Galaxy Clustering: 3D vs 2D

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- Galaxy clustering observables: Angular positions + redshifts of the galaxies.

- Analysis of 3D maps in cartesian space requires that we assume a cosmology in order to estimate the observed power spectrum or 2-pt correlation function.

- If we bin the survey in Nz radial shells and then we use the N_z angular autocorrelations + $N_z(N_z-1)/2$ cross-correlations between the redshift bins, i.e. $C_l(z_1,z_2)$ we can recover the 3D clustering information, paying the price of increasing the number of observables and the use of potentially large covariance matrices.

- Interest on the optimal bin configuration for the 2D analysis

arxiv pre-print: **1207.6487** (in collaboration with M. Crocce, E. Gaztañaga and A. Lewis)

- Considered model for 3D and 2D power spectra:

3D:

$$P_g(k, \mu, z) = (b + f\mu^2)^2 \, D^2(z) \, P_0(k) e^{-k^2 \sigma_t^2(z) \mu^2}$$

$$f(z) \equiv \Omega_m(z)^\gamma \qquad \sigma_t(z) = \frac{c\sigma_z}{H(z)}$$

2D:

$$C_\ell^{ij} = \frac{2}{\pi} \int dk \, k^2 P(k) \left(\Psi_\ell^i(k) + \Psi_\ell^{i,r}(k) \right) \left(\Psi_\ell^j(k) + \Psi_\ell^{j,r}(k) \right)$$

- Covariances given by sample variance + shot noise

- Spectroscopic Survey
  - Narrow redshift range $0.45<z<0.65$
  - Non bias evolution

- Narrow Band Photometric Redshift

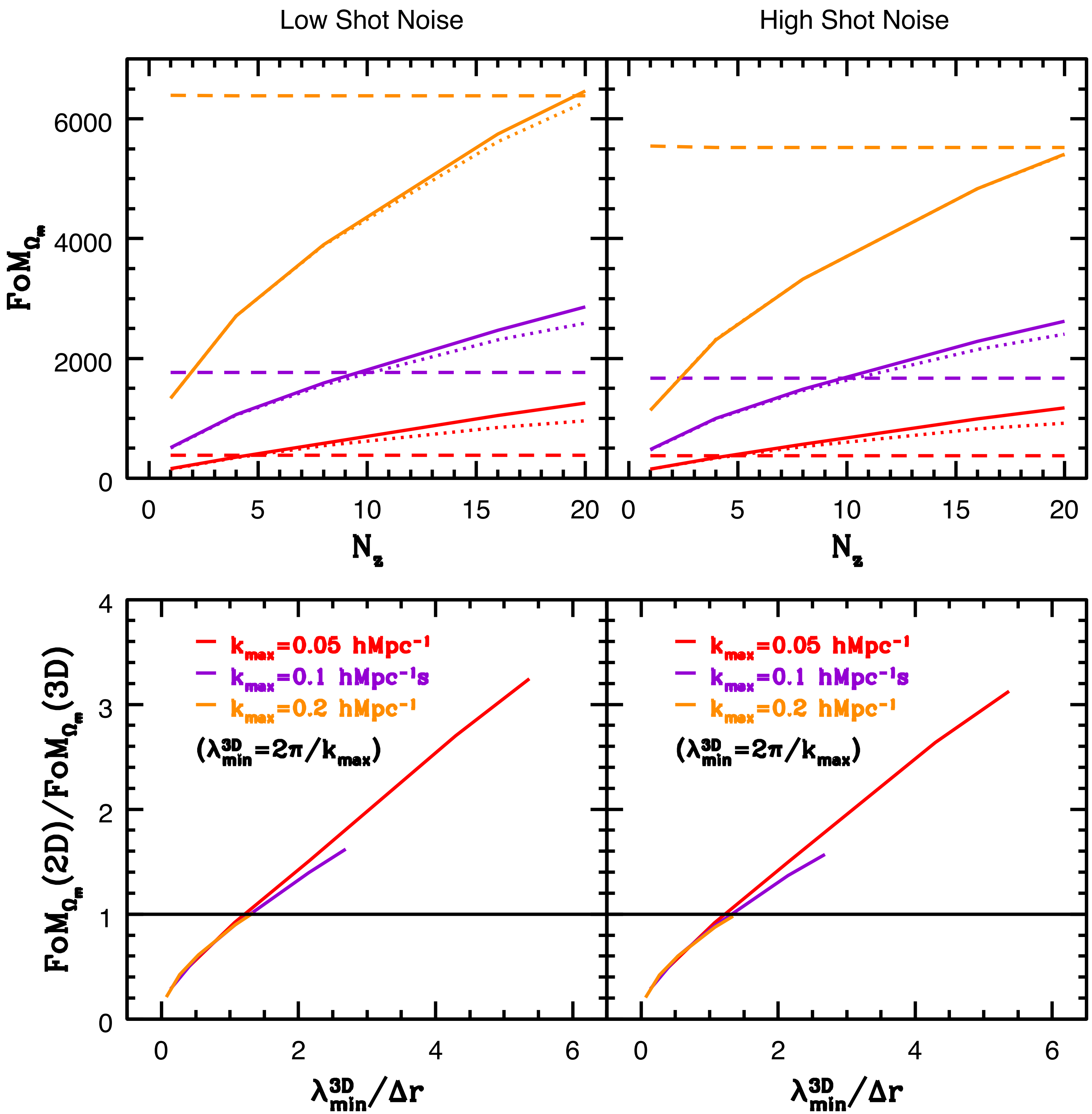
  "PAU-like"
  - Narrow redshift range $0.45<z<0.65$
  - Non bias evolution
  - Gaussian photo-z: $\sigma_z = 0.004$

