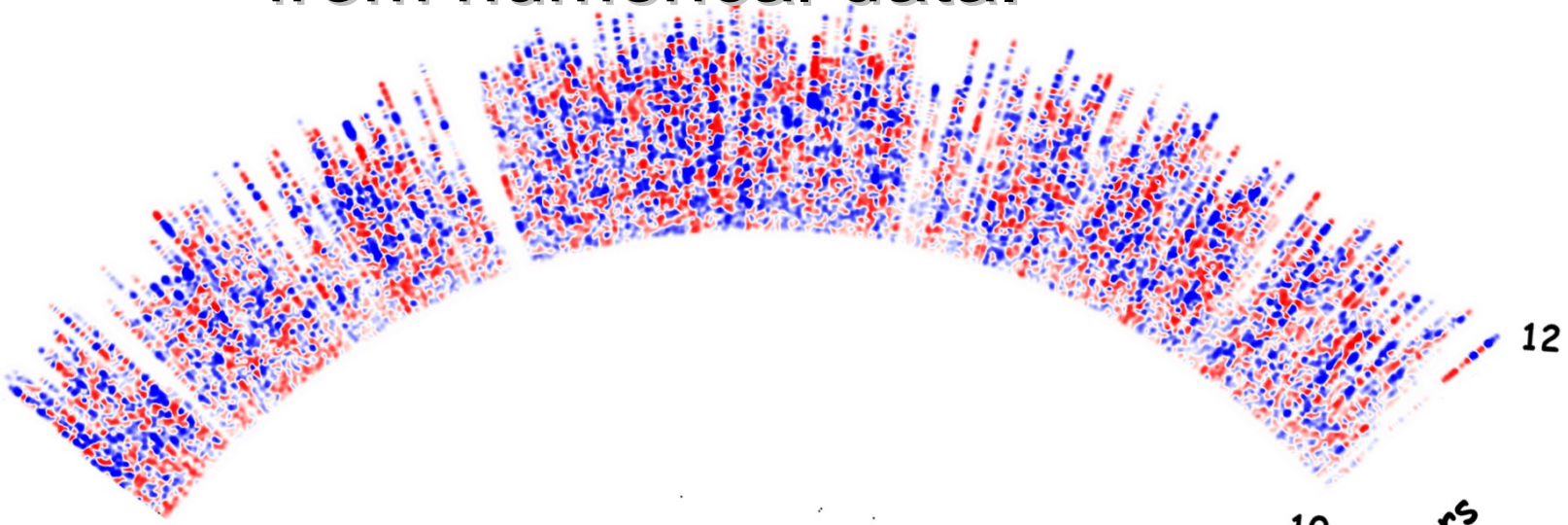
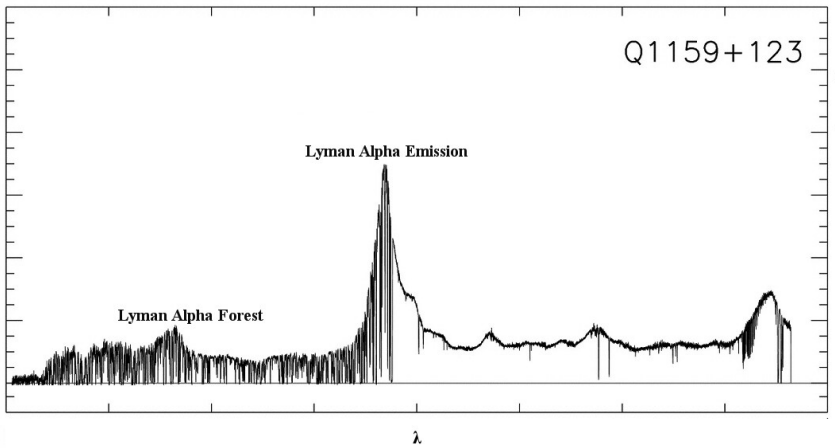
Linear and non linear Lyα 3D Power spectrum of The Large Structure, from numerical data.





