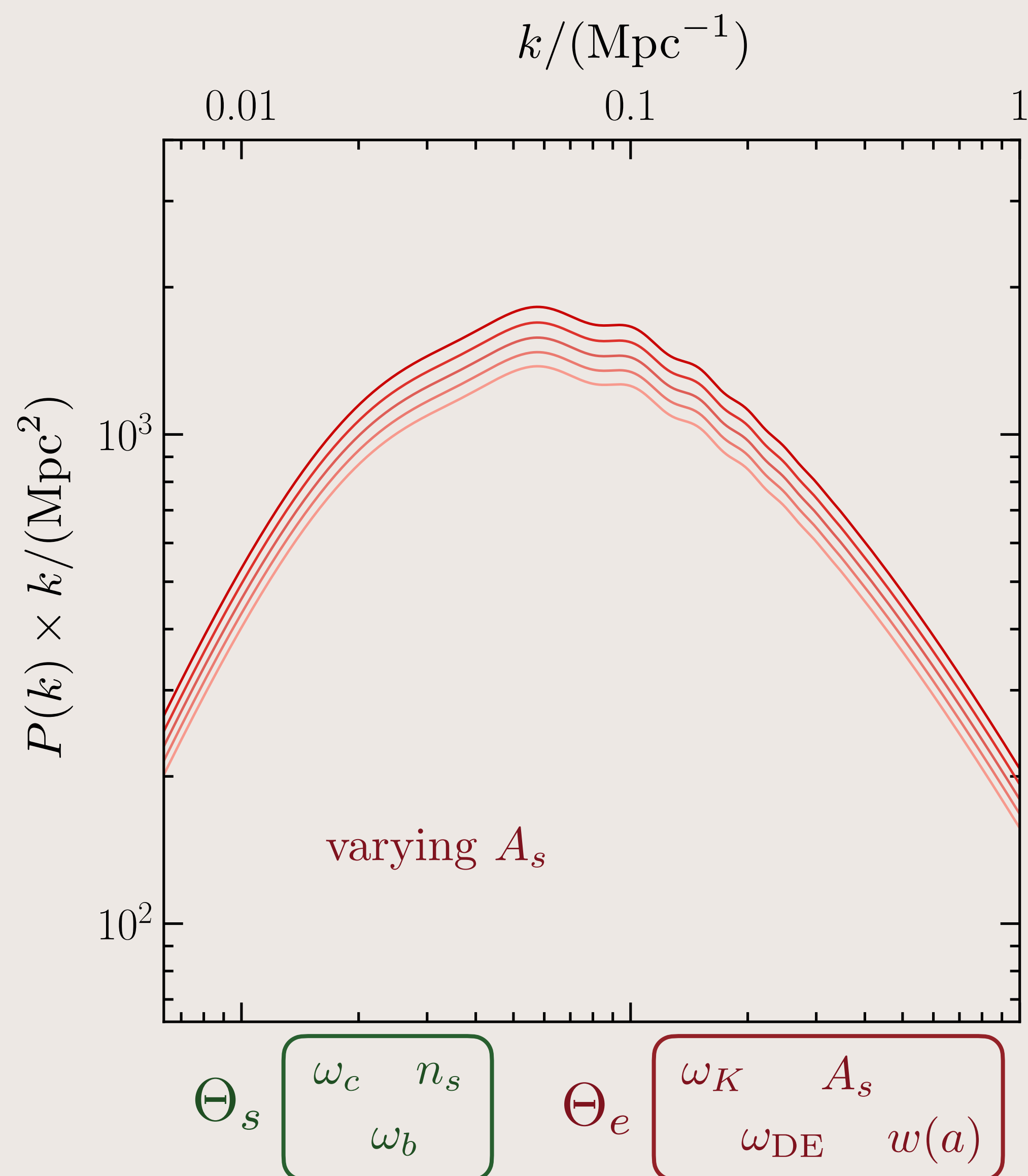


How the right parameters can make your life easier

Matteo Esposito (MPE),
with Ariel Sanchez (MPE), Julien Bel (CPT), Andres N. Ruiz (IATE)



Evolution mapping: linear $P(k)$

- We can classify cosmological parameters in two classes:
 - **shape parameters**, Θ_s , which determine the shape of $P_L(k)$
 - **evolution parameters**, Θ_e , which only affect the amplitude of $P_L(k)$
- Impact of evolution parameters on $P_L(k)$ can be fully described by $\sigma_{12}(z)$, the rms linear variance of the density field in spheres with $R = 12$ Mpc.
- Given Θ_s , all Θ_e and z leading to the same $\sigma_{12}(z)$ give indistinguishable $P_L(k)$.
- Degeneracy broken when using quantities that explicitly depend on h (σ_8, Ω_i) [1].

