Universiteit Leiden

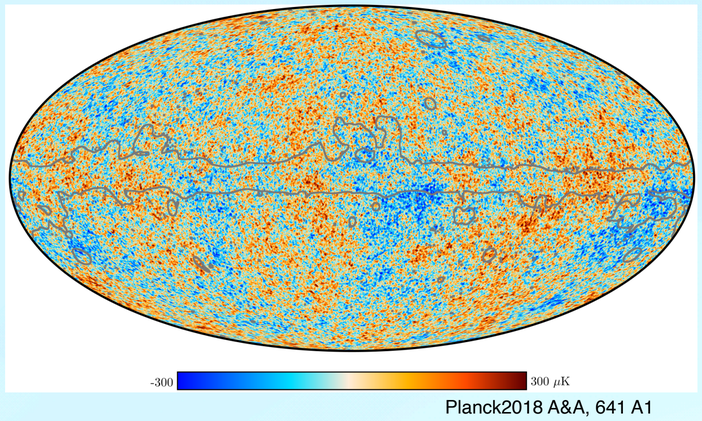
Instituut-Lorentz

Shape of CMB lensing in EDE

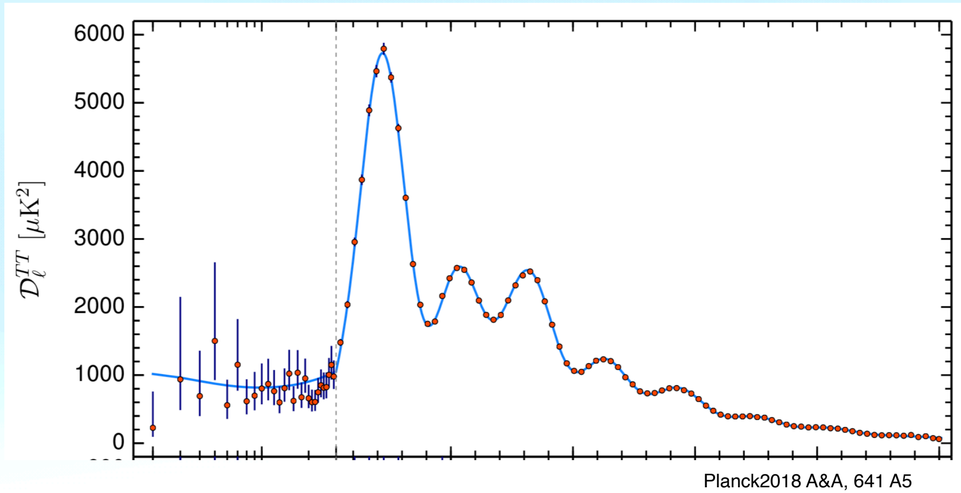
arXiv:2305.18873,

Gen Ye, Jun-Qian Jiang, Yun-Song Piao

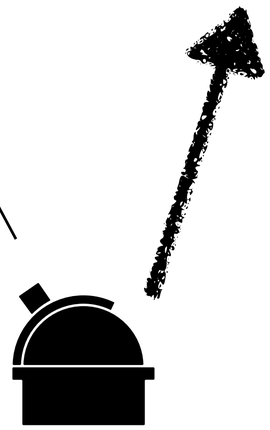
Cosmological model



Planck2018 A&A, 641 A1



Planck2018 A&A, 641 A5

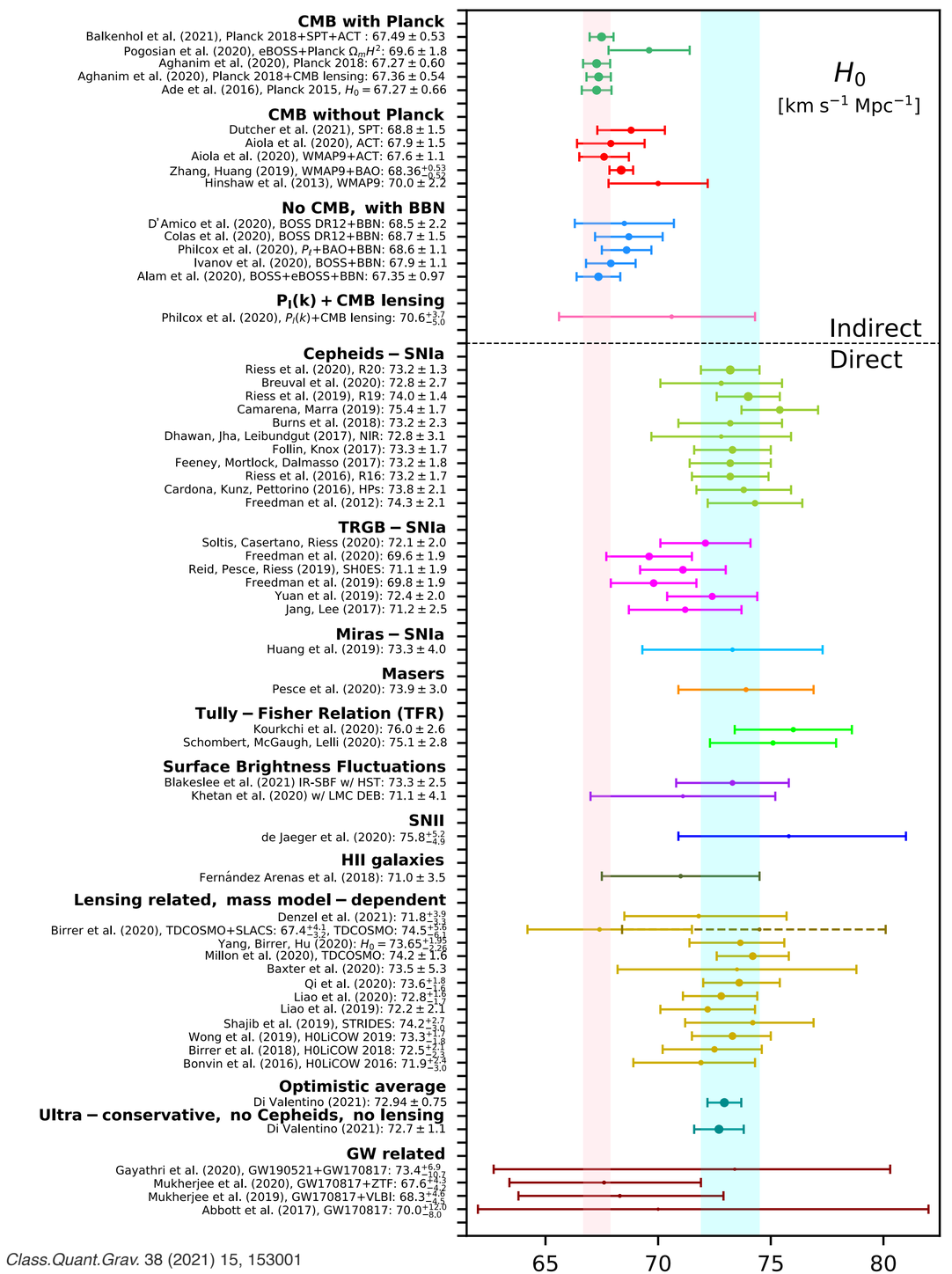


Cosmological Model
e.g. ΛCDM

