Environmental Effects vs Galaxy Interactions

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Outline of Talk

i) Theoretical analysis from simulations:

* building mock catalogues of the SDSS-DR4 from a galaxy sample generated by the SAM of De Lucia & Blaizot (2007) applied to the Millennium Simulation: Galaxy Pairs and Non-Pair Sample (NPS)

* analysing bias effects in the selection of Control Samples (CSs) from the NPS

* suggesting an unique and unbiased CS to study galaxy interactions.

ii) Reproducing theoretical analysis in SDSS-DR4 data:

* correcting biases in SDSS CSs

* isolating the effects of galaxy interactions. How these corrections affect the interpretation of previous observational results

iii) Environmental effects vs. galaxy interactions in SDSS-DR4:

* Analysis of the role of mergers and galaxy interactions different local and global environments

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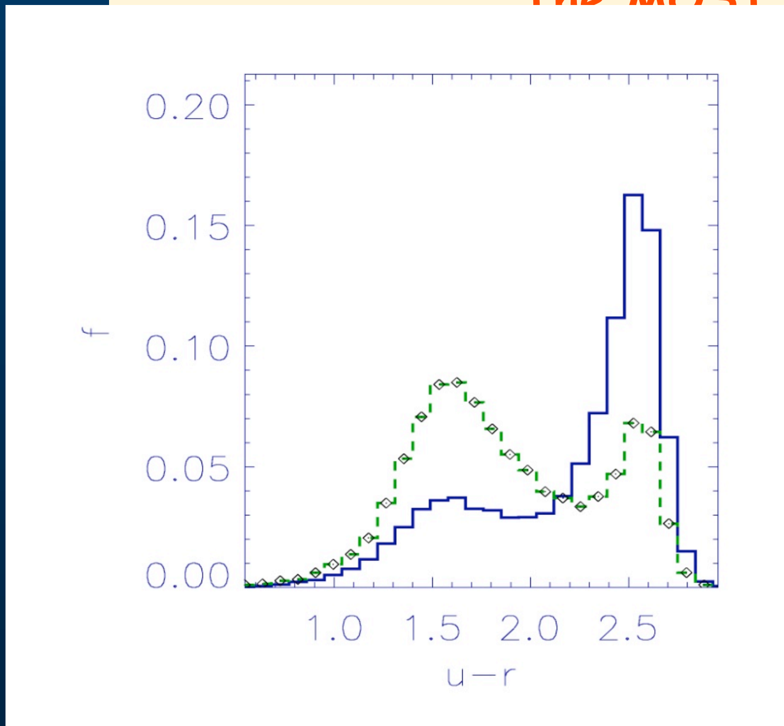
Mock Samples from SAM

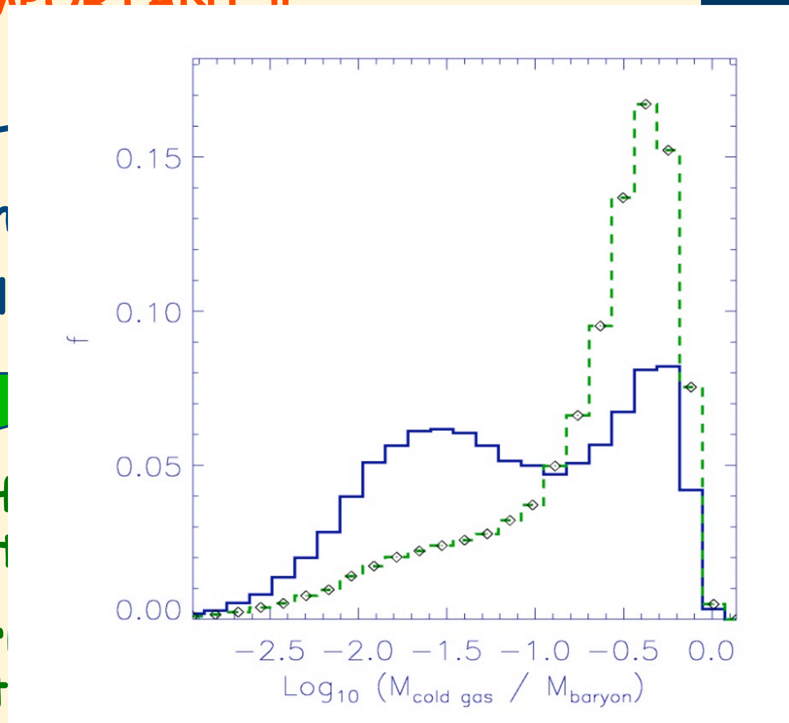
(Perez, Tissera & Blaizot 2008)

*** Mock Galaxy Pairs:** r_p <100 kpc/h, ΔV<350 km/s

(Lambas et al 2003; Alonso et al 2003)

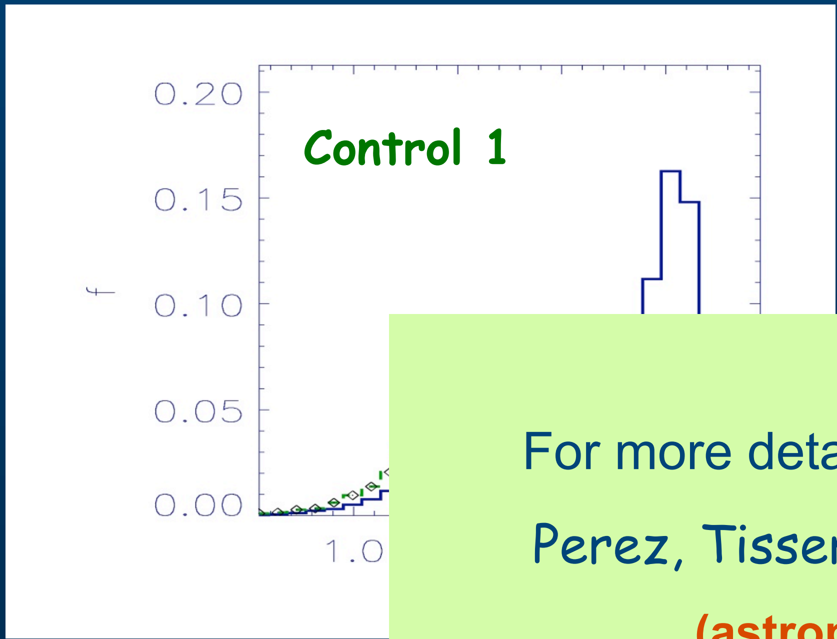
*** Mock Control 1:** from NPS imposing constrain in z and M_r





