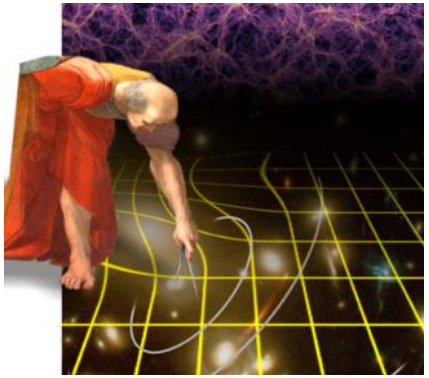

Cosmological Constraints from Shear Peaks with Euclid

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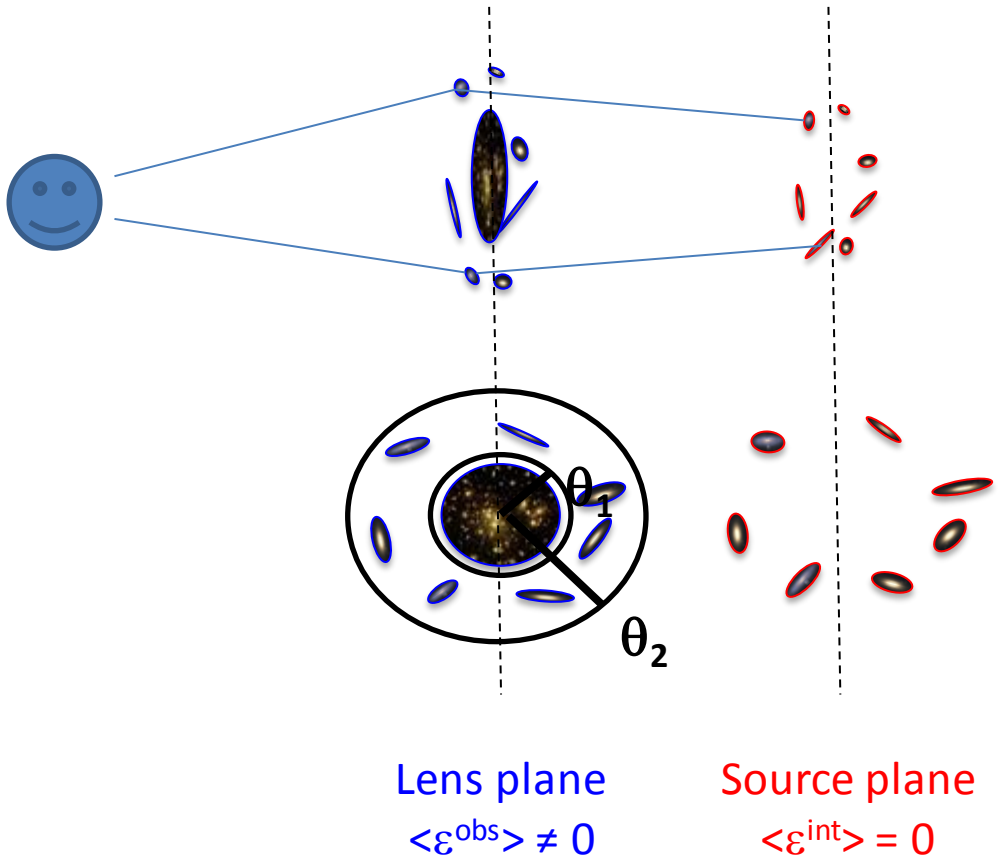
Same data!

