Massive Compact Galaxies

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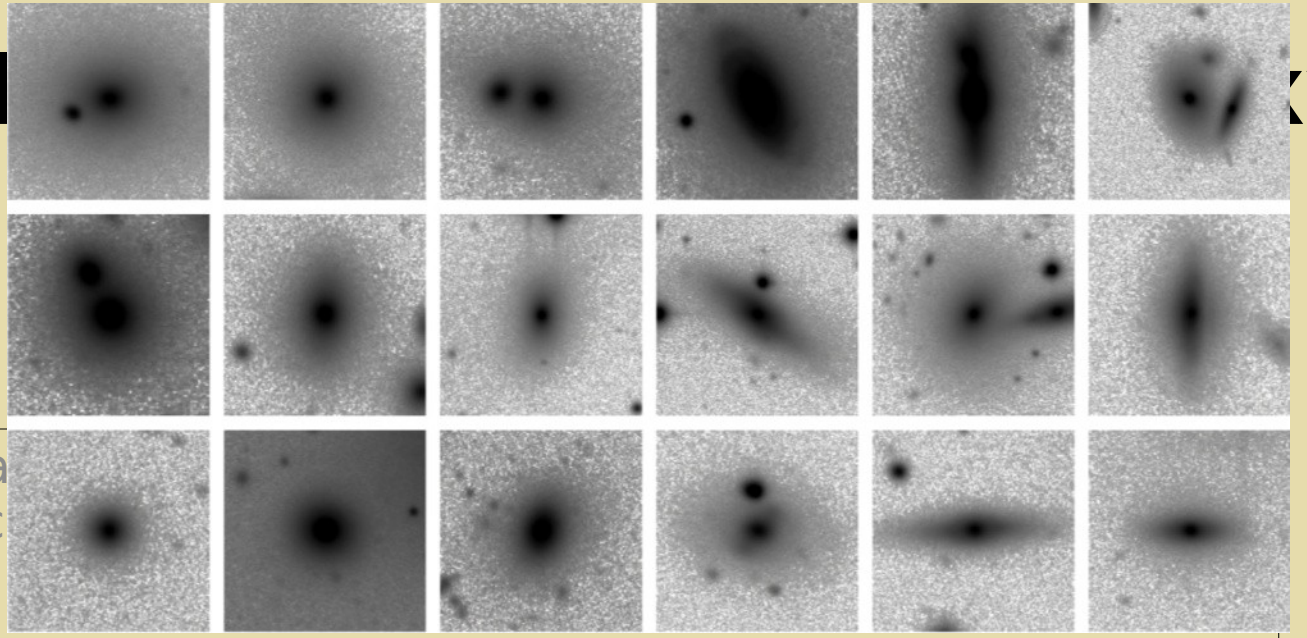

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T.Valentinuzzi, B.M.Poggianti, J.Fritz, M.D'Onofrio

WINGS and EDisCS collaborations

WINGS Team

WINGS
WIde-field Nearby Galaxy-clusters Survey

Core-team





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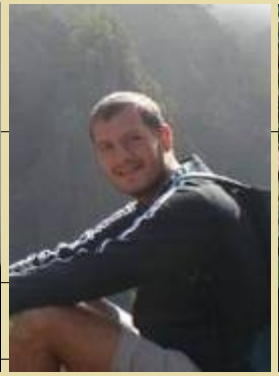
schema

Young(?) collaborators









EDisCS Team

International consortium of 25 astronomers from 6 countries

International consortium of 25 astronomers from 6 countries.
S. White (MPA-Garching, D) **- Principal Investigator**
A. Aragón-Salamanca (Nottingham, UK)
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M. Bremer (Bristol, UK)
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B. Fort (IAP, F)
P. Jablonka (Geneve, CH)
G. Kauffmann (MPA, D)
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J. Moustakas (U. Arizona, USA)
R. Finn (Siena College, USA)

