Discussion about statistical optimization of redshift survey: Halo mass binning

Teppei Okumura
Institute for the Early Universe, Ewha

Redshift-space distortion (RSD): Growth rate from galaxy clustering

- Linear theory RSD

$$P^{(s)}(k, \mu_{\mathbf{k}}) = b^2(1 + \beta\mu_{\mathbf{k}}^2)^2 P_m^{(r)}(k)$$

$$\beta = \frac{f}{b} = \frac{\Omega_m^{\gamma}}{b}$$

$\gamma = 0.55$: ΛCDM + GR

→ Test of gravity theory

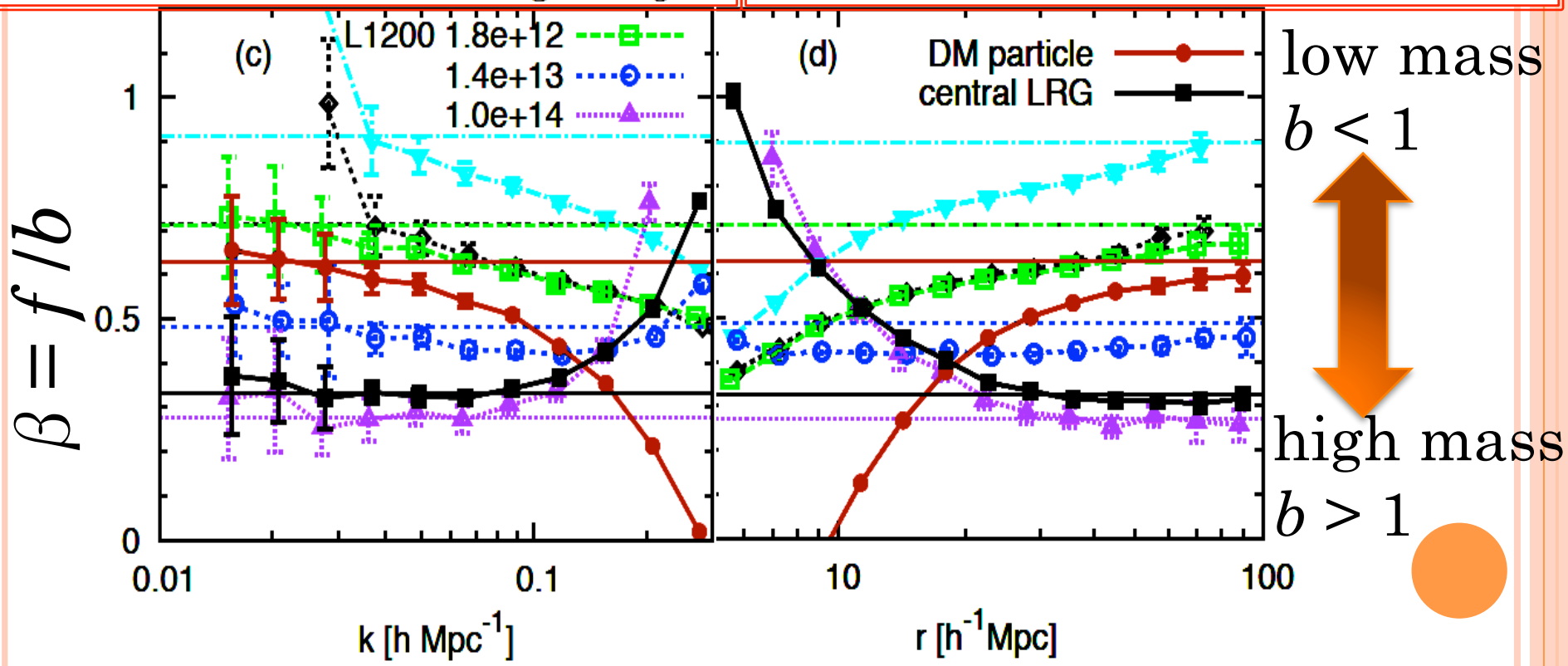
- Questions:
  - Can RSD constrain growth rate unbiasedly?
  - What kind of galaxies is the best sample?
- Halo mass dependence of growth rate
- Halo mass dependence of systematic effects:
  - Finger-of-god
  - Nonlinear stochastic biasing
  - Nonlinear infall velocities and real-to-redshift space mapping

