
ARE THE MOST MASSIVE GALAXIES SUBSTANTIALLY DIFFERENT USING THE DEEPEST SURVEYS?
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In collaboration with: I. Trujillo, V. Bruce + J. Dunlop group + A. Fontana group + T. Targett, M. Montes
ASTRODEEP
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SUPA

OUTLINE & WARNINGS

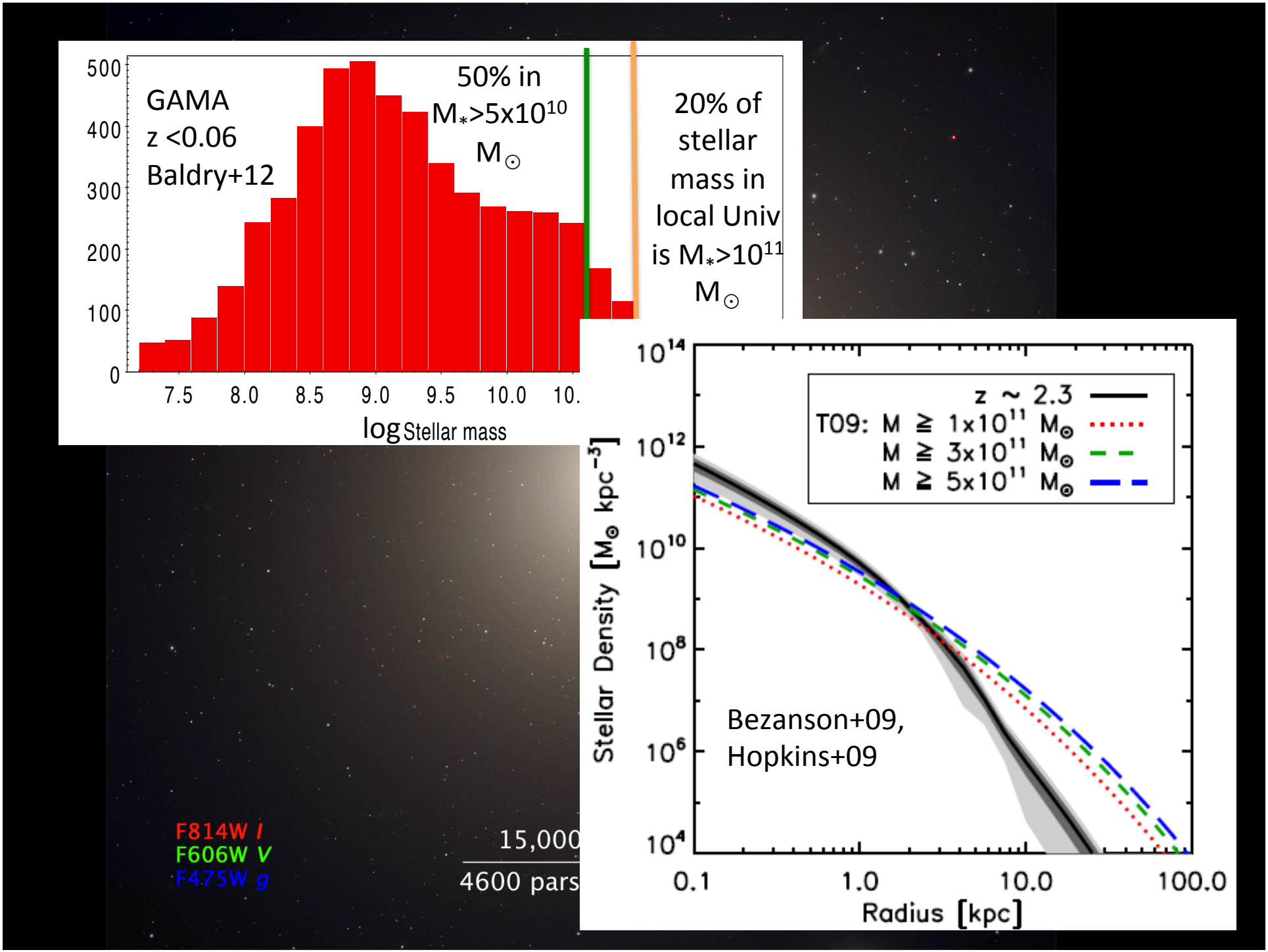
Seleccion: $M_{stellar} > 10^{11} M_{\odot}$ (and whenever spheroid-like n > 2.5)

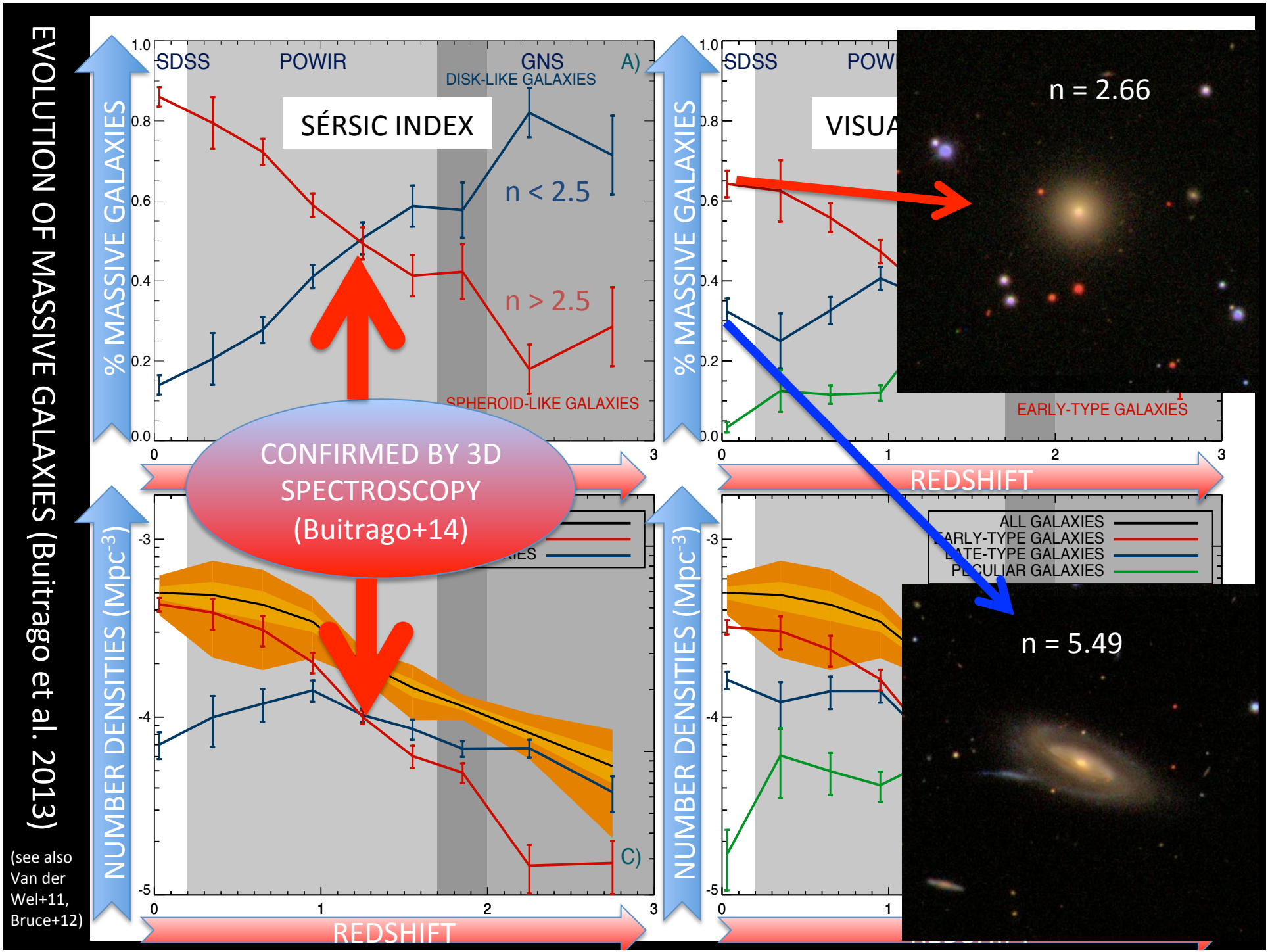
Low surface brightness and massive galaxies… interesting combination because it's where ΛCDM action takes place

Low-z first, then high-z

Please feel free to interrupt me, and I will try to promote debate throwing ideas to discuss with the public

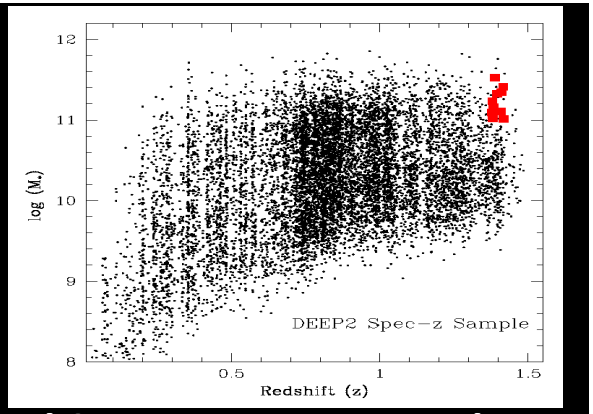
ASTRODEEP: going beyond standard photometry


GAMA
z <0.06
Baldry+12
50% in
M*>5x10^10
M⊙
20% of
stellar
mass in
local Univ
is M*>10^11
M⊙
log Stellar mass
z ~ 2.3
T09: M ≥ 1x10^11 M⊙
M ≥ 3x10^11 M⊙
M ≥ 5x10^11 M⊙
Stellar Density [M⊙ kpc^-3]
Radius [kpc]
Bezanson+09,
Hopkins+09
F814W I
F606W V
F475W g
15,000
4600 pars

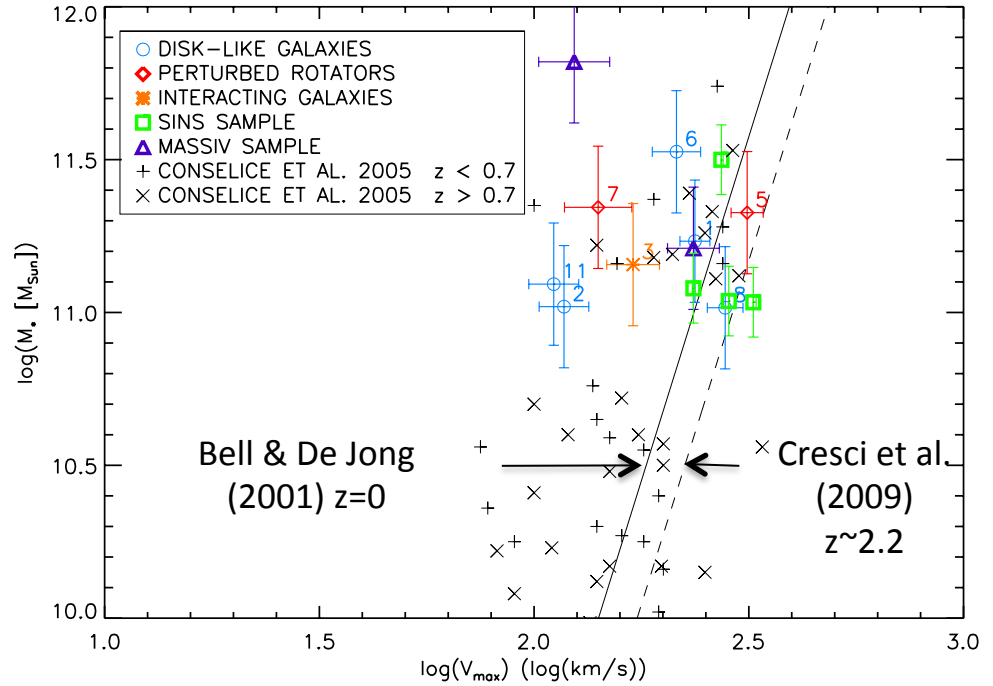

EVOLUTION OF MASSIVE GALAXIES (Buitrago et al. 2013)
(see also Van der Wel+11, Bruce+12)
% MASSIVE GALAXIES
SDSS
POWIR
GNS
A)
DISK-LIKE GALAXIES
SÉRSIC INDEX
n < 2.5
n > 2.5
SPHEROID-LIKE GALAXIES
CONFIRMED BY 3D SPECTROSCOPY (Buitrago+14)
n = 2.66
EARLY-TYPE GALAXIES
REDSHIFT
NUMBER DENSITIES (Mpc^{-3})
ALL GALAXIES
EARLY-TYPE GALAXIES
LATE-TYPE GALAXIES
PECULIAR GALAXIES
C)
n = 5.49
REDSHIFT