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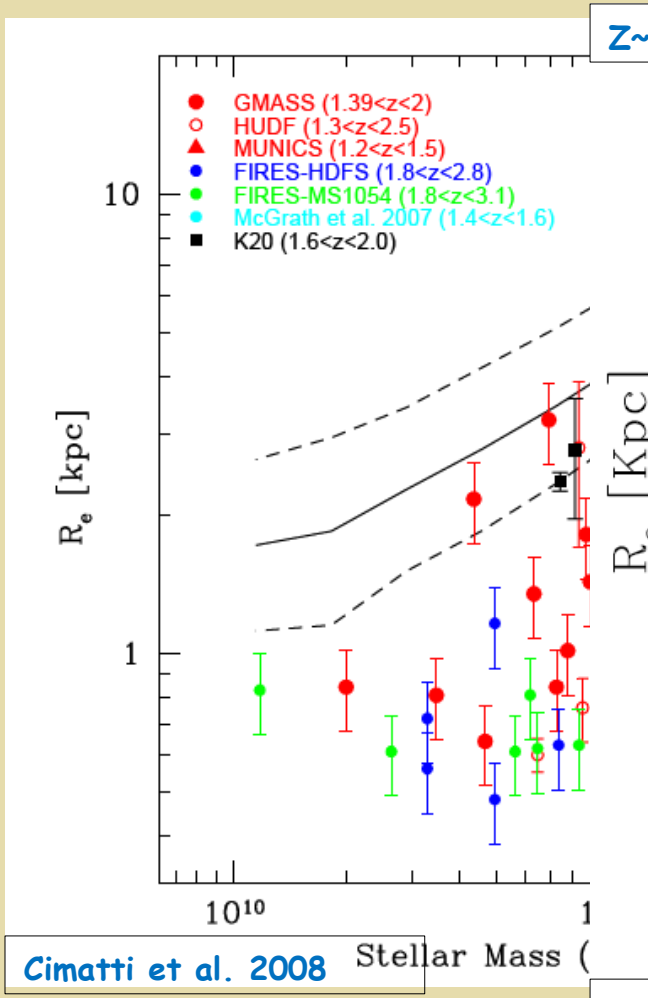
schema

