Mass-size relation at high redshift in different environments

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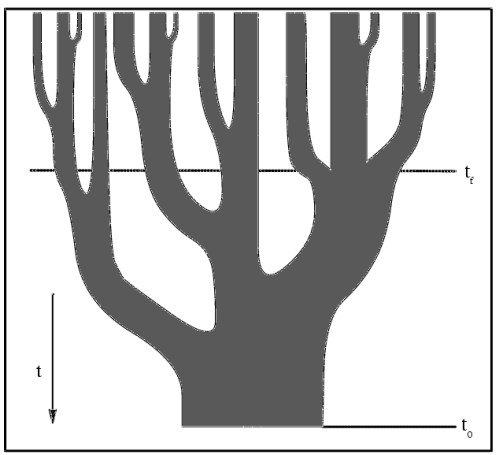
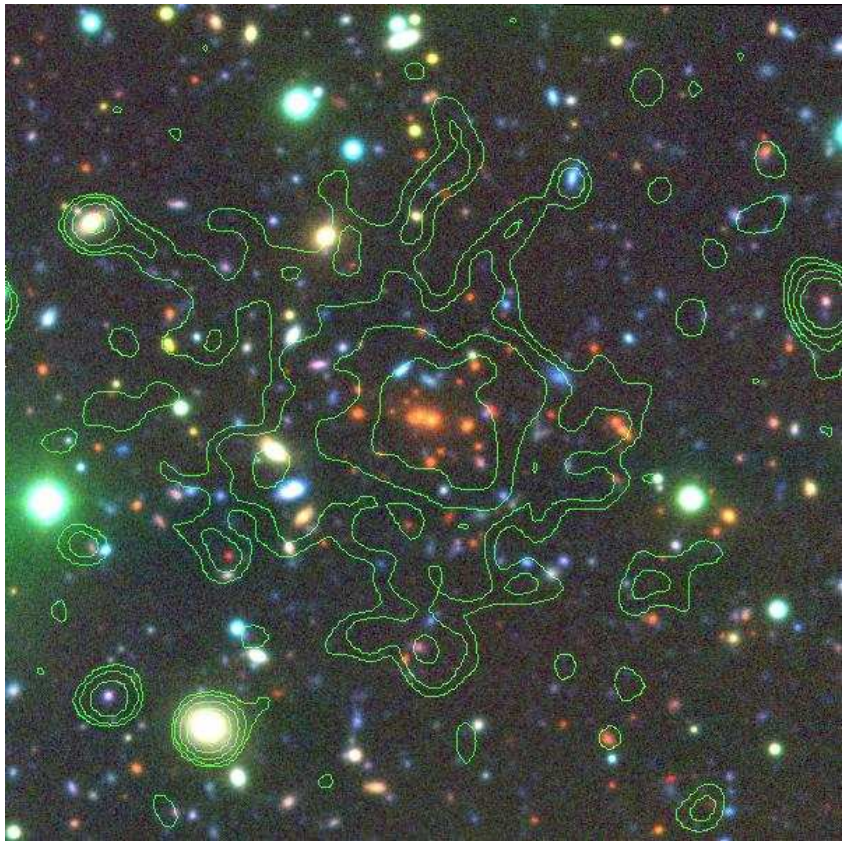
Introduction

- Homogeneous properties observed in early-type galaxies
- Galaxy assembly over cosmic time
- Downsizing scenario in a hierarchical scenario



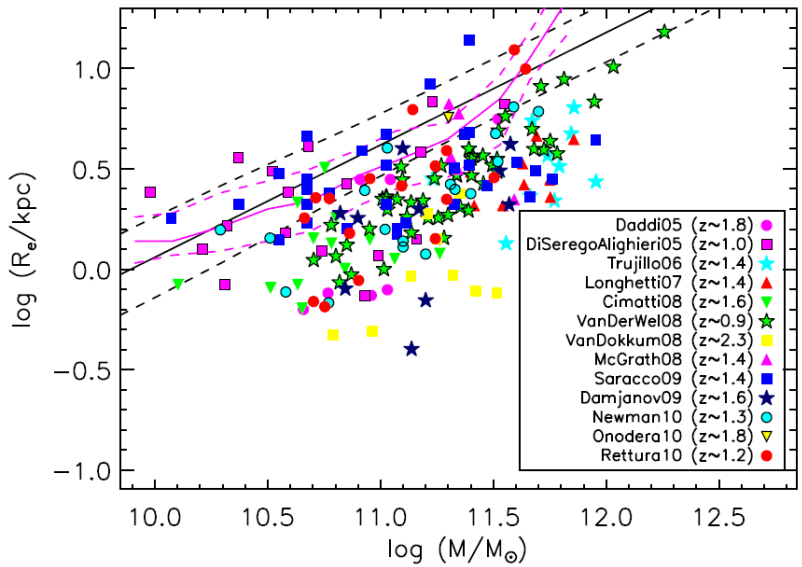
Merger tree, from Lacey & Cole (1993)



