Optimal capture of non-Gaussianity with weak lensing

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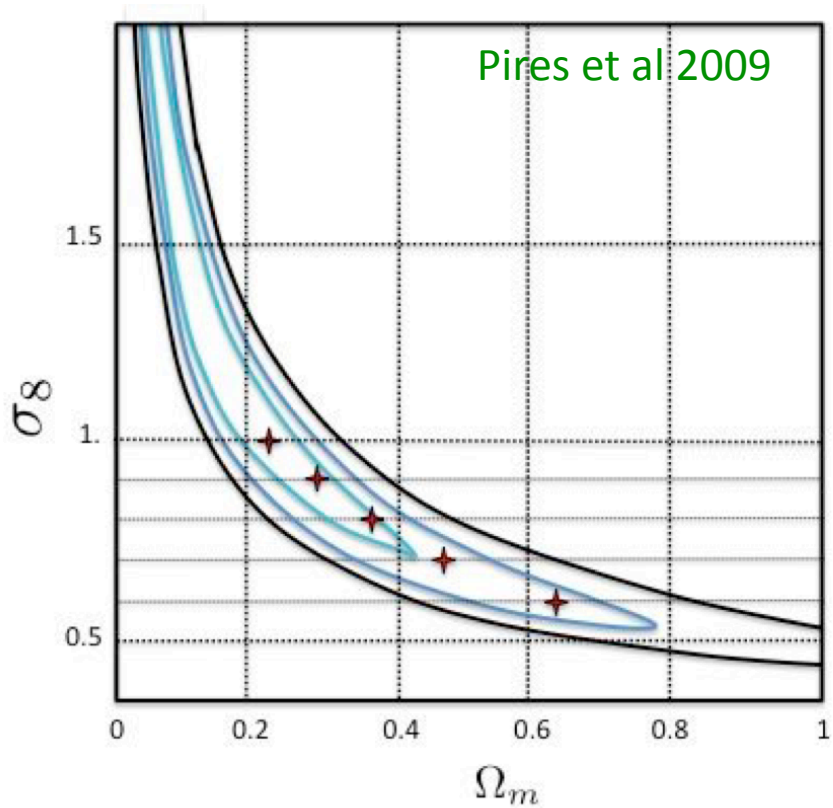
10 Years of Cosmic Shear, Edinburgh, July 22, 2010

Why capture non-Gaussianity ?