Halo mass dependence of growth rate reconstruction

- Fourier space Configuration space

$$P^{(2/0)}(k) \equiv \frac{P_2(k)}{P_0(k)} = \frac{\frac{4}{3}\beta + \frac{4}{7}\beta^2}{1 + \frac{2}{3}\beta + \frac{1}{5}\beta^2}$$

$$\xi^{(2/0)}(r) \equiv \frac{\xi_2(r)}{\xi_0(r) - \bar{\xi}_0(r)} = \frac{\frac{4}{3}\beta + \frac{4}{7}\beta^2}{1 + \frac{2}{3}\beta + \frac{1}{5}\beta^2}$$



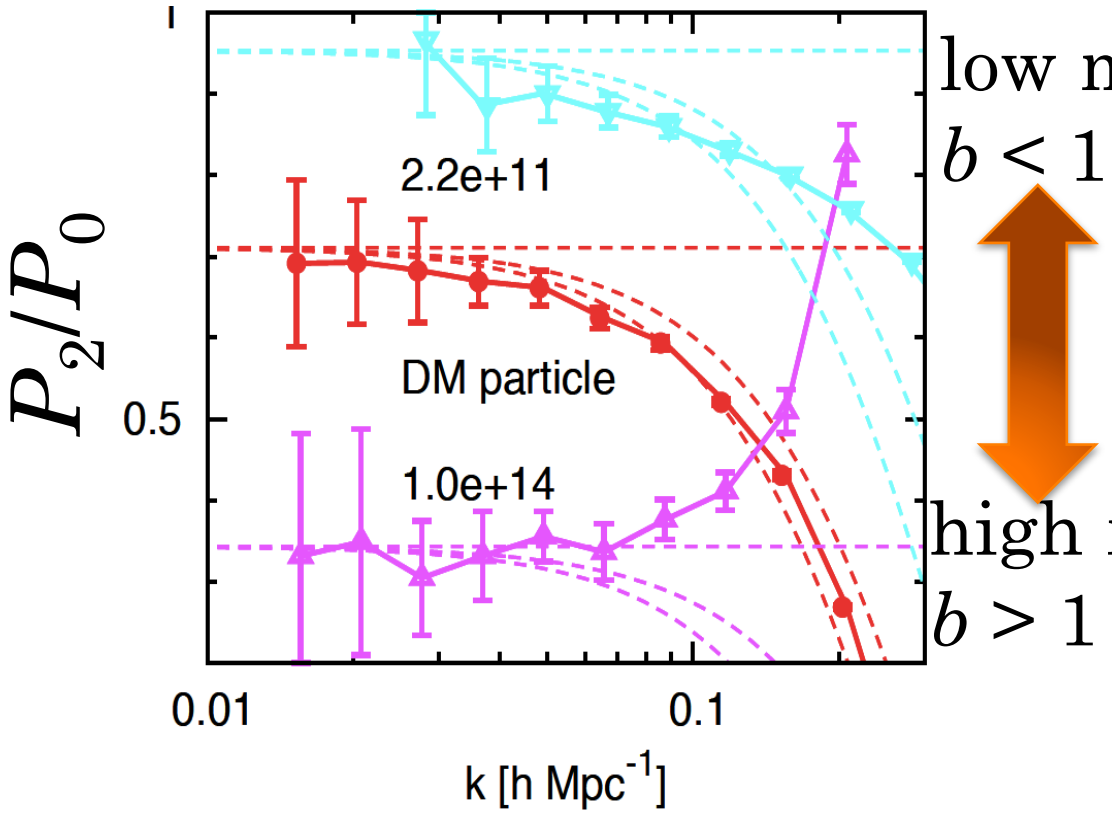
Okumura & Jing (2011)