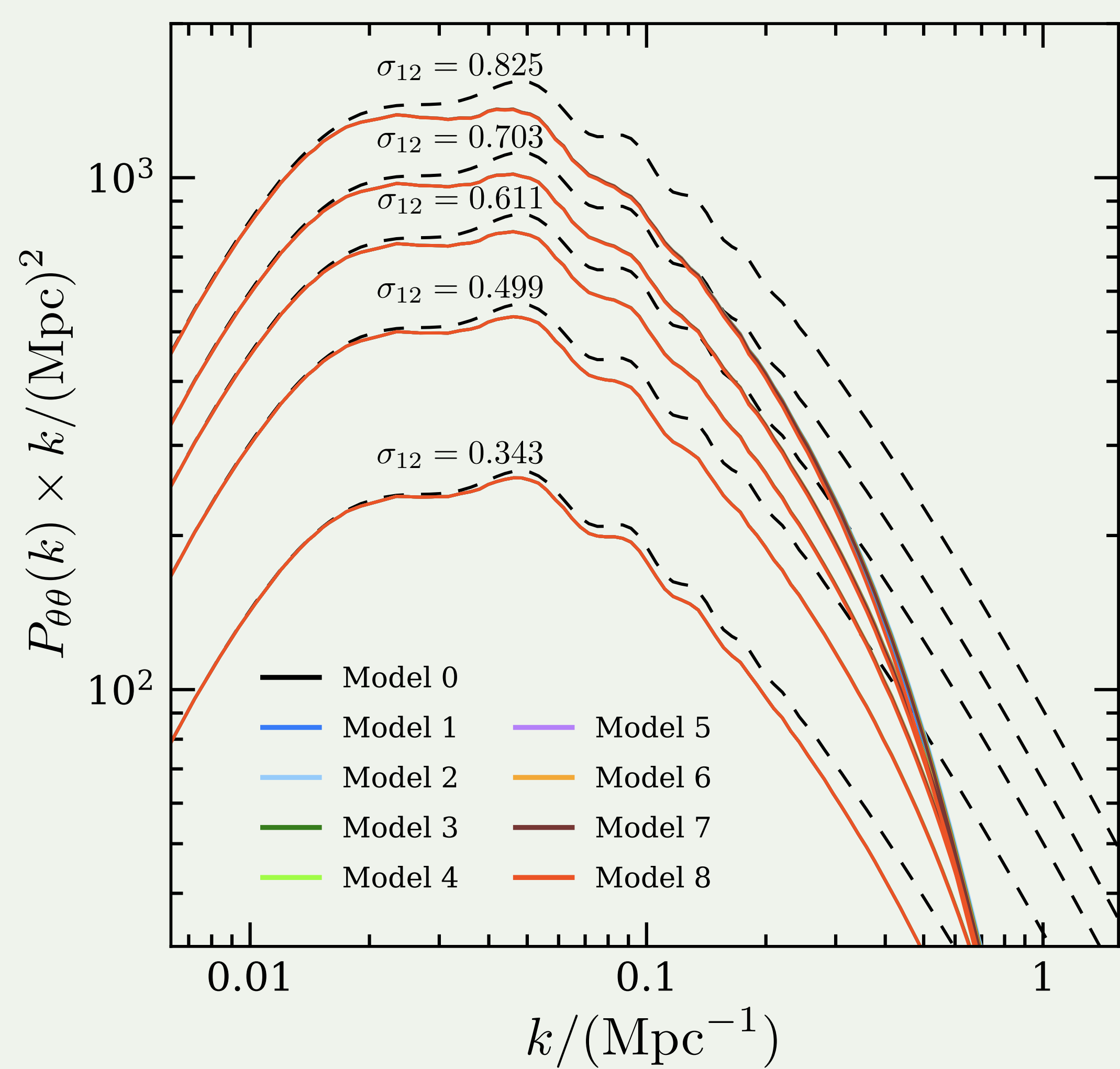
What about velocities?