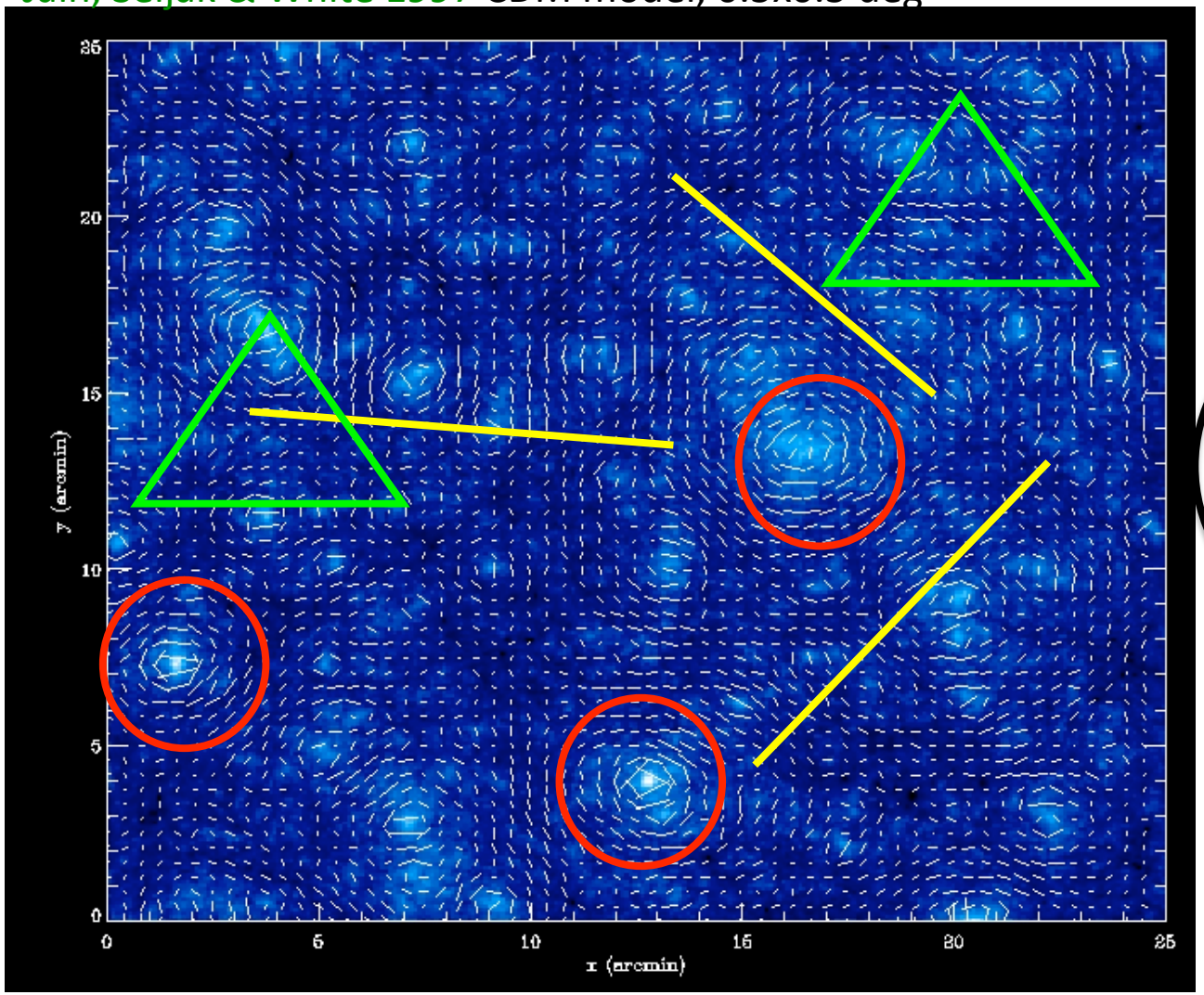
- To break degeneracies left by the power spectrum



- How do we break those degeneracies ?

Weak lensing statistics

Jain, Seljak & White 1997 CDM model, 0.5x0.5 deg^2



2-point correlation function (power spectrum) : $<\gamma_i\ \gamma_i>$

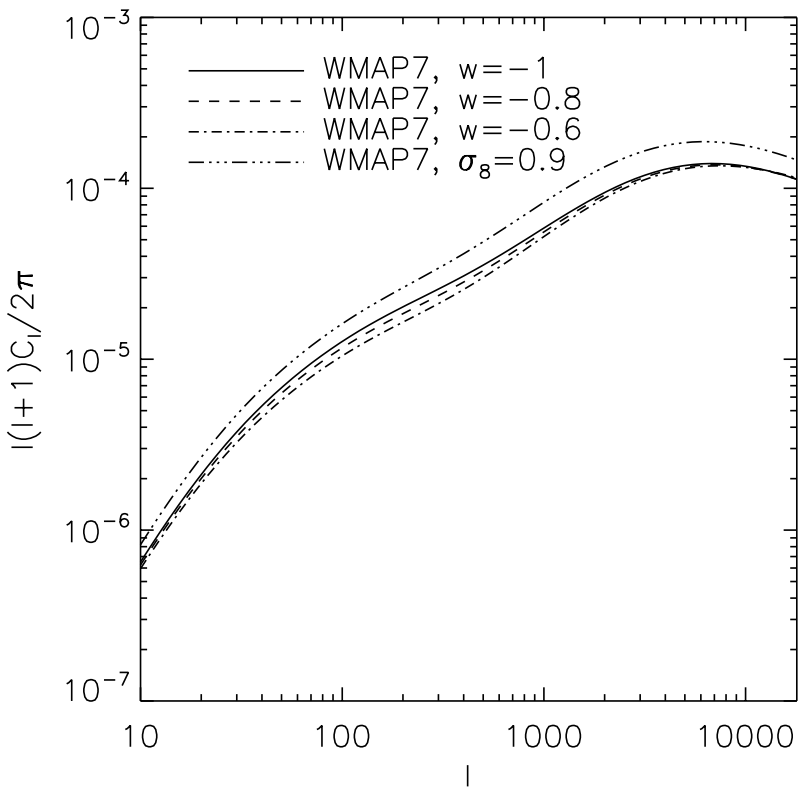
3-point correlation function (bispectrum): $<\gamma_i\ \gamma_l\ \gamma_l>$