Weak Lensing



Shear Peaks

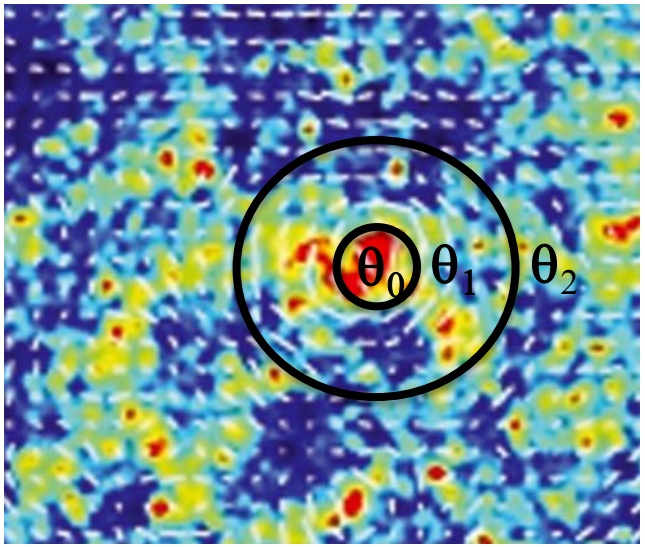


Fig. 1: Convergence (font) and shear (tics) simulated map

- Aperture mass signal to noise in pixel θ_0 (Bartelmann & Schneider 2001):

$$M_{ap}(\boldsymbol{\theta_0}) = \frac{1}{n}\sum_i U(|\boldsymbol{\theta_i} - \boldsymbol{\theta_0}|)k_i(\boldsymbol{\theta_0})$$ $\boldsymbol{\theta}_i$ between θ_0 and θ_2

$$M_{ap}(\boldsymbol{\theta_0}) = \frac{1}{n}\sum_i Q(|\boldsymbol{\theta_i} - \boldsymbol{\theta_0}|)\gamma_{ti}(\boldsymbol{\theta_0})$$ $\boldsymbol{\theta}_i$ between θ_1 and θ_2

- Local noise:

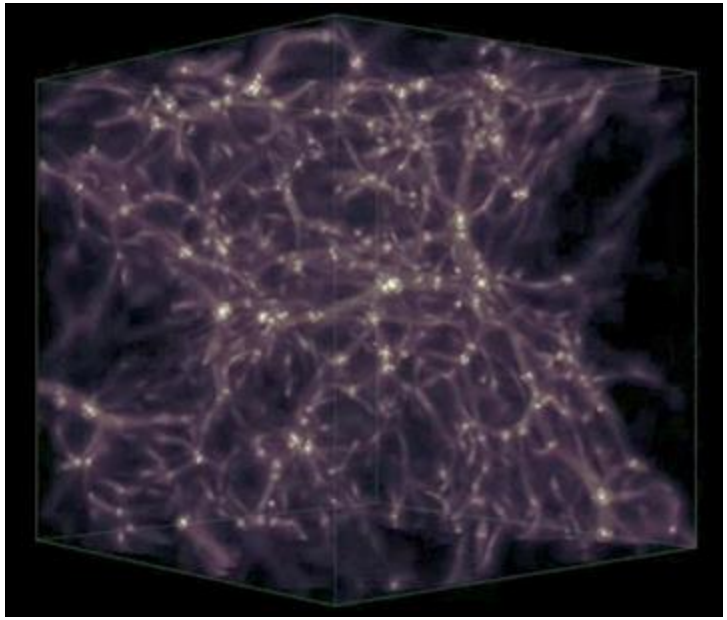
$$\sigma\big(M_{ap}(\boldsymbol{\theta_0})\big) = \frac{\sigma_\varepsilon}{\sqrt{2}n}\left[\sum_i Q^2(|\boldsymbol{\theta_i} - \boldsymbol{\theta_0}|)\right]^{1/2}$$

$$\frac{S}{N}(\boldsymbol{\theta_0}) = \frac{\sum_i Q(|\boldsymbol{\theta_i} - \boldsymbol{\theta_0}|)\gamma_{ti}(\boldsymbol{\theta_0})}{\frac{\sigma_\varepsilon}{\sqrt{2}}\left[\sum_i Q^2(|\boldsymbol{\theta_i} - \boldsymbol{\theta_0}|)\right]^{1/2}} = \frac{\sum_i U(|\boldsymbol{\theta_i} - \boldsymbol{\theta_0}|)k_i(\boldsymbol{\theta_0})}{\frac{\sigma_\varepsilon}{\sqrt{2}}\left[\sum_i Q^2(|\boldsymbol{\theta_i} - \boldsymbol{\theta_0}|)\right]^{1/2}}$$

- Shear peaks are pixels with larger S/N aperture mass over θ_2.