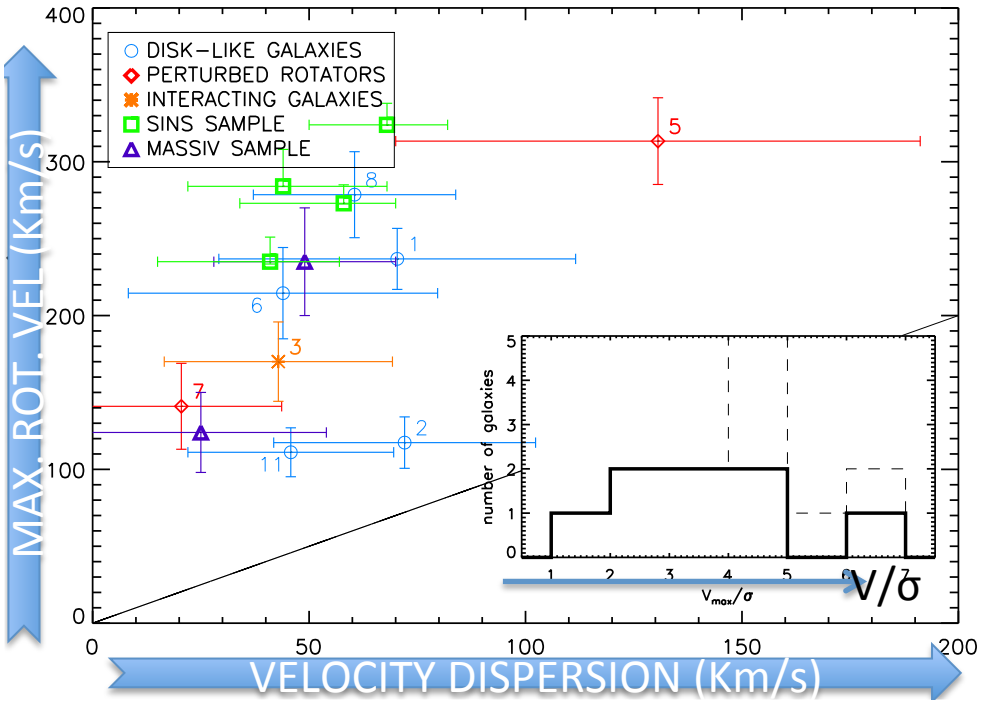
OUR SAMPLE

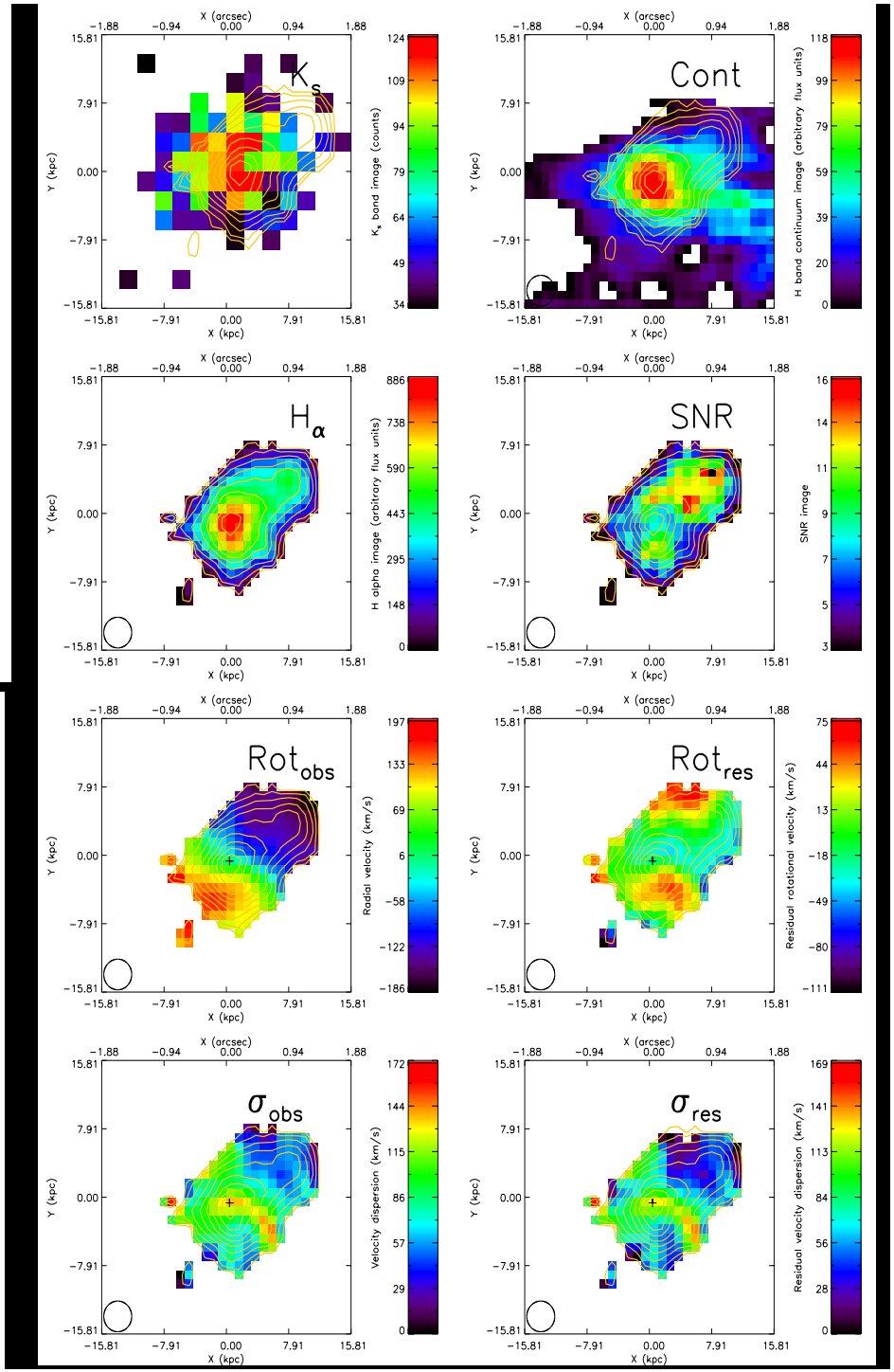
Buitrago et al. (2014)

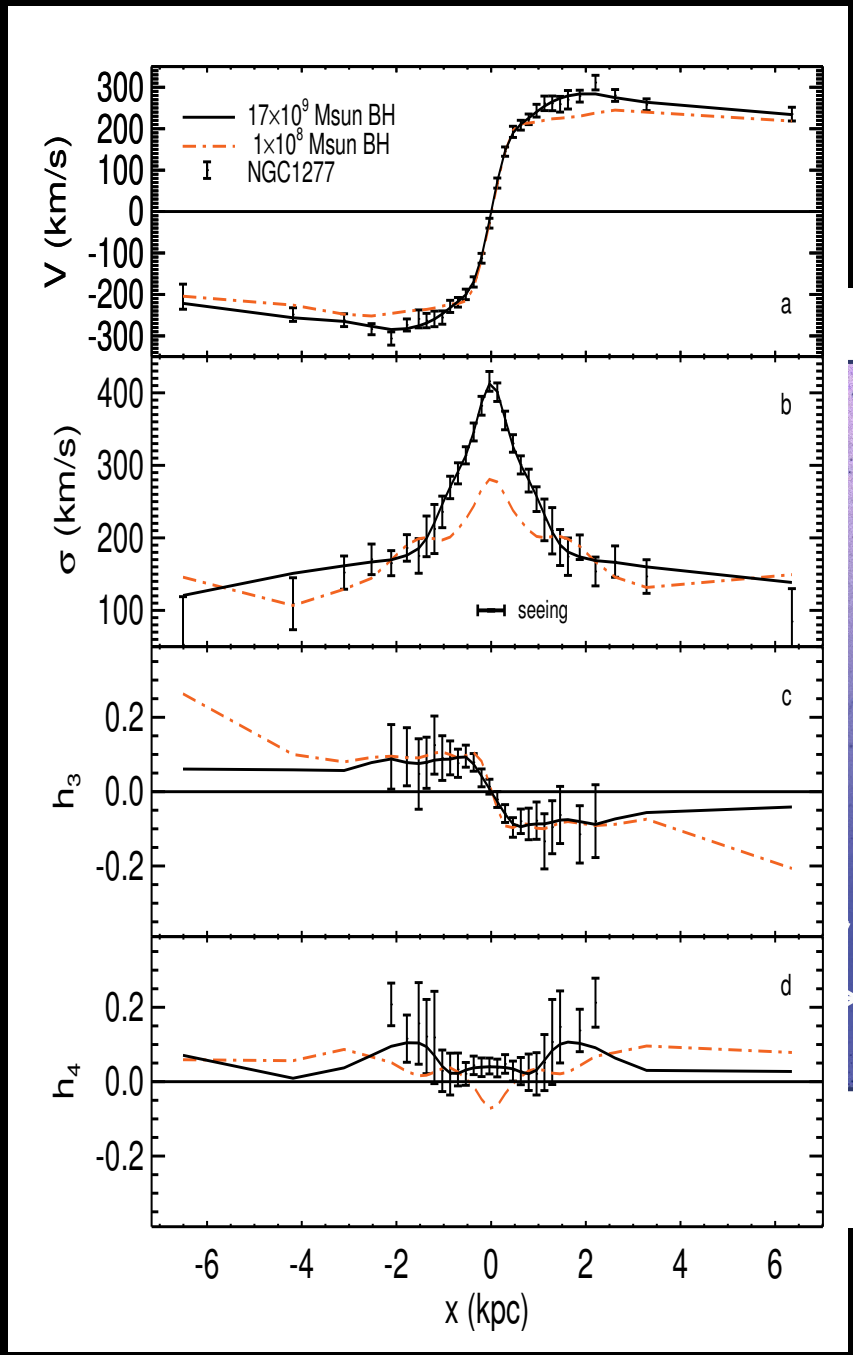


- 10 massive galaxies with z_{spec}~1.4 (from DEEP2)
- Selected solely by stellar mass & $EW_{[OII]}$> 15 Å
- Observed with SINFONI@VLT (1.5 h per object)
- H-band for mapping Hα emission
- Objectives
  -Spectroscopic confirmation of the photometric scenario (galaxy kinematics)
  -Spatial information gives insight on the mass assembly (galaxy mergers)
- Caveats
  -Emission comes from ionized gas not from the stars (but not bad agreement if the system is relaxed, i.e., Förster-Schreiber+2011)
  -Is our sample biased towards star-forming objects? Certain SFR is not unusual (Pérez-González+08, Cava+10) and our equivalent widths are as expected (in HiZELS –Sobral+11– or in 3D-HST –Fumagalli+12–)


DISK−LIKE GALAXIES
PERTURBED ROTATORS
INTERACTING GALAXIES
SINS SAMPLE
MASSIV SAMPLE
CONSELICE ET AL. 2005 z < 0.7
CONSELICE ET AL. 2005 z > 0.7
Bell & De Jong (2001) z=0
Cresci et al. (2009) z~2.2
log(M• [M$_{Sun}$])
log(V$_{max}$) (log(km/s))

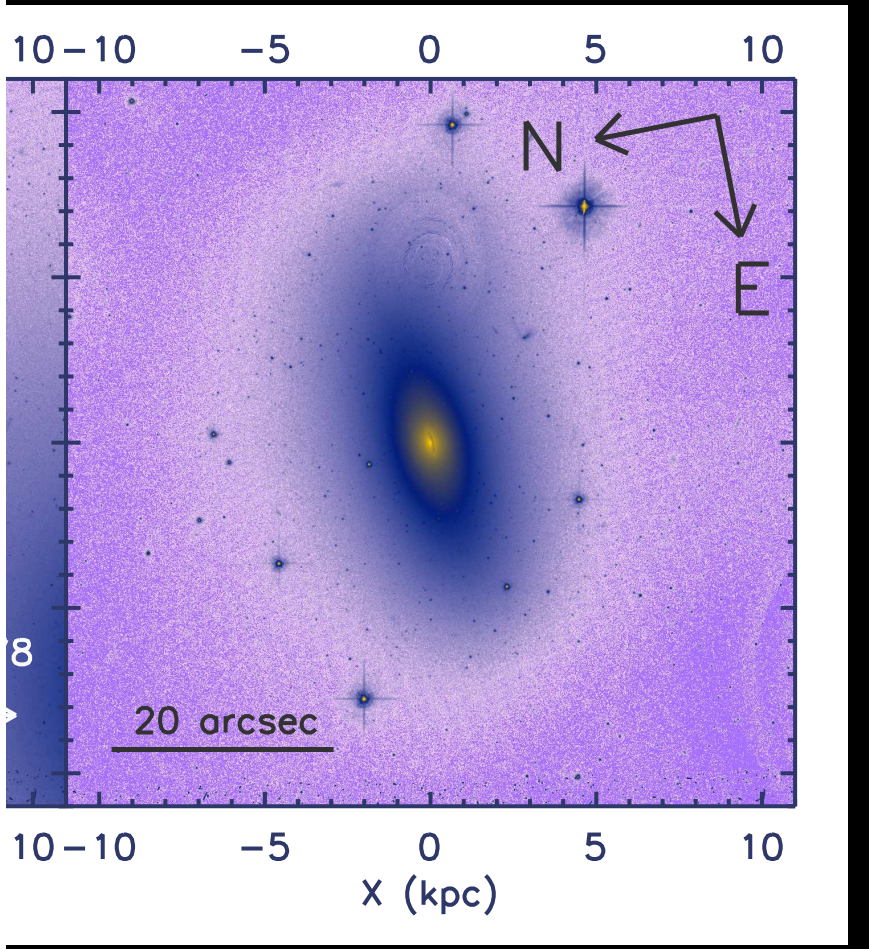

DISK−LIKE GALAXIES
PERTURBED ROTATORS
INTERACTING GALAXIES
SINS SAMPLE
MASSIV SAMPLE
MAX. ROT. VEL (Km/s)
VELOCITY DISPERSION (Km/s)
number of galaxies
V$_{max}$/σ
V/σ