The Framework

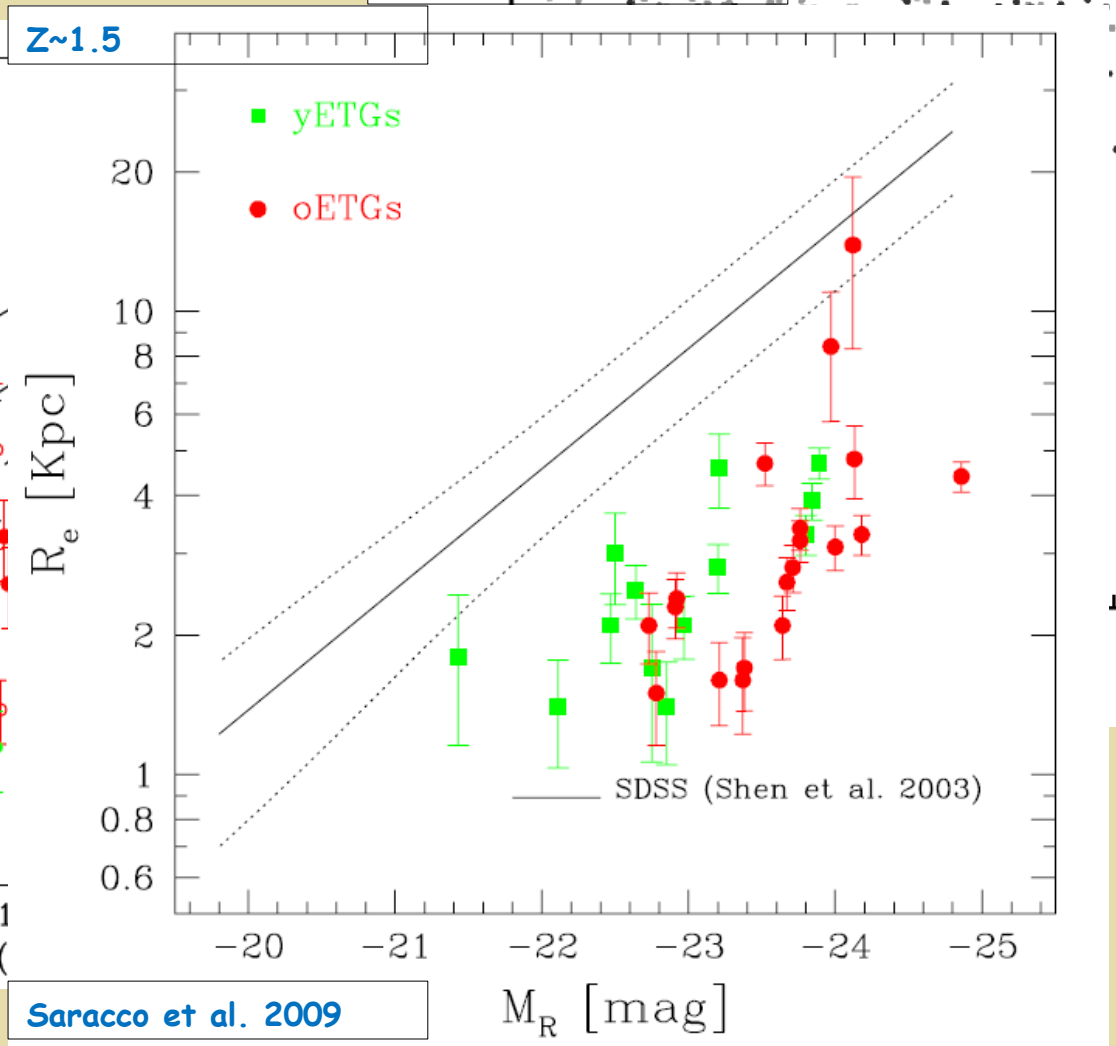
Many authors find high-z (z>1.5), massive (M*>1010Msol), compact (Re<2kpc) and quiescent galaxies.

