Weak lensing detection of a filamentary structure near the massive cluster MACSJ0717 ?

Galaxy Clusters in the Early Universe

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&

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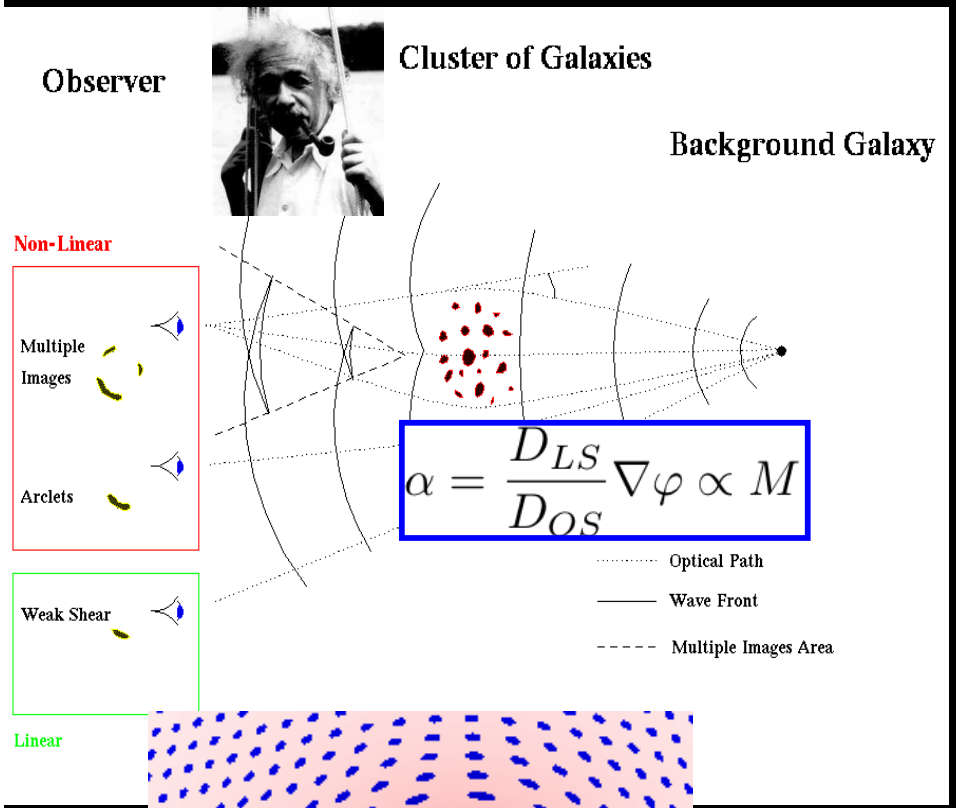
Cluster Lensing back to Basics

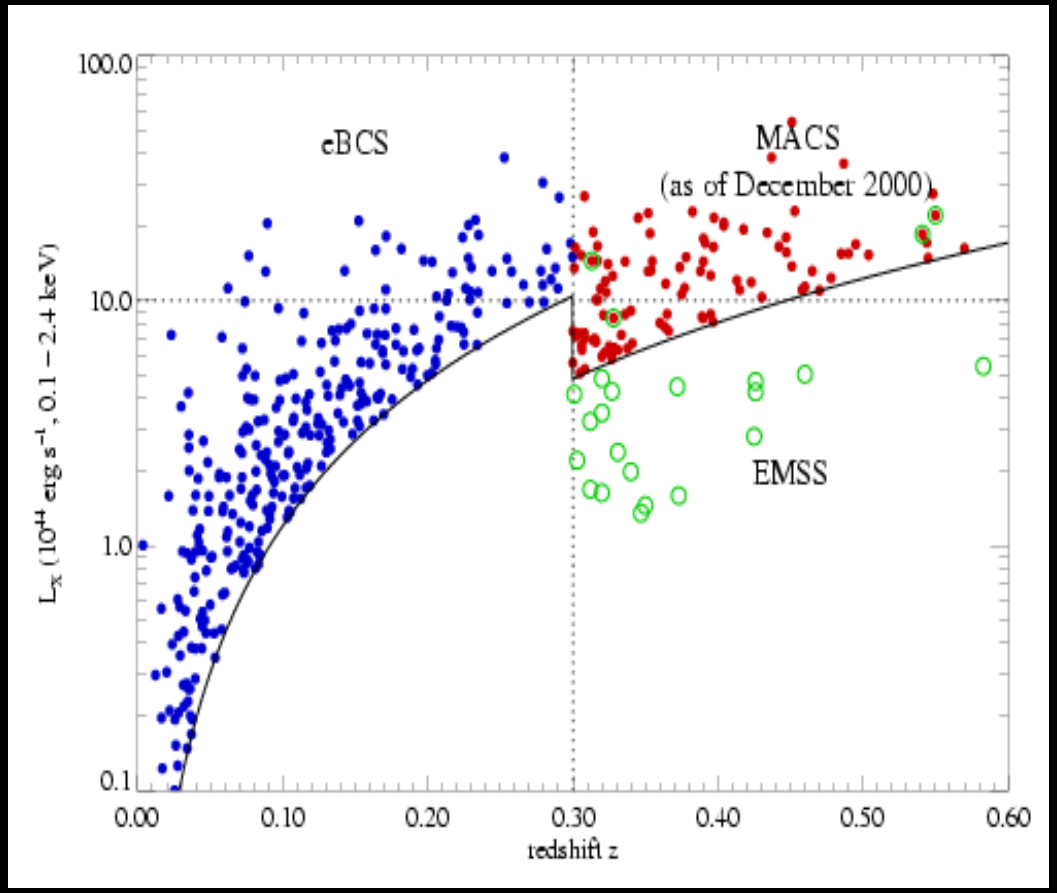


- Basics of lensing:
  - Important mass density locally deform the Space-Time,
  - *A pure geometrical effect, no dependence with photon energy*

- Lensing by a (massive) cluster
  - Strong Lensing (SL) = core of the cluster as arcs & multiple images
  - Weak Lensing (WL) = outskirts of the cluster as statistical deformation of background sources

MAssive Cluster Survey (MACS)

Ebeling, Edge & Henry, 2001



L_X (10^{14} erg.s^{-1})

Redshift z

→ Deep cluster survey which provided very massive clusters, selected in the X-Rays with z > 0.3

→ Based on optical follow-up of faint extended sources in the X-ray ROSAT all sky survey

→ Comprises about 120 clusters that are likely to be the most massive structures in the distant Universe

MACS subsample at z > 0.5

Ebeling et al. , 2007

High-redshift subsample

MACS high-z subsample, reference: [http://adsabs.harvard.edu /abs/2007ApJ...661L..33E Ebeling et al. 2007, ApJ, 661, L33]

name	RA (J2000)	Dec (J2000)	z	HST/ACS
MACSJ0018.5+1626	00 18 33.835	+16 26 16.64	0.5456	F775W
MACSJ0025.4–1222	00 25 29.381	–12 22 37.06	0.5843	F555W, F814W
MACSJ0257.1–2325	02 57 09.151	–23 26 05.83	0.5049	F555W, F814W
MACSJ0454.1–0300	04 54 11.125	–03 00 53.77	0.5377	F555W, F814W
MACSJ0647.7+7015	06 47 50.469	+70 14 54.95	0.5907	F555W, F814W
MACSJ0717.5+3745	07 17 30.927	+37 45 29.74	0.5458	F555W, F814W
MACSJ0744.8+3927	07 44 52.470	+39 27 27.34	0.6976	F555W, F814W
MACSJ0911.2+1746	09 11 11.277	+17 46 31.94	0.5049	F555W, F814W
MACSJ1149.5+2223	11 49 35.093	+22 24 10.94	0.5444	F555W, F814W
MACSJ1423.8+2404	14 23 47.663	+24 04 40.14	0.5431	F555W, F814W
MACSJ2129.4–0741	21 29 26.214	–07 41 26.22	0.5889	F555W, F814W
MACSJ2214.9–1359	22 14 57.415	–14 00 10.78	0.5027	F555W, F814W