RDCS1252, from Lidman et al. (IRAC/VLT)

Introduction

- Mass-size relation and size evolution of ETG: compact passive early-type galaxies at high redshift (Daddi et al. 2005, Trujillo et al. 2006, Buitrago et al. 2008, van der Well et al. 2008, van Dokkum et al. 2008, Saracco et al. 2011, Raichoor et al. 2012, Newman et al. 2012, Cimatti et al. 2012, and many others)

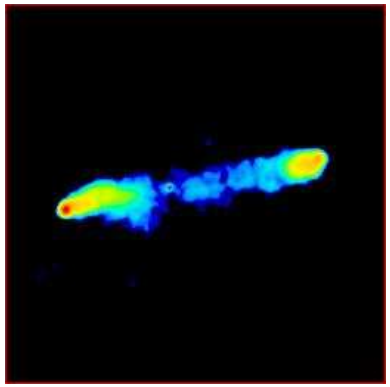


Mass-size relation, from Raichoor's thesis

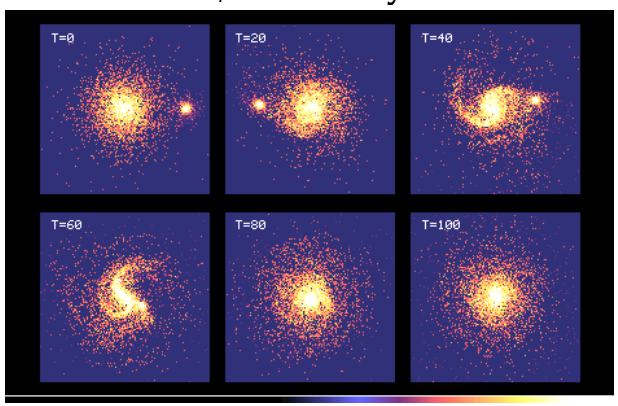
$\rightarrow$ Sizes have to increase by a factor of ~ 2 since $z \sim 1$ (Trujillo et al. 2007)

Introduction

- Puffing-up scenario (Fan et al. 2008, 2010): adiabatic expansion through significant mass loss $\rightarrow$ highly active and young stellar population
- Dry minor mergers scenario (De Lucia et al. 2006, Naab et al. 2009, Hopkins et al. 2009, Shankar et al. 2011) $\rightarrow$ high rate of occurrence of minor mergers, a lot of gas-poor companions
- Effect of the environment: size evolution in low- vs high-density regions



AGN, from Reynaldi



Minor merger simulation, from Mihos

Data & Analysis

Hawk-I Cluster Survey: 9 clusters between $z = 0.8$ and 1.45

Cluster	z_{cl}	Scale (kpc/")	Filters	N_{zspec}
RXJ0152-1357	0.84	7.645	i_{775}, z_{850}, r_{625}, Ks (HAWKI)	107
RCS2319+0038	0.91	7.838	i_{775}, z_{850}, Ks (HAWKI), J (ISAAC)	28
XMMJ1229+0151	0.98	8.000	i_{775}, z_{850}, Ks (HAWKI), J (SOFI)	26
RCS0220-0333	1.03	8.099	i_{775}, z_{850}, Ks (HAWKI), J (ISAAC)	11
RCS2345-3633	1.04	8.117	i_{775}, z_{850}, Ks (HAWKI), J (ISAAC)	23
XMMJ0223-0436	1.22	8.367	i_{775}, z_{850}, Ks and J (HAWKI)	27
RDCSJ1252-2927	1.23	8.377	i_{775}, z_{850}, Ks and J (ISAAC)	31
XMMU2235-2557	1.39	8.497	i_{775}, z_{850}, Ks and J (HAWKI)	34
XMMJ2215-1738	1.45	8.524	i_{775}, z_{850}, Ks and J (HAWKI)	48

Table: HAWK-I Cluster Survey data.

