Quadrupole Power Spectra for the 2dF QSO and Future Redshift Surveys

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Reference

Yamamoto, Bassett and Nishioka Phys. Rev. Lett., 94, 051301 (2005)
Yamamoto, Nakamichi, Kamino, Bassett and Nishioka PASJ 58, 93 (2006)

Outline of the talk

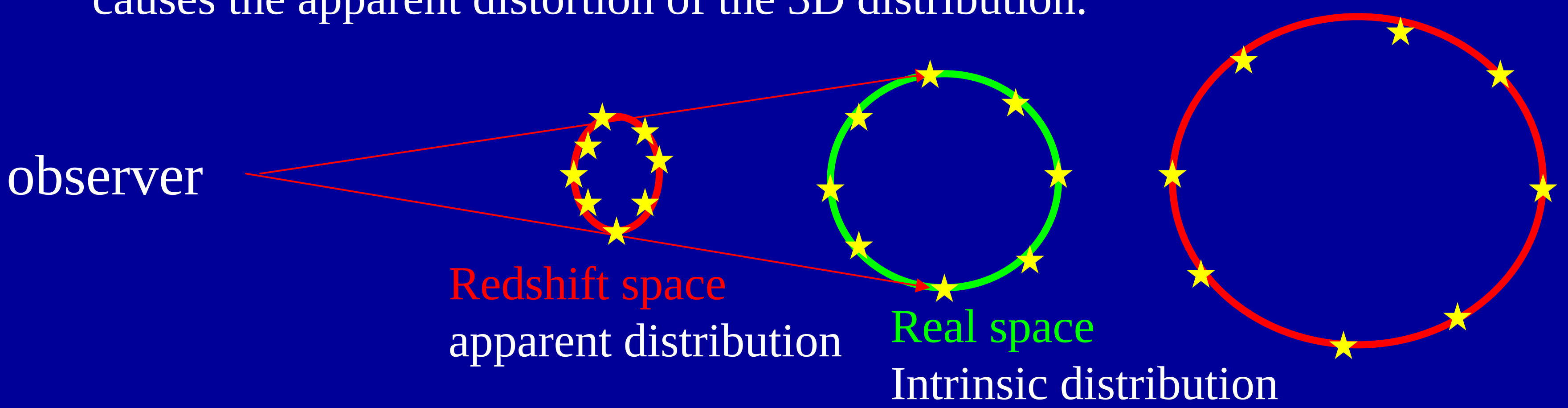
1. Alcock-Paczynski effect and peculiar velocity distortion
2. Multipole power spectrum
3. Expected constraints on dark energy
4. Application to the 2dF QSO survey
5. Summary

Alcock-Paczynski effect

To derive the 3D distribution from the redshift survey, we need to assume the cosmological parameters to convert the redshift to the comoving radial coordinate.

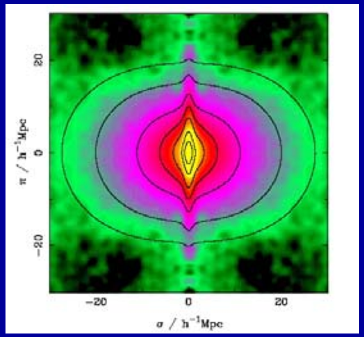
$$r(z\,|\,\Omega_m, w) = \frac{1}{H_0}\int_0^z \frac{dz'}{\sqrt{\Omega_m (1+z')^3 + (1-\Omega_m)(1+z')^{-3(1+w)}}}$$

The wrong choice of the set of cosmological parameters and w causes the apparent distortion of the 3D distribution.