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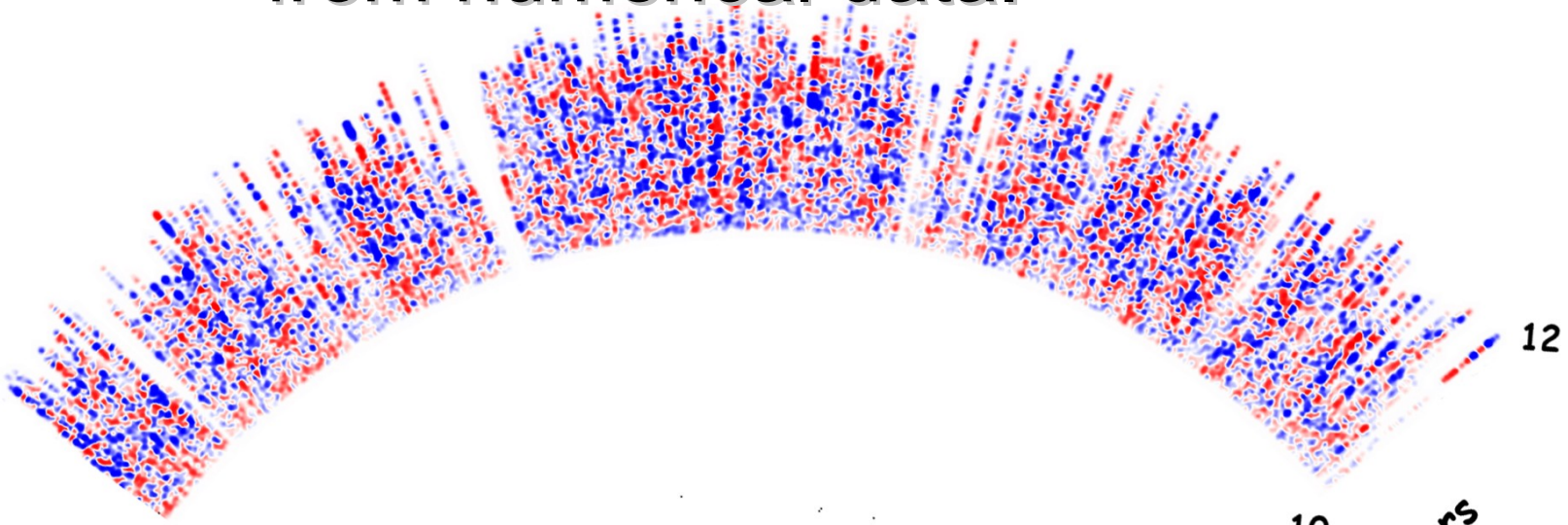
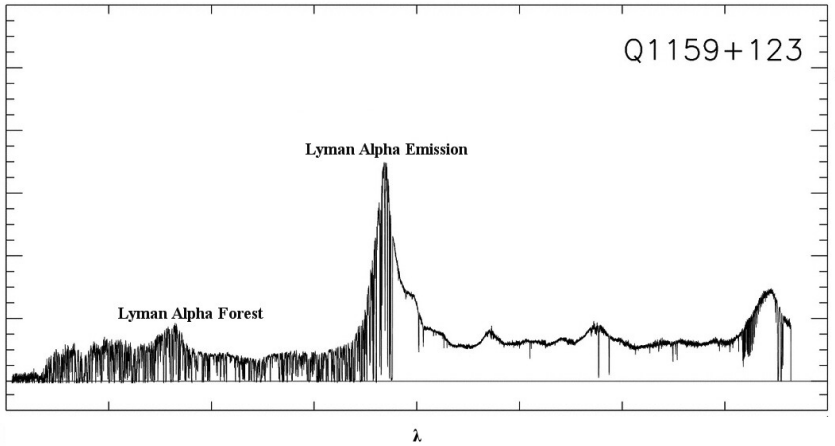
Collaboration with: Jordi Miralda Escudé, Matteo Viel

Sep 3, Cambridge

Linear and non linear Lyα "4D" Power spectrum of The Large Structure, from numerical data.





