

Testing the minor merger scenario: outskirts of elliptical galaxies

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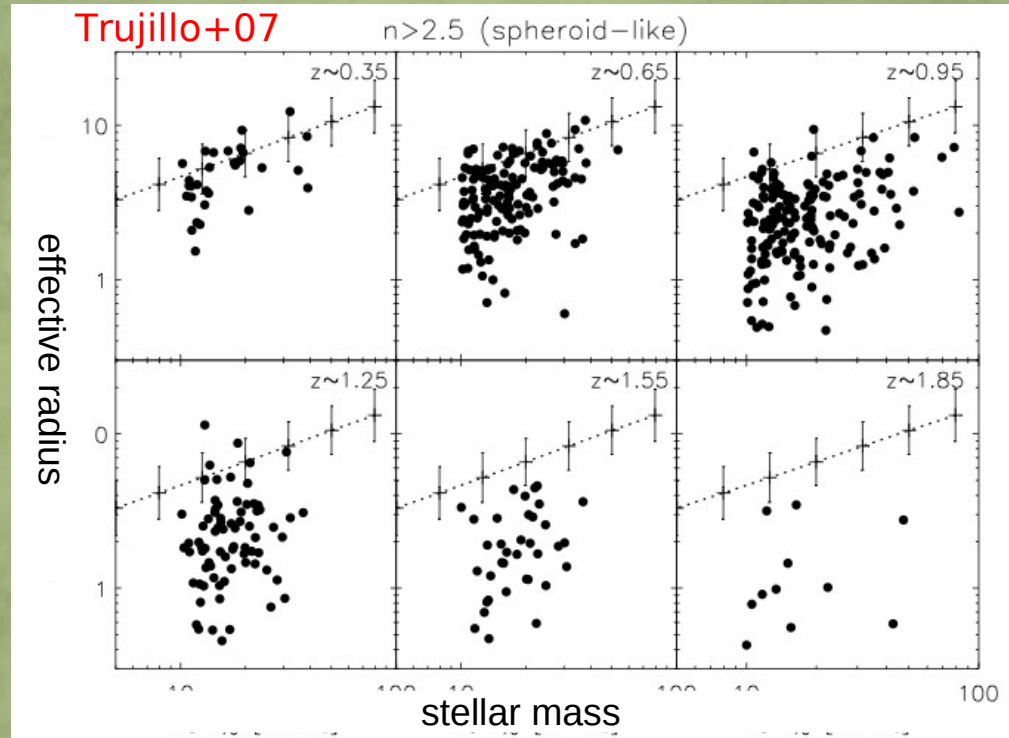
J. Fliri



J. Bakos



Size evolution of massive galaxies



Also found by e.g.: Daddi+05, Zirm+07; Toft+07; Longhetti+07; Buitrago+08; Cimatti+08; Damjanov+08; van Dokkum+08; Cassata09; Saracco+09; Toft+09; Szomoru+10; Willimiams+10; McLure+13

Which is the mechanism that these high- z galaxies follows to reach the current sizes?

Possible scenarios

Mayor (dry) mergers

(e.g. Khochfar & Silk 06
Naab et al. 07)



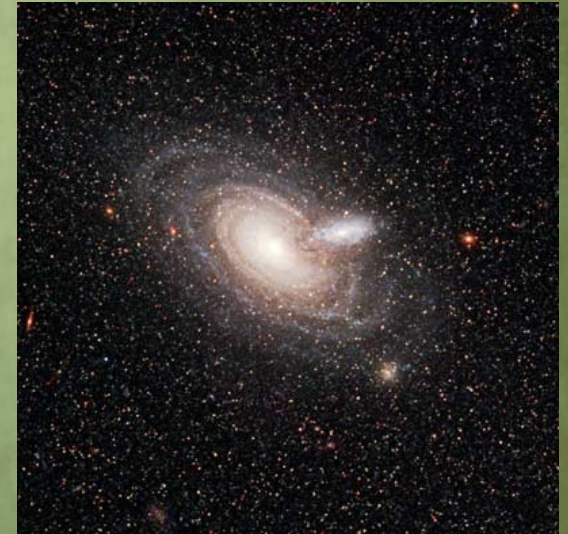
Puffing-up

(Fan+08,10;
Ragone-Figueroa+11)



Minor mergers

(e.g. Khochfar&Burket 06,
Hopkins+09; Oser+10)