Correcting bias effects

(building an unique and unbiased CS for galaxy pairs)



All biases are present

(constrain in z and Mr)

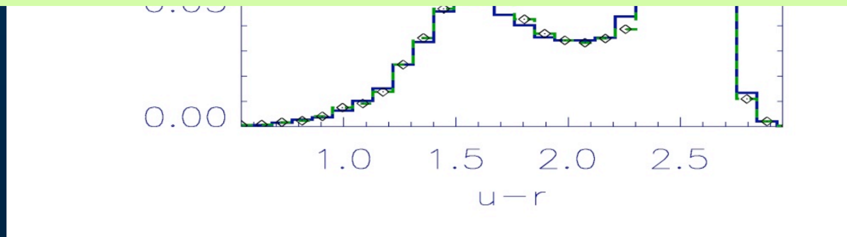
For more details see Poster Nº 49

Perez, Tissera & Blaizot (2009)

(astroph/0904.2845)

removing bias

constrain in z, M*, Σ, morph. and DM halo)



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What happens in real life?

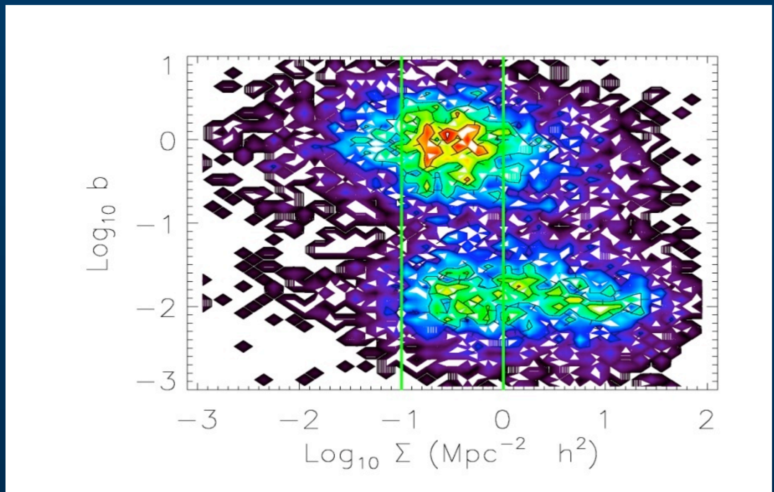
* **SDSS-DR4 Galaxy Pairs:** r_p <100 kpc/h, ΔV<350 km/s
* **SDSS-DR4 Control 1:** from NPS imposing constrain in z and M_r

SDSS Control 1 is also biased —> Main factor: local environment

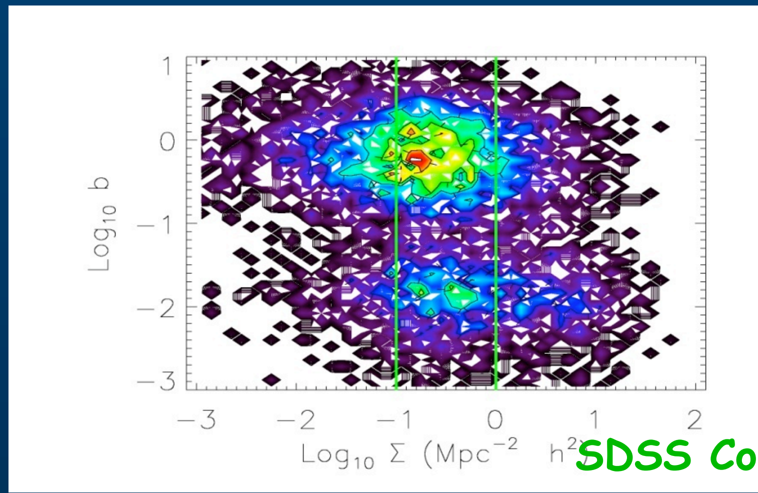
For comparative purpose, we build:

- SDSS Control 2: constrain in z and M_*
- SDSS Control 3: constrain in z, M*, DM halo and Σ
- SDSS Control 4: constrain in z, M*, DM halo, Σ and morphology

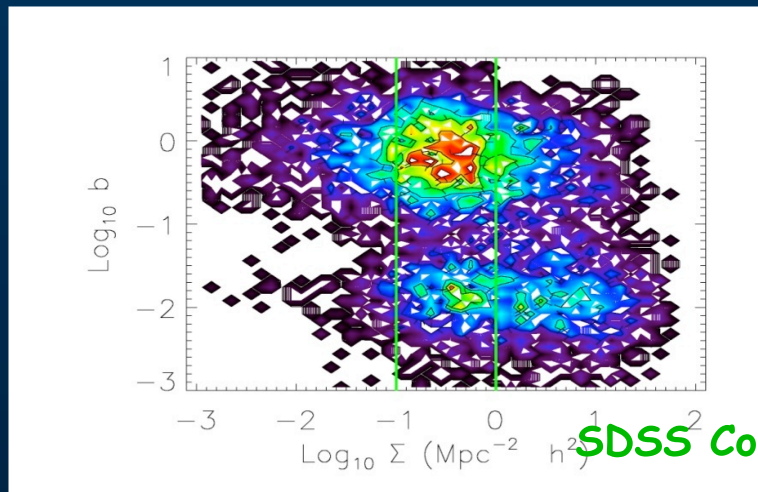
Star formation – Local density relation:



