GEE, Bologna, 4 November 2009

How Galaxy Mass and Environment influence the evolution of Early-Type Galaxies

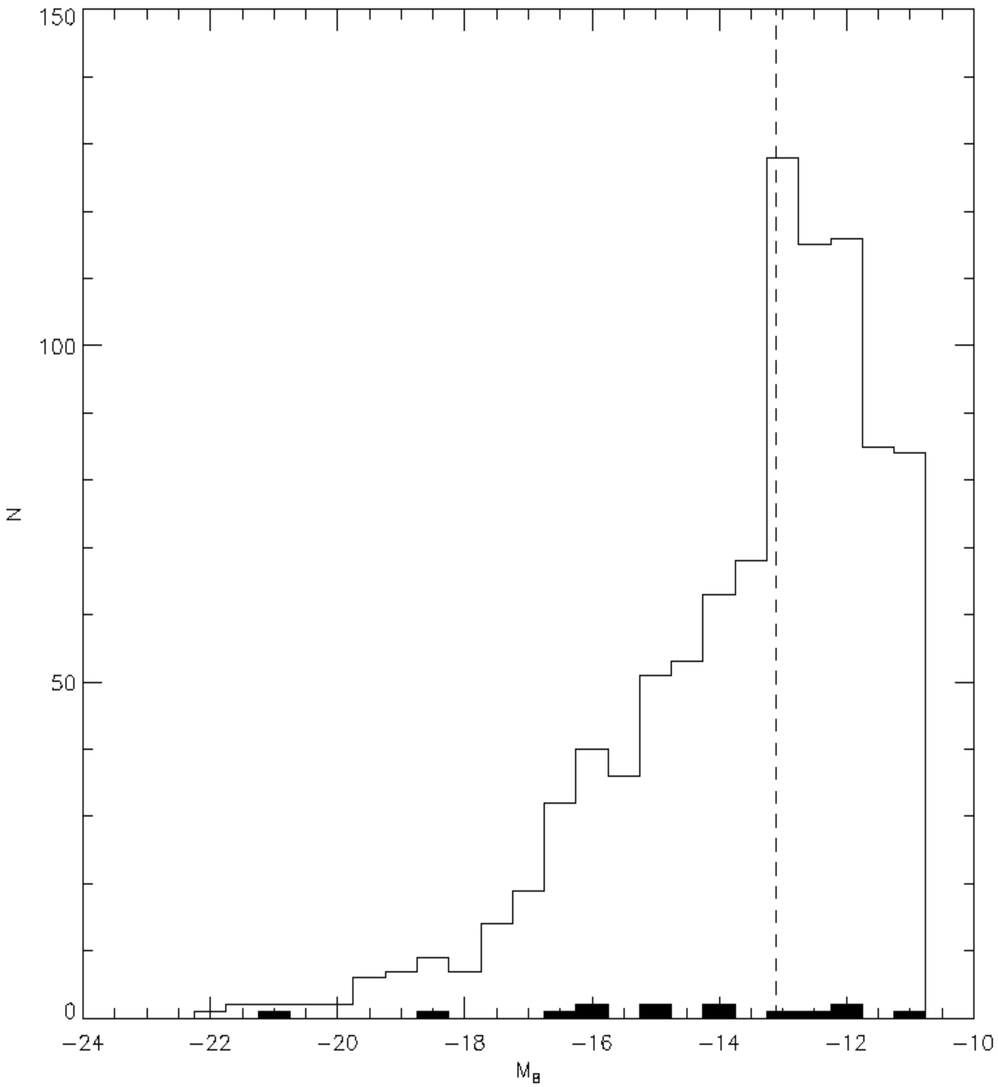
Sperello di Serego Alighieri

Arcetri: Carlo Giovanardi, Marco Grossi
Bologna: Andrea Cimatti, Luca Ciotti, Barbara Lanzoni, Marco Mignoli,
Michele Moresco, Lucia Pozzetti, Silvia Pellegrini e Gianni Zamorani
ESO: Jaron Kurk, Piero Rosati
Hilo: Inger Jørgensen
Ithaca: Riccardo Giovanelli, Martha Haynes
Milano: Peppo Gavazzi, Marco Scodeggio e Ginevra Trinchieri
Oxford: Michele Cappellari
Padova: Alberto Franceschini, Alvio Renzini e Giulia Rodighiero
Parigi: Emanuele Daddi
Pasadena: Pat McCarthy
Tucson: Mark Dickinson

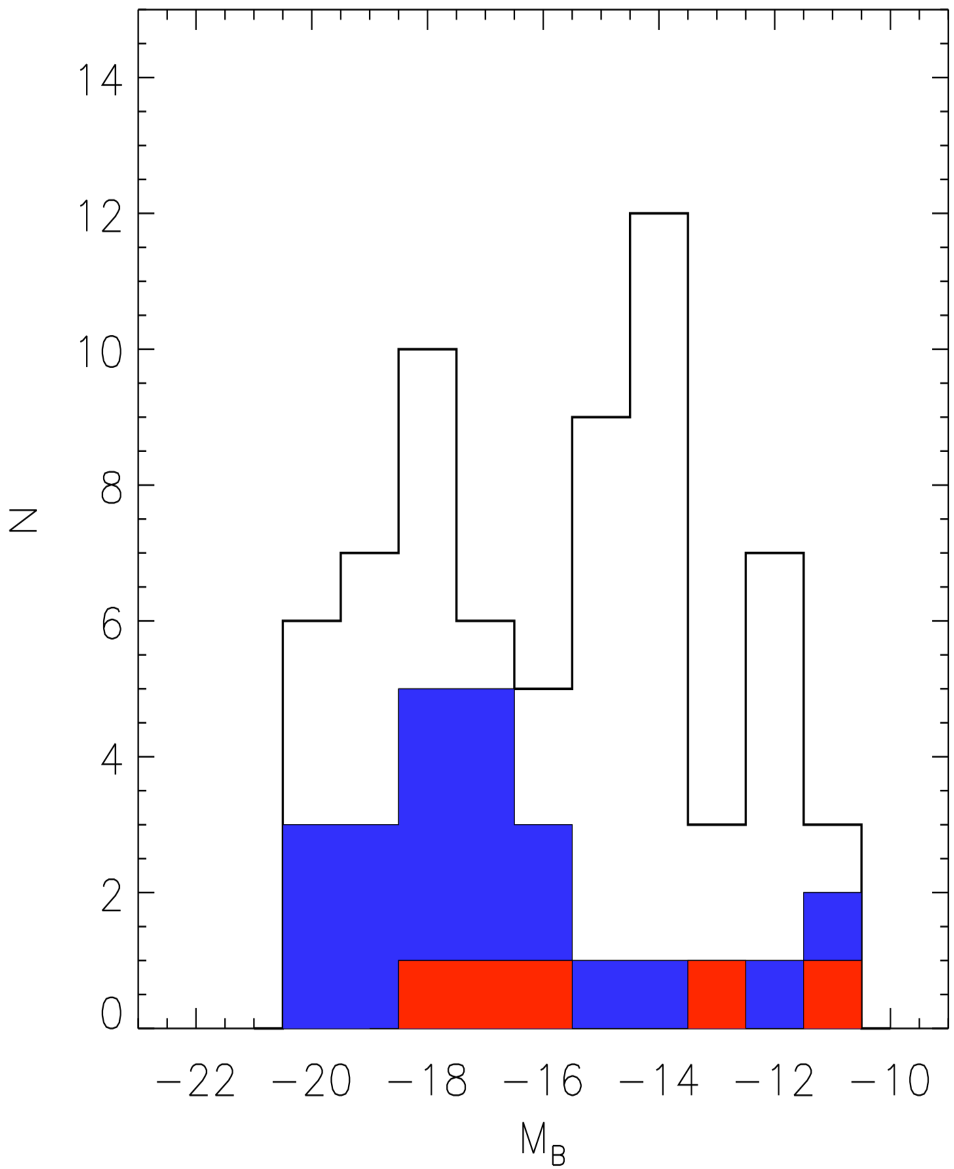
See: http://www.arcetri.astro.it/~sperello