- Broad Band Photometric Redshift

  "DES-like"
  - Broad redshift range $0.4<z<1.4$
  - Linear bias evolution
  - Gaussian photo-z: $\sigma_z = 0.1$

Full sky assumption in all of them

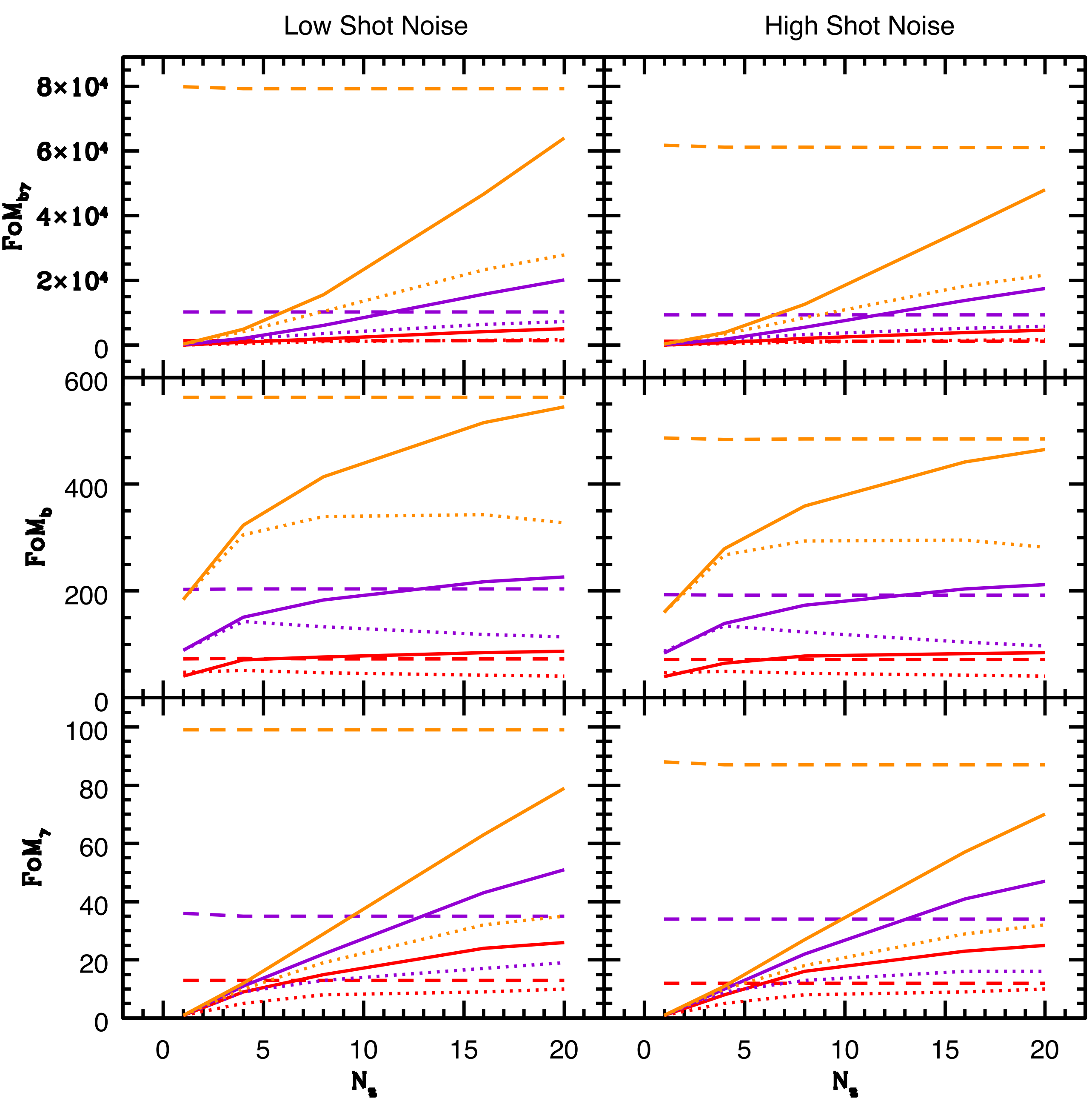
Spectroscopic survey: Ω_m

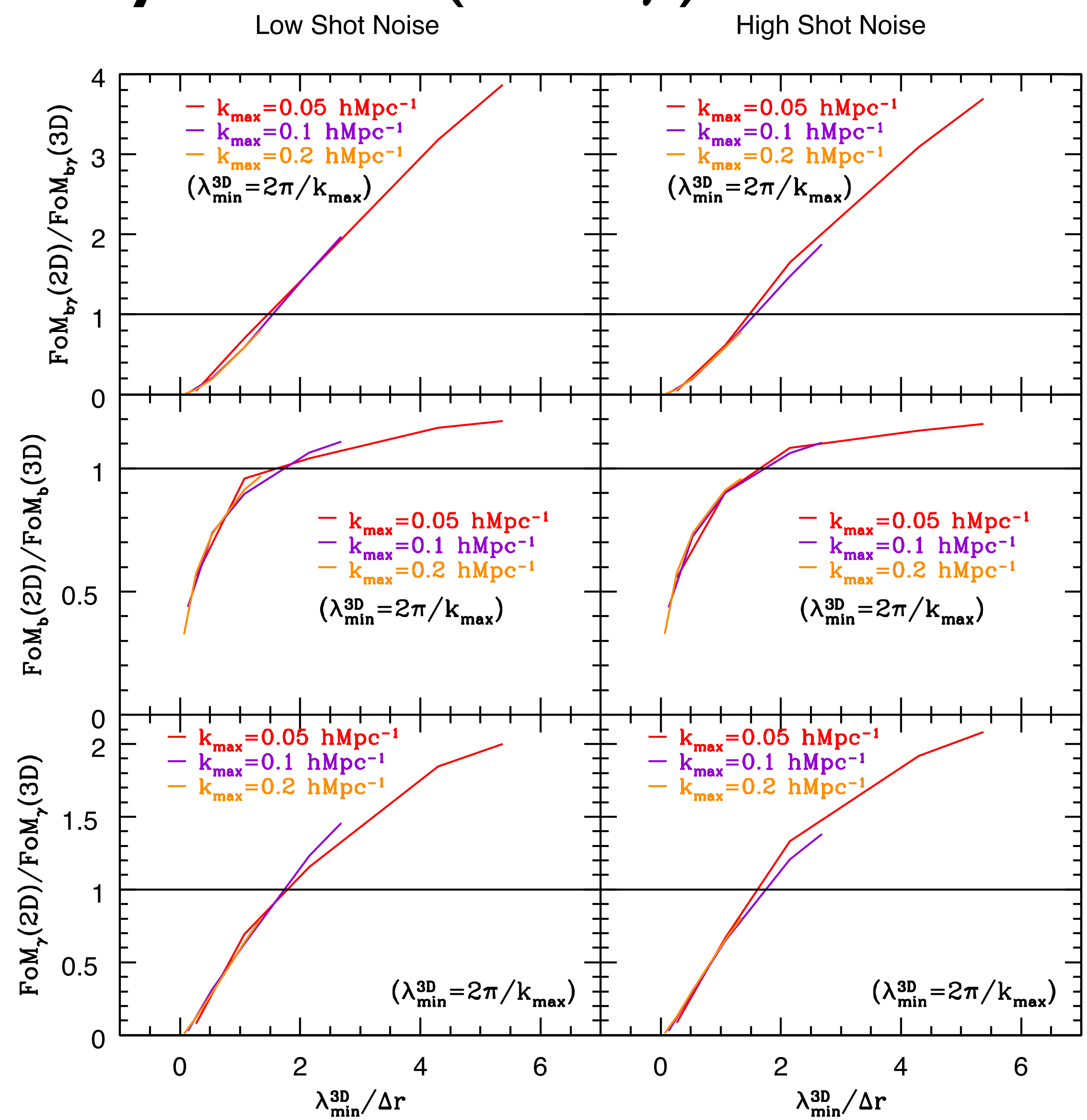


- Same constrains than in 3D analysis when the width of the redshift bins is similar to the minimum scale that we have included in the 3D analysis.

- In this case, most of the information comes from the shape of the power spectrum. Therefore, no much difference if we add the radial modes including the cross-correlations between redshift bins or not.

Spectroscopic survey: RSD (b & γ)

