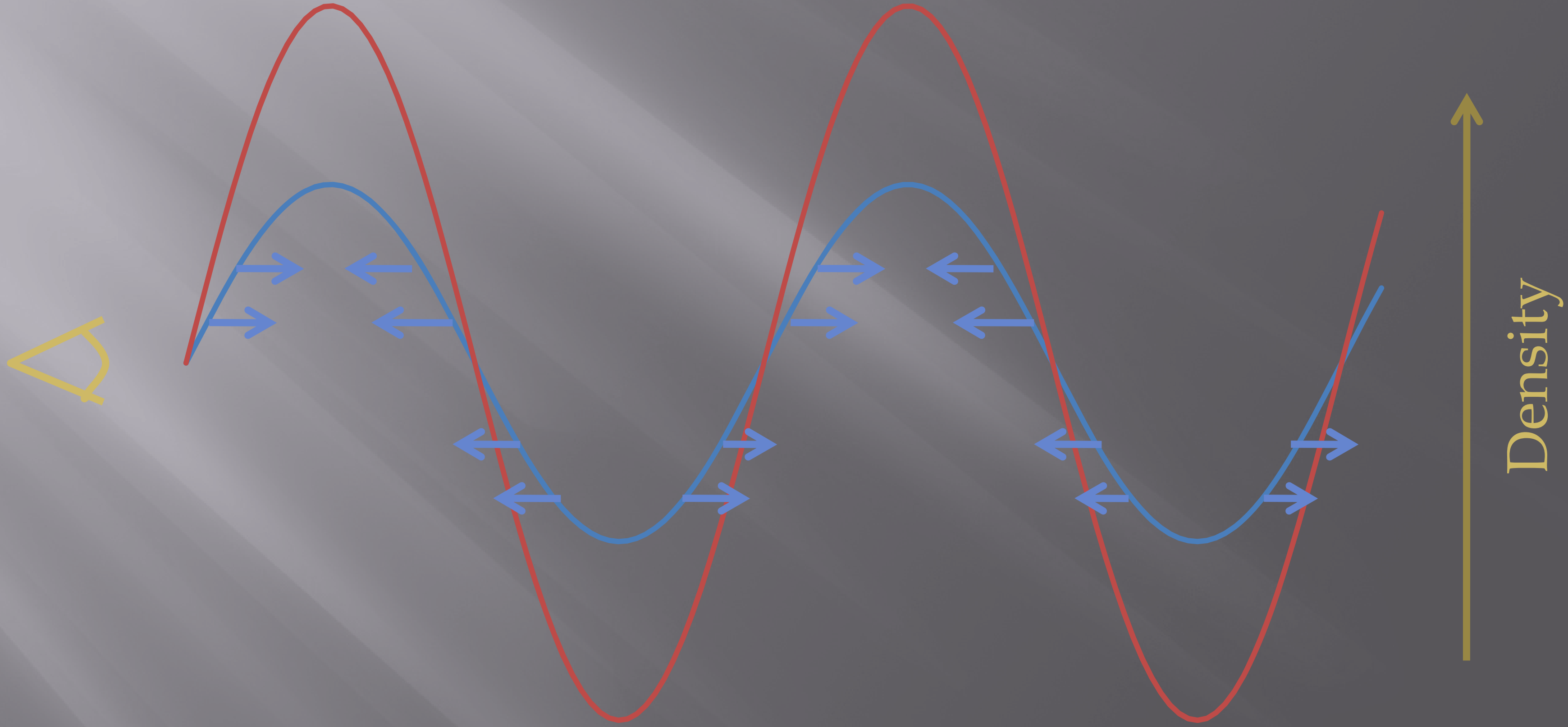
REDSHIFT SPACE DISTORTIONS DURING THE EPOCH OF REIONIZATION

Geraint Harker

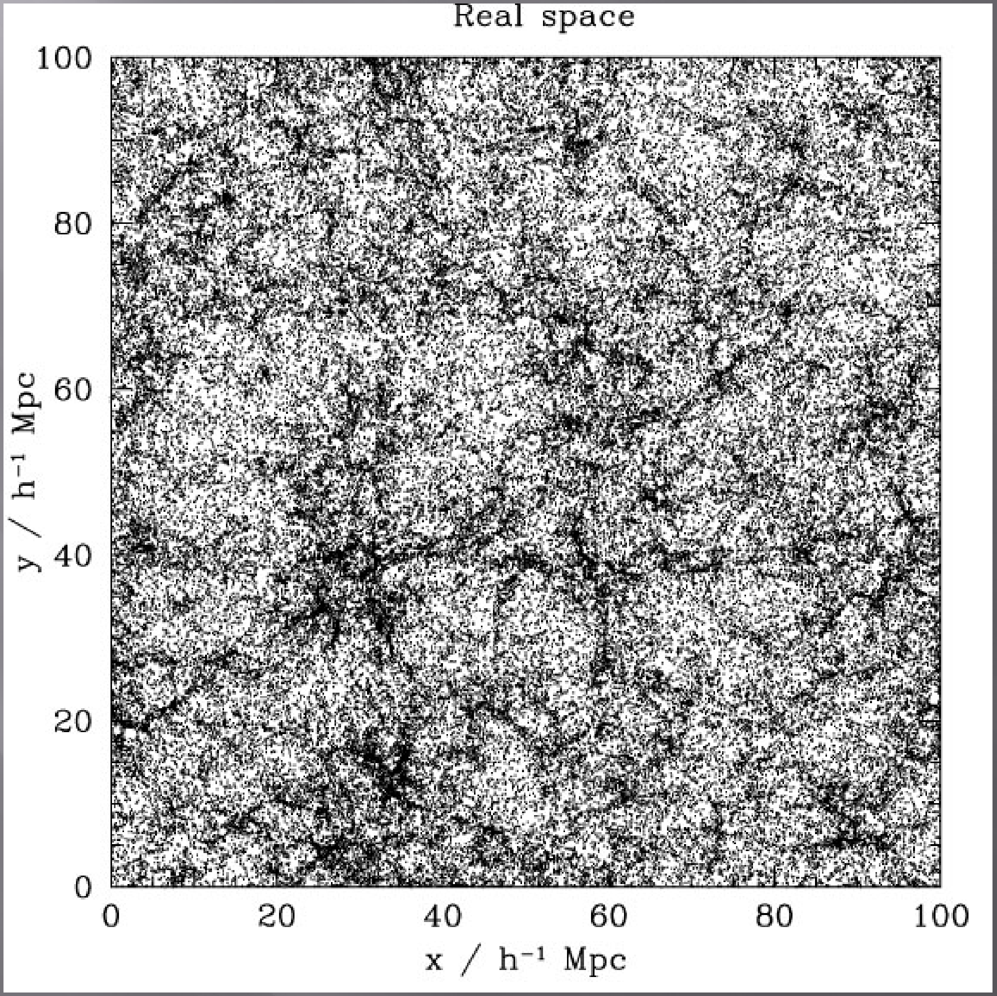
Redshift space distortions

- Hubble's Law: $cz = H_0 d$
- Real space distance $r = H_0 d$
- Redshift space distance $s = cz$
- But $s = r + \hat{\mathbf{r}}.\mathbf{v}$