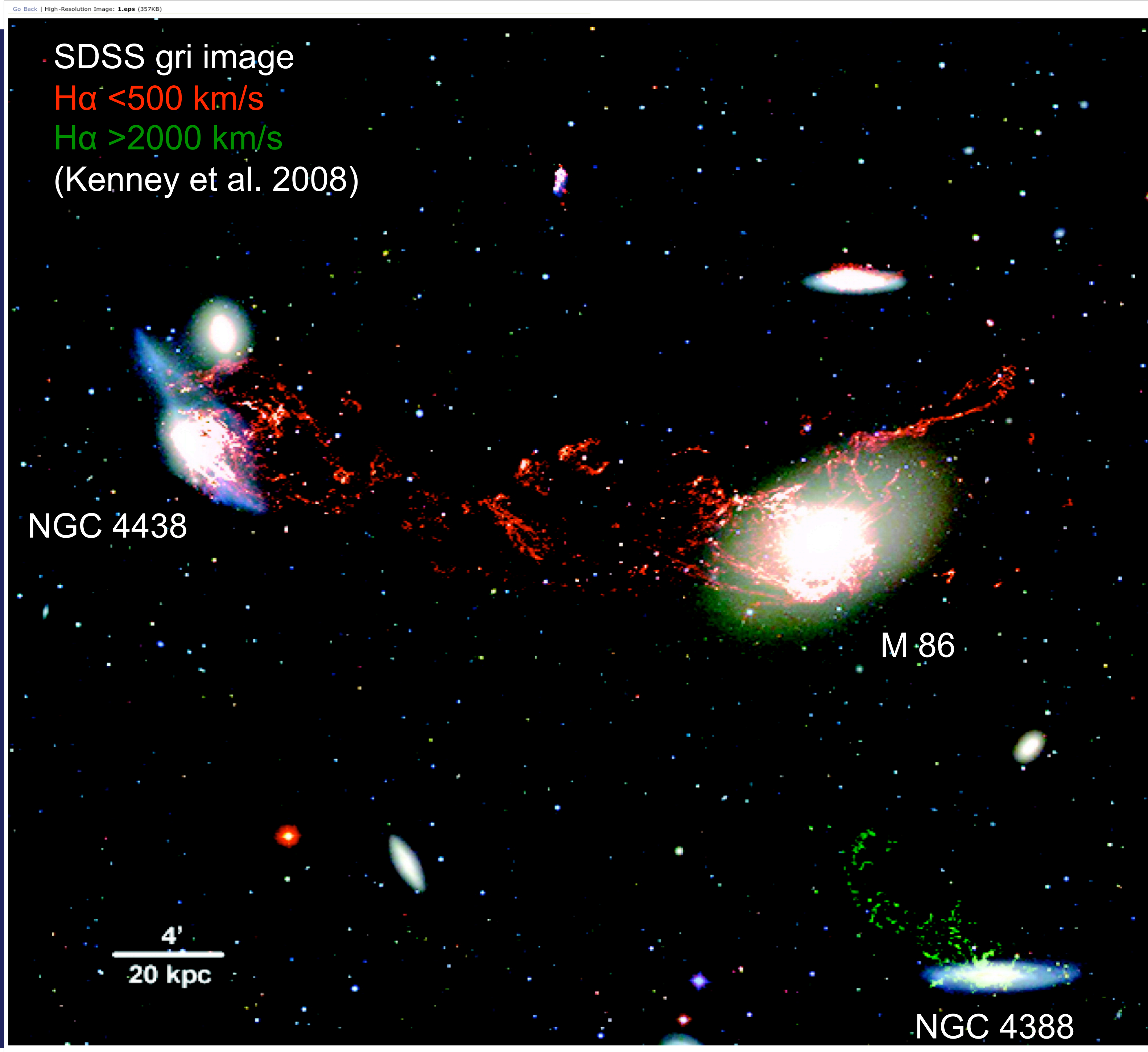
HI detection rates in field vs. cluster ETG

Virgo cluster: 9 of 457 (2%) dSA et al. 2007



Field sample: 15 of 62 (25%) Grossi et al. 2009





Go Back | High-Resolution Image: 1.eps (357KB)
SDSS gri image
Hα <500 km/s
Hα >2000 km/s
(Kenney et al. 2008)
NGC 4438
M 86
NGC 4388
4'
20 kpc

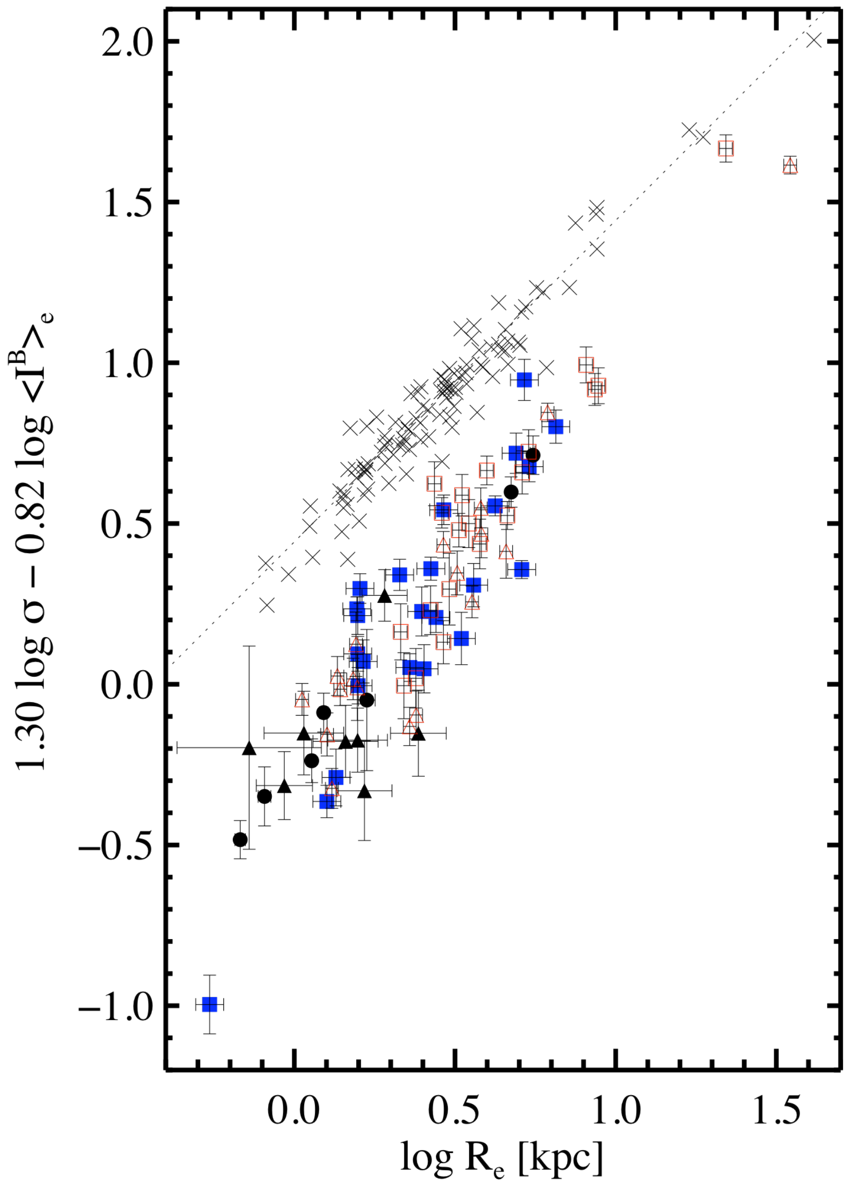
The evolution of the FP since z~1

▲ ● K20 field ETG, 0.88<z<1.3, 2 separate fields (19.8 and 32.2 arcmin^2), complete to M_B=-20.0 (SSA05).

■ GOODS-N field ETG, 0.88<z<1.3, 160 arcmin^2 (Treu et al. 2005).

