No-Go Guide for the Hubble Tension

Wang-Wei Yu

Institute of Theoretical Physics, Chinese Academy of Sciences
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·2012.08292 Do the observational data favor a local void?   PRD
·2102.02020 Chameleon dark energy can resolve the Hubble tension   PRD Letter
·2107.13286 No-go guide for the Hubble tension: Late-time solutions   PRD Letter
·2202.12214 No-go guide for the Hubble tension : matter perturbations under review

Rong-Gen Cai   Zong-Kuan Guo   Shao-Jiang Wang
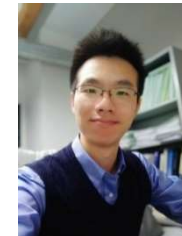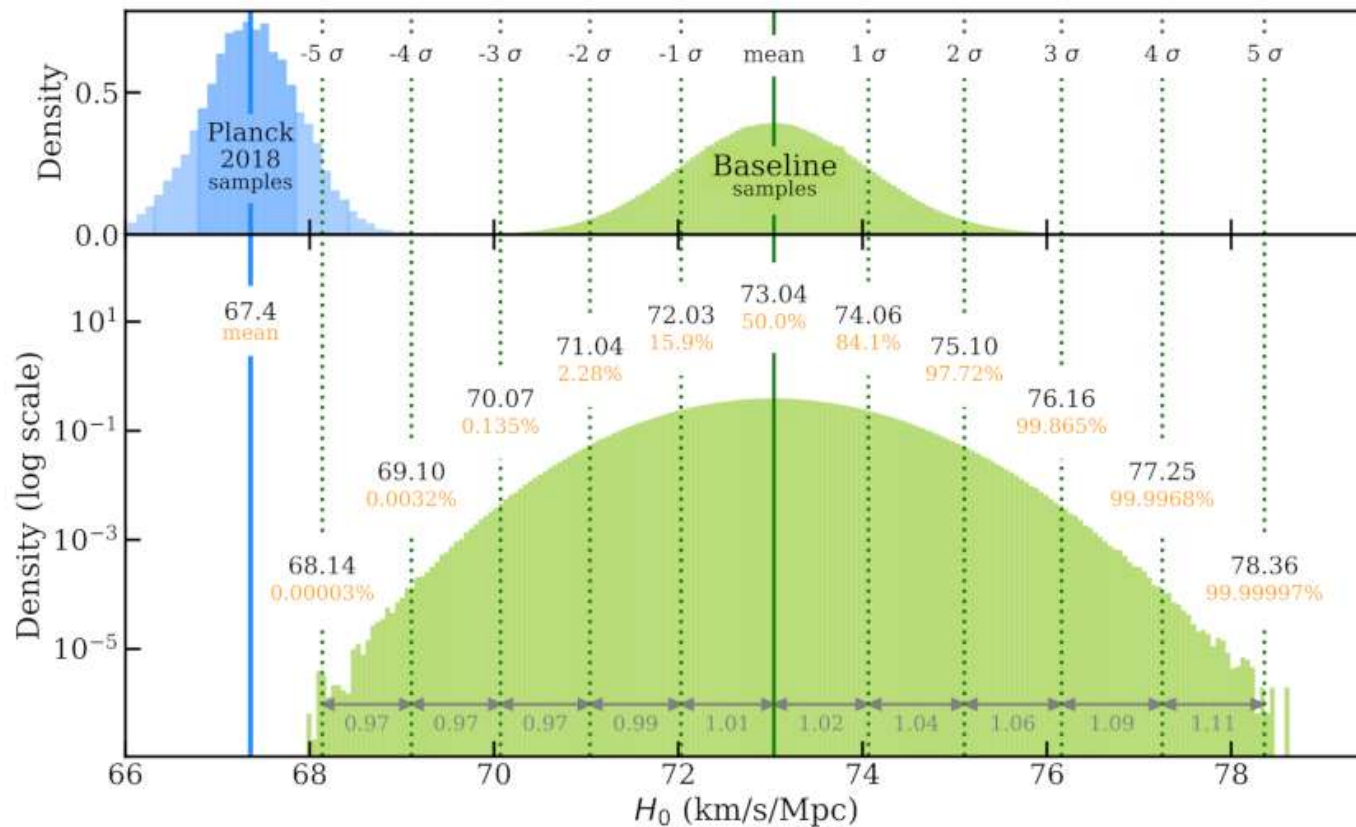

Li Li   Yong Zhou   Jia-Feng Ding

Hubble Tension

Hubble tension is becoming a Hubble crisis at 5-sigma C.L. !