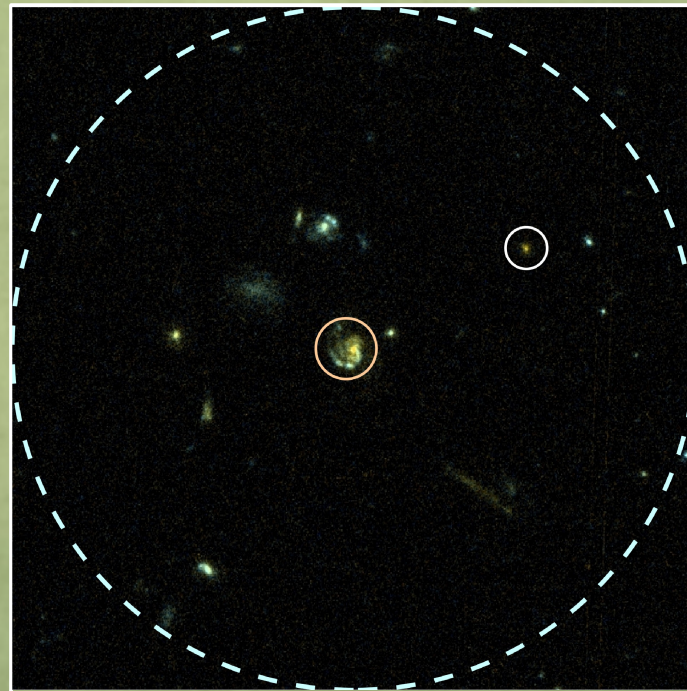
Minor merging scenario? Searching for satellites



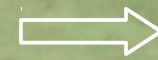
$R < 100$ kpc

1:10 (1:100)

