IAP Colloquium 2008

"Far Away: Light in the young Universe"

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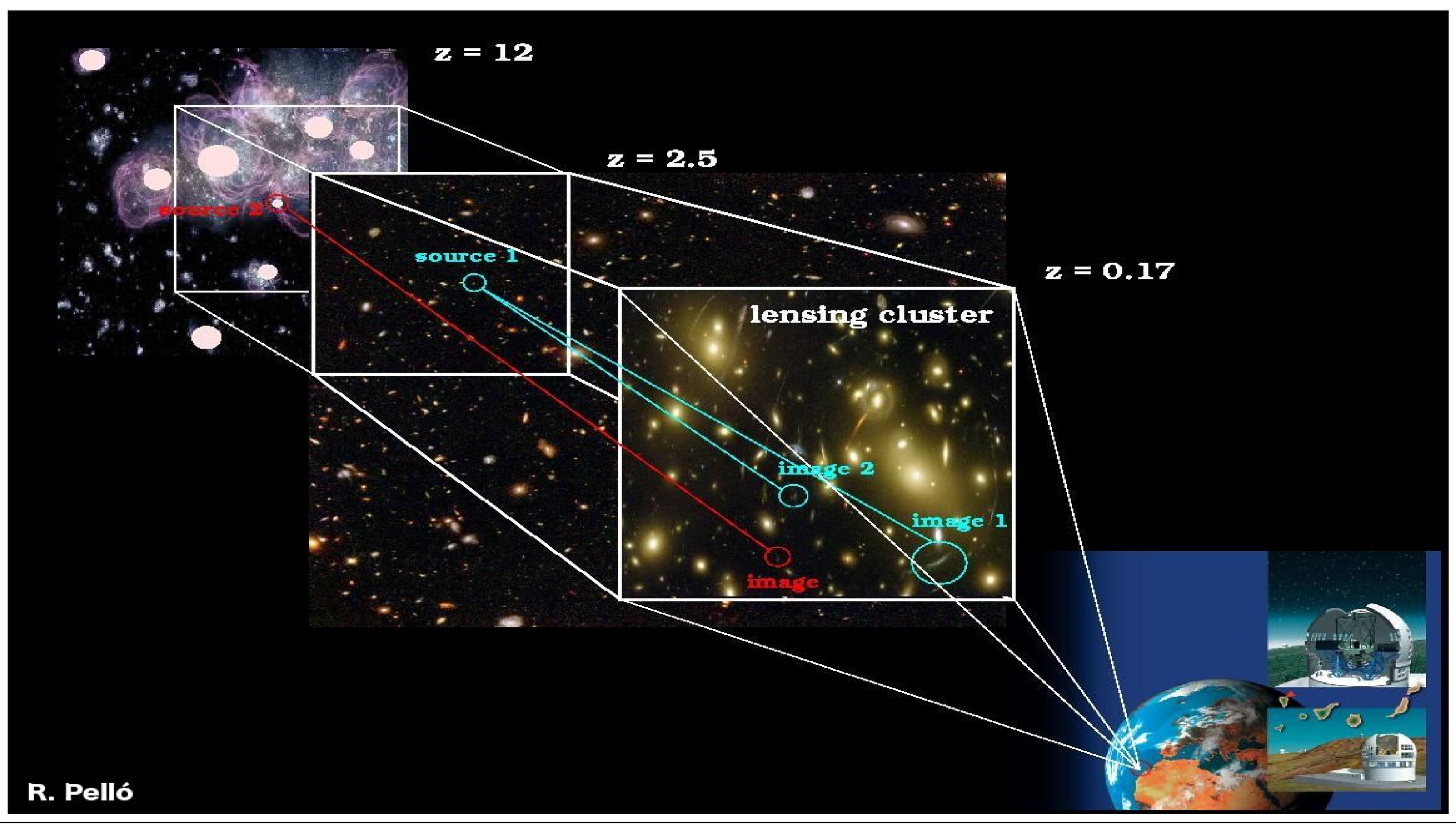
Looking for the first galaxies: lensing or blank fields ?

I) Introduction



Context :

Identification and study of the first galaxies

Aims :

This work is intended to discuss the relative efficiency of lensing and blank fields in the indentification and study of sources at $6 < z < 12$.