SDSS Galaxy Pairs

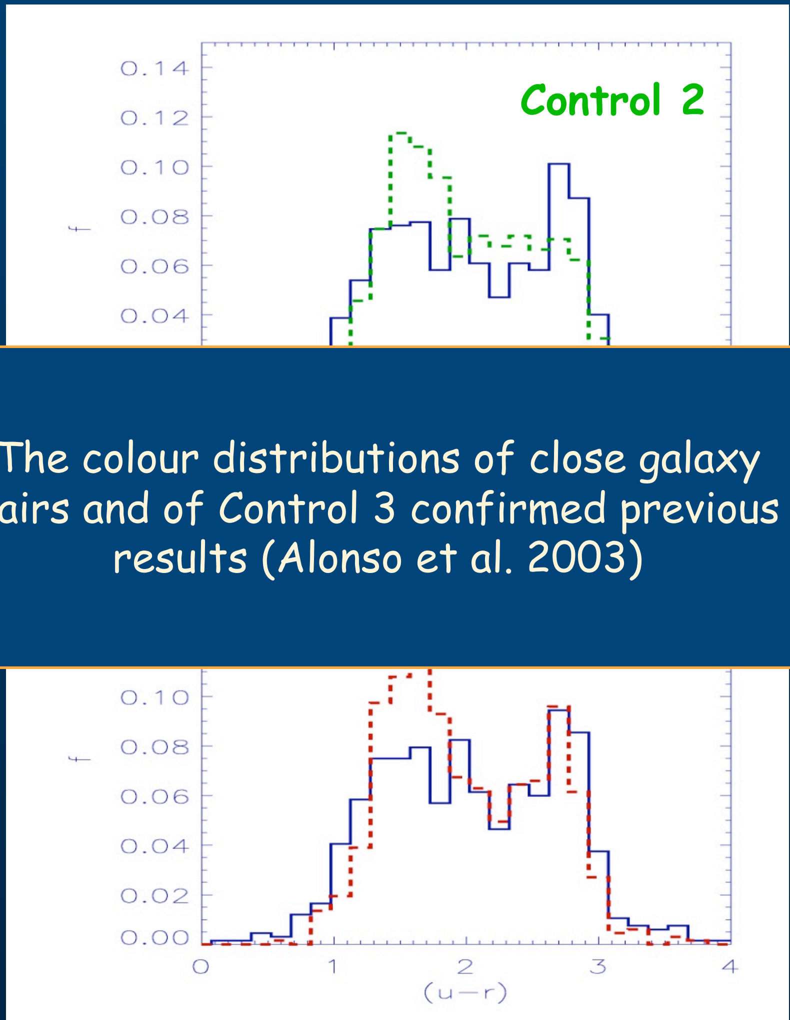


SDSS Control 2

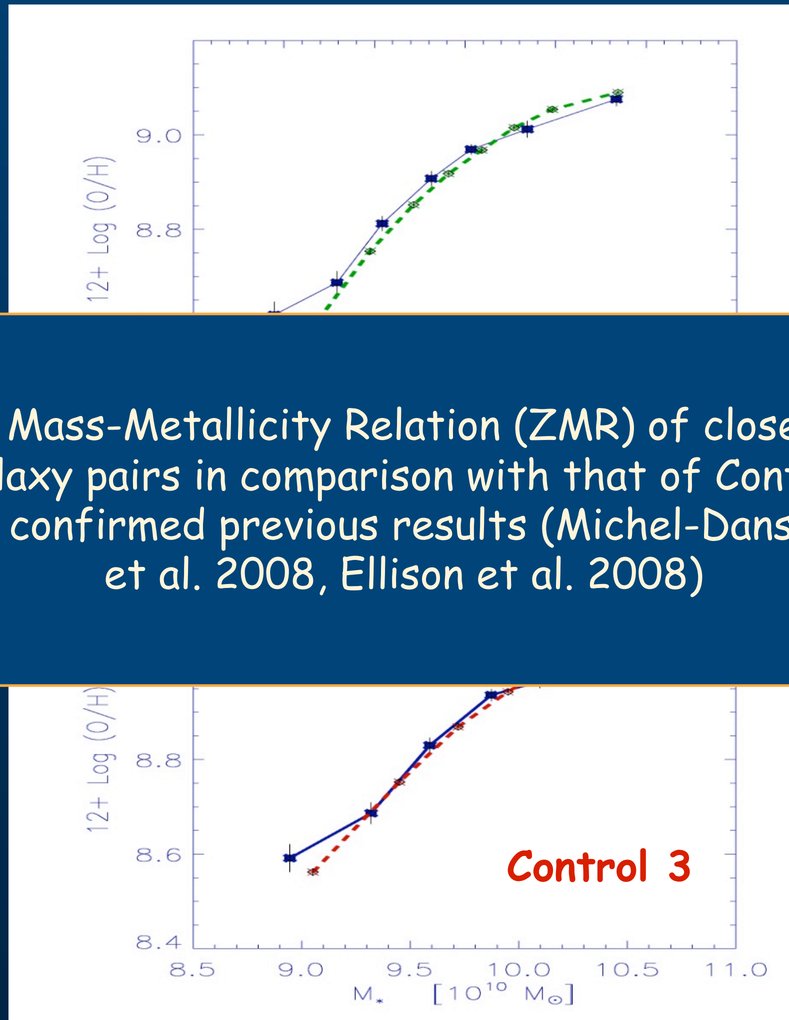


SDSS Control 3

How could previous observational results change?