$\Delta z = 0.068$

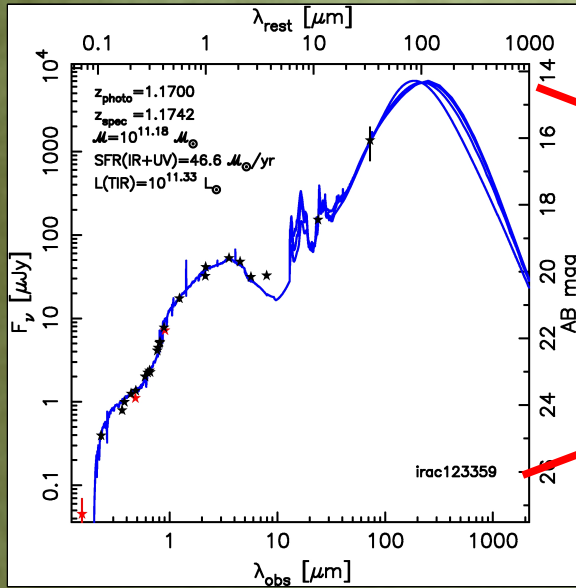


Minor merging scenario? Searching for satellites

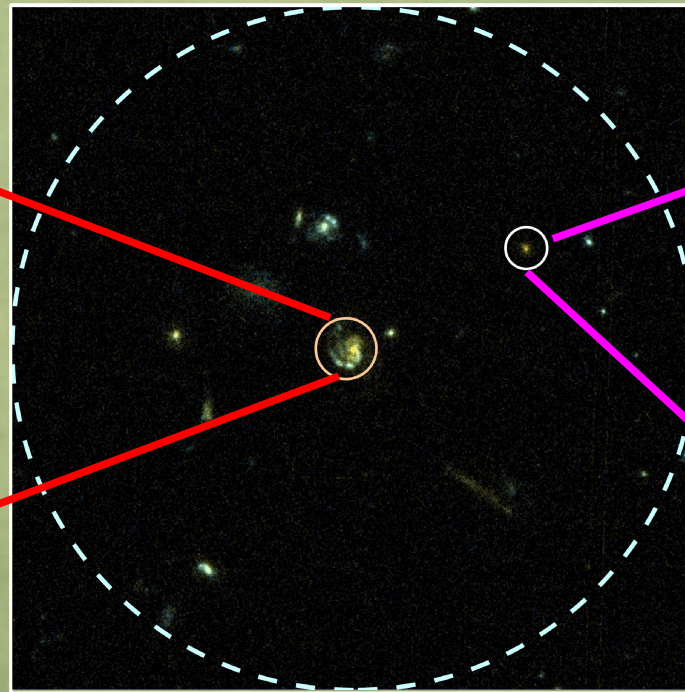


$R < 100$ kpc
1:10 (1:100)
 $\Delta z = 0.068$

Massive galaxy

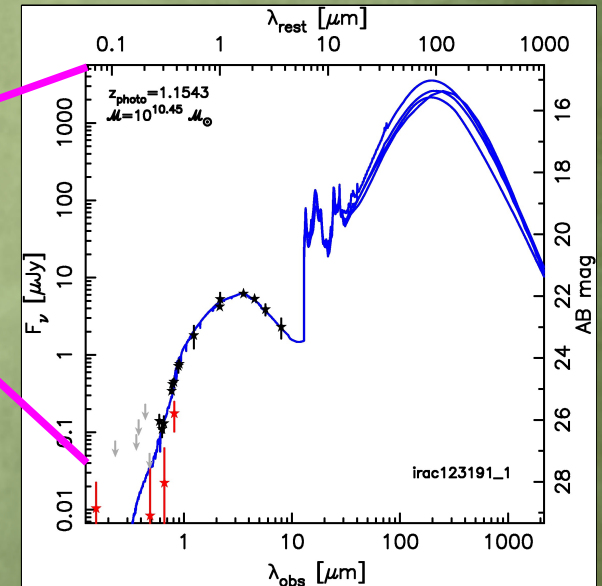


629 massive galaxies
from Trujillo+07



$0.2 < z < 2.0$

Satellite

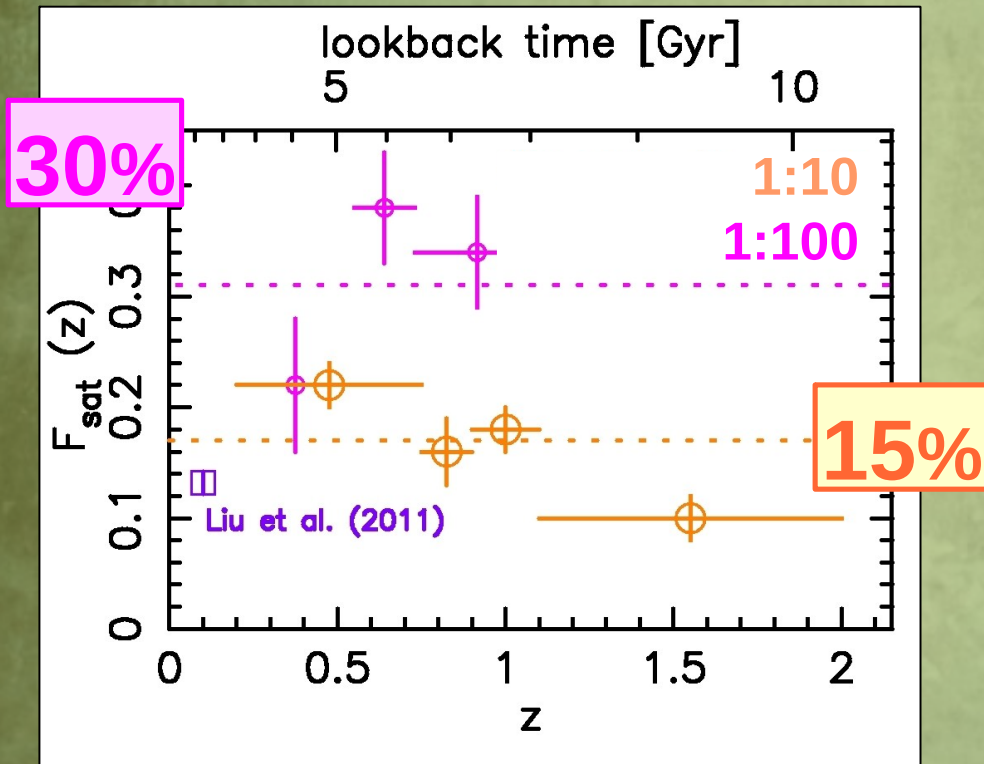


Pérez-González+08
Barro+11a,b



Toward the minor merging scenario?

