Aix*Marseille université
Socialement engagée

Weak-lensing mass determination of the galaxy cluster Abell3926

presented by: Abdelhamid Haddad

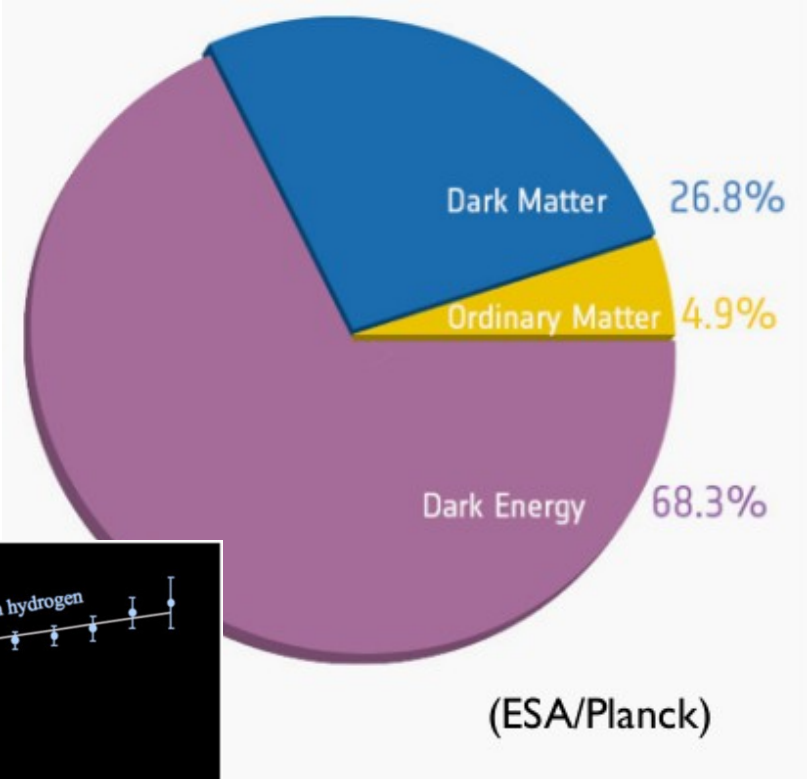
Supervised by: *Pr. Nicolas Martinet*

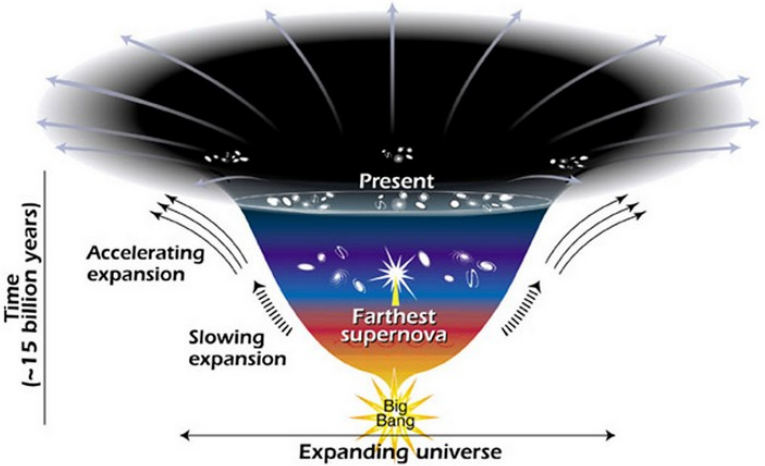
Outline

- **Overview:**
  - General introduction.
  - Gravitational lensing.
- **The Abell3926 cluster.**
- **Computational part:**
  - Intermediate preparations.
  - Concluding results and perspectives.

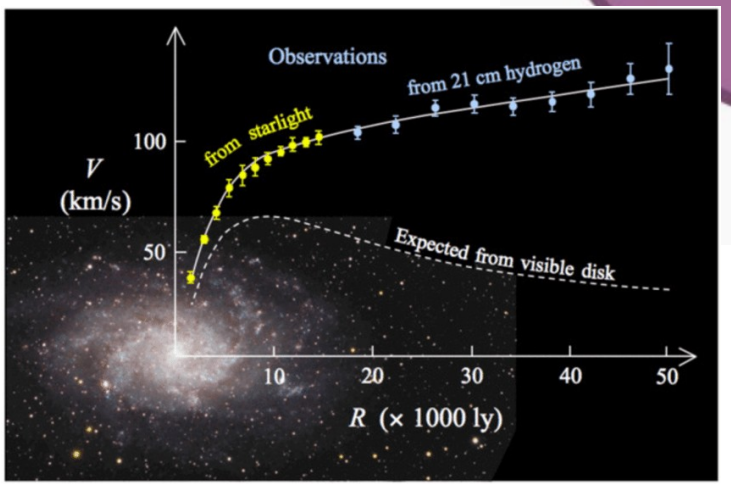
General Introduction

- Almost all of it are from unknown components : **dark energy** and **dark matter**.
- Could “explain” many observations in a consistent manner.