Credit: Riess et. al. 2112.04510

Hubble Solutions

Modify the cosmic sound horizon
- Changing expansion history
    - Dark radiation(s)
    - Early dark energy
- Changing recombination history
    - Primordial magnetic fields
    - Varying fundamental constants

Jedamzik, Pogosian and Zhao (2010.04158)
Nature.Communications.Physics 4(2021)123
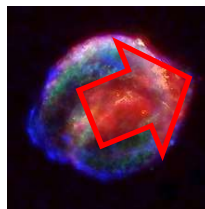"Why reducing the cosmic sound horizon alone can not fully resolve the Hubble tension"

$H_0 = 67.4 \pm 0.5\,\mathrm{km/s/Mpc}$

Hubble Tension

$H_0 = 73.04 \pm 1.04\,\mathrm{km/s/Mpc}$

Hubble Diversity

Our Works!

- Changing expansion history
    - Phantom dark energy
    - Interacting dark energy
    - Underdensities (cosmic voids)
    - Overdensities (chameleon DE)
- A astronphysical problem
    - The absolute magnitude (MB) tension
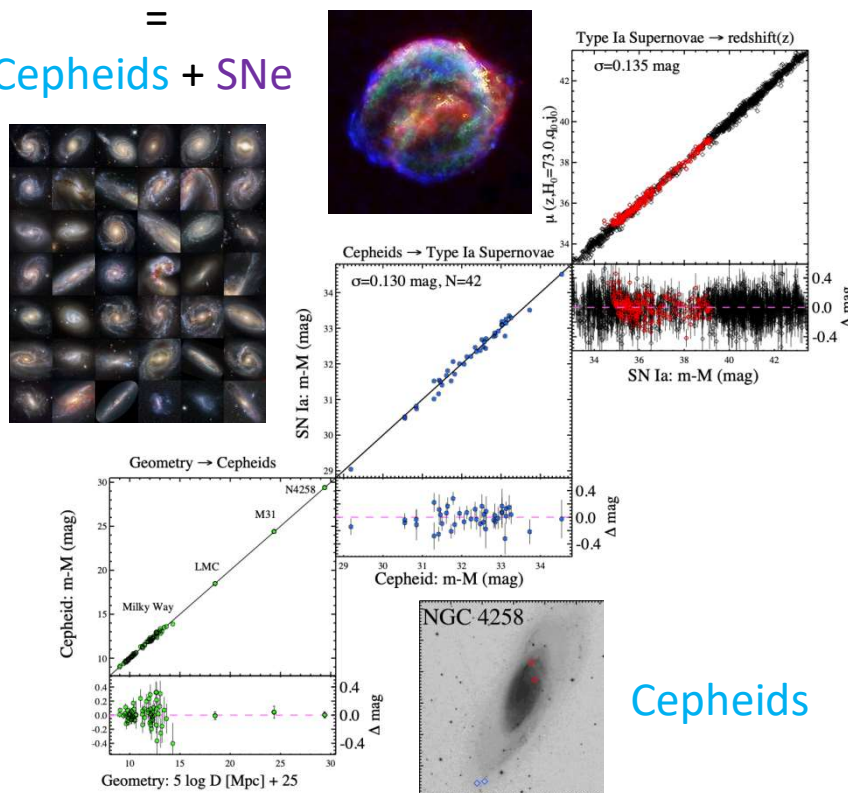   - Consider other systematics in observation

Distance Ladder

$$\mu = m - M_B = 5\lg\frac{D_L}{10\text{pc}} = 5\lg\frac{c}{H_0} + 5\lg\frac{d_L}{10\text{pc}}$$

Distance Ladder

=

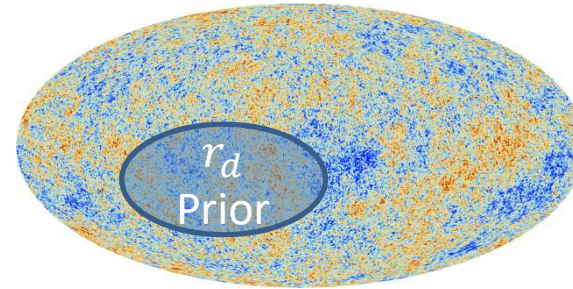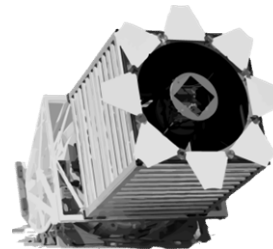Cepheids + SNe