Z~2.3

Z~1.5



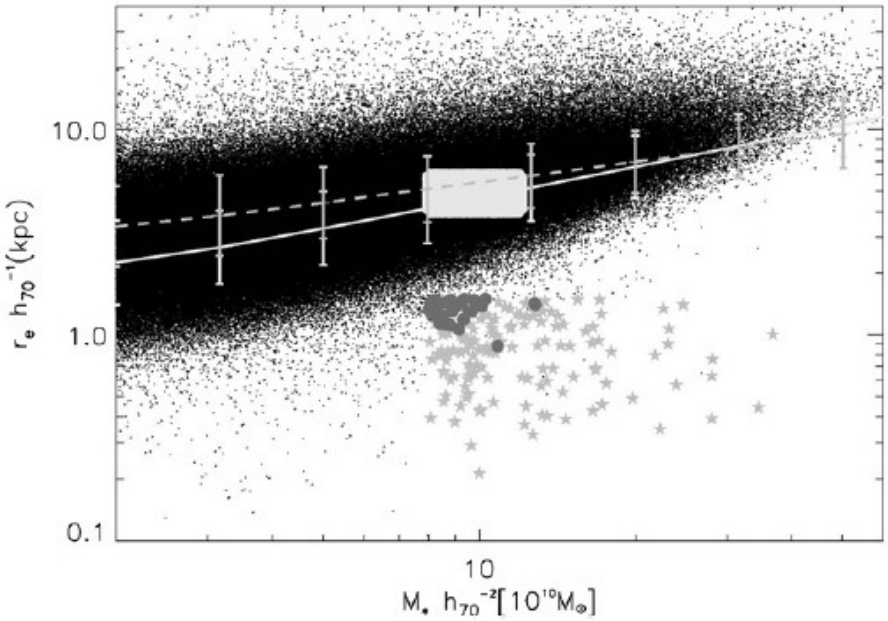
Cimatti et al. 2008

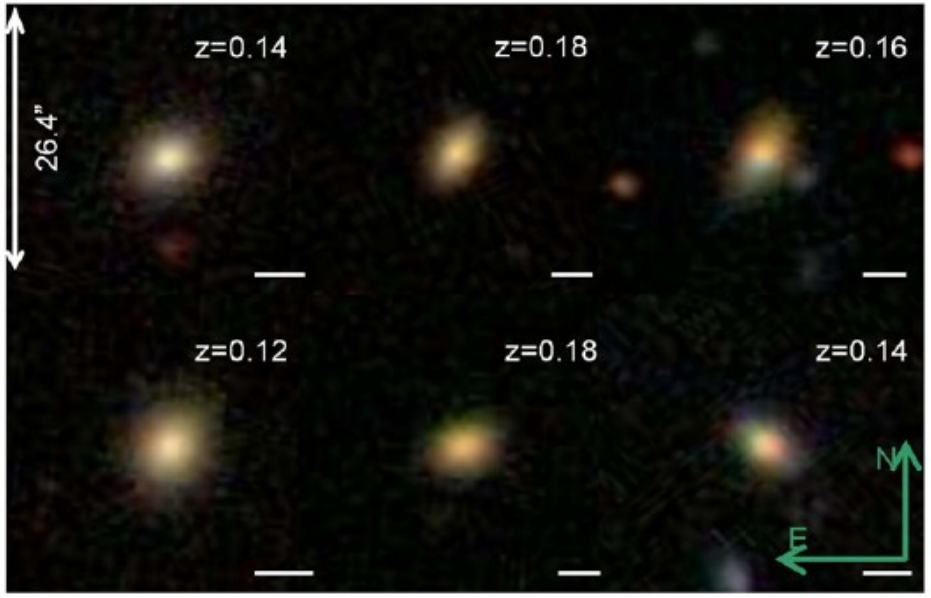


Saracco et al. 2009

Where are local compact galaxies?

Trujillo+09 don't find any candidate in SDSS-DR7 at z<0.2
which could be a descendant of such compact high-z galaxies





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Possible evolution scenarios

i) High-z masses and/or radii are incorrect: models with proper description of the TP-AGB phase of stellar evolution, yields as far as 0.2dex less massive galaxies (Maraston05). S/N of high-z images (with HST too) can alter (reduce) the recovered Re (Mancini+10).

ii) Evolution of radius with redshift

1) Major merging (conflict with evolution of mass function)
2) Minor merging (Bernardi+09,Van del Wel+09,Hopkins+10, etc.)
3) Quasar feedback (Fan+08)

iii) Compact galaxies are somewhere else, or they must be searched for carefully, or the local relation is not the proper one… need to properly homogenize all the literature data, IMFs, limits, modeling, mass types, etc. (what we think to have done in Valentinuzzi+10)

WINGS dataset

i) WINGS local cluster galaxies 0.04<z<0.07 (Fasano+06)

ii) 21 clusters with average spectroscopic completeness >50%

iii) Redshifts and memberships from WINGS-SPE (Cava+09)

iv) Masses from SED fitting (Fritz+10 in prep.)

v) Sizes from GASPHOT (Pignatelli+06)

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vi) Morphologies from MORPHOT (Fasano+10 in prep.)

A total of ~1300 galaxies with M*>1010Msol

The WINGS mass-size relation

Offset between SDSS mass-radius and the WINGS one (~0.1dex) at large masses.

Rapid change in the mass-radius relation at M*~4x1011Msol.