The colour distributions of close galaxy pairs and of Control 3 confirmed previous results (Alonso et al. 2003)



Mass-Metallicity Relation (ZMR) of close galaxy pairs in comparison with that of Control 3 confirmed previous results (Michel-Dansac et al. 2008, Ellison et al. 2008)

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Motivations

The effect of environments in driving galaxy evolution is well established. Several mechanisms have been proposed to operate at cluster scales: ram-pressure stripping, harassment, strangulation…

Alternatively, recent works have proposed a pre-processing of disc-blue galaxies to red earlier type systems at intermediate density environments:

*** enhanced red galaxy fraction in the outskirt of clusters (Patel et al 2008)**

*** enhanced current SFR in the infall population of clusters (Porter et al 2008)**

*** an excess of red dusty obscured star-forming galaxies (Gallazzi et al 2008, Wolf et al 2005, Miller & Owen 2002, Poggianti et al 2008)**

*** evidence stating that cluster giant S0 population can be explained as the outcome of minor mergers in the infall population (Moss 2006)**

Motivations

Suggested mechanisms could be galaxy interactions, frequent at this moderate environments

Galaxy clusters would form not by accreting individual galaxies, but rather through infalling galaxy groups, where merging systems and slow galaxy-galaxy encounters are preferentially found (Mihos 2004, Moss 2006)

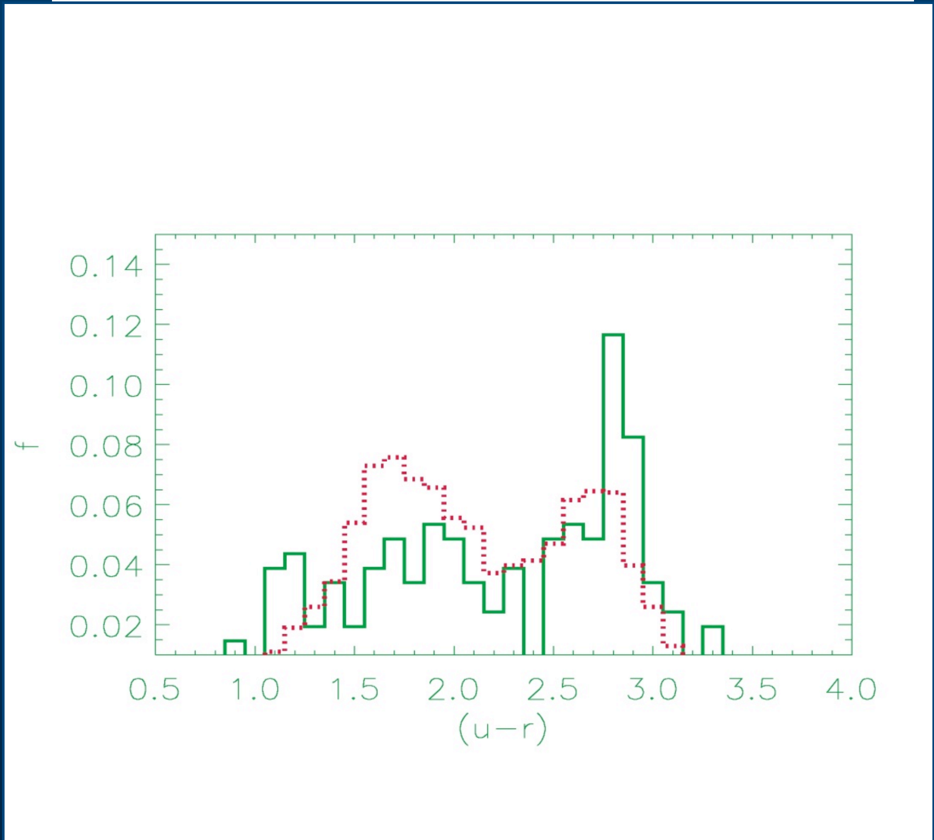
We propose to revise the role of mergers and close galaxy interactions in driving galaxy evolution at different density environments by using the SDSS-DR4 data.