Its aim is to determine the best possible observing strategies in order to build up a representative sample of spectroscopically confirmed z>6 galaxies.

For more detail: Maizy et al. (2008) in preparation

II) Method : simulations of lensing and blank field observations

The detection efficiency is estimated from direct simulations of both blank and lensing fields observations. Observed UV luminosity functions are used to determine the distribution and properties of distant sources. And different models for well known lensing clusters are also used to simulate the magnification and dilution effects on the background distant population of galaxies. The main ingredients of the simulations are :

Source properties :

- Simulated sources in the redshift range $6 < z < 12$
- Luminosity function (LF) : $\phi(L)\,dL = \phi^*_{1500}\left(\frac{L}{L^*}\right)^{\alpha}\exp\left(-\frac{L}{L^*}\right)d\left(\frac{L}{L^*}\right)$

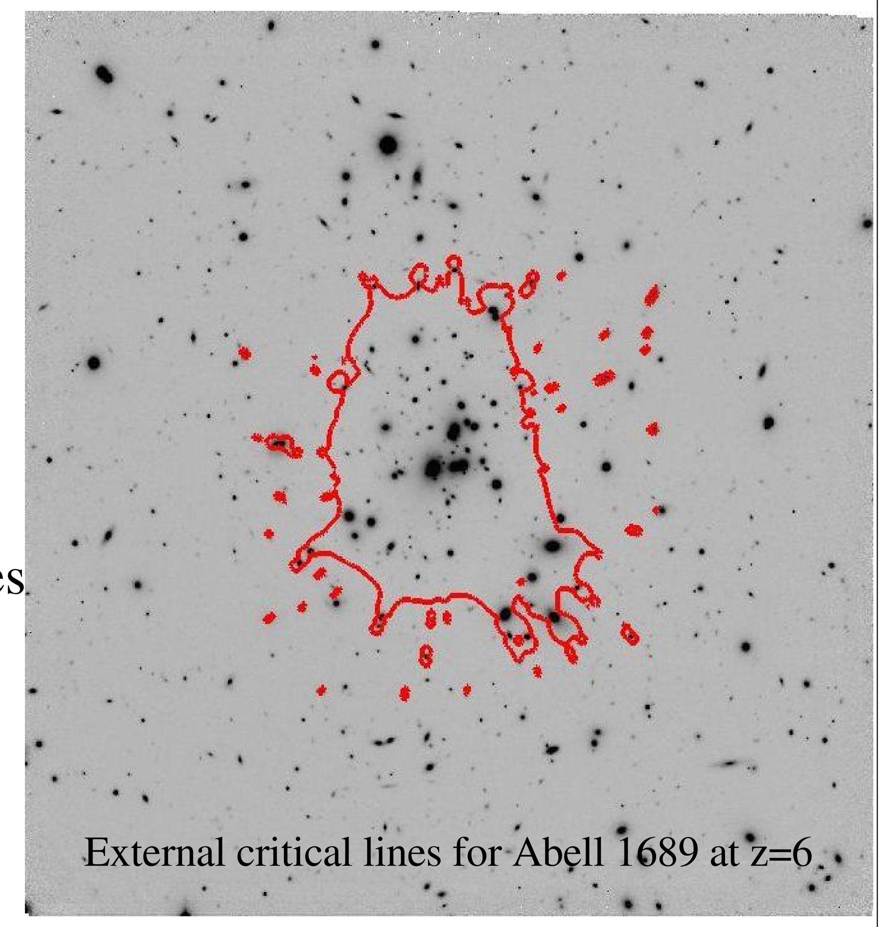
$<z>= 4.0$	$\alpha = 1.6,$	$\phi^* = 1.3\ 10^{-2}\mathrm{Mpc}^{-3},$	$M^* = -21.07$	Steidel et al. (1999)
$<z>= 5.9$	$\alpha = 1.74,$	$\phi^* = 1.1\ 10^{-3}\mathrm{Mpc}^{-3},$	$M^* = -20.24$	Bouwens et al. (2006)
$3.8 < z < 7.4$	$\alpha = 1.74,$	$\phi^* = 1.1\ 10^{-3}\mathrm{Mpc}^{-3},$	$M^* = -21.02 + 0.36\,(z - 3.8)$	Bouwens et al. (2008)

- Scale relation between UV luminosities of high redshift sources with their Lyman - α emission

Lensing effect :

Well known lensing clusters used at reference

- Mass models : clusters and galaxies scales components
- Lenstool mass models (www.oamp.fr/cosmology/lenstool/)



External critical lines for Abell 1689 at z=6.

