Study of the blending impact on galaxy clusters with Rubin/LSST

LSST-France meeting - 05/18/2022

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M2 internship
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Marine KUNA

LPSC - Dark team

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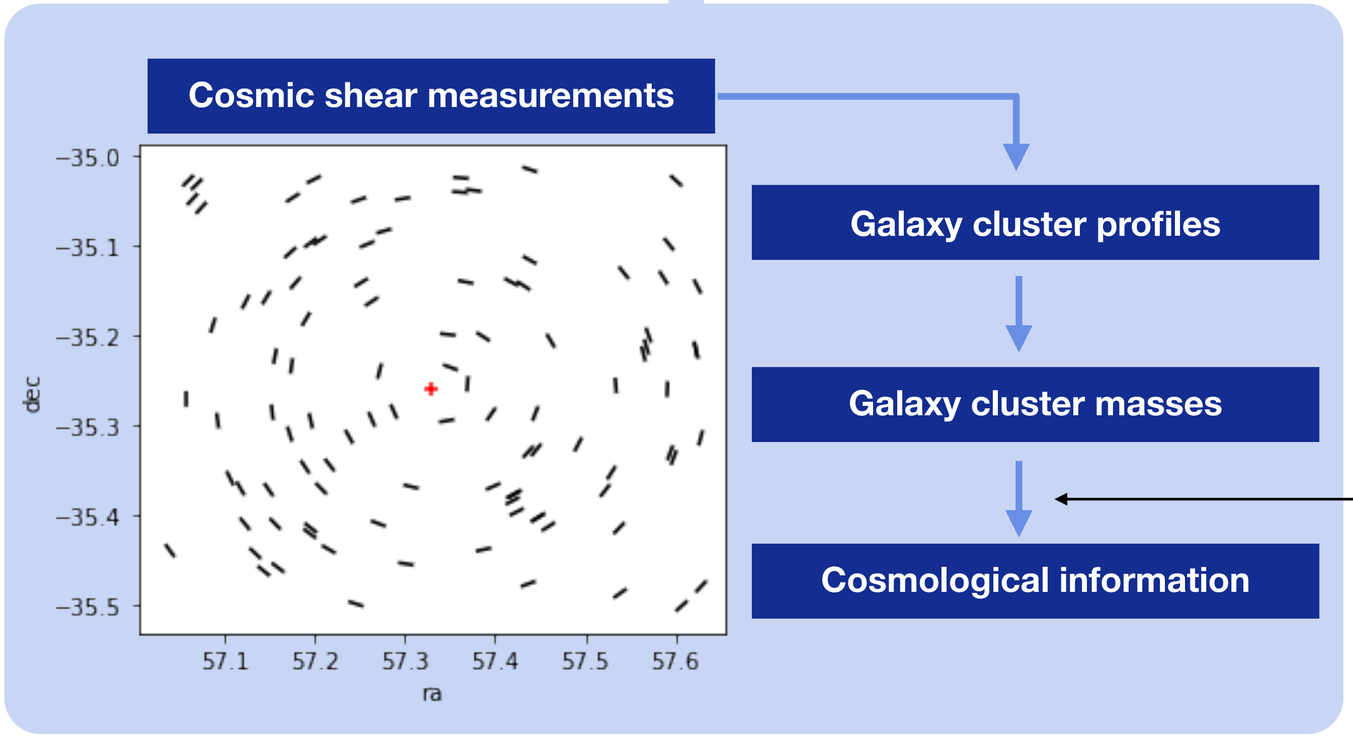
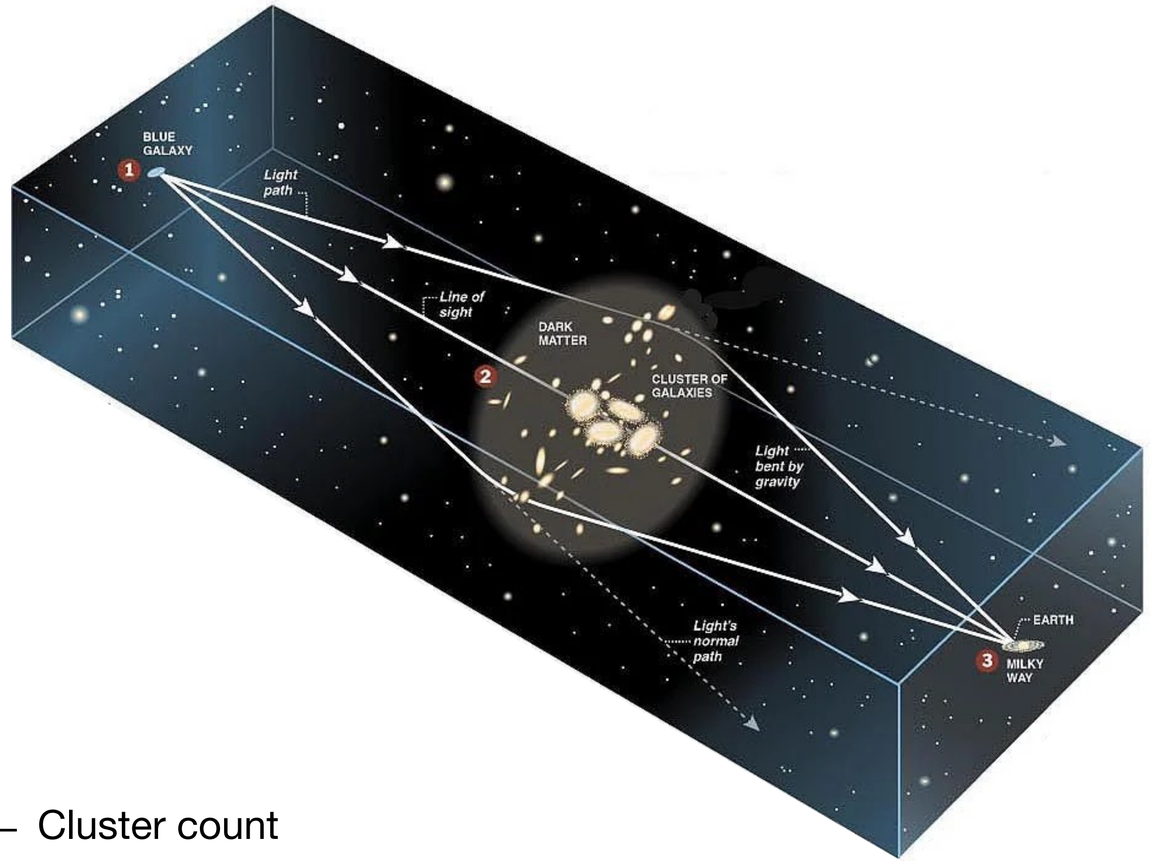
Physics overview and tools
Weak gravitational lensing