K$_s$
Cont
H$_α$
SNR
Rot$_{obs}$
Rot$_{res}$
σ$_{obs}$
σ$_{res}$
X (arcsec)
X (kpc)
Y (kpc)



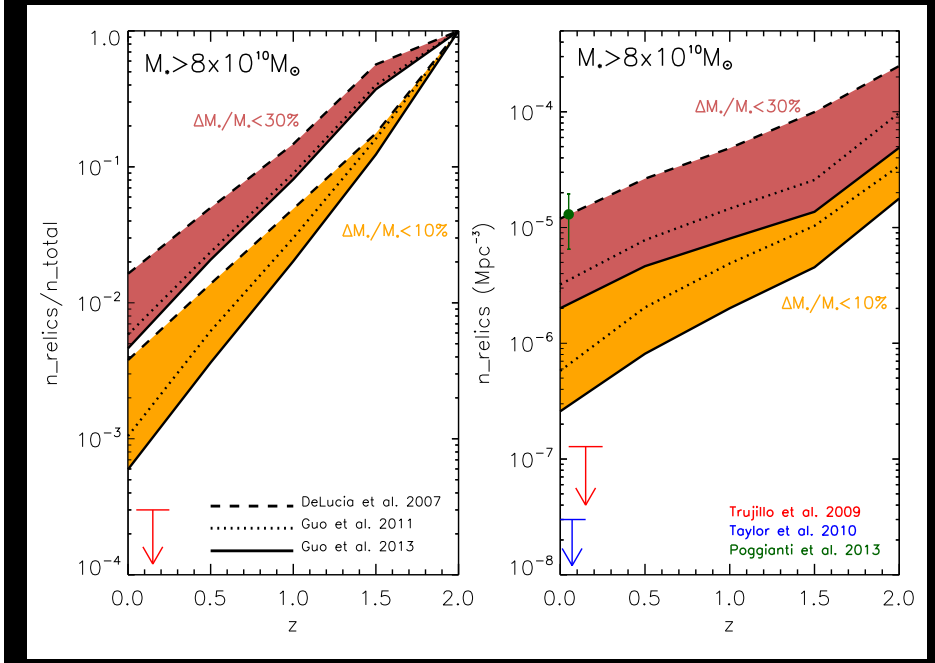
NGC1277 @ 73 Mpc

r_e=1.2 kpc, $M_{stellar}$=1.2x10^{11} $M_\odot$

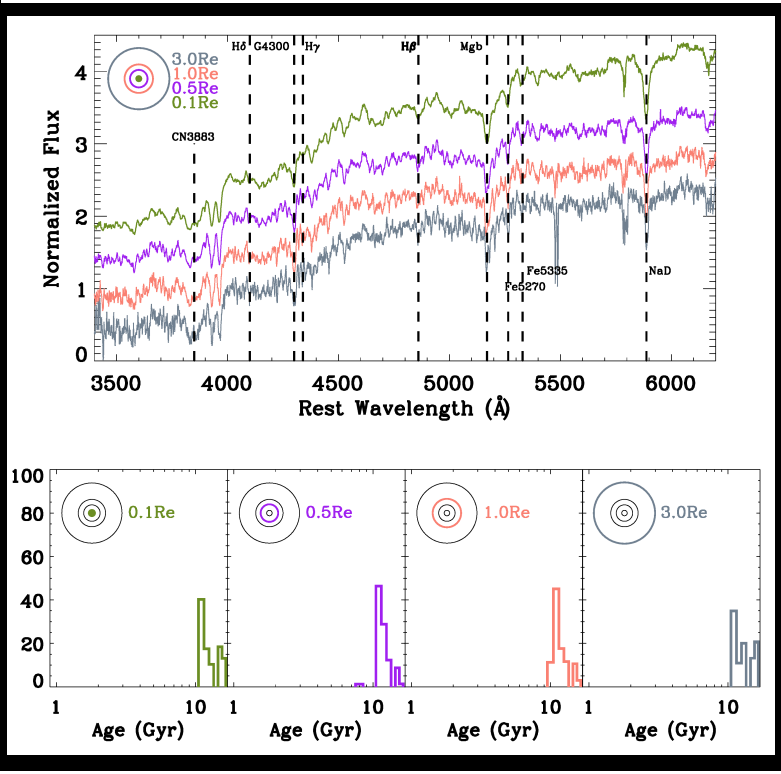


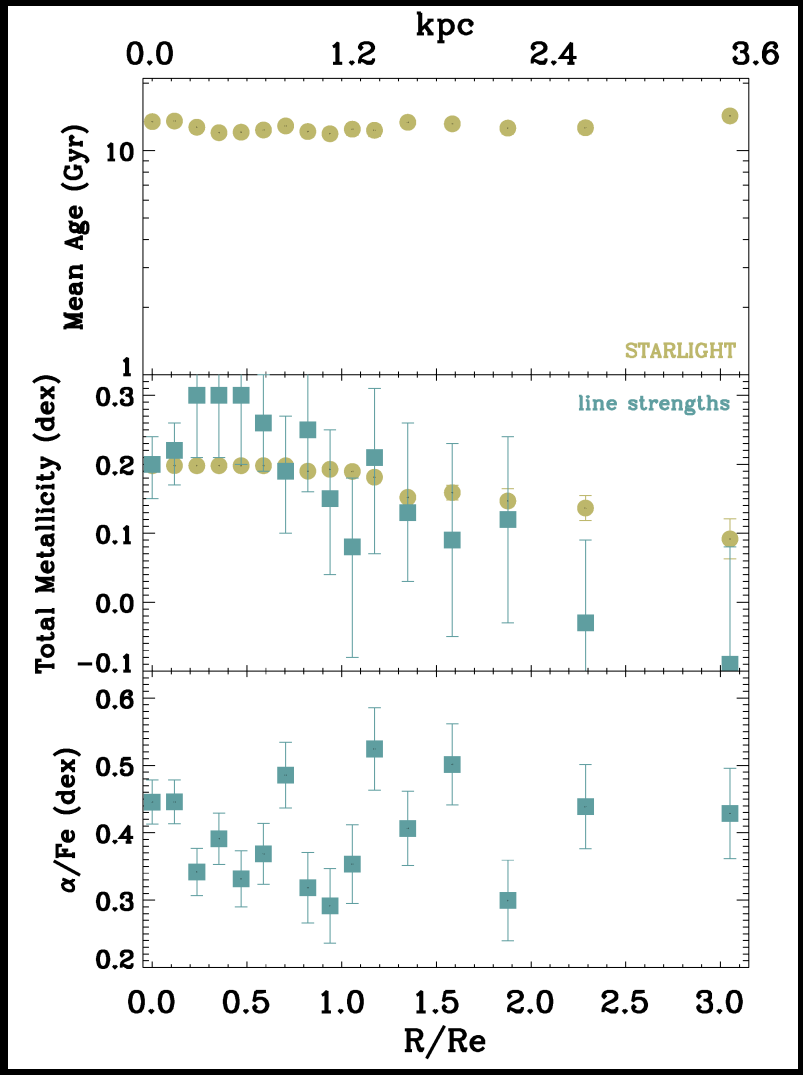
Van der Bosch et al. 2012, Trujillo et al. 2014

Quilis+13

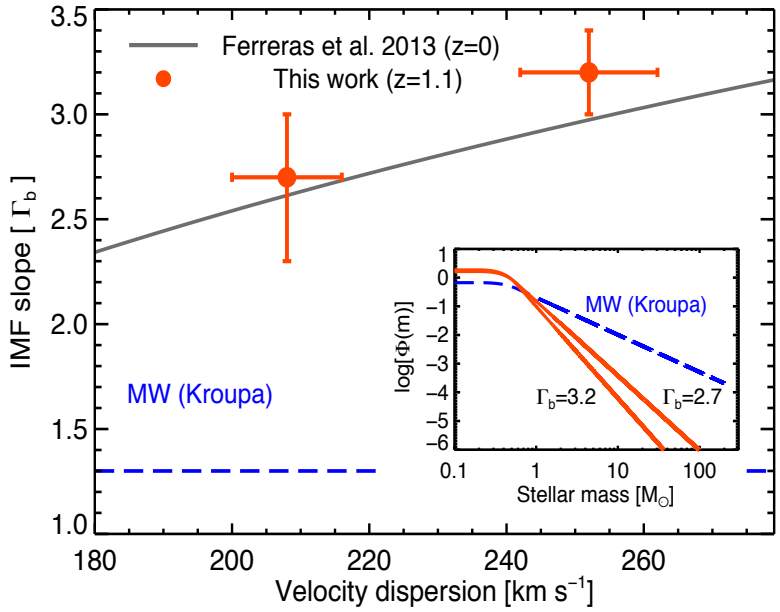


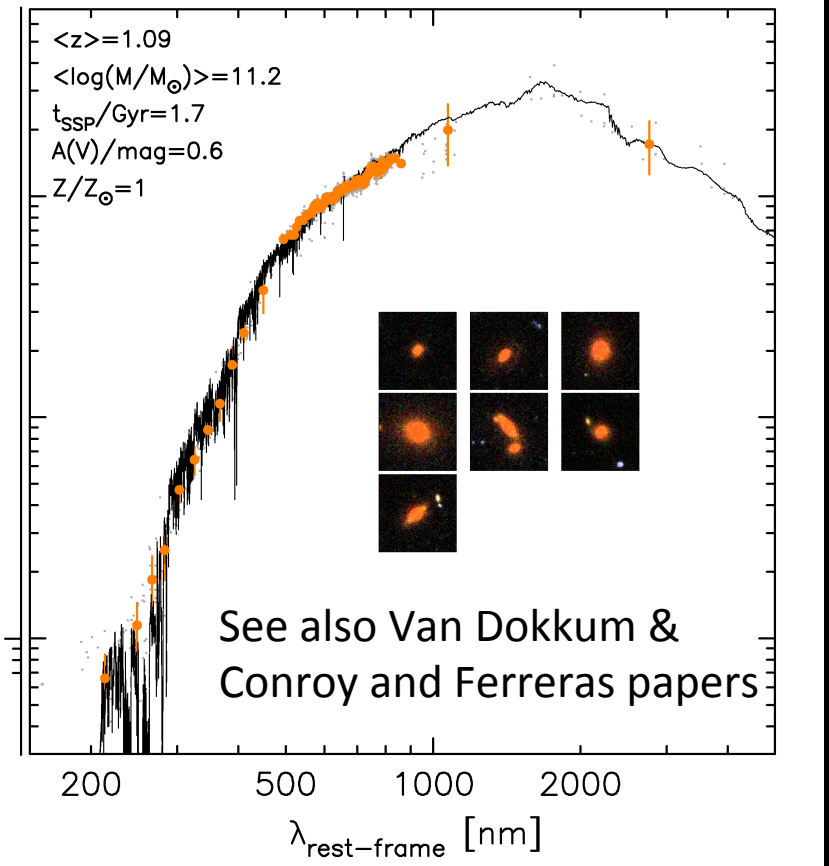
Trujillo+14

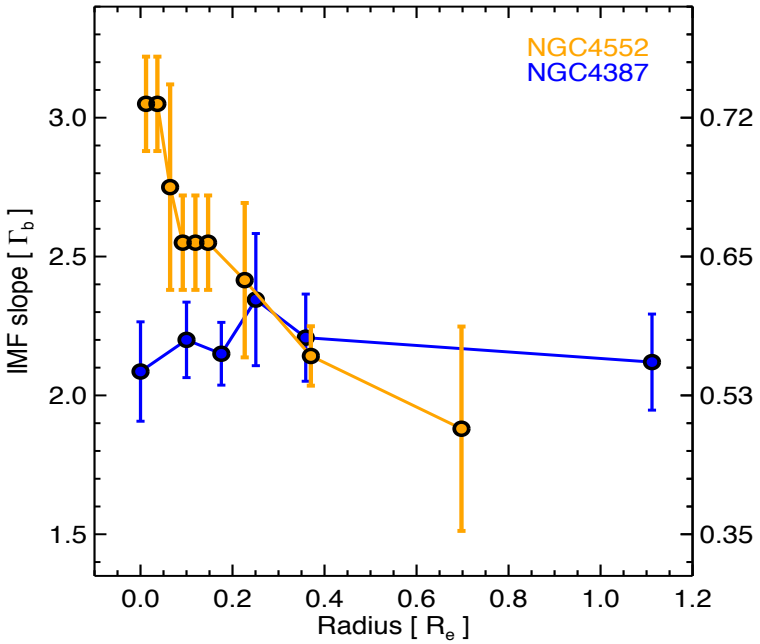


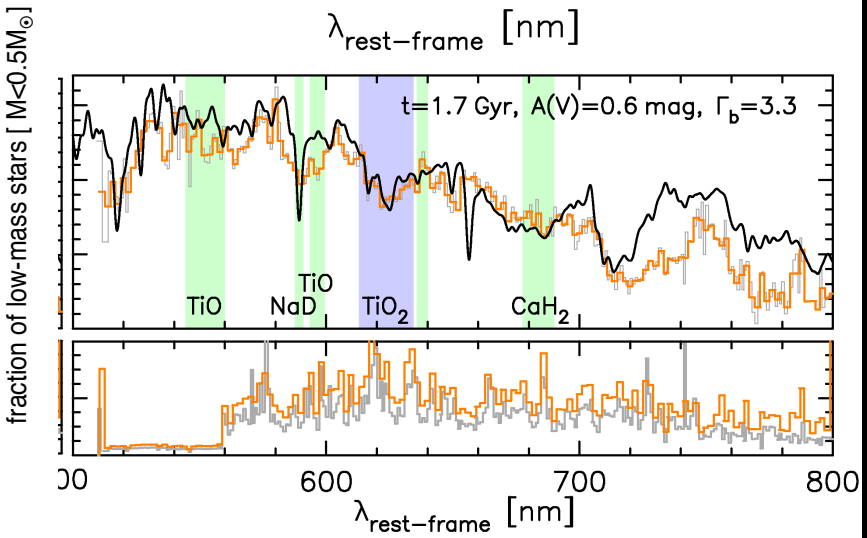


Martín-Navarro et al. 2014a,b (within SHARDS)