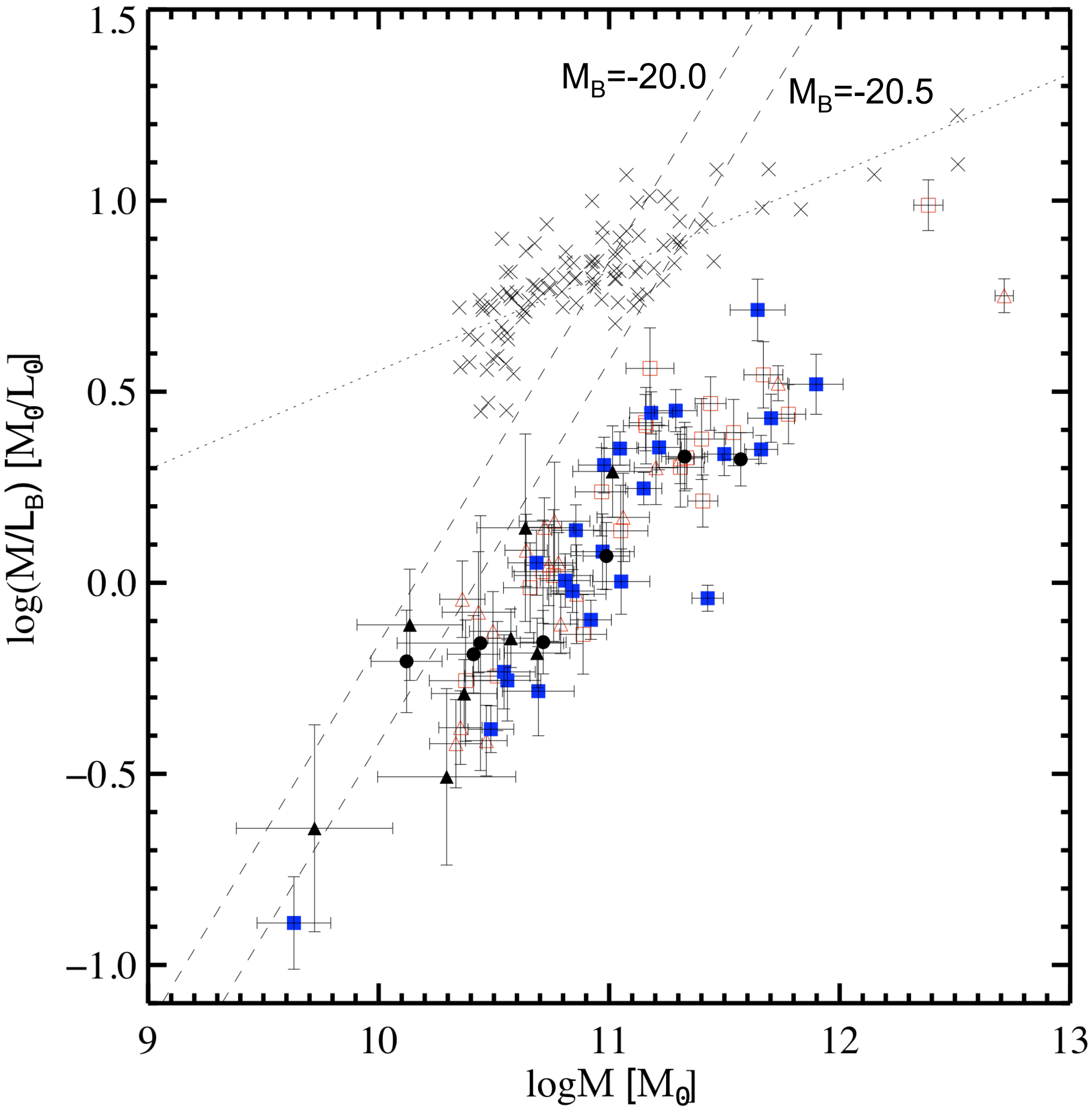
□ Cluster ETG from 2 clusters at z=0.835 and z=0.892, complete to M_B=-20.5 (Jørgensen et al. 2006).

Compared with the local one, the FP of field and cluster ETG at z~1 shows both an offset and a **rotation (steepening ≈ downsizing),** and keeps a remarkably small scatter.



The evolution of the FP interpreted as changes in the $\mathscr{M}$/L

Assuming $R^{1/4}$ homology the total galaxy mass is given by:
$\mathscr{M} = 5R_e\sigma^2/G$
Then one can apply to the FP a coordinate change to $\mathscr{M}$ and $\mathscr{M}$/L.
Not only there is an overall $\mathscr{M}$/L evolution between z~1 and z=0, corresponding to the passive evolution of the stellar population, but the change in $\mathscr{M}$/L is larger for smaller masses.
This evolution does not seem to depend on the environment.
However field and cluster ETG are at a different average redshift and a more appropriate analysis is necessary.



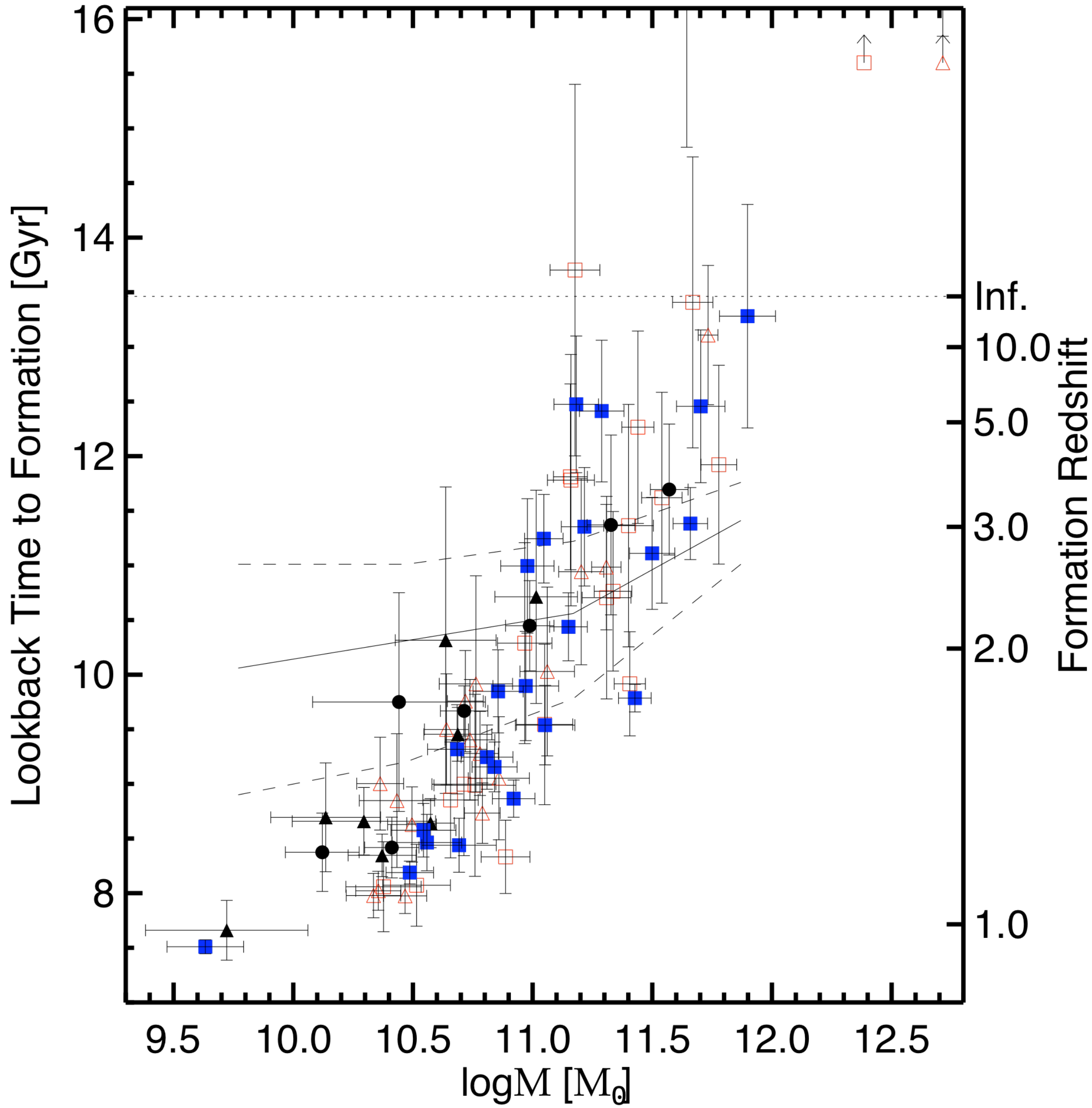
The formation epoch of ETG

We can interpret the changes in $\mathscr{M}$/L ratio as age differences. Then, using the evolutionary population synthesis models of Maraston (2005), we have estimated ages from the $\mathscr{M}/L_B$ and derived a formation redshift for each ETG at z~1, both in the field and in clusters.

The continous line is the median model ages obtained from a semianalytic of hierarchical galaxy formation with feedback (De Lucia et al. 2006).

Clearly z_f depends strongly on the galaxy mass, but not on environment. The mass dependence appears stronger than foreseen by hierachical models, even with feedback, and the small,if any, influence of the environment is definitely anti-hierarchical.