MacsWiki: High-redshift subsample (dernière édition le 2009-04-03 12:54:00 par JeanPaulKneib)

→ 12 clusters at z > 0.5

→All observed with ACIS-I instrument aboard Chandra X-ray Observatory

→Deep observations with SuprimeCam wide-field imager on the Subaru 8.3m telescope (B,V,R,I & z' bands)

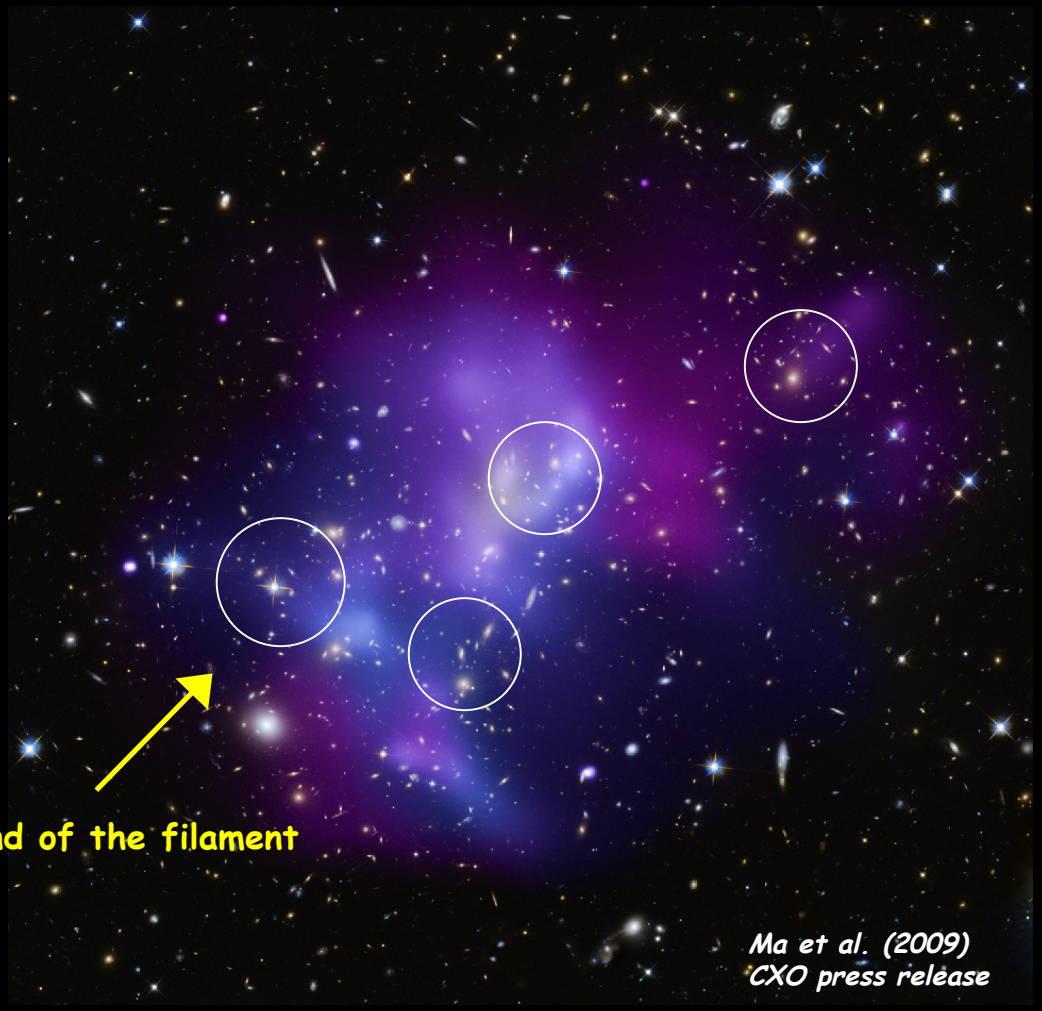
→Imaged by MegaCam 1-degree imager on 3.6m Canada-France-Hawaii Telescope (U-band)

→High resolution imaging of cluster cores with ACS datas (f555w & f814w)

→ extensive spectroscopic observations of galaxies in the fields with multi-object spectrograph on 8m-class telescopes on Mauna Kea (Gemini, Keck-I, Keck-II)
⇨ A catalogue of more than 3000 redshifts of galaxies in MACS cluster fields (Barrett & Ebeling, 2007)