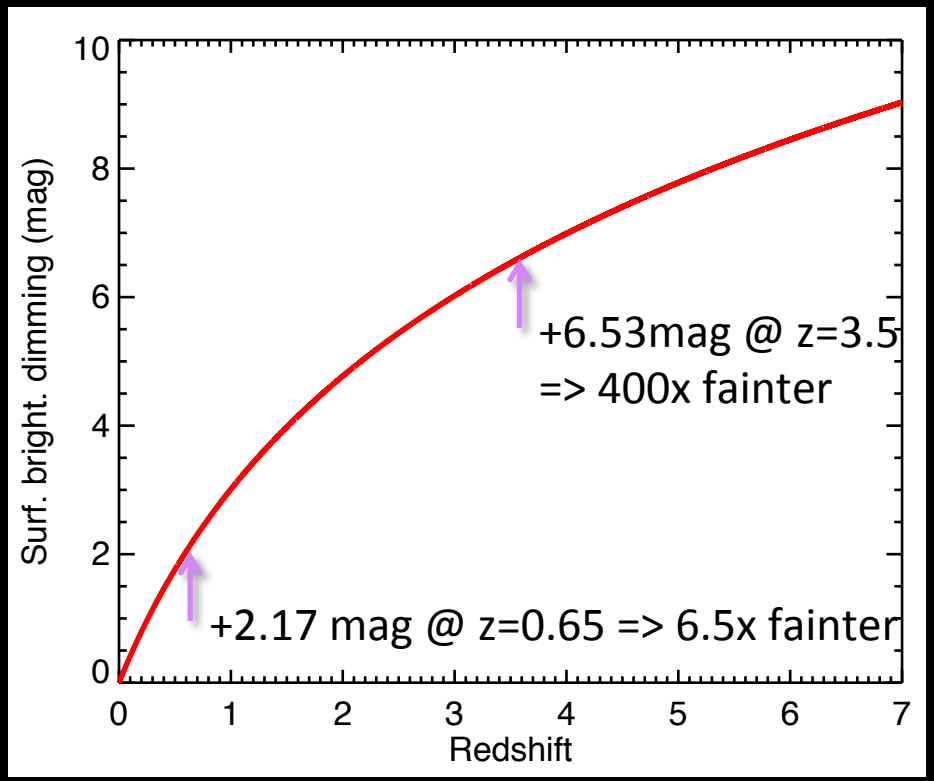


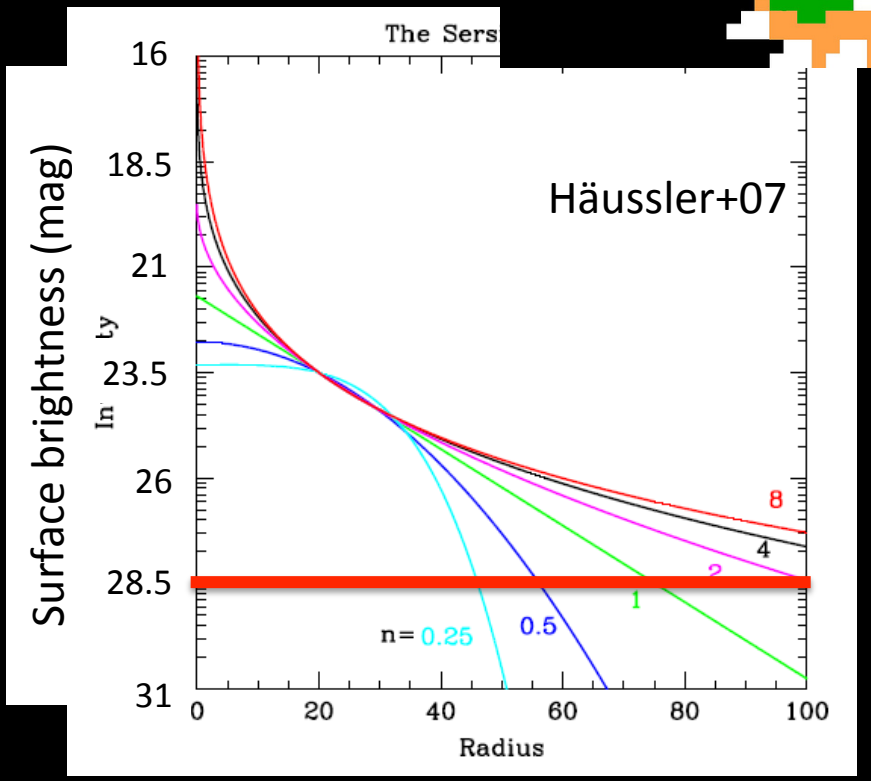




OBSERVATIONAL PROBLEMS

- Surface brightness dimming at high-z
  - The factor $(1+z)^{-4}$ => +10 log (1+z)



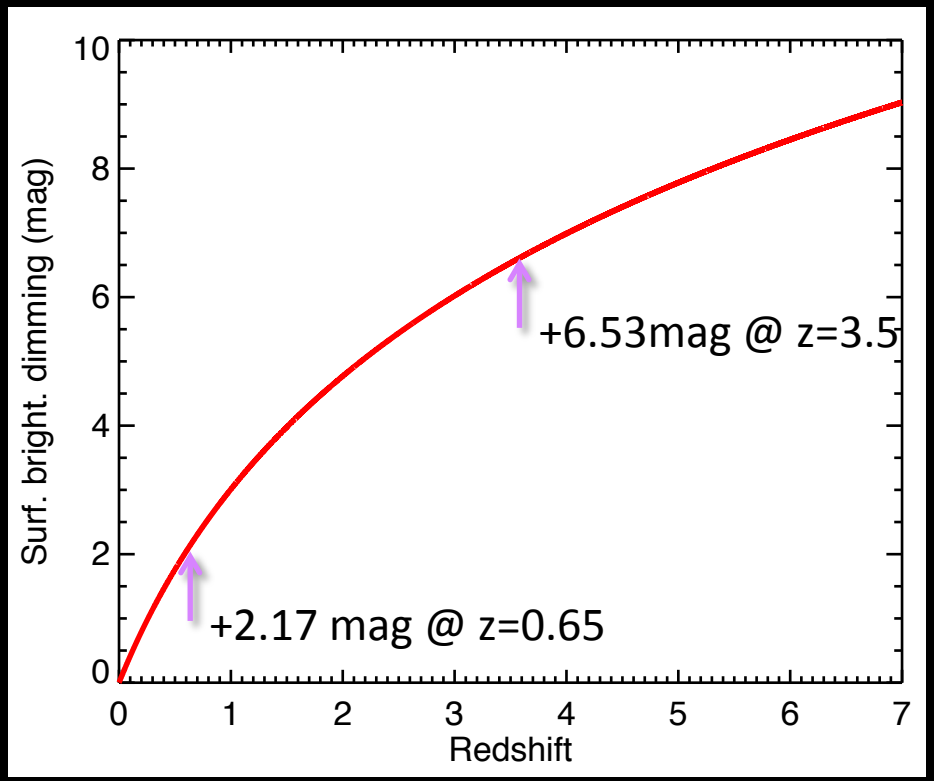


- Limitations in our stellar evol. codes, photometry, difficulty to get (decent) spectra...

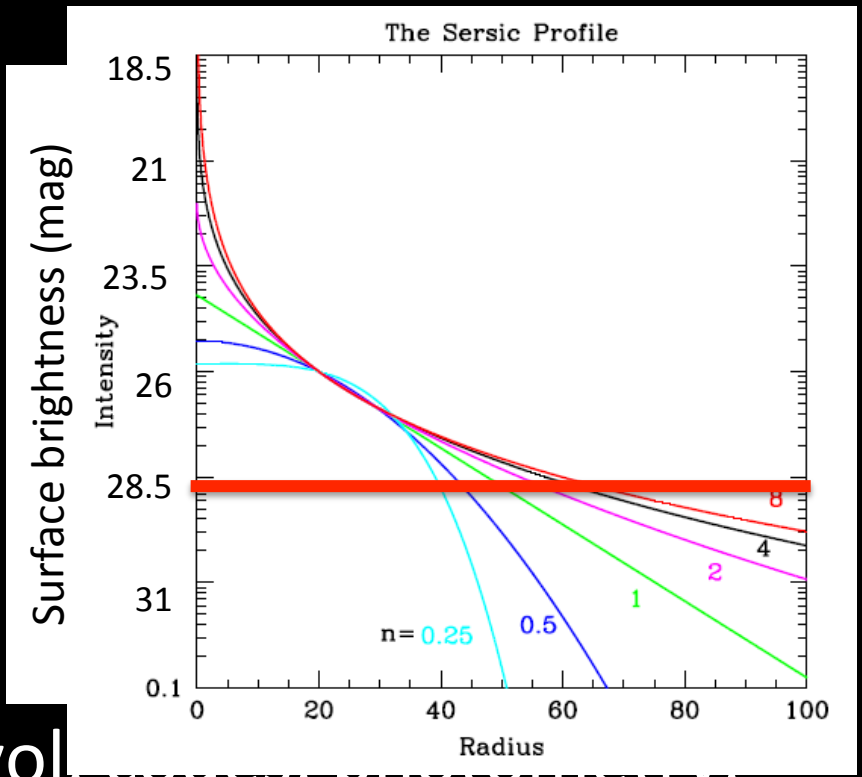
OBSERVATIONAL PROBLEMS

- Surface brightness dimming at high-z
  - The factor $(1+z)^4$ => +10 log (1+z)

z = 0.65



16

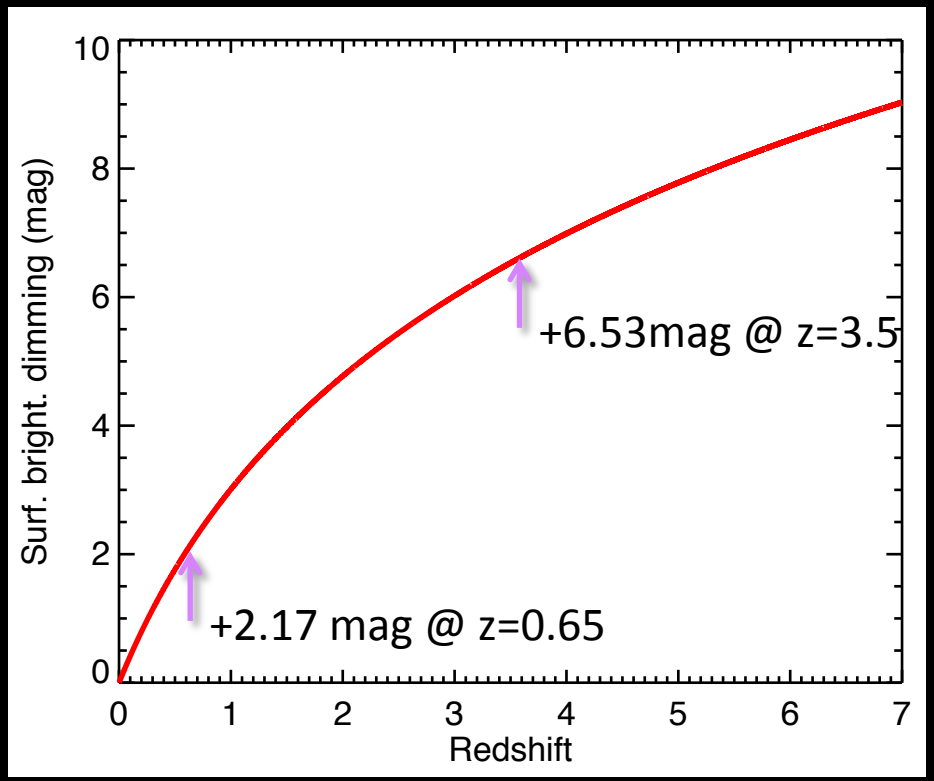


- Limitations in our stellar evol[illegible], photometry), difficulty to get (decent) spectra...