ESA/Hubble



The NFW Profile

In 1997, Navarro, Frenk & White wrote a seminal paper in which they showed that the density profiles of the dark matter haloes can always be fit by a universal fitting function: the NFW profile !

$$\rho(r) = \rho_{\rm crit} \frac{\delta_{\rm char}}{(r/r_{\rm s})\,(1 + r/r_{\rm s})^2}$$

A UNIVERSAL DENSITY PROFILE FROM HIERARCHICAL CLUSTERING

JULIO F. NAVARRO[1]
Steward Observatory, 933 North Cherry Avenue, University of Arizona, Tucson, AZ 85721-0065; jnavarro@as.arizona.edu.
CARLOS S. FRENK
Department of Physics, University of Durham, South Road, Durham DH1 3LE, England; c.s.frenk@uk.ac.durham
AND
SIMON D. M. WHITE
Max-Planck-Institut für Astrophysik, Karl-Schwarzschild-Strasse 1, 85740, Garching bei München, Germany; swhite@mpa-garching.mpg.de
Received 1996 November 13; accepted 1997 July 15

Credit: Volker Springel

Gravitational lensing

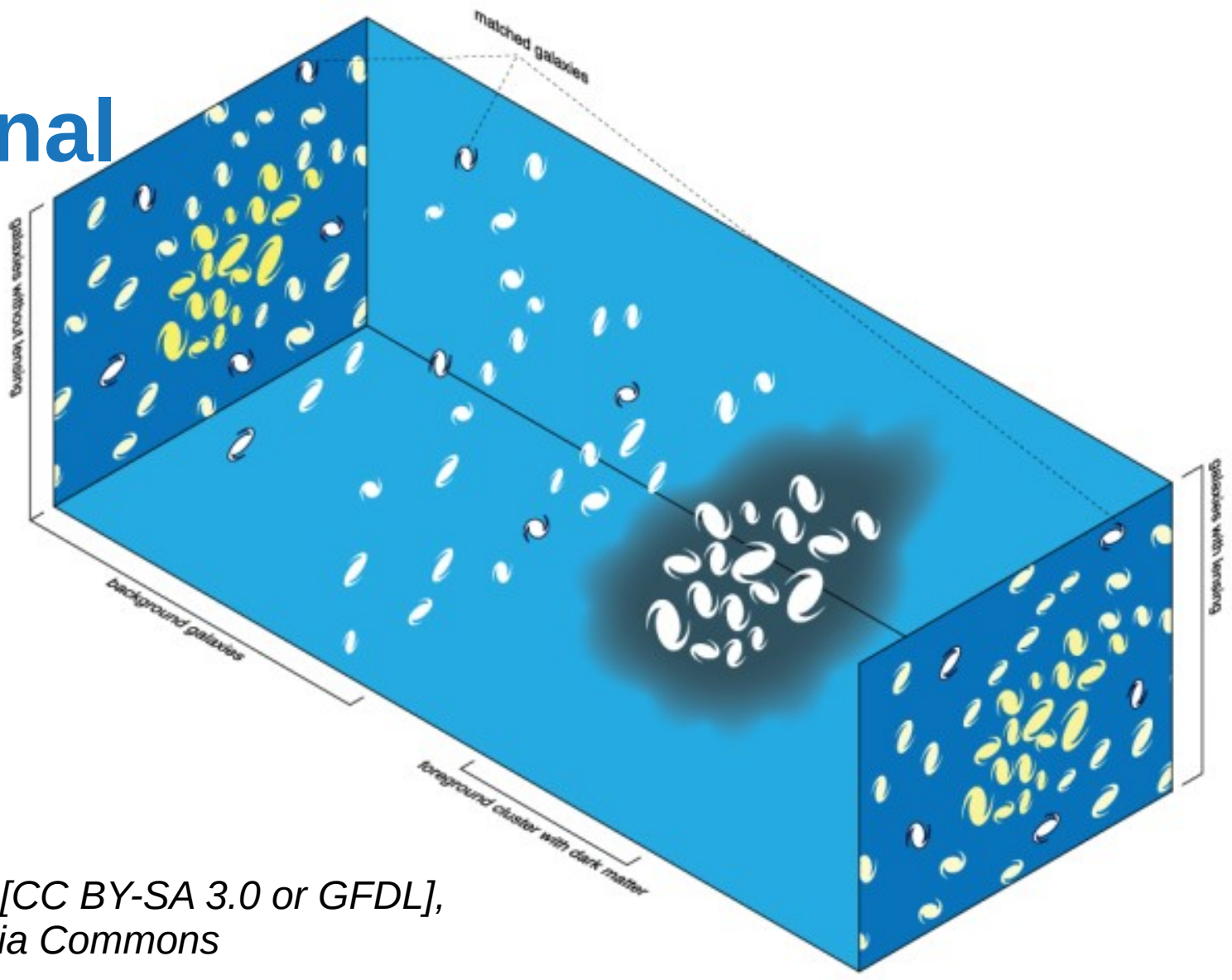
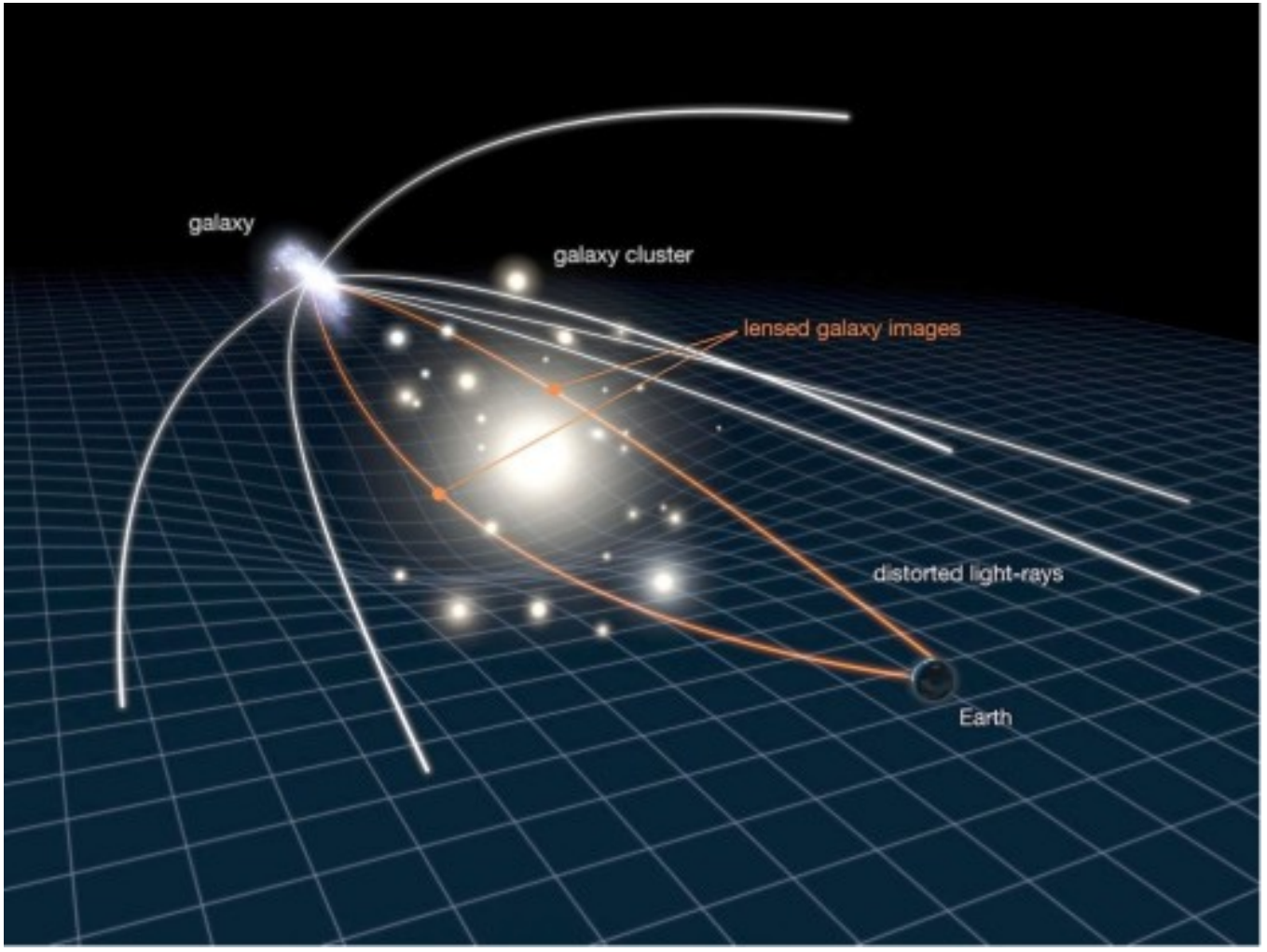