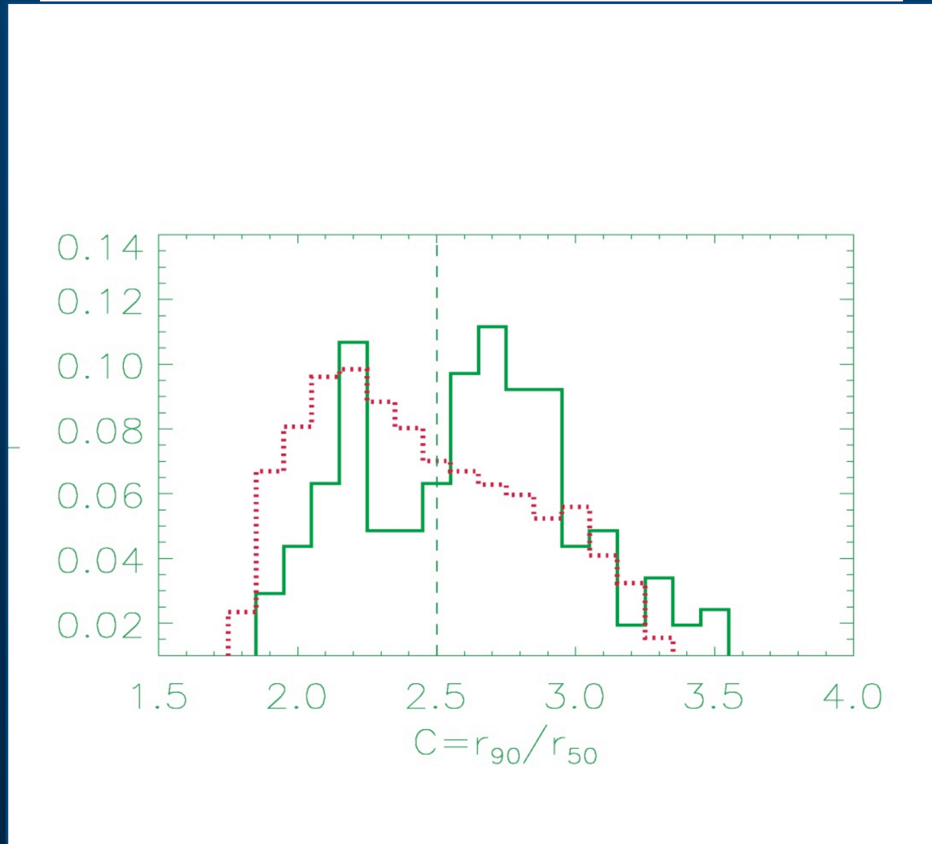
Local and Global Environments

Local Environment: characterized by the local projected density parameter, Σ, computed by using the 5th nearest neighbour brighter than Mr< -20.5

Global Environment: characterized by the DM halo mass, M_{vir}, estimated in the SDSS-DR4 galaxy group catalogue of Zapata et al. (2009) by dynamical methods

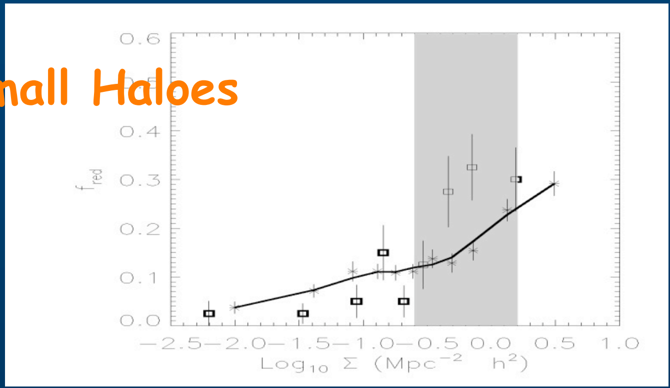
Local Environment vs Galaxy Interactions