- Massive object (cluster of galaxies): the lens
- Background objects: the sources
- Curvature of light rays: **distortions of the images**





Physics overview and tools

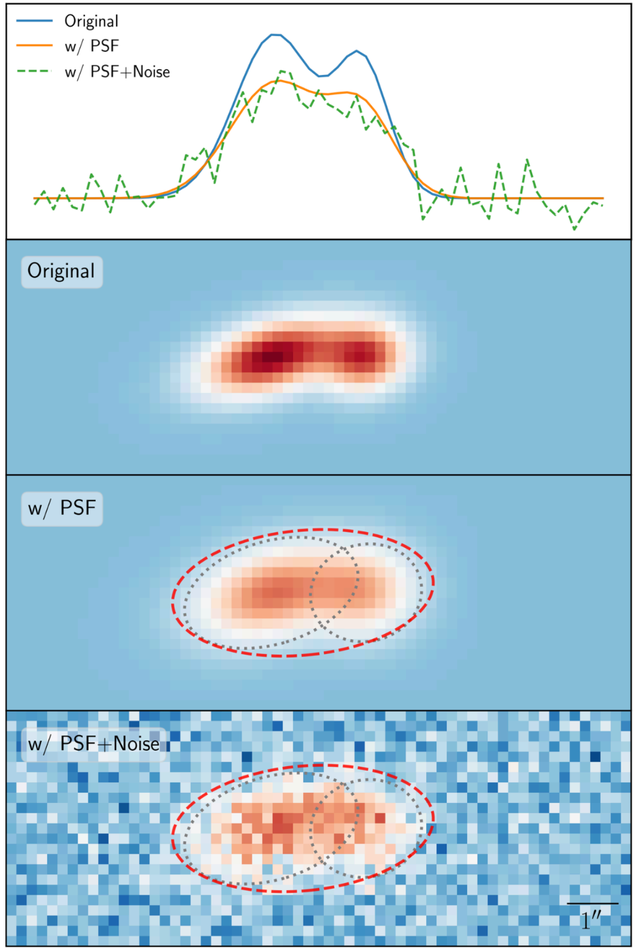
Blending effect

- Superposition of galaxy fluxes in the images due to the increasing depth of our observations + the atmospheric PSF

- 2 different types of blending
  - **Recognized blends**
  - **Unrecognized blends**

- Impact cosmic shear measurements

- 14% of the galaxies will be unrecognized blends for Rubin/LSST*



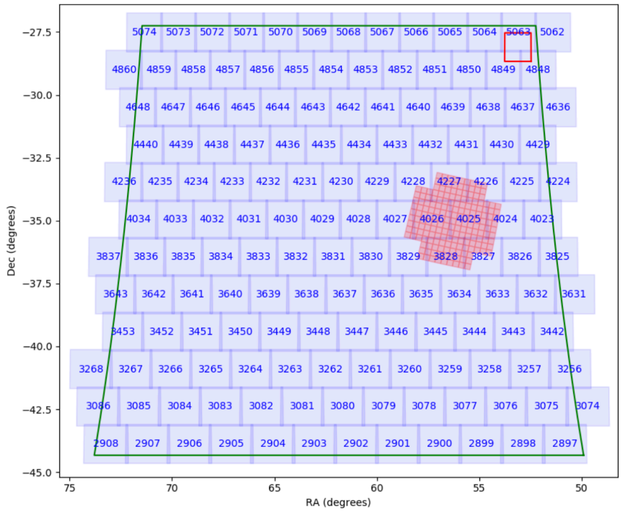
PSF : Point Spread Function

E. Nourbakhsh et al. 2021

** Dawson et al. 2016* ***: proportion in the Musket Ball cluster***

Physics overview and tools

Catalogs

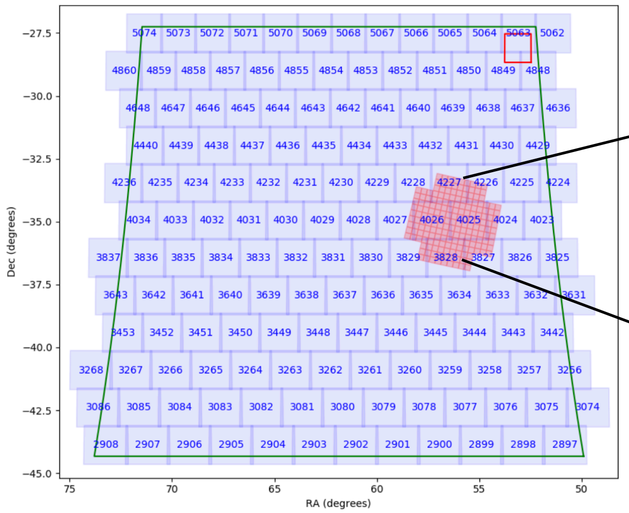


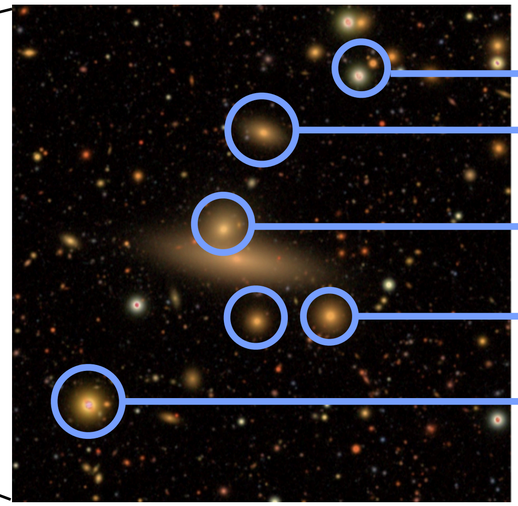
cosmoDC2 = truth catalog

- 440 squared degrees extragalactic catalog for the DESC DC2
- Model the **galaxies** that will be observed by Rubin/LSST
- Up to mag = 28 and z = 3