Peculiar velocity distortion

Peculiar velocities also cause the apparent distortion of the the distrituion. (linear distortion and Finger of God)

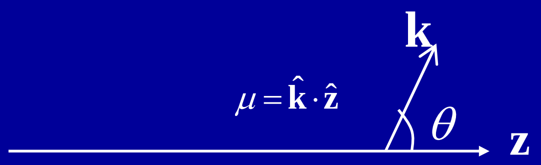


Peacock et al., 2001, Nature, 410, 196

Multipole power spectrum

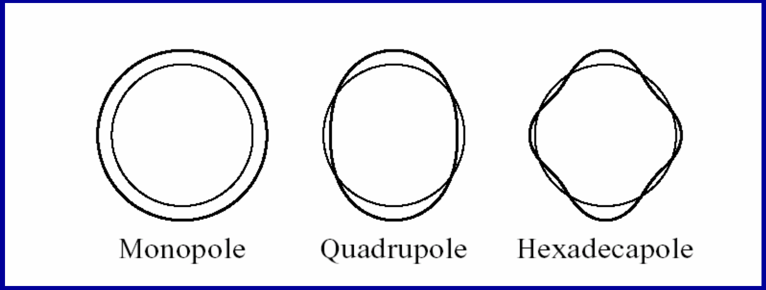
In this work, we adopt the multipole moments of the spatial power spectrum to quantify the anisotropy.
The power spectrum can be written as a function of wavenumner k and direction cosine.

$$P(\mathbf{k}) = P(k, \mu)$$



The direction-dependent power spectrum can be expanded in Legendru polynomials

$$P(k, \mu) = \sum_{l=0,2,...} P_l(\mu) P_l(k)$$



Multipole power spectrum

$$P_l(k) = \frac{2l+1}{2} \int_{-1}^{1} d\mu P(k, \mu) P_l(\mu)$$

The multipole power spectra from real data sets from the redshift survey data

Estimator:

$$R_l(\mathbf{k}) = \frac{\int d\mathbf{s}_1 \int d\mathbf{s}_2 \psi(\mathbf{s}_1,\mathbf{k})\psi(\mathbf{s}_2,\mathbf{k}) F(\mathbf{s}_1) F(\mathbf{s}_2) e^{i\mathbf{k}\cdot(\mathbf{s}_1-\mathbf{s}_2)} \mathcal{L}_l(\hat{\mathbf{s}}_h \cdot \hat{\mathbf{k}})}{\int d\mathbf{s}\bar{n}^2(\mathbf{s})\psi(\mathbf{s},\mathbf{k})^2}$$

Integration over the survey area

Legendre polynomials
as a function of the direction cosine

$$F(\mathbf{s}) = n_g(\mathbf{s}) - \alpha n_s(\mathbf{s})$$

Galaxy over density field in redshift space

Number density of the random sample

$$n_g(\mathbf{s}) = \sum_i \delta(\mathbf{s} - \mathbf{s}_i)$$

Galaxy number density

The ensemble average of this quantity is

$$\langle R_l(\mathbf{k})\rangle = \frac{\int d\mathbf{s}\bar{n}(\mathbf{s})^2\psi(\mathbf{s},\mathbf{k})^2 P(\mathbf{k},|\mathbf{s}|)\mathcal{L}_l(\hat{\mathbf{s}}\cdot\hat{\mathbf{k}})}{\int d\mathbf{s}\bar{n}^2(\mathbf{s})\psi(\mathbf{s},\mathbf{k})^2} + S_l(\mathbf{k})$$

The product of the anisotropic power spectrum and Legendre polynomial averaged over the redshift

