Kinematics of high redshift compact early-type galaxies : are they really denser?

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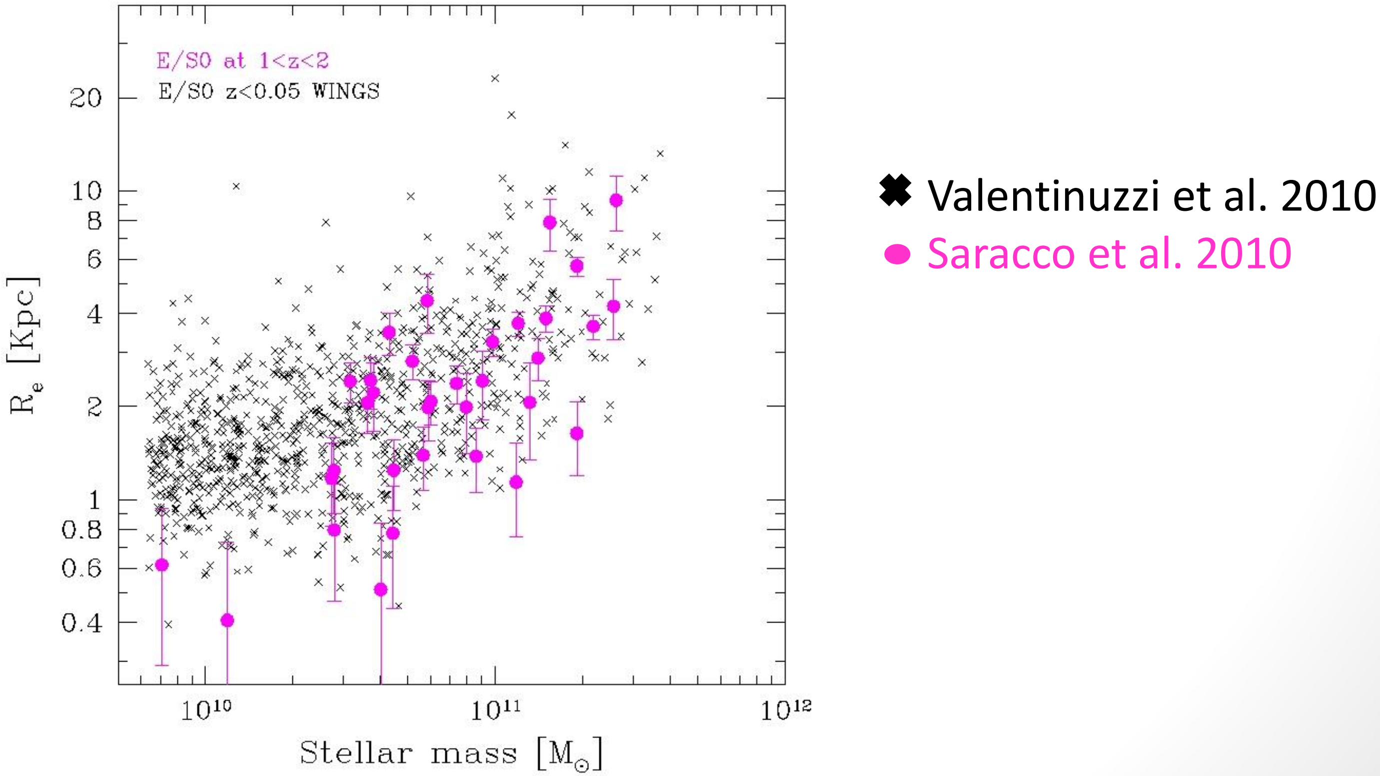
Outline

- The size of early-type galaxies at high (1<z<2) and low redshift
- FORS2 – VLT spectra for compact ETGs at z~ 1.4
- Results
- Conclusions

The size of early-type galaxies at high redshift

- At fixed mass, local ETGs show a remarkable difference (~ an order of magnitude) in the value of their effective radii → difference in stellar mass density of a factor 100 -1000;
- High-z ETGs follow the same size-mass relation of local ETGs: are smaller high-z ETGs really denser?



Are high-z compact ETGs really denser?