MACSJ0717.5+3745 : X-ray/optical analysis

Ma et al. 2009

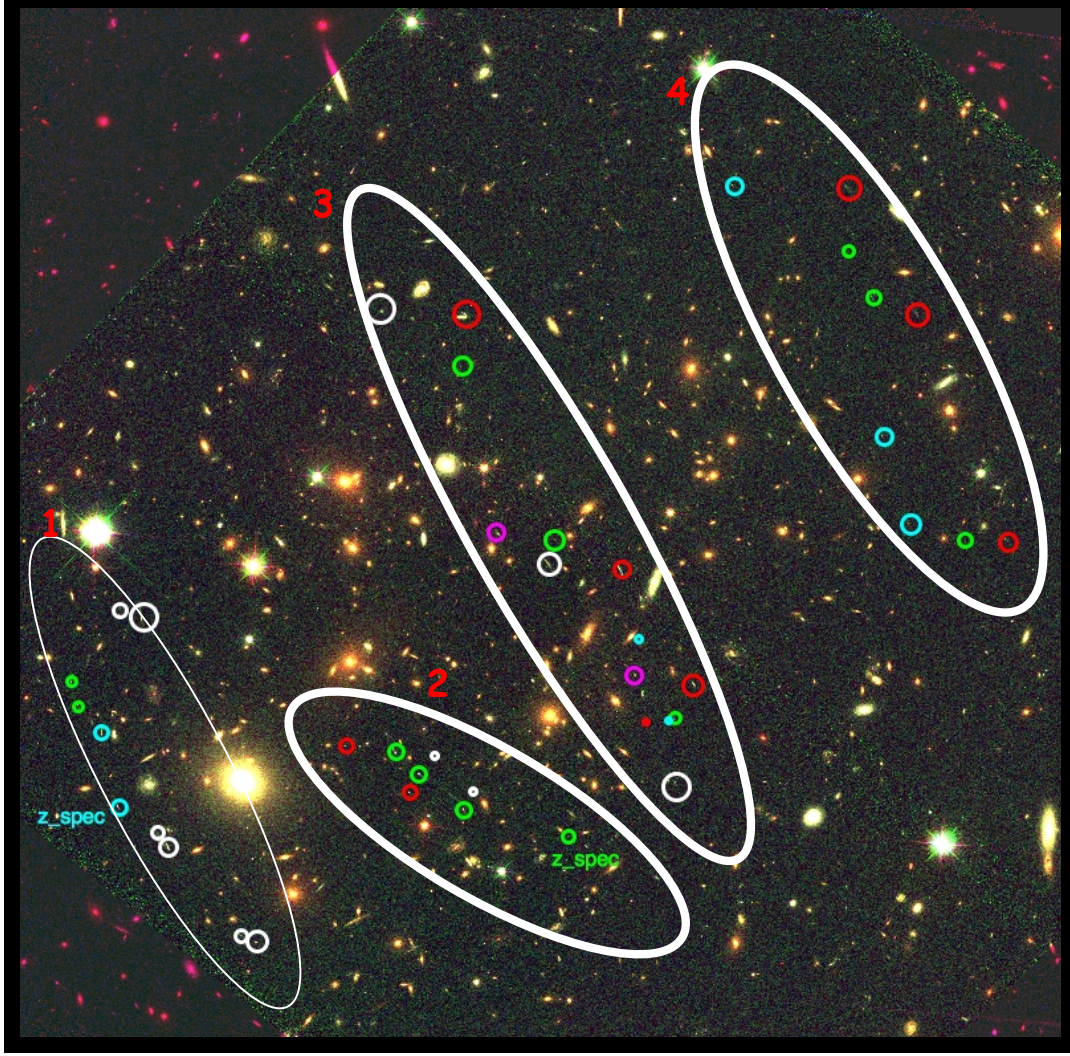


- X-ray luminous cluster at z=0.55
- X-ray evidence + distribution & velocities of cluster galaxies
- Active triple merger (ICM T°=20keV)
- All 3 mergers proceed along distinctly different directions

→ partial alignment of the merger axes points to a common origin in the large-scale filament (SE of cluster core)

STRONG LENSING ANALYSIS

ACS Data with f814w & f555w



Zitrin et al.(2009)

13 multiple systems ->

$M(<350\ kpc) = 7.4 * 10^{14} M_{SUN}$

WORK IN PROGRESS

- 4 more multiple systems
- 2 with zspec & 2 nights at Keck

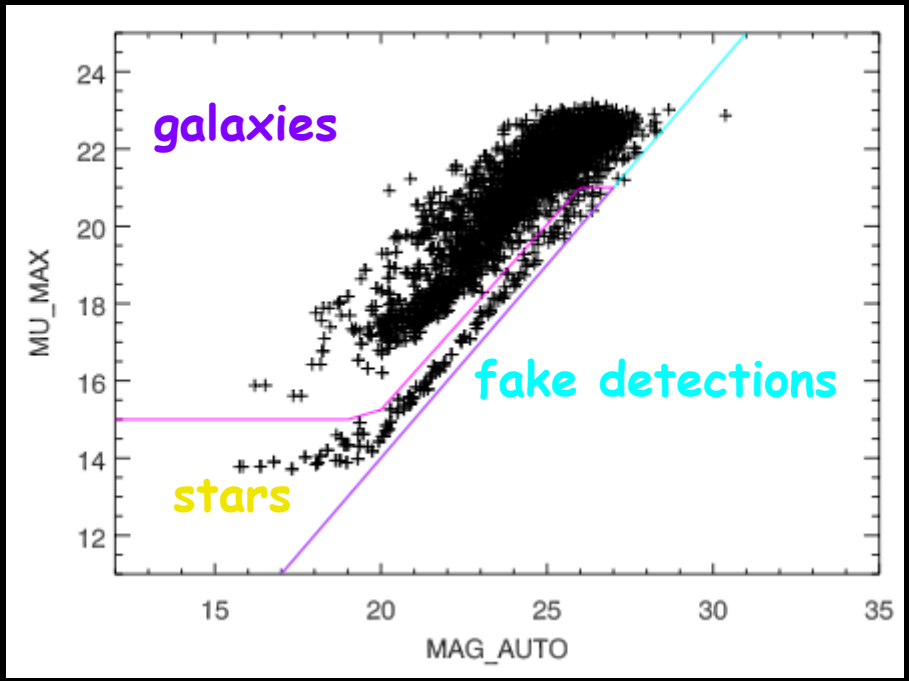
- 3 straight (2,3,4) structures (no curvature, 1)= mass on each side !

WEAK LENSING CATALOGUES : 1ST STEP

→ ACS datas : need to be corrected from PSF & CTE (Charge Transfer Efficency)

Pipeline by A. Leauthaud for COSMOS field (Leauthaud et al. 2007)

- Detection of sources using Sextractor : *the 'Hot-Cold' method* (used in Rix et al. 2004)
- Cleaning process : objects within noisy border of tile , objects with automatically defined masks , with manually defined masks & objects with double or more detections
- Shape measurements using RRG method (Rhodes, Refregier & Groth 2000) : correction from PSF & CTE
- Lensing cuts : d>3.6 pix , S/N>4.5 , e<2



MU MAX

MAG AUTO

WEAK LENSING CATALOGUES : 2ND STEP

→ Galaxy clusters : contamination from clusters' galaxies

Add lensing cuts for galaxy clusters

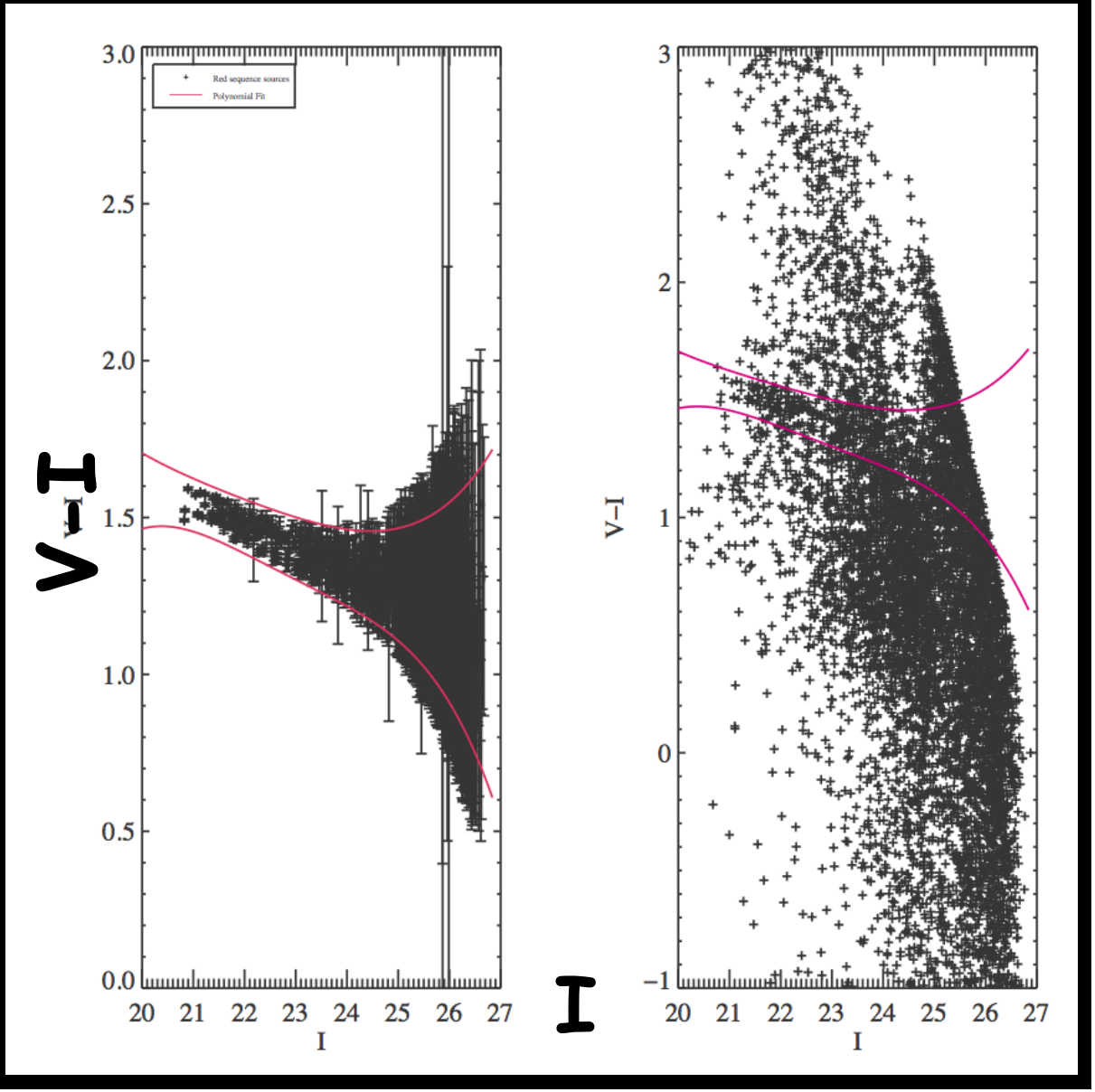
- Color-Magnitude Selection : remove galaxies in the cluster red sequence
- Redshift cut : $z > 0.6$
- Magnitude cut : $mag\_aper > 23$
- Size cut : $rH > 0.2''$
- (V-I) criteria
- Ellipticity cut : $\varepsilon < 0.8$

