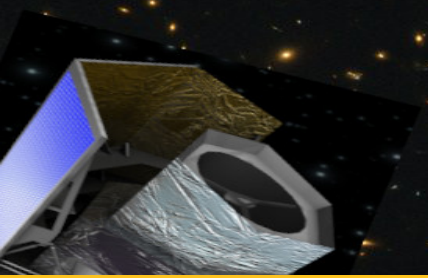
ReACT and HyPk
general, non-linear, unified, codes for cosmology

Ben Bose

EPFL 2020



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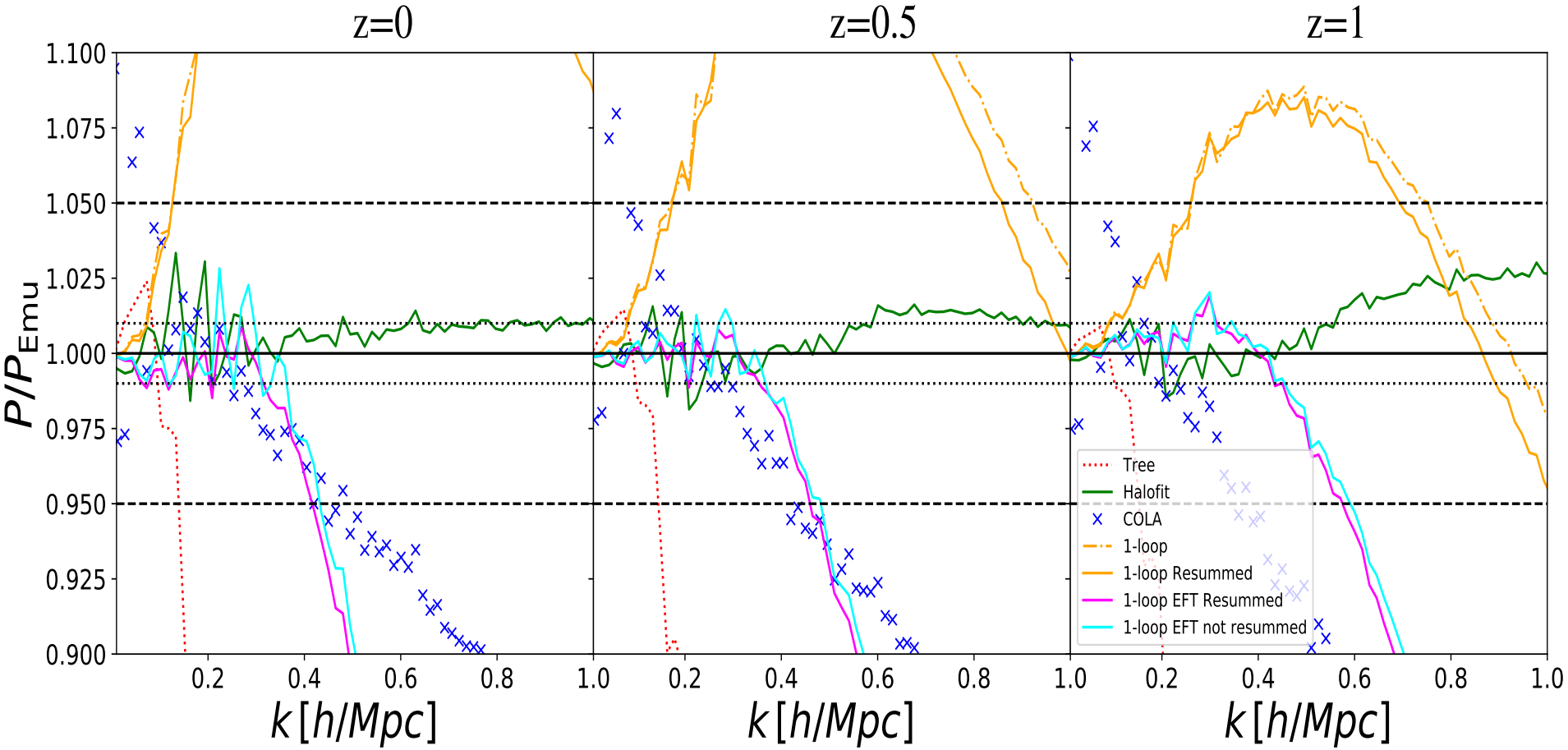

Rough 1%-accuracy regime Euclid :

$$\ell_{\rm max} = 5000 \text{ and } z_{\rm source} = 1.5 \Rightarrow \chi_{\rm peak} = 1000 \Rightarrow k_{\rm max} \sim 5!$$

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Reaction approach to model non-standard, non-linear physics

$$P_{\rm NL}^{\rm real}(k;z) = \mathcal{R}(k;z) \times P_{\rm NL}^{\rm pseudo}(k;z)$$

$P_{\rm nl}^{\rm pseudo}(k;z)$: accurate LCDM spectrum with modified dynamics in linear clustering only - our 'black box' - Ex.Halofit, Emulator.