Cosmological simulations

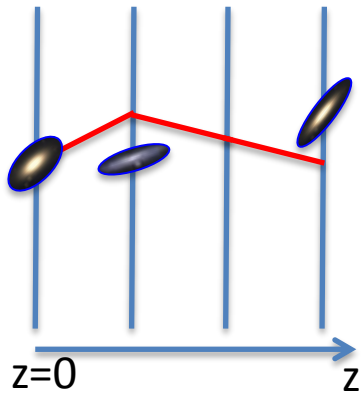
- Cosmological simulation are done with GADGET2
- We used WMAP-9 cosmological parameters
  - $h = 0.71$
  - $\Omega_M = 0.272$
  - $\Omega_\Lambda = 0.728$
  - $\Omega_b = 0.0449$
  - $\sigma_8 = 0.809$
- 100 deg^2
- z=0 to z=2
- Final maps down sampled to 30 galaxies/$arcmin^2$
- 150 fiducial realizations



WL maps

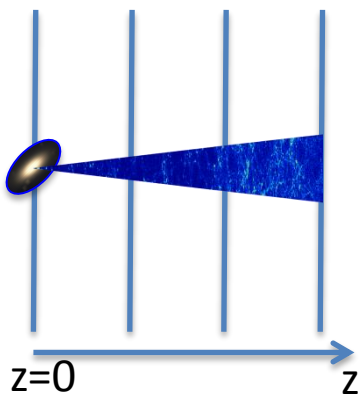
- Discrete approach

(Ray tracing)



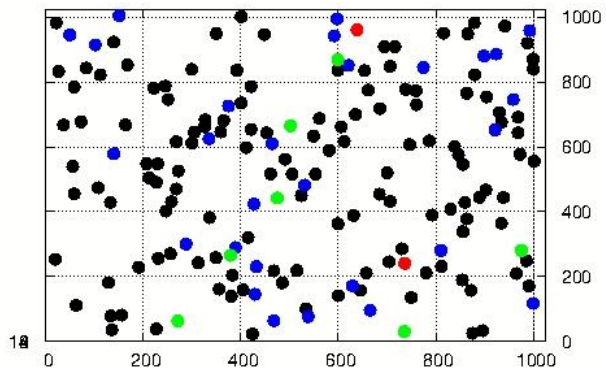
- Continuous approach

(Line of sight integration)

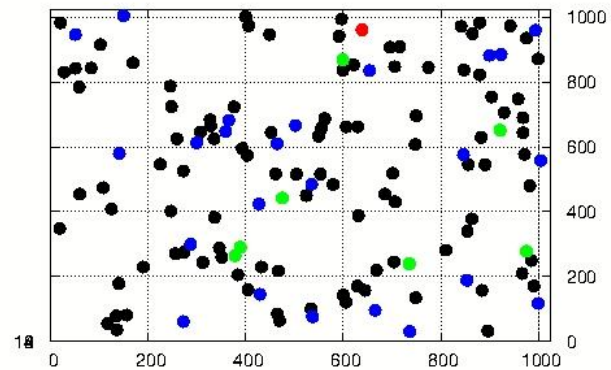


SUNGLASS (Kiessling et al. 2011)

Comparison between shear and convergence



Shear peaks



Convergence peaks

	Amplitude	γ	κ
●	$3 < S/N < 5$	136	104
●	$5 < S/N < 7$	28	24
●	$7 < S/N < 9$	7	7
●	$9 < S/N$	2	1