Galaxy clusters counts

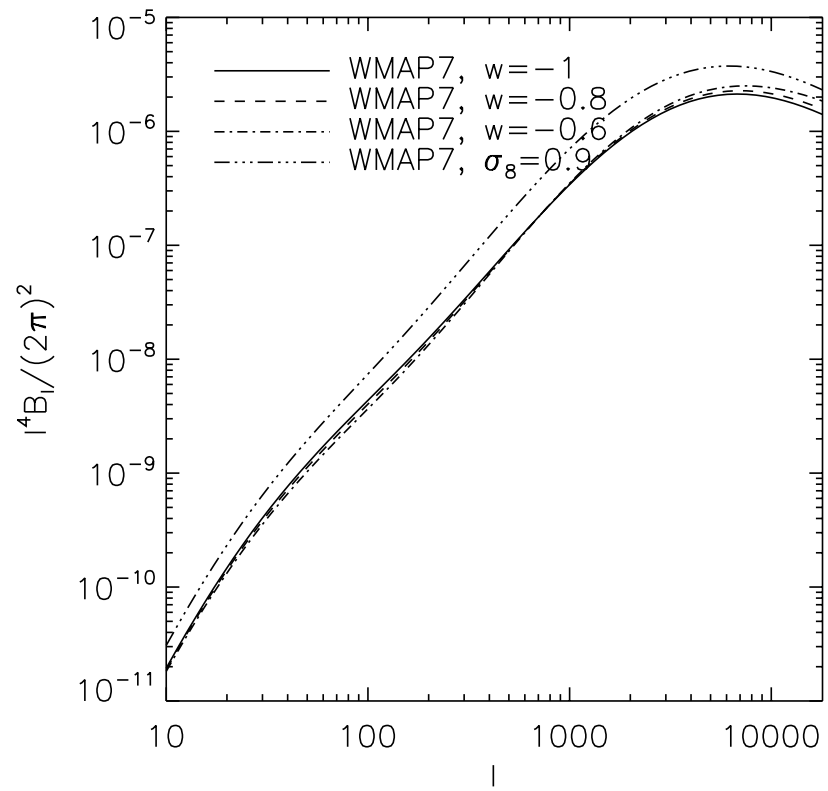
Sensitive to non-Gaussianity

Weak lensing as a cosmological probe : power spectrum and bispectrum

Power spectrum

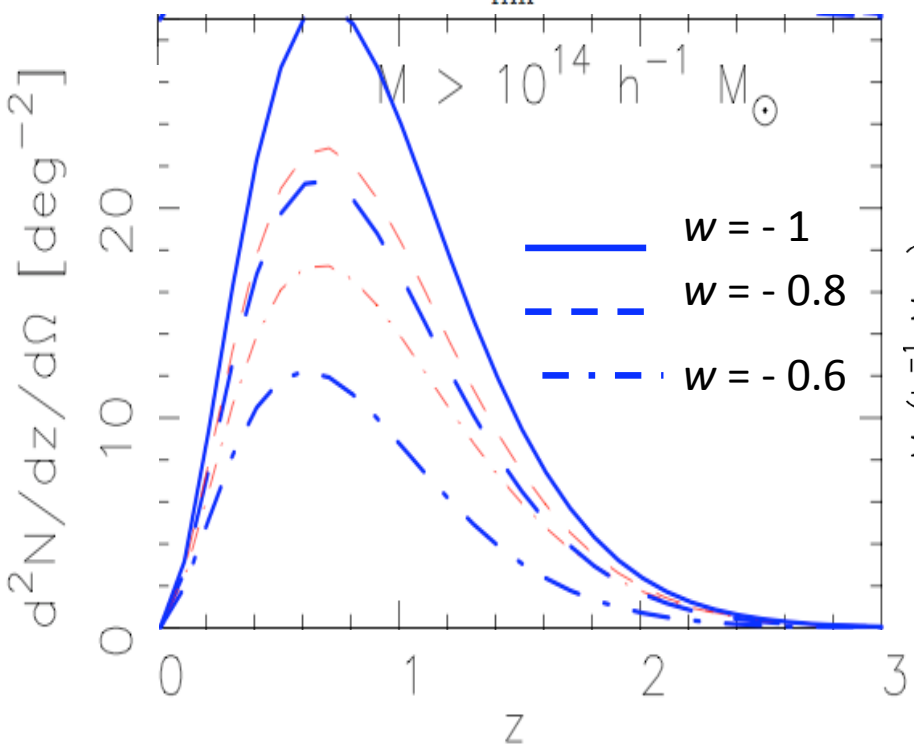


Bispectrum



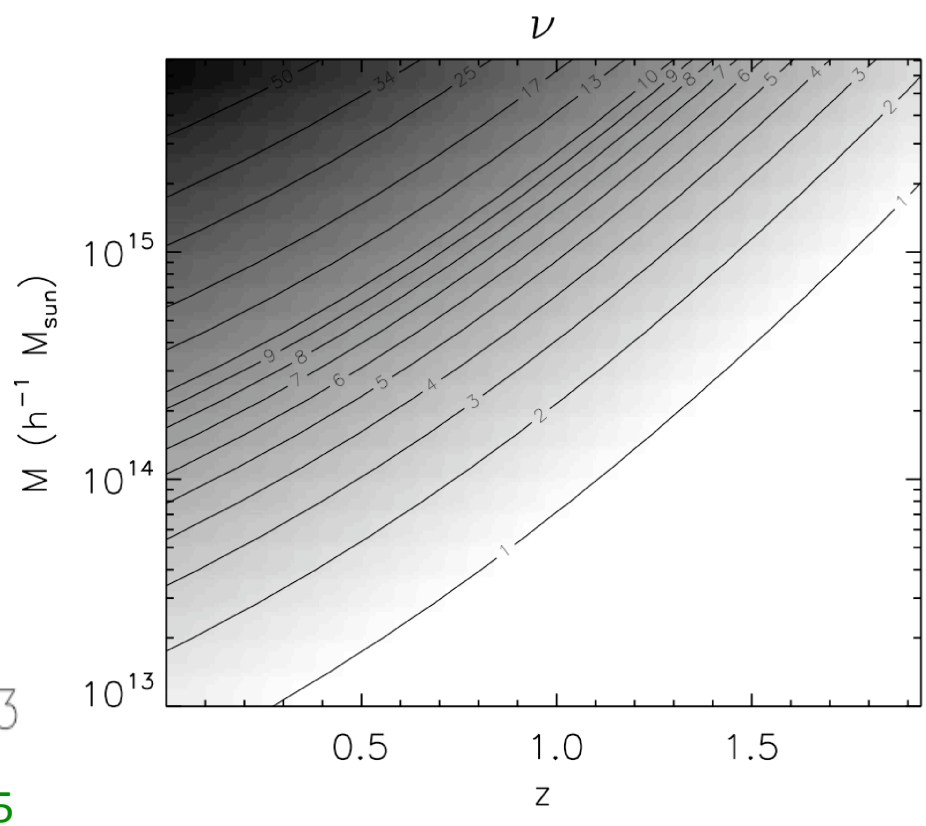
Weak lensing as a cosmological probe : galaxy clusters counts

$$\frac{\mathrm{d}^2 N(z,w)}{\mathrm{d}\Omega\ \mathrm{d}z} = \frac{\mathrm{d}^2 V_c}{\mathrm{d}\Omega\ \mathrm{d}z} \int_{M_{\mathrm{lim}}}^{\infty} n(M,z,w)\ \mathrm{d}M$$



Horellou & Bergé 2005

$$\nu = \frac{\sqrt{n_g}}{\sigma_\gamma} \sqrt{\int \mathrm{d}^2 x\, \kappa^2(x)}$$