Image by Michael Sachs [CC BY-SA 3.0 or GFDL], via Wikimedia Commons

Gravitational lensing

Image: cfhtlens.org



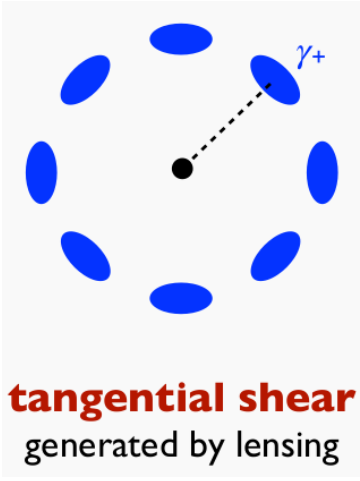
(Weak) lensing parameters
(Measuring shear)

- except for rare cases, lensing effect is weak.
- observed shape is affected by weak lensing distortion :

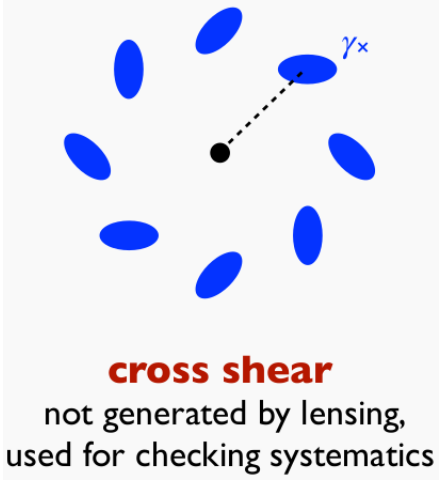
$$\epsilon_i^{obs} = \epsilon_i^{int} + \gamma_i$$

- shear is measured by averaging observed galaxy shapes.
- we can extract information on the cluster by fitting the observed shear profile with a model.

Tangential and cross shear



tangential shear
generated by lensing



cross shear
not generated by lensing,
used for checking systematics

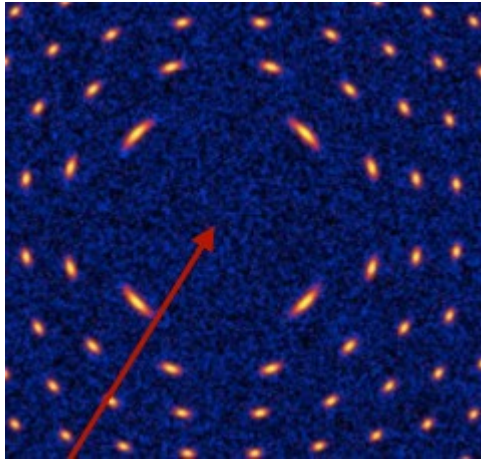
- The lens distorts shapes of background galaxies along tangential Direction.
- Thus, by measuring the tangential shear, we could obtain the mass dist.

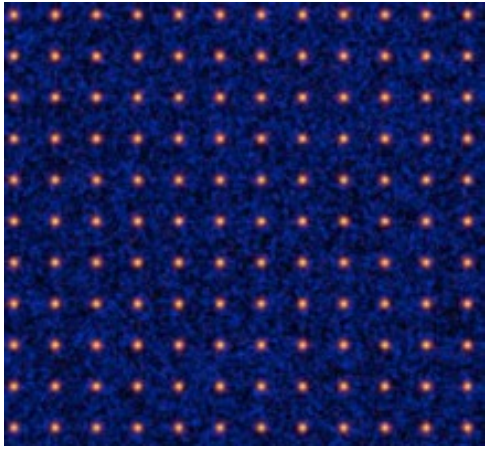
tangential shear

$$\gamma_+ = -\gamma_1 \cos 2\phi - \gamma_2 \sin 2\phi$$

cross shear (45 degree rotated)

