First Measuremente of σ_8 using supernovae magnitudes only

TIAGO CASTRO AND MIGUEL QUARTIN
Instituto de Física - UFRJ
{castro and mquartin}@if.ufrj.br

ABSTRACT

Using the closest 732 supernovae of the recent JLA catalog and the method of moments (**MeMo**) we show that a simple treatment of intrinsic non-Gaussianities with a couple of nuisance parameters is enough to make the first measurement of σ_8 using only supernovae data.

LENSING SIGNATURE

- Universe has structures (e.g. filaments and voids) that lenses SN
- No magnification on average is expected by # photon conservation
- Most photons passed through huge voids $\rightarrow$ little demagnification
- Just a few photons passed near structures $\rightarrow$ strong magnification
- Major effect: Increase the scatter in Hubble residual diagram (the so-called lensing degradation)
- But also adds lensing bias in cosmological constraints

MEMO IN A NUTSHELL [2] & [3]

- **Parametrize** and **distinguish** different PDFs through their **statistical moments**
- Advantages: faster, directly related to observations and simpler to control systematics
- Disadvantage: more equations involved
- MeMo likelihood is a functional of the sample $\mathcal{A}$ and the distribution trial $\mathcal{D}$

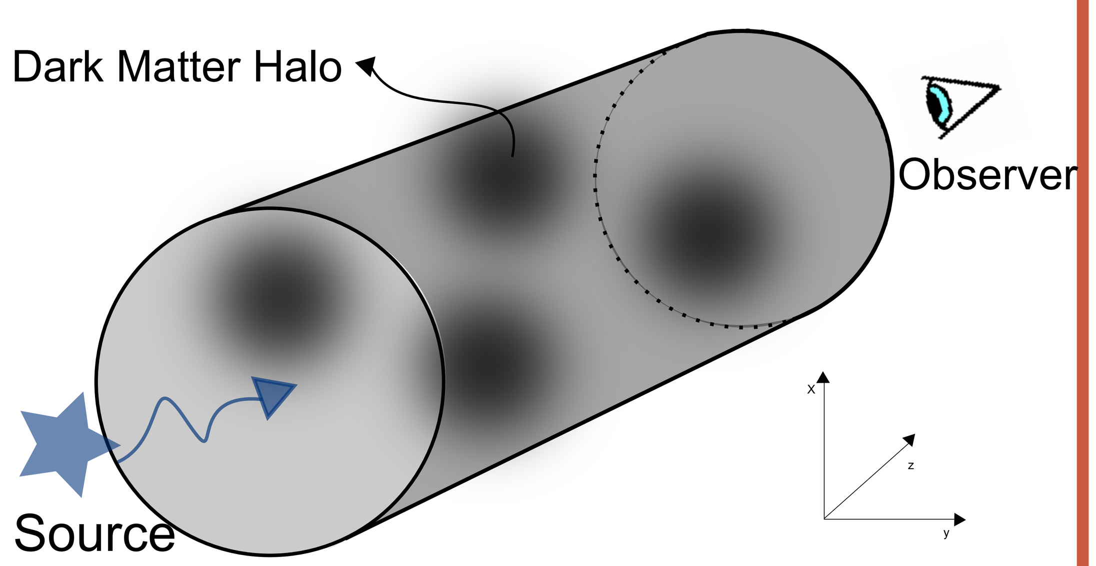
$$L_{\rm MeMo}[\mathcal{A},\mathcal{D}] = \exp\left(-\frac{1}{2}\chi^2\right),$$