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3D Power spectrum.

- Analytical description: linear theory (Kaiser '87, McDonald '03).

Linear term

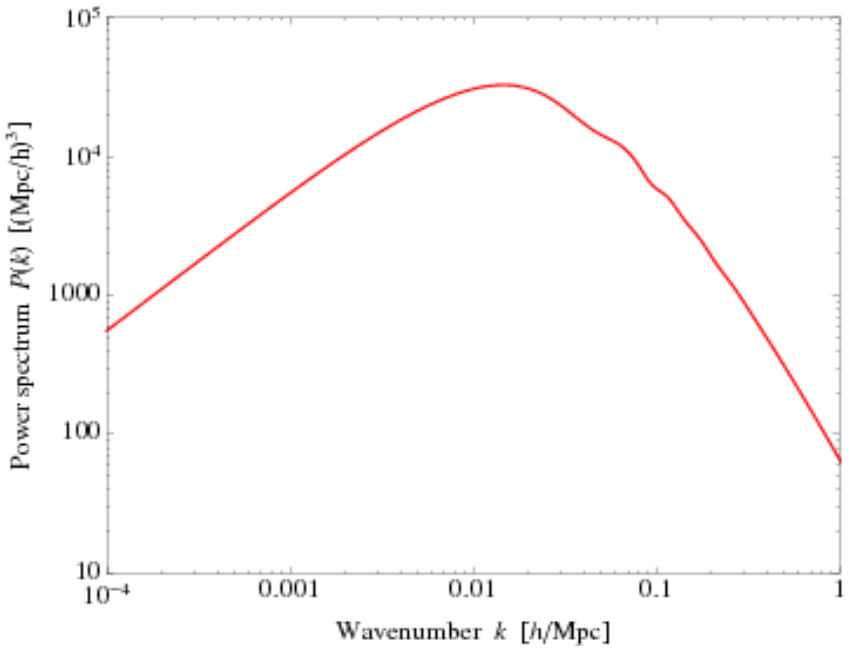
$$P_{3D}(k,\mu) = b_\delta^2 (1+\beta\cdot\mu^2)^2 \cdot P_l(k) \cdot D(k,\mu)$$

$\mu = k_\parallel / k$

Bias

β , b_δ

Non linear term.



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Non linear term.

- Fitting expression: non linear terms.

$$D(k,\mu) = \exp\left(P_l k^3 k_{nl} - (k/k_p)^2 - P_l k^3 \mu^{b_v} (k/k_v)^{a_v} \right)$$