CMB prior

r_d Prior

BAO Data

SDSS Experiments

Cepheids

Credit: Riess et. al. 2112.04510
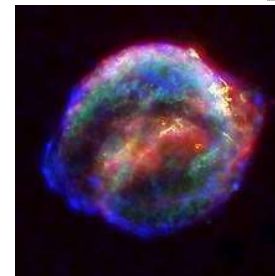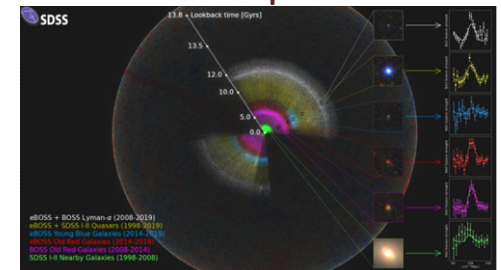
SNe + CMB prior

=

Inverse Distance Ladder

Our Late-time No-Go
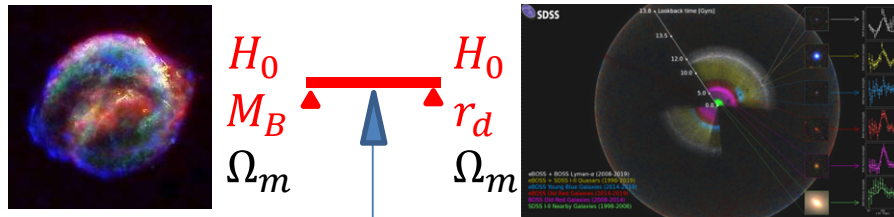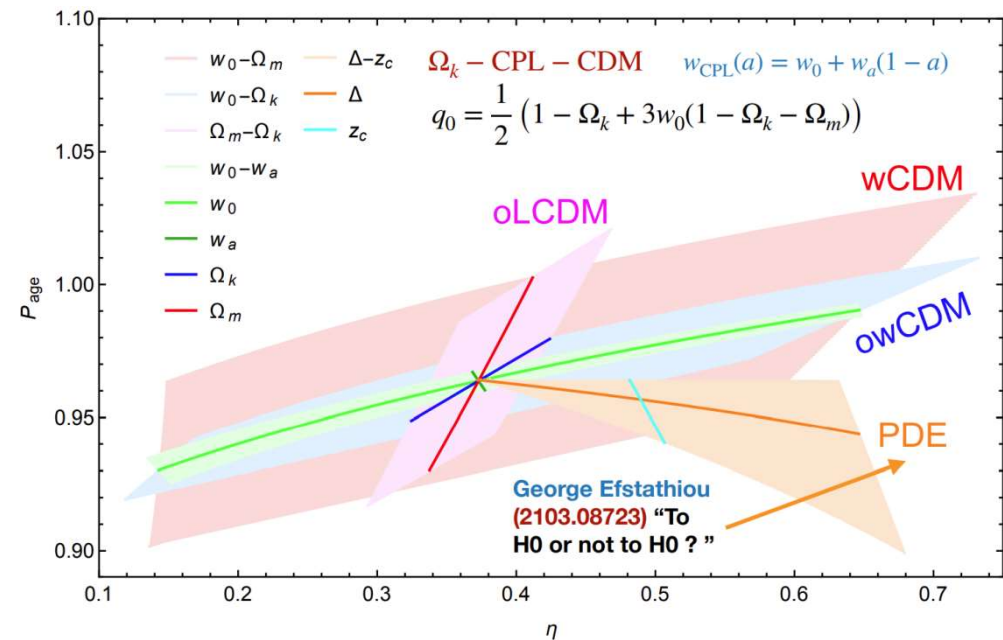
Better late-time model parametrization
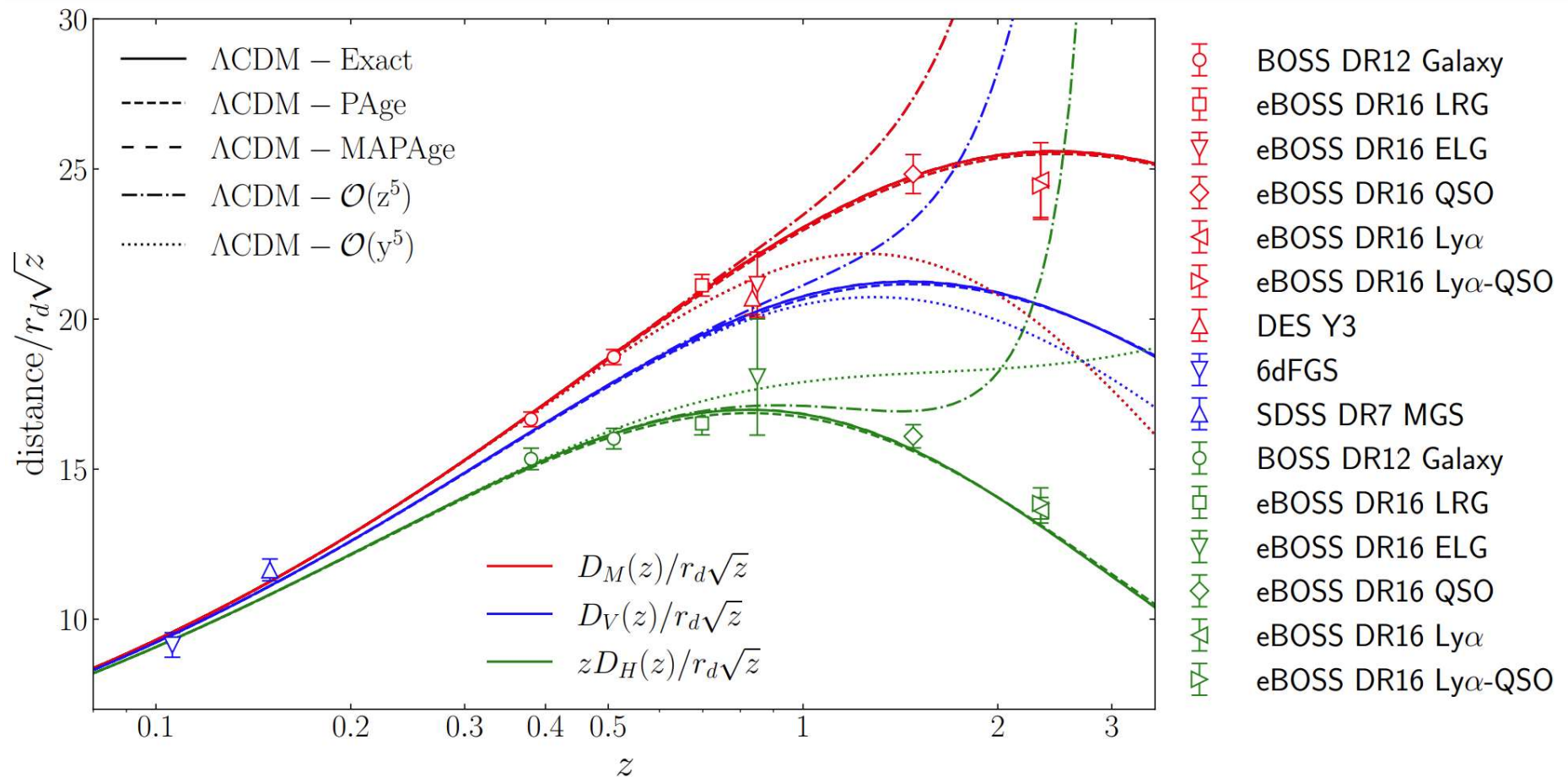
No Evidence Beyond LCDM at Late-time