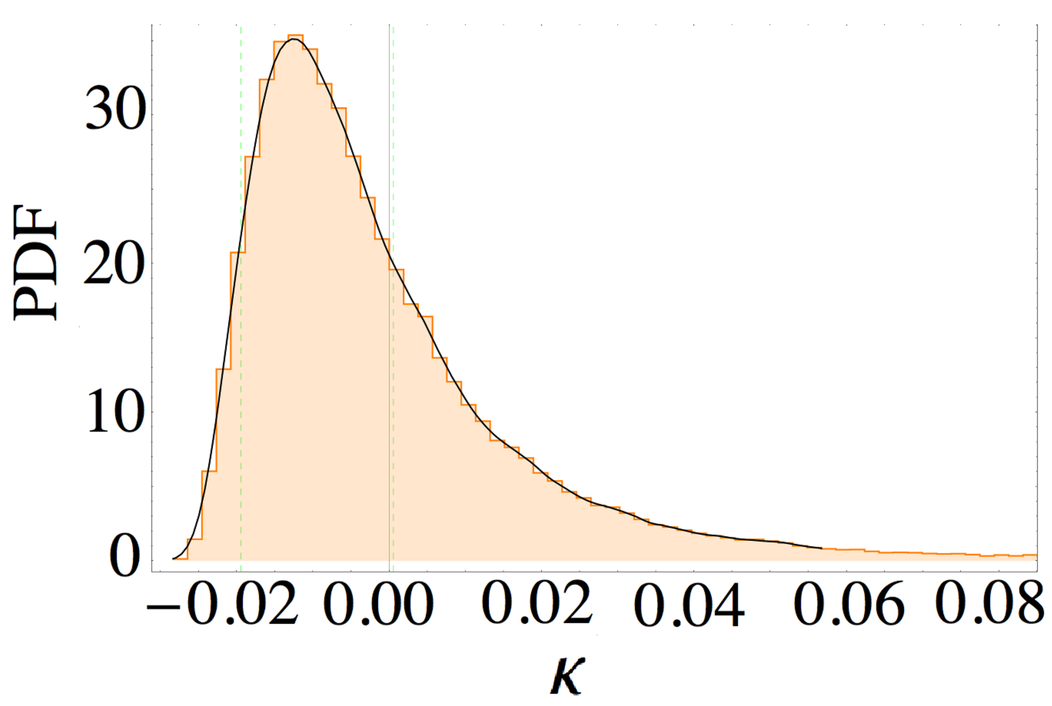
where:

$$\chi^2 = (\boldsymbol{\mu}_\mathcal{D} - \boldsymbol{\mu}_\mathcal{A})^t\, \Sigma^{-1}\, (\boldsymbol{\mu}_\mathcal{D} - \boldsymbol{\mu}_\mathcal{A}).$$

TURBOGL

- Populate the Universe stochastically with NFW halos
- Bin in distance and impact parameter
- Compute the cumulative convergence in weak lensing regime as a function of z and the cosmological parameters
- Orders of magnitude faster than any ray-tracing method using N-body simulations
- More details in developers originals papers [4], [5] & [6].