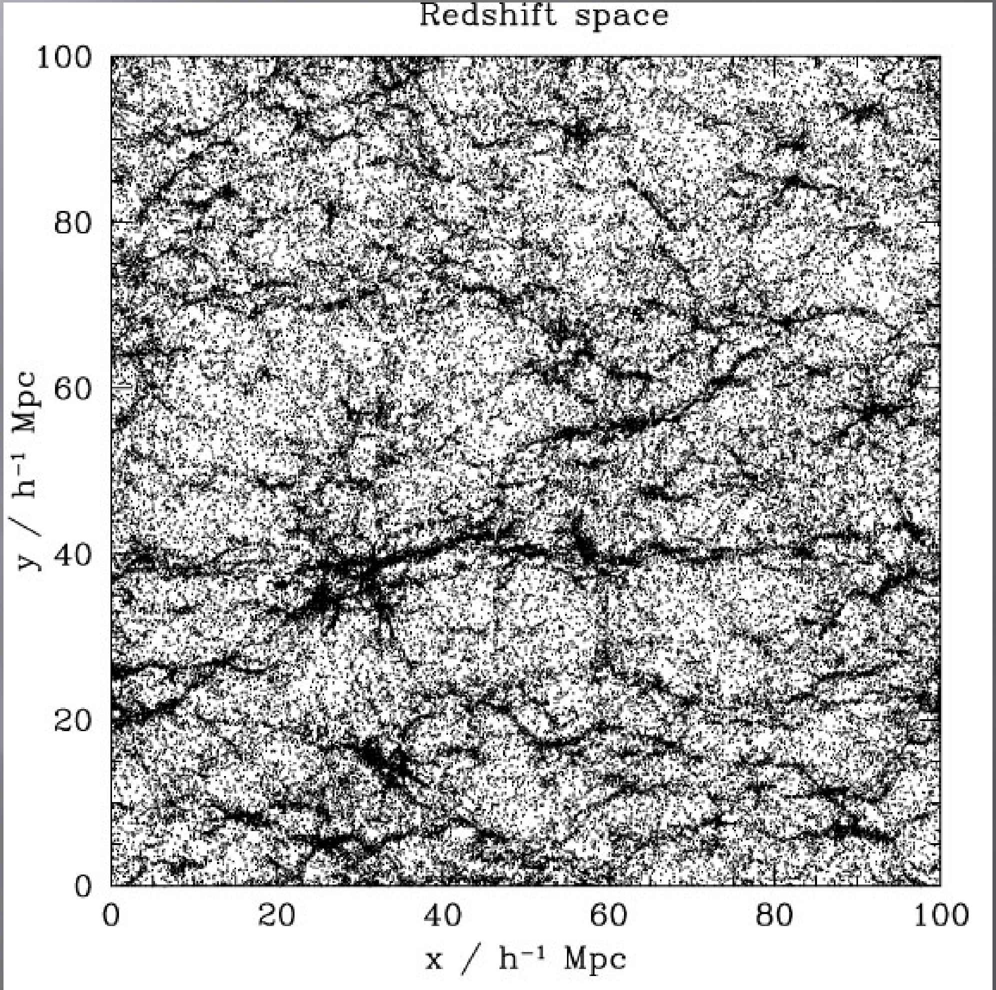
Linear distortions



High redshift



High redshift



Kaiser's formula

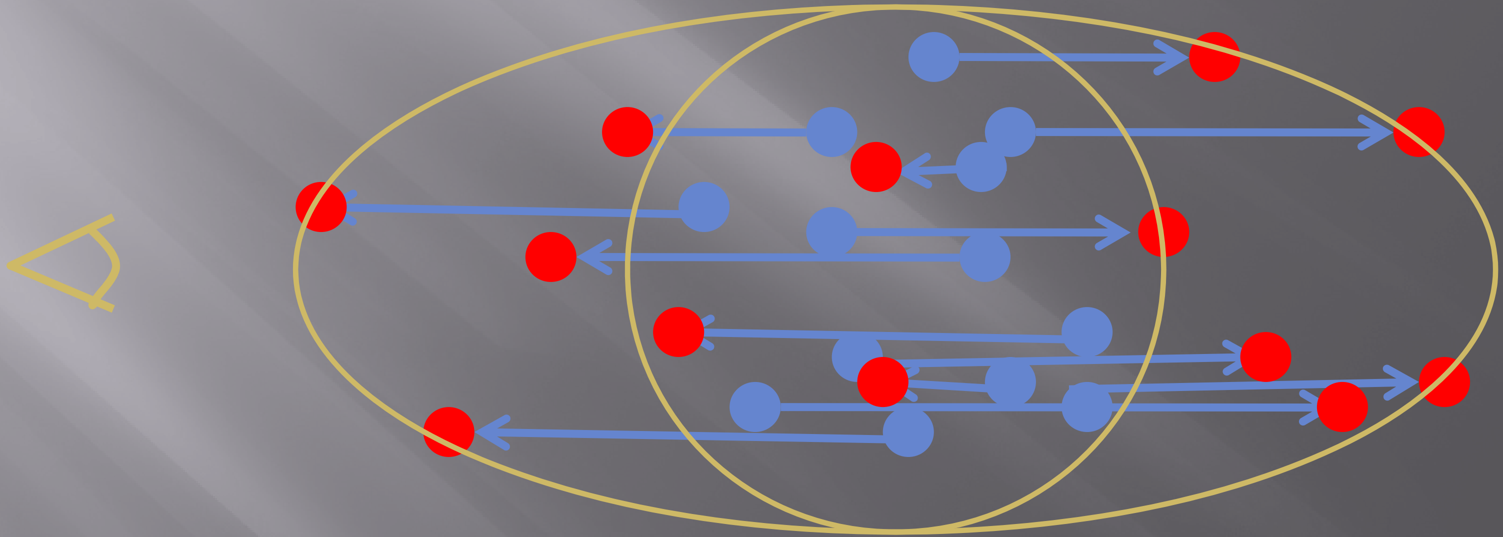
$$P_s(\mathbf{k}) = P_r(\mathbf{k})\left(1 + f(\Omega)\mu^2\right)^2$$