PAIRWISE VELOCITY DISPERSION (PVD)

- Simplest example: Gaussian model

$$P^{(s)}(k,\mu_{\mathbf{k}}) = b^2(1+\beta\mu_{\mathbf{k}}^2)^2 P_m^{(r)}(k) \times G(k,\mu_k,\sigma_v)$$

$$G(k,\mu_{\mathbf{k}},\sigma_v) = (1+k^2\mu_{\mathbf{k}}^2\sigma_v^2/2)^{-1}$$



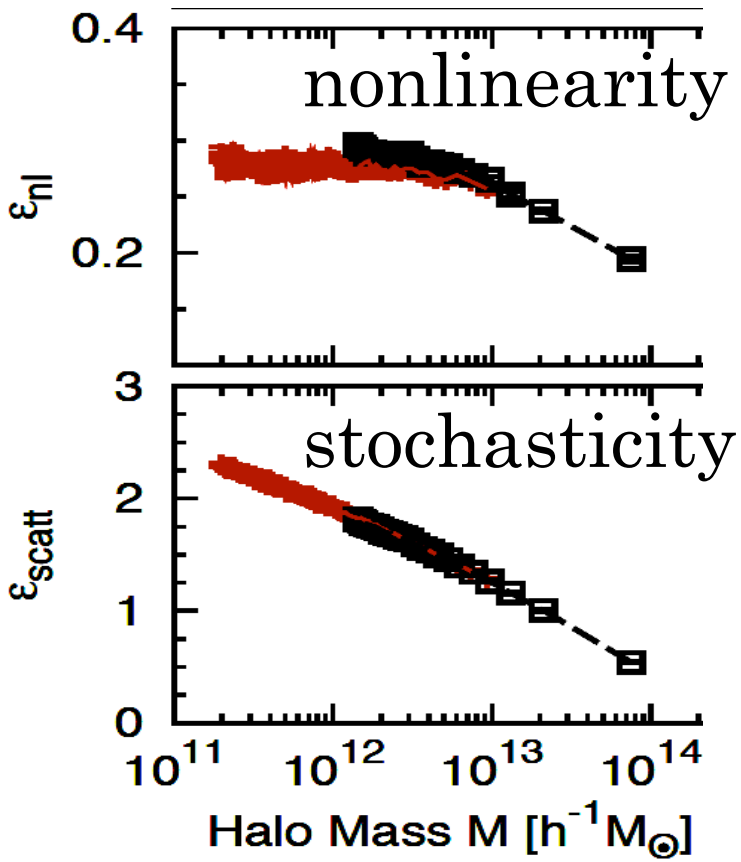
low mass
$b < 1$

high mass
$b > 1$

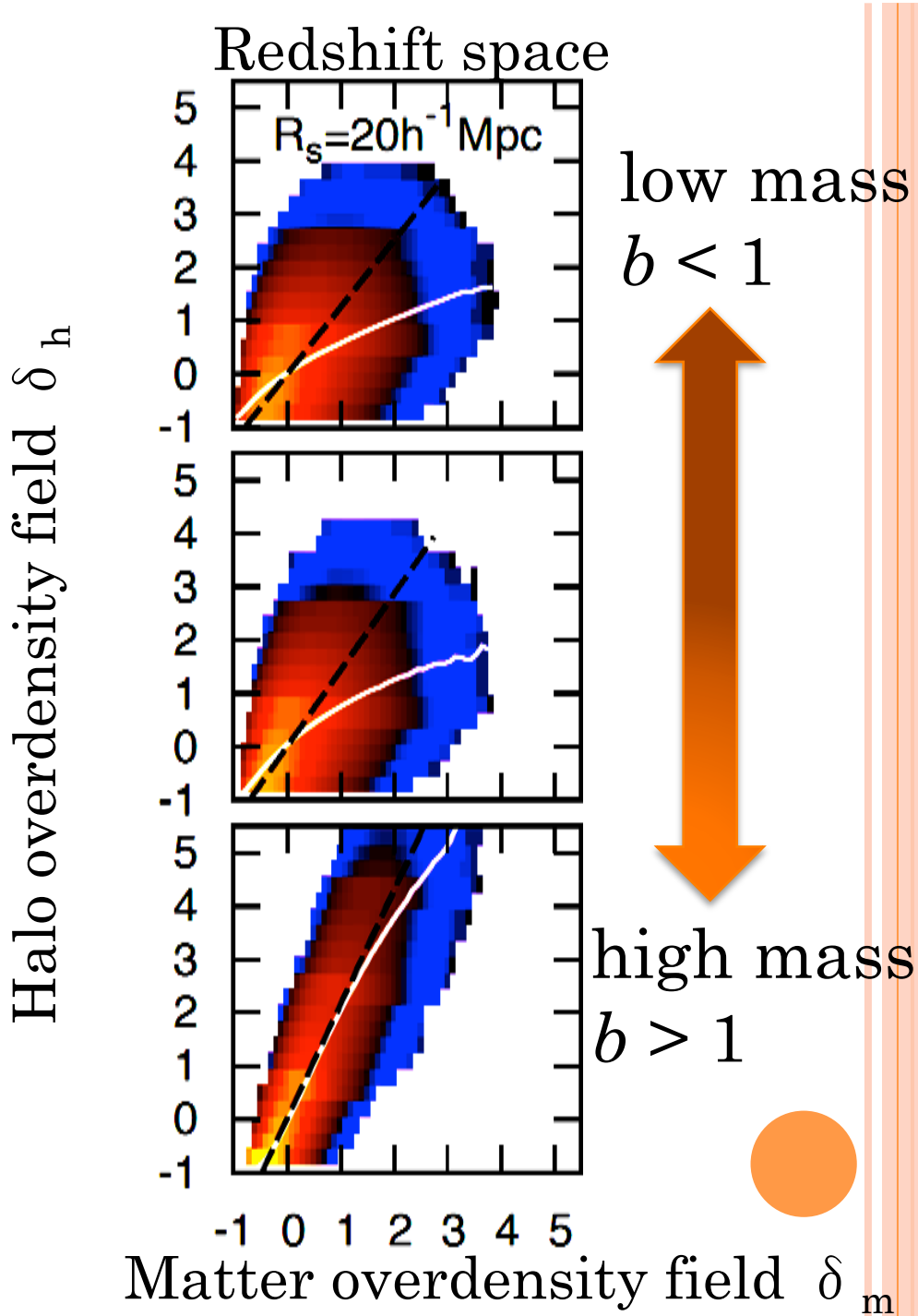
- PVD does not have strong halo mass dependence

Okumura & Jing (2011)

NONLINEARITY AND STOCHASTICITY OF BIASING



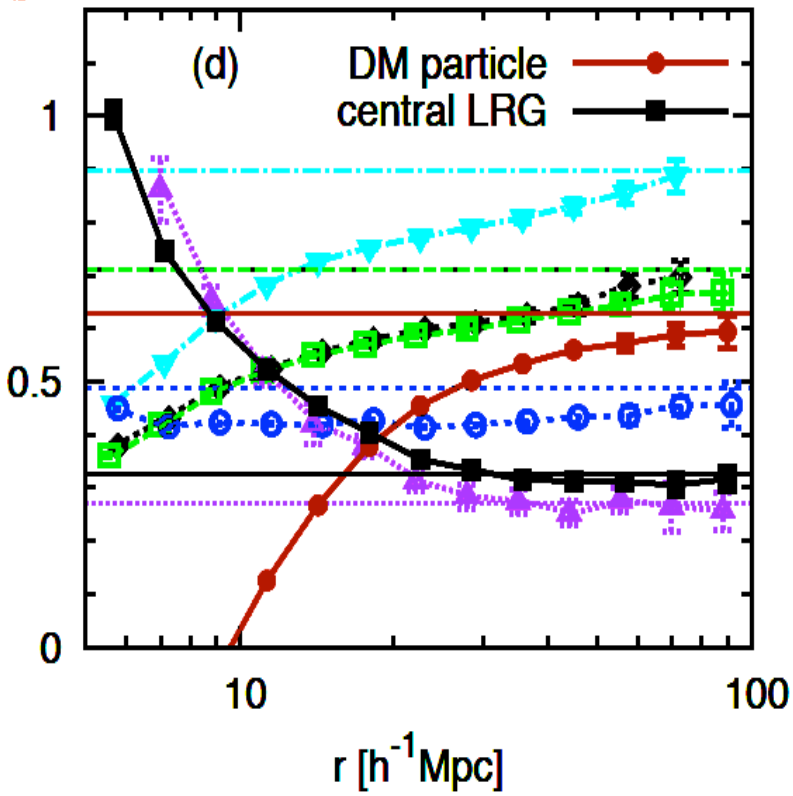
Okumura & Jing (2011)