Capturing non-Gaussianity: high-precision cosmology

Bergé, Amara & Réfrégier 2010

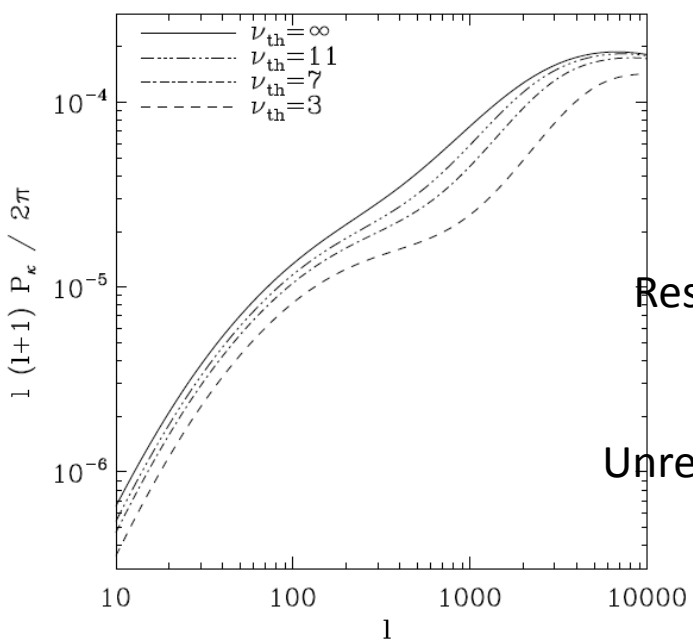
- Fisher matrix analysis to forecast errors on cosmological parameters
- Halo model
- Euclid-like survey : 20,000 deg^2, 40 gal/arcmin^2, z_m=1
- Vary 8 parameters : Ω_m, Ω_Λ, Ω_b, σ_8, h, n, w_0, w_a
- Marginalized errors from :
  - weak lensing power spectrum
  - weak lensing bispectrum
  - weak-lensing-selected cluster counts
- We investigate cluster counts with different amount of information
  - S/N
  - redshift
  - mass
  - redshift and mass

Resolved vs unresolved parts

Discrimination against
- *resolved* part : S/N > ν_{th} ; non-linear part of data
- *unresolved* part : S/N < ν_{th} ; linear part of data

