

Early Dark Energy and the BAO

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Early Dark Energy

- Can arise for instance in quintessence models with attractor solutions and coupled dark energy models
- Even percent levels of Ω_e could have a significant impact on BAO (and other) measurements
- Previous work (Linder and Robbers 2008) found ignoring EDE would lead to significantly biased BAO measurements of w
- On the other hand, EDE has relatively mild impact on non-linear structure formation, comparable to late time DE models (Francis, Lewis and Linder 2008, Grossi & Springel 2008)



Non Linear Effects on the BAO?

- How do the changes in the non-linear growth in EDE models affect our ability to infer cosmology from the BAO?
- Two possible problems
 - The original peaks are shifted, and non-linear distortion is scale dependent
 - Unlike conventional late time DE models, the early universe does not have a common heritage with Λ CDM. EDE may be imprinted in a different non-linear distortion of the BAO scale

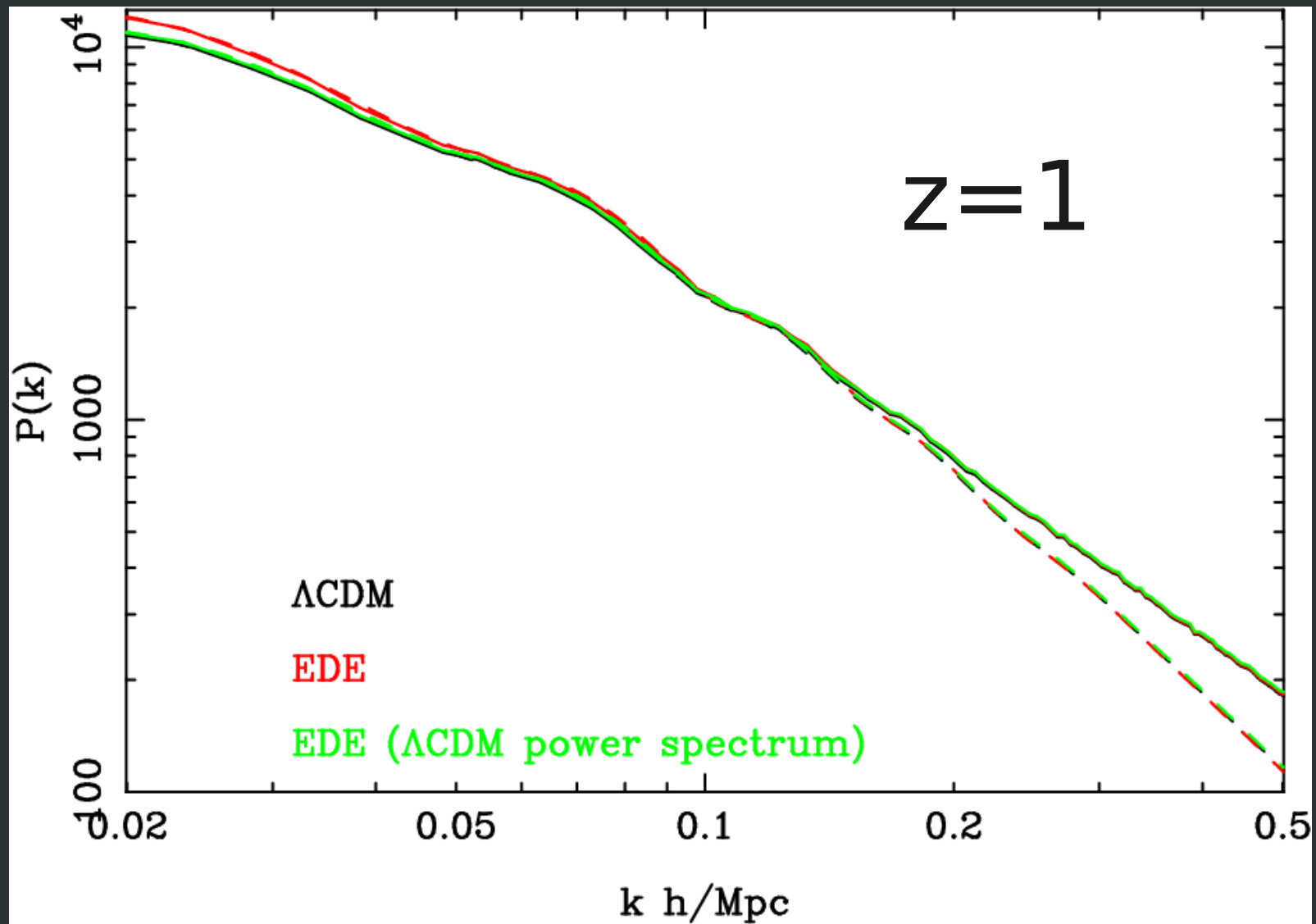


N-Body Simulations

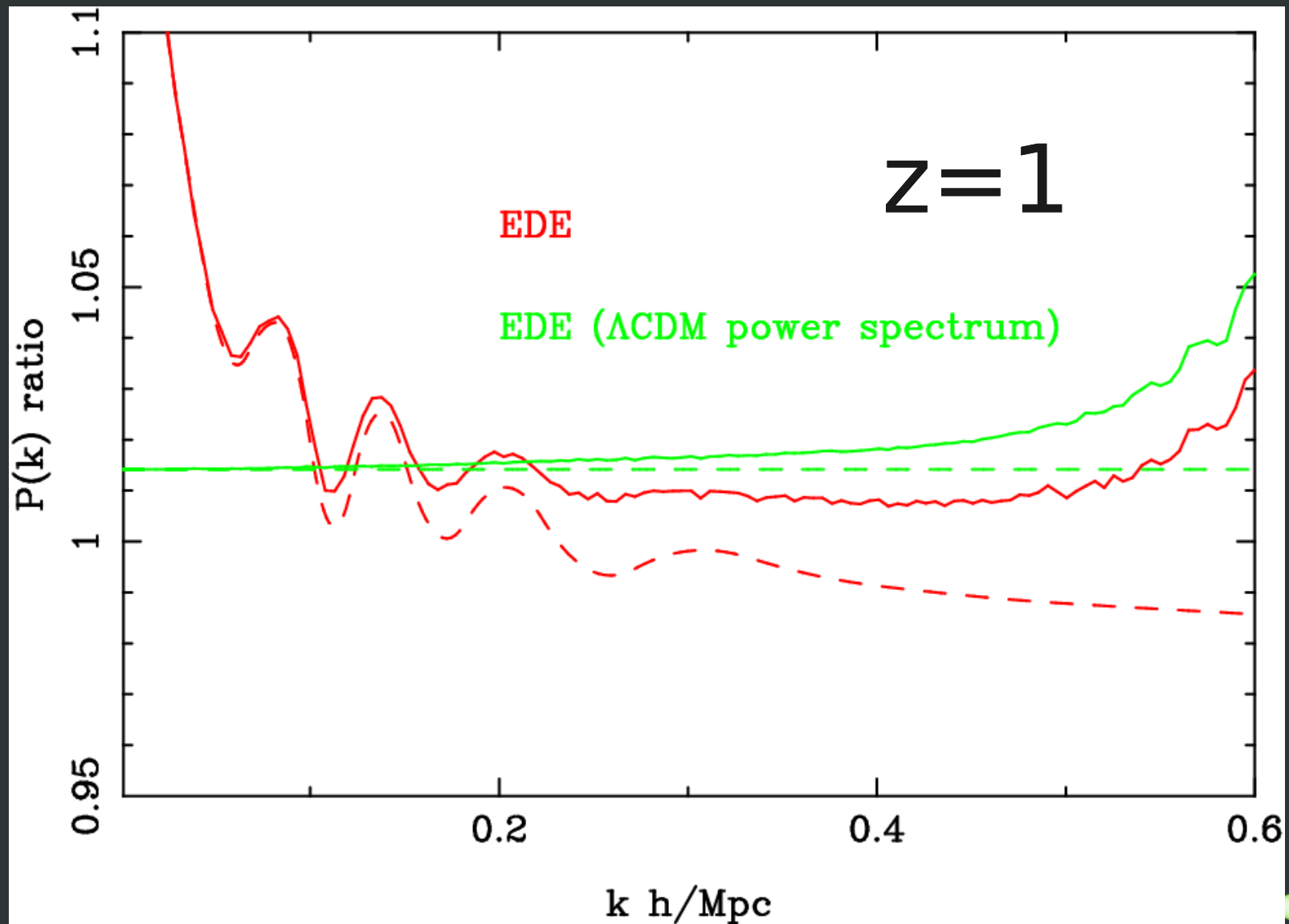
- Reference Λ CDM simulation and two EDE sets, one utilizing the Λ CDM initial linear power and the other the correct EDE linear power
- Boxes 1024 Mpc/h on a side with 512^3 dark matter particles
- Set $\Omega_e = 0.05$ using parametrization of Doran & Robbers 2006