OBSERVATIONAL PROBLEMS

- Surface brightness dimming at high-z
  - The factor $(1+z)^4$ => +10 log (1+z)

z = 3.5



16

18.5

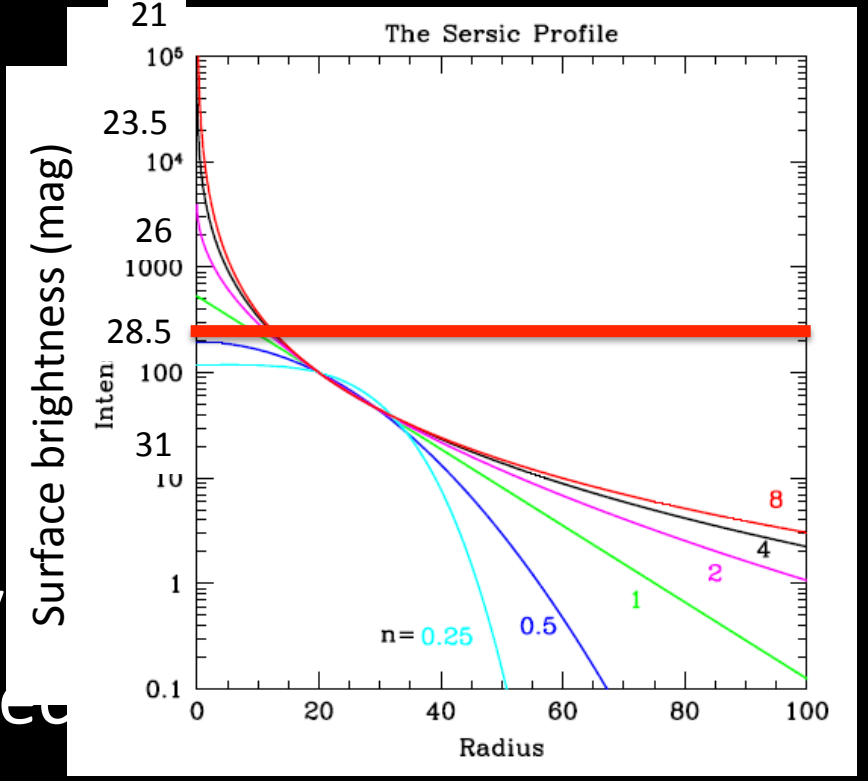
21

23.5

26

28.5

31



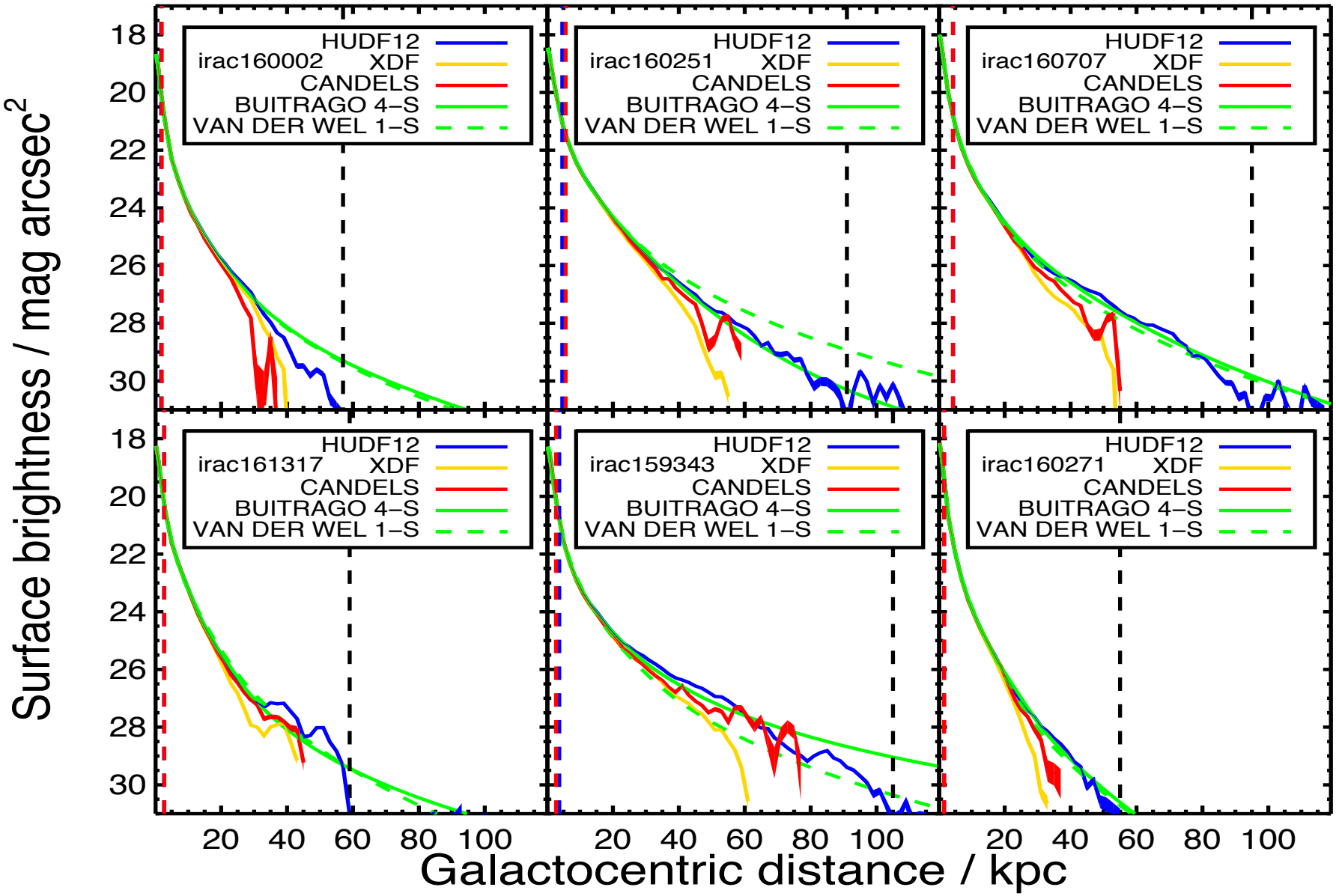
- Limitations in our stellar ev
  difficulty to get (decent) spe

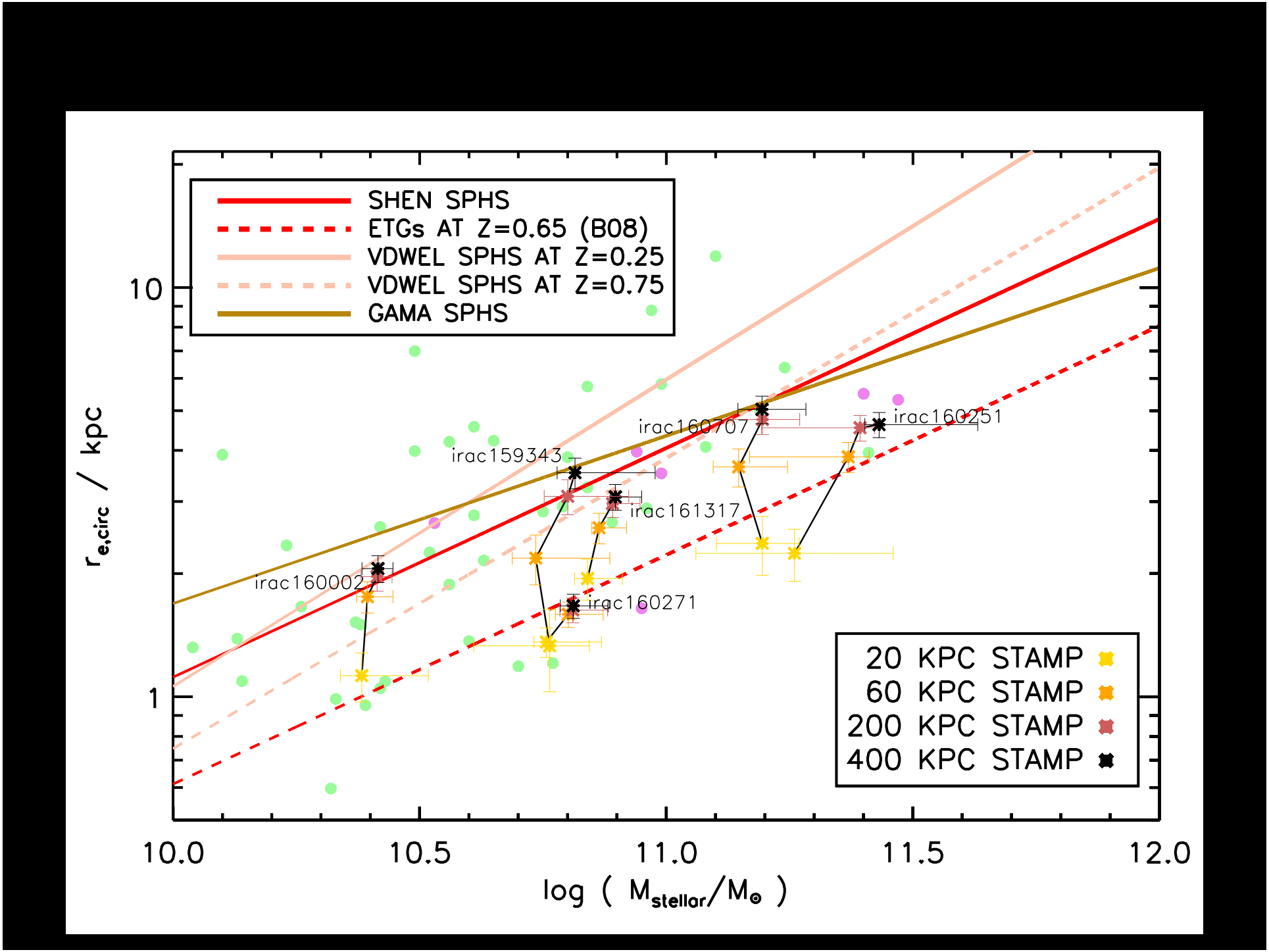

HUDF12
(PI Ellis &
McLure)
Ellis et al.
2012
Koekemoer
et al. 2012
x2 in WFC3,
x4 in Y_{105},
first time J_{140}
+ ACS optical
coverage
653 orbits
5σ~30 mag”^{2}

CAUTION :
Providing the right data reduction, our deep high-z extragalactic deep & wide surveys could be key to understand the low-z Universe

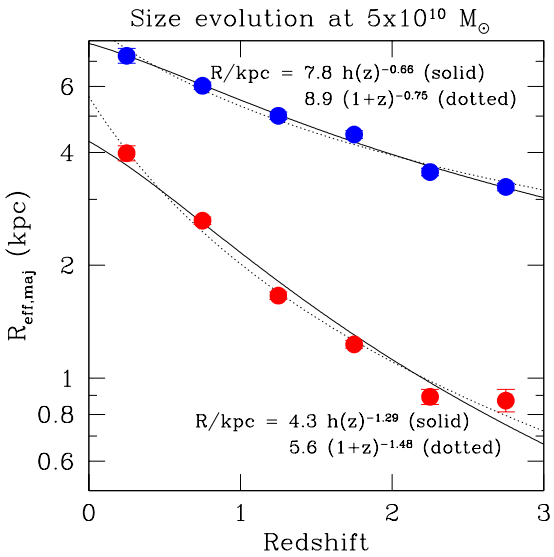
Investigating the low surface brightness stellar haloes at z = 0.65! or how to use HUDF for low-z