See dSA et al. 2006, ApJ 647, L99

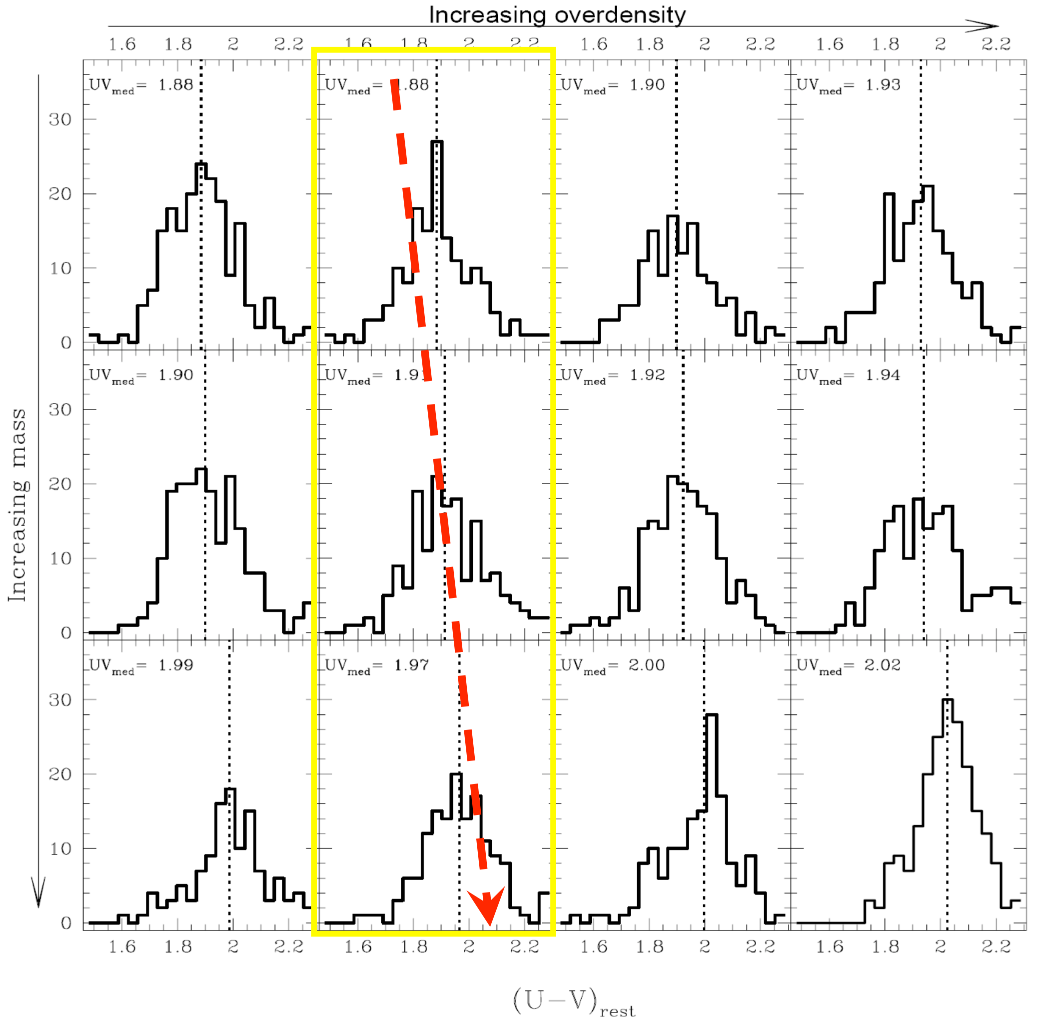


Exploring mass and environment dependence in Early Type Galaxies

M. Moresco, L. Pozzetti, A. Cimatti, G. Zamorani, M.Mignoli, M.Bolzonella, E. Zucca & zCOSMOS team

We analysed a sample of 981 ETG at 0.1<z<1 selected from the 10K zCOSMOS spectroscopic sample as thosegalaxies whose SED is better fitted by an elliptical template, by eliminating those with emission lines, and those classified as spirals by both the Marseille and Zurich groups: ***RED & PASSIVE ETGs***

Looking at $(U\text{-}V)_{rest}$ distributions in bins of mass and environment overdensity, the reddening from low to high masses at fixed overdensity is clear; changing the over-density at fixed mass has a smaller effect.



zCOSMOS 10-k bright spectroscopic sample

Exploring mass and environment dependence in Early Type Galaxies

M. Moresco, L. Pozzetti, A. Cimatti, G. Zamorani, M.Mignoli, M.Bolzonella, E. Zucca & zCOSMOS team

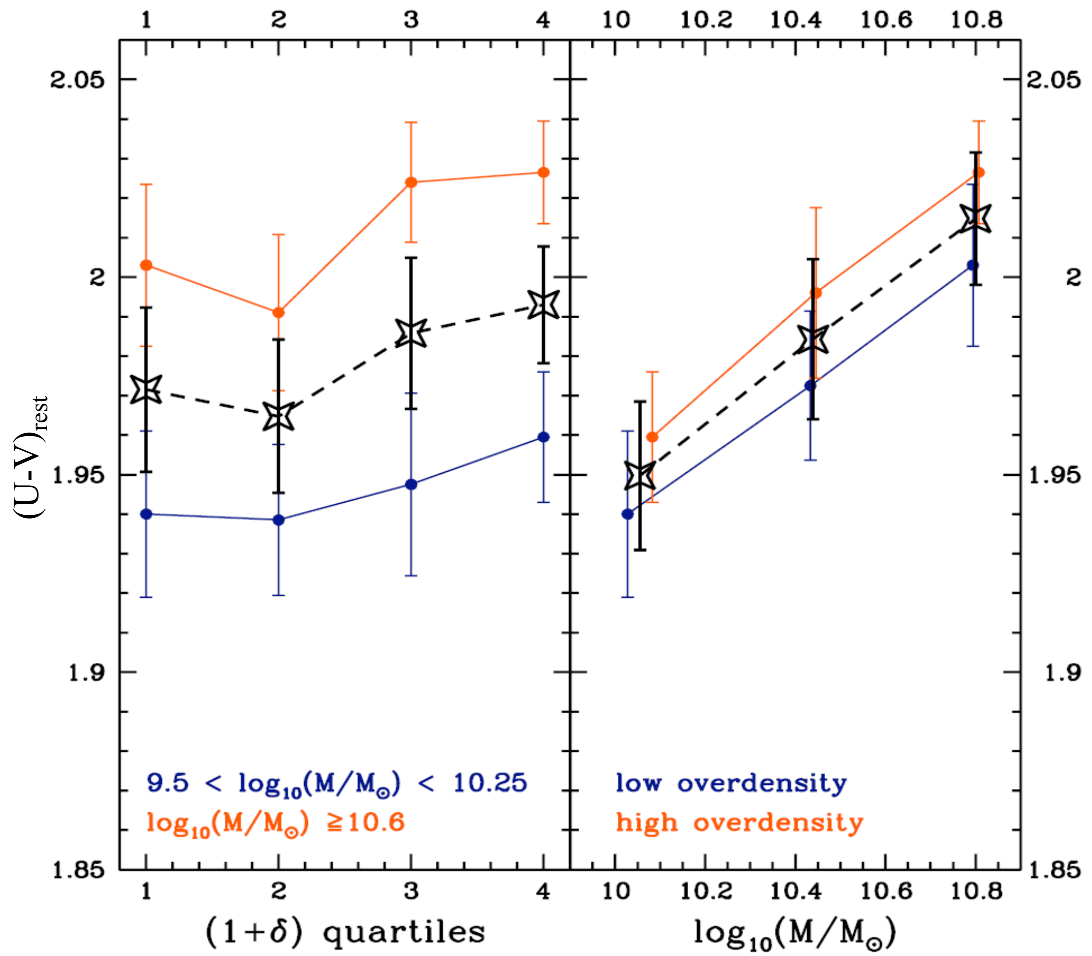
We analysed a sample selected by matching spectroscopic, morphologic, and photometric characteristics:
RED & PASSIVE ETGs

Looking at $(U-V)_{rest}$ distributions in bins of mass and environment overdensity, the reddening from low to high masses at fixed overdensity is clear; changing the over-density at fixed mass has a smaller effect.

RESULTS

- a **strong dependence on the mass** (~0.1 mag) for all the environments, that corresponds to a difference in age of ~1 Gyr *(right panel)*

- a **weak but significant dependence on the environment** (~0.02 mag) throughout the whole masses range , that corresponds to a difference in age of ~0.2 Gyrs *(left panel)*



The analysis on D4000 & EW(Hδ) dependence on mass and environment gives results in complete agreement.