WEAK LENSING CATALOGUES :

COLOR-MAGNITUDE SELECTION

« Trumpet-like » color-magnitude selection

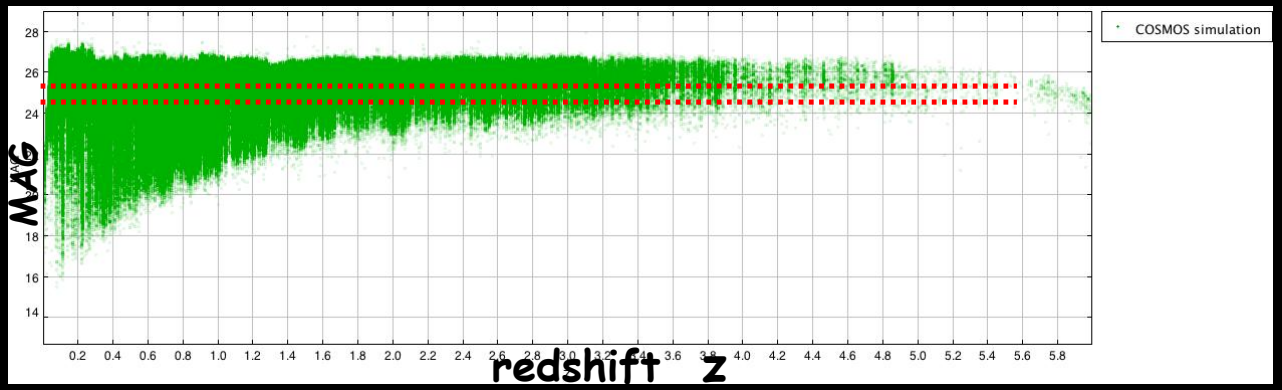
1. Linear fit based on low magnitude population
2. Polynomial fit based on the linear fit population



WEAK LENSING CATALOGUES : REDSHIFT SELECTION

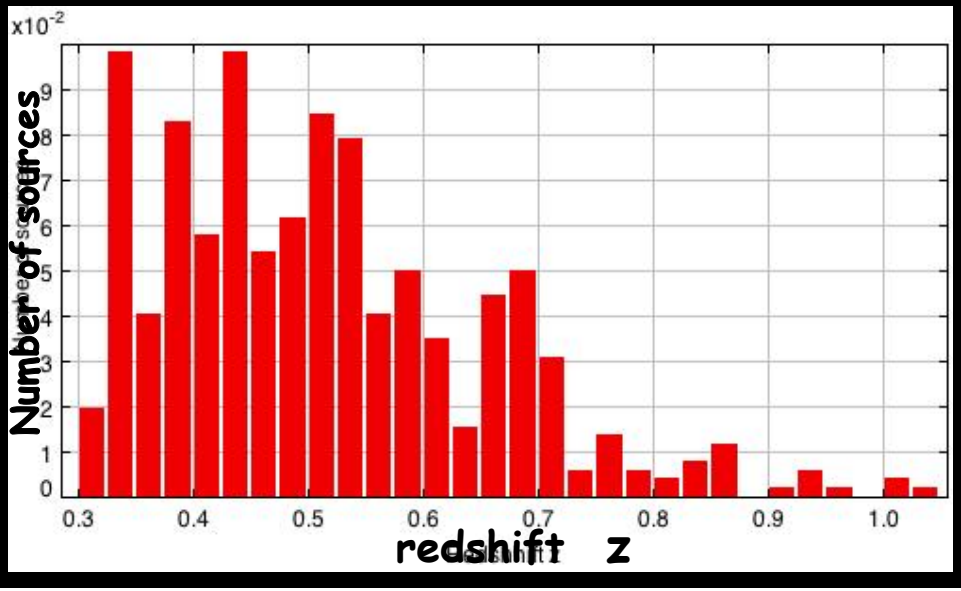
Add a redshift thanks to COSMOS redshift distribution :

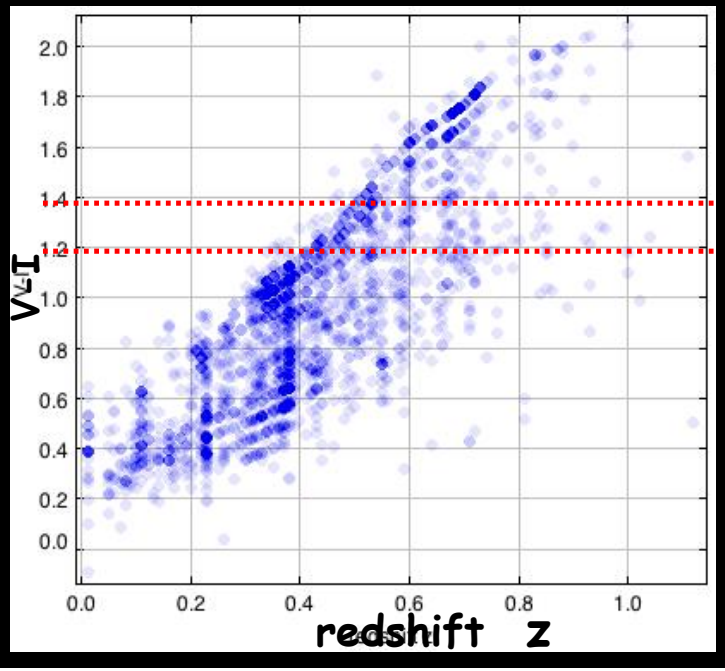
1. 1 MACS source with : MAG_macs & Color_macs
2. MAG_macs = bin MAG_cosmos -> Color_cosmos(z_cosmos)