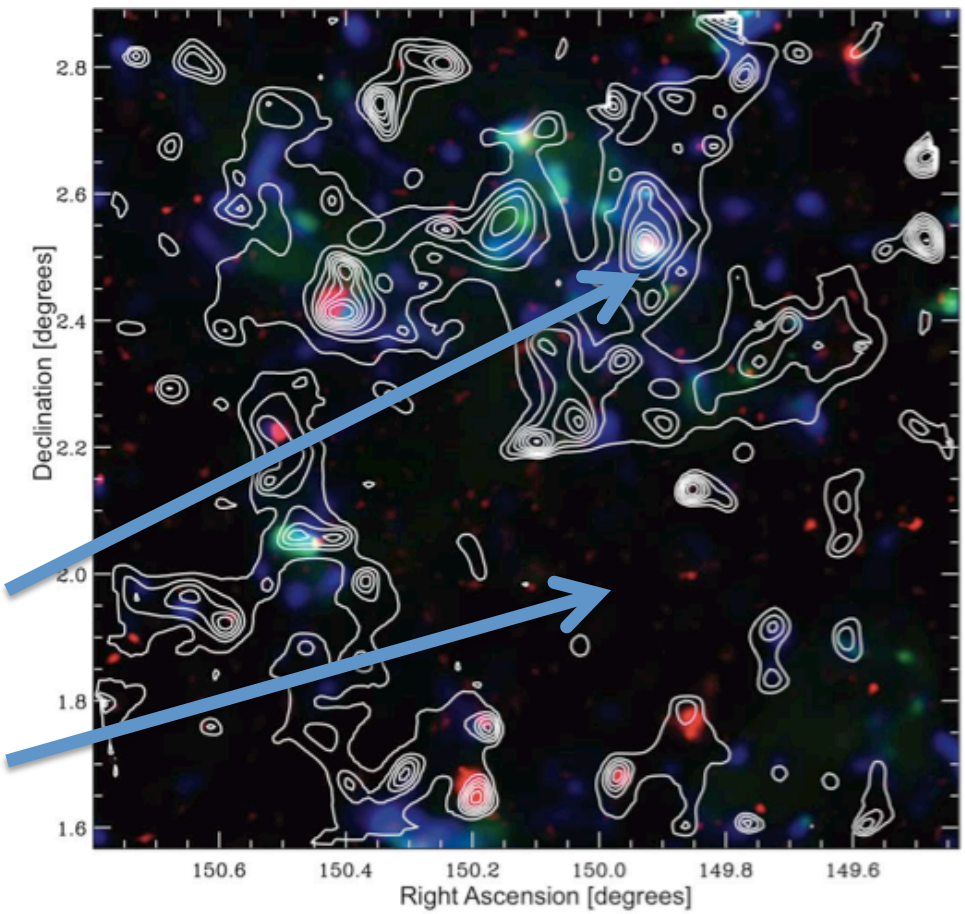
Massey et al 2007

Resolved part : cluster counts
Unresolved part : power spectrum

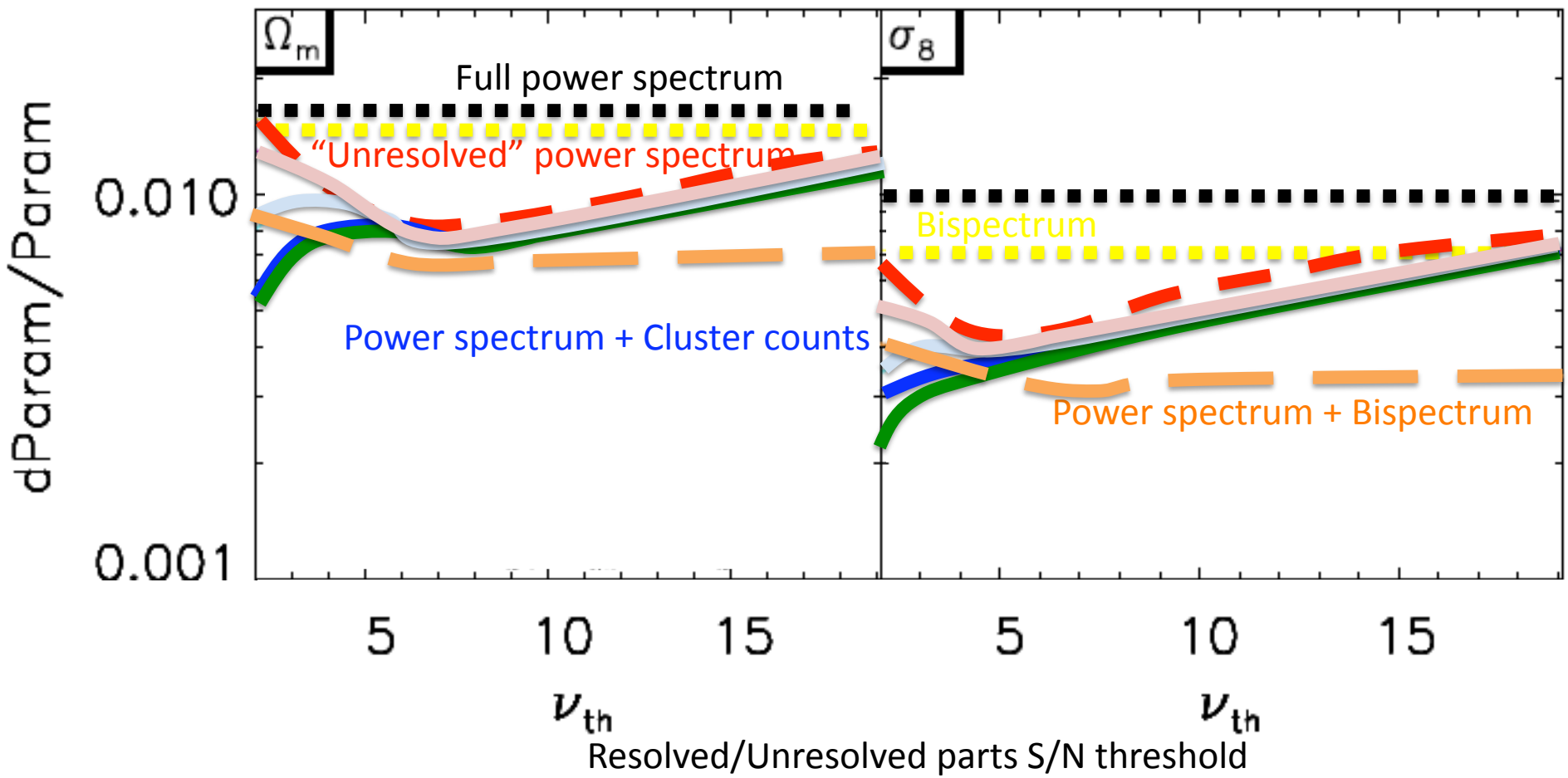


Resolved part

Unresolved part

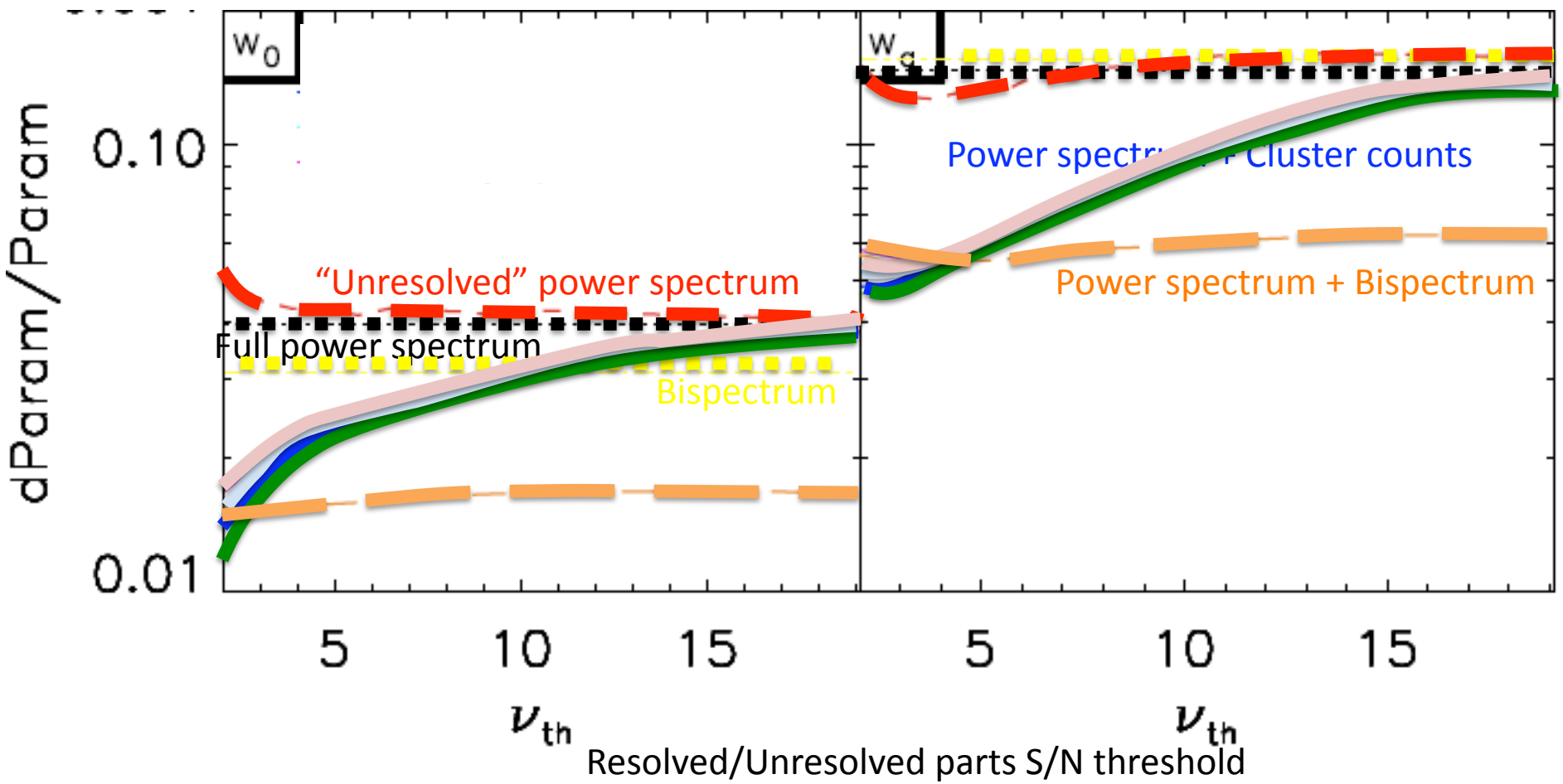


Forecasted errors : Ω_m-σ_8 plane



Forecasted errors : dark energy plane

$w(a)=w_0+(1-a)w_a$