Mármol-Queraltó+12a

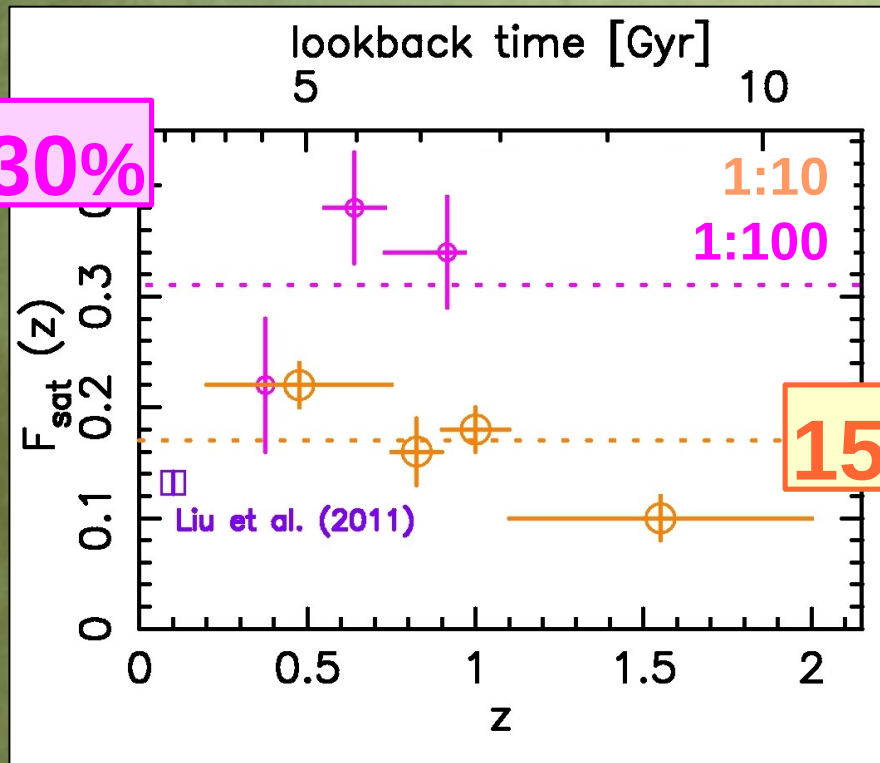


Not change since $z \sim 2$

In agreement with observations by:
Williams+11 (6 – 20 % $0.4 < z < 2$)
Newman +12 (13-18 % in $0.4 < z < 2$)

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Mármol-Queraltó+12a



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Number of expected mergers

$$N_m = T(z) F_{\text{sat}} / \tau_m$$

- $T(z)$: interval of cosmic time until now
- τ_m : merging time-scale
(e.g. 1.5 Gyr; Lotz et al. 2011)

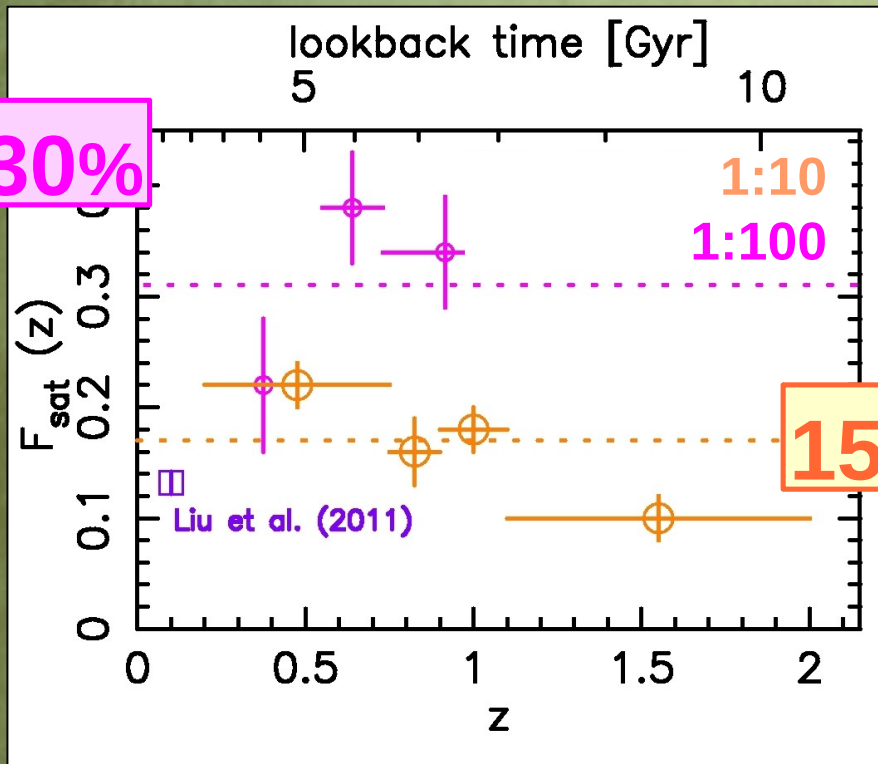


$N_m \sim 1$ since $z \sim 2$

$N_m \sim 1.5$ since $z \sim 1$

Toward the minor merging scenario?