3. Color_macs -> Color_cosmos(z_cosmos)

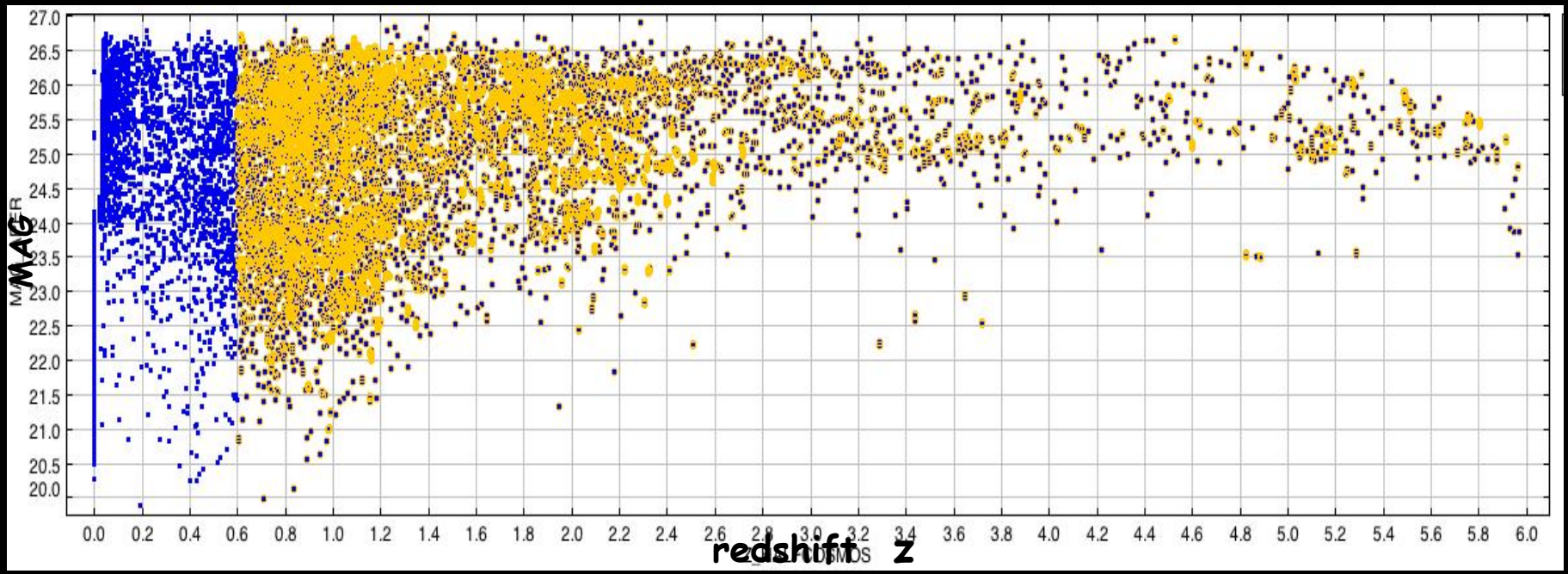
4. z_macs randomly selected in cosmos redshift distribution





WEAK LENSING CATALOGUES : REDSHIFT SELECTION

Add a redshift thanks to COSMOS redshift distribution :



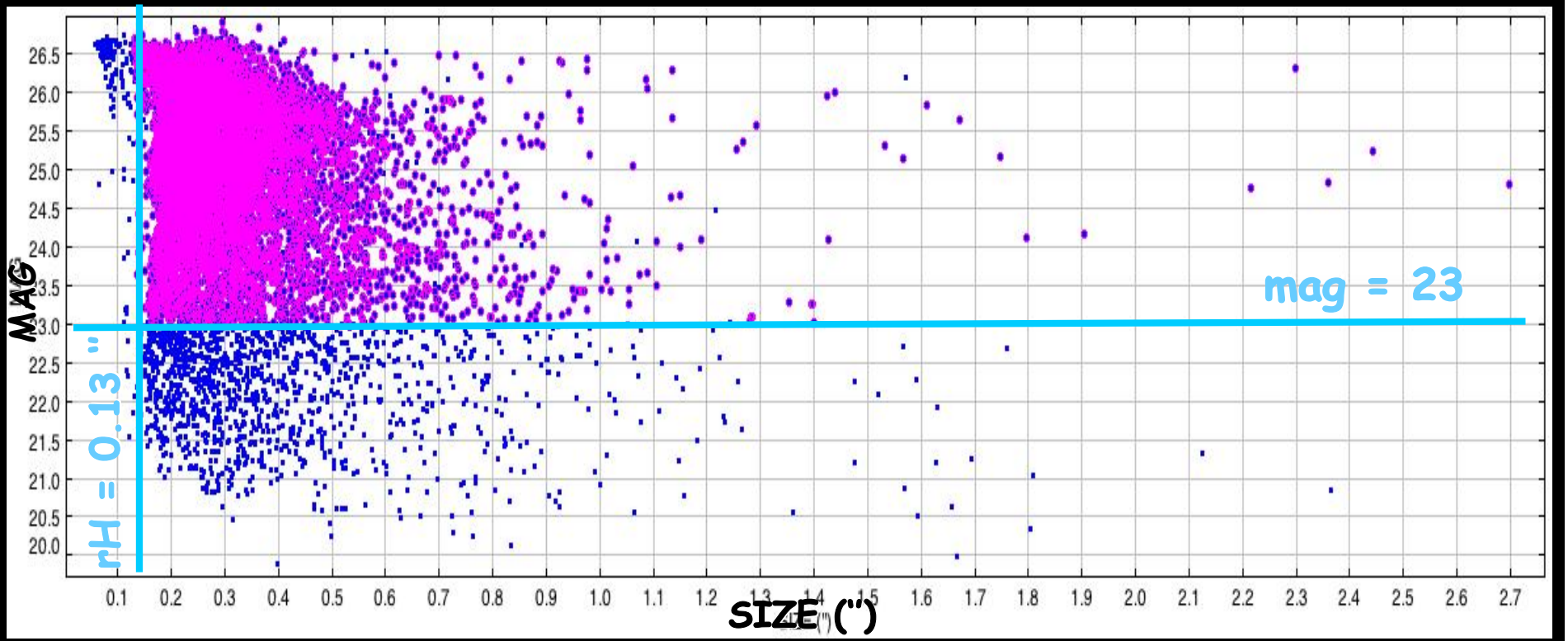
Redshift of MACSJ0717 = 0.55
Redshift cut = 0.6

WEAK LENSING CATALOGUES :

MAGNITUDE & SIZE & CM SELECTION

Reliable Shape Measurements :