$$\gamma_\times = \gamma_1 \sin 2\phi - \gamma_2 \cos 2\phi$$





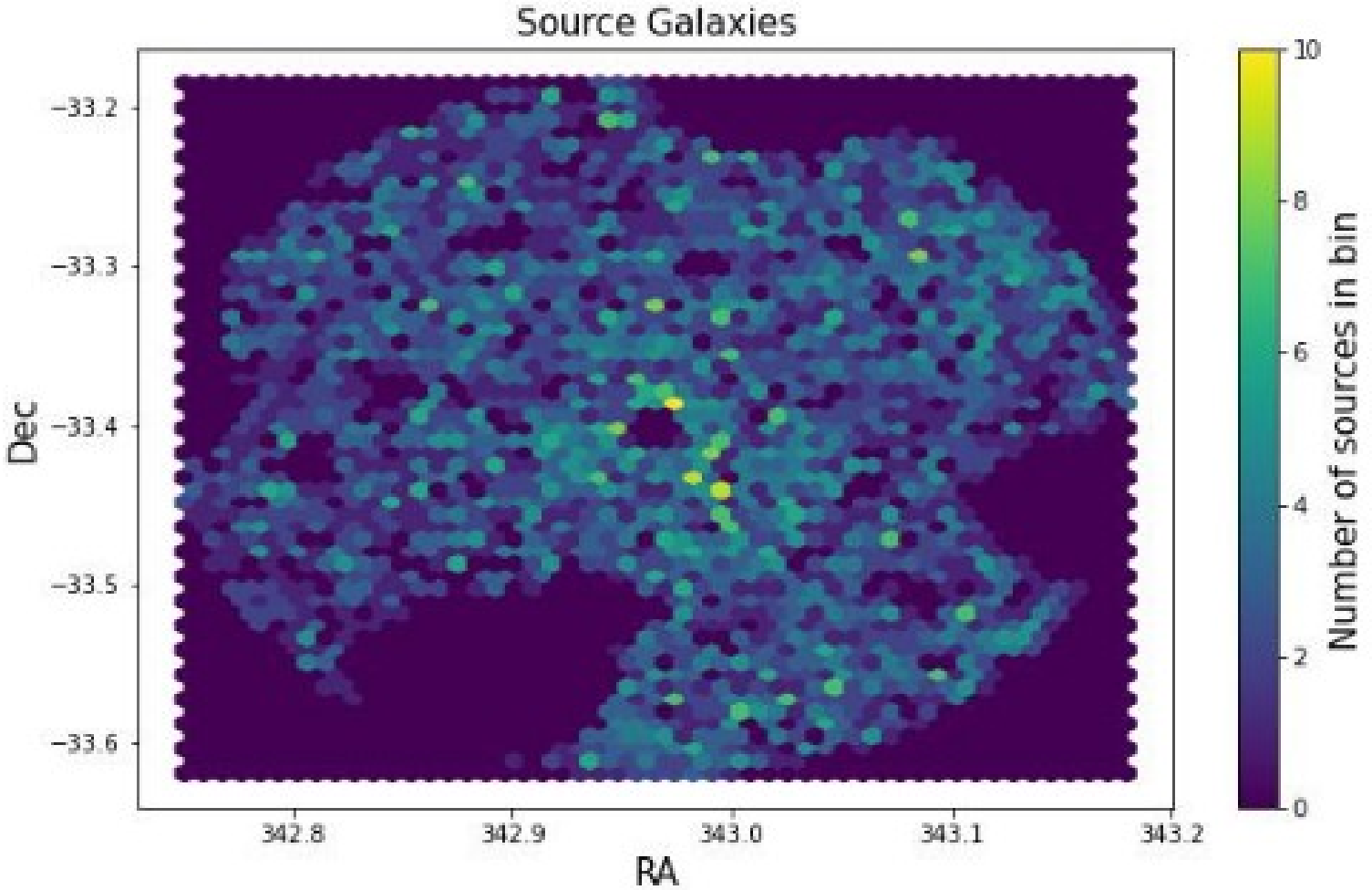
simulated by glafic

The Abell3926 cluster

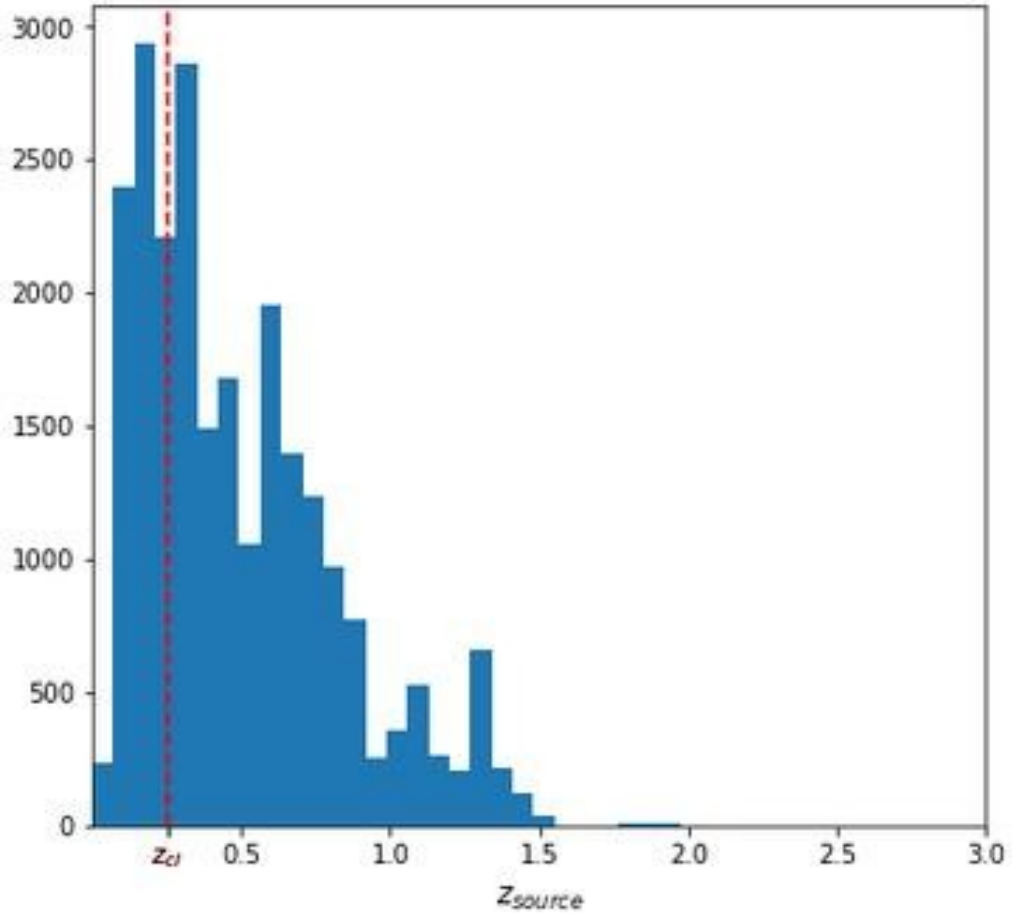