$\omega_b, \omega_{cdm}, H_0, A_s, n_s, \tau$

Tensions in the model?

Hubble tension



Class.Quant.Grav. 38 (2021) 15, 153001

Early Dark Energy (EDE)

$$\theta_s = \frac{r_s}{D_A} \sim \frac{1}{\Delta l}$$

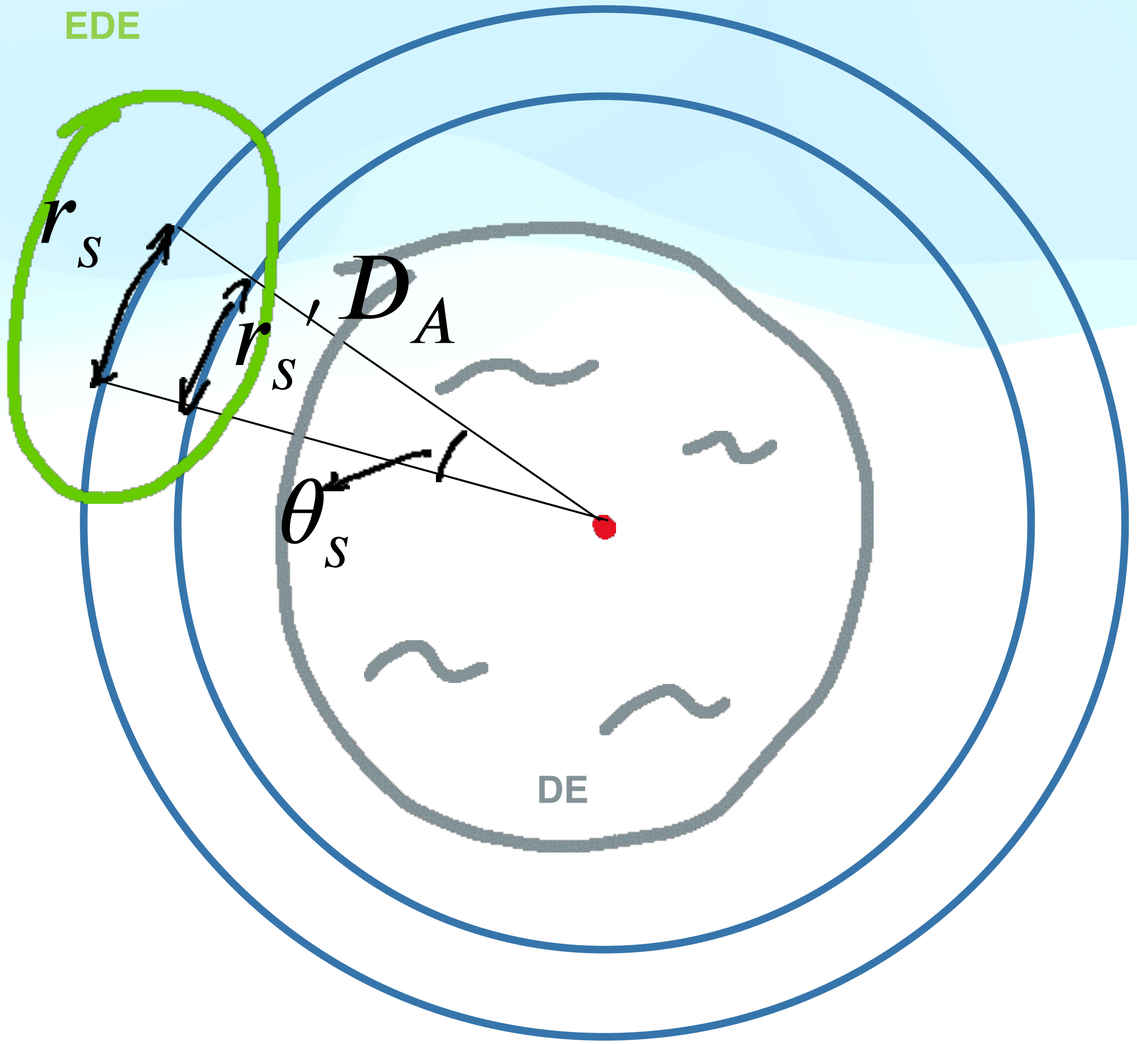
Tanvi Karwal, Marc Kamionkowski, PhysRevD.94.103523
Vivian Poulin, Tristan L. Smith, Tanvi Karwal, Marc Kamionkowski, PhysRevLett.122.221301