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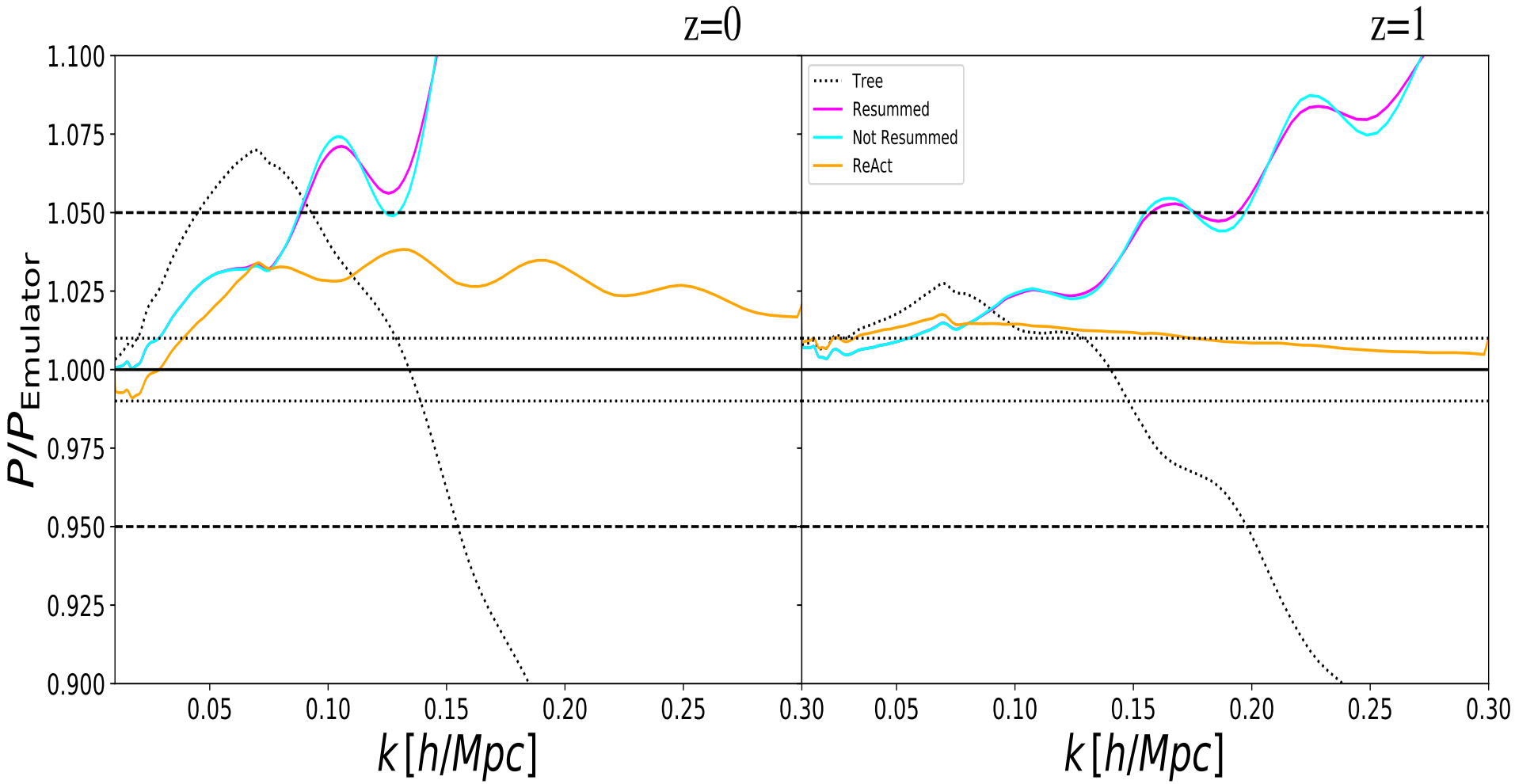
Can be applied to a host of non-standard physics: Modified gravity, dark energy, neutrinos ...