If high-z ETGs are virialized systems ($\sigma^2 \propto M/Re$) → ETGs with the smallest radii, say compact ETGs, are denser than ETGs with greater radii, say normal ETGs.

↓

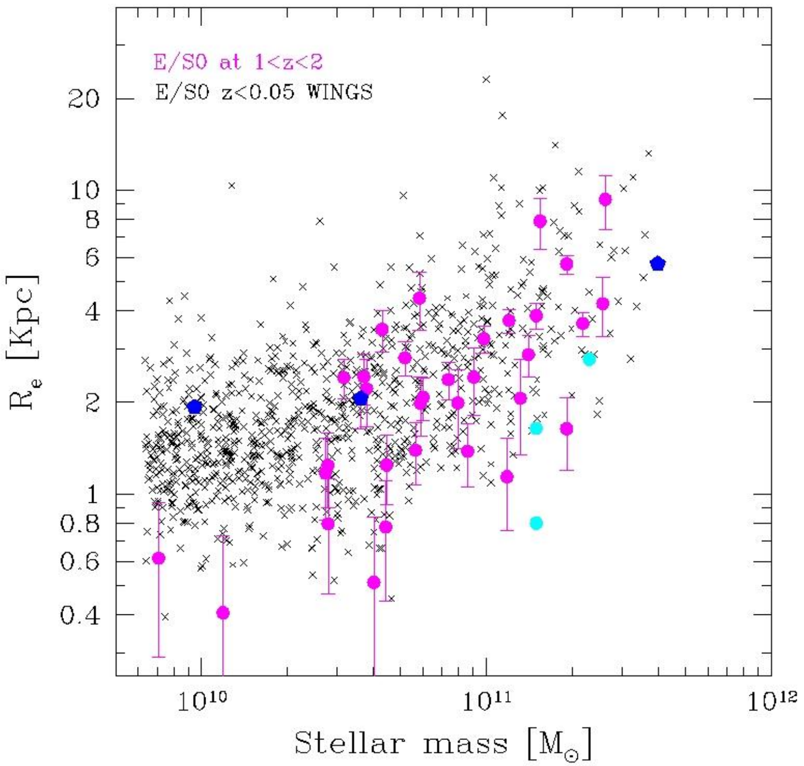
Velocity dispersion measurements of compact and normal ETGs.

Due to the limits of near-IR spectroscopy

↓

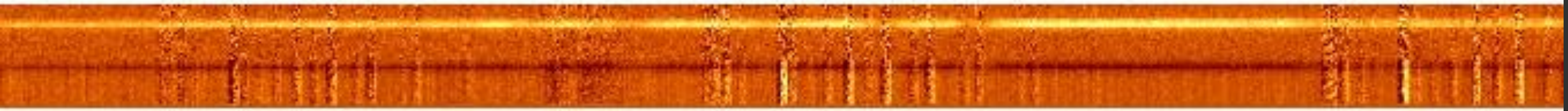
few estimates of σ for high-z ETGs (van Dokkum et al.2008, Toft et al. 2010, Van de Sande et al. 2011, Cappellari et al. 2009, Onodera et al. 2010).

All velocity dispersions measured, being in agreement with the virial theorem, seem to confirm the denser nature of high-z compact ETGs.



FORS 2 – VLT spectroscopy for compact ETGs at z~1.4

We obtained FORS2 near-IR spectra for 5 compact ETGs at z~1.4 to measure their velocity dispersions.



8100 Å   10000 Å

TECHNICAL INFO:

Multi Object Spectroscopy (MXU)

GRISM : 600z (7300-10700 Å) to sample the Ca H+K doublet

SLIT : 1"

MEDIUM RESOLUTION: R = 1400 (~ 7 Å at 9000 Å)