$$r_s = \int_{z_*}^{\infty} \frac{c_s}{H(z)} dz$$

Early Dark Energy

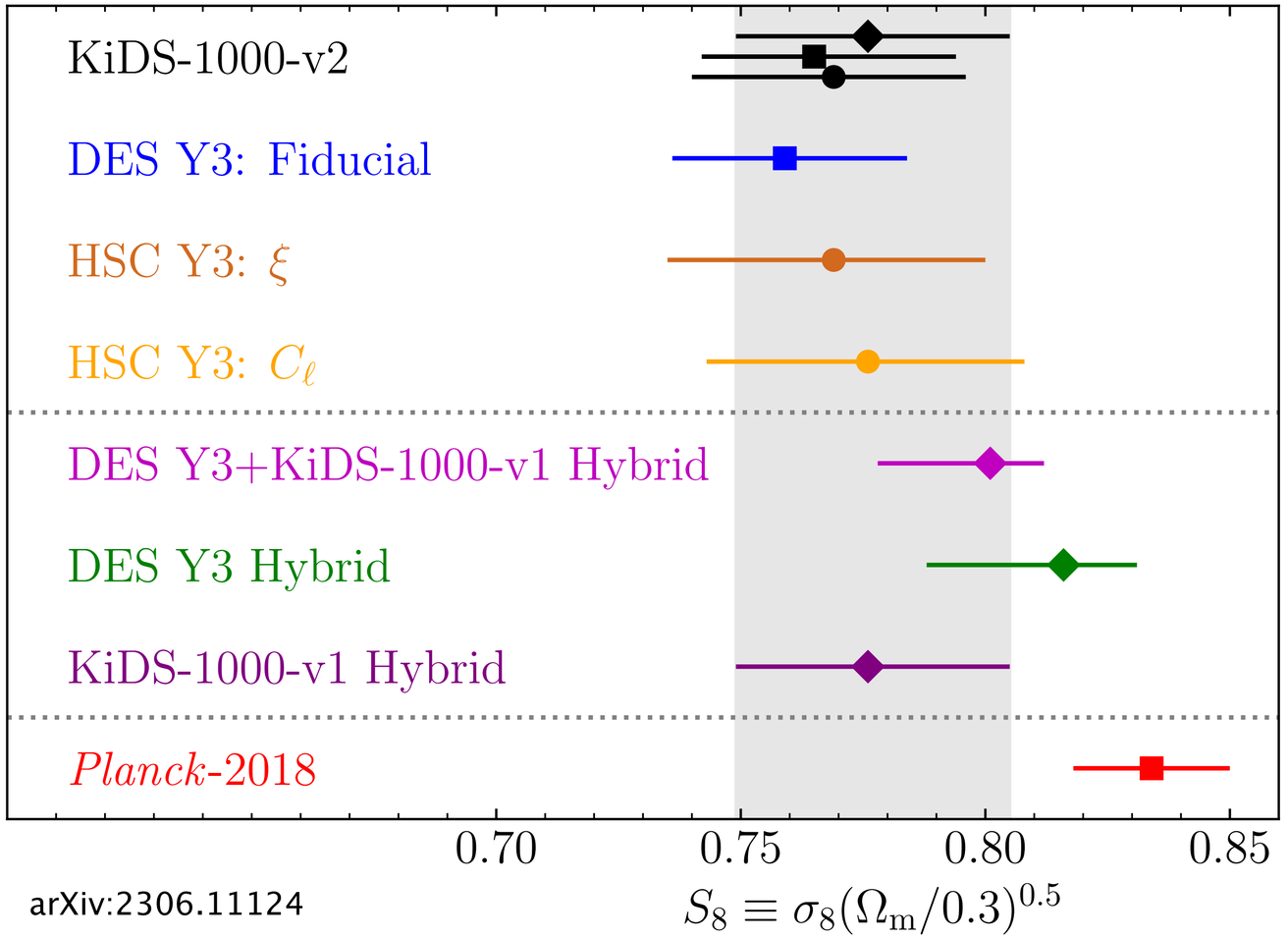
$$D_A = H_0^{-1} \int_0^{z_*} \frac{dz}{E(z)}$$