Physics overview and tools

Catalogs





mag_i	ra	dec	photoz_mean
26.000307	65.651380	-40.165275	0.993726
25.979636	65.669211	-40.164807	1.310777
25.684754	65.689560	-40.164402	1.272034
26.028899	65.586829	-40.165072	0.771660
25.987172	65.572840	-40.165155	0.717548
...	...	...	...
26.485500	63.842943	-38.683229	0.500387
26.517529	63.842136	-38.683610	1.988279
26.576436	63.997678	-38.683232	1.622917
26.411173	63.879234	-38.679307	1.249039
26.521166	63.958090	-38.810907	1.486370

cosmoDC2 = truth catalog

- 440 squared degrees extragalactic catalog for the DESC DC2
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DC2object = object catalog

- Images simulated using 300 squared degrees of CosmoDC2
- Detection of **objects** from those images → DC2 Object Catalog
- Measured positions, magnitudes, shapes, photo-z…

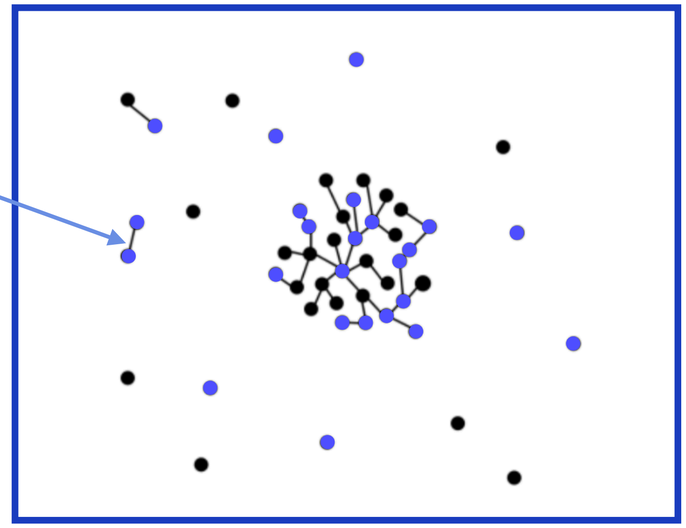
- Comparison of the two catalogs = comparison between the truth and the observations

Physics overview and tools

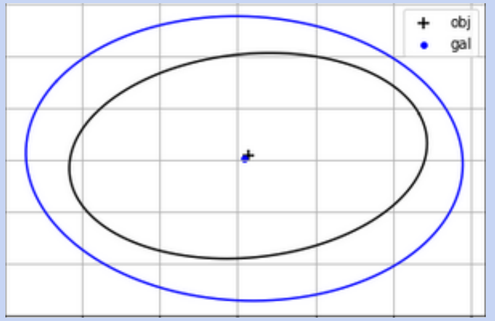
Friends-of-Friends algorithm

https://github.com/yymao/FoFCatalogMatching

- To match the previous catalogs
- Linking length in arcseconds (between 0.1” and 1”)
- Creation of groups with objects and galaxies: n-m systems (**n = # of galaxies**, **m = # of objects**)



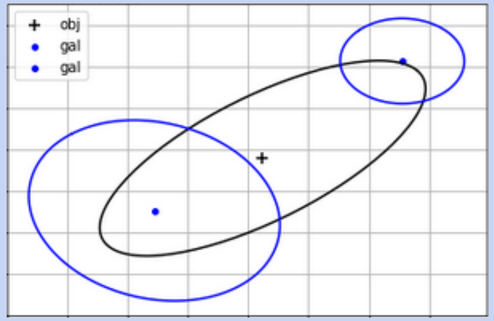
Perfect matches



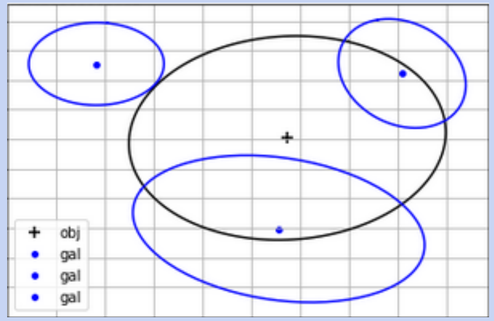
1-1 systems

Unrecognized blends

2-1 system



3-1 system



n-1 systems (n > 1)

