



University of
Zurich ^{UZH}

Dark Acoustic Oscillations : Imprints on the Matter Power Spectrum and the Halo Mass Function

(Signals from astrophysical sources)

[arXiv:2101.12229 \(MNRAS\)](https://arxiv.org/abs/2101.12229)

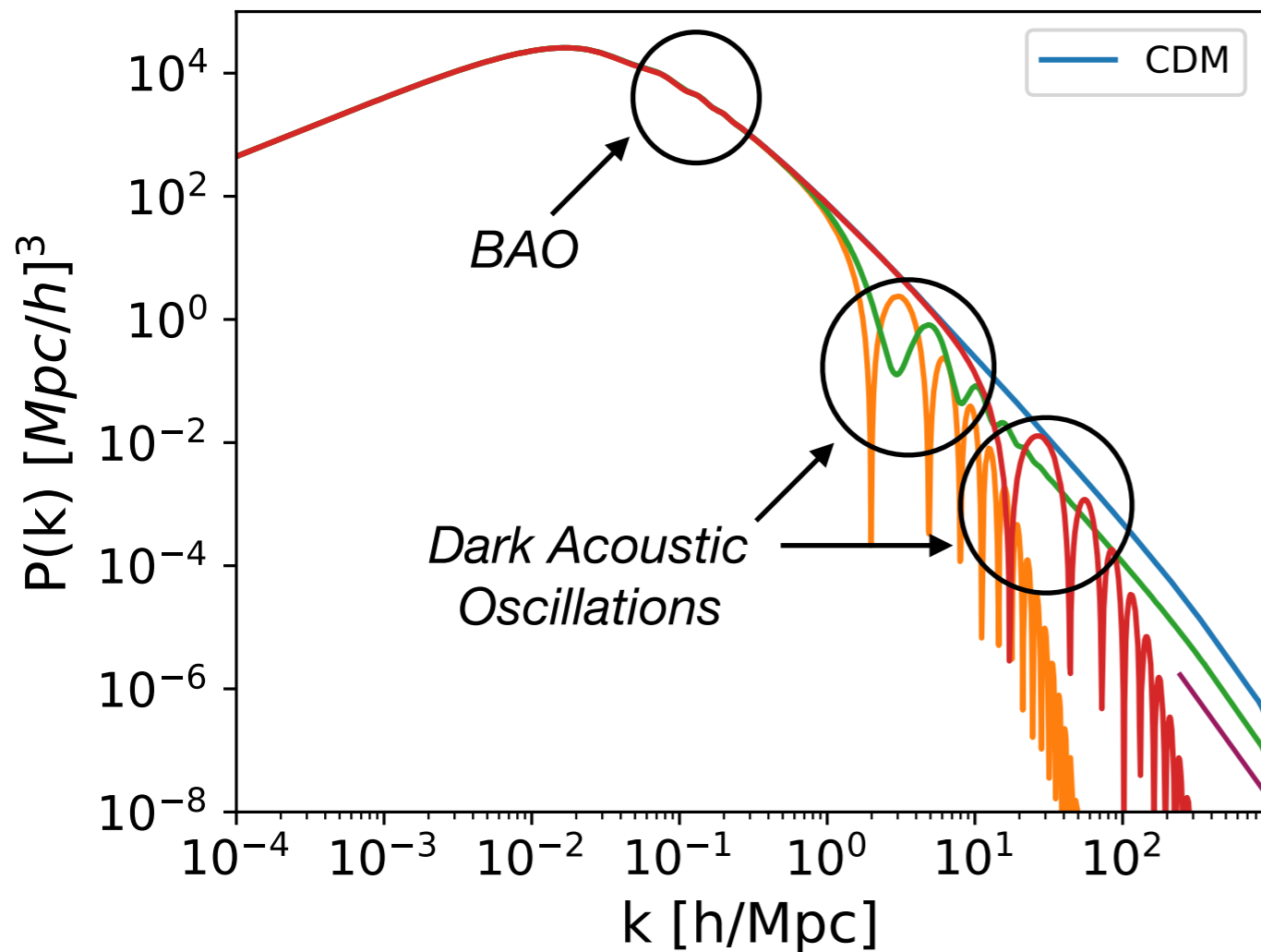


Timothée Schaeffer



Aurel Schneider

Dark Acoustic Oscillations : definition and origin



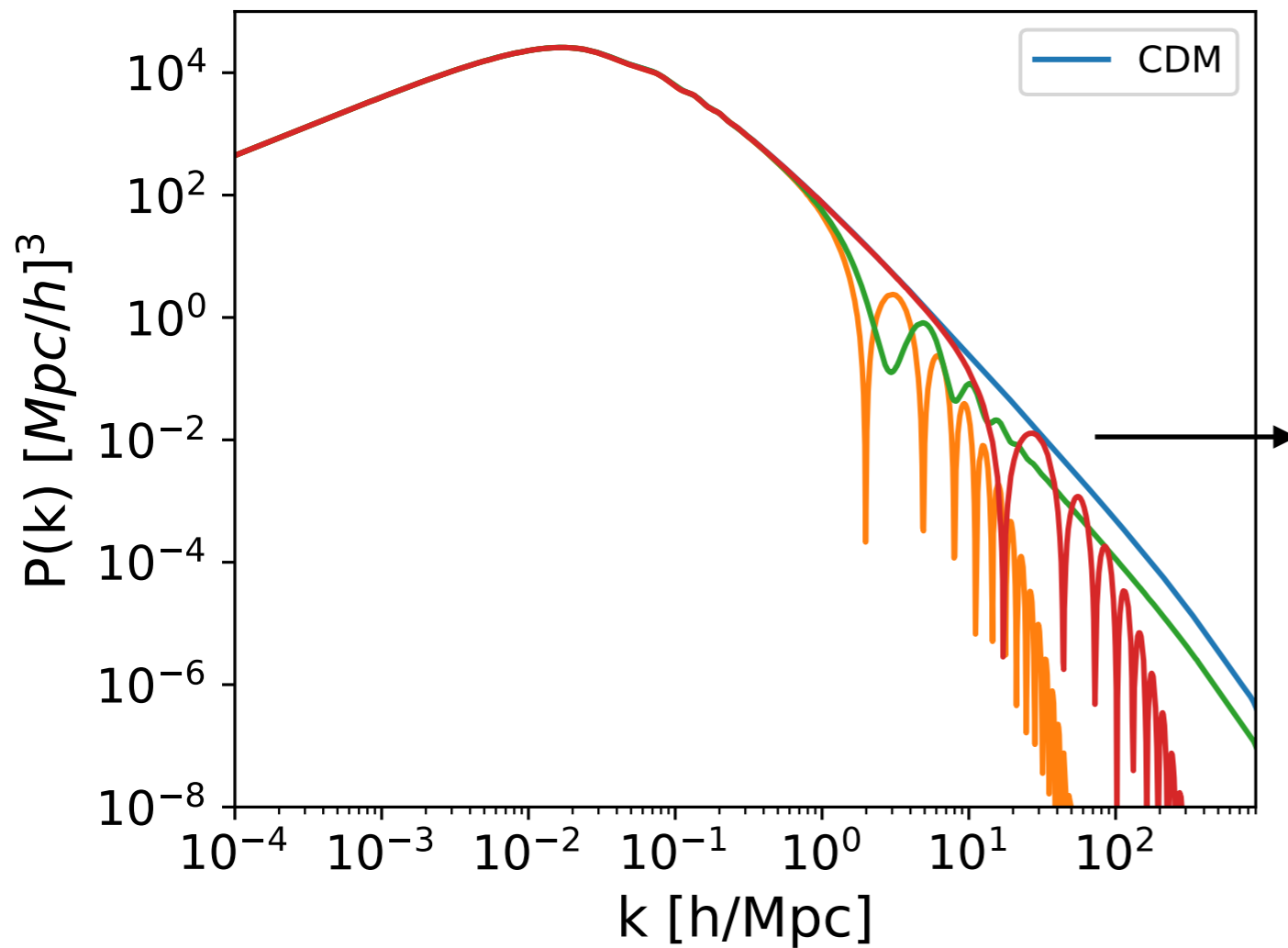
Linear DM power spectrum : CDM and different types of Oscillating Dark Matter (DM+Dark Radiation) featuring Dark Acoustic Oscillations

- Oscillations visible in the linear Dark Matter Power Spectrum
- They can arise when DM is assumed to interact with a light particle (neutrinos, photons, dark radiation..)
- The process is similar to BAO : pressure-gravity waves leave an imprint in clustering statistics