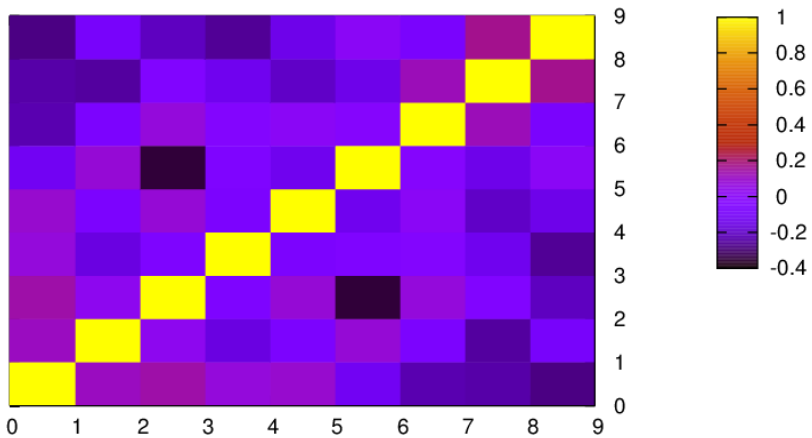
Shear and convergence number of peaks

- Shear and convergence peaks with S/N ratio for the same 100deg² field of view
- Use shear!

Peak Statistics

1) Peak distributions

2) Fiducial covariance matrix



3) χ^2 distribution

4) Fisher matrix

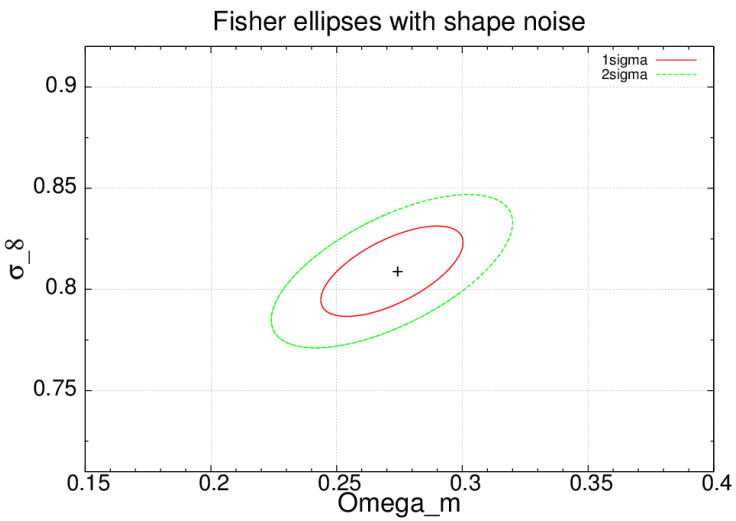
$$F_{p_a,p_b} = \sum_{i,j} \left\langle \frac{\partial N_i}{\partial p_a} \right\rangle_r (Cov_{i,j}^{p_a,p_b})^{-1} \left\langle \frac{\partial N_j}{\partial p_b} \right\rangle_r$$

$$\left\langle \frac{\partial N_i}{\partial p_a} \right\rangle_r = \frac{1}{R} \sum_r \frac{N_{i.r}(p_a + \Delta p_a) - N_{i.r}(p_a - \Delta p_a)}{2\Delta p_a}$$

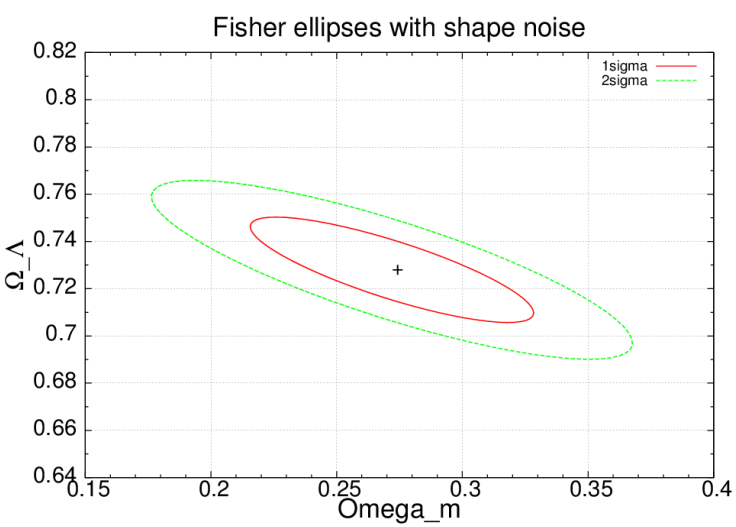
	Ω_M	Ω_Λ	σ_8
fiducial	0.272	0.728	0.809
low	0.245	0.655	0.728
high	0.299	0.801	0.890