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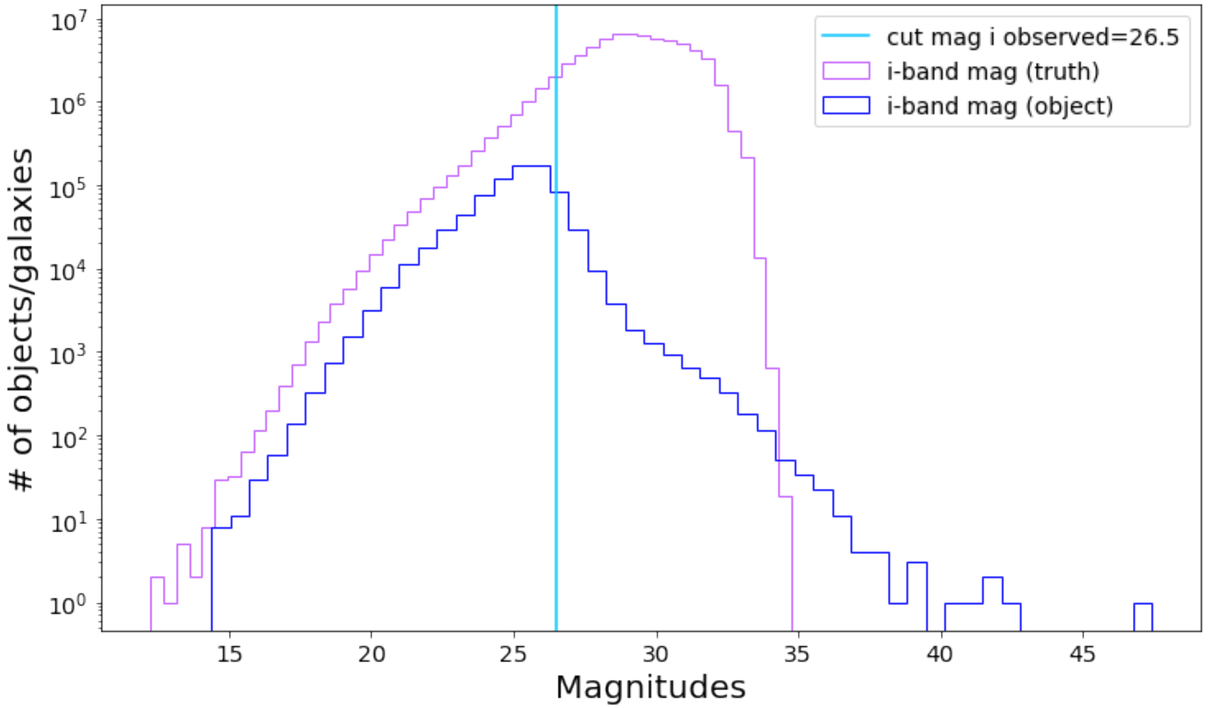
Preliminary studies

Magnitude cuts and linking length

Magnitude cuts

Distribution of i-band magnitudes for truth and object catalogs



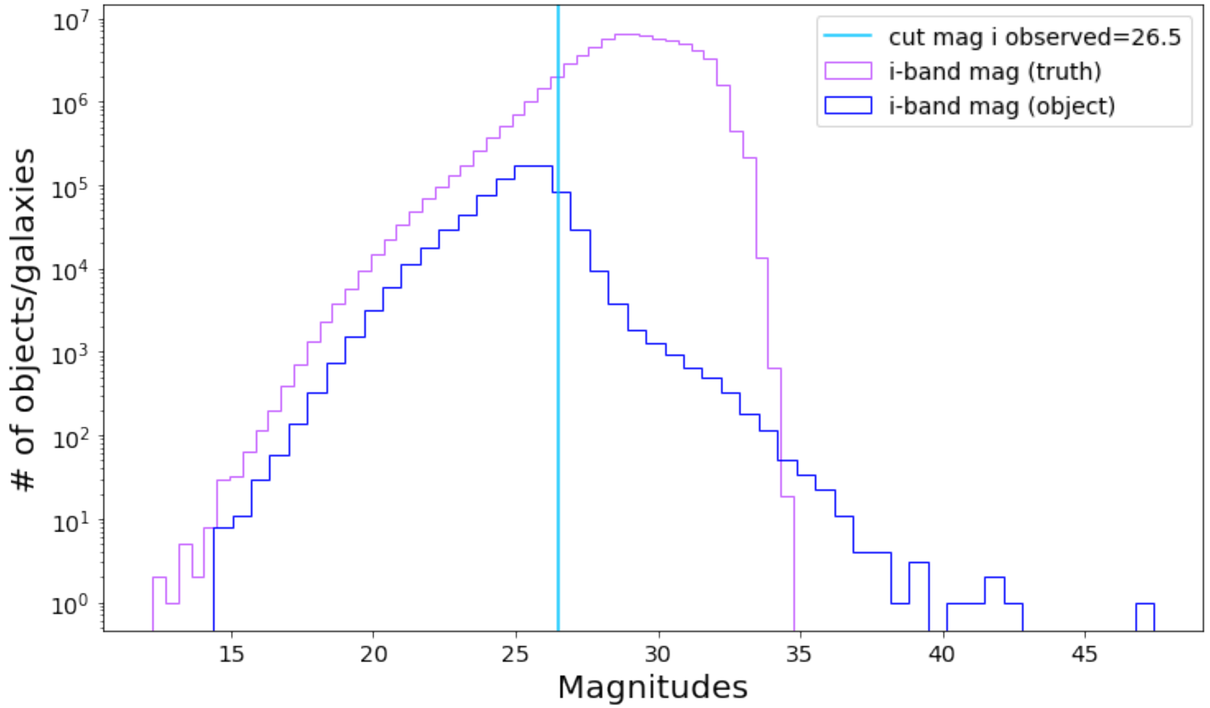
- We decide to take a cut = 26.5
- Truth catalog magnitude cut : 28

