GTC Velocity Dispersions of the Most Compact and Massive ETGs at z~1

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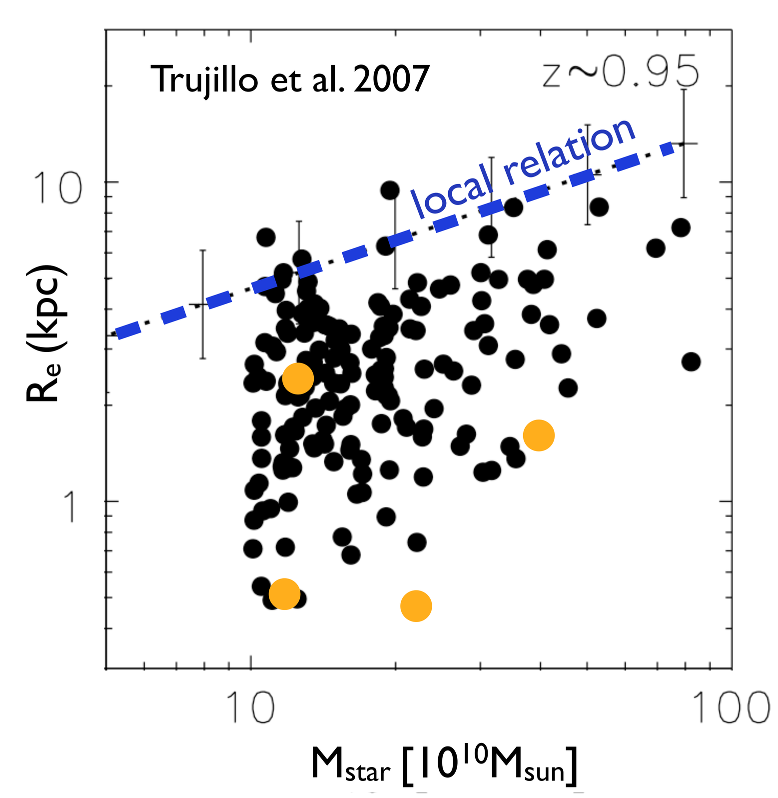
ABSTRACT

We present Gran-Telescopio-Canarias/OSIRIS optical spectra of 4 of the most compact and massive early-type galaxies in the Groth Strip Survey at redshift z~1, with effective radii R_e=0.5-2.4 kpc and photometric stellar masses M_{star}=1.2-4x10^{11} M_{sun}. We find these galaxies have velocity dispersions σ=156-236 kms. The spectra are well fitted by single stellar population models with approximately 1 Gyr of age and solar metallicity. We conclude that: i) the dynamical masses of these galaxies are systematically smaller by a factor of ~6 than the published stellar masses; ii) when estimating stellar masses as 0.7xM_{dyn}, a combination of passive luminosity fading with mass/size growth due to minor mergers can plausibly evolve our objects to match the properties of the local population of early-type galaxies.

The question

The observed stellar mass-size relation shows that at a given mass, early-type galaxies at z=1 are on average 2 times smaller in radius than their local counterparts (Trujillo et al. 2011). However, for the most massive and compact population (R_e < 1 kpc, M_{star} > 10^{11} M_{sun}), this factor is in the range of 5-10.

How can these high-z massive galaxies experience such a dramatic growth in size without significantly increasing their stellar mass?