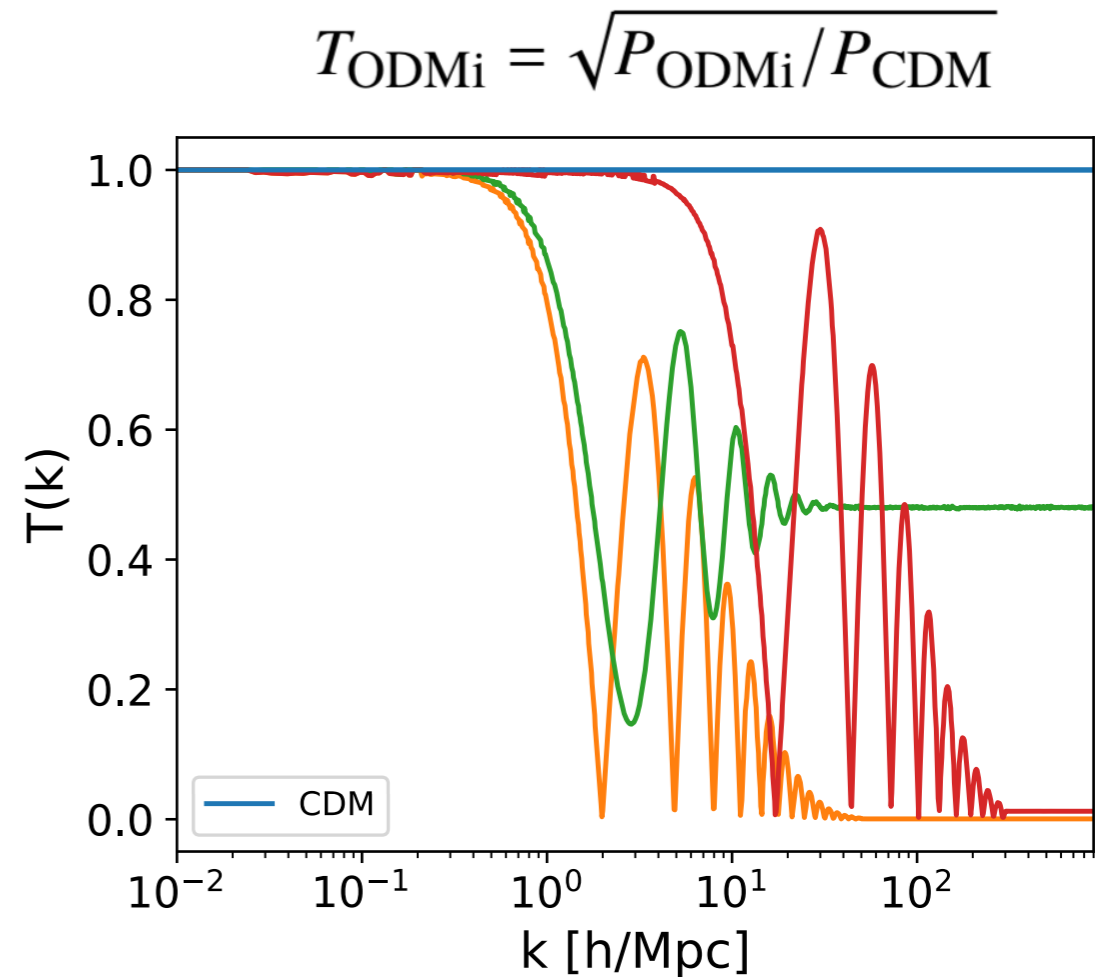
Could we see a signature of this in observation ?

