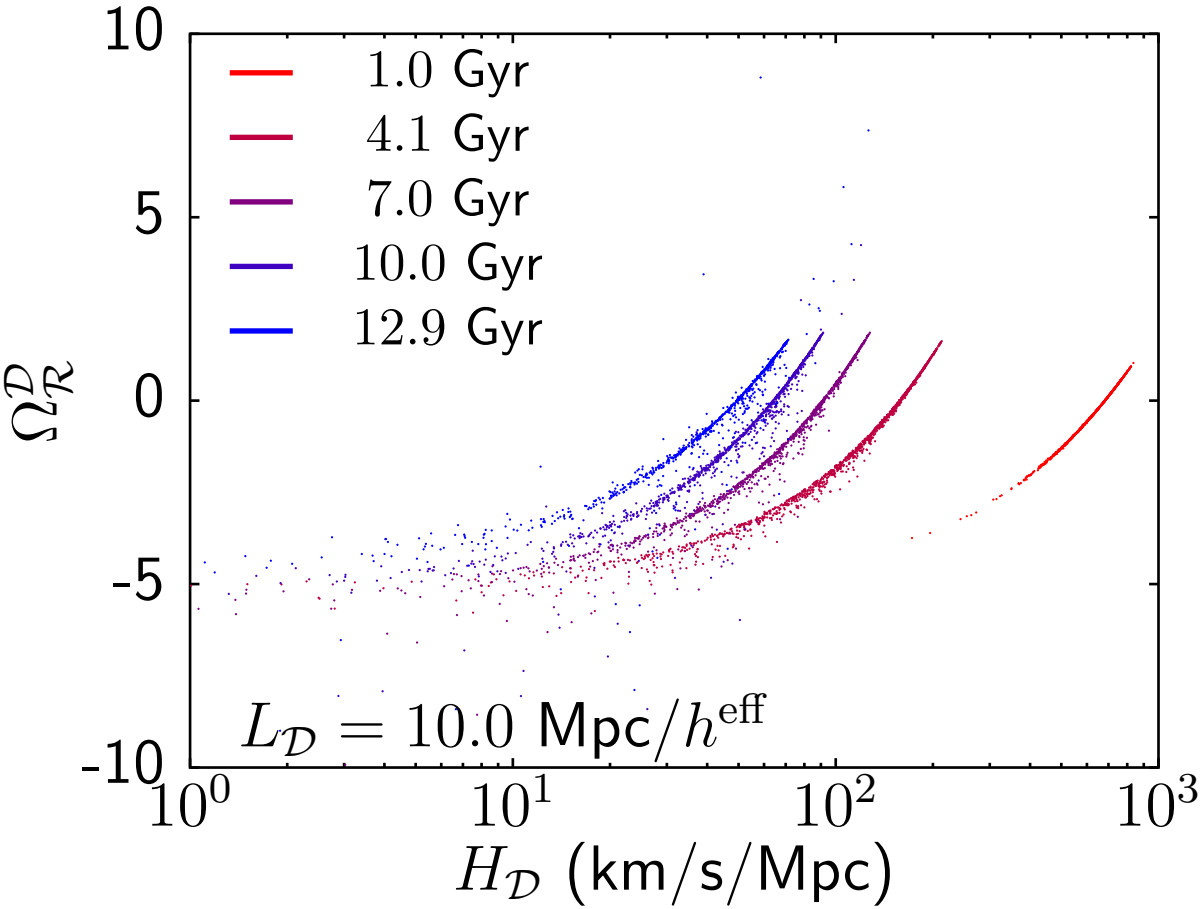

EdS

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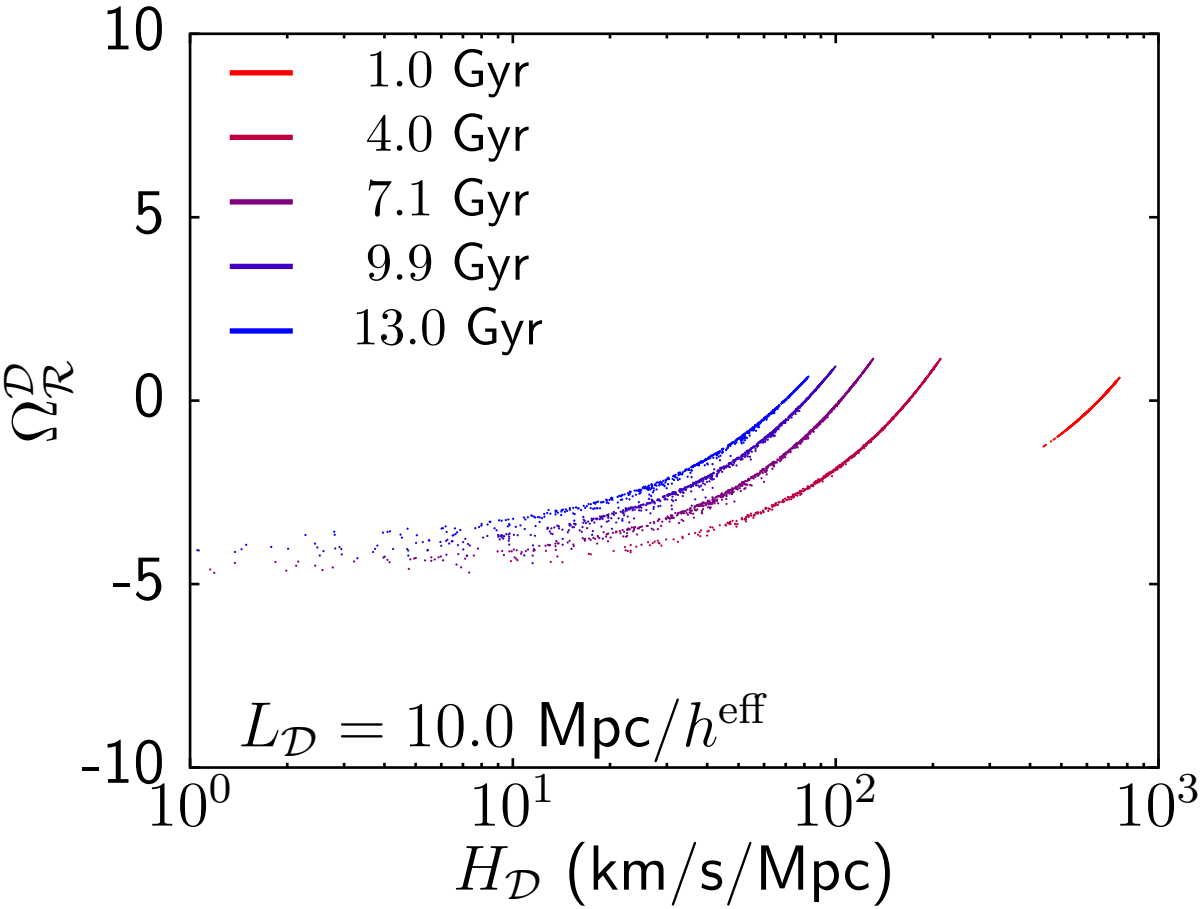