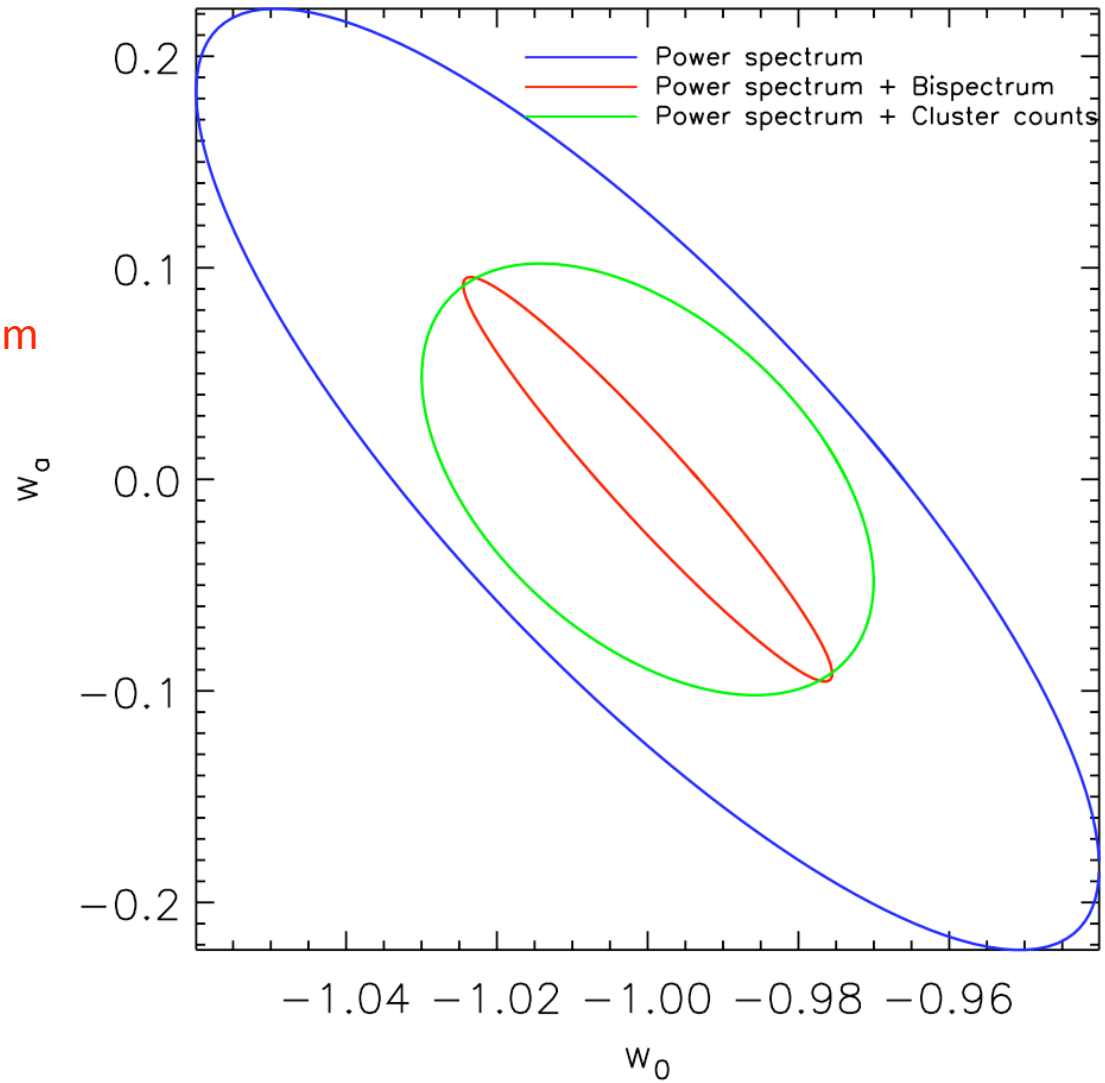


Forecasted errors : dark energy plane

Power spectrum

Power spectrum + Bispectrum

Power spectrum + Peak counts (S/N>5)



Conclusions

- Cluster counts : counting S/N peaks breaks power spectrum degeneracies as well as counting clusters with additional information
- Bispectrum : provides constraints similar to those from the power spectrum
- Bispectrum : provides constraints similar to those from cluster counts (when combined with the power spectrum)

<u>Guidelines to constrain cosmology with weak lensing</u>

1) Measure power spectrum
2) Count S/N peaks, combine with 1)
3) Measure bispectrum, combine with 1), should be consistent with 2)