Preliminary studies

Magnitude cuts and linking length

Magnitude cuts

Distribution of i-band magnitudes for truth and object catalogs



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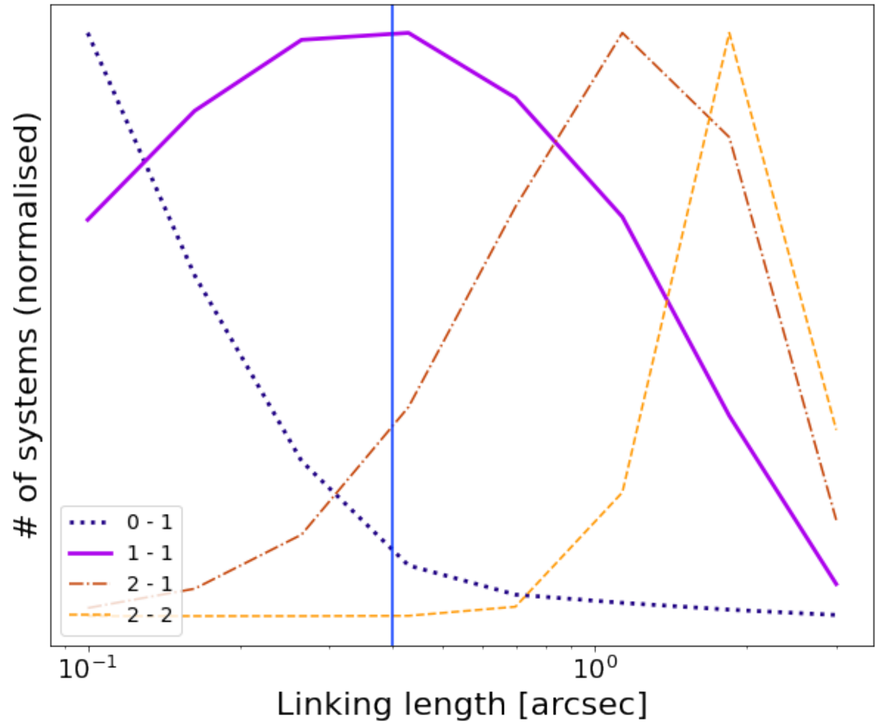
Linking length

➔ **Still under study!**

- Maximize the 1-1 systems = perfect matches



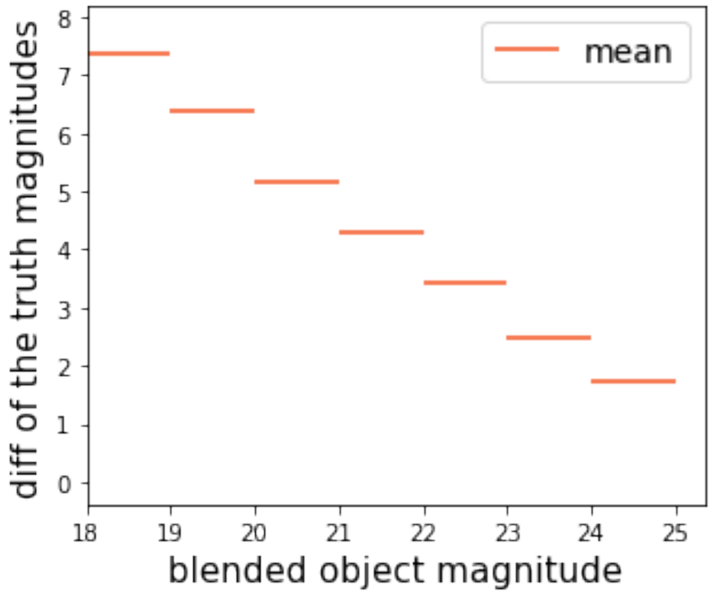
We choose: 0.4” (pixel size: 0.2”)

- Proportion of unrecognized blends (n-1 systems with n > 1) : ~ 2%

Preliminary studies

2-1 systems = 2 galaxies and only 1 detected object

Differences in magnitude between the two galaxies



- On average: blending between a very bright galaxy and a fainter one

Preliminary studies

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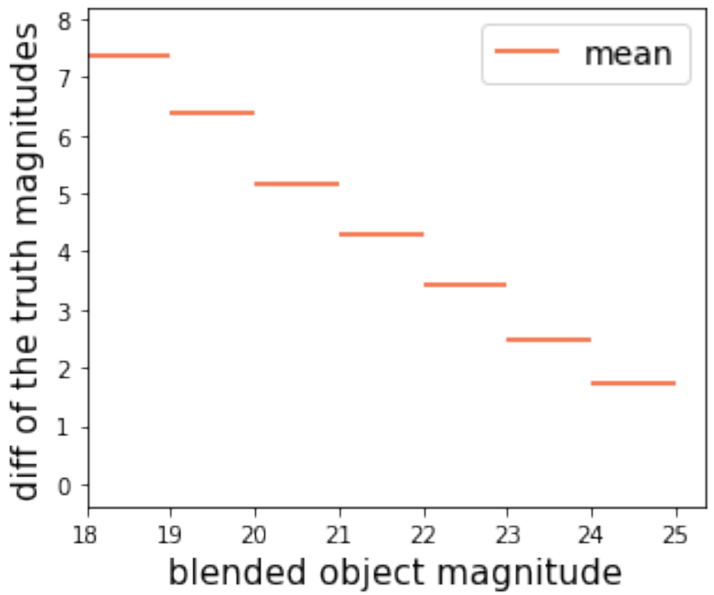


- On average: blending between a very bright galaxy and a fainter one

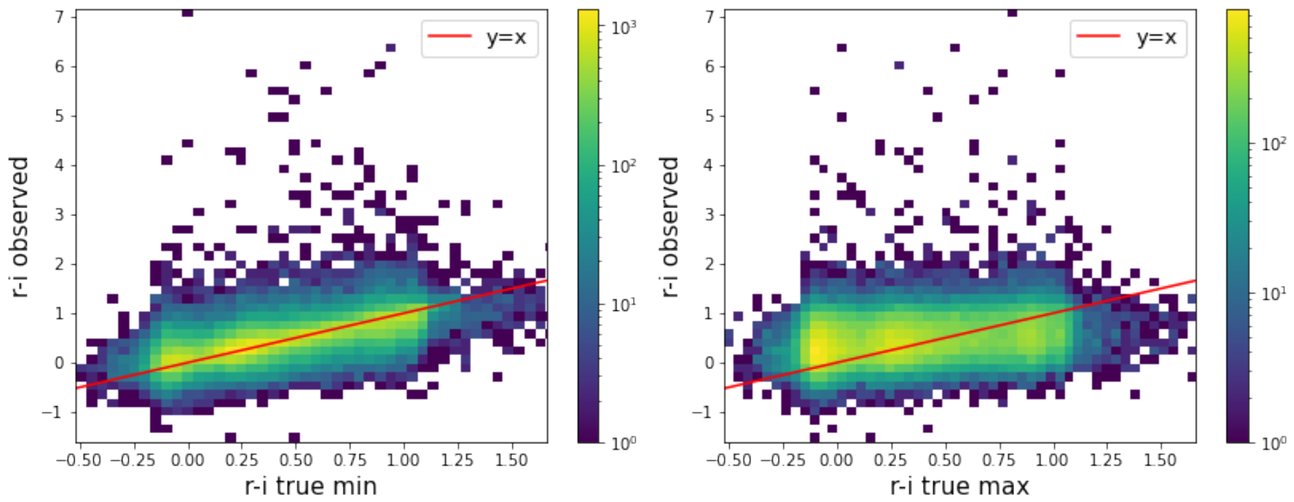
Differences in colors between the object and the galaxies