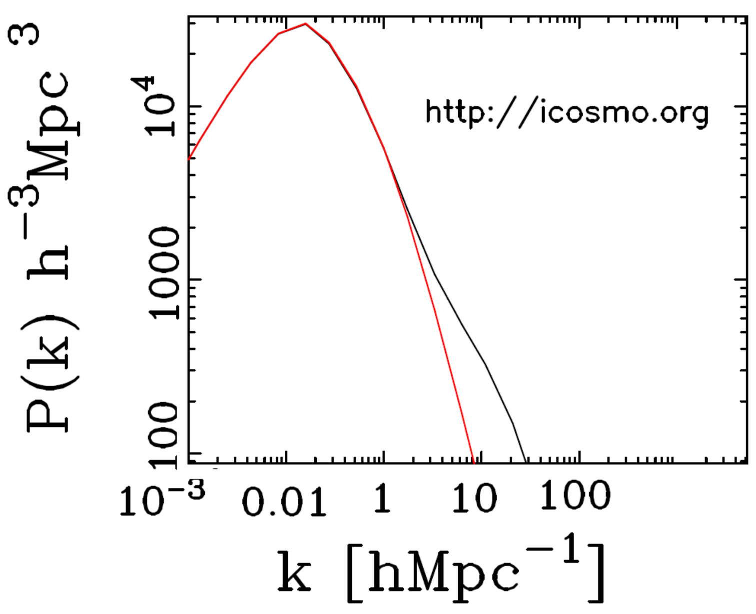




turboGL webpage:http://www.turbogl.org/

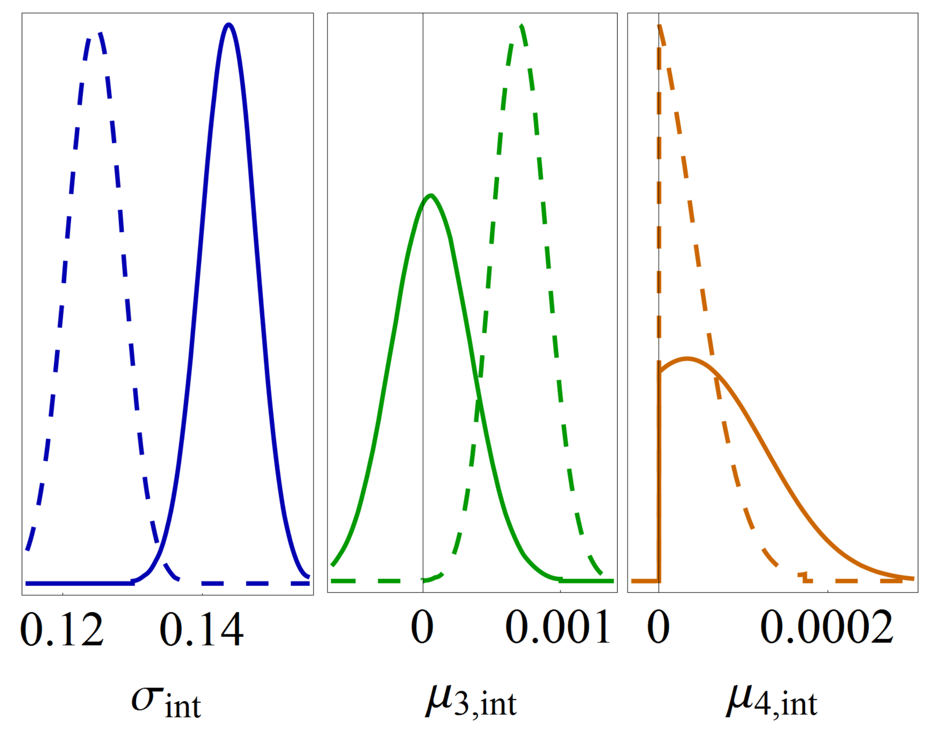
WHAT IS σ_8?

- σ_8 is the amplitude of the matter fluctuations at the scale of 8 Mpc/h: direct measure of Universe's **inhomogenity**.
- Why 8 Mpc/h? The deviation of the power spectrum (black) from the linear regime (red) begins roughly on the scale of 5 Mpc/h for any reasonable universe model
  - So...$R = (8\,Mpc\,h^{-1})$ **maximizes** the possible number of samples inside the **linear regime**