Simulated clusters at different redshifts

- No evolution in the total mass distribution and galaxies properties
- Simulated mass distribution (magnification maps) and photometric properties of cluster galaxies (mask map)

Lensing cluster	Abell 1689	$z_{cl} = 0.178,$	σ_0=1320 km/s	Limousin et al. (2007)
	Abell 1835	$z_{cl} = 0.25,$	σ_0=1210 km/s	Smith et al. (2005)
	AC114	$z_{cl} = 0.31,$	σ_0=1080 km/s	Natarajan et al. (1998)
Fiducial cluster redshift	$z_{cl} = 0.1 - 0.8$			

III) Results for a typical field of view 6'×6' (e.g.: EMIR/GTC)

Lensing vs Blank field efficiency

Magnitude limit: 25,5 (AB)

Depth: $\Delta z = 1$

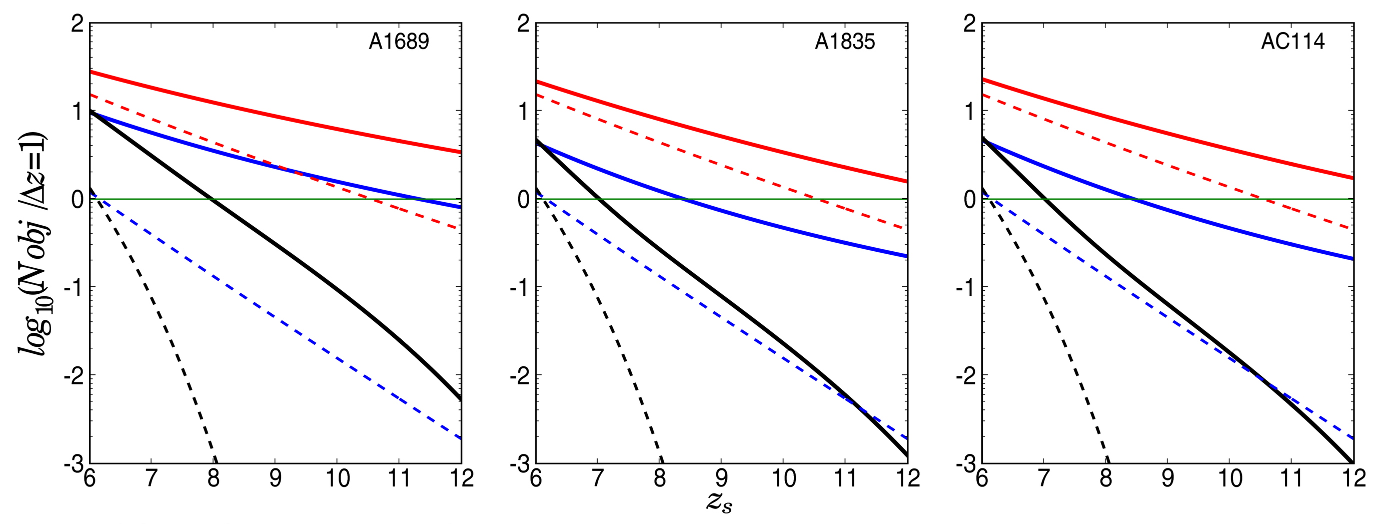


Fig. 1

Redshift of the lensing cluster

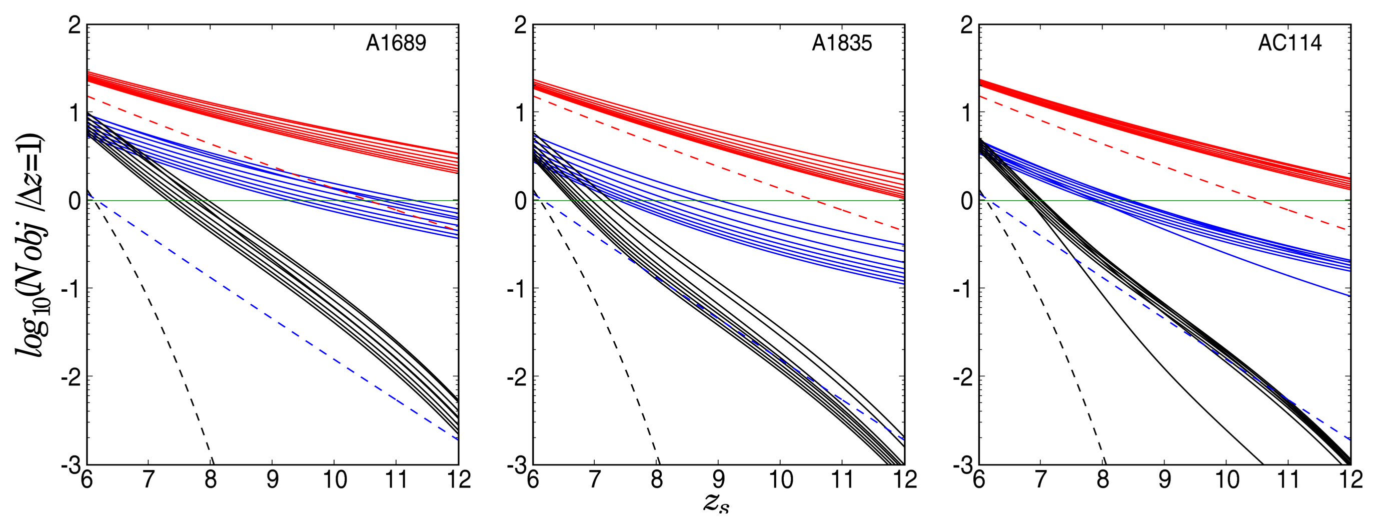


Fig. 2

Three main effects :

1. The source LF (Fig. 1)
2. The cluster redshift (Fig. 2)