- Size estimation: Galapagos (Barden et al. 2005) using Galfit (Peng et al. 2002) on F850LP filter imaging
- Mass estimation: LePhare (Arnouts et al. 1999; Ilbert et al. 2006) using Bruzual & Charlot (2003) library and a Chabrier (2003) IMF
- Morphology: GalSVM (Huertas-Company et al. 2008, 2009, 2011)

Galaxy selection

- Red sequence defined by spectroscopic redshifts in $(i-z)$ vs z diagram for each cluster $\rightarrow$ selection of galaxies inside the red sequence $\pm 3\sigma$
- Selection of early-type galaxies (P(ETG) > 0.5)
- Galfit limits $|M_{SEx} - M_{Galfit}| < 0.8$, $n \neq 8$ and $0.1 < R_{eff} < 1.5$ arcsec
- Stellar masses: $log(M/\mathrm{M}_{\odot}) > 10.5$

Final sample of cluster and field galaxies

- Cluster galaxies from HCS

Cluster	#ETGs
RXJ0152	123
RCS2319	61
XMMJ1229	67
RCS0220	45
RCS2345	33
XMMJ0223	33
RDCSJ1252	34
XMMU2235	14
XMMJ2215	26

- Field galaxies from HCS, COSMOS (Huertas-Company et al., submitted), and GOODS-CDFS (Raichoor et al. 2012)

redshift bin	HCS #ETGs	COSMOS #ETG	GOODS-S #ETG
$[0.7, 0.9]$	13	122	...
$[0.9, 1.1]$	16	98	...
$[1.1, 1.6]$	11	40	24