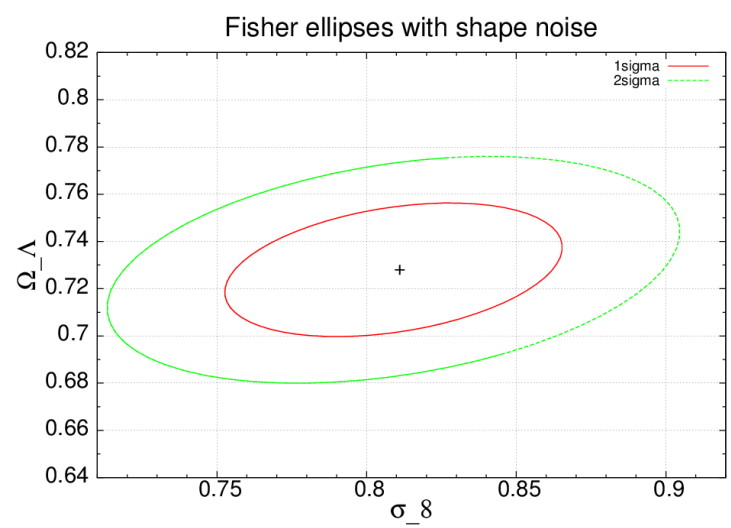
5) Variation of cosmological parameters

Fisher ellipses



	Ω_M	Ω_Λ	σ_8
Unmarginalized, with shape noise			
All galaxies	2.3	2.7	1.6
Marginalized, with shape noise			
All galaxies	5.4	5.1	2.3





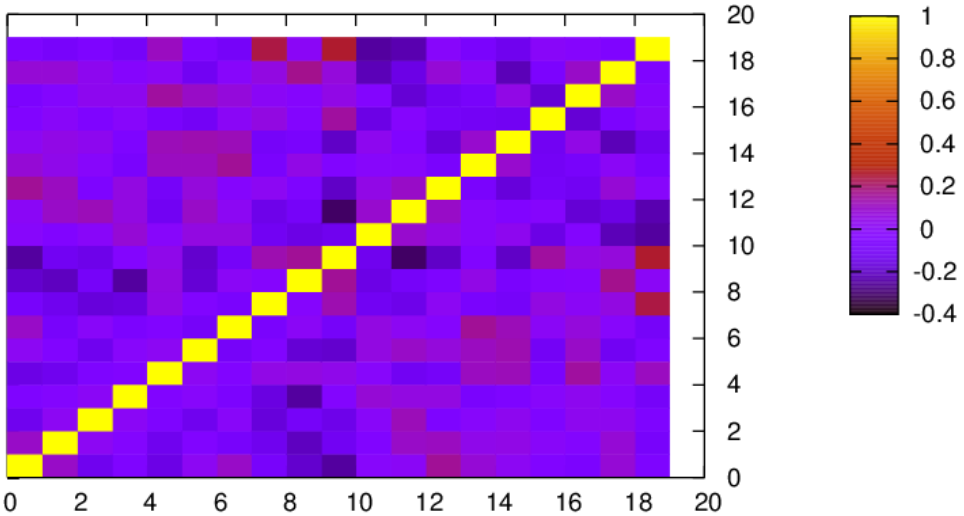
Using tomography

- Slice the redshift distribution
- Remove foreground galaxies (z<0.5)