Covered by the Kilo Degree Survey (Path G23)

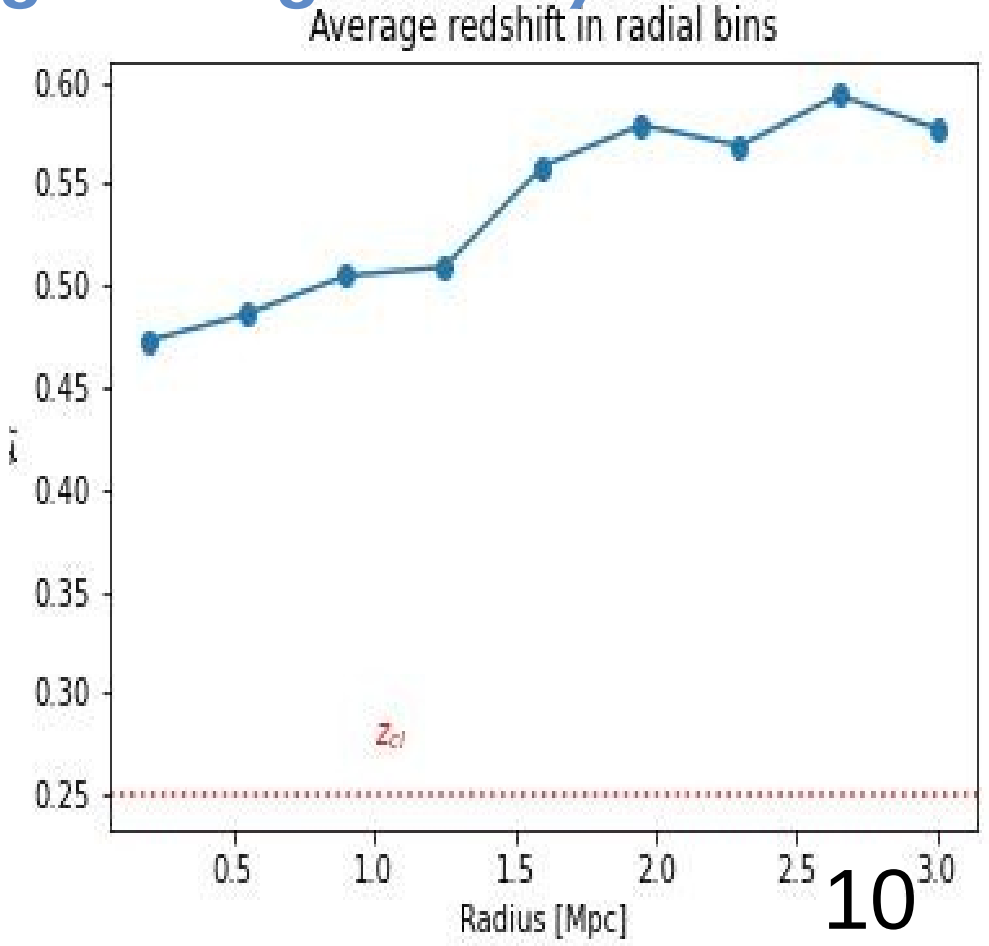
(342.9, -33.4)

- Positions (Ra,Dec).
- Photo-metric redshift
- Ellipticities (e_1,e_2).
- ect.