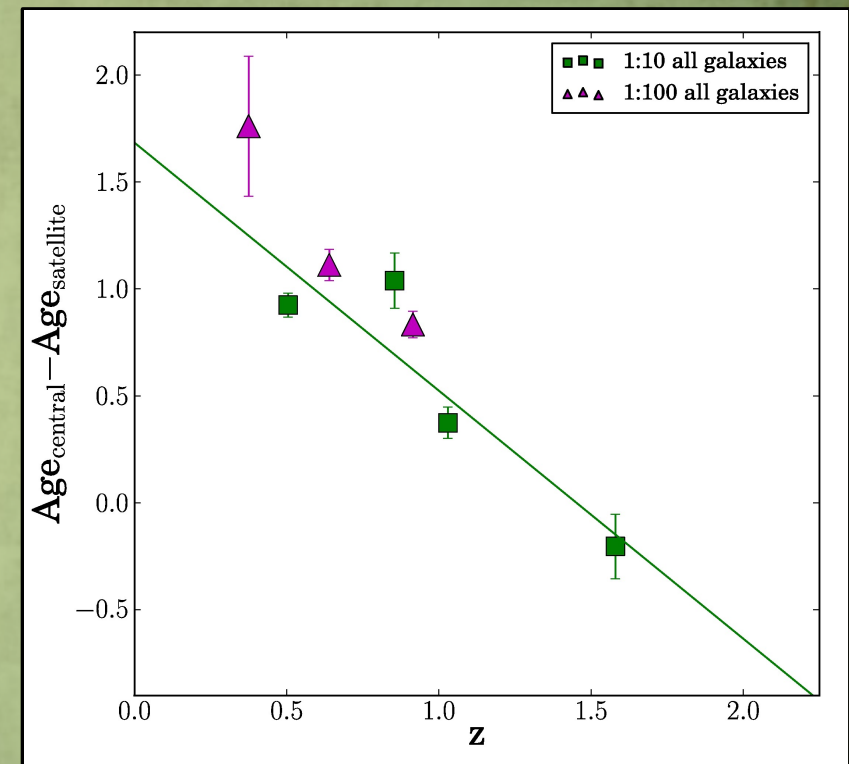
Mármol-Queraltó+12a



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Mármol-Queraltó+2012b



Satellites are 1.5 Gyr younger than massive galaxies at low z

Imprints of the satellites in the outskirts of local massive galaxies?

Data in the Stripe82



Region between $-1.25 < \text{dec} < 1.25$ deg and $-59 < \text{RA} < 50$ deg
Total area ~ 270 square degrees

Observed up to 80 times as part of the SDSS Supernovae and Legacy Surveys

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New data reduction

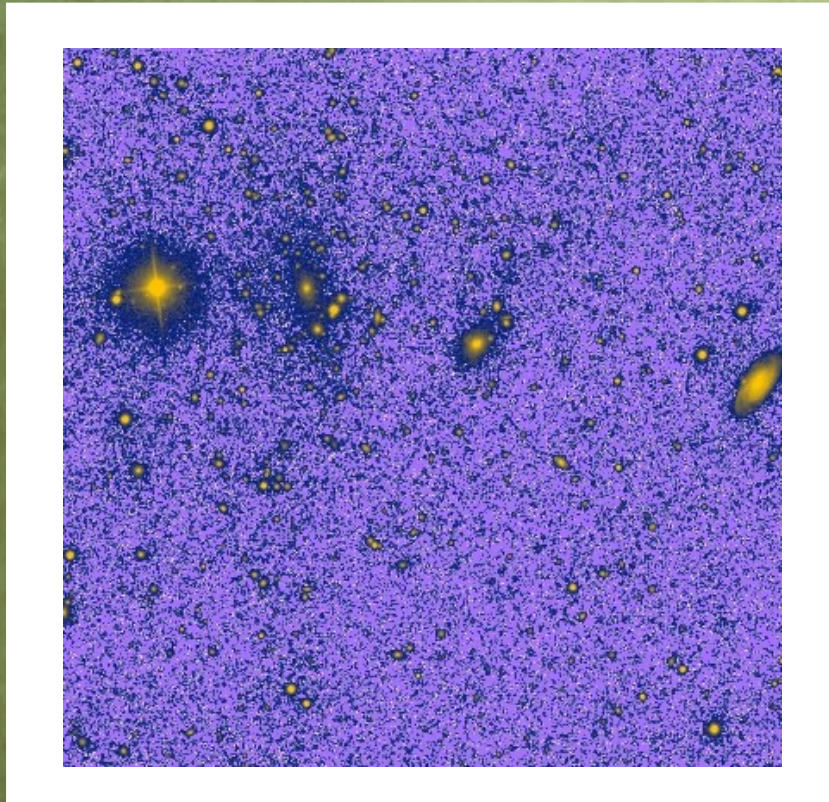
Fliri & Trujillo, in prep.