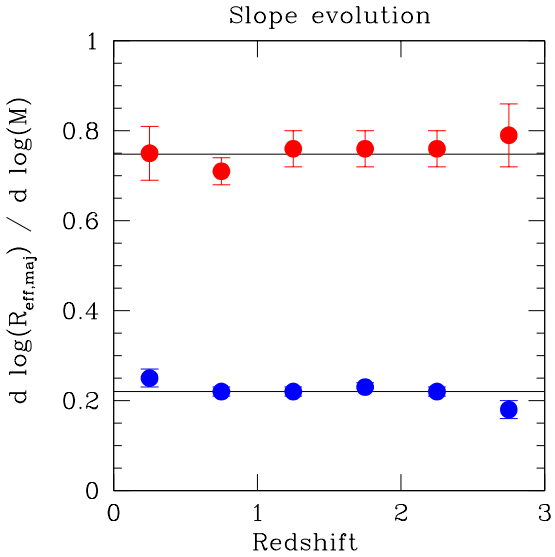
Buitrago et al. 2015 almost ready

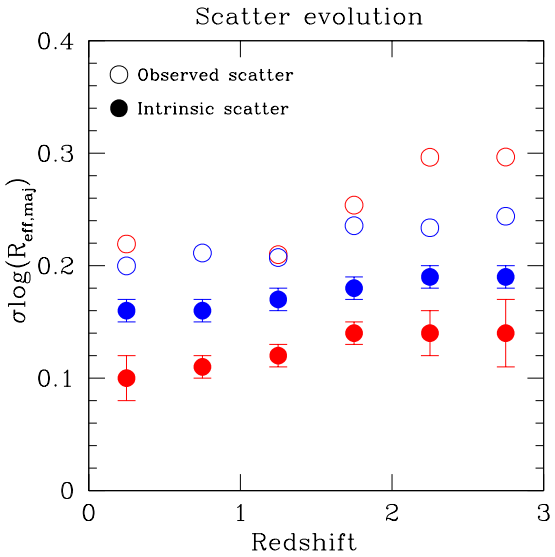


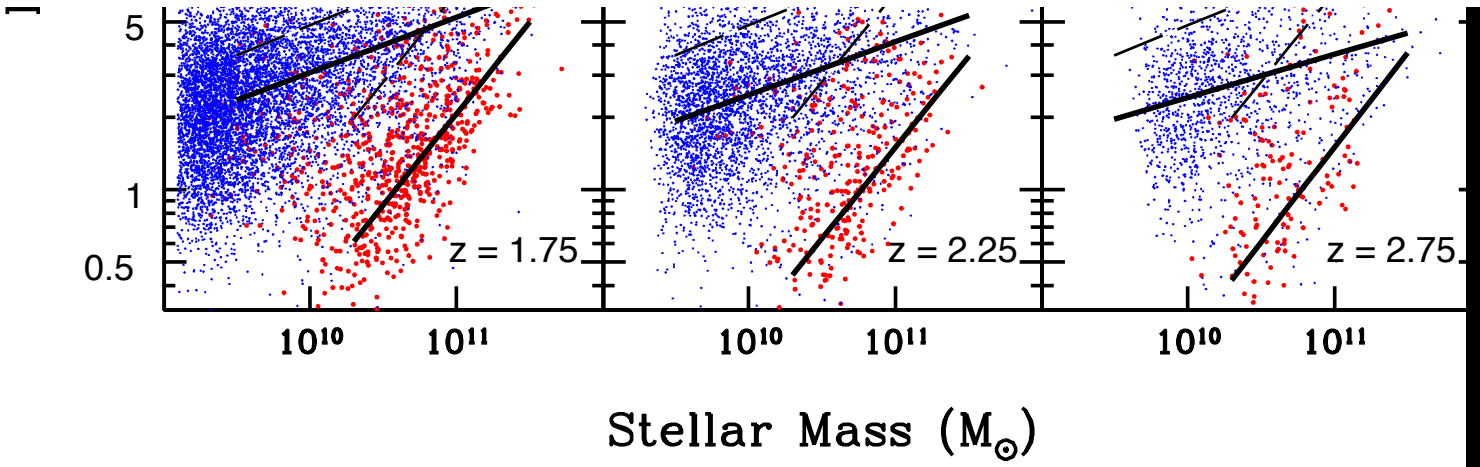

SHEN SPHS
ETGs AT Z=0.65 (B08)
VDWEL SPHS AT Z=0.25
VDWEL SPHS AT Z=0.75
GAMA SPHS
irac160707
irac160251
irac159343
irac161317
irac160002
irac160271
20 KPC STAMP
60 KPC STAMP
200 KPC STAMP
400 KPC STAMP
10
1
$r_{e,circ}$ / kpc
10.0
10.5
11.0
11.5
12.0
log ($M_{stellar}/M_{\odot}$)

The last of the size evolution (Van der Wel et al 2014) – CANDELS results

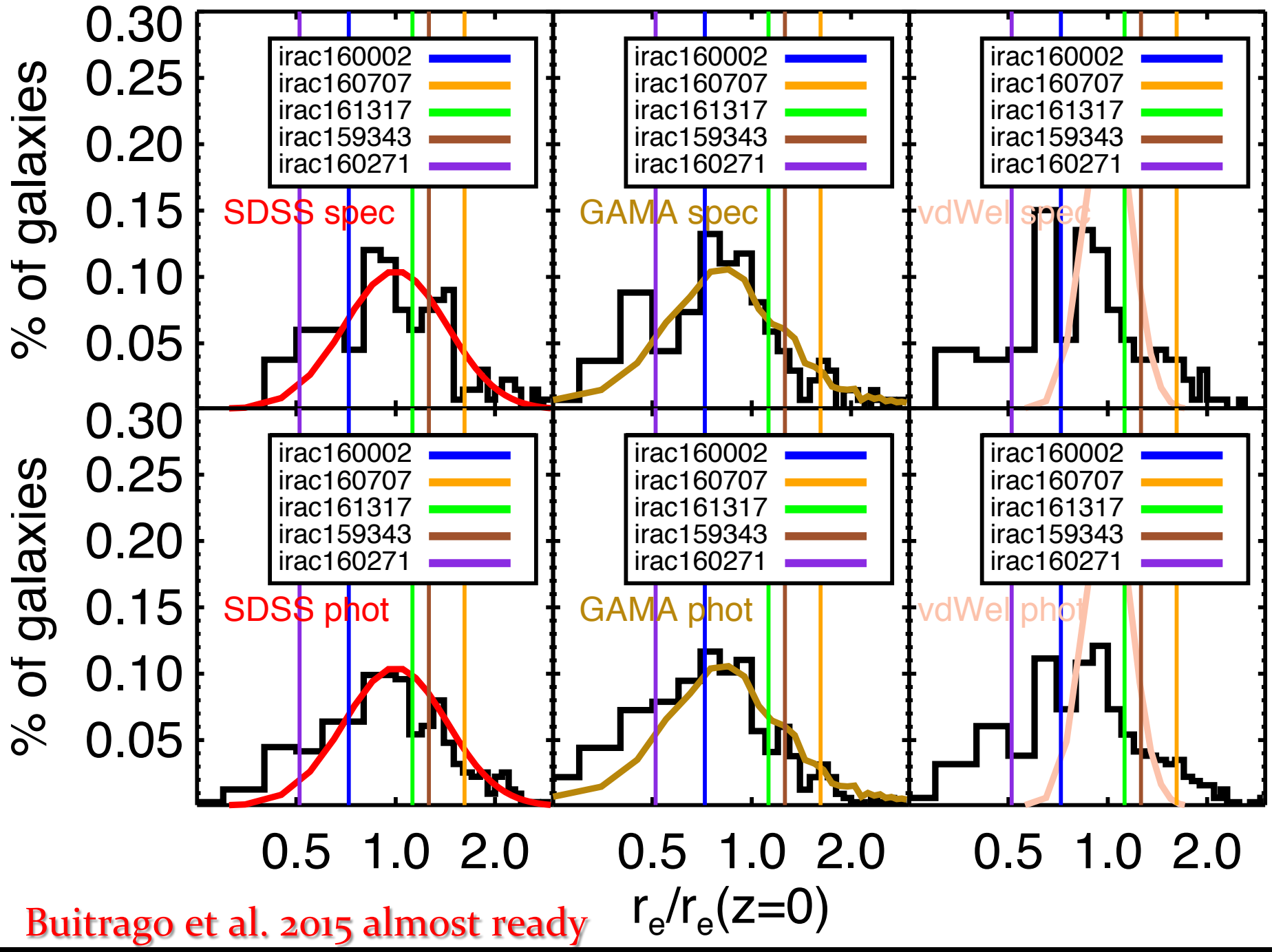








Constant scatter interpreted as puffing-up scenario not consistent with the data (Trujillo+11)