Dark Energy



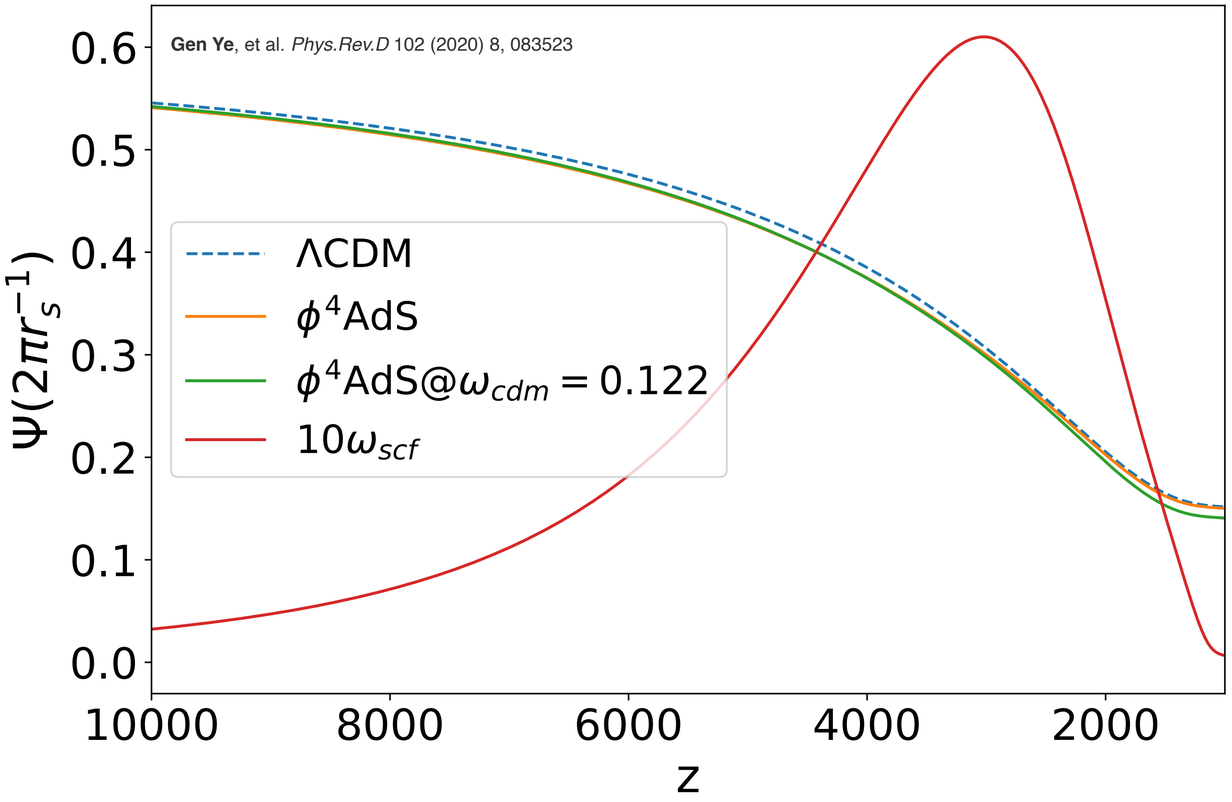
Tensions in the model?