Shot noise term

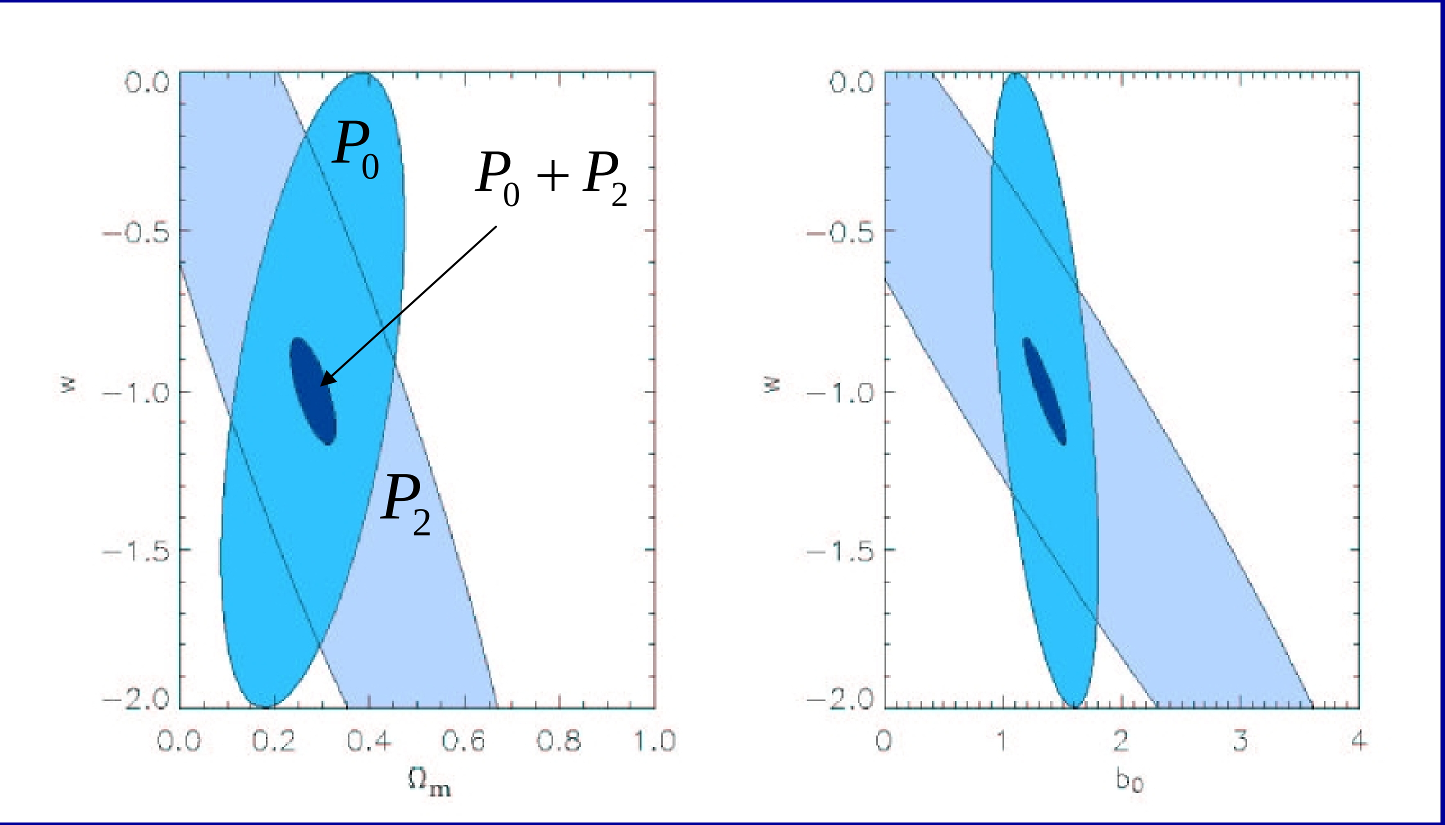
The multipole moment of the power spectrum is extracted by

$$\mathcal{P}_l(k) = \frac{1}{\Delta V_k}\int_{\Delta V_k} d\mathbf{k}\mathcal{P}_l(\mathbf{k})$$