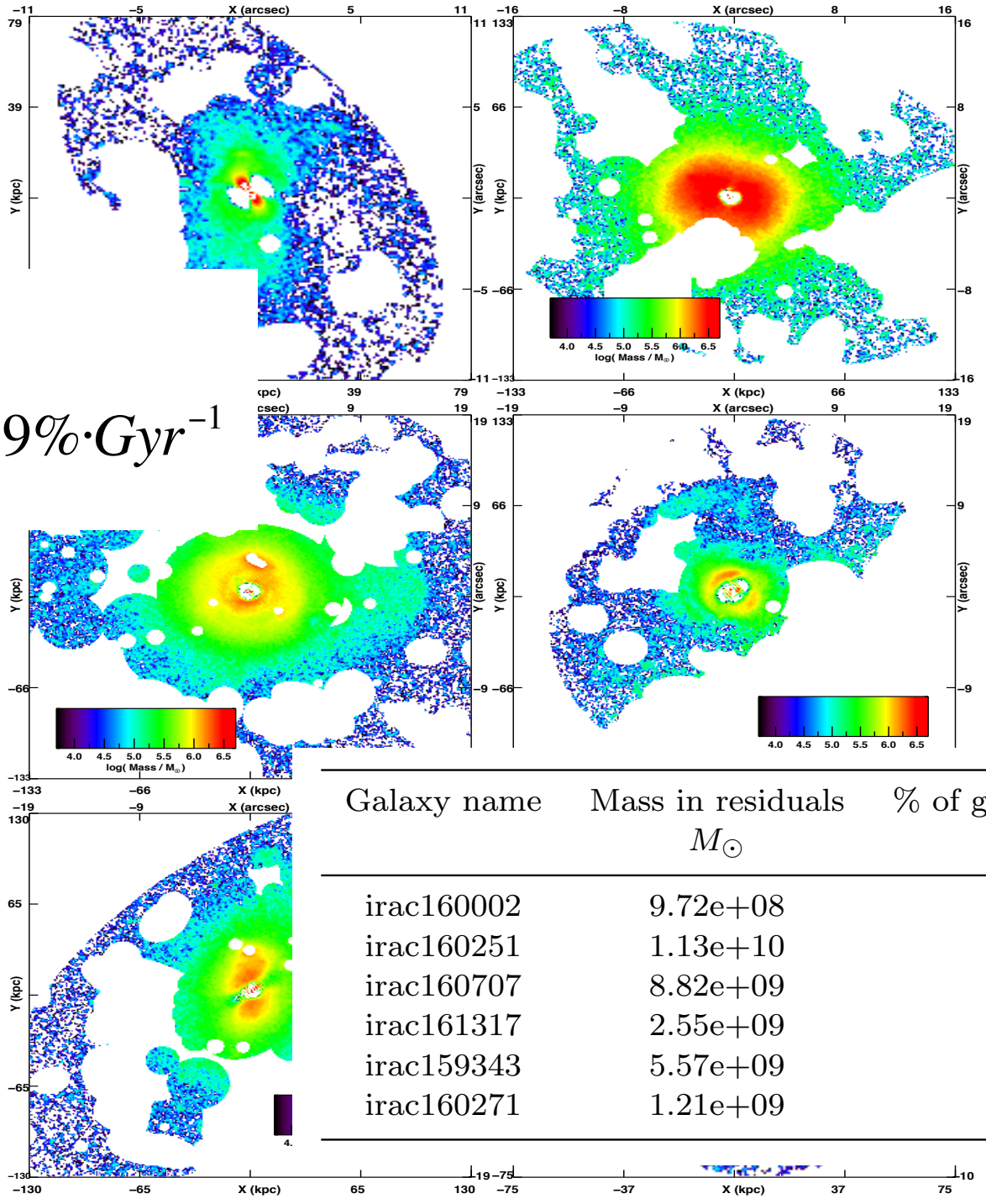
Buitrago et al. 2015 almost ready

Van Dokkum 2005
Ferreras et al. 2015

R

E

$$\frac{\left(\frac{\Delta M}{M}\right)}{\Delta t} = 8 - 9\% \cdot Gyr^{-1}$$



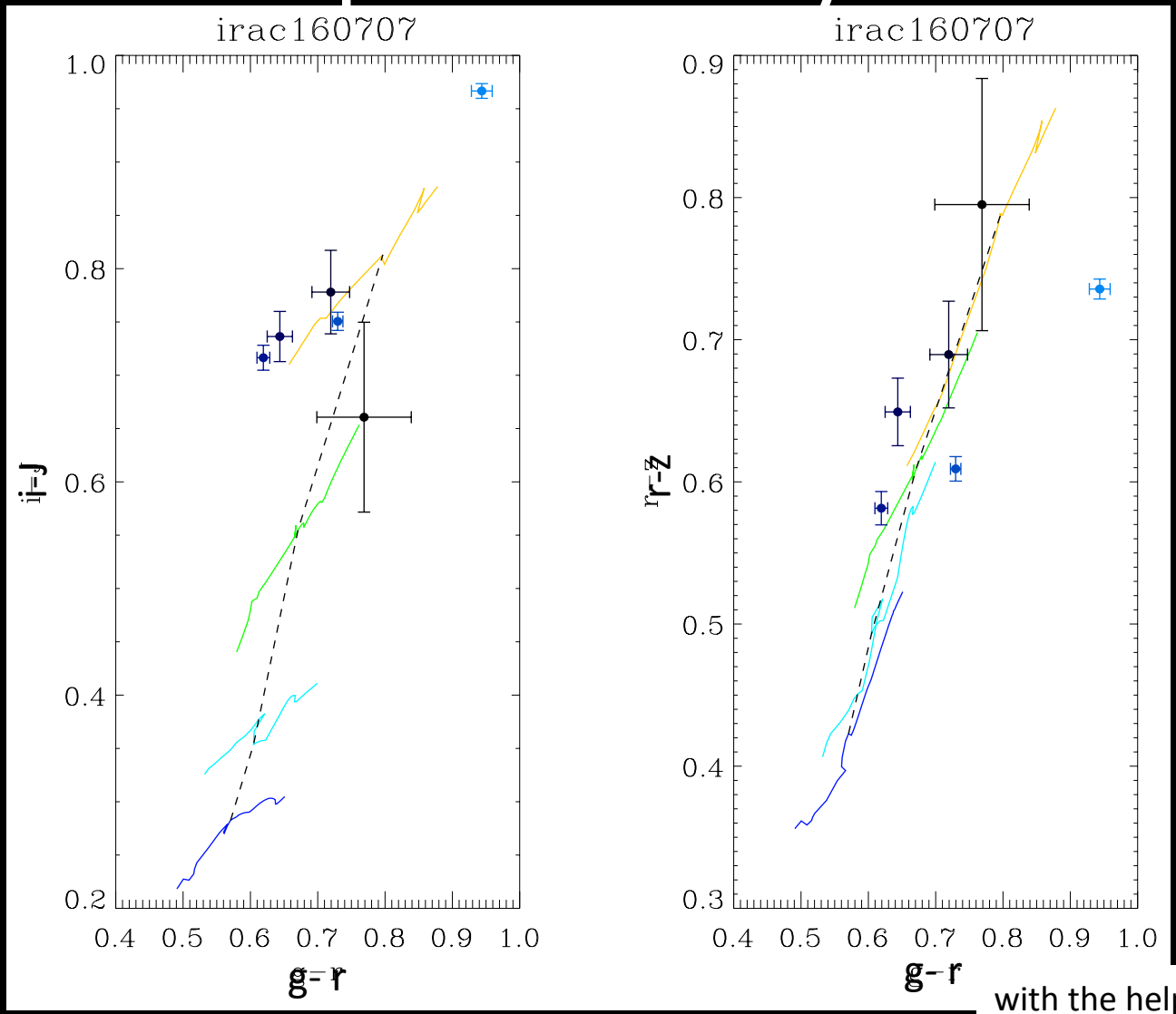
Stellar halo mass fractior

0.

0.0

Galaxy name	Mass in residuals $M_\odot$	% of galaxy's mass
irac160002	9.72e+08	3.7
irac160251	1.13e+10	4.2
irac160707	8.82e+09	5.6
irac161317	2.55e+09	3.2
irac159343	5.57e+09	8.5
irac160271	1.21e+09	1.9

Age & metallicity gradients from photometry

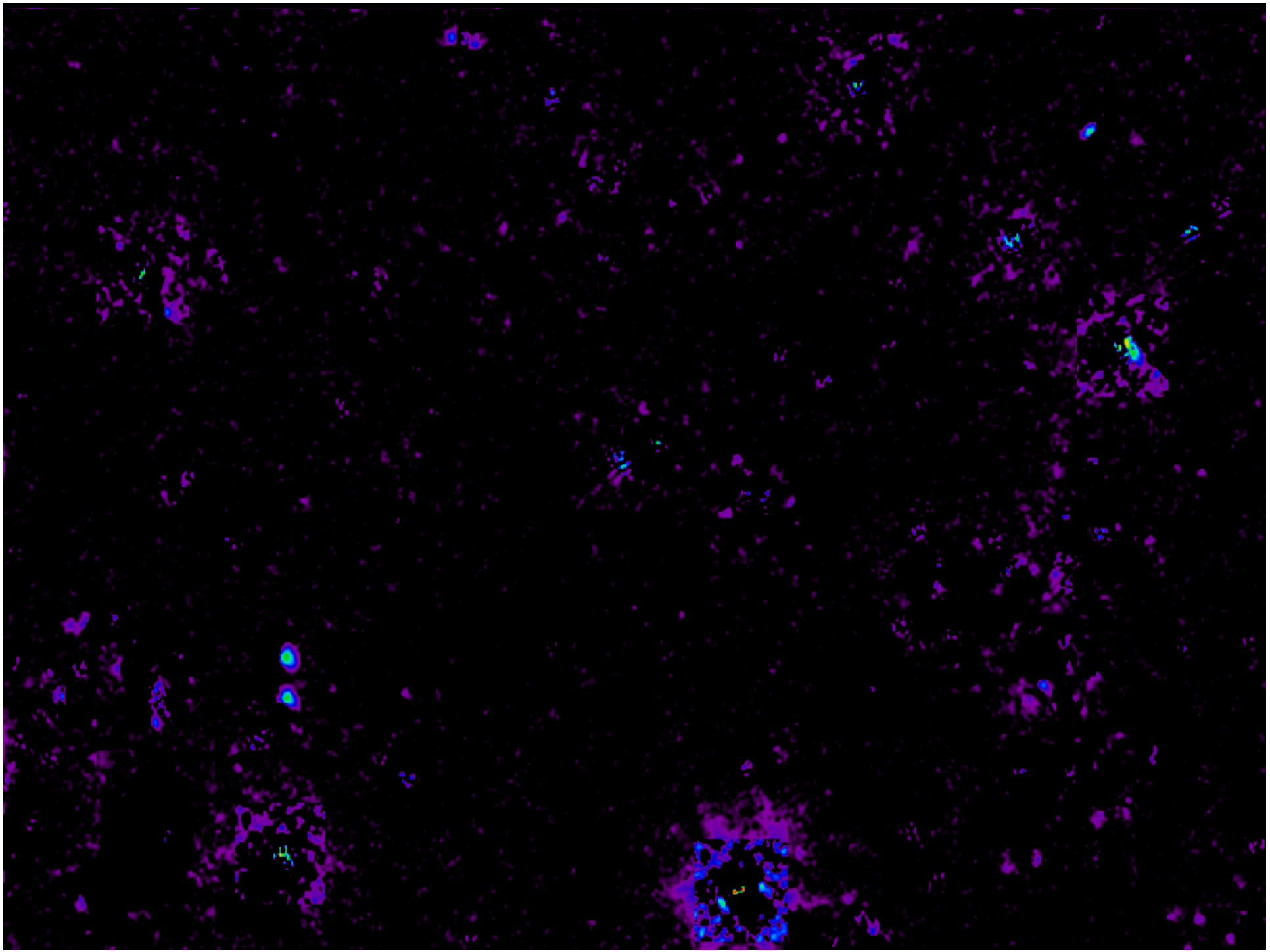


with the help of Mireia Montes

OBJECTIVES

www.astrodeep.eu

- Best photometry ever
- Double Sérsic decompositions (and bulge + disk)
- Photometric masses, redshifts & SEDs
- IRAC DECONFUSION ALGORITHM



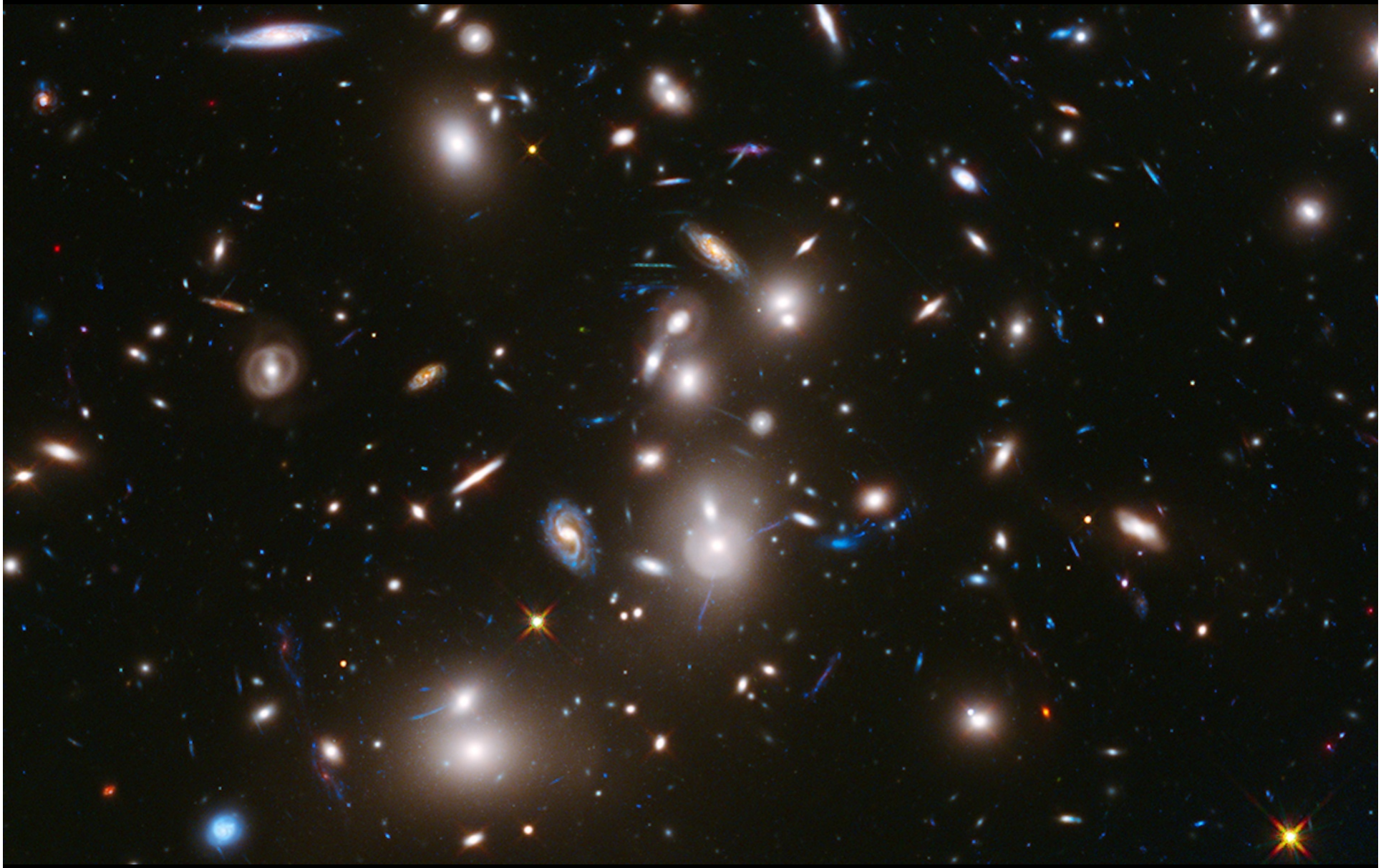
my problems with… ASTRODEEP

Apart from the typical: objects close to stars or very bright neighbours,
SExtracting properly ALL the objects in the image, spirals, tidal tails and the like

- -> Deliverables: document about analysis of S.B. fitting codes (both parametric and not)
- When signal-to-noise (quantify) permits it, a double Sérsic is a better description of the data –> It should always be the case –> No, GALFIT fits elongated objects when it is not able to fall in a space parameter minimum

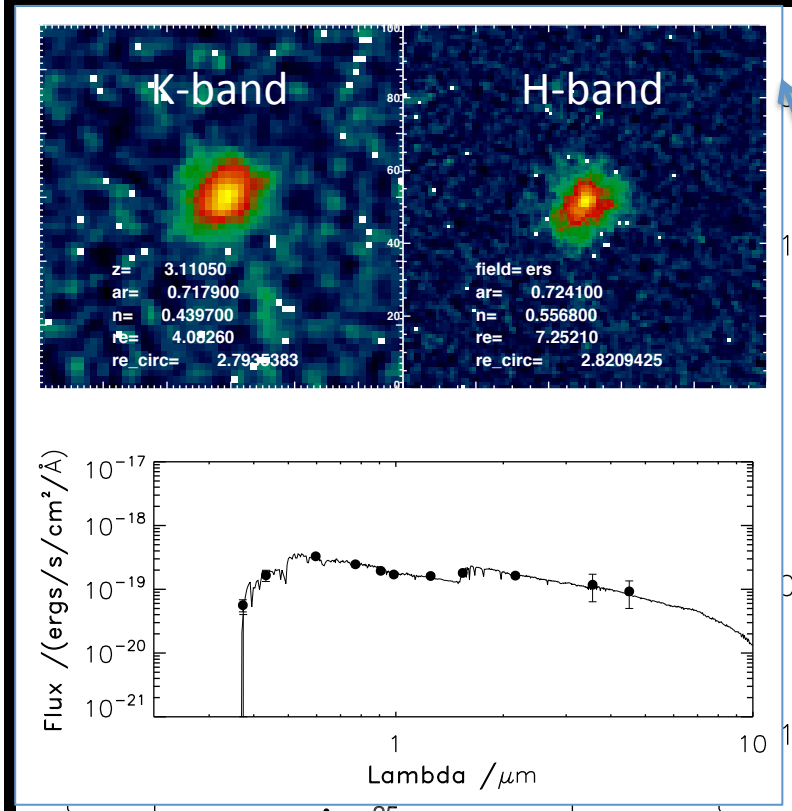
SOLUTION: Fits “a la Bruce+14” (take as good double fits those for which none of the components is less than 10% in flux) + remove clearly wrong axis ratios (those smaller than 0.01). All the rest of the models should be modelled as single Sérsic functions.