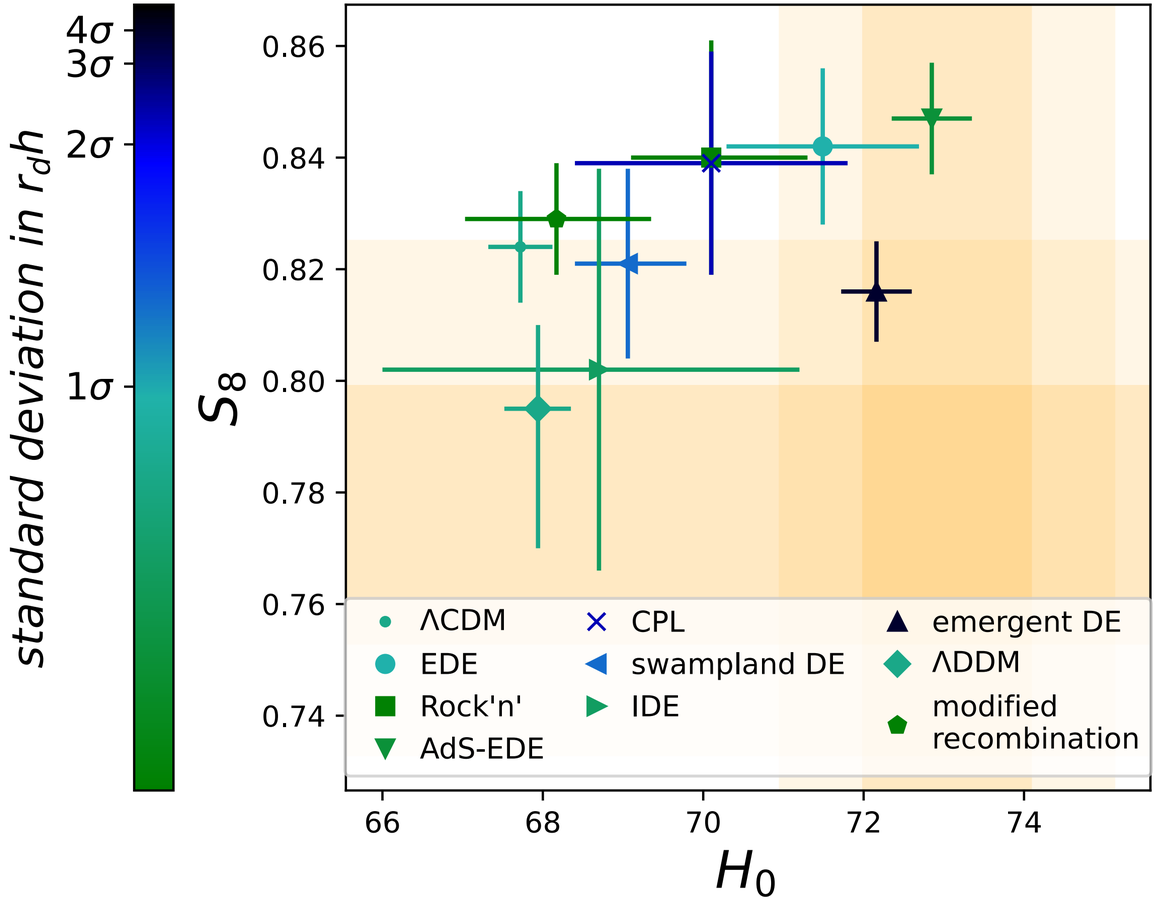
S_8 tension



arXiv:2306.11124

EDE and S_8



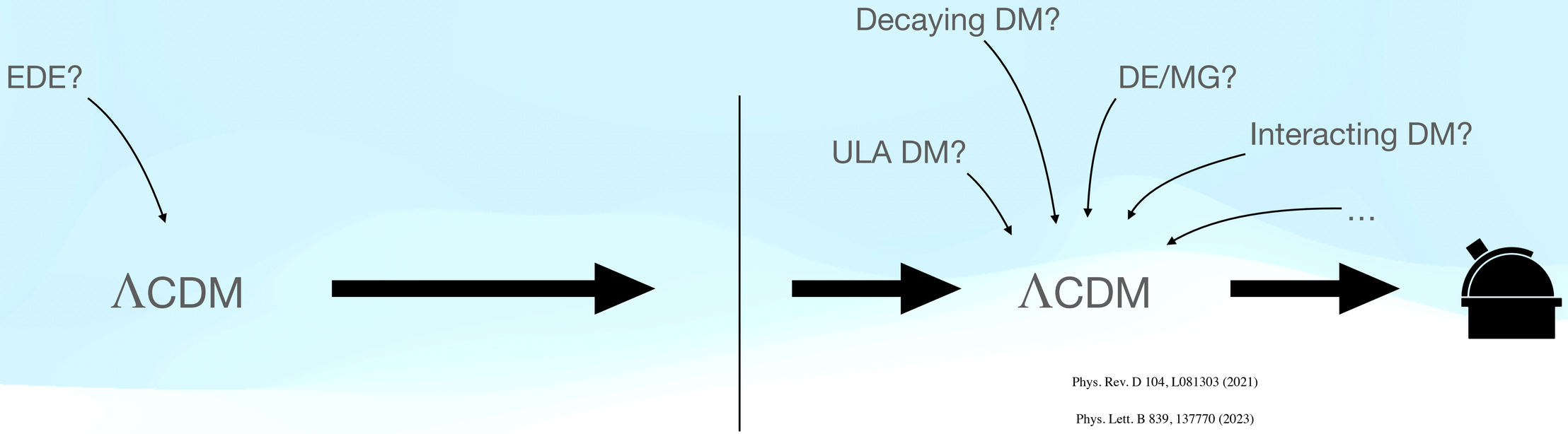


S_8 tension exacerbated by EDE

Phys. Rev. D 102, 043507 (2020)
Phys. Rev. D 102, 103502 (2020)
JCAP 05, 072 (2021)

ω_{cdm} is increased to compensate for EDE's effect in radiation driving and ISW

Gen Ye, et al. *Phys.Rev.D* 102 (2020) 8, 083523
Astrophys. J. Lett. 904, L17 (2020)
Phys. Rev. D 104, 063524 (2021)



Phys. Rev. D 104, L081303 (2021)

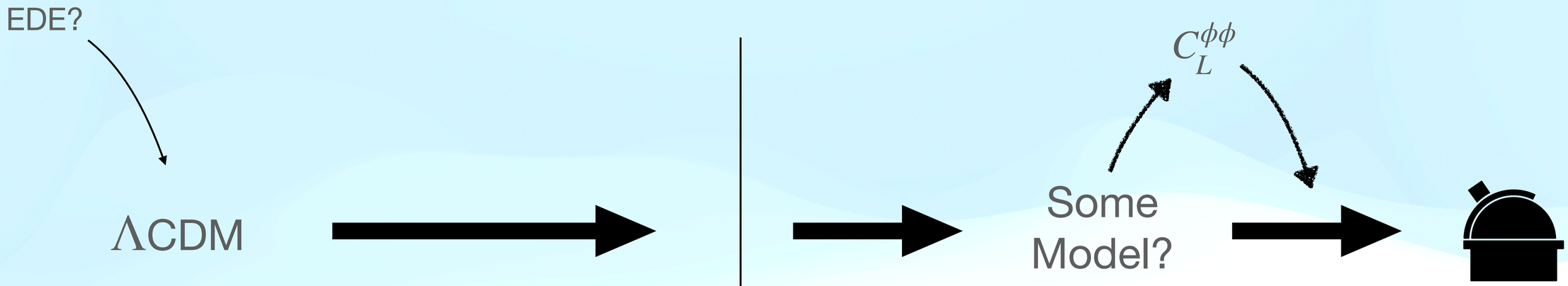
Phys. Lett. B 839, 137770 (2023)

Phys. Rev. D 107, 083527 (2023)

Mon. Not. Roy. Astron. Soc. 520, 3688 (2023)

Phys. Rev. D 104, 12533 (2021)

…



Background compatibility?

Recombination

Perturbation compatibility?

Cosmological parameters

$$D_A = H_0^{-1} \int_0^{z_*} \frac{dz}{E(z)}$$

Dark energy EoS $w(z)$

Phys. Lett. B 832, 137244 (2022)

arXiv:2302.07333

Reionization

Low ℓ E polarisation

High ℓ optical depth

Gravitational Lensing

This work arXiv:2305.18873

Recombination

EDE?