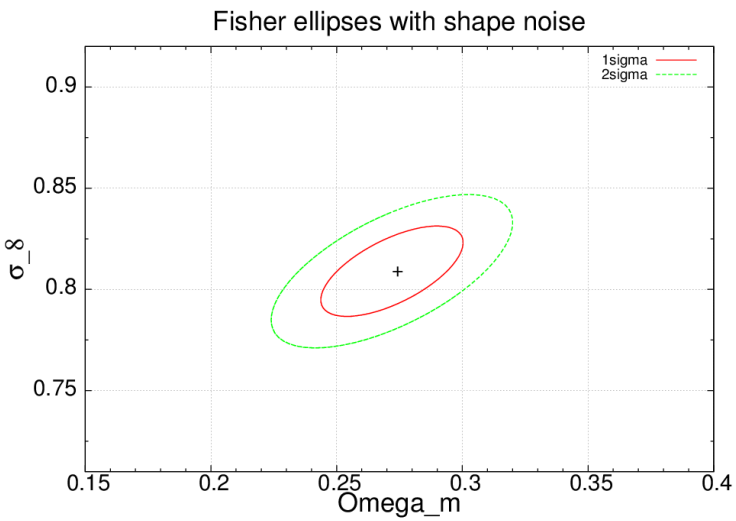
Shape noise limitation

- 2000 galaxies per aperture
- 2 slices with 13 gal/arcmin² each

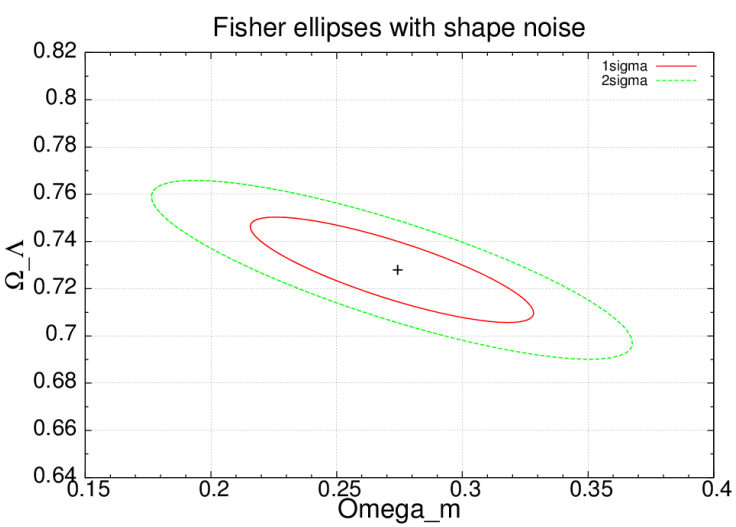
Fiducial covariance matrix

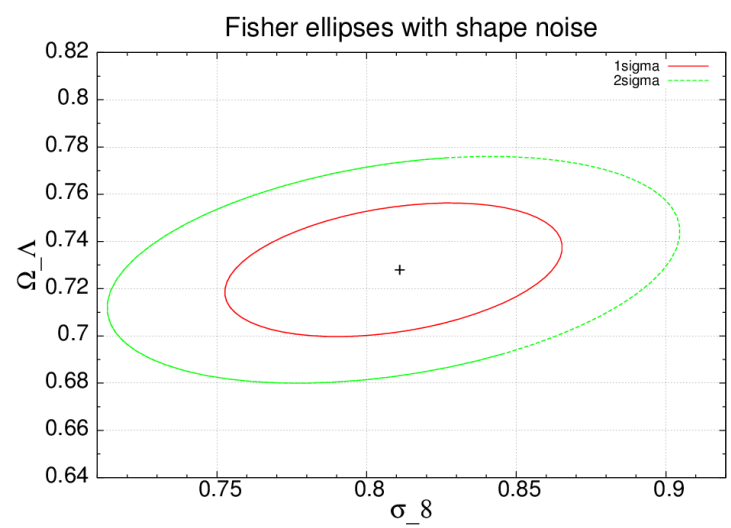


Fisher ellipses

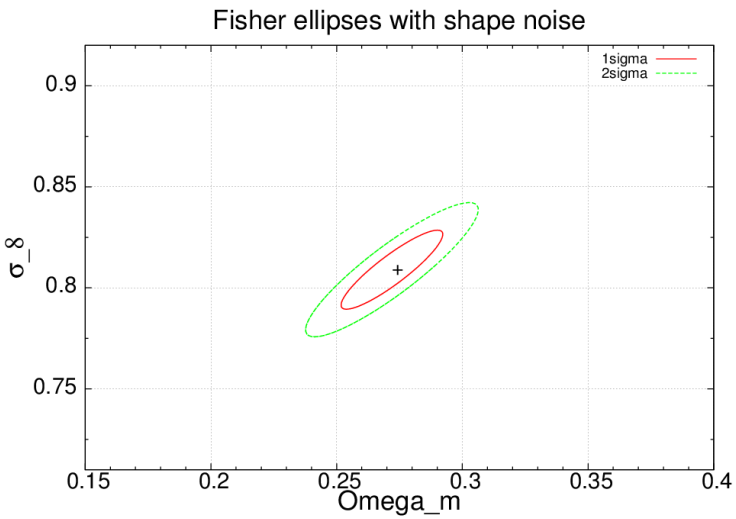


	Ω_M	Ω_Λ	σ_8
Unmarginalized, with shape noise			
All galaxies	2.3	2.7	1.6
Marginalized, with shape noise			
All galaxies	5.4	5.1	2.3