In linear theory, the density and peculiar velocity fields are linked through the continuity equation:

$$\frac{\nabla \cdot \vec{v}}{faH} = -\delta \quad \frac{d\vec{x}}{d \ln \sigma_{12}} = \frac{\vec{v}}{faH}$$

Evolution mapping also applies to velocities if expressed in terms of $\ln \sigma_{12}$

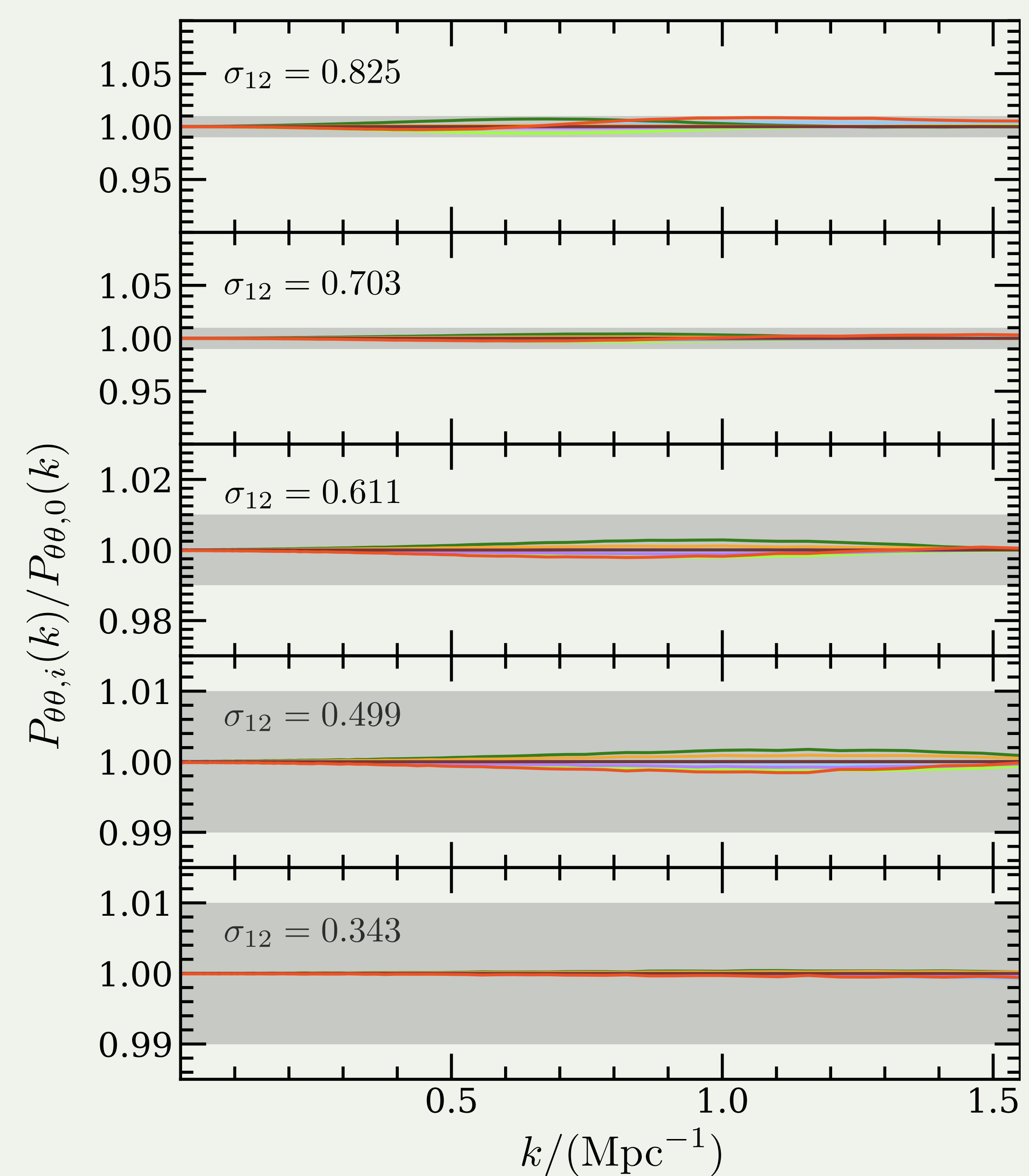
Non-linear statistics: $P_{\delta\delta}(k)$, $P_{\theta\theta}(k)$



TAKE HOME MESSAGE

Even with significantly different Θ_e , cosmologies with the same Θ_s show remarkably similar non-linear density [2] and velocity statistics [3] when measured at the same σ_{12} .

Deviations are due to the different growth histories $g(a) = D(a)/a$ and can be corrected for.