ΛCDM

$C_L^{\phi\phi}$

Gaussian Process

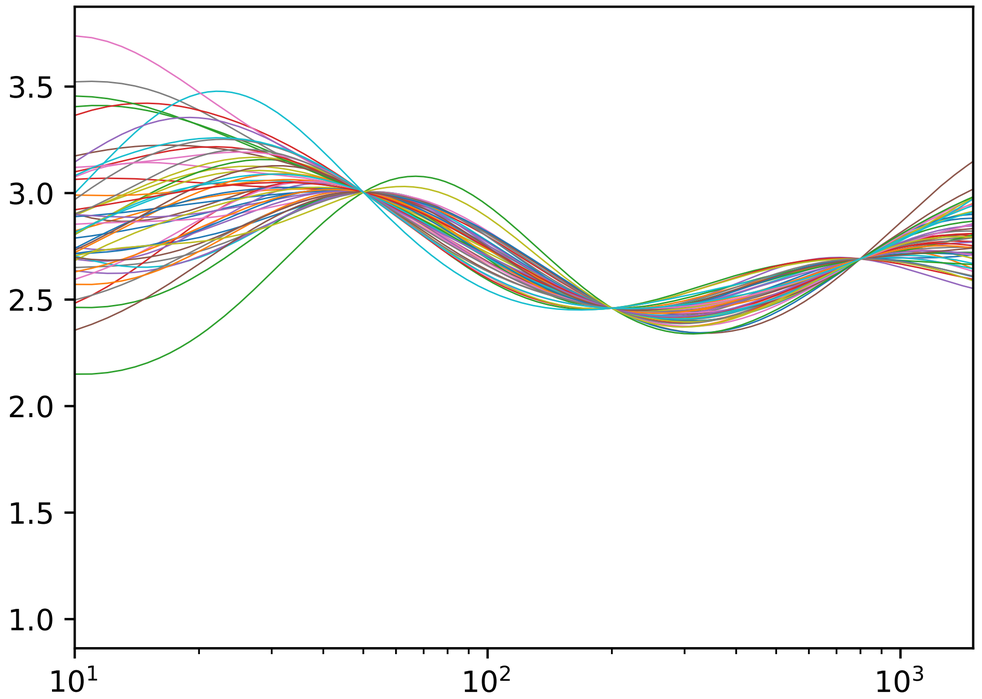
$$C_L^{\phi\phi} = A(L) C_{L,fid}^{\phi\phi}$$