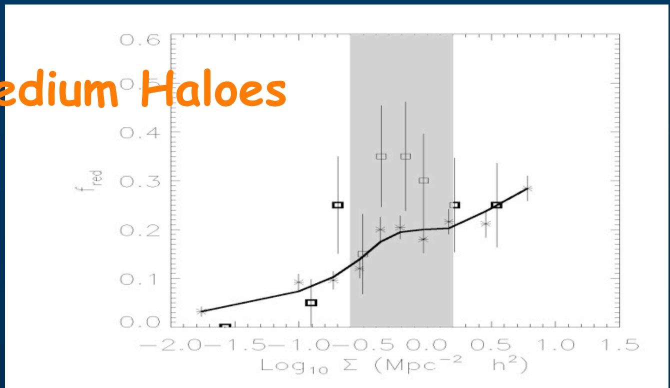


Global Environment vs Galaxy Interactions

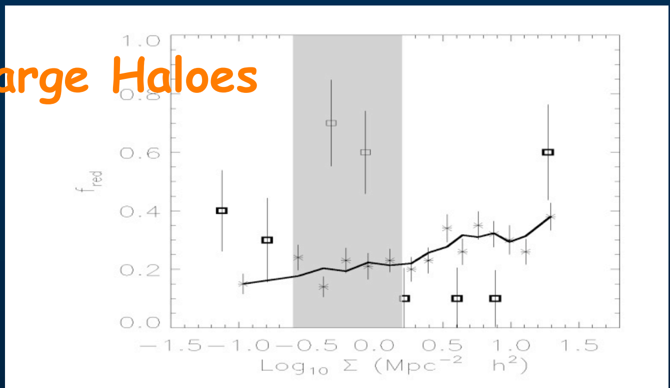
Small Haloes



Medium Haloes



Large Haloes

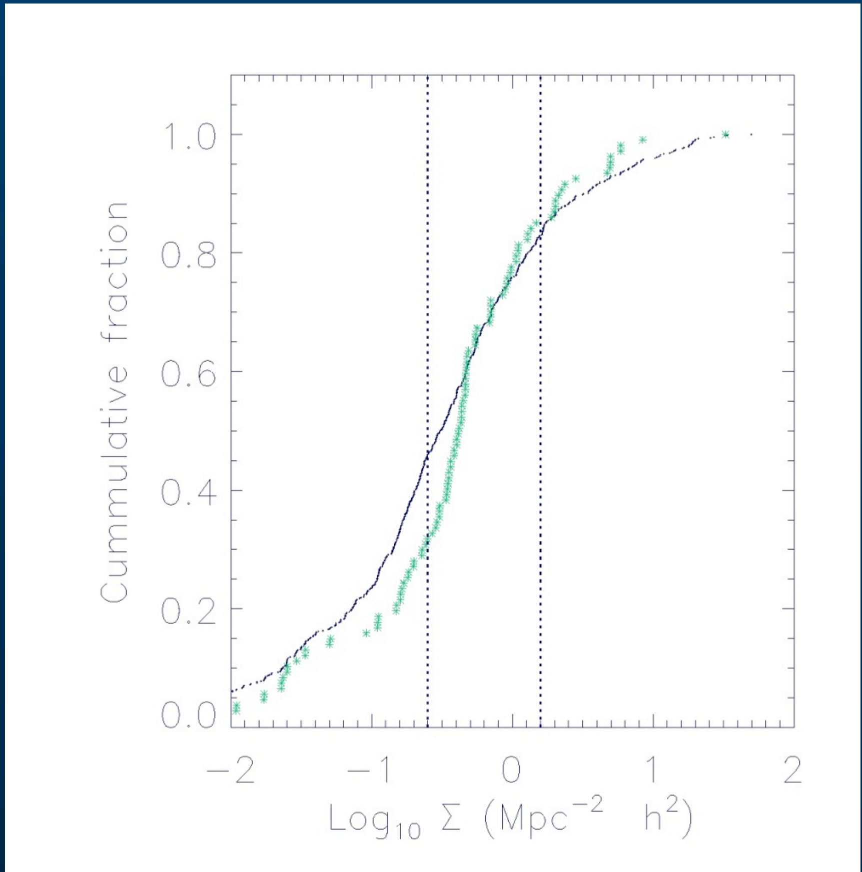


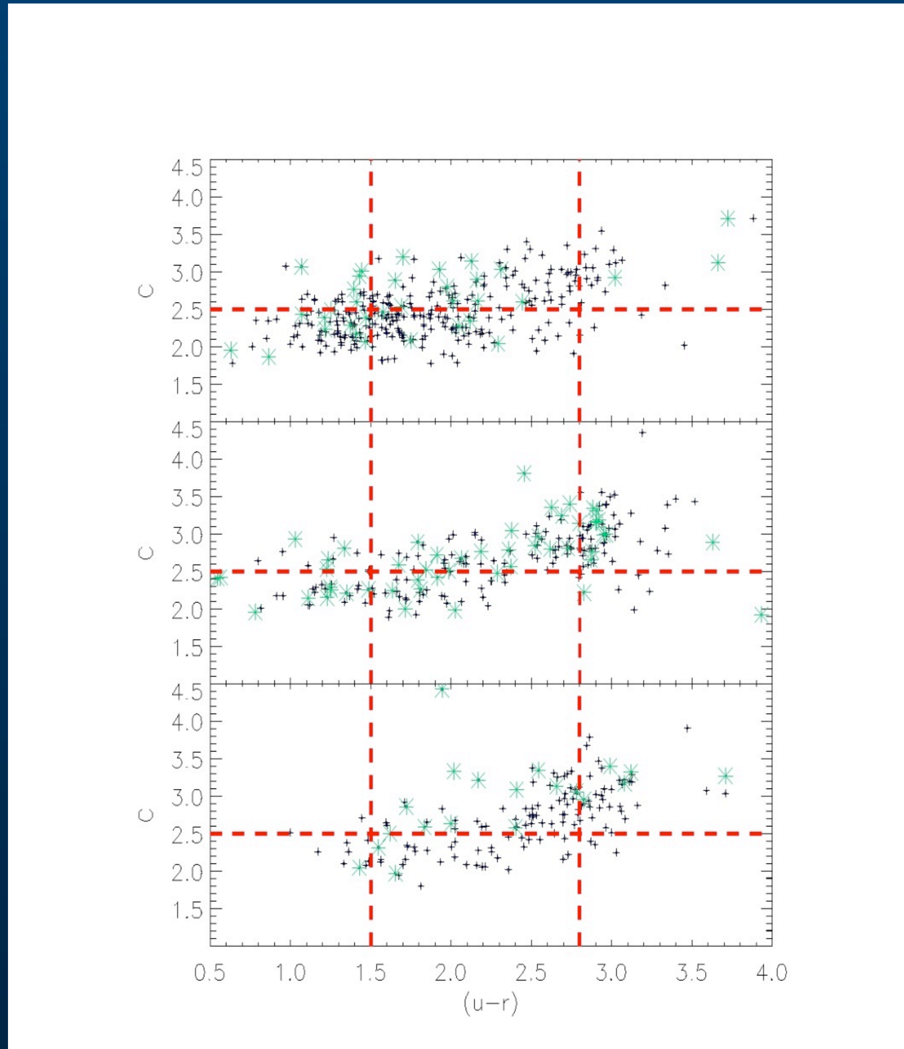
Perez et al. 2009, (astroph/0904.2851)

$M_{vir} \setminus \Sigma$	*Low*	*Intermediate*	*High*	*Samples 3*
Small	16.9%	37.5%	66.1%	CP
	18.9%	29.8%	57.9%	CS3
Medium	17.8%	50.7%	42.0%	CP
	20.8%	36.7%	48.2%	CS3
Large	33.3%	85.7%	56.1%	CP
	32.8%	40.1%	60.9%	CS3

Intermediate local densities

Close Pairs and Merging Galaxies





CONCLUSIONS

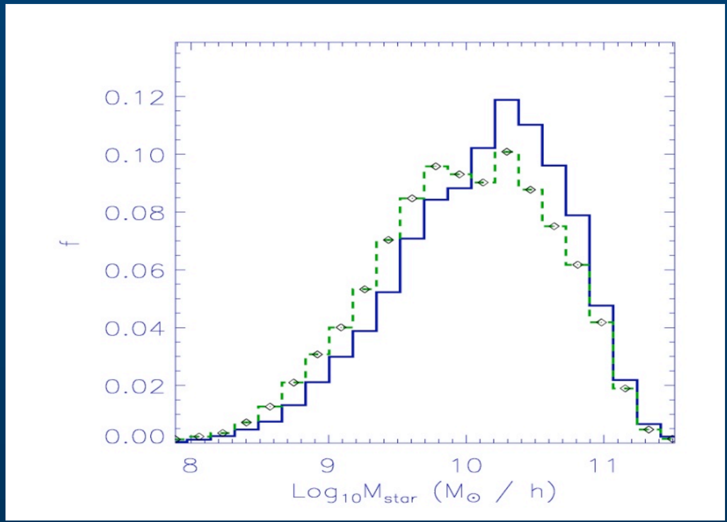
1) Theoretical analysis shows that a CS defined by imposing its galaxies to have the same luminosity and redshift than galaxies in pairs, presents several biases