- ⇒ Deep coadds produced by a fully automatic reduction pipeline
(independent to Annis+11)
- ⇒ Typically 1200 images per band and 0.25 square degree field of the final data product: coadds, weight maps, PSF, (completeness maps)
- ⇒ Pipeline includes
 - photometric alignment
 - object masking
 - sky determination and subtraction
 - statistics for each field and band for selecting the optimal images

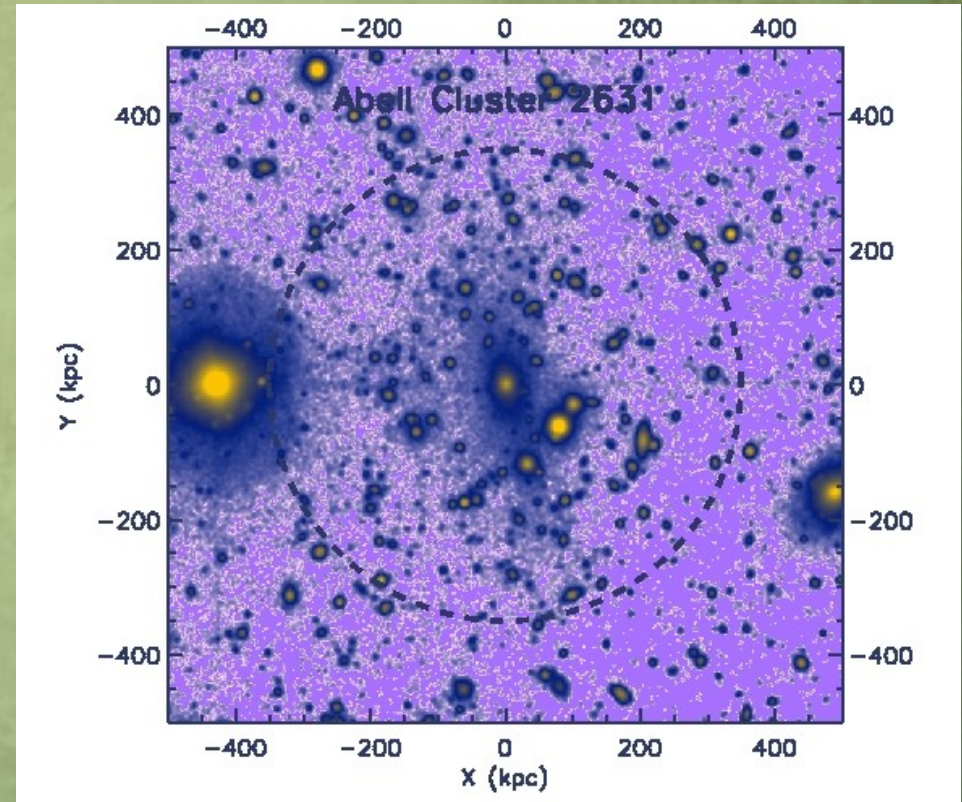
3σ SB limit ~ 27.7 mag/arcsec² (r-band)
 ~ 1.7 mag deeper than SDSS DR7

As an example: Abell 2631

Fliri & Trujillo, in prep.



DR7



Stripe82

The sample



Massive elliptical galaxies
in the Stripe 82

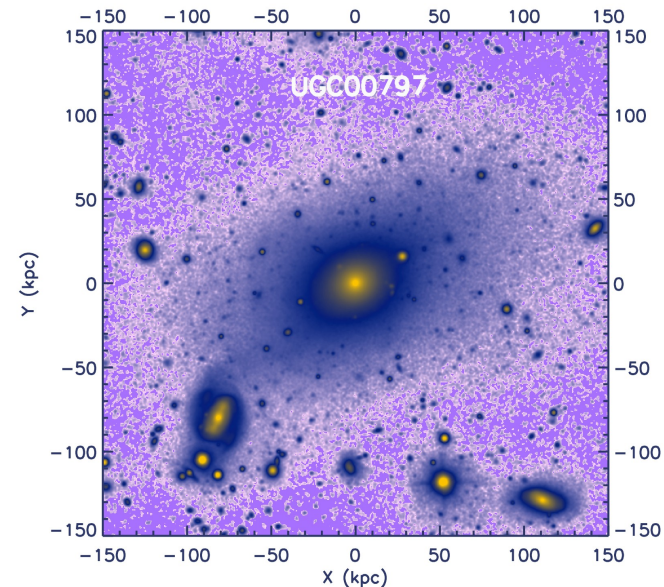
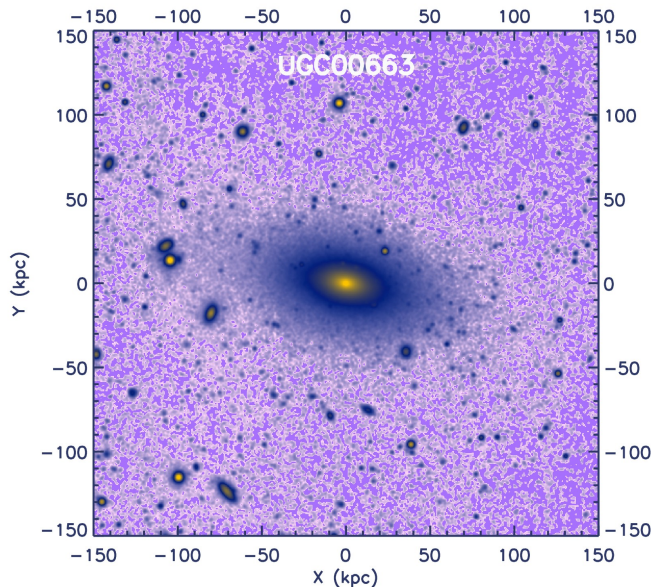
$$\left\{ \begin{array}{l} -5 < T_{\text{Hubble}} < 3.5 \\ M_{\text{abs}} < -19 \\ \sigma > 200 \text{ km/s} \end{array} \right.$$