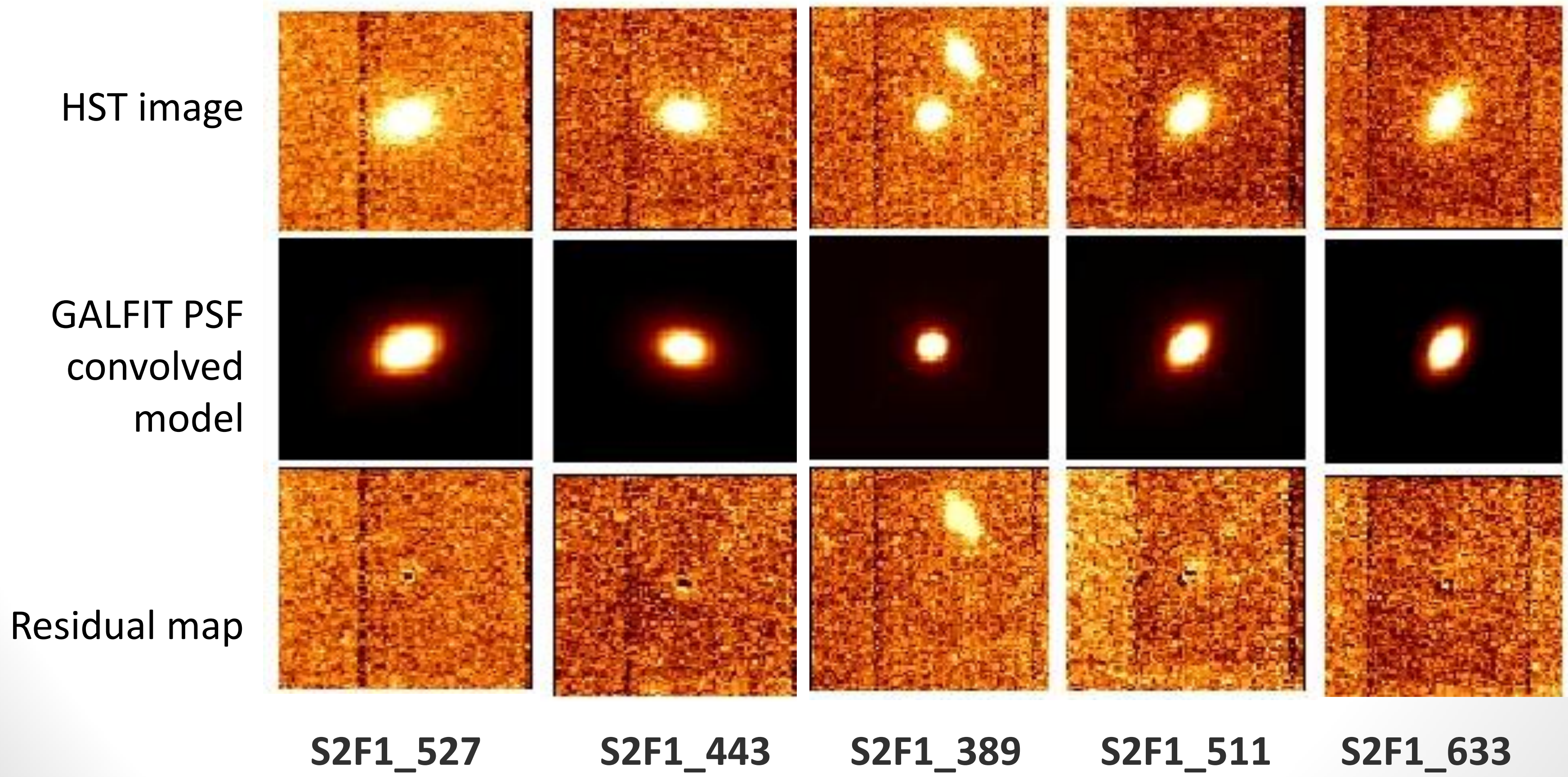
TOTAL INTEGRATION TIME : ~10 hours

S/N per pixel= 8 -10

The sample and the available data

5 ETGs with:

- HST-NIC2 imaging (0.075 "/px, S/N > 3 at $3R_e$) (Longhetti et al. 2007)
- Munich Near-IR Cluster Survey multiband photometry (Drory et al. 2001)
  → Stellar mass M* (Longhetti et al. 2005)