$$\boxed{f(\Omega) \equiv \frac{\mathrm{d}\ln D}{\mathrm{d}\ln a} \approx \Omega^{0.6}}$$

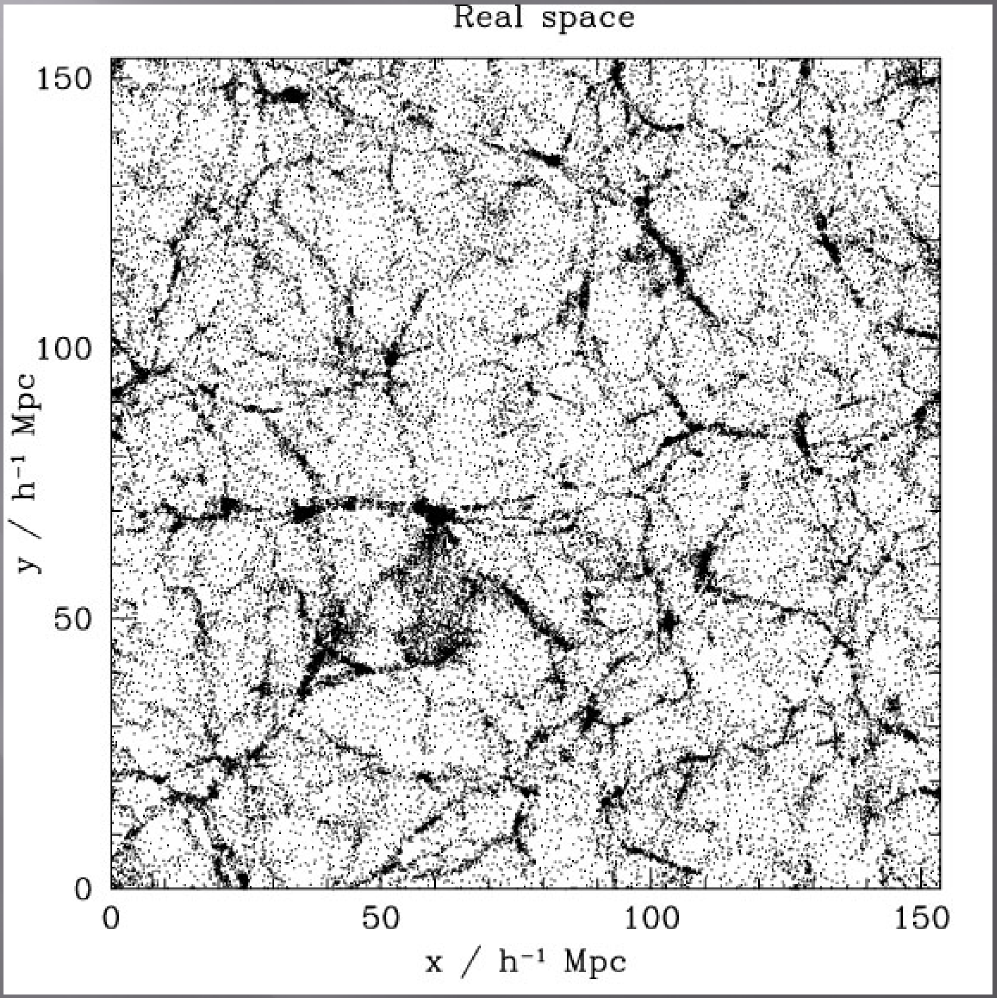
$$\boxed{\mu \equiv \hat{\mathbf{z}}.\hat{\mathbf{k}}}$$