RESULTS: INTRINSIC DISPERSIONS

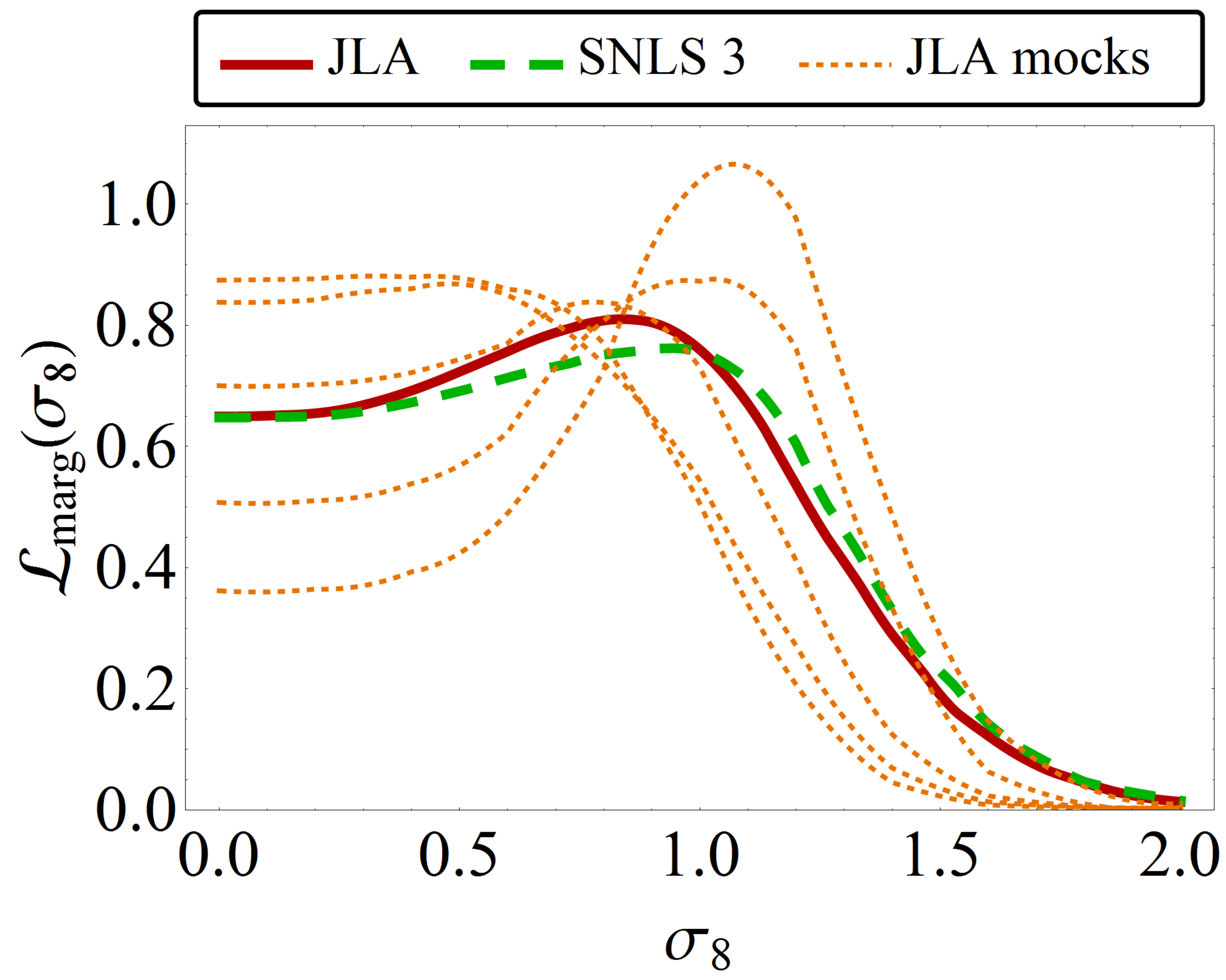
Aside of the lensing PDF we have to deal with supernovae intrinsic dispersion. For both SNLS (dashed) and JLA (solid) the simplistic choice of one nuisance parameter for each central moment showed to be enough to provide good fits. **We find that JLA does not demand any nuisance parameter for kurtosis or skewness!**