$$A(L) \sim GP[\bar{f}(L), K]$$

3 Nodes: $\{A_{L=50}, A_{L=200}, A_{L=800}\}$

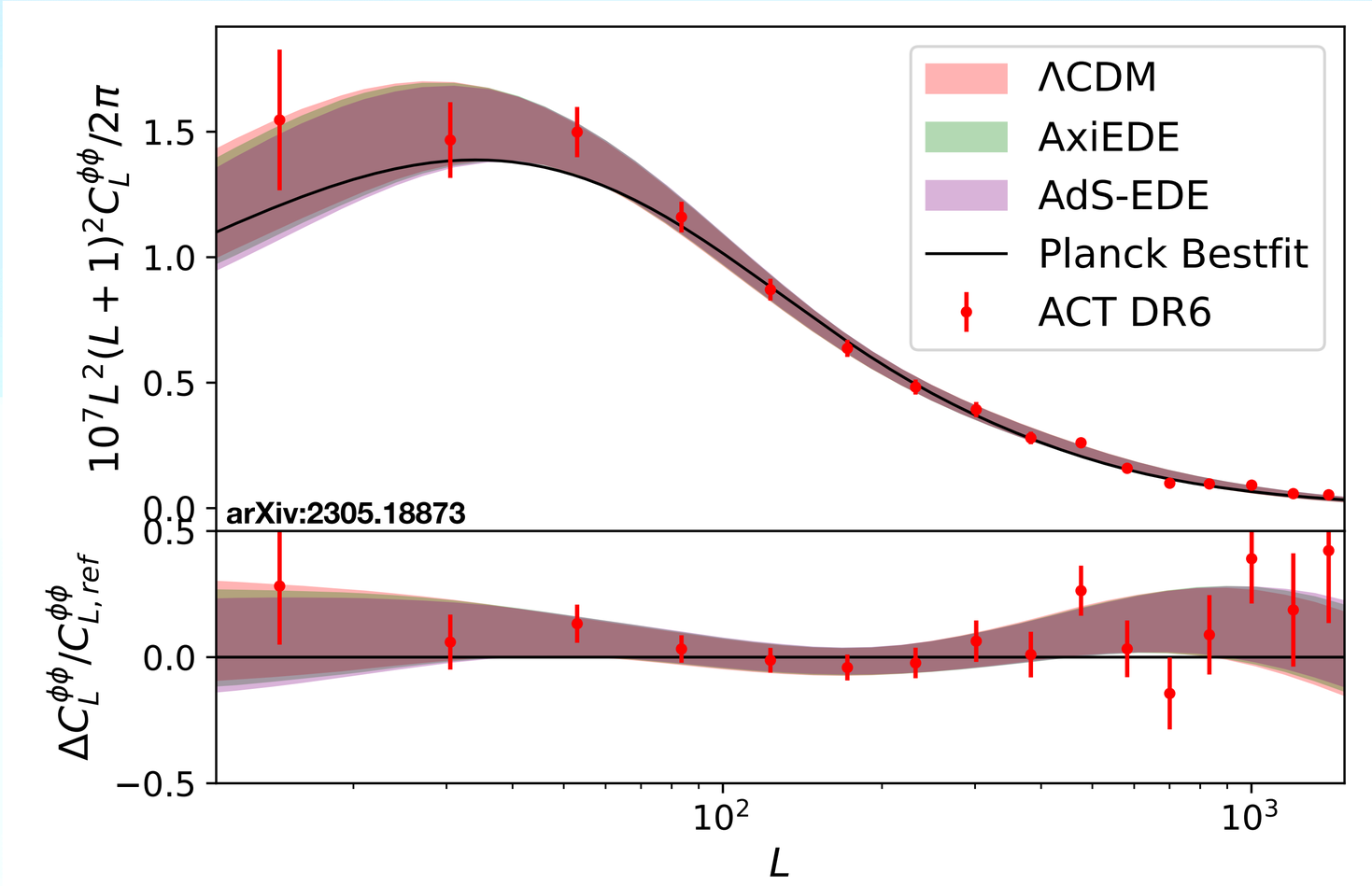
Previous works: binning+interpolation

Phys. Rev. D, 107 103505, …



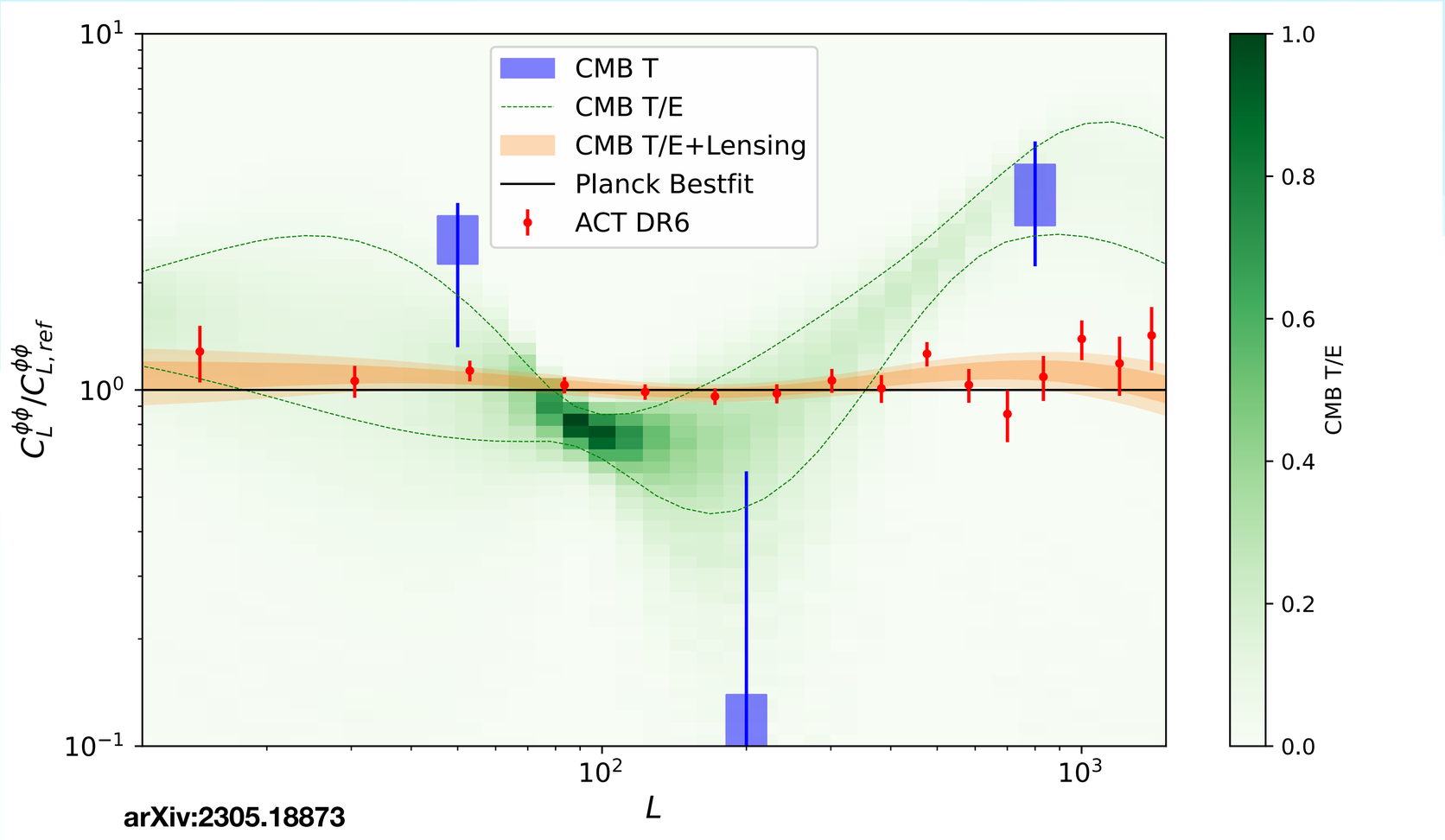
Results

CMB TTTEEE + Lensing reconstruction



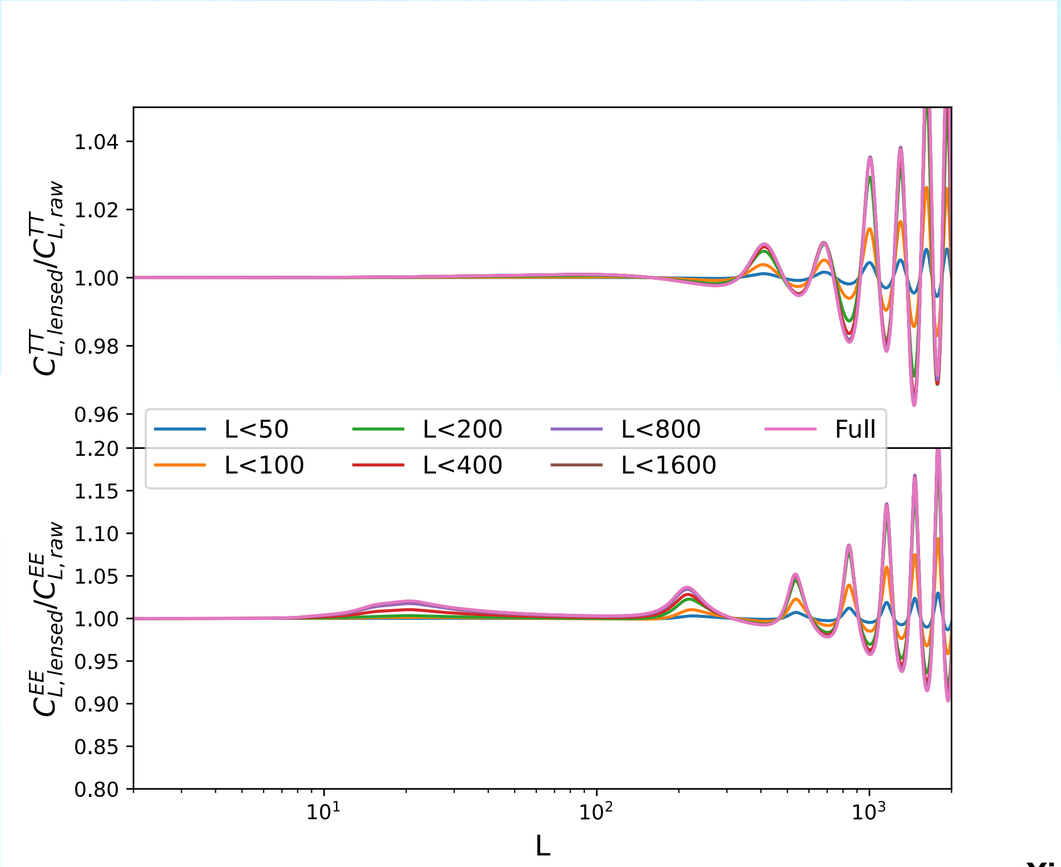
Results

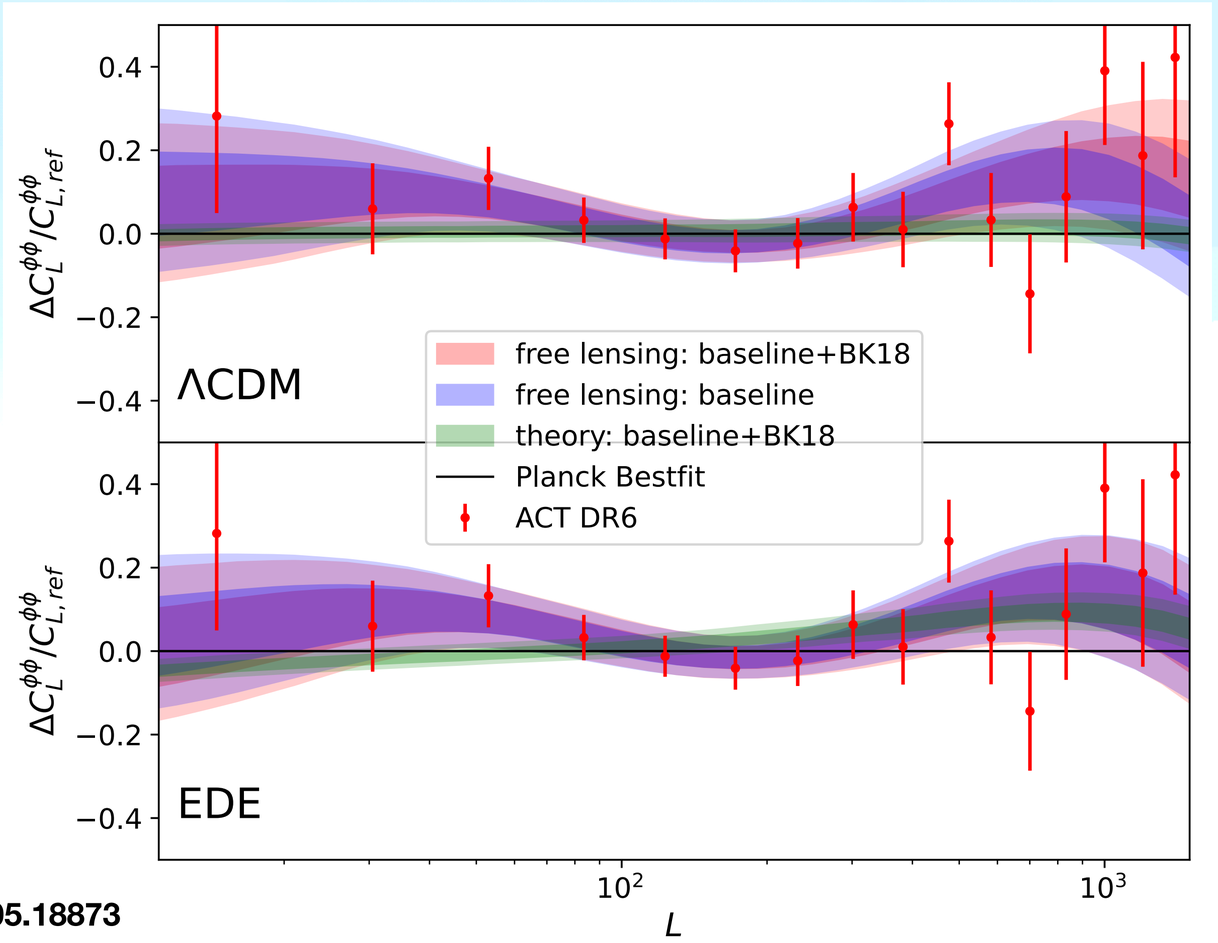
CMB T/E + Lensing reconstruction



Results

CMB TTTEEE + CMB B mode + Lensing reconstruction





arXiv:2305.18873

Conclusion

- GP sampling method, fewer nodes required
- Late universe independent constraint on lensing
  - Insensitive to early Universe model (ΛCDM vs EDE)
  - 80<l<400 dominated by lensing reconstruction
  - High and low l pushed up by lensed T/E
  - New constraint from B mode
- Work in progress: crossing with galaxy weak lensing