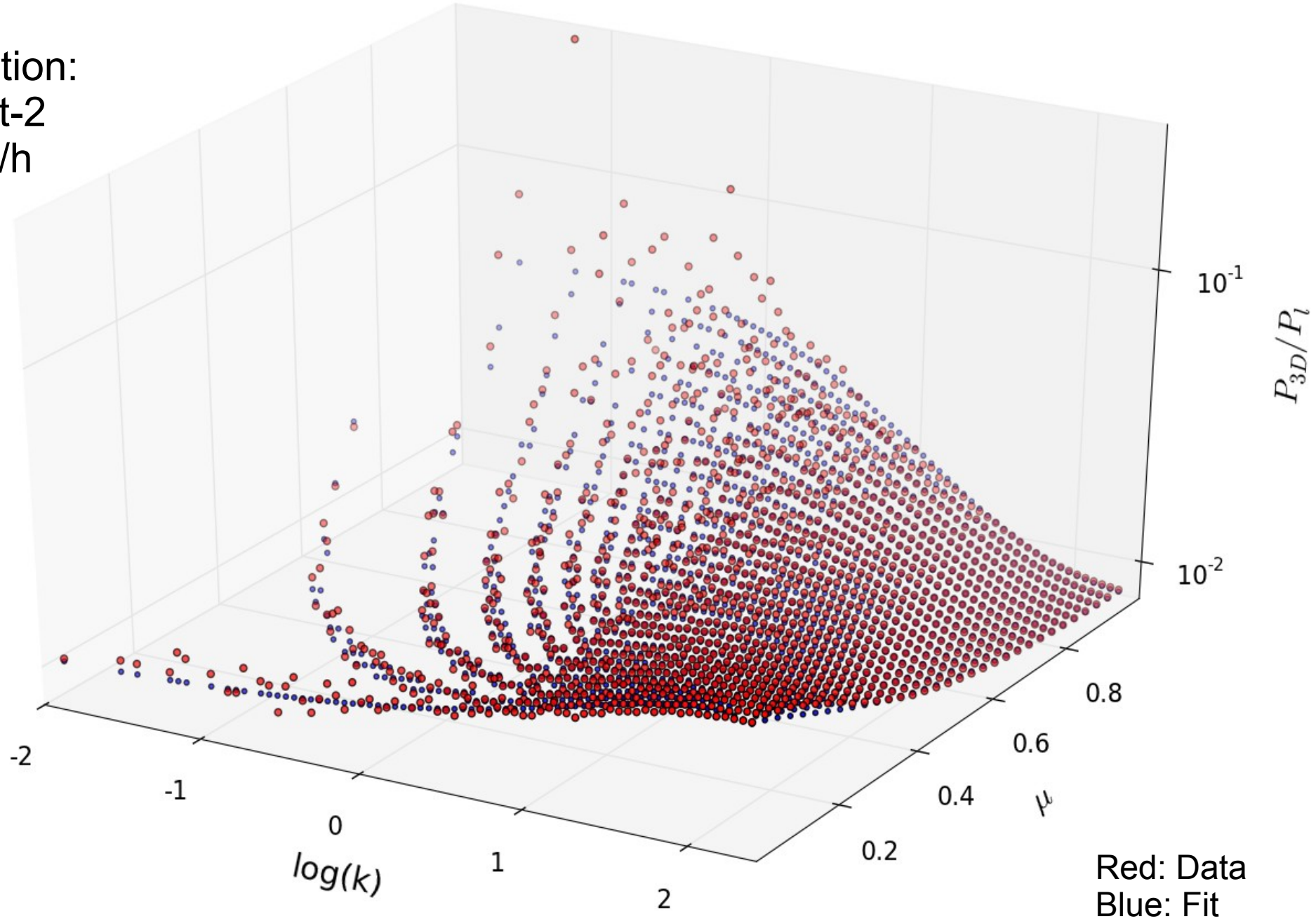
Non linear evolution.

Pressure term.

Peculiar velocities
And temperature.