ΛCDM

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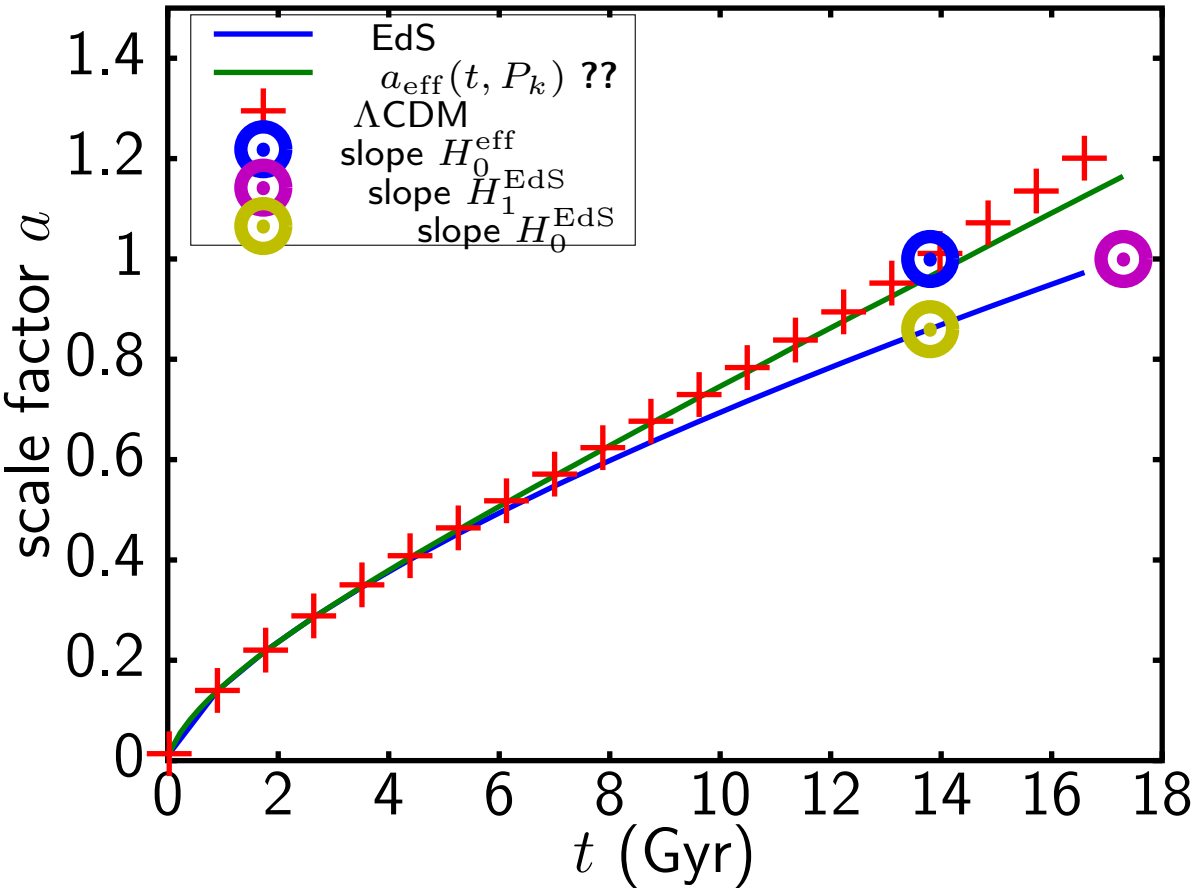
Discussion!

initial conds: ΛCDM proxy

obsvns $\Rightarrow H_0^{\rm eff}, H_1^{\rm EdS}, H_0^{\rm EdS} = 67.74, 37.7, 47.24$ km/s/Mpc
(Roukema+2016 A&A arXiv:1608.06004)



EdS +
VQZA($P_k, L_{\mathcal{D}}$)
$\Rightarrow$
$\sim \Lambda$CDM ?

RZA = relativistic Zel'dovich approximation (PRD arXiv:1303.6193)
VQZA: N-body init condns + RZA : A&A arXiv:1706.06179