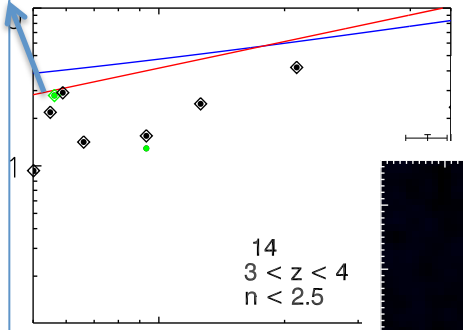
NEXT CHALLENGE: HUBBLE FRONTIER FIELDS PROGRAMME

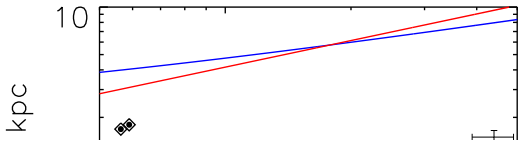


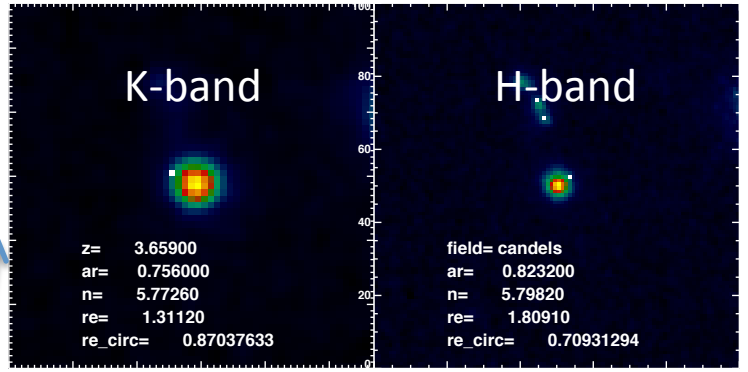
Parametric analyses of the galaxies' surface brightness are specially suited for dealing with overcrowded images: why not adding this capability to TPHOT? Merlin et al. (2015) in preparation

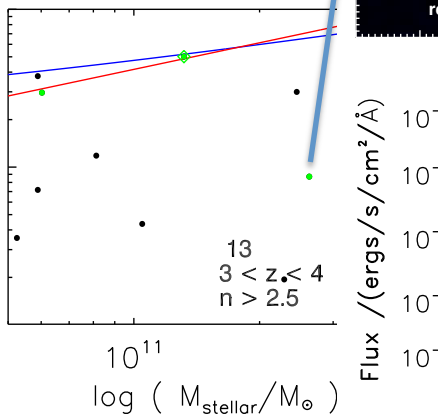
MASS-SIZE RELATION FOR MASSIVE GALAXIES UP TO Z=4.5 USING THE DEEPEST K-BAND SURVEY - HUGS

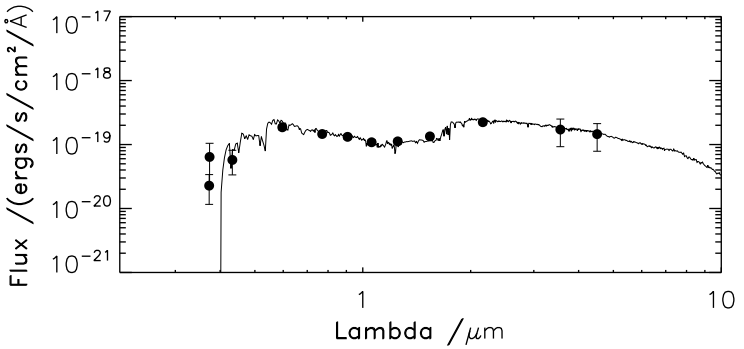






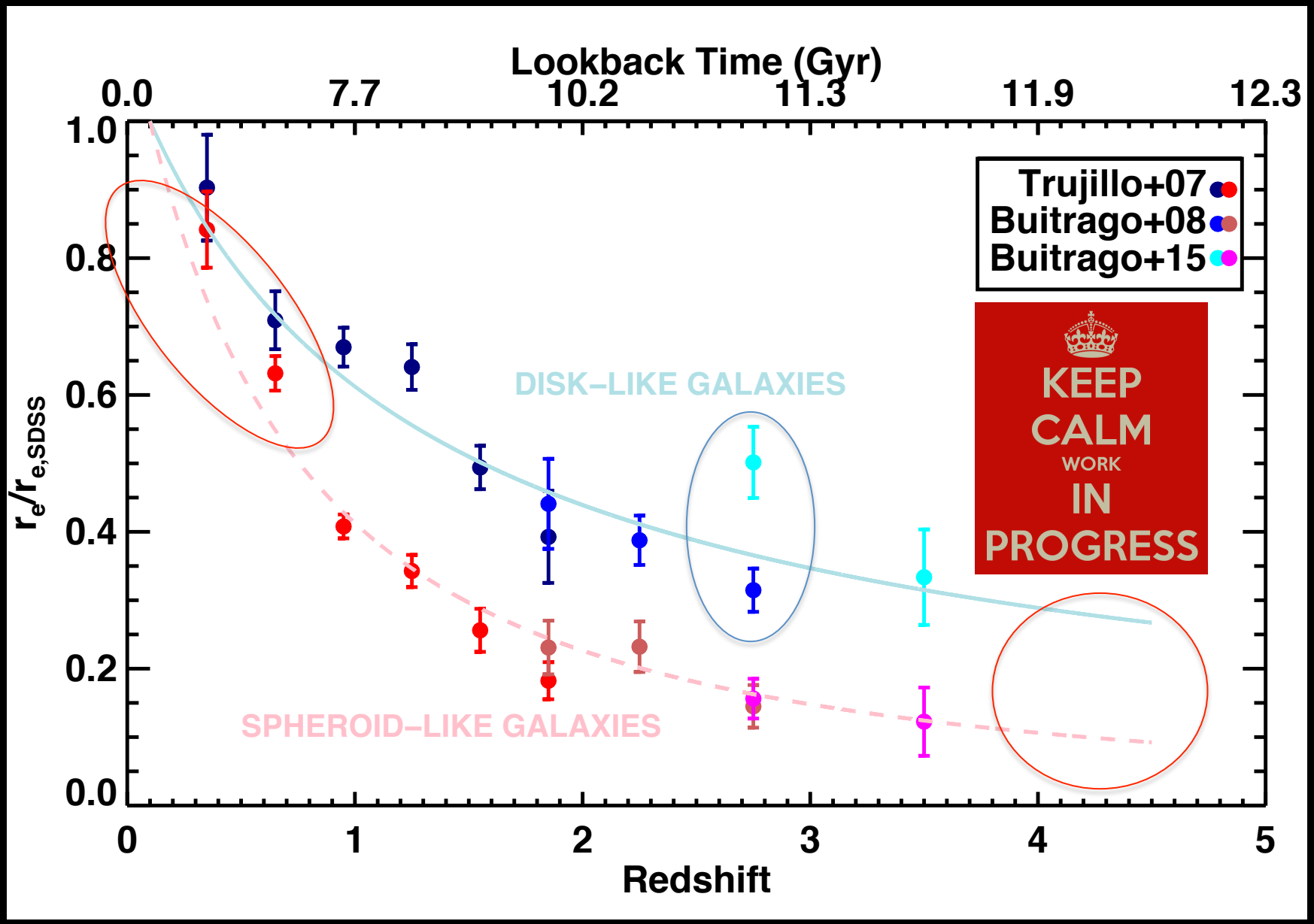






Buitrago, Targett et al. 2015 in prep.

SIZE EVOLUTION – MASSIVE – OPT. RESTFRAME

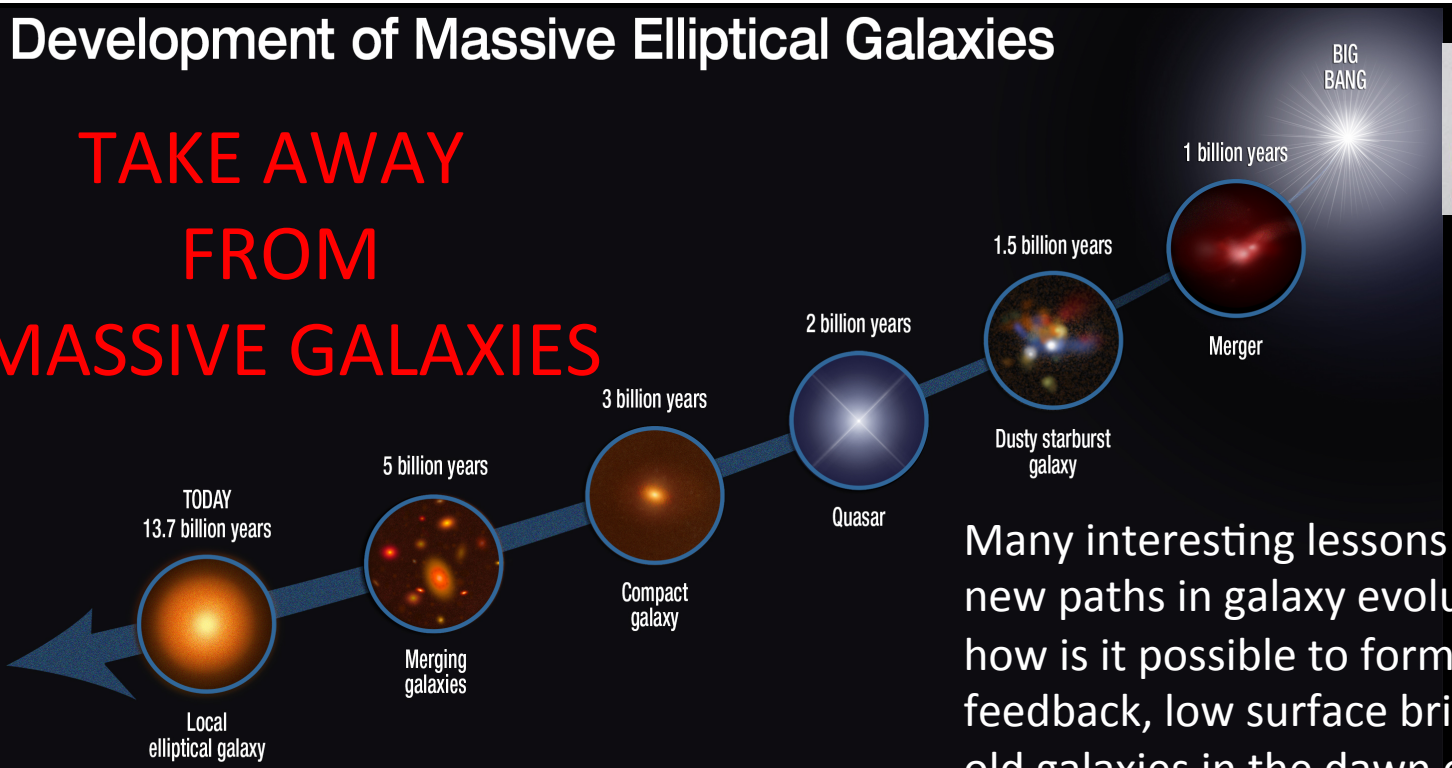


VERY INCOMPLETE SELECTION OF IDEAS THAT HAVE TO DO WITH THIS TALK

- Size-mass relation is an AVERAGE relation
- Galaxies do not shrink
- Should local mass-size relations be corrected because shallower data? Apparently not, if using Sersic fits magnitudes as GAMA (sizes & masses)
- What's the right combination of minor & major merging?
- How to distinguish at high-z between clumps, merging and dust effects?

Development of Massive Elliptical Galaxies

TAKE AWAY
FROM
MASSIVE GALAXIES



Compact disks

Huge spheroids

Many interesting lessons:
new paths in galaxy evolution, IMF change, how is it possible to form such galaxies, feedback, low surface brightness assembly, old galaxies in the dawn of the Universe, …

- Observational Cosmology: constraining ΛCDM
- Once we have access to the low surface brightness (up to 100 kpc or >25 r_e) size-mass rel. is accurate
- CANDELS spheroids@z=0.65 no need for size evolution
- Preliminar analysis shows extended/interacting and compact massive galaxies up to z=4.5
- Is at 1<z<3 where evolution takes place for massive galaxies?