$$P_0^s(k) = \left(1 + \tfrac{2}{3} f + \tfrac{1}{5} f^2\right) P^r(k)$$

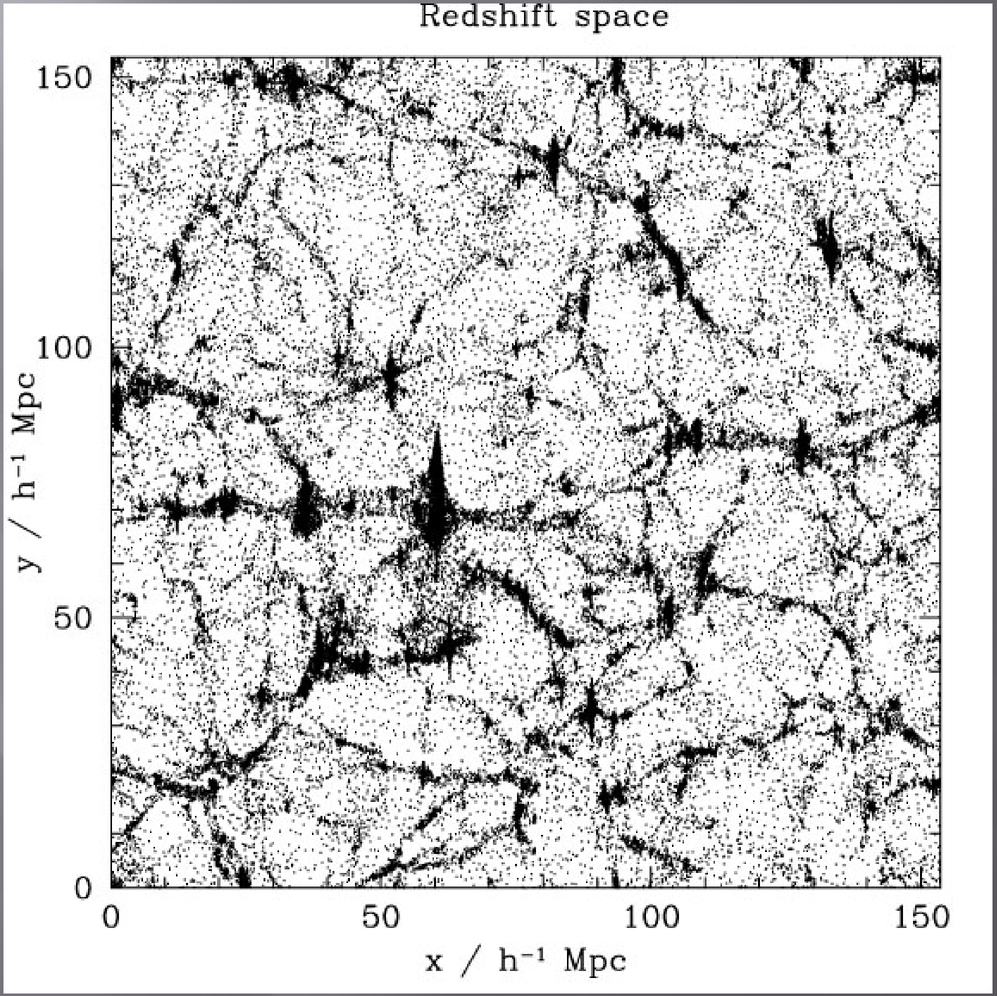
‘Fingers of God’