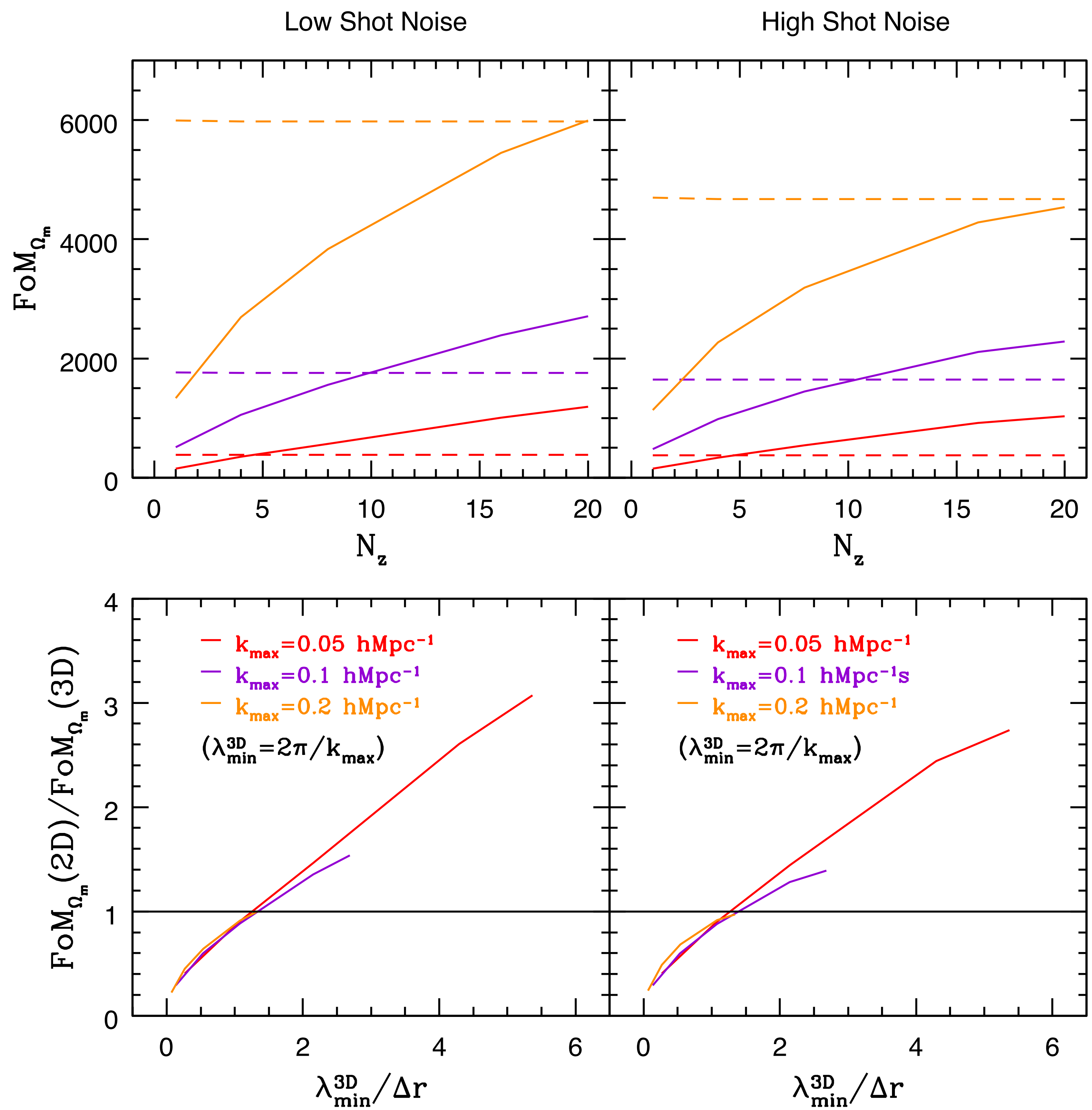




- In this case, we need to include the cross correlations if we want to recover 3D information.