Brightest true underlying galaxy

Pearson coefficient : 0.66

Faintest true underlying galaxy

Pearson coefficient : 0.26



- Less correlation between the color observed and the color of the faintest galaxy

- The detection corresponds to the brightest galaxy of each group

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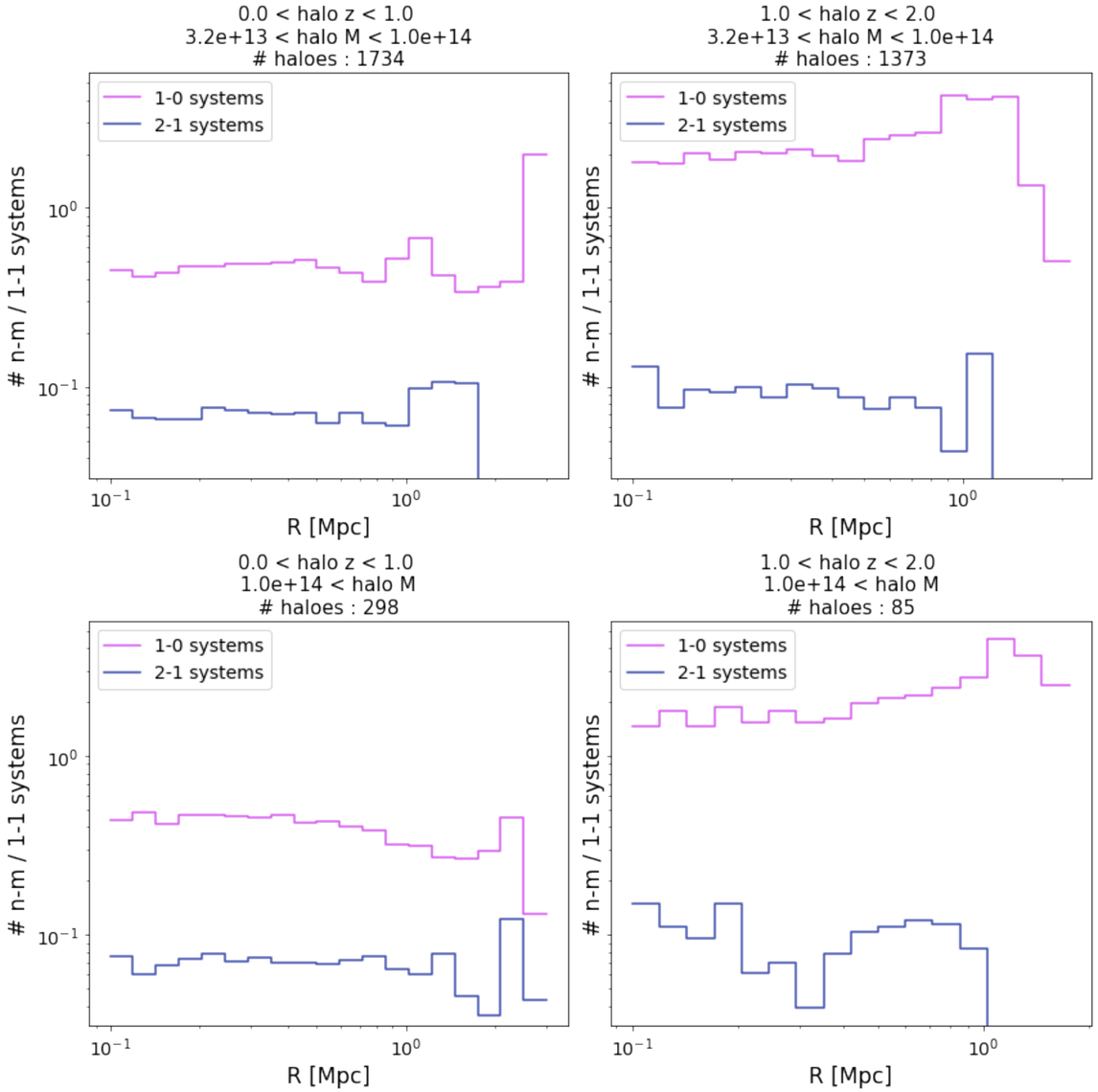
Impact of blending in haloes

Number of systems versus the distance to the halo centre



- Halo of the group = halo of the brightest galaxy
- Look at systems in haloes of mass $M > 10^{13.5} M_{\odot}$
- Proportion of unrecognized blends in haloes: **~10 %**
  Dawson et al.: ~14 %

- # of 2-1 systems seems independent of R (distance to the halo centre)

Impact of blending in haloes

Impact of blending on tangential shear profiles

https://github.com/LSSTDESC/CLMM

Aguena M., et al., 2021, Monthly Notices of the Royal Astronomical Society, 508, 6092

- **CLMM** = Cluster weak Lensing Mass Modeling library: Developed by LSST DESC (LPSC + LAPP)