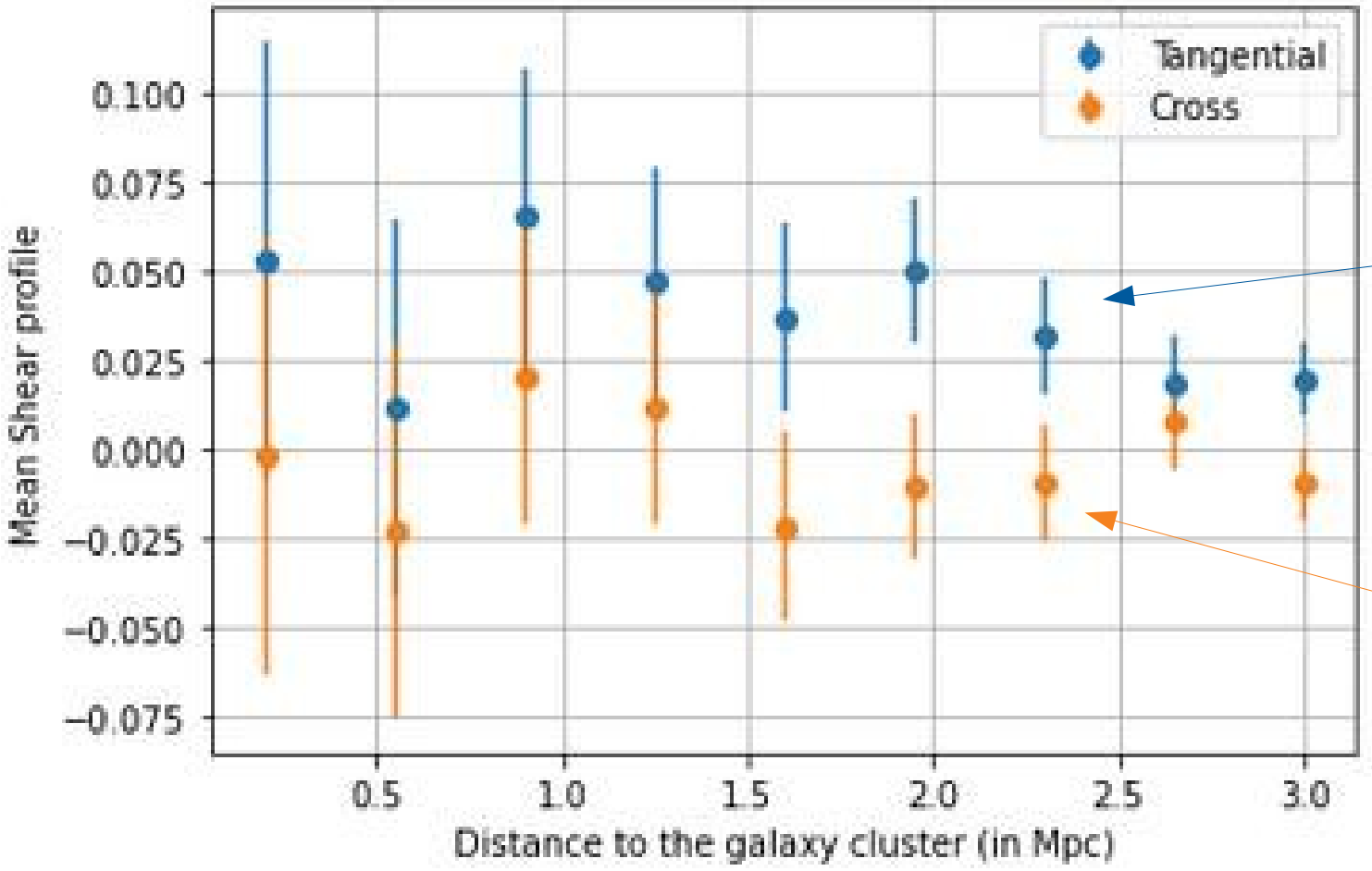


Intermediate Computation
(Selecting background galaxies)