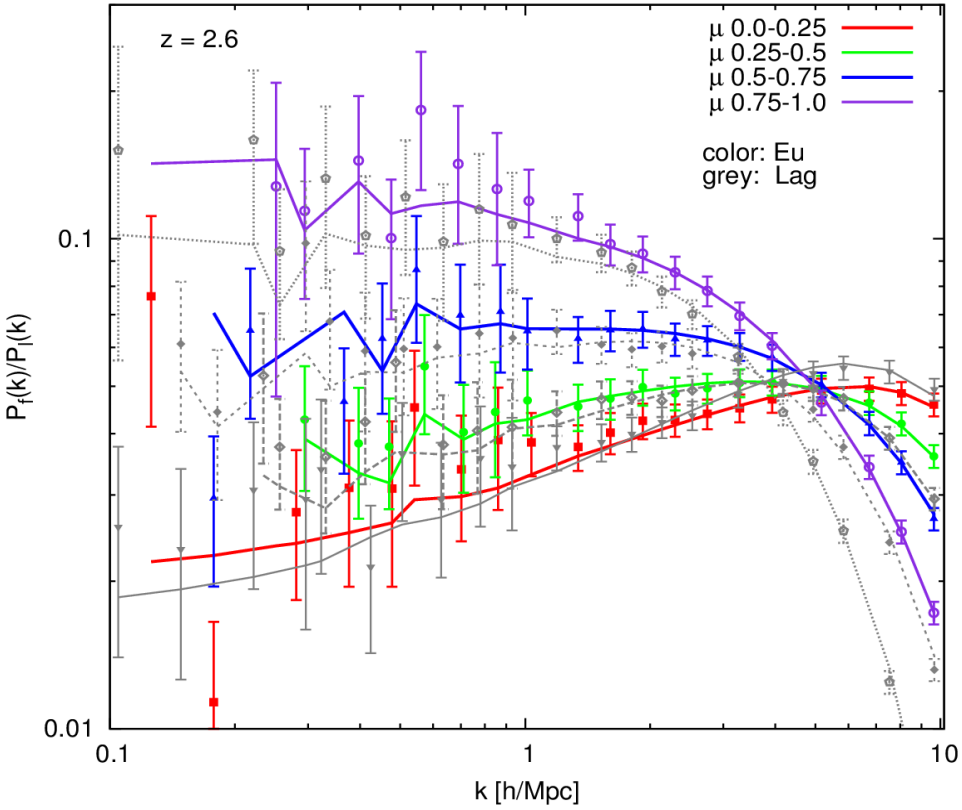
3D Power Surface from simulations

Simulation:
Gadget-2
60Mpc/h
z 2.2



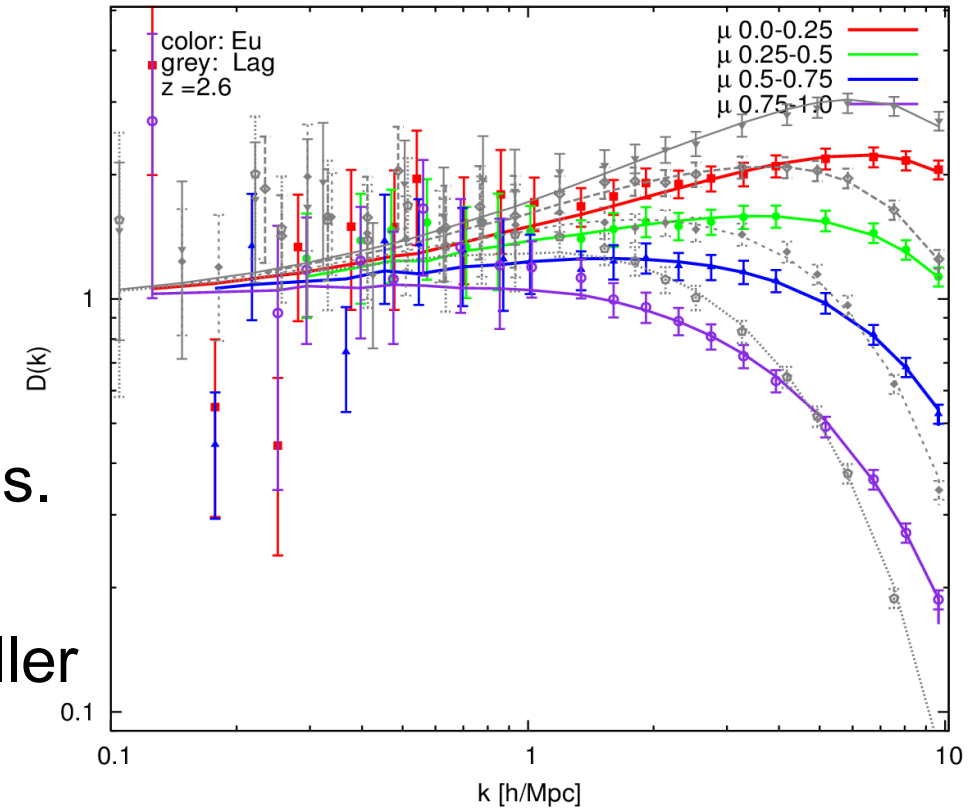
Red: Data
Blue: Fit

Results



Comparing different simulations
SPH (grey) vs Eulerian (color).