Lensed ellipticities measurement for each source

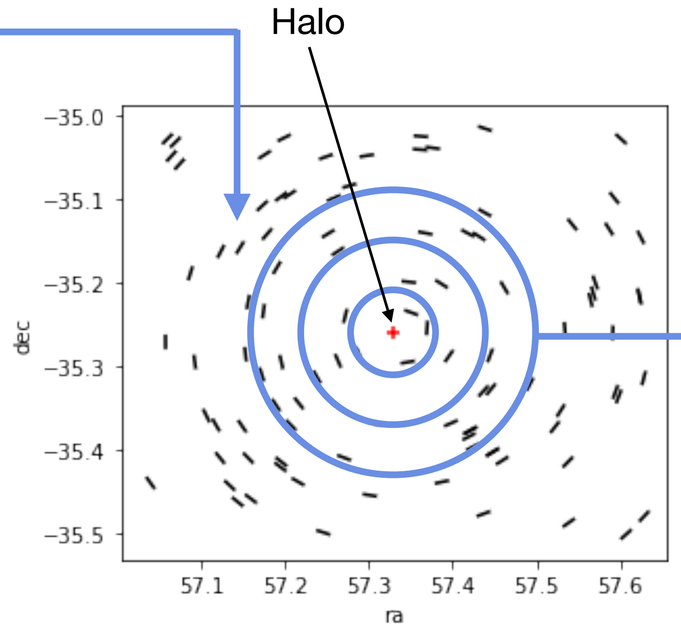
HSM | Metacalibration

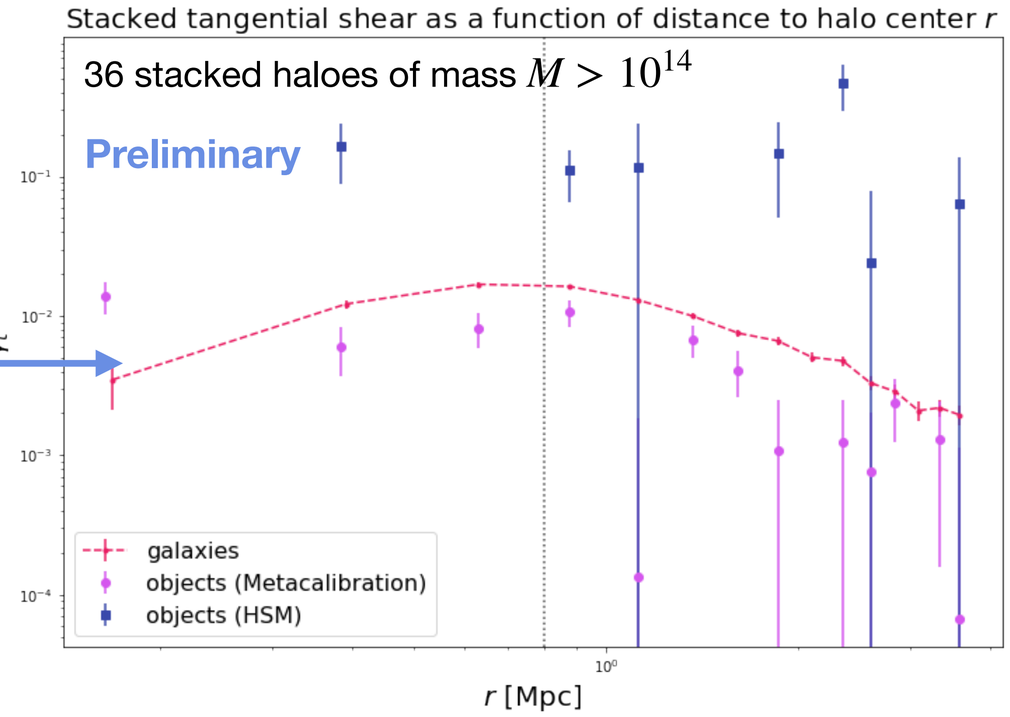
↓

Radial binning: tangential shear profile

↓

Fitting a halo mass





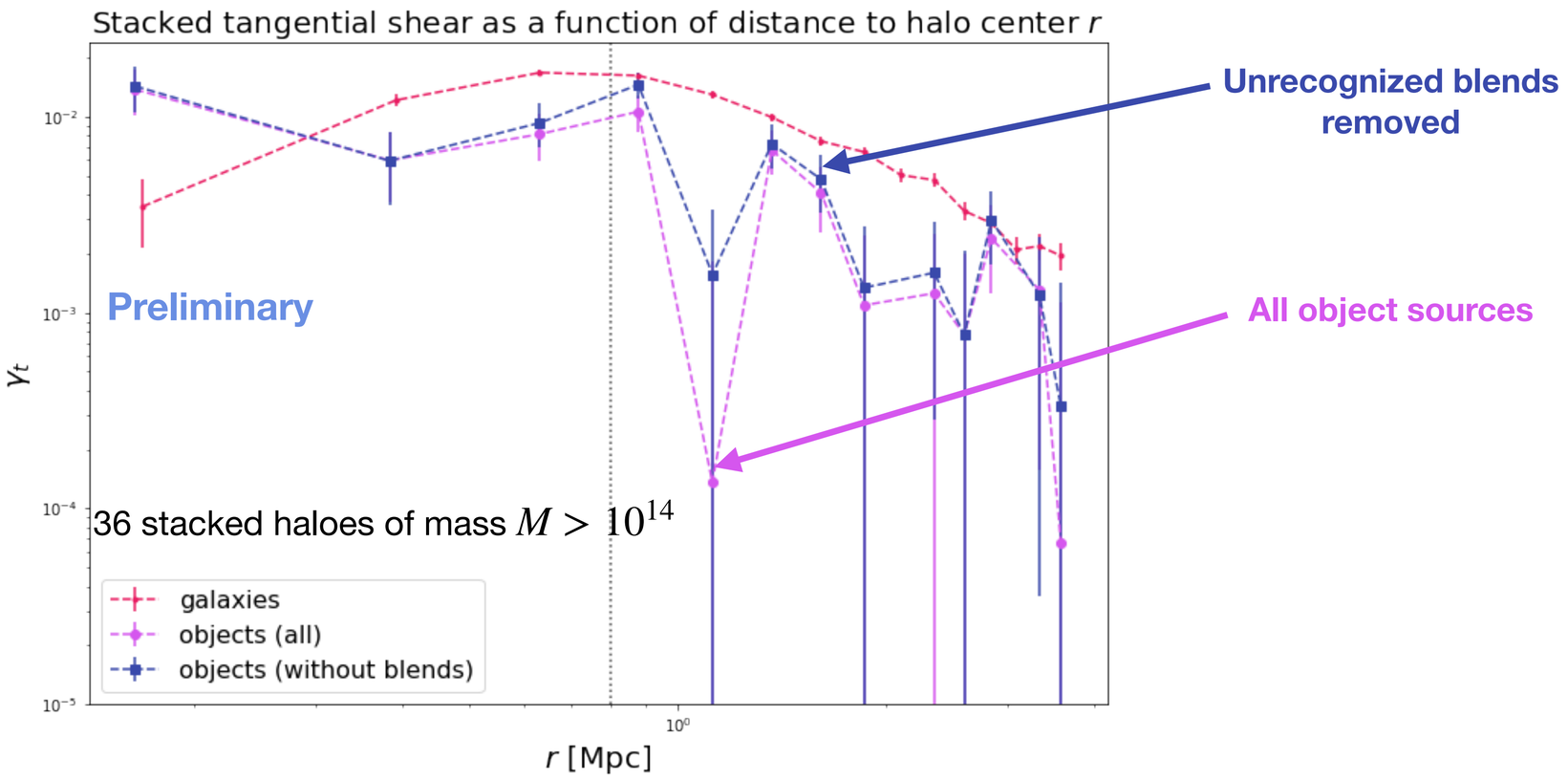
Non-calibrated measurements for HSM and Metacalibration