Mass-size relation

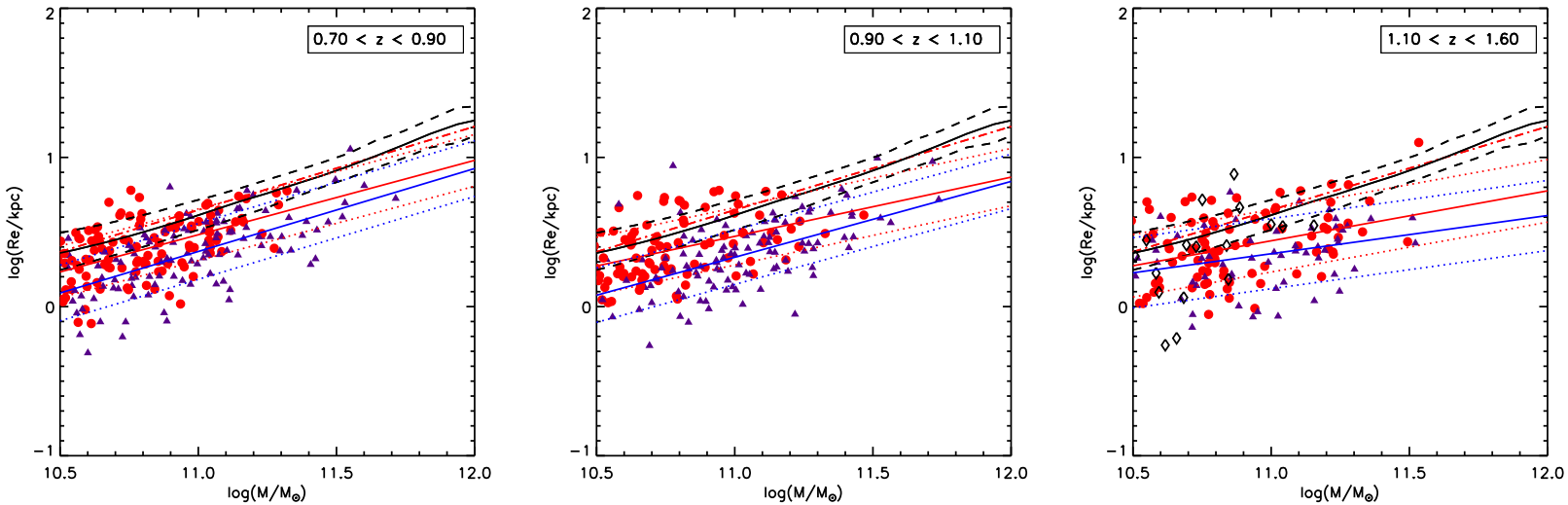
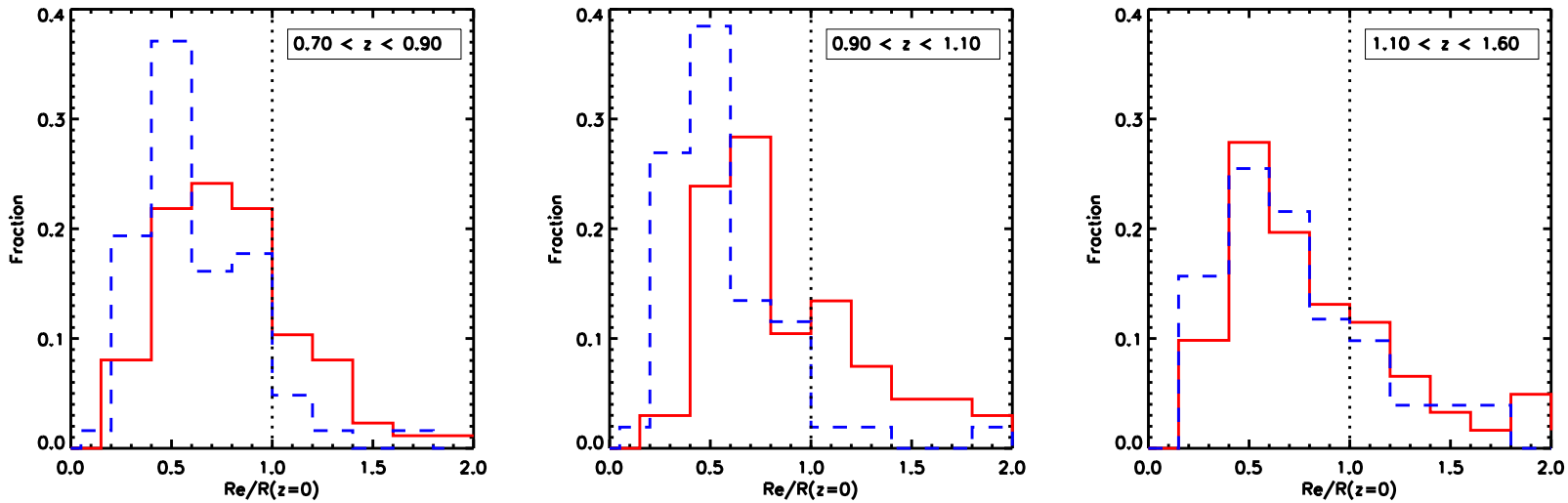
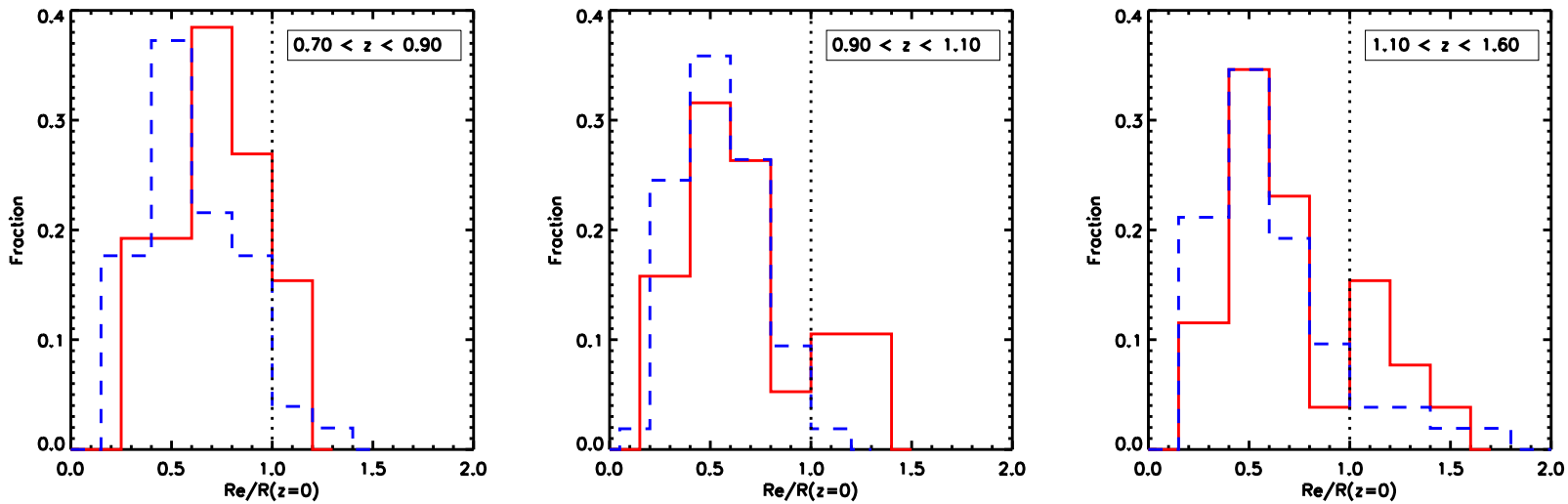


Fig.: Mass-size relation of passive early-type galaxies in clusters (red circles) and in the field (blue triangles). Blue and red lines correspond respectivelly to the fit for field sample and for cluster sample. The local mass-size relation of Shen et al (2003) is in red dashed line and Bernardi et al (2010) in black lines. Diamonds represent field galaxies from Raichoor et al. (2012).