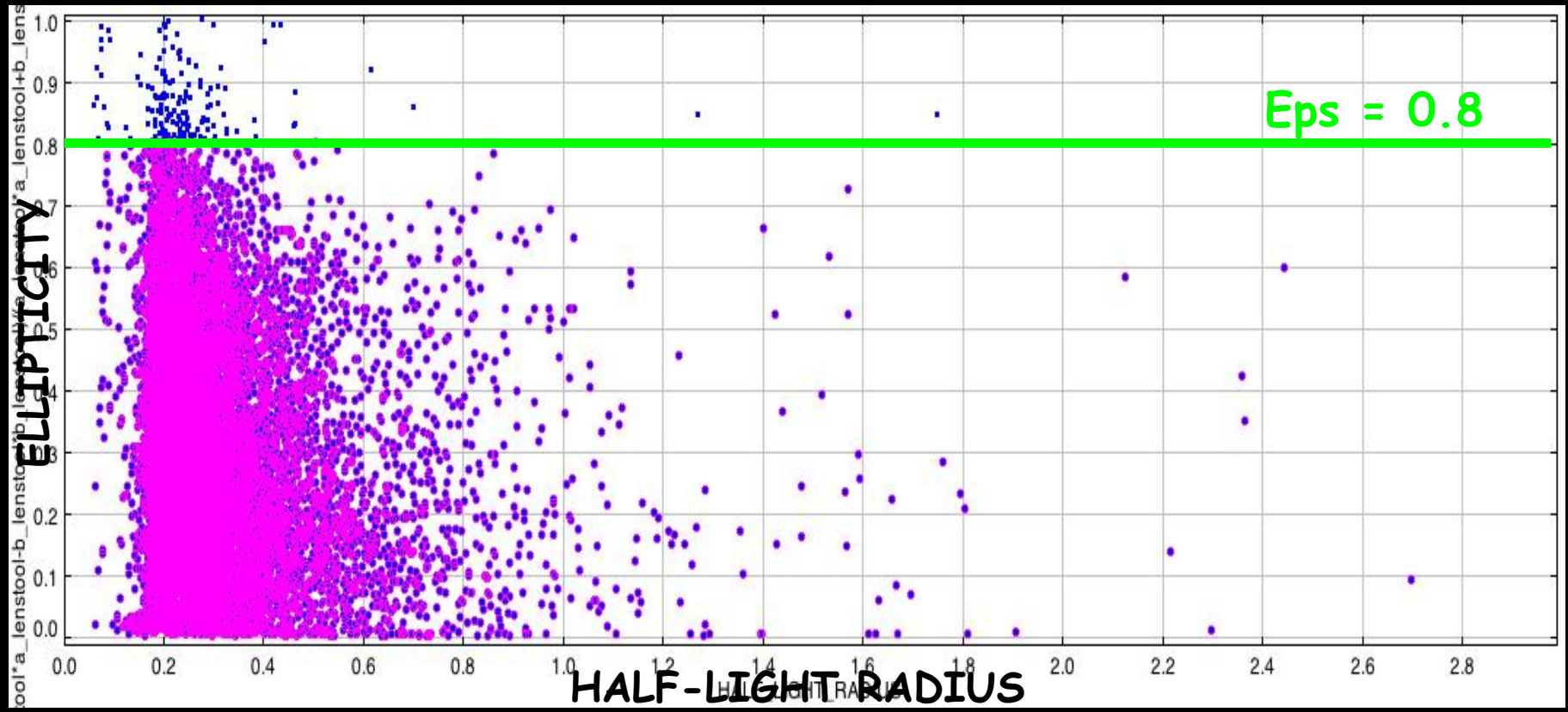
1. Contamination from foregroung galaxies -> mag > 23
2. Relevant shape measurements -> rH > 0.13 ''
3. Identification of a population with mag ~ 23.5 & rH ~ 0.34 -> CM criteria



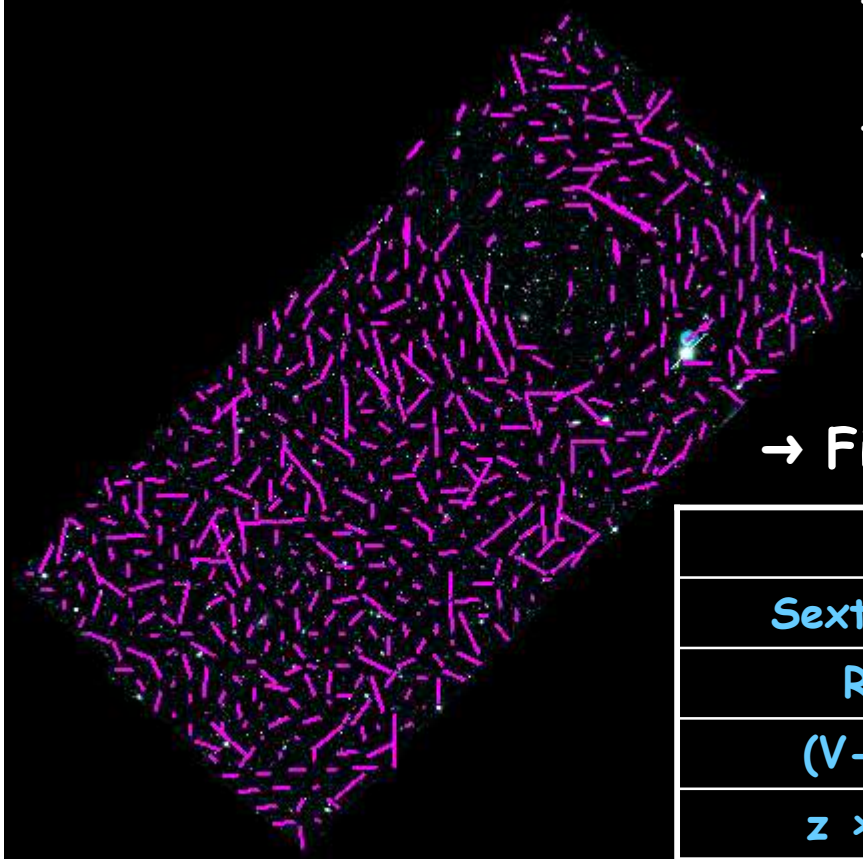
WEAK LENSING CATALOGUES : ELLIPTICITY CUT

Reliable Shape Measurements

-> high ellipticity objects = no confidence with shape measurement
-> eps < 0.8



MACSJ0717.5+3745 : WL ANALYSIS



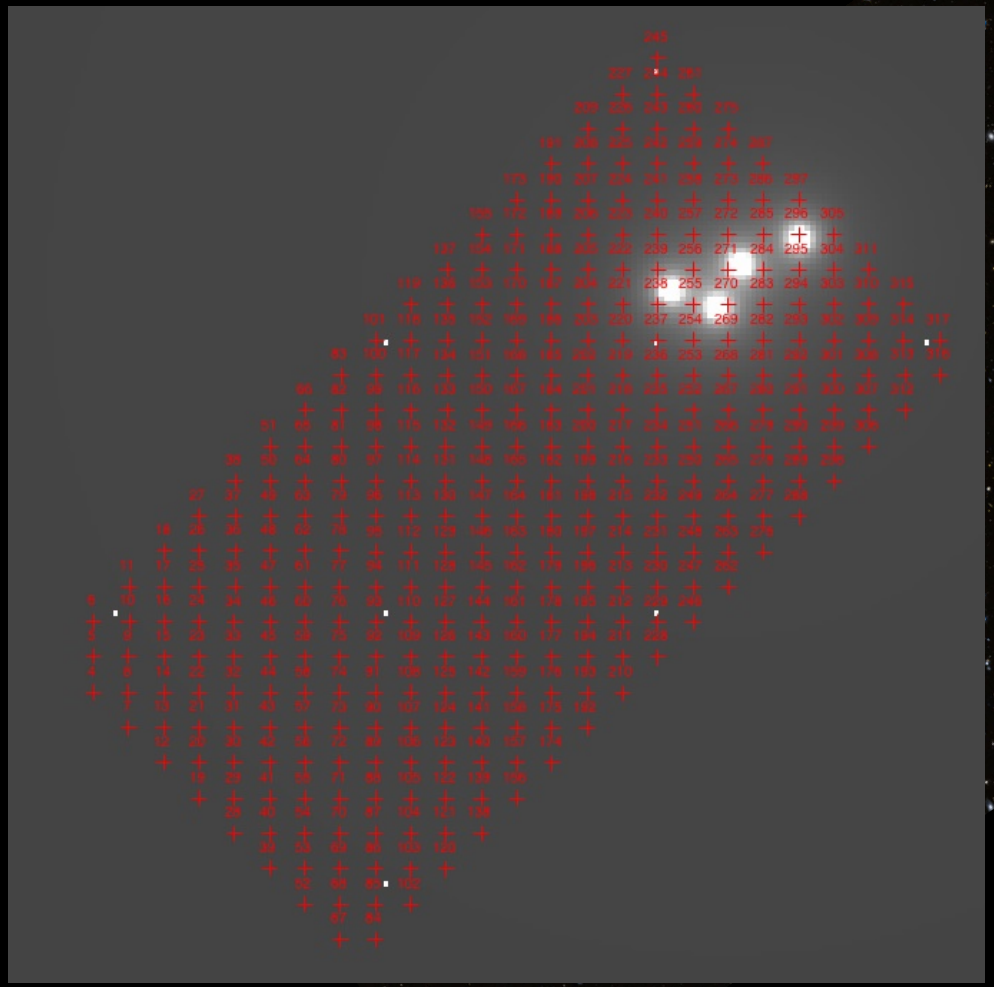
- 18 ACS maps :
  - 17 representing the field (f814w & f606w)
  - 1 representing the cluster core (f814w & f555w)
  - Analysis made separatelly
    - 5302 background sources in the field
    - 159 sources in cluster core