Reminder : Transfer Function

Power Spectrum

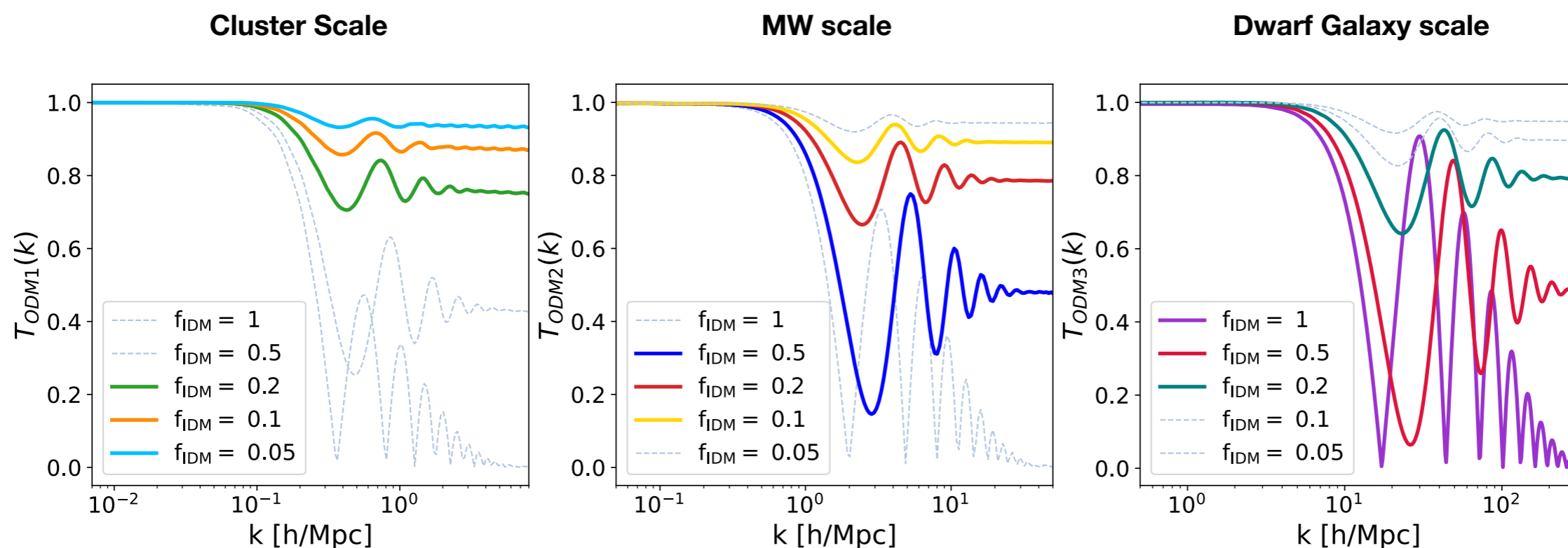


Transfer function



—> Easier to visualise the scale and amplitude of the oscillations

Dark Acoustic Oscillations can appear at different scales



Roughly :

- The amount of Dark Radiation determines the scale of oscillation
 - The amount DM interacting (f_{idm}) determines the amplitude of the oscillations
- (the exact parametrisation is more complicated)

3 models : ODM1, ODM2, ODM3, to test the effect of DAO on observation

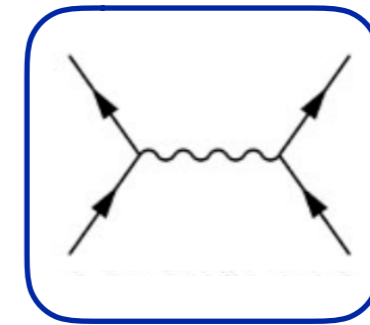
3 different fractions of ODM for each model, so 9 models to test in total.

Quick Summary

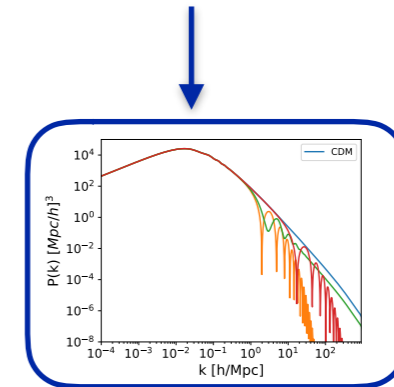
- *Dark Acoustic Oscillations are a generic feature of DM models involving interactions with a light particle*

- *We want to test whether they might be observed as distinct feature in the data*

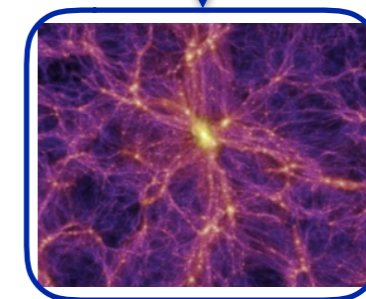
- *We run N-body simulations and post process them to predict the shape of different astrophysical observables*