Reactions for non-standard theories, example $f(R)$



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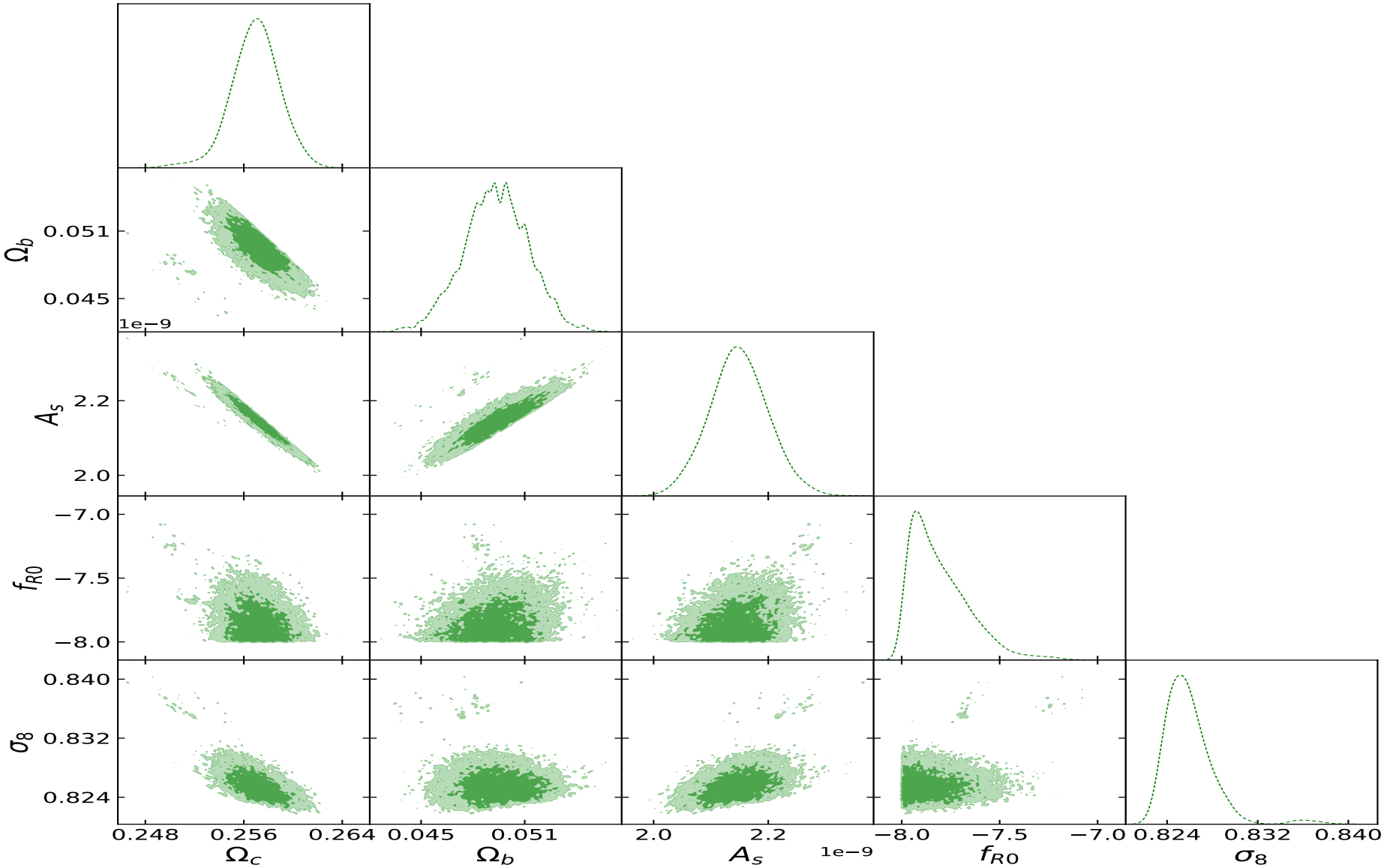
We can start by testing on the **convergence spectra.**

$f(R)$ tested on LCDM mock data, Gaussian covariance with SIV-like specs



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- Severely restricted range of scales $\leq 0.4h/\mathrm{Mpc}$.
- Poor convergence of loop expansion.
- Slow to calculate in general theories of gravity.
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$\Rightarrow$ Development of HyPk - code for non-linear redshift space spectra

[1911.04391]

Streaming-model-based approach

$$P^S(k,\mu) = \int\int \xi^S(s,\mu_s) e^{-i(kr+\mu\mu_s)} ds d\mu_s \tag{1}$$

$$1 + \xi^S(s,\mu_s) = \int [1+\xi(r)] \mathcal{P}(s,\mu_s, v_{12}, \sigma_{12}^2) dr\,,$$

where

$$\xi(r) = \frac{1}{2\pi^2} \int_0^\infty k^2 \mathcal{R} P_{\delta\delta}^{\rm NL,pseudo}(k) j_0(kr) dk\,.$$