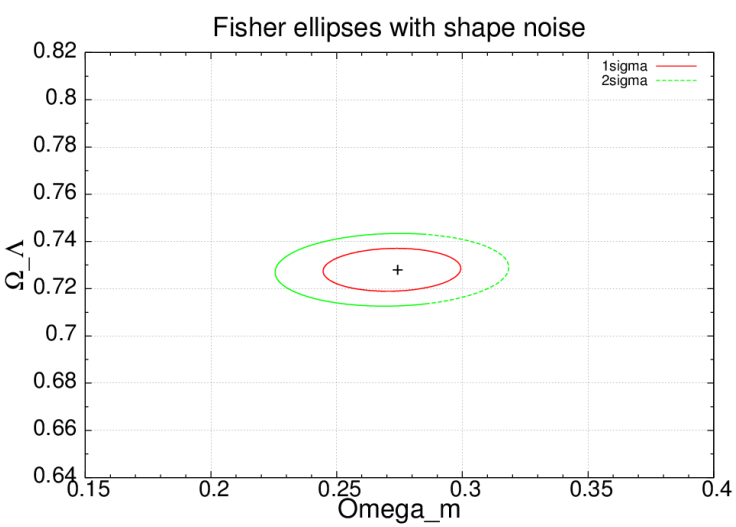


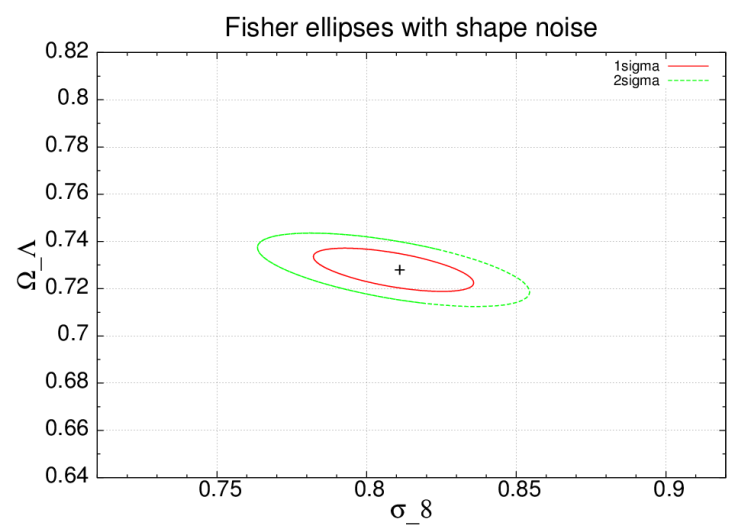


Fisher ellipses with tomography

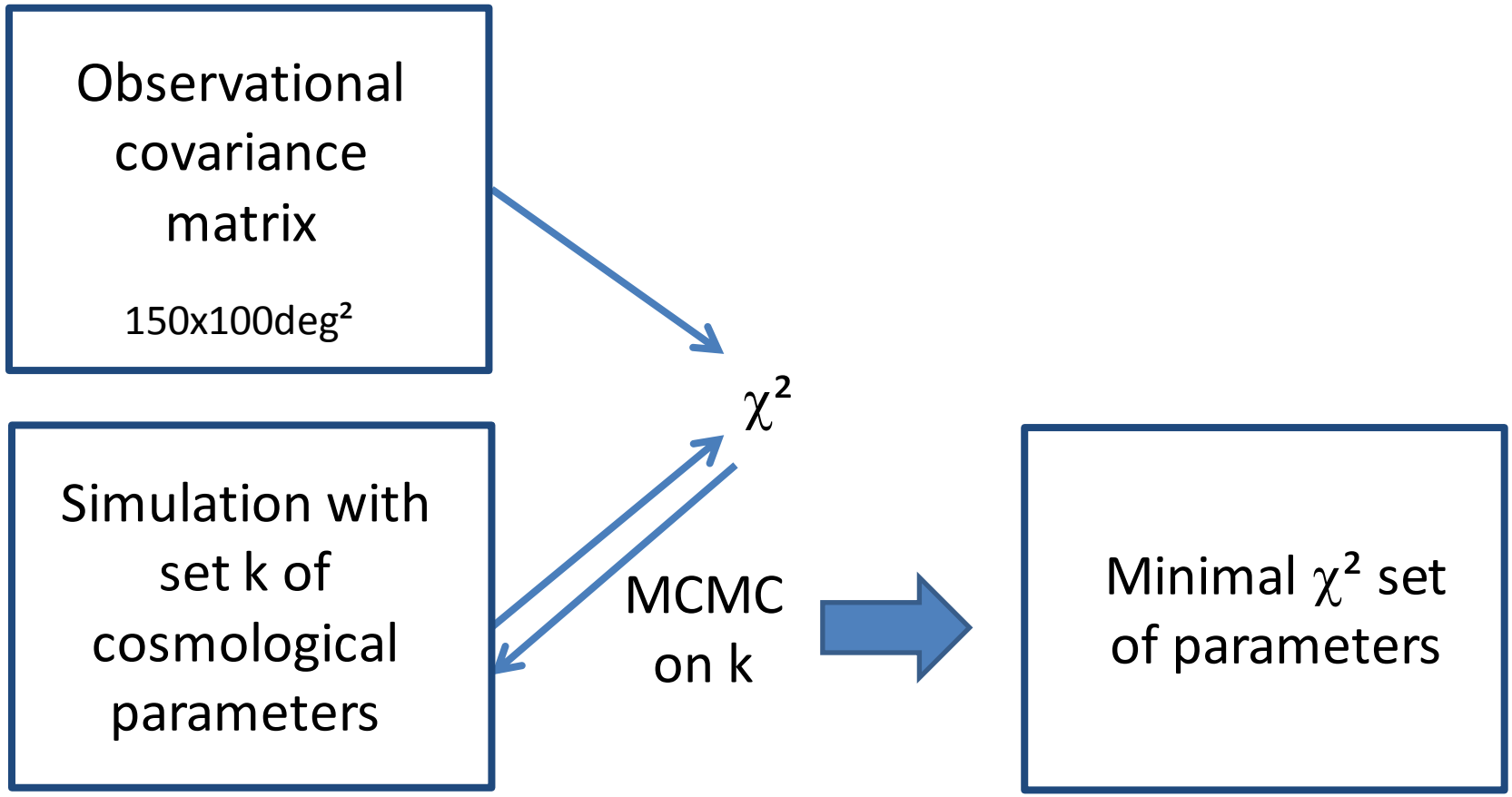


	Ω_M	Ω_Λ	σ_8
Unmarginalized, with shape noise			
All galaxies	2.3	2.7	1.6
Tomography	1.8	1.8	0.5
Marginalized, with shape noise			
All galaxies	5.4	5.1	2.3
Tomography	2.2	2.5	0.8





Adapting to observation



Conclusion

- Shear peaks applied on simulated WL maps
- Use shear rather than convergence
- **Cosmological constraints complementary to classical method**
- **Tomography greatly improves the constraints**
- **Can be applied to Euclid… for free!!!**