Size distribution of passive cluster and field ETGs



ETGs with $10.5 \leq \log(M/\mathrm{M}_{\odot}) < 11$



ETGs with $\log(M/\mathrm{M}_{\odot}) \geq 11$

Size evolution of cluster and field passive early-type galaxies

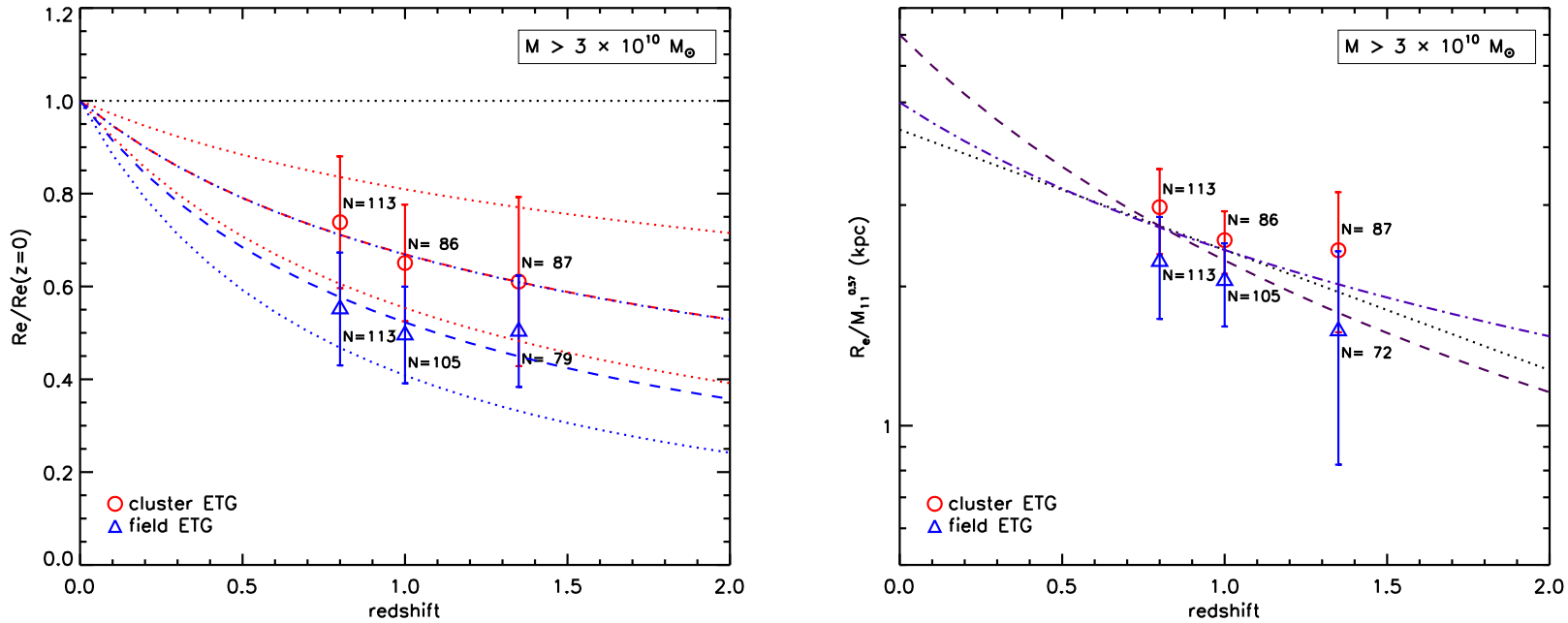


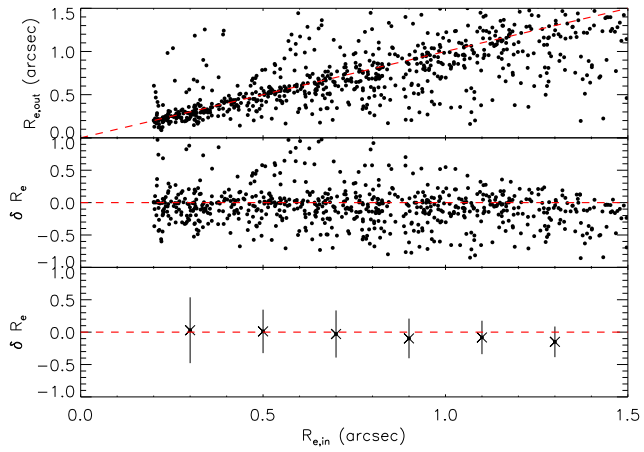
Fig.: Size evolution in function of redshift for passive ETGs galaxies with $\log(M/\mathrm{M}_\odot) \geq 10.5$ in clusters (red circles) and in the field (blue triangles). *Left*: The blue and red dashed curves correspond to the fits $R_e \propto (1+z)^\alpha$ of field and cluster galaxies respectivelly. *Right*: Radius are normalized to 10^{11} $\mathrm{M}_\odot$. Dashed line corresponds to the fit of Cimatti et al. (2012), black dotted line to the fit of Newman et al. (2012) and the dash-dotted line to the one of Damjanov et al. (2011).