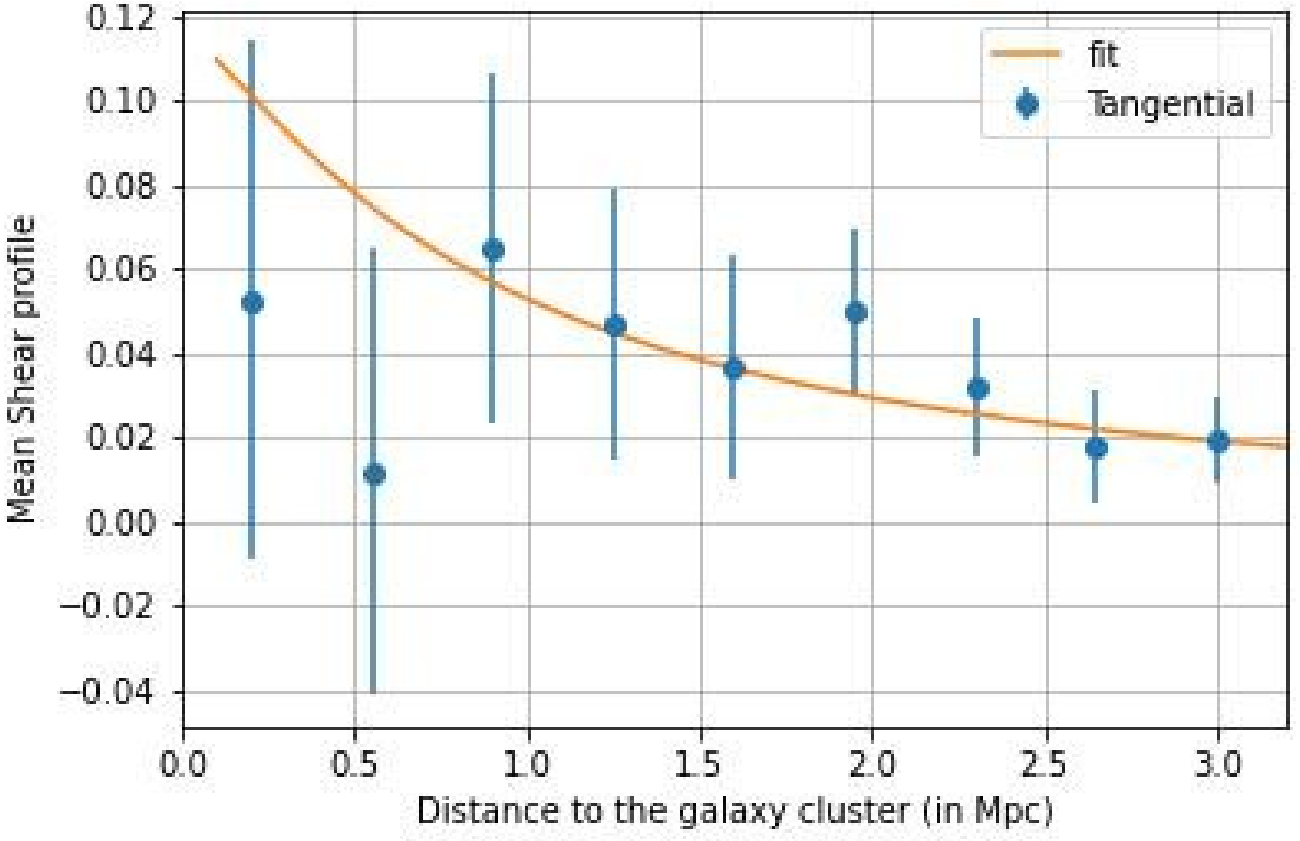
Tangential and cross shear profiles



Tangential shear
Significantly detected

cross shear
consistent
with zero
as expected

NFW fitting result
(good fit achieved)



Analytic expression of tangential shear expressed by : **Wright & Brainerd**

C_{200}= 1.801 +/- 0.886

r_s = 1.585 +/- 0.907 Mpc

Concluding results

- We could then compute the mass M_{200} enclosed in a sphere of radius r_{200} as :

$$M_{200} = (3.608 +/- 8.165) \cdot 10^{15} M_{sun}$$

- Additionally, and because the degeneracy of c_{200} and r_{200} ($r_{200} = r_s \,.\, c_{200}$), we fixed $C_{200} = 3.5$ and obtain :

$$M_{200} = (2.616 +/- 0.589) \cdot 10^{15} M_{sun}$$

Conclusions

- Weak gravitational lensing provides a powerful means of studying of dark matter distribution.

- We need many galaxies with accurate shape measurements, but we have also to be more careful with :
  - The selected background galaxies.
  - The binning of our tangential shear.
  - Try different cluster centers.

Thanks for your Attention !

Your questions are more than welcomed :)