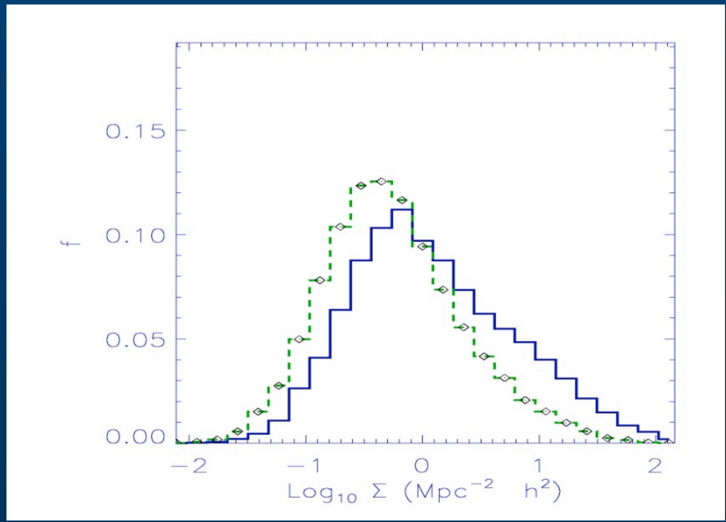
2) We suggest how to build an unbiased and unique CS to study galaxy interactions **(Perez, Tissera & Blaizot 2009, astroph/0904.2845)**

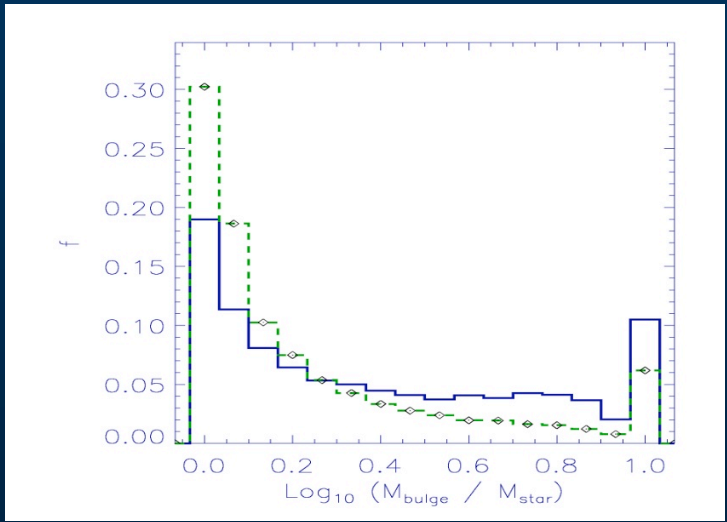
4) Analysis from SDSS-DR4 data indicates that when comparing galaxy pairs with this unbiased CS, the effect of interactions (although with lower signal in some cases) persists confirming previous observational results **(Lambas et al. 2003; Alonso et al. 2004,2006; Michel-Dansac et al. 2008)**

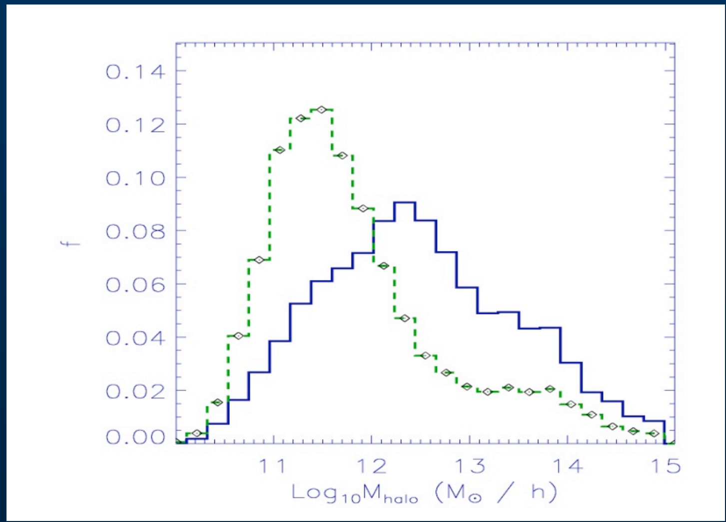
4) Our analysis shows that close galaxy interactions and merging systems seem to be more effective than more global environmental mechanisms (at least at intermediate local density regions) in driving a fast evolution **(Perez, Tissera, Padilla, Alonso & Lambas 2009, astroph/0904.2851)**