Impact of blending in haloes

Impact of blending on tangential shear profiles

- # source galaxies: ~2301614/halo
- # source objects: ~486677/halo
- # source objects (without unrecognized blends): ~ 441961/halo

Impact of unrecognized blends on tangential shear profiles



Possible bias observed **(!!! To be confirmed with more data !!!)**

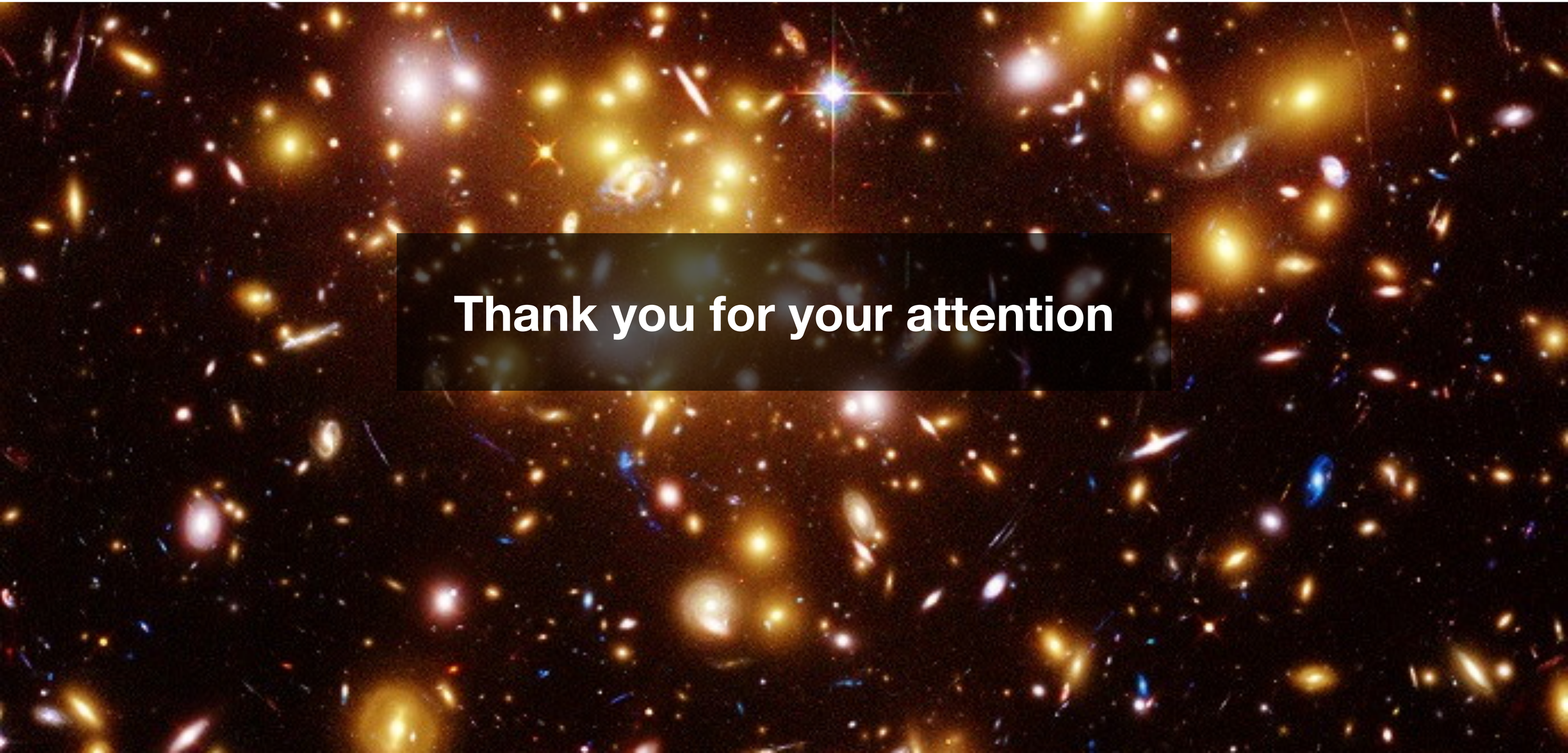
Conclusion and perspectives

Conclusion

- Optimization of the linking length for the FoF algorithm
- Importance of blended systems near to the haloes centres
- Possible impact of blending on tangential shear profiles

Perspectives

- Continue to study the impact of the linking length on formed systems
- Stack more haloes to have more statistics / Work with more tracts
- Impact of recognized/unrecognized blends on halo masses with CLMM


Thank you for your attention