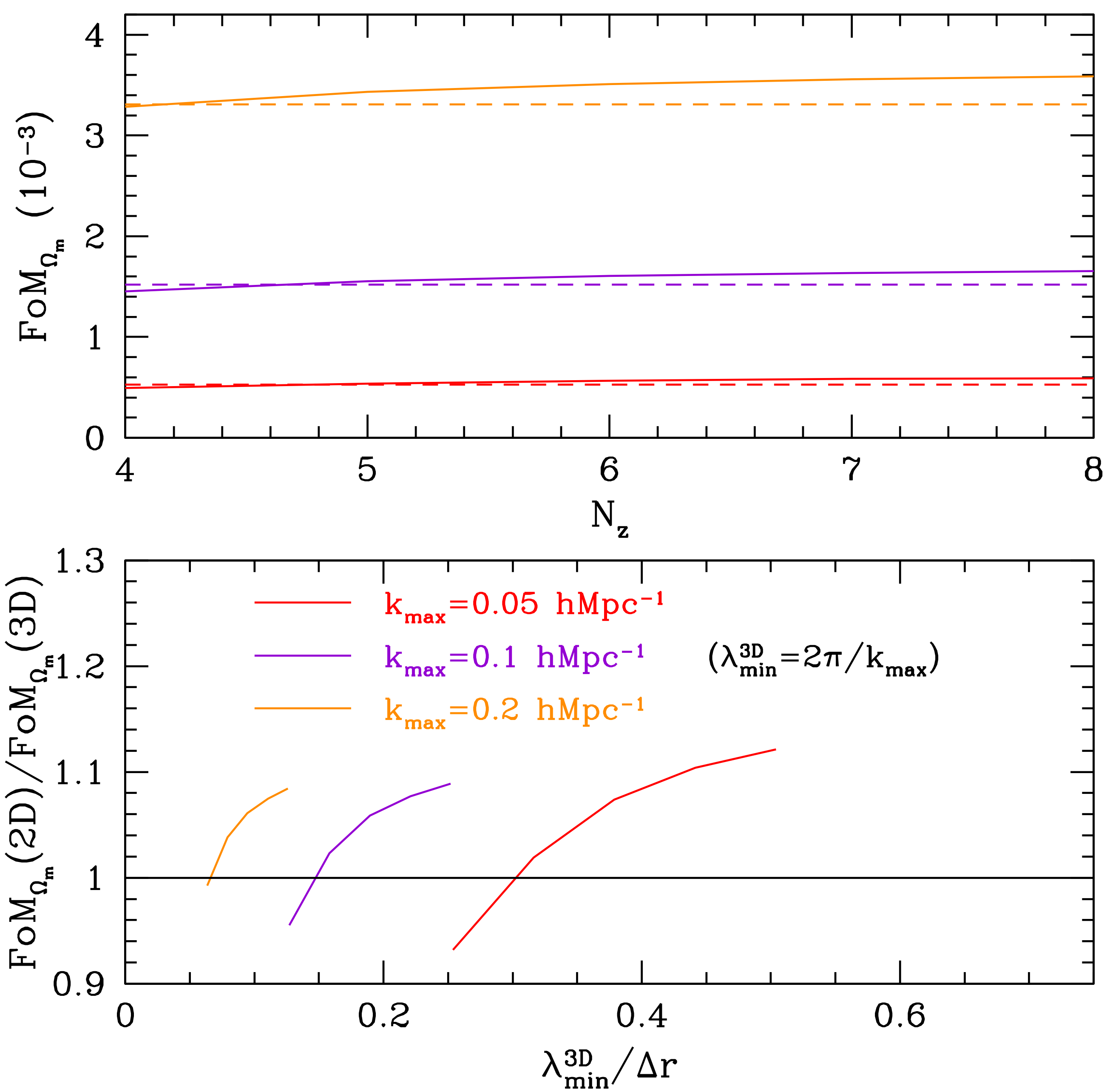
- Also, we need more bins than in the case in which we basically measure the shape of P(k).