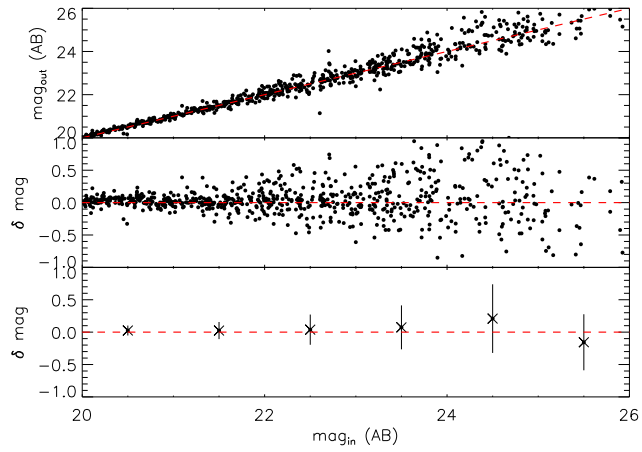
Conclusion

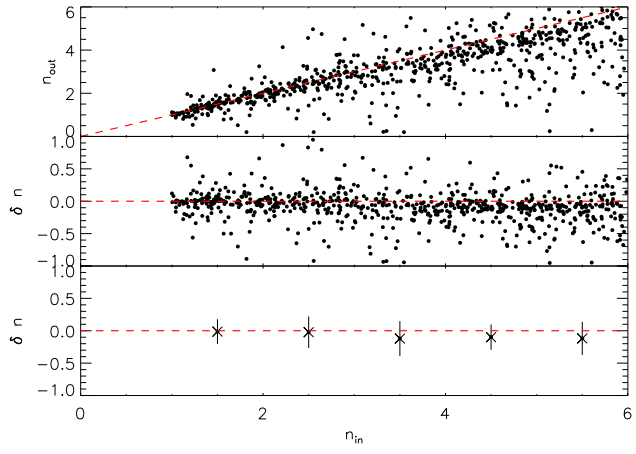
- Cluster galaxies seem to be larger on average than field galaxies but sizes are consistent in 1σ dispersion
- On-going work: (Delaye et al. in prep)
  - Galaxy morphologies: distinction between ELL and S0s to be confirmed by a visual classification
  - Comparison and discussion with previous studies and with models (Hopkins et al 2009, Guo et al 2010, Shankar et al 2011, Nipoti et al 2012)

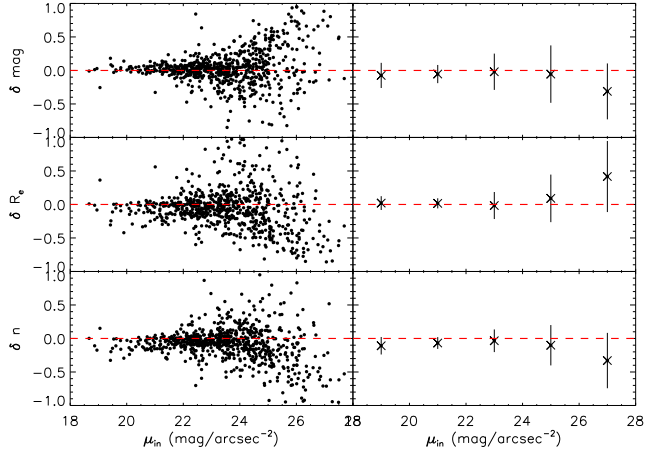
Thank you for your attention

Galapagos validation tests









Difference between the estimated parameter by GALFIT and the input parameter are as follows $\delta r_e = (r_{e,out} - r_{e,in})/r_{e,in}$, $\delta mag = (mag_{out} - mag_{in})$, $\delta n = (n_{out} - n_{in})/n_{in}$