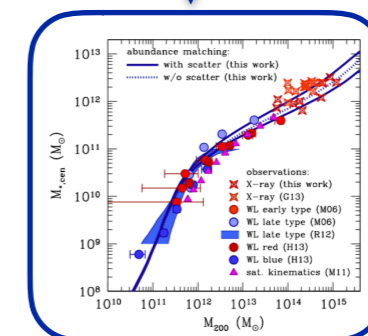
**DM
Microphysics
(interactions, production
mechanisms)**



Linear Power Spectrum



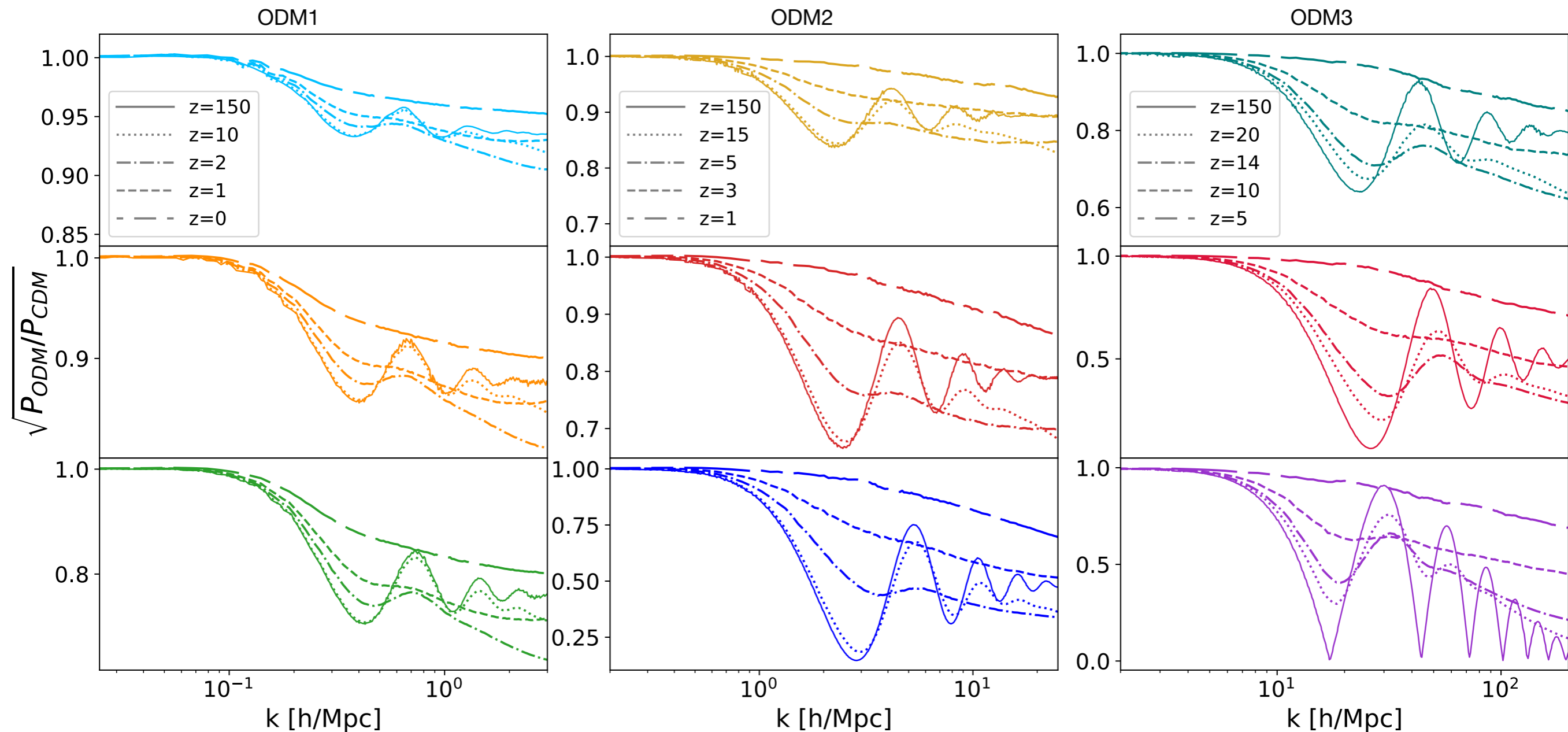
Cosmic Web



Observation

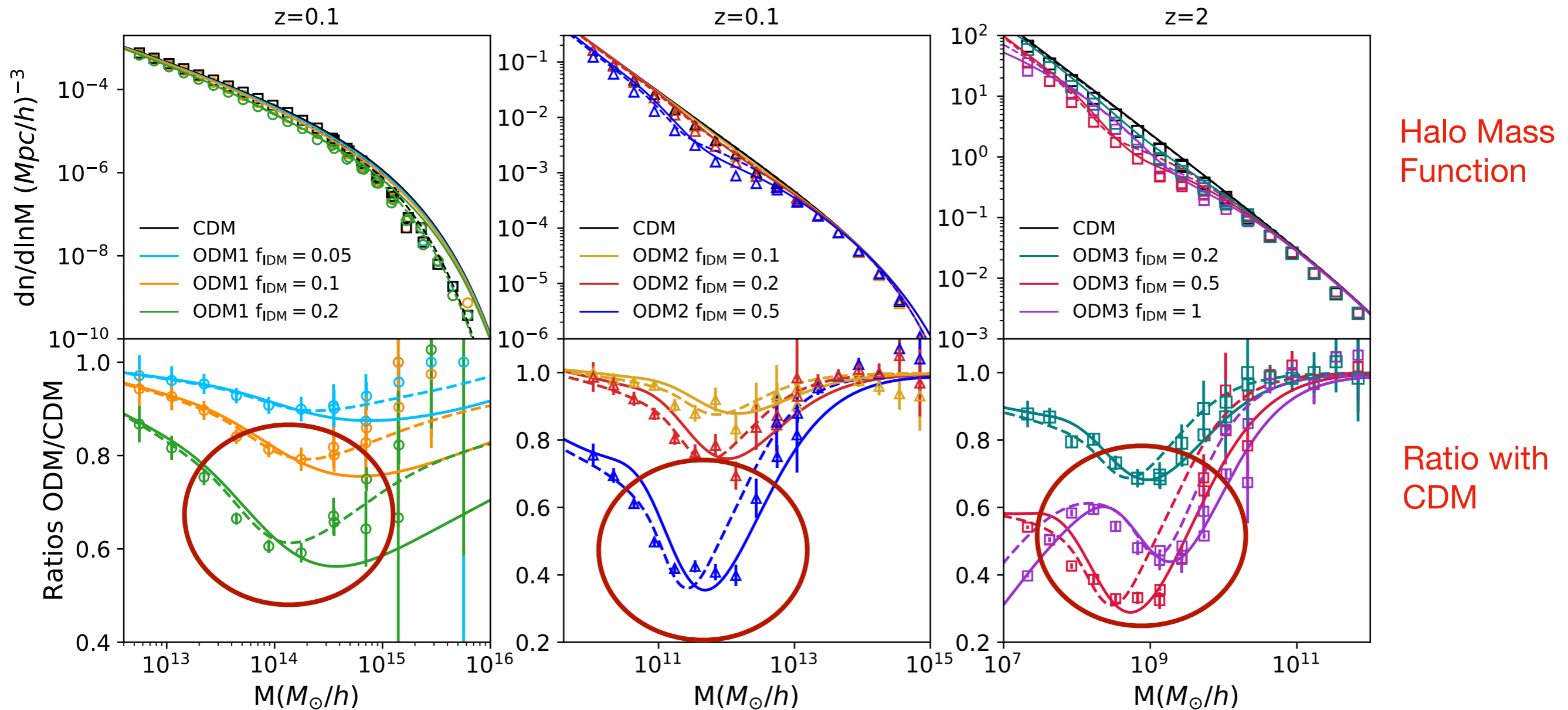
Dark Acoustic Oscillations : Non linear Power Spectrum

- DAO are washed out from 2 point statistics at low redshift : **non-linear** effect known as **mode coupling**



Dark Acoustic Oscillations : Halo Mass Function

- DAO leave an imprint on the halo mass function at low redshifts



—> They are theoretically detectable !
We however need to connect the HMF to observable quantities

Conclusion

- Dark acoustic oscillations are a very specific feature, unlikely to be degenerate with other feature from astrophysics
- They are washed out from 2 point statistics because of mode coupling, but leave an oscillatory feature in the Halo Mass Function
 - We then need to connect DM clustering statistics to observation (Cluster Mass Function, Stellar-to-Halo mass relation, Lyman-alpha forest) —> [arXiv:2101.12229](https://arxiv.org/abs/2101.12229)

Conclusion

Thanks !