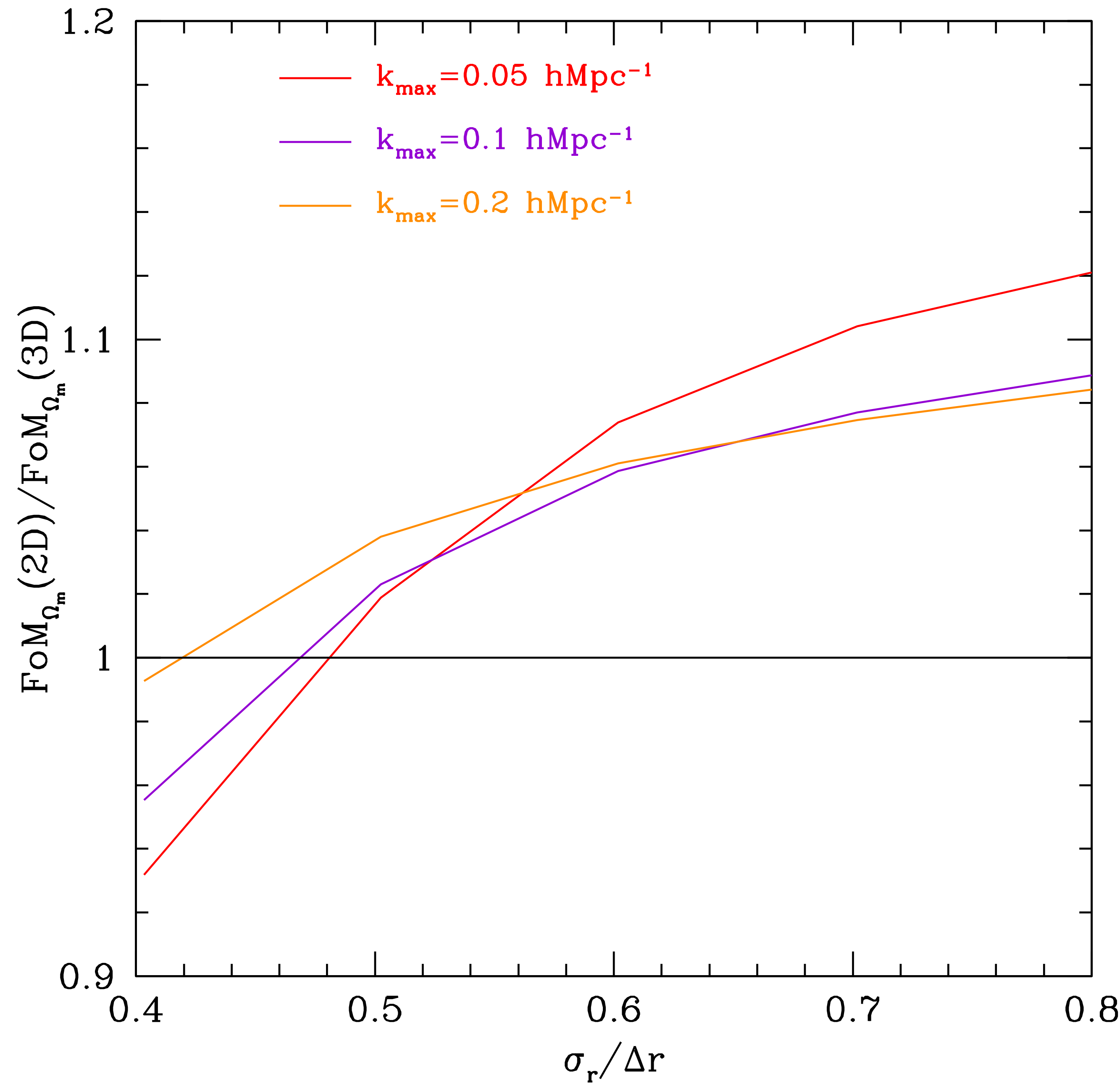
Narrow band photometric survey (PAU-like): Ω_m



- If the scale of the photometric redshift is smaller than the minimum scale in which we trust in the 3D analysis we find the same results than in the spectroscopic survey.

Broad band photometric survey (DES-like): Ω_m





- In this case, photo-z scale is larger than the minimum scale of the 3D analysis and it is degrading both analysis.

- The number of bins needed in the 2D analysis does not depend strongly on that minimum scale. In this case, this number is 5 (bins).

Conclusions

- When we observe galaxy we measure their redshift and angular position. If we want to use the 3D map we have to assume a cosmology to convert this to distances. In order to avoid that, we can bin the survey volume in radial shells and use angular correlations (auto+cross).

- Recovery of 3D clustering information in **spectroscopic** and **narrow band photometric surveys** in the case of Ω_m when the width of the redshift bins is similar to the minimum scale used in the full 3D analysis. Most of the information is given by the autocorrelations.

- When studying **RSD** we find that in order to recover 3D constrains we have to include all the cross-correlations because radial information is more important in this case than when most information comes from the shape of the power spectrum. This is important in order to do a full analysis of RSD + WL in 2D.

- For a **broad band photometric survey**, radial information is degraded in 3D and 2D cases and we the width of the z-bins that allow us to recover the 3D clustering information is not strongly related with the 3D minimum scale because photo-z scale is greater than the latter.