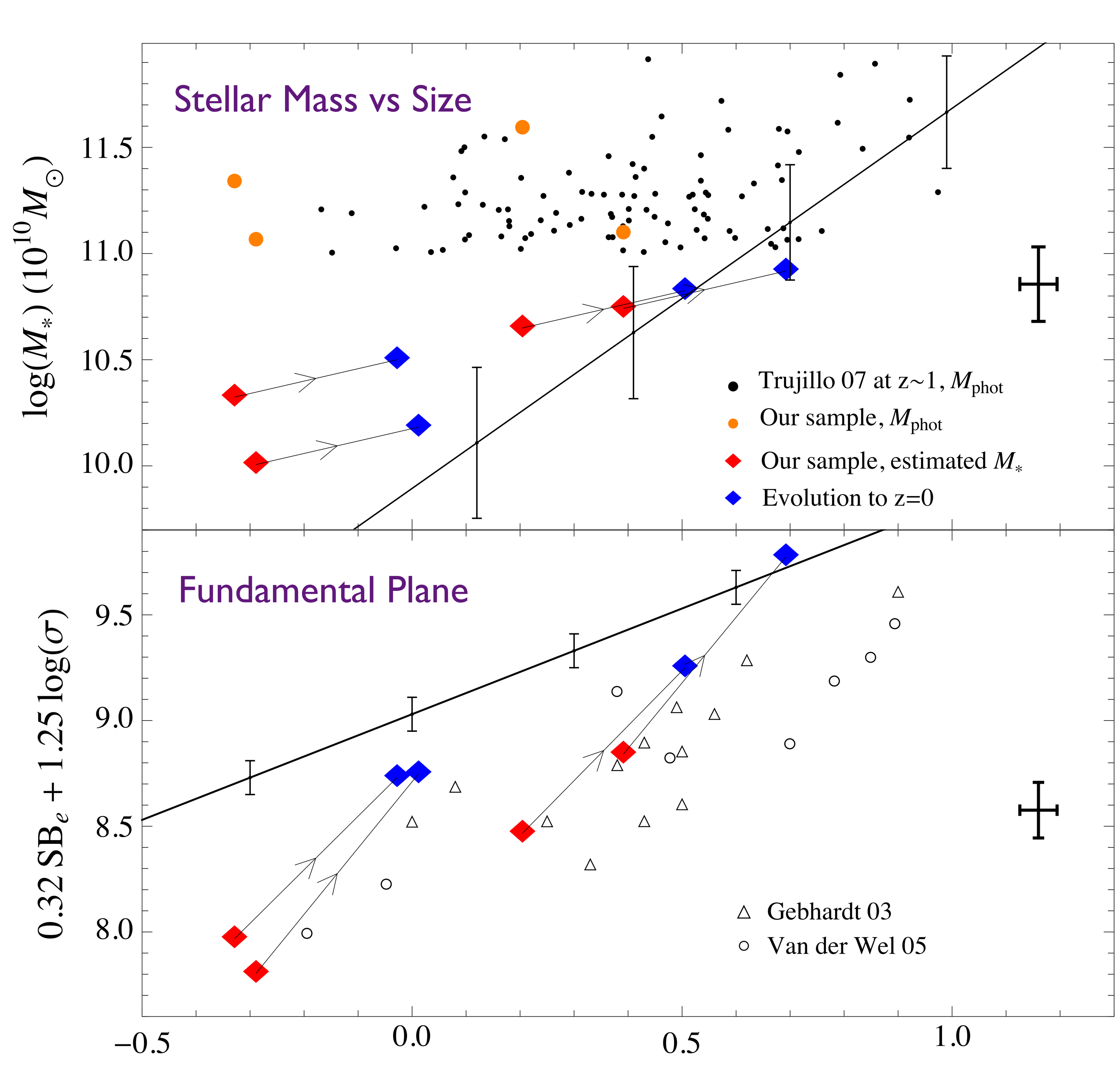


Our findings

From our σ measurements we derive dynamical masses that are, on average, a factor of **6 smaller** than the published stellar masses. Thus, for our analysis we estimate their stellar masses as M_{star}=0.7xM_{dyn}.(Gavazzi et al. 2007).

Our σ measurements place these galaxies on the same fundamental plane as the one defined by normal early-type galaxies at z~1 (e.g. Gebhardt et al. 2003; van der Wel et al. 2005).

In order to model the evolution of our galaxies to z=0, we consider a scenario of passive luminosity evolution combined with minor merger growth. For the minor merger model, we apply a 50% of total increase in mass for each galaxy following Naab et al. (2009). We find that with this simple scenario our galaxies evolve to positions consistent with the local population in **both** the Mass-Size and Fundamental Plane relations.