10 nearby elliptical massive galaxies ($z < 0.06$)

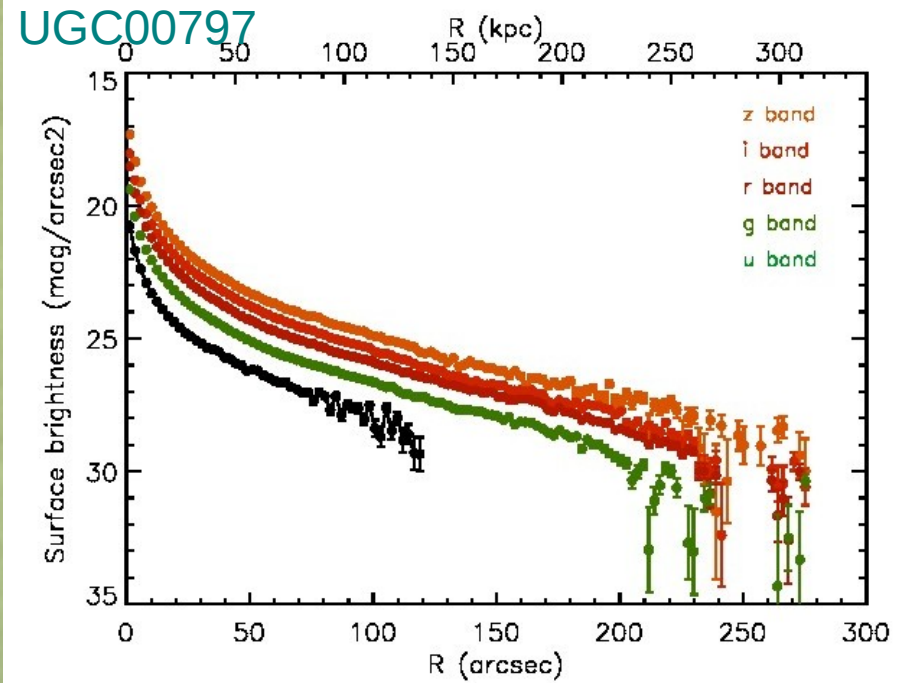
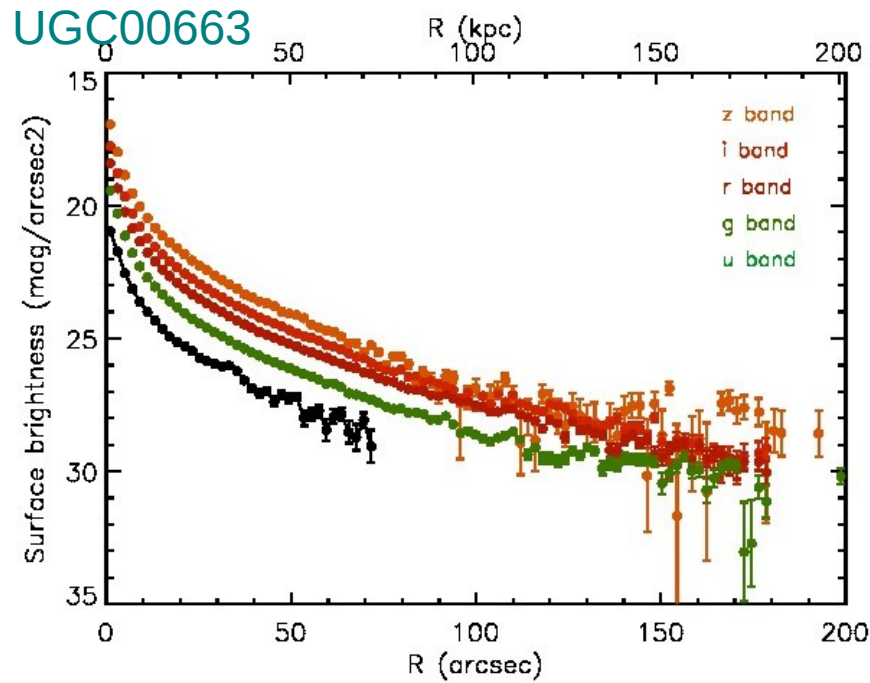
5 galaxies in the catalog of peculiar galaxies of Kaviraj10