Low redshift



Low redshift



Dispersion model

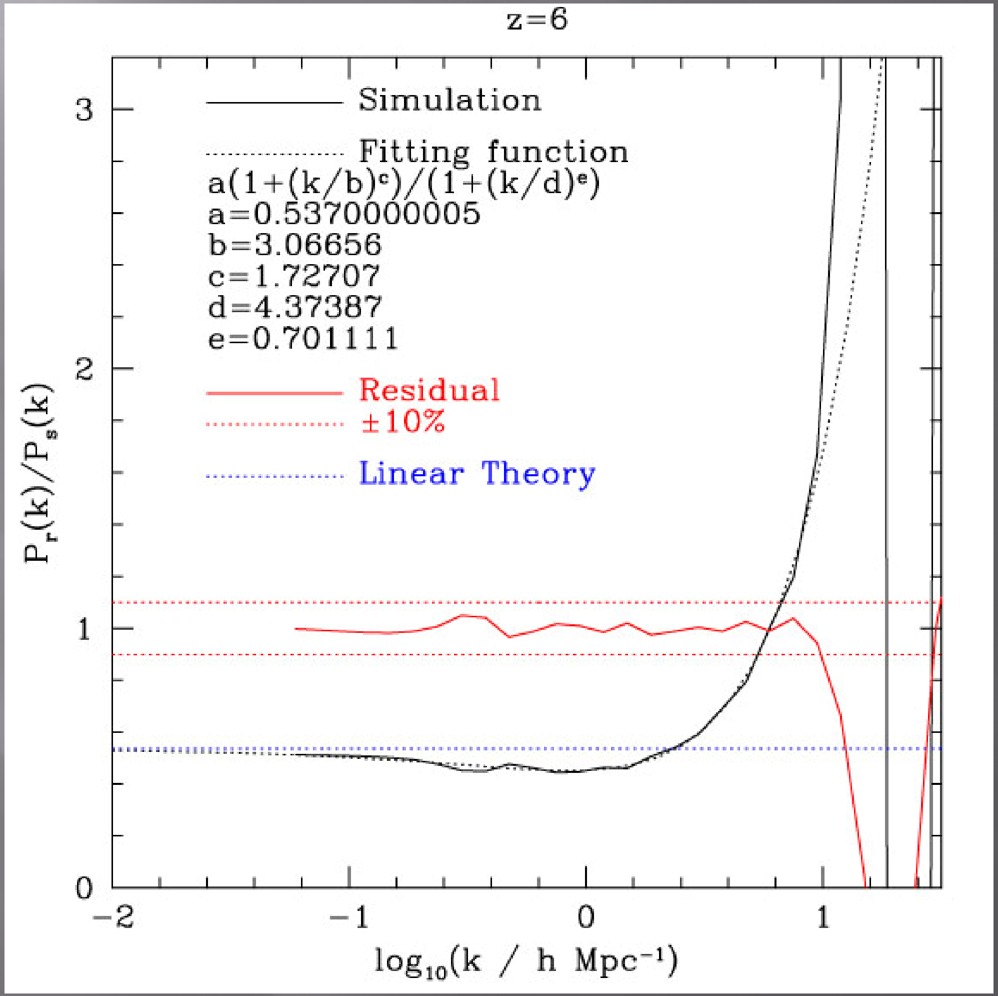
$$\boxed{\beta \equiv f(\Omega)/b}$$

$$P_s(\mathbf{k}) = \underbrace{P_r(\mathbf{k})\left(1+\beta\mu^2\right)^2}_{\text{Linear theory with bias}} \underbrace{\frac{1}{1+k^2\mu^2\sigma_p^2/2}}_{\text{Velocity dispersion corresponding to exponential pairwise velocity distribution function}}$$

Linear theory
with bias

Velocity dispersion
corresponding to
exponential
pairwise velocity
distribution
function