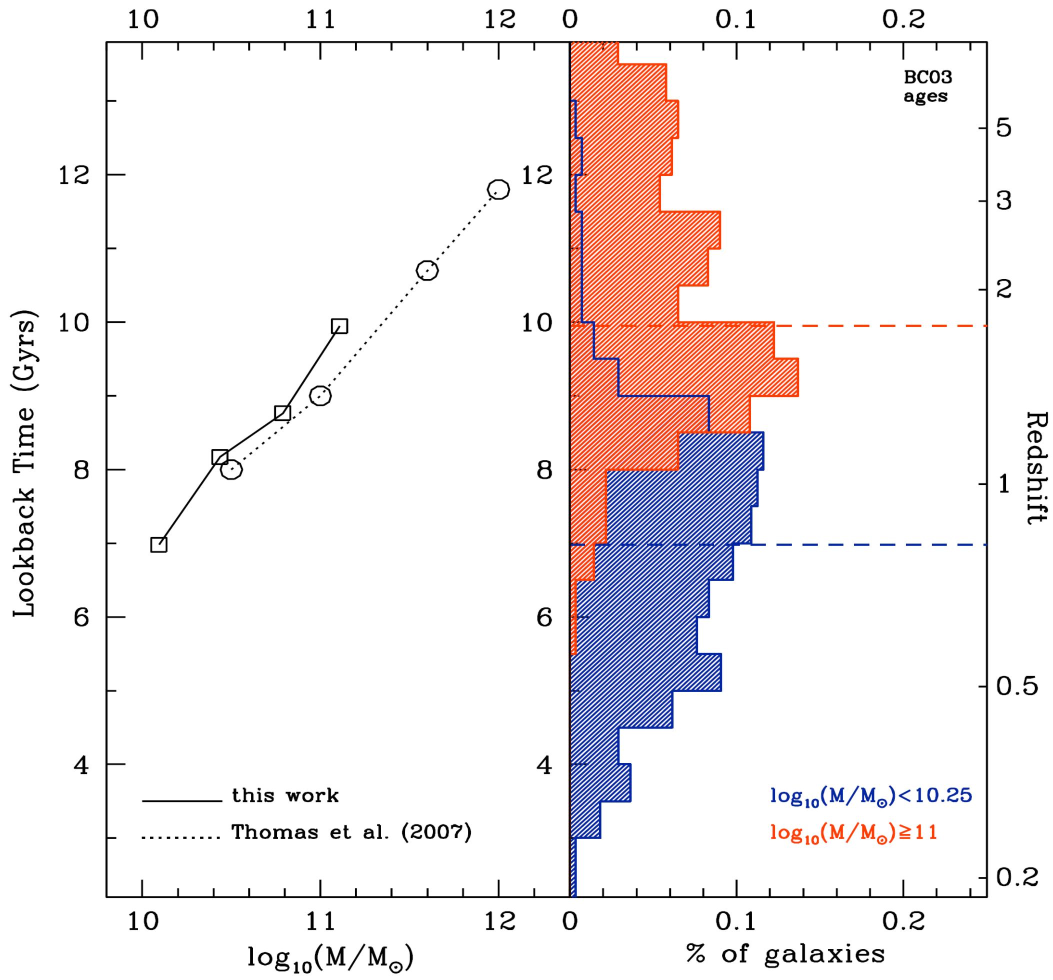
Exploring mass and environment dependence in Early Type Galaxies

M. Moresco, L. Pozzetti, A. Cimatti, G. Zamorani, M.Mignoli, M.Bolzonella, E. Zucca & zCOSMOS team

The look-back time to formation of ETGs as a function of mass underlines even more the fundamental role of the mass in driving galaxies evolution

In agreement with SDSS DR4 analysys on elliptical galaxies (Thomas et al. 2007) we found:

- **strong dependence on mass**
- **weak dependence on environment**



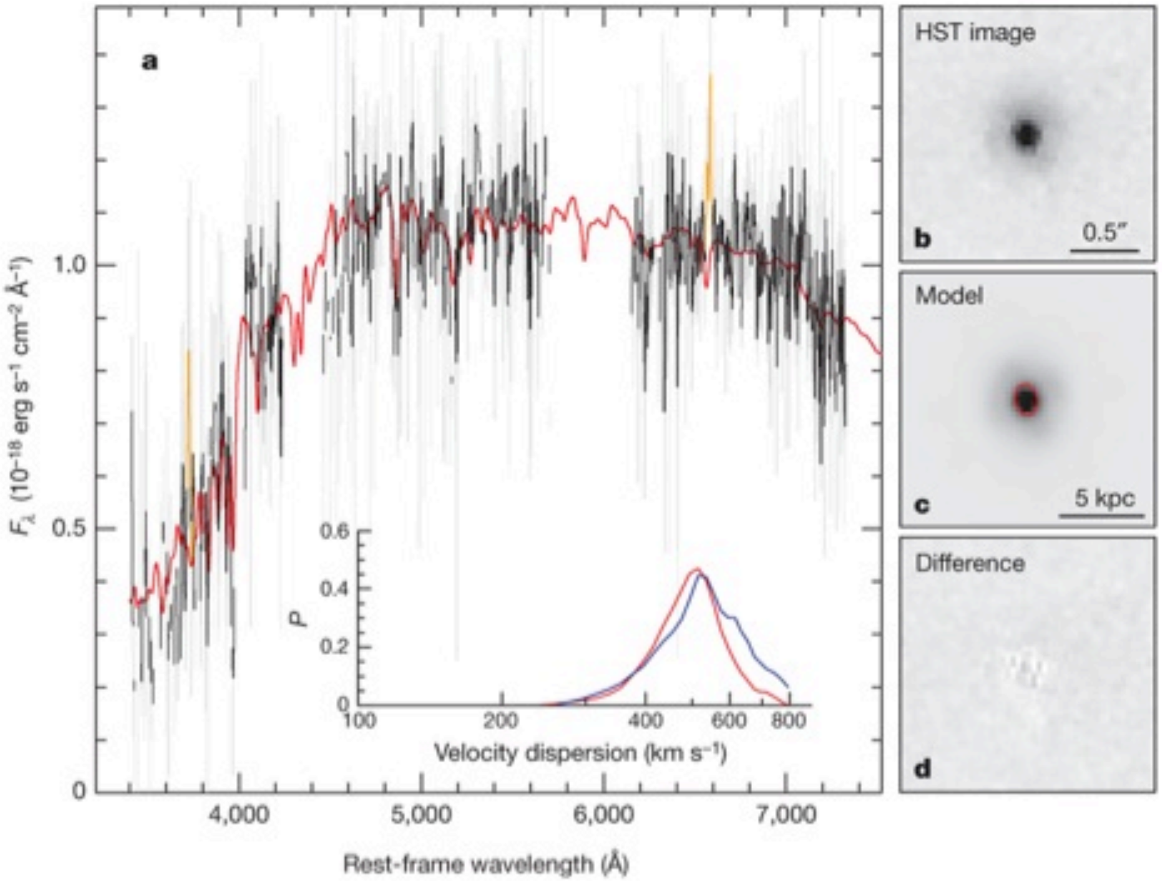
Measuring the ETG velocity dispersion at z>1

Spectrum and HST images of 1255-0 at z = 2.186.

$\sigma = 510_{-95}^{+165}$ km/s

$R_e = 0.78 \pm 0.17$ kpc

$M_B \sim -23.4$



PG van Dokkum *et al*. *Nature* **460**, 717-719 (2009) doi:10.1038/nature08220

Results on GMASS ETG at $1.4<z<2.0$

Cappellari et al. 2009 examined a sample of 9 massive ETG from GMASS at $1.4<z<2.0$ and could measure the velocity dispersion for two of them:

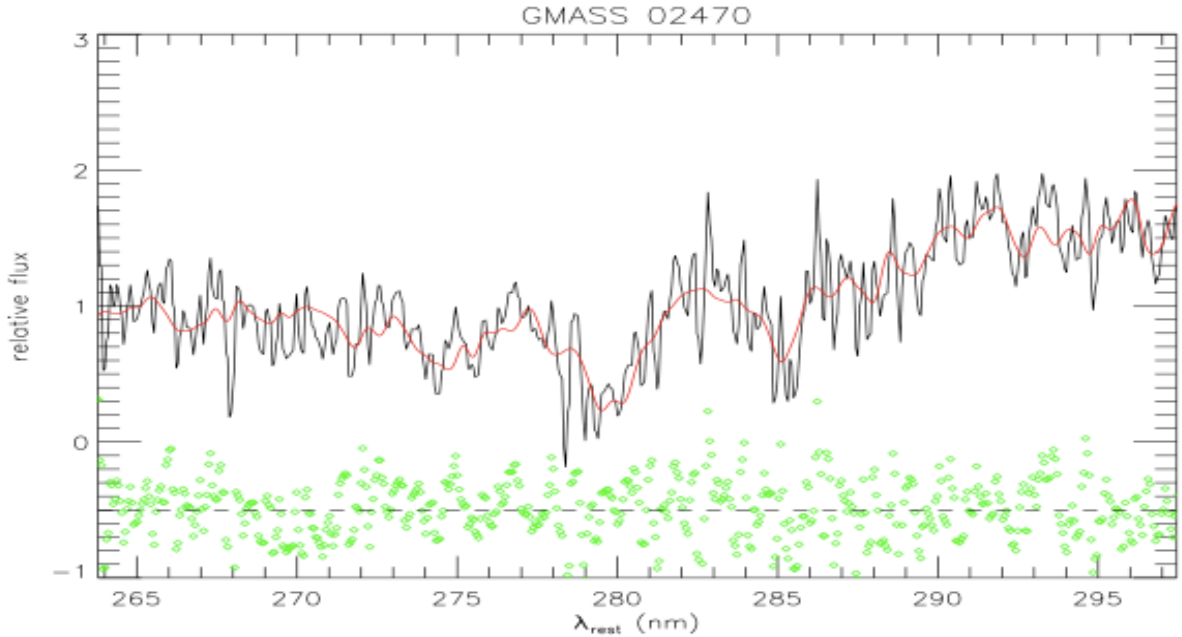
$\sigma_* = 111\pm35$ km/s for GMASS 2239 at z=1.415