DM Power Spectrum

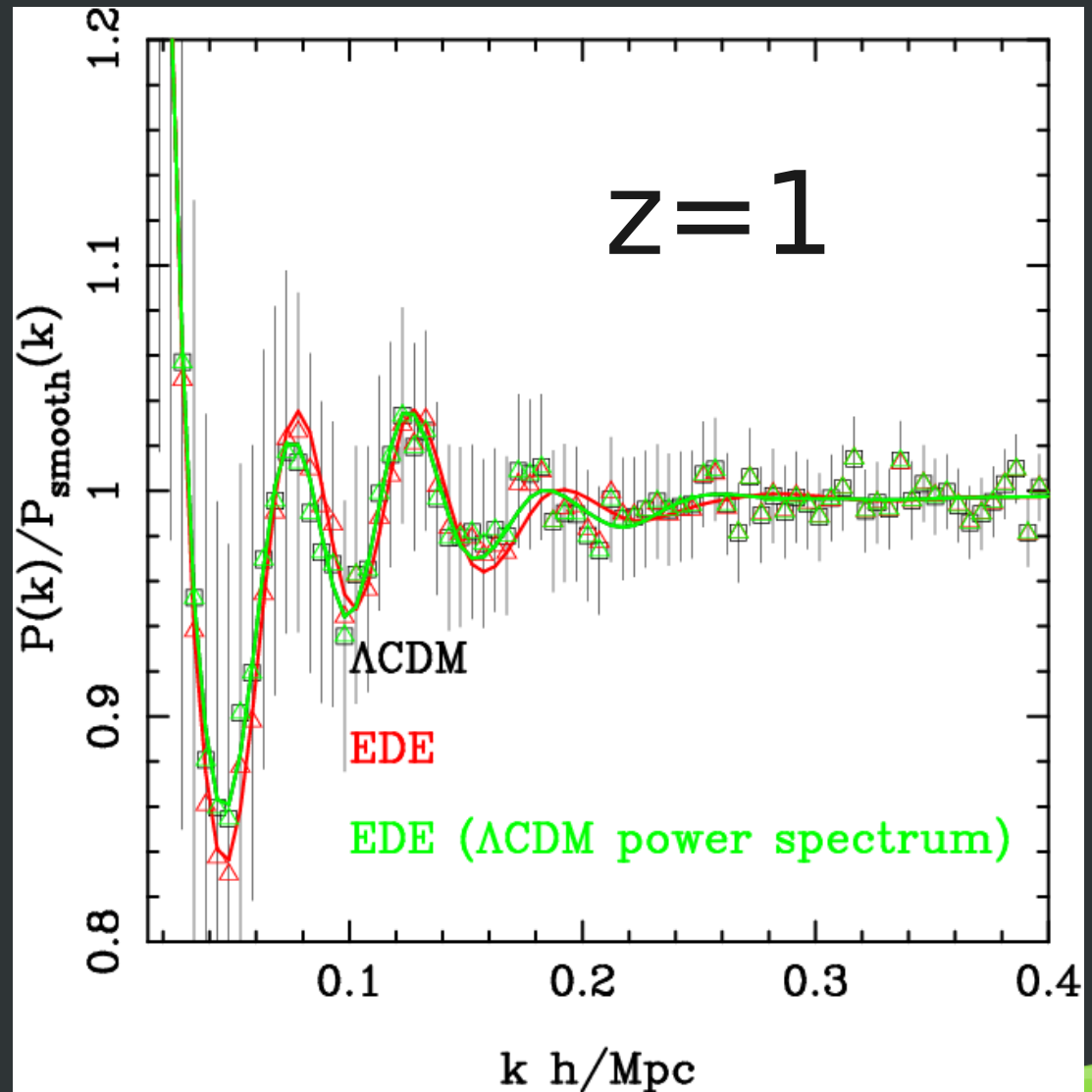


Ratio to Λ CDM

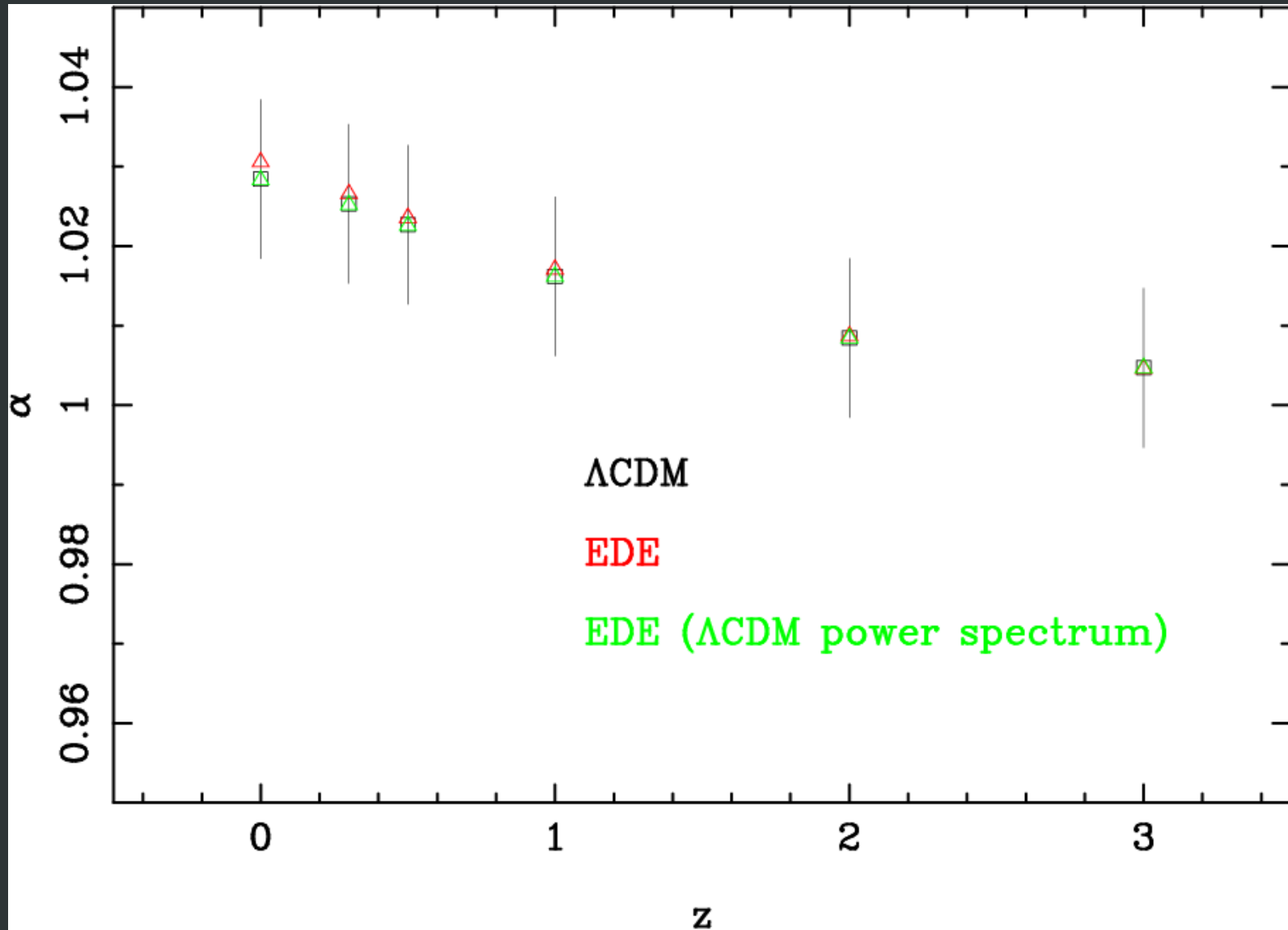


Recovering the BAO scale

- Divide the power spectrum smooth reference
- Fit for the shift α and a non-linear damping envelope.



α fits



EDE and α

- When the linear power spectrum is unchanged from Λ CDM, difference in shift is negligible; non-linear structure formation history of EDE has little effect
- When the input linear peaks are shifted by EDE, the recovered scale is altered compared to Λ CDM, but by a very small amount, $\Delta\alpha \sim 10^{-3}$ at $z=1$ (verified in 4 different realizations)



Summary

- The evidence suggests the BAO scale is robust against additional non-linear effects from EDE
- Examined the DM power spectrum; need improved resolution and more realistic mock survey analysis