Fitting the ratio



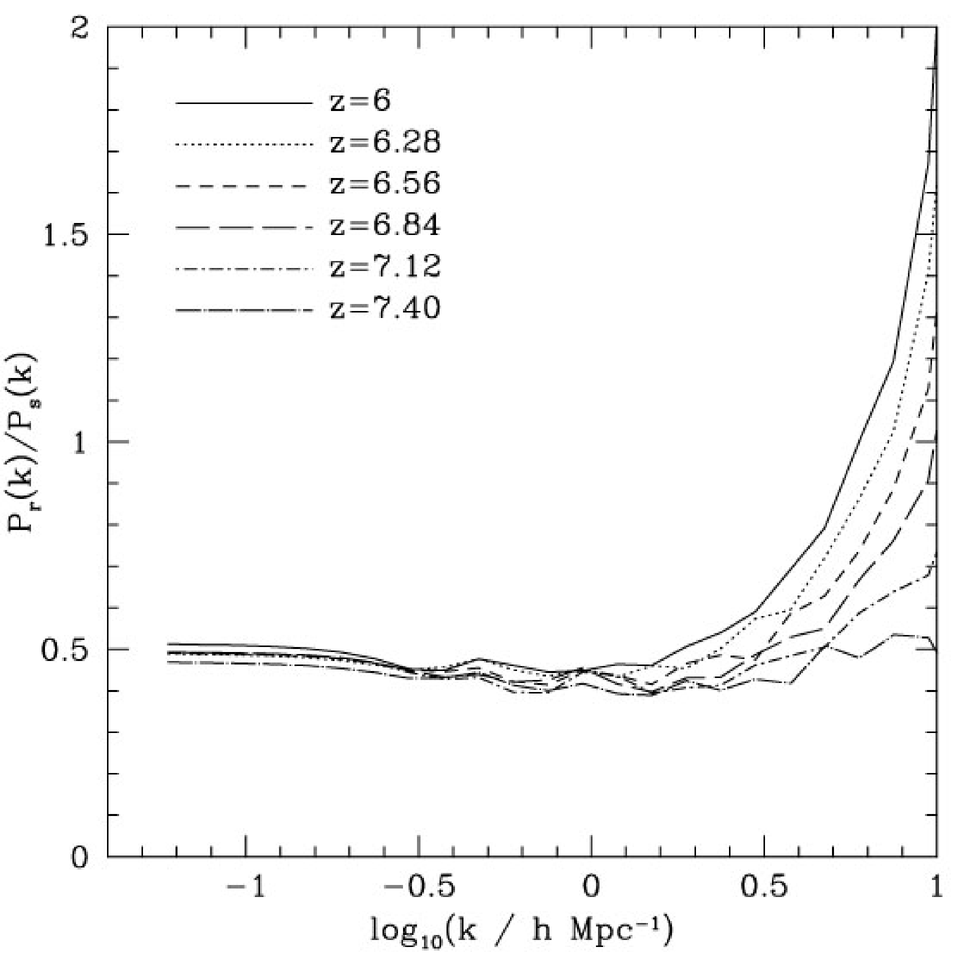
An enhancement in excess of linear theory

$$\boxed{U \equiv \hat{\mathbf{r}}.\mathbf{v}}$$

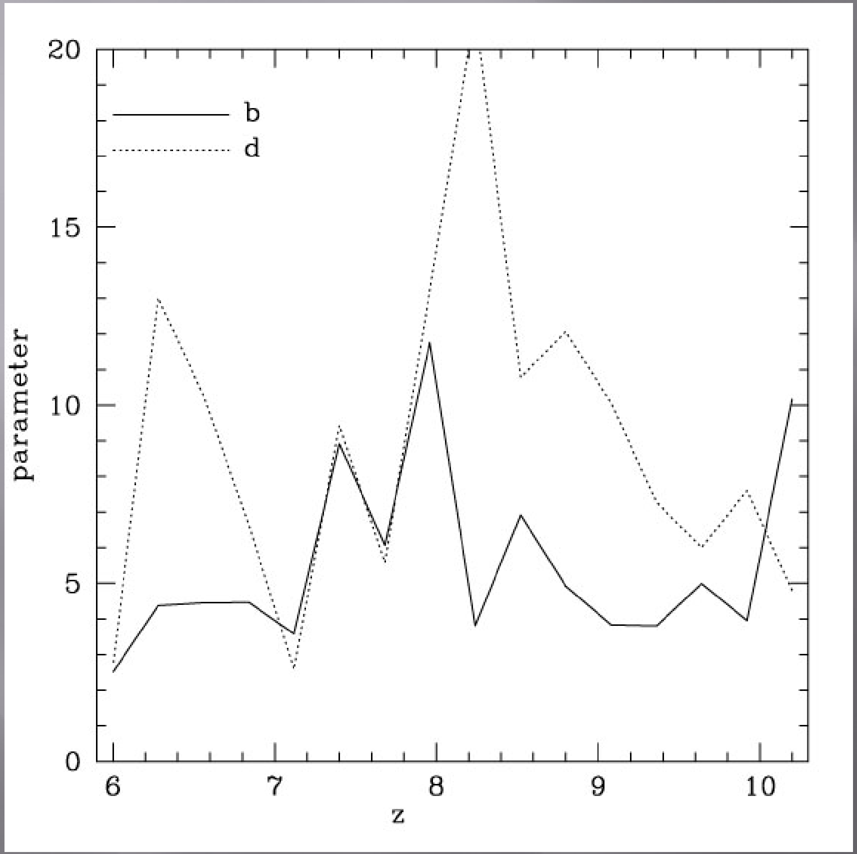
$$1+\delta_s(\mathbf{r}) = \left(1+\frac{\mathrm{d}U}{\mathrm{d}r}\right)^{-1}\left(1+\delta_s(\mathbf{r})\right)$$