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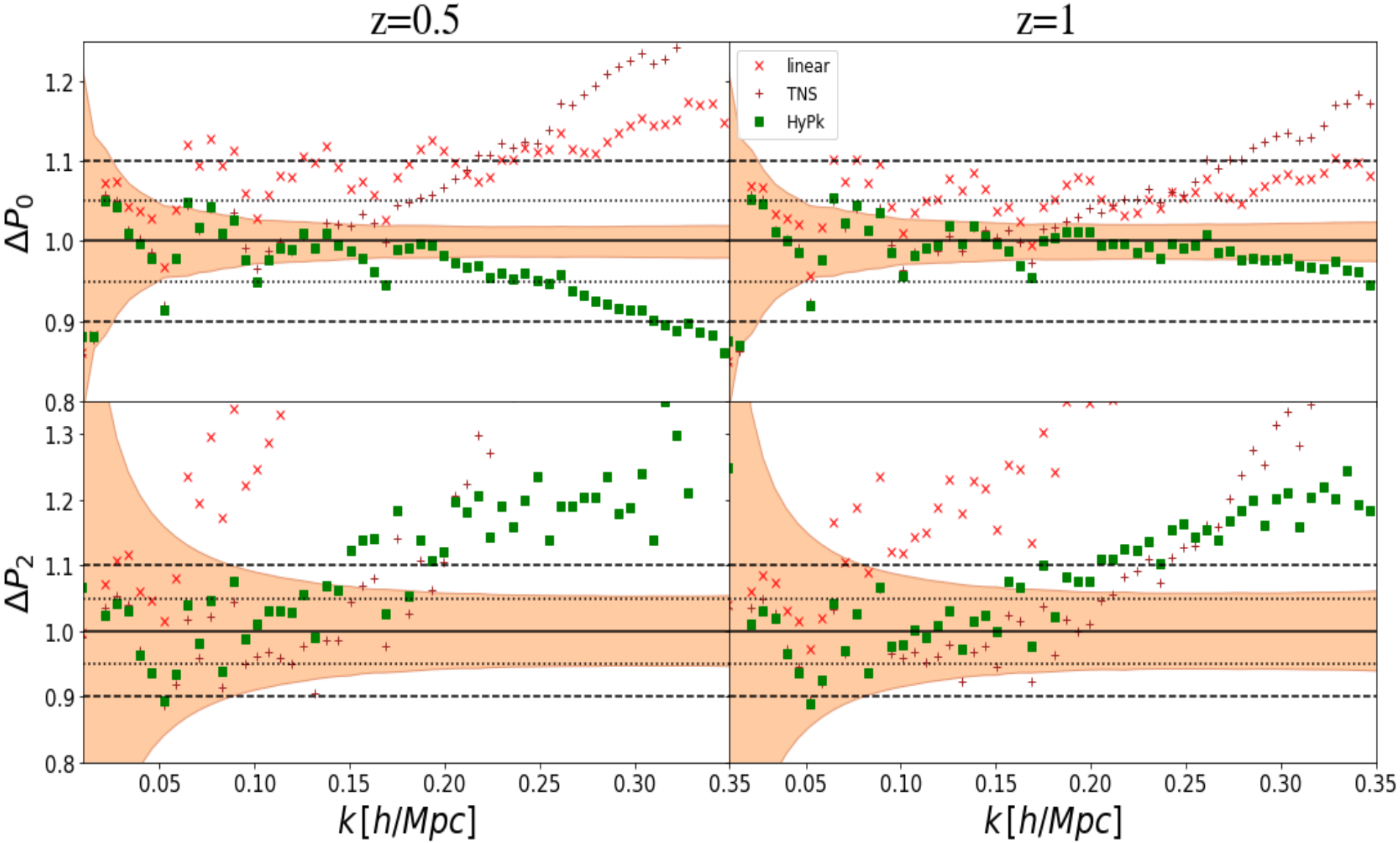
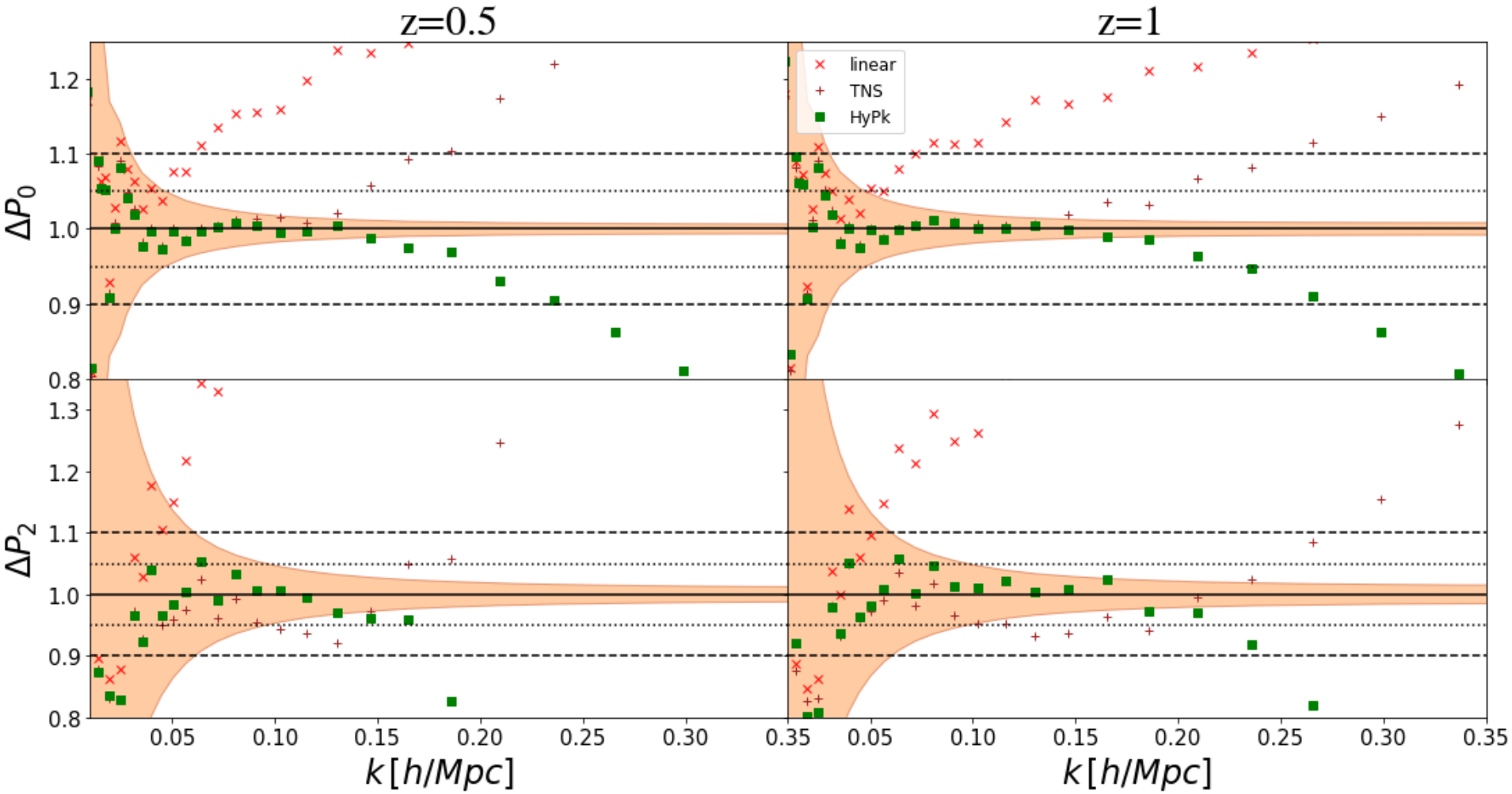
1. $\xi(r)$: Reaction approach for modified gravity and dark energy.
2. $v_{12}(r,\mu)$ and $\sigma^2_{12}(r,\mu)$: 1-loop SPT, various theoretical non-linear prescriptions or halo model approach .
3. $\mathcal{P}$ assumed to be Gaussian, but more sophisticated forms have been shown to achieve higher accuracy.

We test assuming Gaussian PDF and 1-loop PT predictions for moments.

Performance vs TNS in LCDM:



... and in $f(R)$:



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- High synergy with ReACT.
- Potential for joint pipeline for lensing and clustering with consistent $P(k)$ using ReACT.

“What about bias?”

-quite a few people

Lensing: The Need for Non-Linear

$$P_\kappa(\ell) = 2\pi \int_0^{\chi_s} d\chi \frac{W(\chi, \chi_s)^2}{\chi^2} P(k = \ell/\chi, z(\chi)) \tag{2}$$

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So can we combine these methods somehow?