$$\mathcal{P}_l(\mathbf{k}) = R_l(\mathbf{k}) - S_l(\mathbf{k})$$

Expected constraints on dark energy

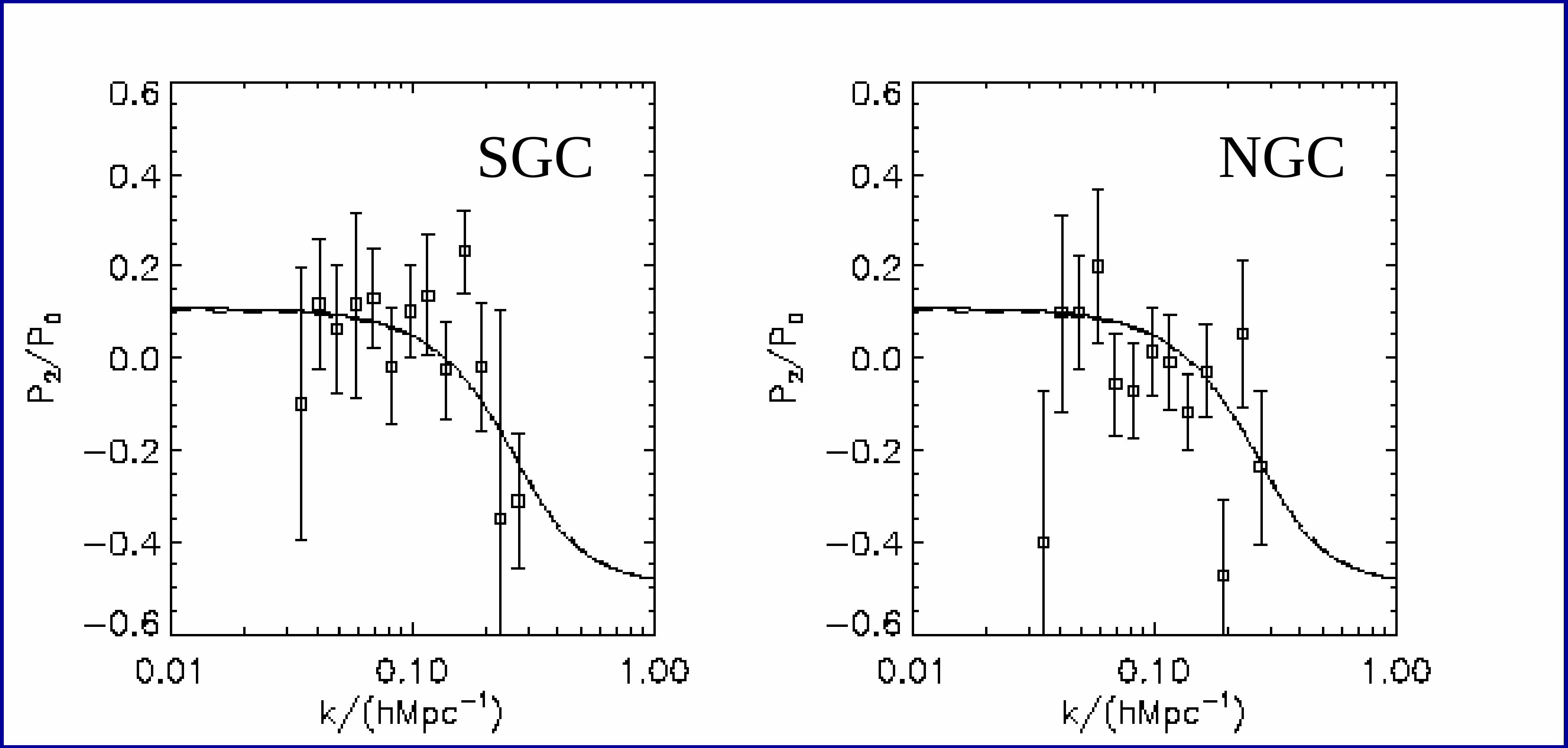
We have done the Fisher matrix analysis for the mulipole power spectra assuming the sample from WFMOS.