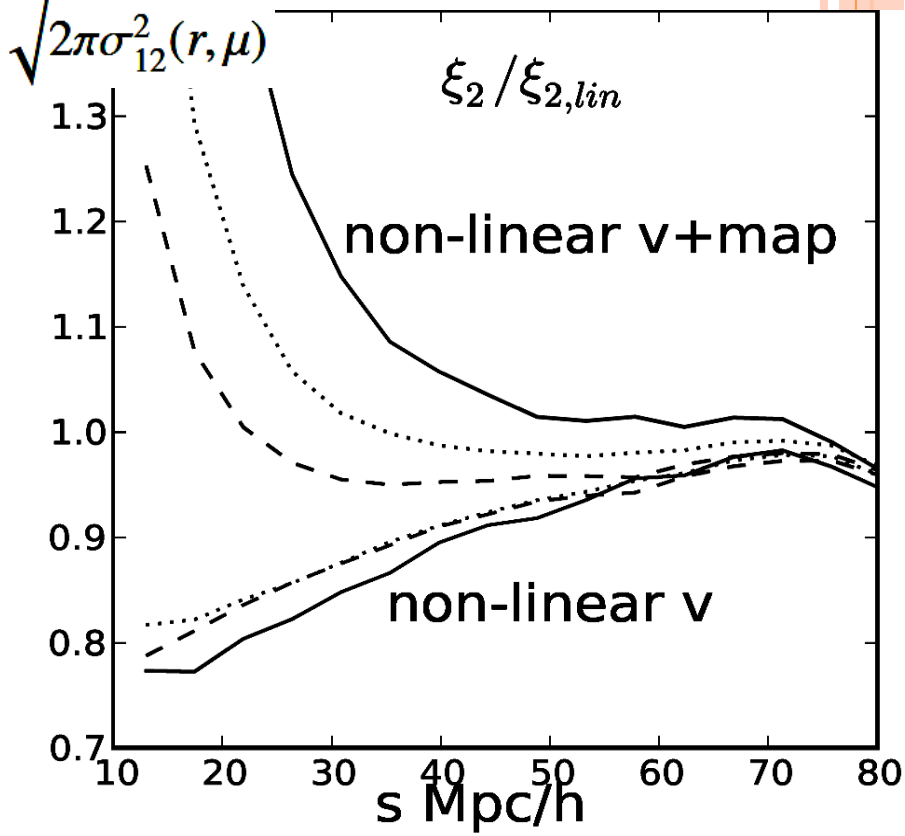


Nonlinear infall velocity and mapping between real and redshift space

- Non-perturbative real-to-redshift space mapping

$$\xi_g^s(r_\sigma, r_\pi) = \int \left[1 + \xi_g^r(r)\right] e^{-[r_\pi - y - \mu v_{12}(r)]^2/2\sigma_{12}^2(r,\mu)} \frac{dy}{\sqrt{2\pi\sigma_{12}^2(r,\mu)}}$$





Reid & White (2011)