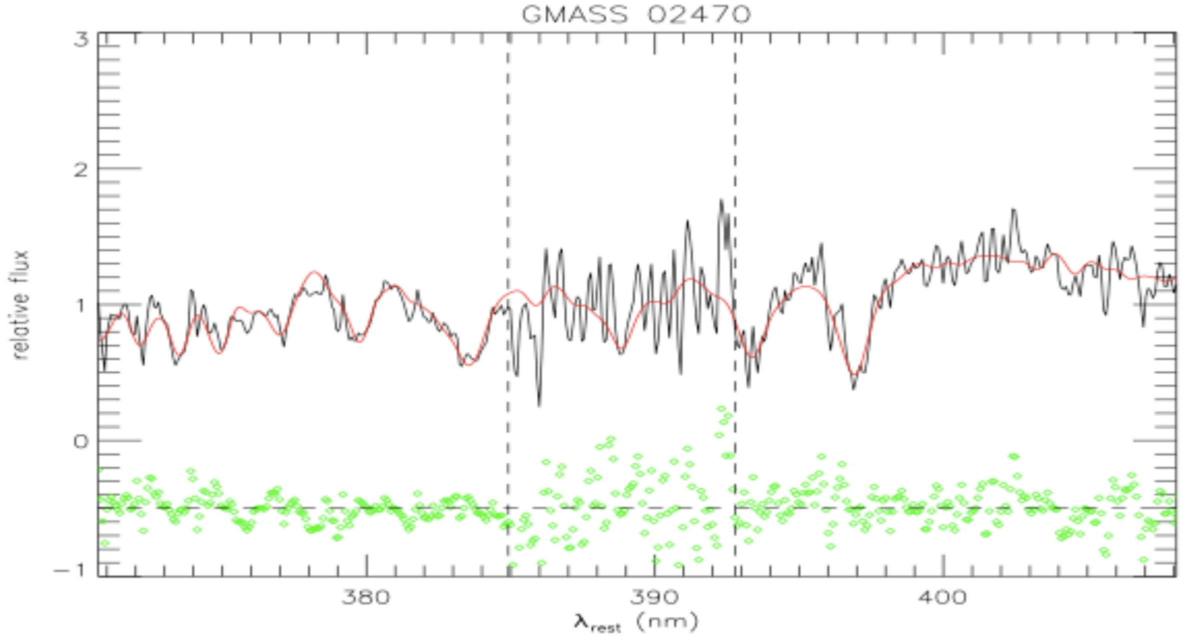
$\sigma_* = 141\pm26$ km/s for GMASS 2470 at z=1.416

They also have photometry and morphology from HST images (C08).

For GMASS 2239:
$M_B = -21.40$, $R_e = 2.16\pm0.43$ kpc, $n_{Sersic} = 2.2\pm0.2$

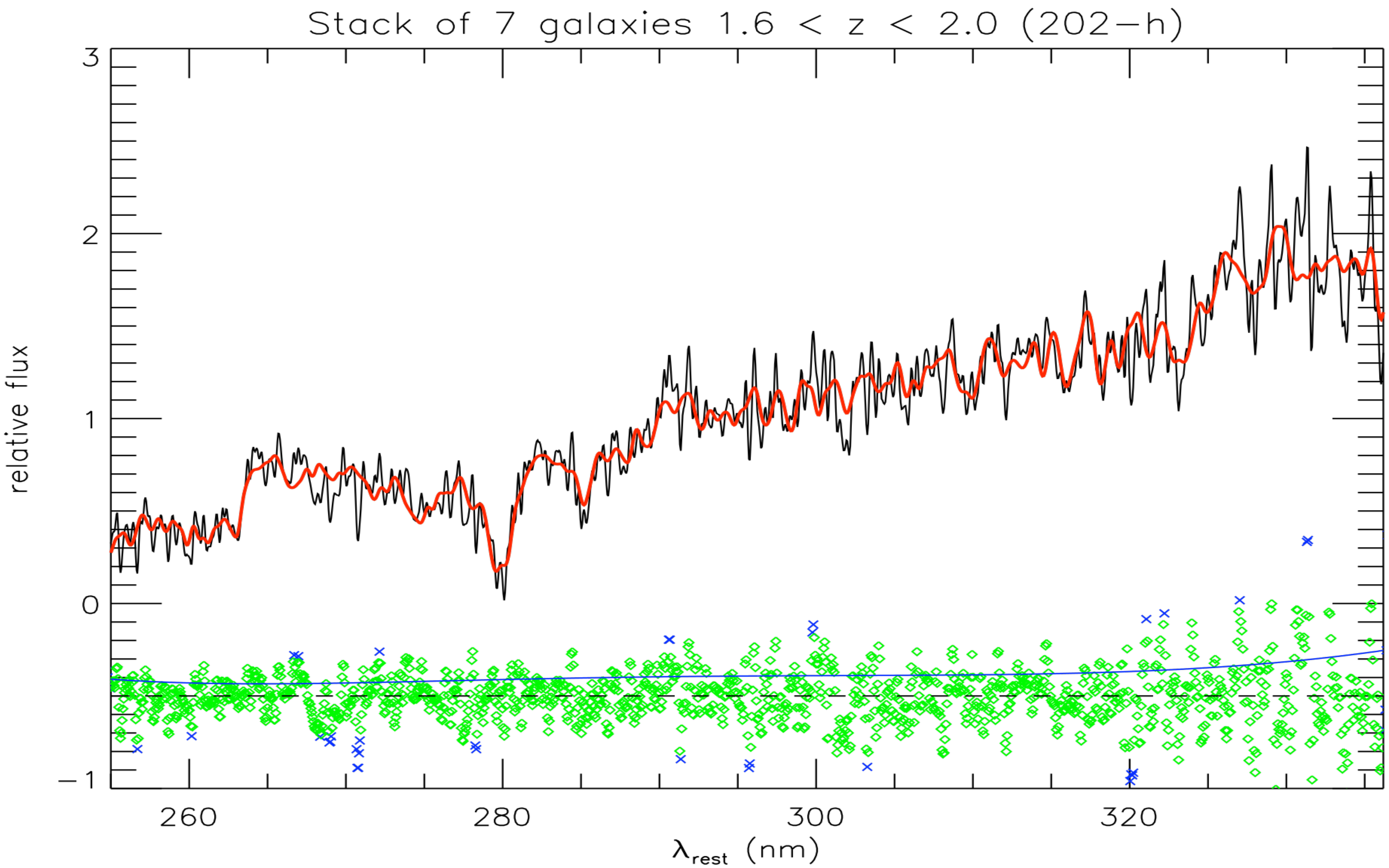
For GMASS 2470:
$M_B = -22.07$, $R_e = 1.81\pm0.36$ kpc, $n_{Sersic} = 4.2\pm0.3$





We have also measured the velocity dispersion on the coadded spectrum of the other 7 GMASS passive galaxies with $1.39<z<1.99$ ($z_{av.} = 1.6$, C08). After correction for the instrumental resolution we get: $\sigma = 202\pm23$ km/s.

However this is strictly an upper limit, since the coadded spectrum is broadened by the errors in the redshifts of the individual spectra. However this broadening is almost negligible, since the average redshift error corresponds to ~30 km/s.