Morphology at $z \sim 0.8$

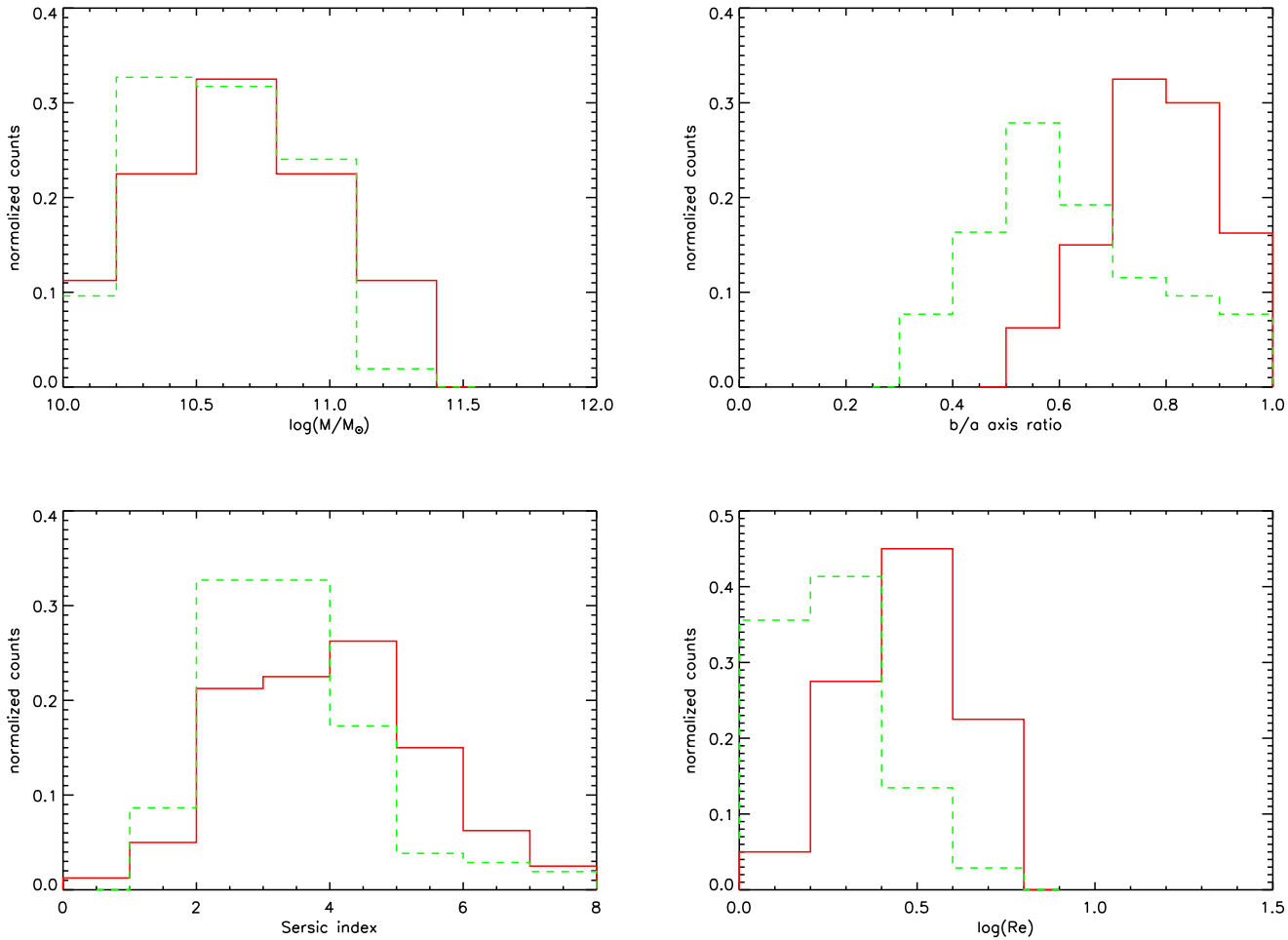


Fig.: Stellar mass (top left panel), axis ratio (top right panel), Sersic index (bottom left panel) and size (bottom right panel) distributions for elliptical (red solid line) and lenticular galaxies (green dashed line) in clusters distinguished