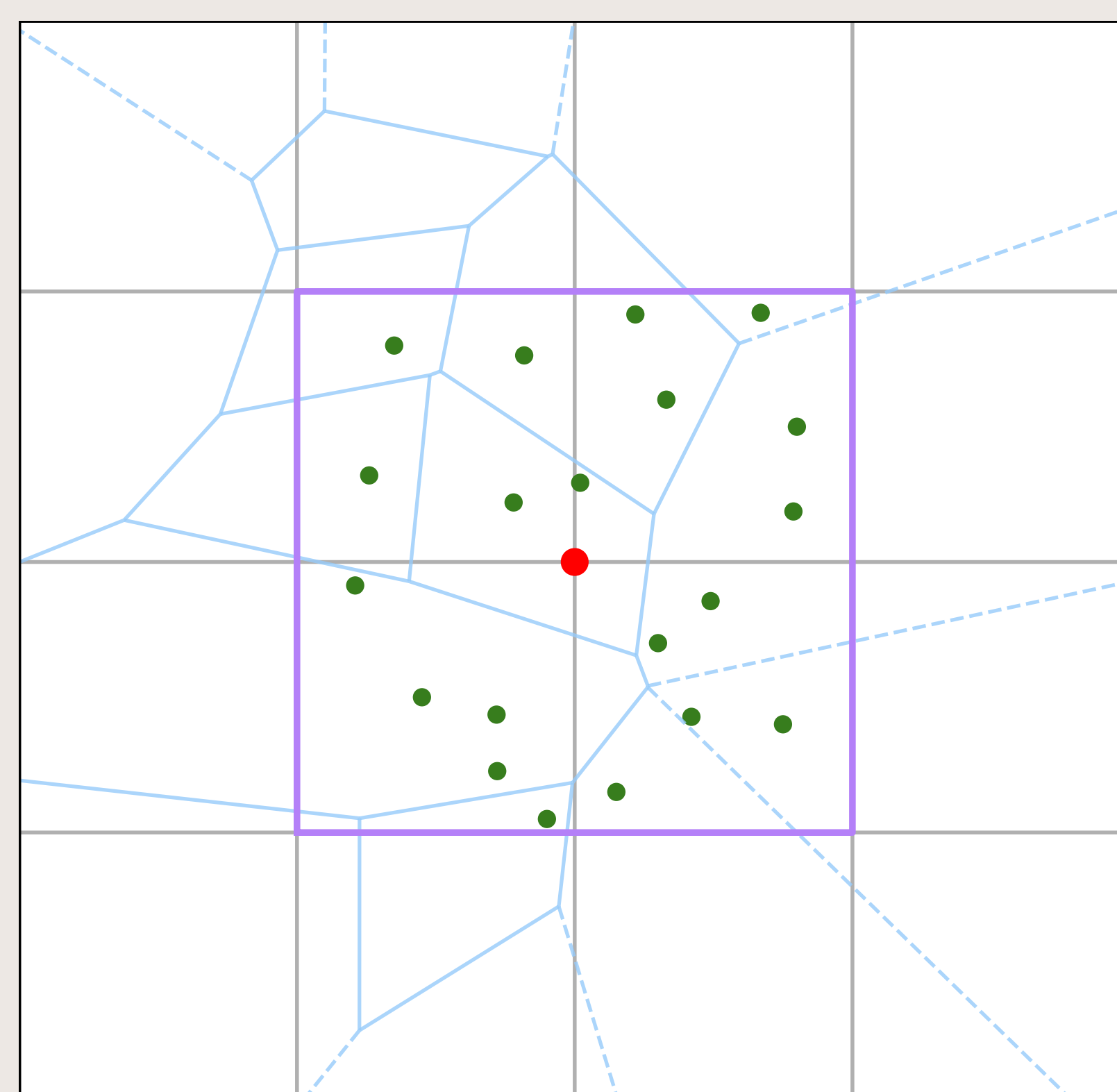


Measuring velocity statistics

Nbody particles are biased tracers of the velocity field: we need to re-sample empty regions.

A simple approximation is to assume the field to be constant inside Voronoi cells.

We can use a glass-like point distribution to obtain a volume-weighted sample of the velocity field.



A few more things we could chat about:

- What about massive neutrinos? We have another poster about that!
- Interested in fitting functions? Coming soon
- Running Gadget4 and working with velocities: be careful!
- Other methods are available for sampling the velocity field in Nbody simulations

References:

- [1] Sánchez A. G., 2020, Phys. Rev. D, 102, 123511
- [2] Sánchez A. G., et al., 2022, MNRAS, 514, 5673-5685
- [3] Esposito M., et al., 2024, MNRAS, stae2351, 0035-8711

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