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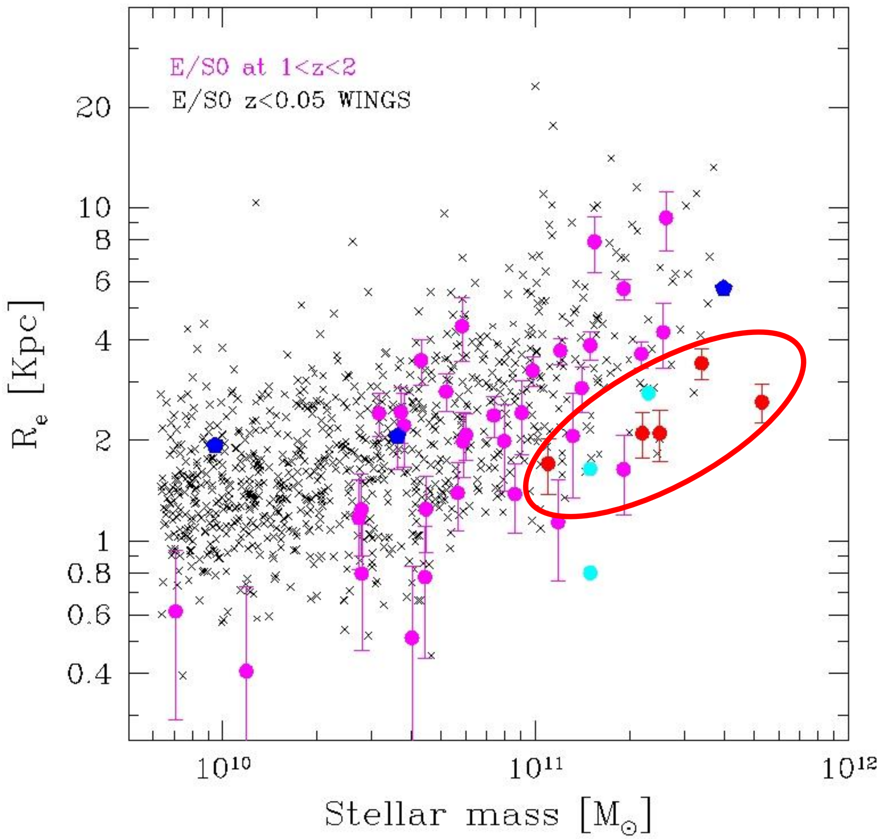
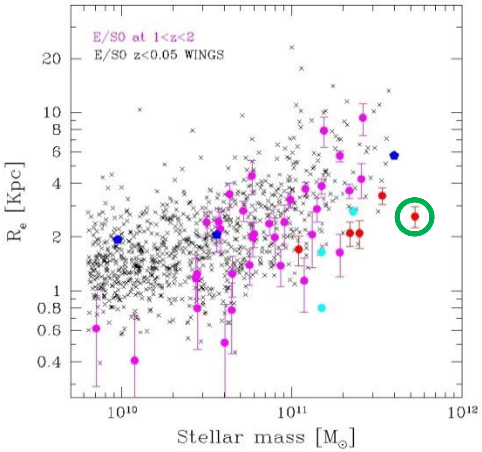
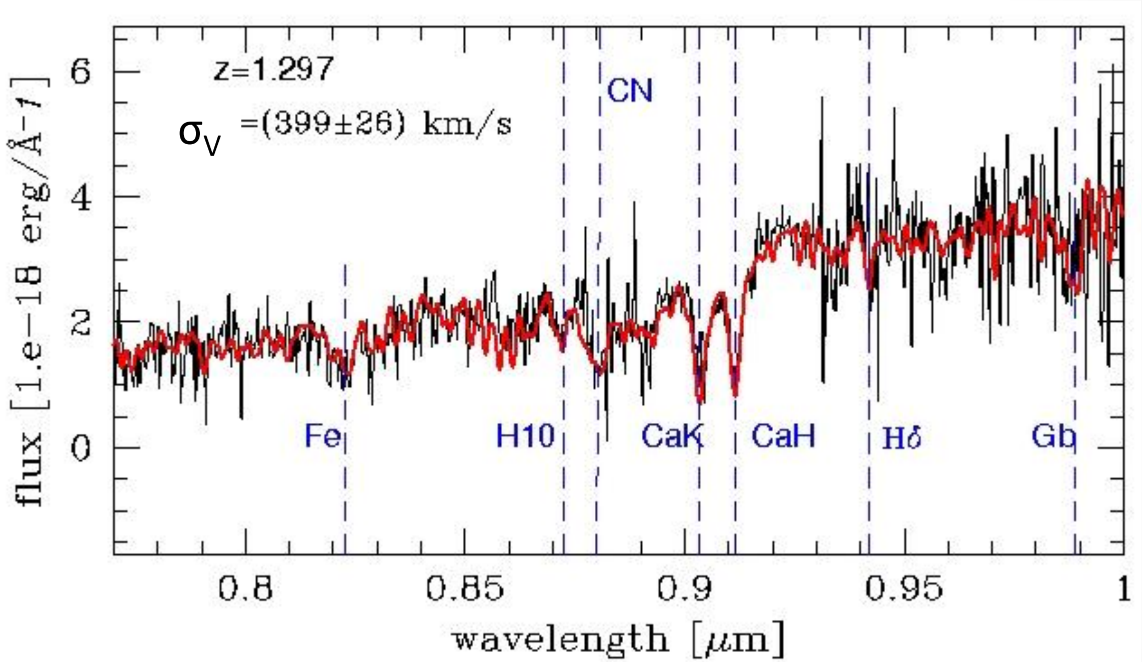