Morphology at $z \sim 1.4$

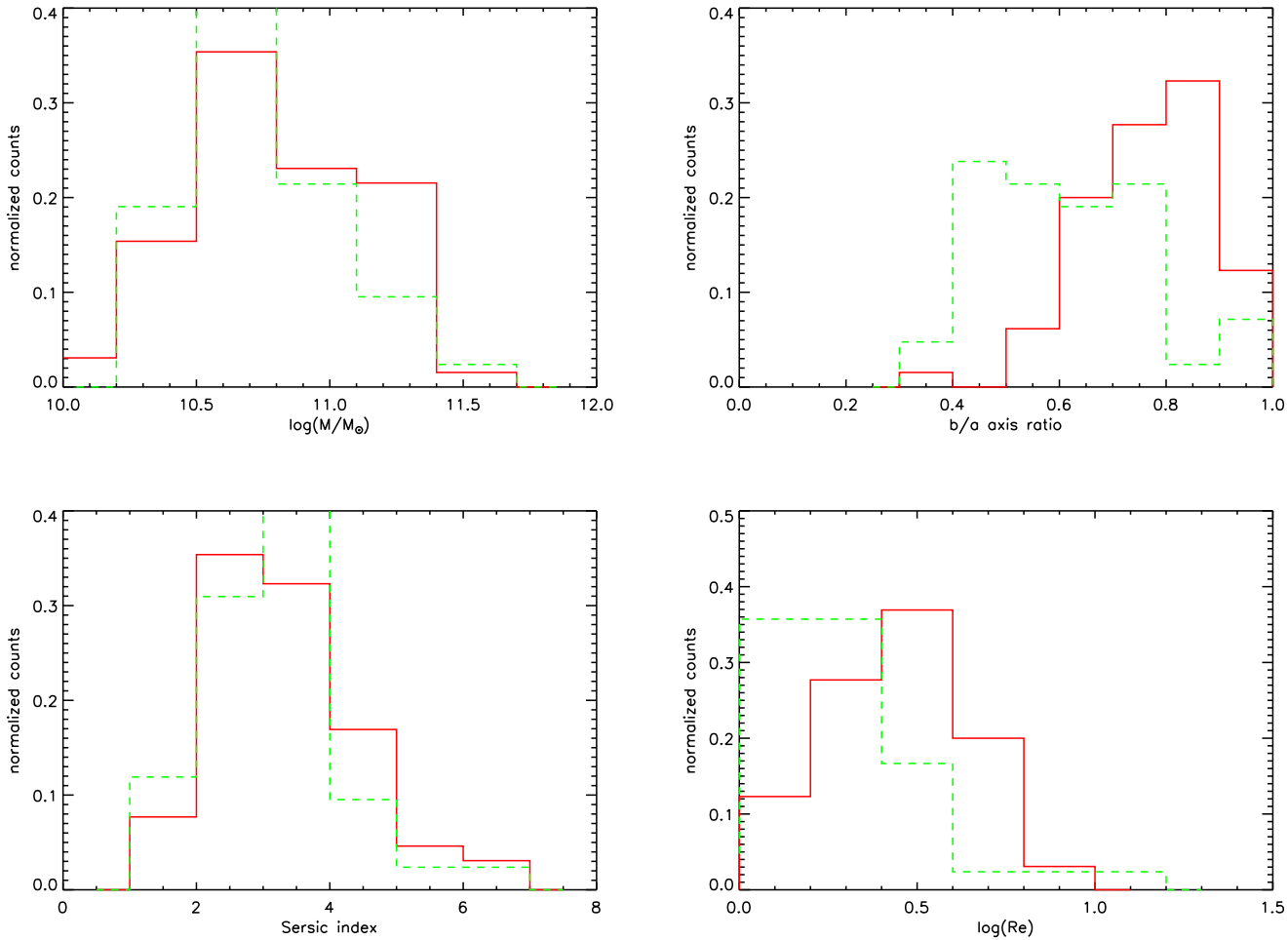


Fig.: Stellar mass (top left panel), axis ratio (top right panel), Sersic index (bottom left panel) and size (bottom right panel) distributions for elliptical (red solid line) and lenticular galaxies (green dashed line) in clusters distinguished