The FP towards z~2

× Coma ETG (Jorgensen et al. 2006)

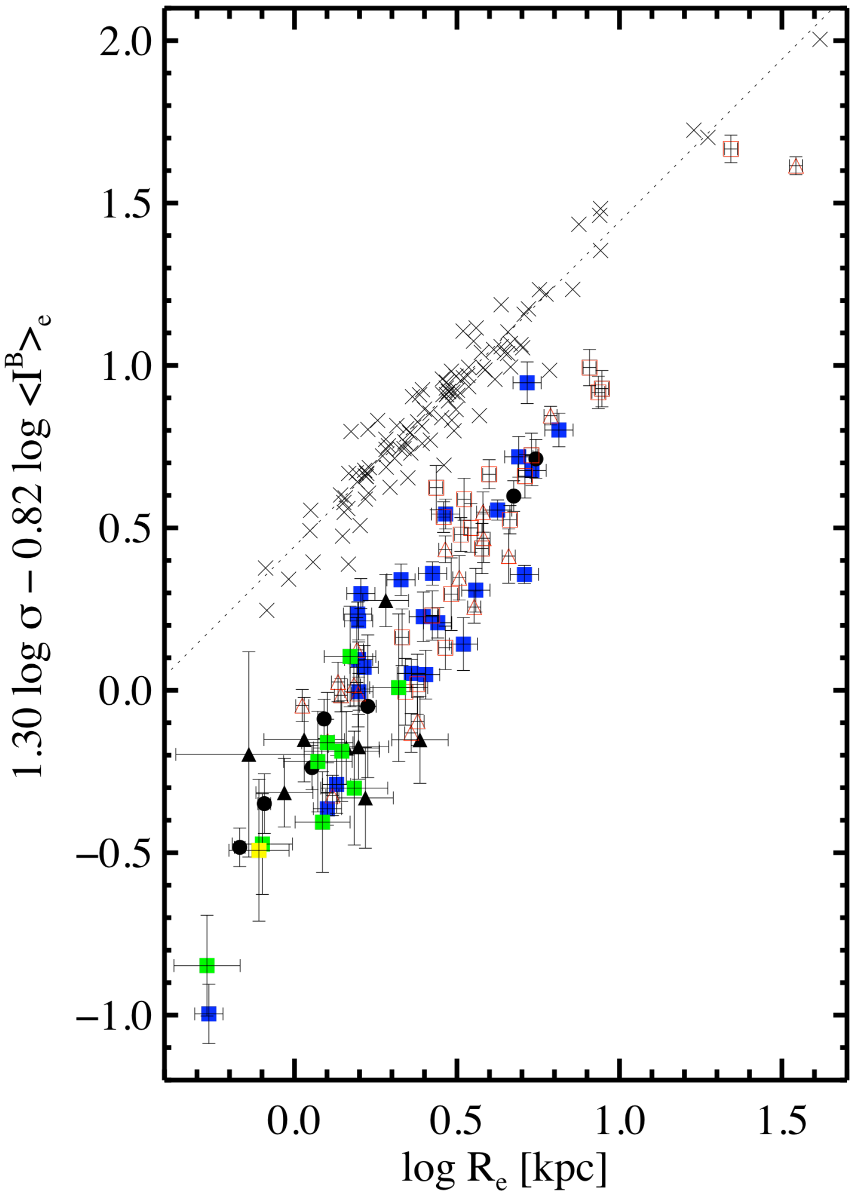
● K20 ETG 0.9<z<1.3 (di Serego Alighieri et al. 2005)

■ Field ETG z~1 (Treu et al. 2005)

□ 2 clusters at z~0.85 (Jorgensen et a.l 2006)

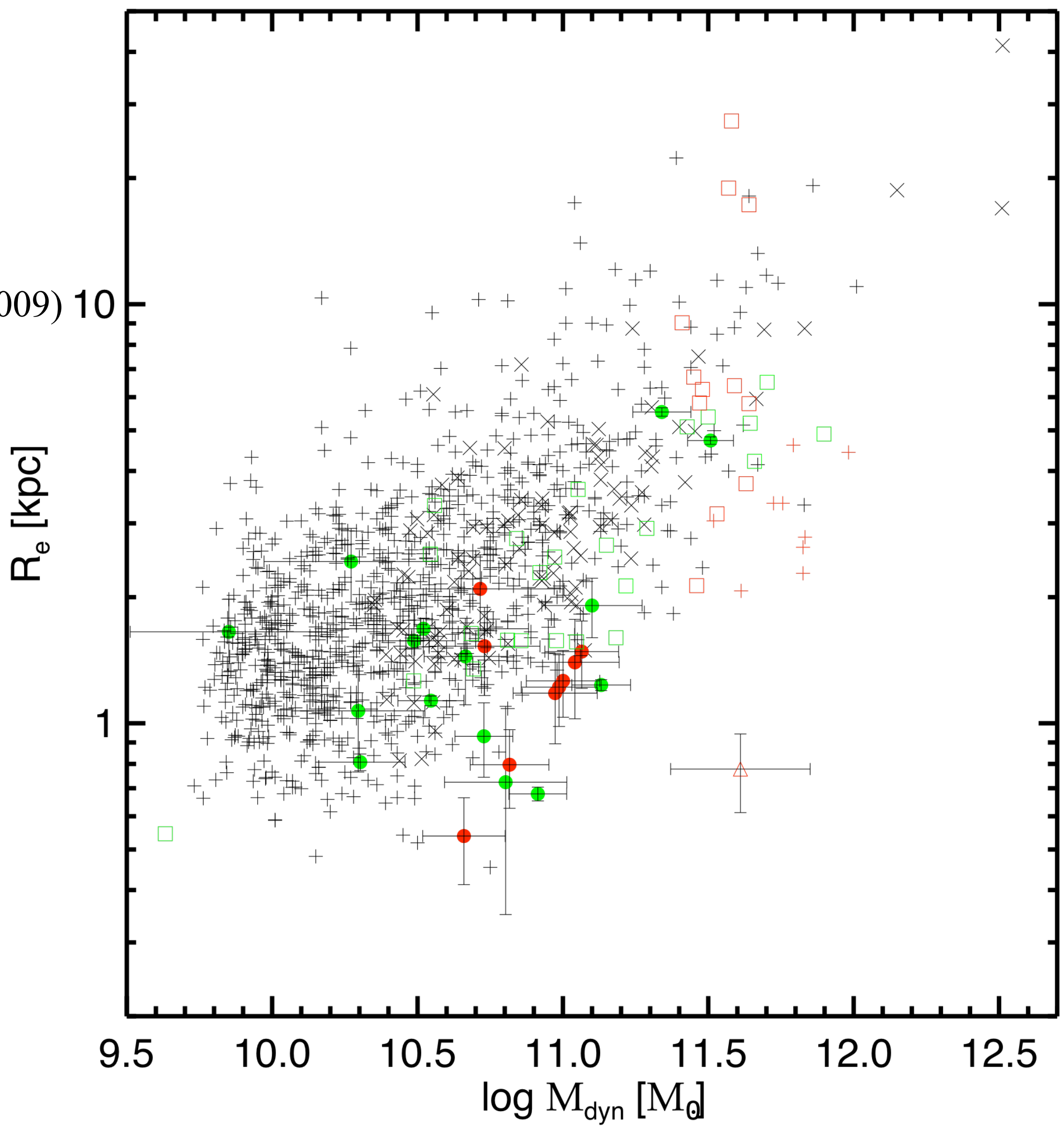
■ GMASS ETG 1.4<z<2 (Cappellari et al. 2009)

■ Massive ETG at z=2.2 (van Dokkum et al. 2009)



Compact ETG at z>1?

× Coma ETG, z=0.0248 (Jorgensen et al. 2006)
+ Wings cluster ETG, 0.04<z<0.07 (Valentinuzzi et al. 2009)
* SDSS compact ETG 0.066<z<0.12 (Taylor et al. 2009)
● K20 ETG 0.9<z<1.3 (di Serego Alighieri et al. 2005)
□ Field ETG z~1 (Treu et al. 2005)
□ COSMOS ETG, 1.4<z<1.8 (Mancini et al. 2009)
● GMASS ETG 1.4<z<2 (Cappellari et al. 2009)
Δ Massive ETG at z=2.2 (van Dokkum et al. 2009)
+ Massive ETG z=1-2 (Longhetti et al. 2007)
* GDDS ETG 1.2<z<2 (Damjanov et al. 2009)