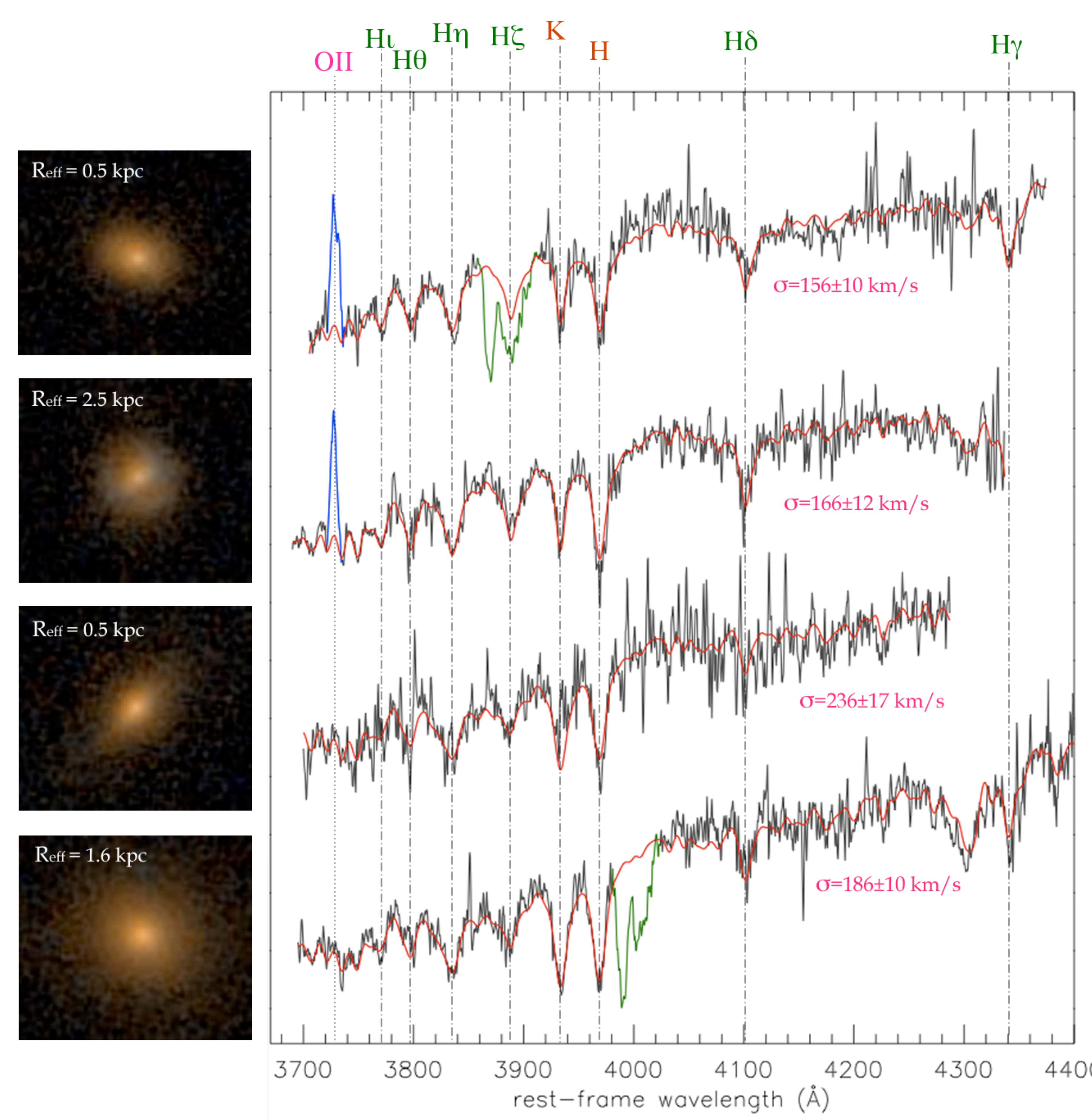


Our data

We have observed with the OSIRIS spectrograph at GTC four of the most compact and massive early-type galaxies in Trujillo et al. (2007)'s sample at redshift ~1 (see left). Their stellar masses and effective radii range from 1.2 to 4x10^{11} M_{sun} and 0.5 to 2.5 kpc, respectively, with magnitudes I(AB)~21.5. Each target was observed for 3.5 hrs with R1000R, yielding a spectral range of 5000-10000Å with FWHM~7Å.

The spectra have S/N~27 Å per pixel and are well fitted by SSP templates of approximately 1 Gyr of age and solar metallicity.

We find velocity dispersions in the range of σ=156-236 km/s. These measurements contrast with previous measurements of similar of objects at z~2 that yielded σ~500 km/s (Van Dokkum et al. 2009).



Conclusions

✦ Our sample of 4 compact and massive early-type galaxies at z=1 has on average σ=186 km/s.

✦ Our σ's yield dynamical masses that are on average **6 times** smaller than the previously published photometric stellar masses. At fixed dynamical mass these galaxies are just ~2 times smaller in radius than their local counterparts. This result alleviates the need for a dramatic size evolution of these objects.

✦ We model the evolution of our galaxies to z=0 by a combination of passive luminosity fading and minor dry mergers. This simple and plausible model brings our galaxies to lie consistent with the normal local population in the Mass-Size and Fundamental Plane relations.

References

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