Results

Galaxy S2F1_633

Gargiulo et al. 2012 in preparation





R_e = 2.6 kpc
M^* = 5.3 x 10^{11} M_{sol}

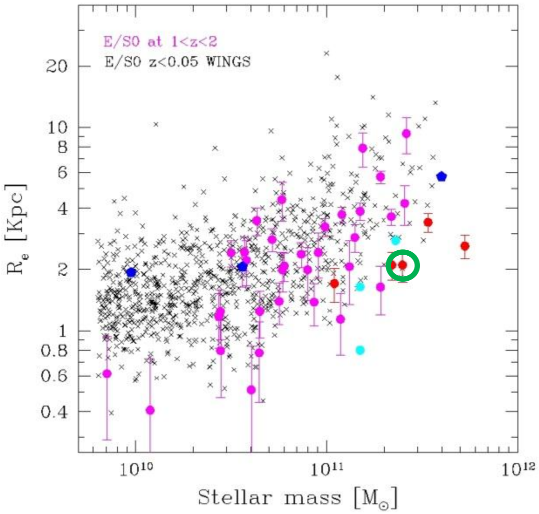
Unsmoothed and not rebinned spectrum
Best fit model

σ_V = 399 ± 26 km/s

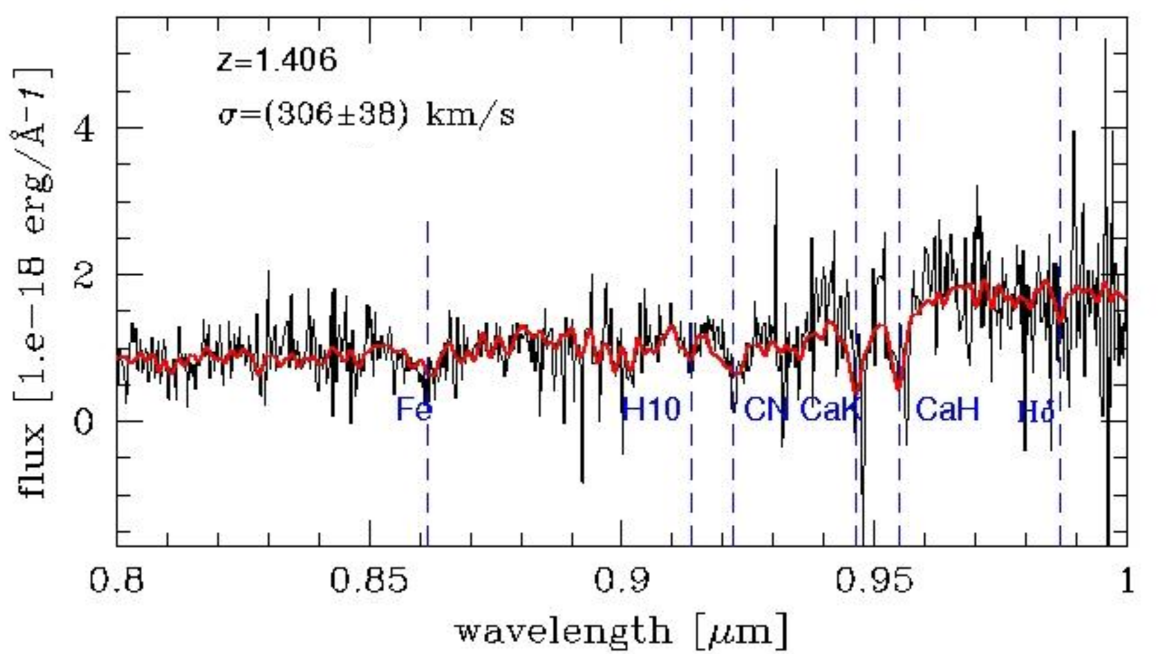
in agreement with the σ expected scaling to our R_e and M* the Cappellari et al. velocity dispersion derived for normal ETGs at the same redshift (σ_{exp} = 417 km/s) , in the hypothesis that ETGs are virialized systems.