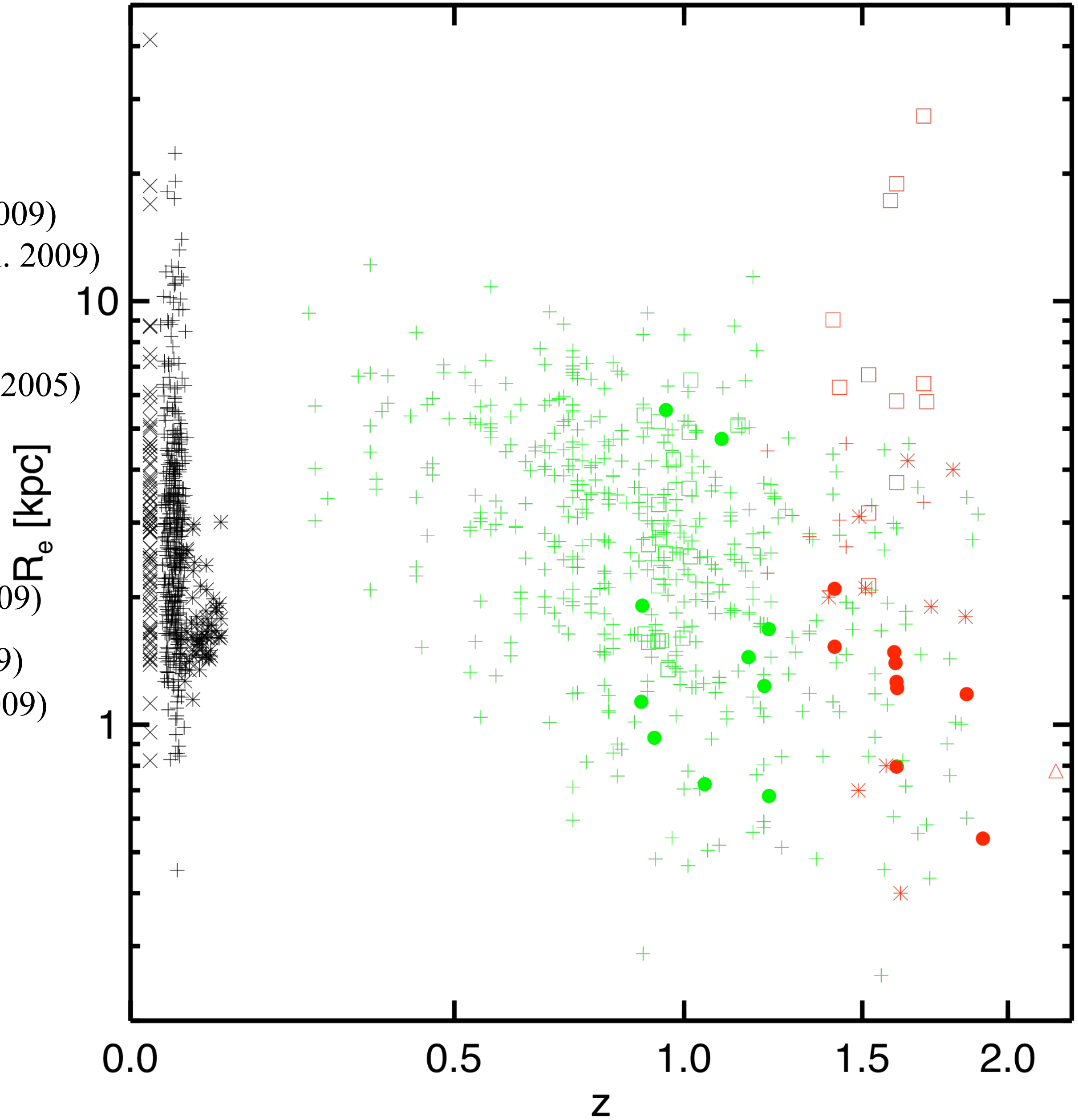


Compact ETG at z>1?

× Coma ETG, z=0.0248 (Jorgensen et al. 2006)
+ Wings ETG, 0.04<z<0.07 (Valentinuzzi et al. 2009)
* SDSS compact ETG 0.066<z<0.12 (Taylor et al. 2009)

● K20 ETG 0.9<z<1.3 (di Serego Alighieri et al. 2005)
□ Field ETG z~1 (Treu et al. 2005)
+ DEEP2 ETG 0.3<z<2 (Trujillo et al. 2007)

□ COSMOS ETG, 1.4<z<1.8 (Mancini et al. 2009)
● GMASS ETG 1.4<z<2 (Cappellari et al. 2009)
Δ Massive ETG at z=2.2 (van Dokkum et al. 2009)
+ Massive ETG z=1-2 (Longhetti et al. 2007)
* GDDS ETG 1.2<z<2 (Damjanov et al. 2009)

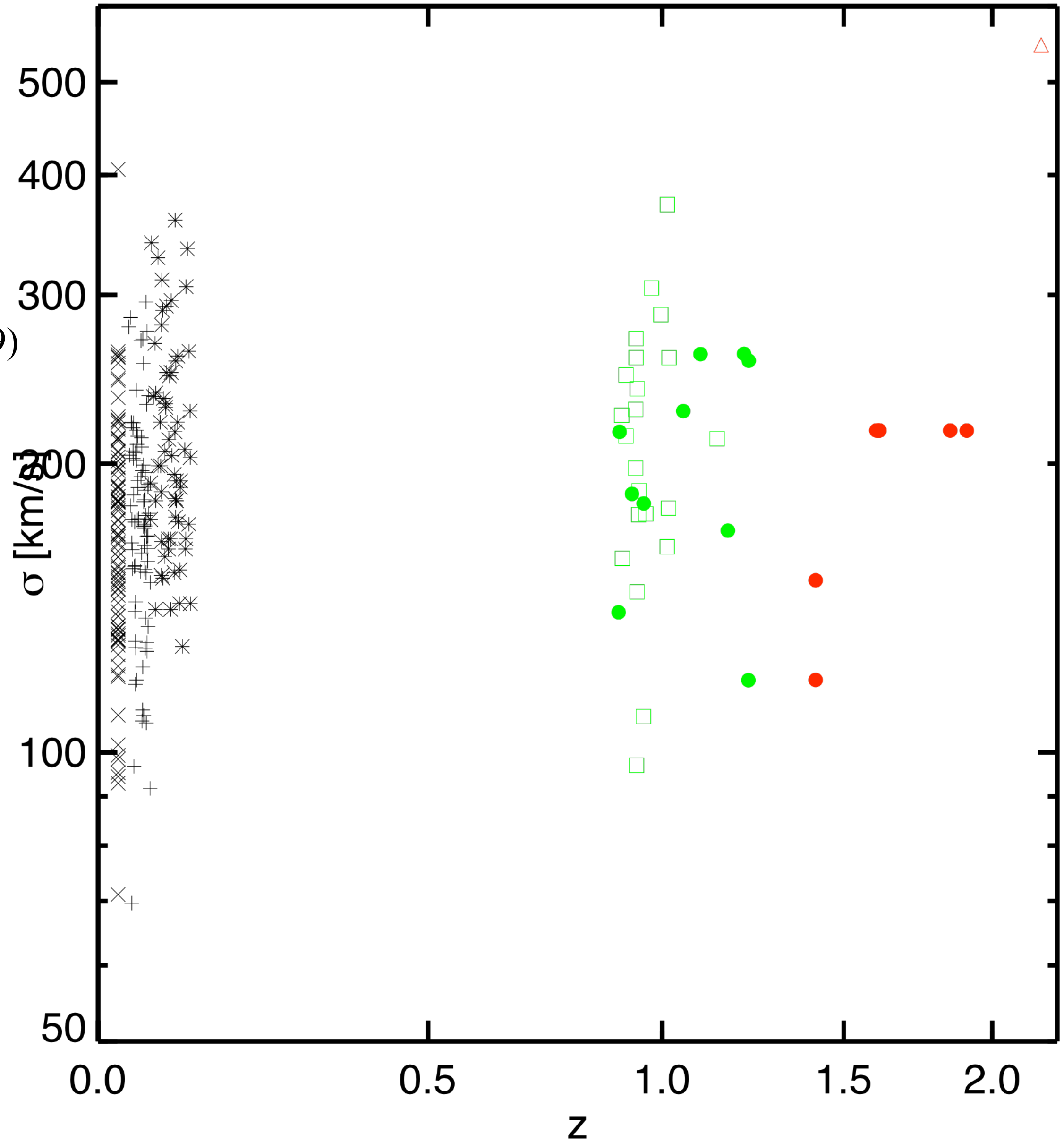


Compact ETG at z>1?

× Coma ETG, z=0.0248 (Jorgensen et al. 2006)
+ Wings ETG, 0.04<z<0.07 (Valentinuzzi et al. 2009)
* SDSS compact ETG 0.066<z<0.12 (Taylor et al. 2009)

● K20 ETG 0.9<z<1.3 (di Serego Alighieri et al. 2005)
□ Field ETG z~1 (Treu et al. 2005)
+ DEEP2 ETG 0.3<z<2 (Trujillo et al. 2007)

□ COSMOS ETG, 1.4<z<1.8 (Mancini et al. 2009)
● GMASS ETG 1.4<z<2 (Cappellari et al. 2009)
Δ Massive ETG at z=2.2 (van Dokkum et al. 2009)



Final remarks on size evolution

•The reasons for the claimed increase in size could be quasar feedback (the puffing-up scenario, e.g. Fan et al. 2008) or a growth of the outskirts due to merging of smaller units.

•However selection effects due to surface brightness dimming must play a role, as well as the possible influence on the measurement of R_e of a central AGN.

•We are working on very deep VLT+FORS2 spectra of about 20 ETG at z=1-2 from the GDDS

Hall of Fame

- The ETG evolution appears to be driven mostly by (dynamical) mass, while the effect of the environment appears minor, at most.
- The problem: also at high redshift get to the detail necessary to see also the influence of the environment.