→ Final catalogue = 5461 sources

	CORE	FIELD
Sextractor	3126 sources	30897 sources
RRG	592	10123
(V-I)(I)	432	8811
z > 0.6	322	6736
eps	540	9948
Mag & Rh & CM	372	8293
	159 sources (16 sources/arcmin^2)	5302 sources (31 sources/arcmin^2)

MACSJ0717.5+3745 : MODELISATION

LENSTOOL : 4 clumps in the Xray + 1 homogeneous grid



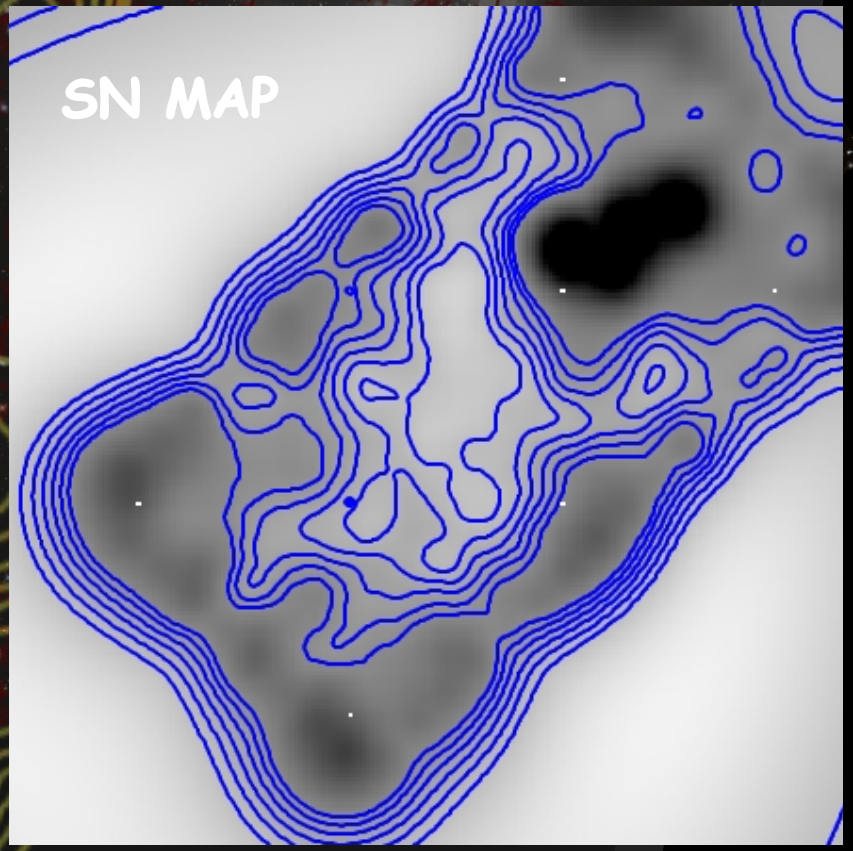
-> Interpolate the gravitational potential of the cluster using a uniform grid of potential and 4 well defined potential to modelise the cluster core

LENSTOOL

1. 'unlens each galaxy' : $e_s = f(e^i, gt^h)$
2. bayesian MCMC optimisation in the source plan

MACSJ0717.5+3745 : PRELIMINARY RESULTS

M_{tot} = 2.51 * 10^{15} M_{SUN}
Sigma = 2.6 * 10^{9} M_{SUN} / kpc^2



Bayesian method ->
Informations on mean & errors

MACSJ0717.5+3745 : PRELIMINARY RESULTS

Zitrin et al. (2009) :
M(<350 kpc) = 7.4 * 10^{14} Msol
Sigma_Zitrin ~ 2*10^{9} M_{sol} / kpc^2

-> Sigma_Zitrin < Sigma

-> expecting Sigma < Sigma_Zitrin
-> mass sheet degeneracy ???
-> next step is to include the wider field subaru data to break the mass sheet degeneracy

CONCLUSION

→ Preliminary Results

- Mfield = 2.51 * 10^{15} M_{SUN}
- Detection of a structure in the field ?

→ Future works

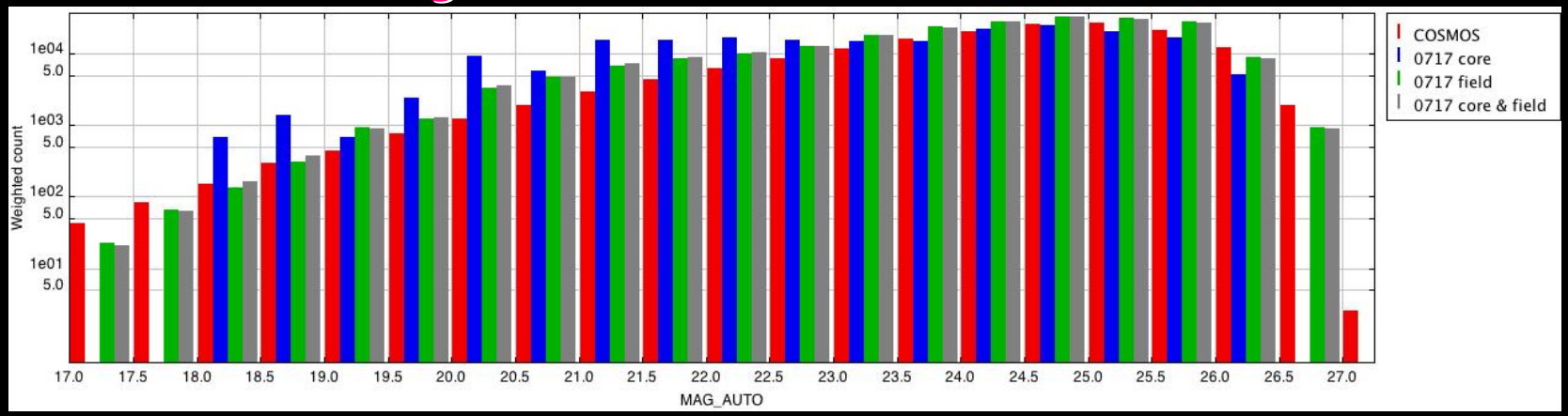
- Improve modelisation
- include the wider field subaru data to break the mass sheet degeneracy & remove edge effects
- SL+WL analysis on MACSJ0717

- WL analysis on all high-z MACS sample !