4 relaxed systems

1 galaxy with tidal features¹ → prints of previous interactions

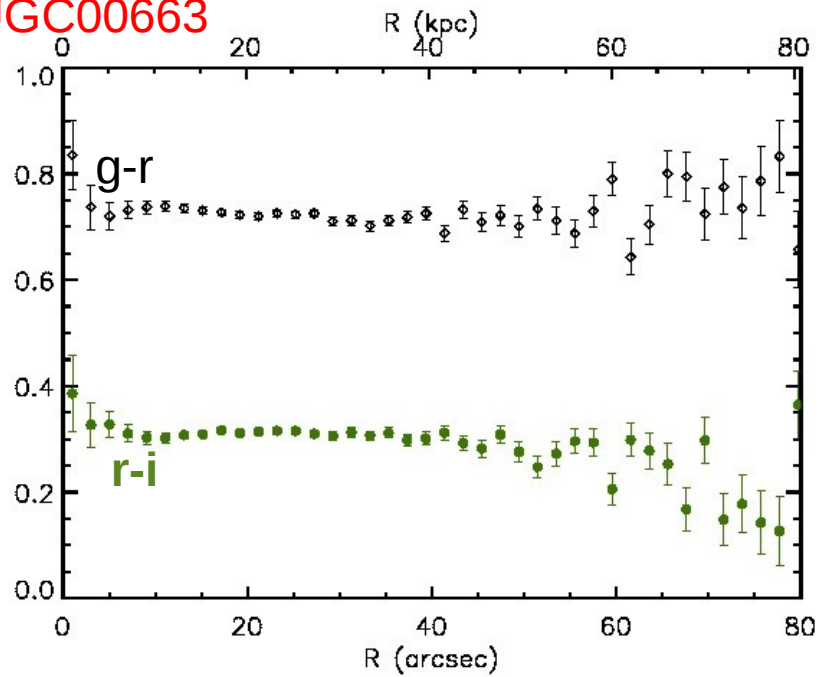


Surface brightness profiles

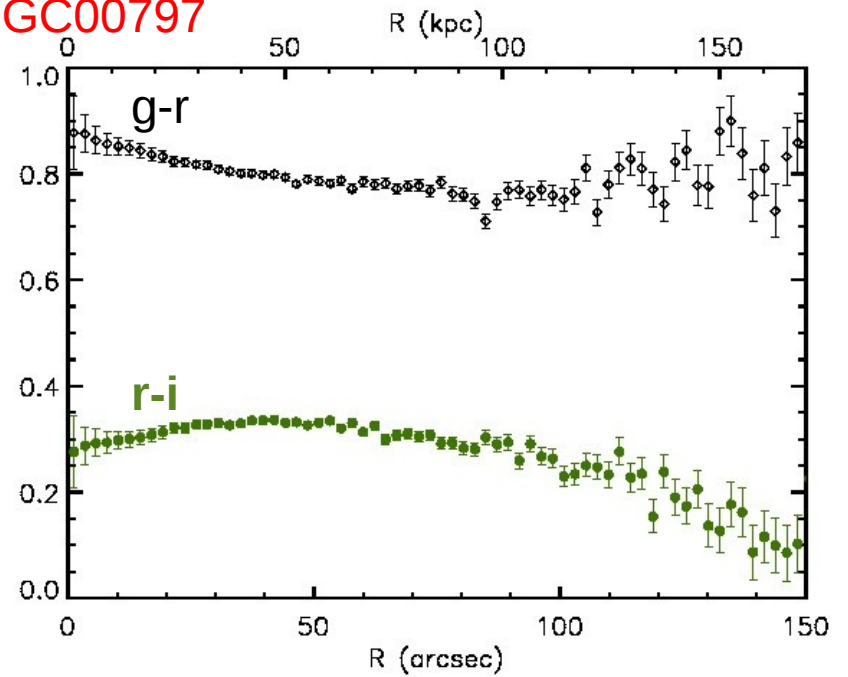


Color profiles

UGC00663



UGC00797



Summary

The fraction of massive galaxies with satellites has not change with time since $z \sim 2$

~ 15 % if $0.10 < M_{\text{sat}}/M_{\text{central}} < 1.0$ (up to $z \sim 2$)

~ 30 % if $0.01 < M_{\text{sat}}/M_{\text{central}} < 1.0$ (up to $z = 1$)

Satellites have are younger than central galaxies:
imprints in the outskirts of local massive galaxies?

Now we are ready to explore the stellar populations in
the outer parts of massive galaxies: new results coming soon