Results

Galaxy S2F1_389



M* = 2.5 x 10^{11} M_{sol}

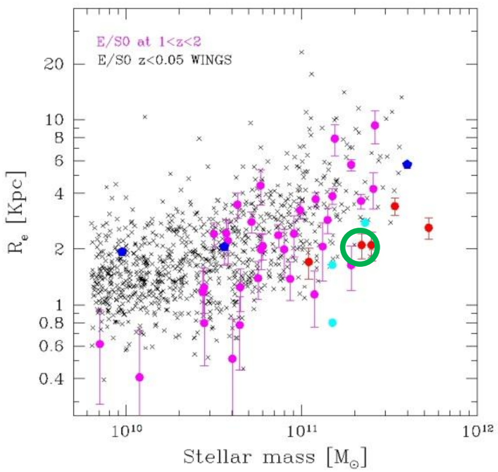


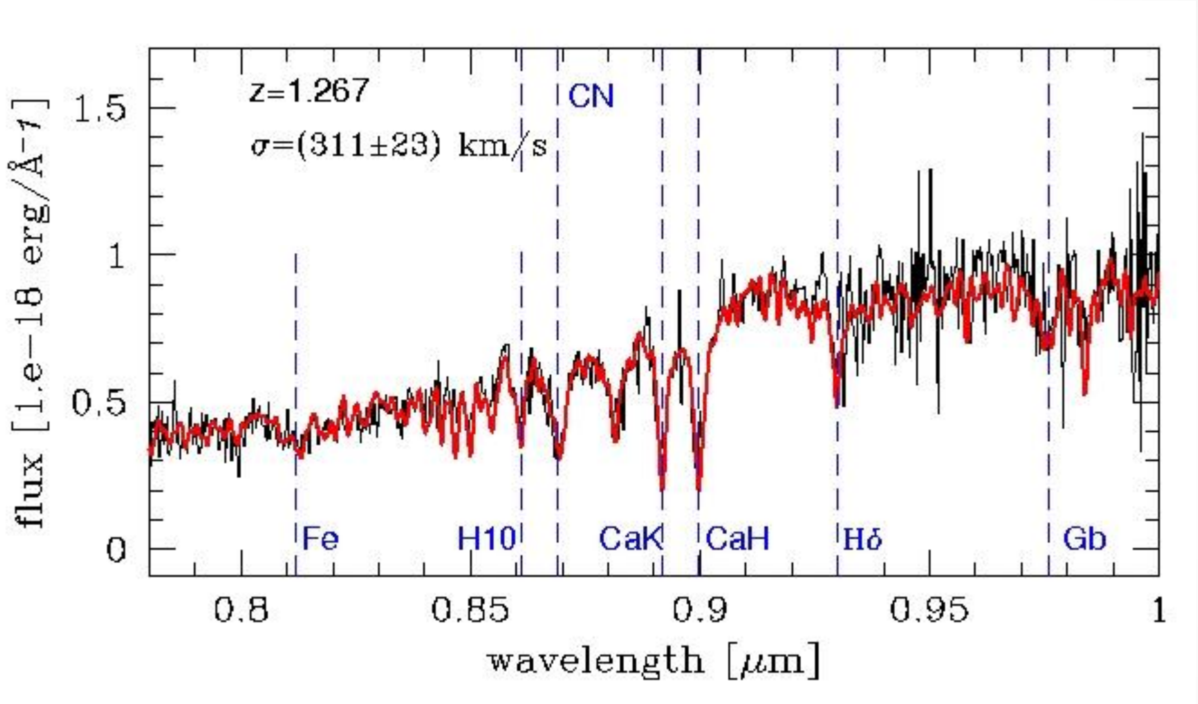
σ_V = 306 ± 38 km/s

in agreement with σ_{exp} = 322 km/s

Results

Galaxy S2F1_511





R_e = 2.07 kpc
M^* = 2.2 x 10^{11} M_{sol}

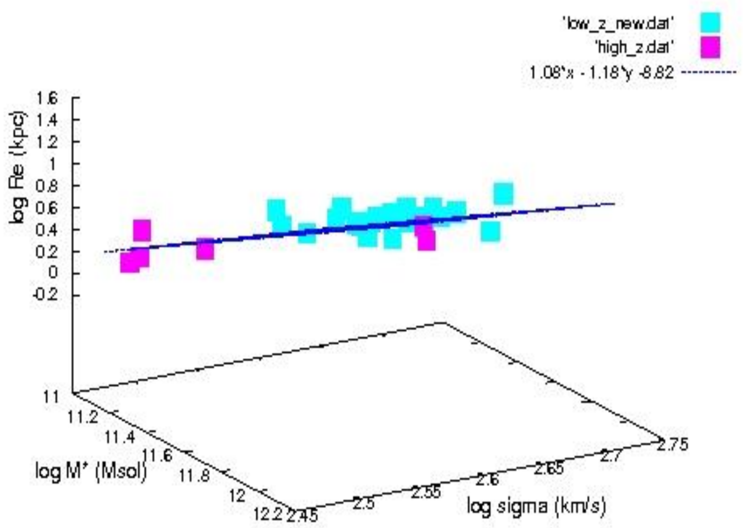
σ_V = 311 ± 23 km/s
in agreement with σ_{exp} = 302 km/s

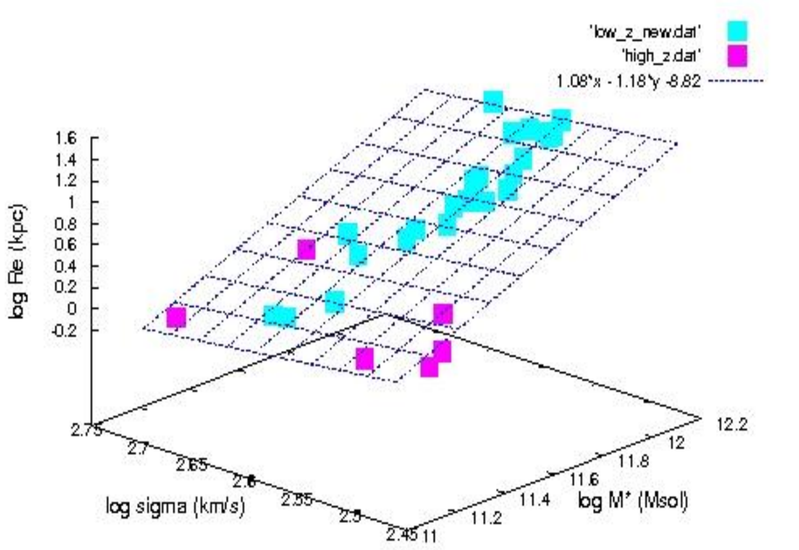
Conclusions…

- We obtained FORS2 spectra for 5 compact ETGs at high redshift to measure their velocity dispersions;
- These measures allow, for the first time, to directly and homogeneously (almost same instrumental set-up, same software, same spectral libraries) compare the velocity dispersions of compact and normal ETGs at the same redshift.
- **Our results firmly establish that compact high-z ETGs are denser and virialized stellar systems.**

…and some hints.

High-z compact ETGs identify a plane in the space defined by logR_e, log M*, and log σ.





To perform a first comparison with local data, we select a sample of local ETGs with velocity dispersions similar to those of high-z compact ETGs : local BCGs of Bernardi et al. (σ>350km/s) → they lay on the same plane of high-z compact ETGs.

Possible evolution of compact/normal high-z ETGs in compact/normal low-z ETGs ?

Thank you!