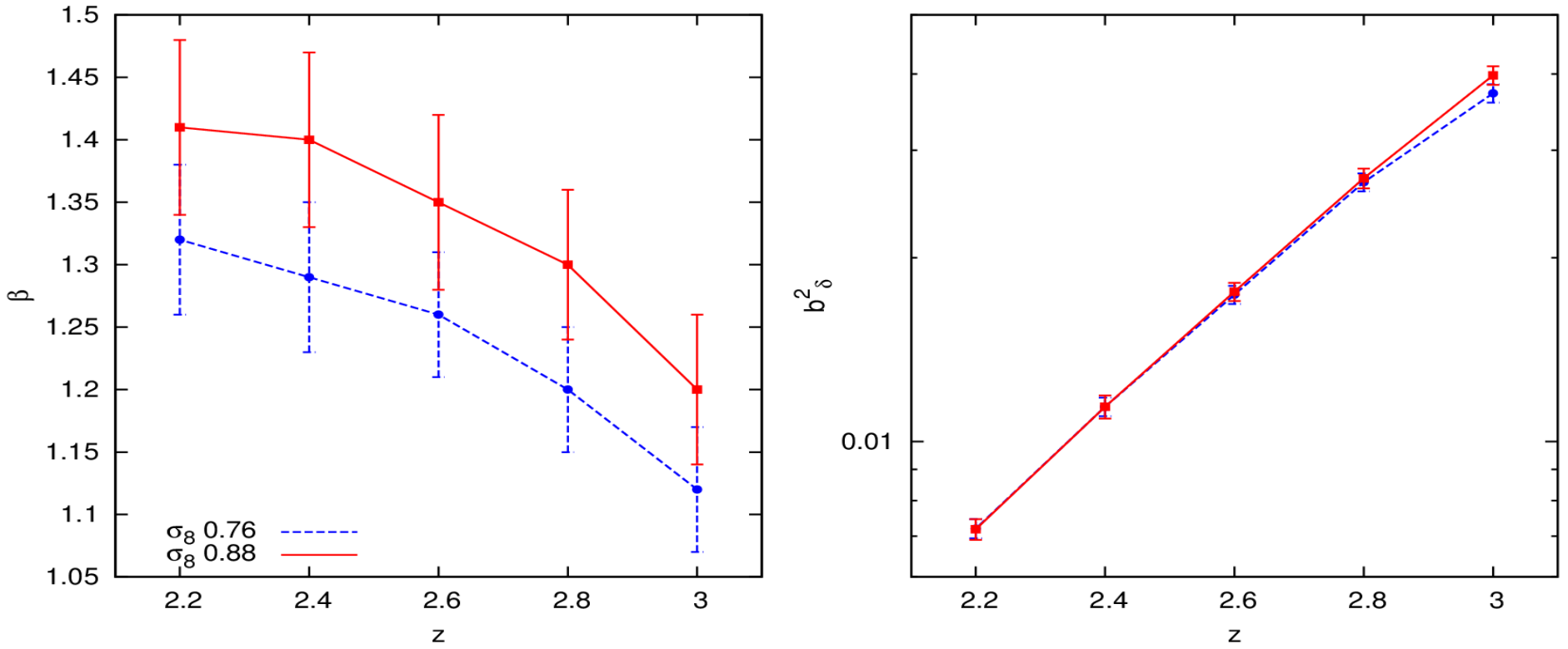
Data: points
Fit: lines



- The 3D power allows for clear discrimination between simulations.
- Non linear terms (D(k)) have an strong effect on the power at smaller scales.

Redshift evolution for the Bias.

Fitted bias for different amplitude of the perturbations.



- Clear trend with redshift for the bias parameters.
- The redshift distortion (β) is sensitive to variations of the physics.
- This allows for away to check simulations with observations

Conclusions

- The 3D power spectrum of the Lya forest is a useful tool to describe and characterize the IGM. The observable bias factors and other non-linear parameters are predictable from hydrodynamic simulations.
- However the IGM is very complex. Many simulations of different models are needed to compare theory with observations and learn what the observations imply. In this way we can better understand what physical phenomena affect the observations.
- Special care needs to be taken to ensure that simulations have converged to a unique solution as a function of resolution and numerical method.