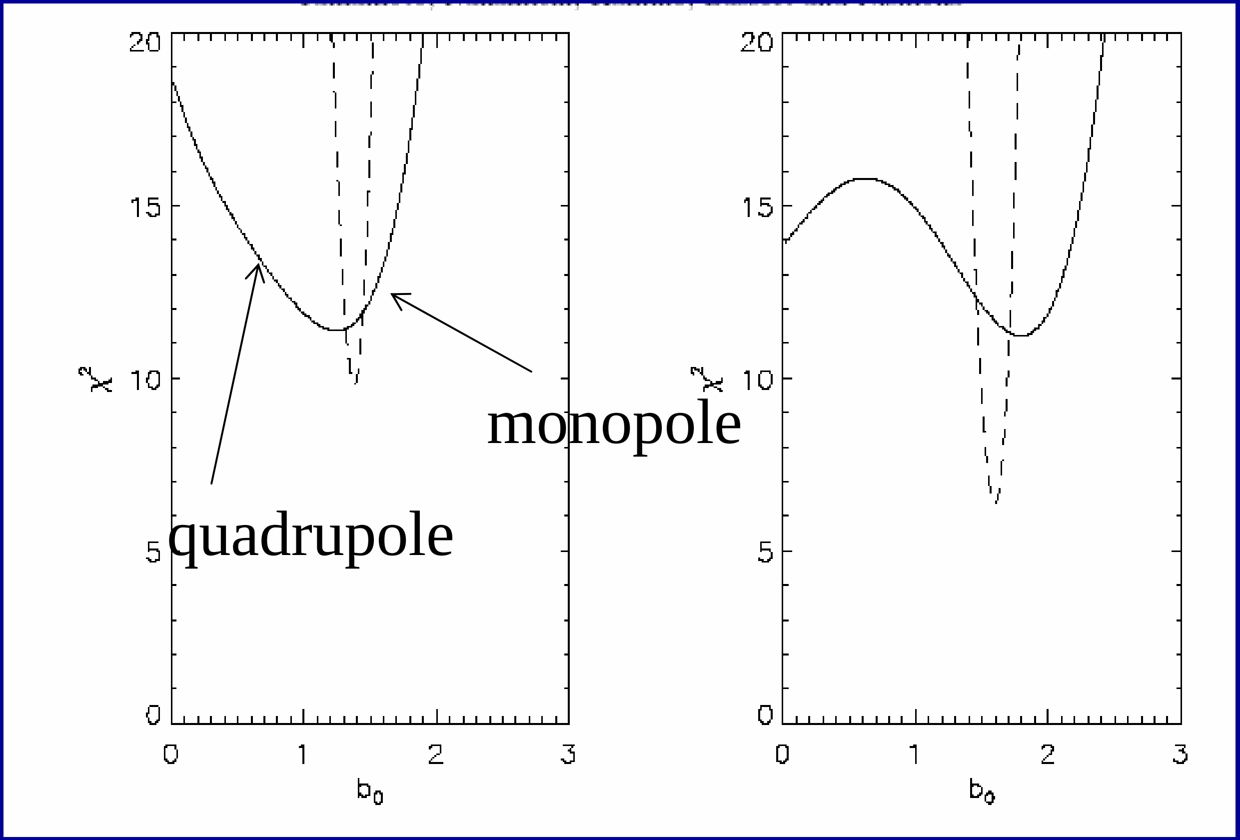
Expected constraints on the dark energy (equation of state parameter, w).

Application to the 2dF QSO survey

Measured quadrupole power spectra and best-fit theoretical model (bias parameter).



Chi^2 of the monopole and quadrupole power spectra as a function of bias parameter.



Best-fit parameters from monopole and quadrupole are consistent. Also the result is consistent with previous results from 2QZ group (Croom et al 2005).

Summary

- We have done the Fisher matrix analysis to estimate the constraints on dark energy from the anisotropy of the spatial power spectrum adopting the quadrupole power spectrum assuming the WFMOS sample.
- We have shown that the anisotropy(quantified by the quadrupole power spectrum) will play an important role to constrain the dark energy.
- We applied the same estimator of the quadrupole power spectrum to the 2dF QSO survey to test our algorithm
- We got the consistent results of the bias parameter with the previous results(Croom et al. 2005) although the measured quarupole spectrum is noisy.