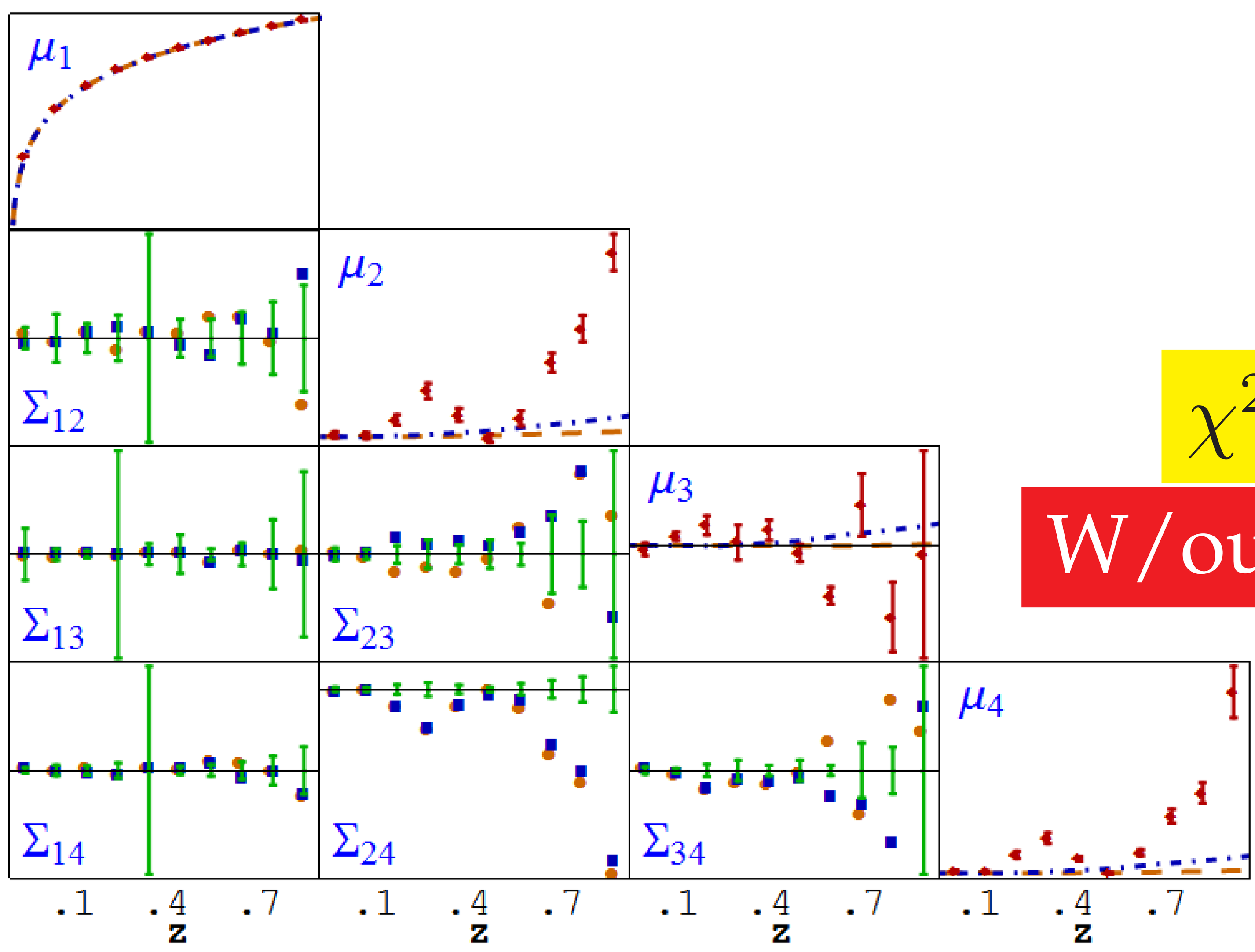


RESULTS: MEASURING σ_8

SNLS:
1σ: $\sigma_8 = 0.93^{+0.24}_{-0.72}$
2σ: $\sigma_8 < 1.49$

JLA:
1σ: $\sigma_8 = 0.84^{+0.28}_{-0.65}$
2σ: $\sigma_8 < 1.45$





χ^2/d.o.f.$\sim$ 1.3

W/out outlier $\sim$ 1.06!

CONCLUSIONS & POSSIBILITIES

- Conclusions
  - Our work represents an important proof of principle and a cross-check of the theory
  - **First measure ever of σ_8 using only SNe magnitudes**
- Possibilities
  - Constrain halo profiles and dark matter clustering
  - Better understand the 2σ tension in current measuments of σ_8
  - Test the power spectrum directly

REFERENCES

1. CASTRO & QUARTIN, 1403.0293 (MNRASL) (†)
2. MARRA, QUARTIN & AMENDOLA, 1304.7689 (PRD)
3. QUARTIN, MARRA & AMENDOLA, 1307.1155 (PRD)
4. KAINULAINEN & MARRA, 0909.0822 (PRD)
5. KAINULAINEN & MARRA, 1011.0732 (PRD)
6. KAINULAINEN & MARRA, 1101.4143 (PRD)