THE END !!!
In memory of Philippe Jauzac, my father
29th of August 1948 - 22nd of October 2009

MACSJ0717.5 : Comparison with COSMOS

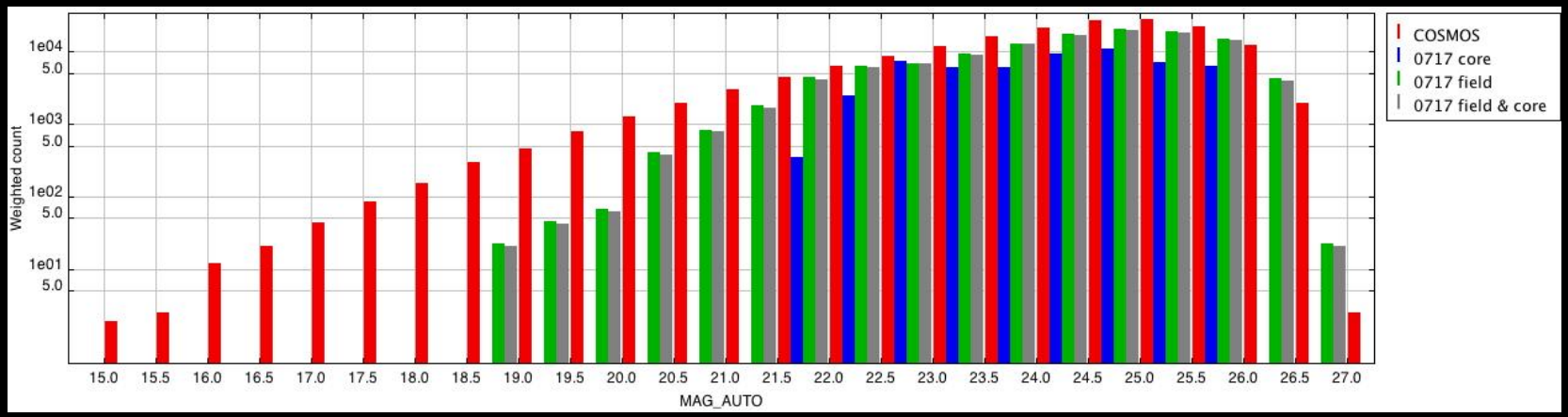
→ Just after runing RRG



→ Density of sources in 0717 greater than COSMOS's

→ High magnitude : more objects than COSMOS (2 HST orbits = deeper observations)

→ Just after WL selection



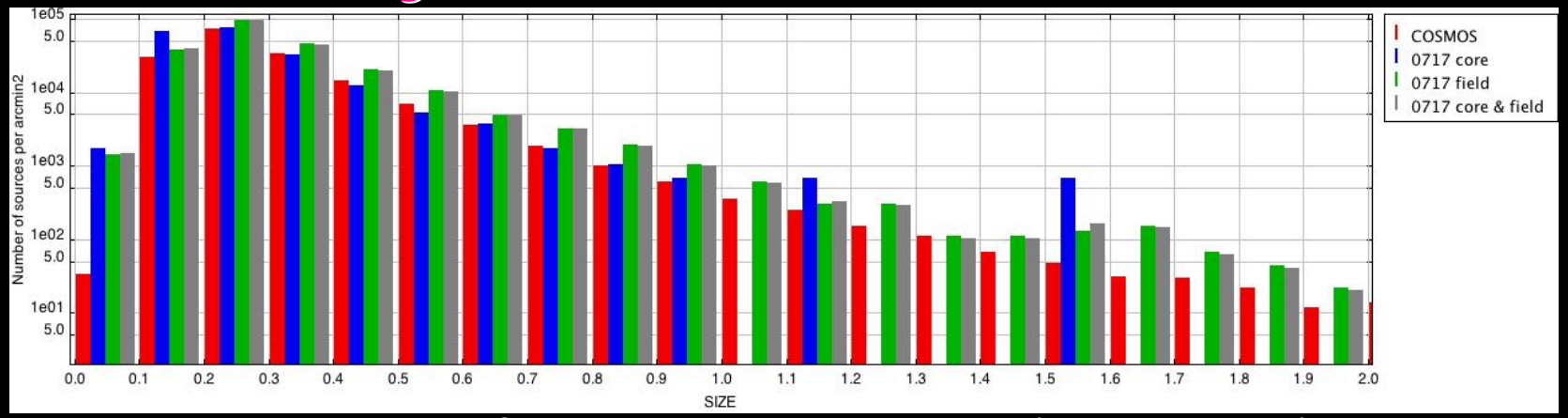
→ Low magnitudes : few 0717 bright objects

→ High magnitudes : 0717 density still larger than COSMOS' one

COSMOS field = 1.64 deg^2 & 3.9*10^5 background sources MACSJ0717 field = 0.06 deg^2 & 6780 background sources

MACSJ0717.5 : Comparison with COSMOS

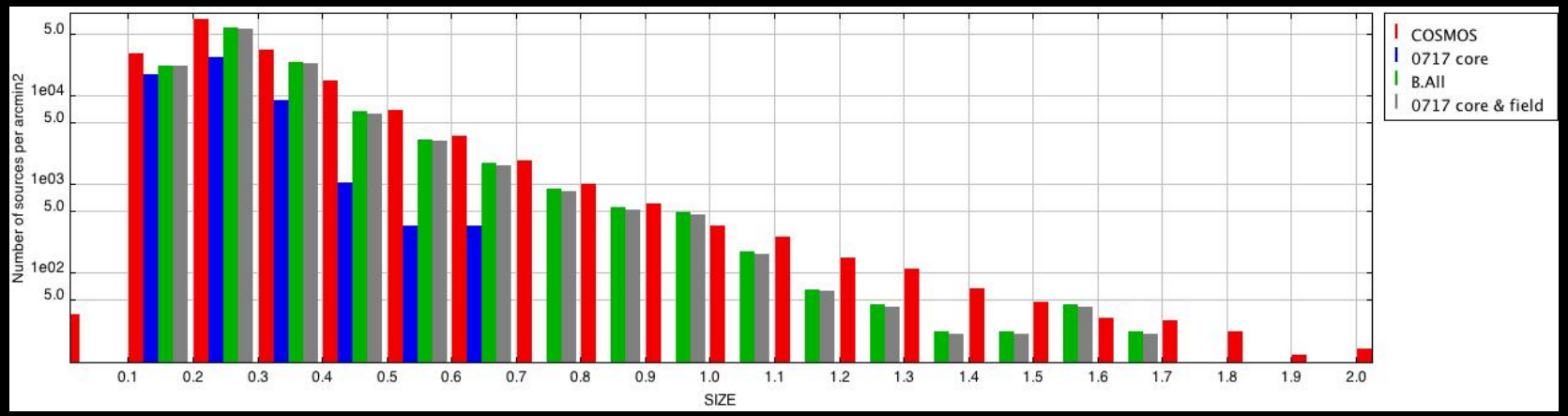
→ Just after runing RRG



→ Density of sources in 0717 greater than COSMOS'

→ Small & Large sizes : more 0717 objects (deeper HST observations)

→ Just after WL selection



→ Small sizes : COSMOS & 0717 distributions mostly the same

→ Large sizes : high number of COSMOS sources

COSMOS field = 1.64 deg^2 & 3.9*10^5 background sources MACSJ0717 field = 0.06 deg^2 & 6780 background sources