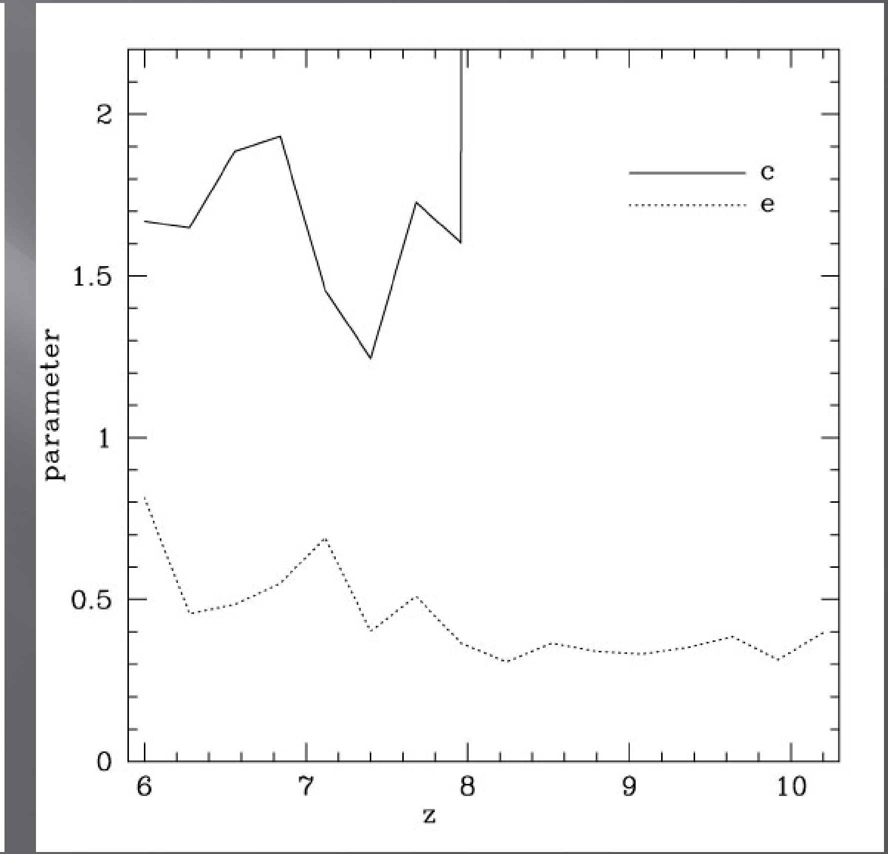
$$\Rightarrow \delta_s \approx \underbrace{\delta_r - \frac{\mathrm{d}U}{\mathrm{d}r}}_{\to\text{Kaiser formula}} - \underbrace{\delta_r \frac{\mathrm{d}U}{\mathrm{d}r}}_{\to\text{Enhancement?}}$$

Variation with redshift



Parameter variation





Conclusions and further work

- We see an enhancement in the redshift-space power spectrum in excess of linear theory at quasilinear scales.
- A simple fitting function describes the ratio of the power spectra very well over the scales accessible to LOFAR.
- Further theoretical work is required to understand the form of this function and its dependence on redshift.
- Robustly determine the dependence on μ and z (more volume and fewer transients?)

Anomalies in the correlation function