without RSD

with RSD 2021
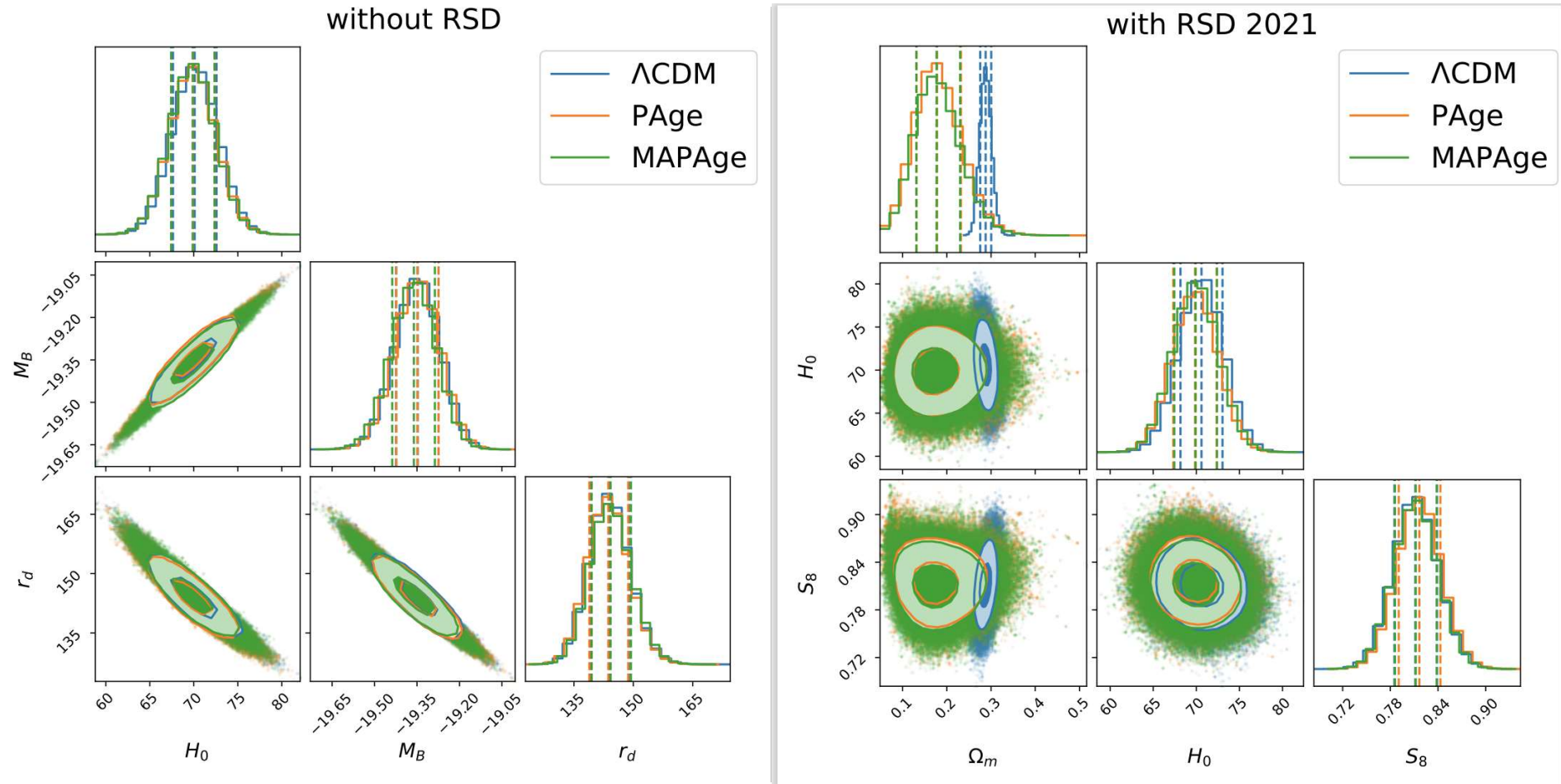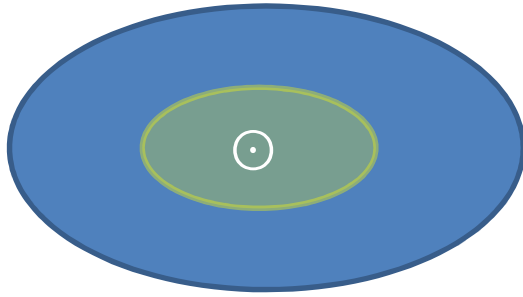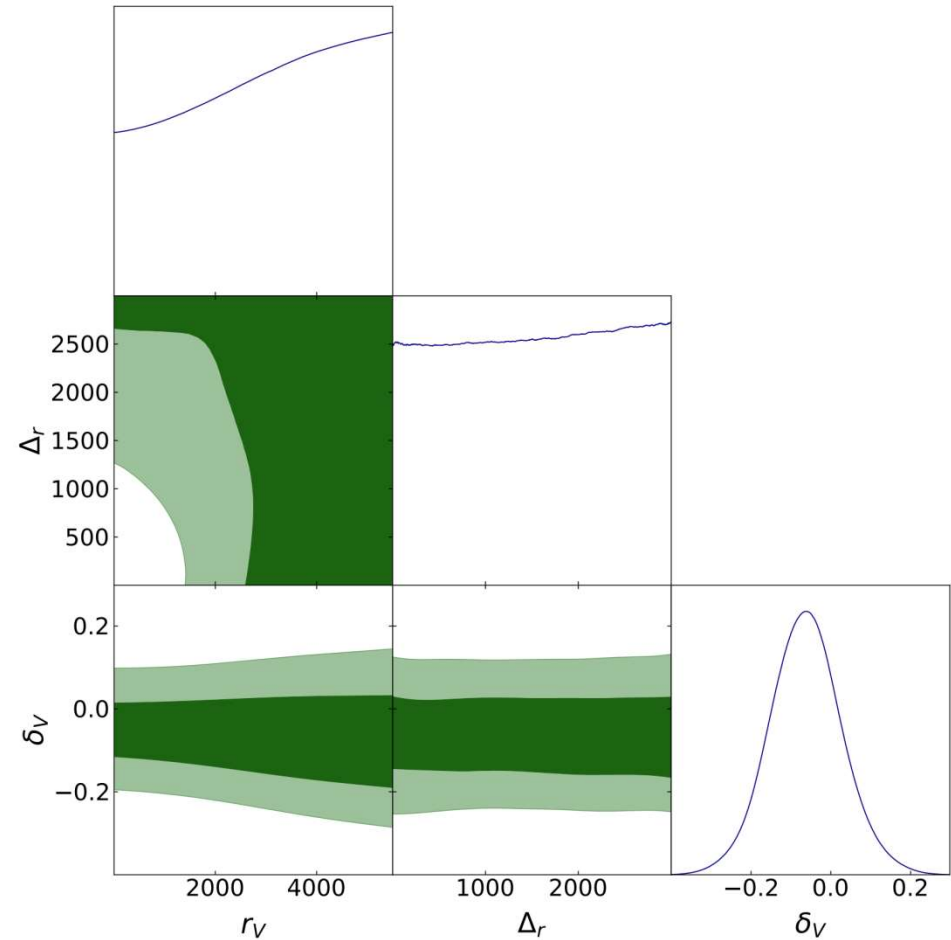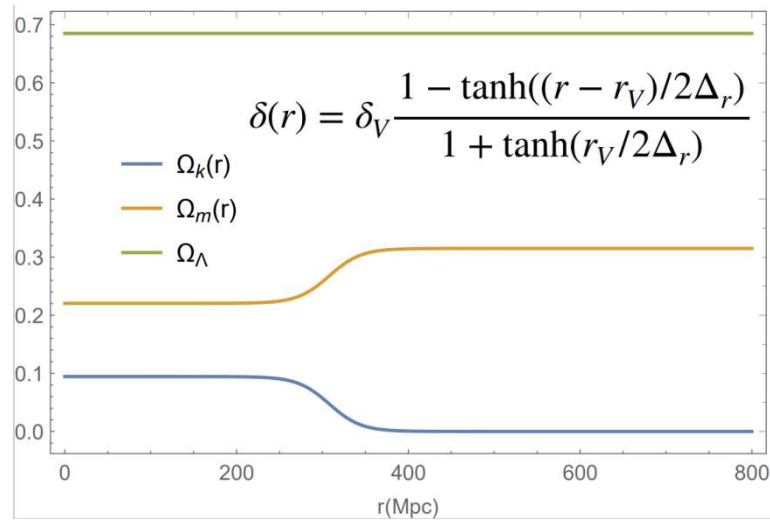
No Evidence for a Large Local Void

Pantheon SNe data with GBH profile in ΛLTB model

$$H^2(r,t)$$
$$= H_0^2(r) \left[\Omega_M(r) \left(\frac{R_0(r)}{R(r,t)} \right)^3 + \Omega_k(r) \left(\frac{R_0(r)}{R(r,t)} \right)^2 + \Omega_\Lambda(r) \right]$$

$$\delta(r) = \delta_V \frac{1 - \tanh((r - r_V)/2\Delta_r)}{1 + \tanh(r_V/2\Delta_r)}$$

- $\Omega_k(r)$
- $\Omega_m(r)$
- Ω_Λ

Conclusion

- Hubble tension might be a smoking gun for new physics but we don't find it up to now;

- Local homogeneous solutions might not the key for resolving the Hubble tension;

- Local inhomogeneous solution with GBH profile in ΛLTB model might not resolve the Hubble Tension;

- Chameleon dark energy with Hubble Diversity scenario? ----- maybe.

Thanks for your listening!