3. The lensing cluster properties (Fig. 3)

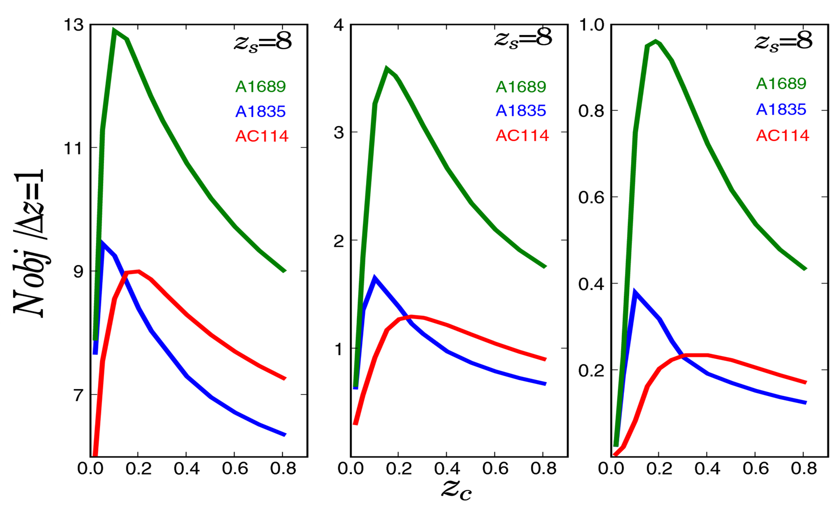


Fig. 3

Field to field variance : from the Millenium simulation

	Blank field			Lensed field								
				A1689			A1835			AC114		
z	6	7	8	6	7	8	6	7	8	6	7	8
$\langle N\rangle$	2.74	1.10	0.39	7.50	2.43	0.87	4.23	1.48	0.51	4.20	1.34	0.46
σ	1.88	1.10	0.65	4.18	2.02	1.09	2.59	1.38	0.76	2.60	1.31	0.72
v_r	68%	100%	168 %	56%	83%	127%	61%	93%	149%	62%	98%	157%

IV) Conclusion

- Lensing clusters improve the survey efficiency by a factor ~ 5 – 10^2 depending on source LF. (Fig. 1 and Fig. 2)
- The most efficient lensing clusters are at moderate redshift (z~0,1- 0,3). (Fig. 3)
- Important variance effect for spectroscopic depths (~25,5 AB).
- Blank fields are needed to constrain the bright-end of the LF.
- Observing different lensing clusters allows us to constrain the LF.