Bias effects in Control Sample 1









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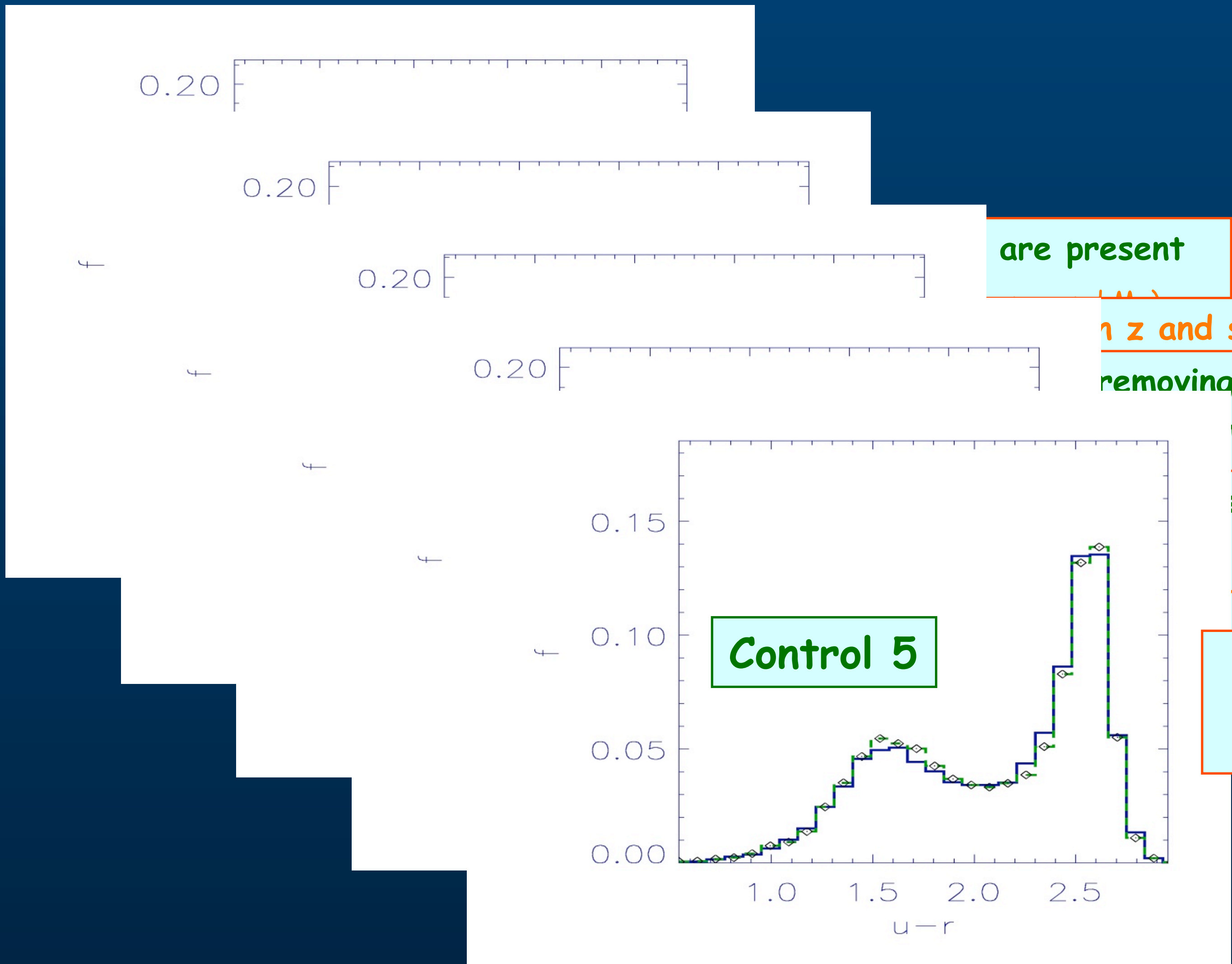


are present

n z and stellar

removing global density
nent bias (Σ)

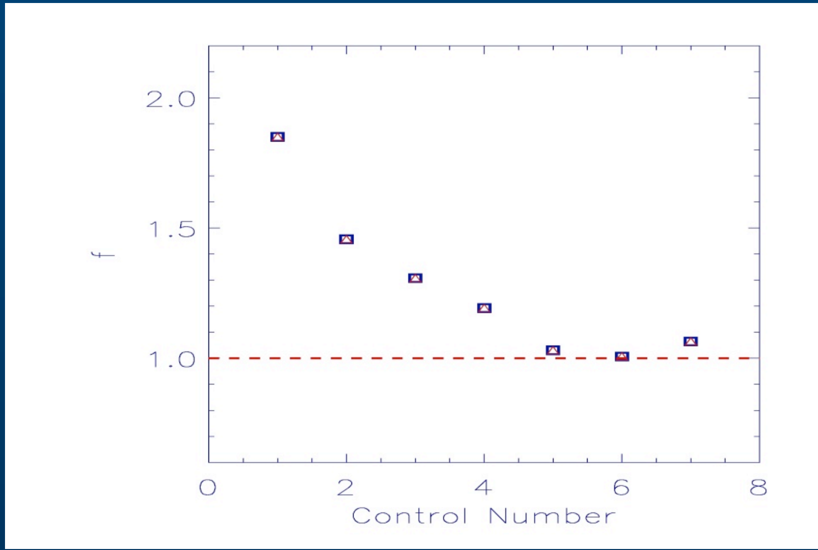
emoving morphology
bias

nstrain on z, M*, Σ and
morphology)

+ removing DM halo bias

(constrain on z, M*, Σ, morph.
and DM halo)

Perez, Tissera & Blaizot (2008)



CS's Efficiency

Fractions of red galaxies: (u-r)>2.5

GP respect to each CS

Modelling bias

DM halo could be overestimated in SAMs

Local and Global Environments

Local Environment: characterized by the local density parameter, Σ.

Global Environment: characterized by the DM halo mass, M_{vir}

Environment	Σ $(\mathrm{Mpc^{-2}h^{-2}})$	*HaloMass*	M_{vir} $(10^{10}\,M_{\odot}h^{-1})$
Low	$\log\Sigma < -0.57$	*Small*	0
Intermediate	$-0.57 < \log\Sigma < 0.05$	*Medium*	$0 < M_{vir} < 13.5$
High	$\log\Sigma > 0.05$	*Large*	$M_{vir} > 13.5$