BCG-like galaxies do evolve…

We consider only galaxies with 3x1010<M/Msol<4x1011*

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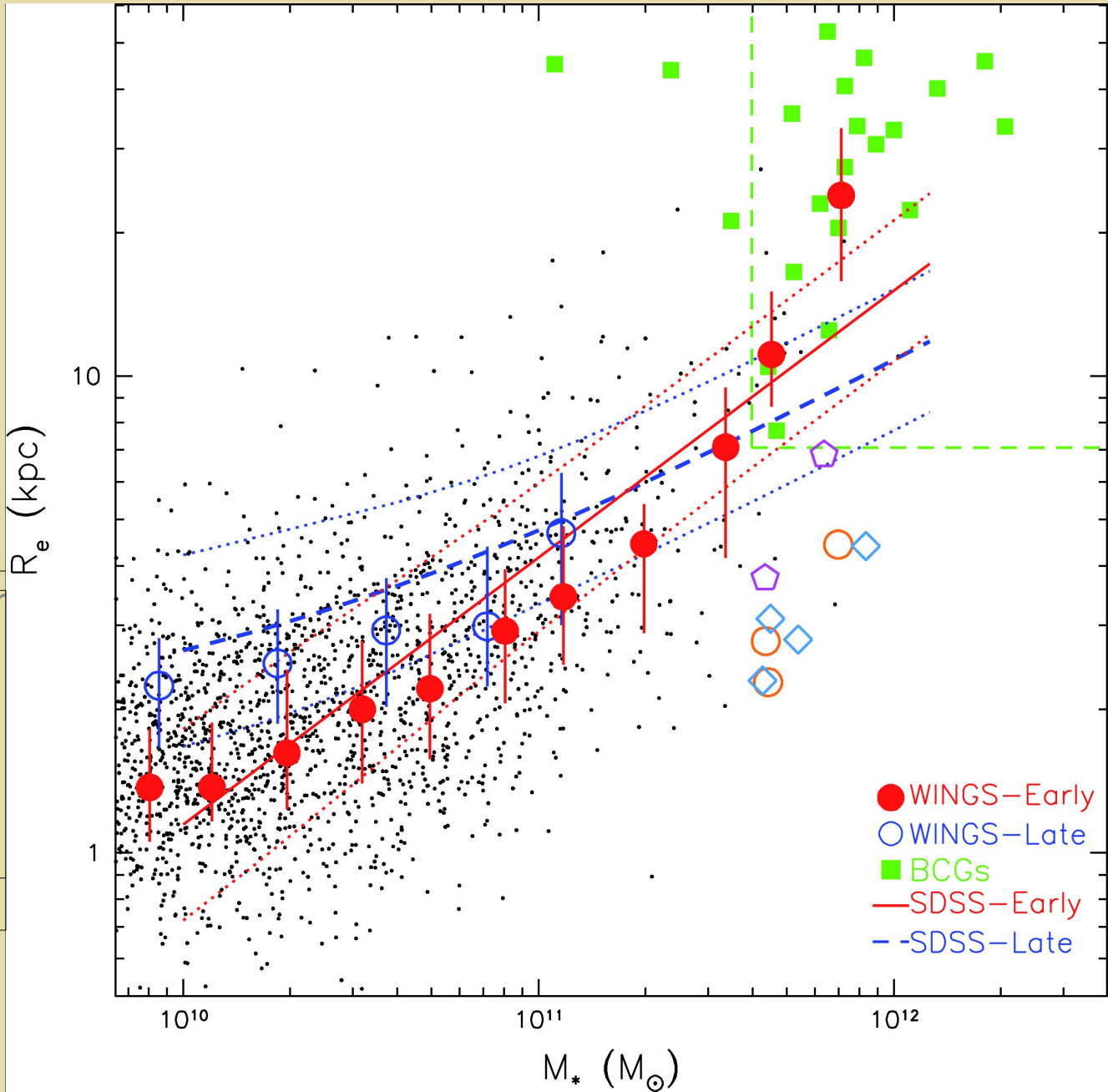
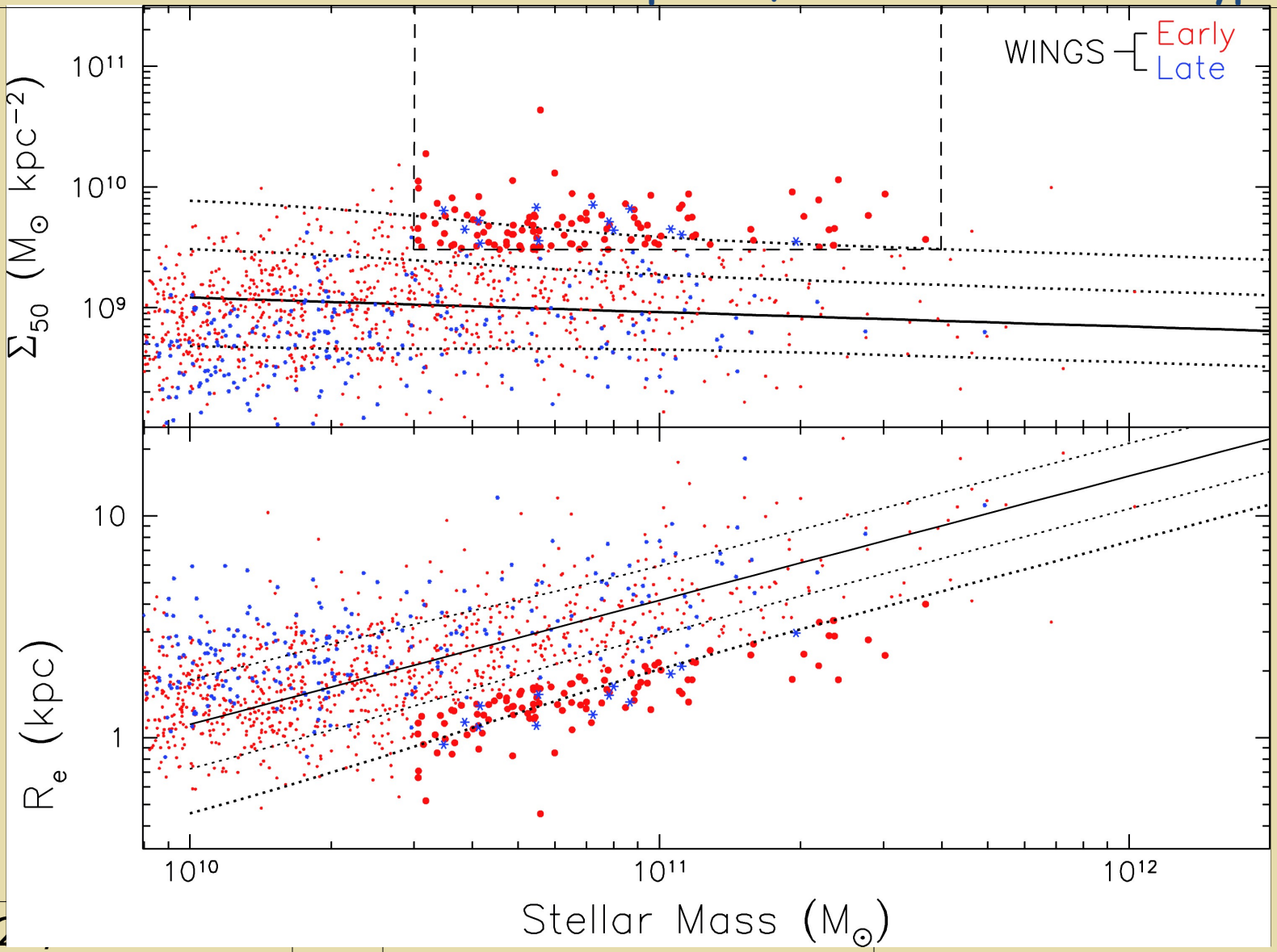


Superdense Massive Galaxies in WINGS

122 SDGs in 21 local clusters: 31 ellipticals, 78 S0s and 13 late-types.



Superdense Massive Galaxies in WINGS

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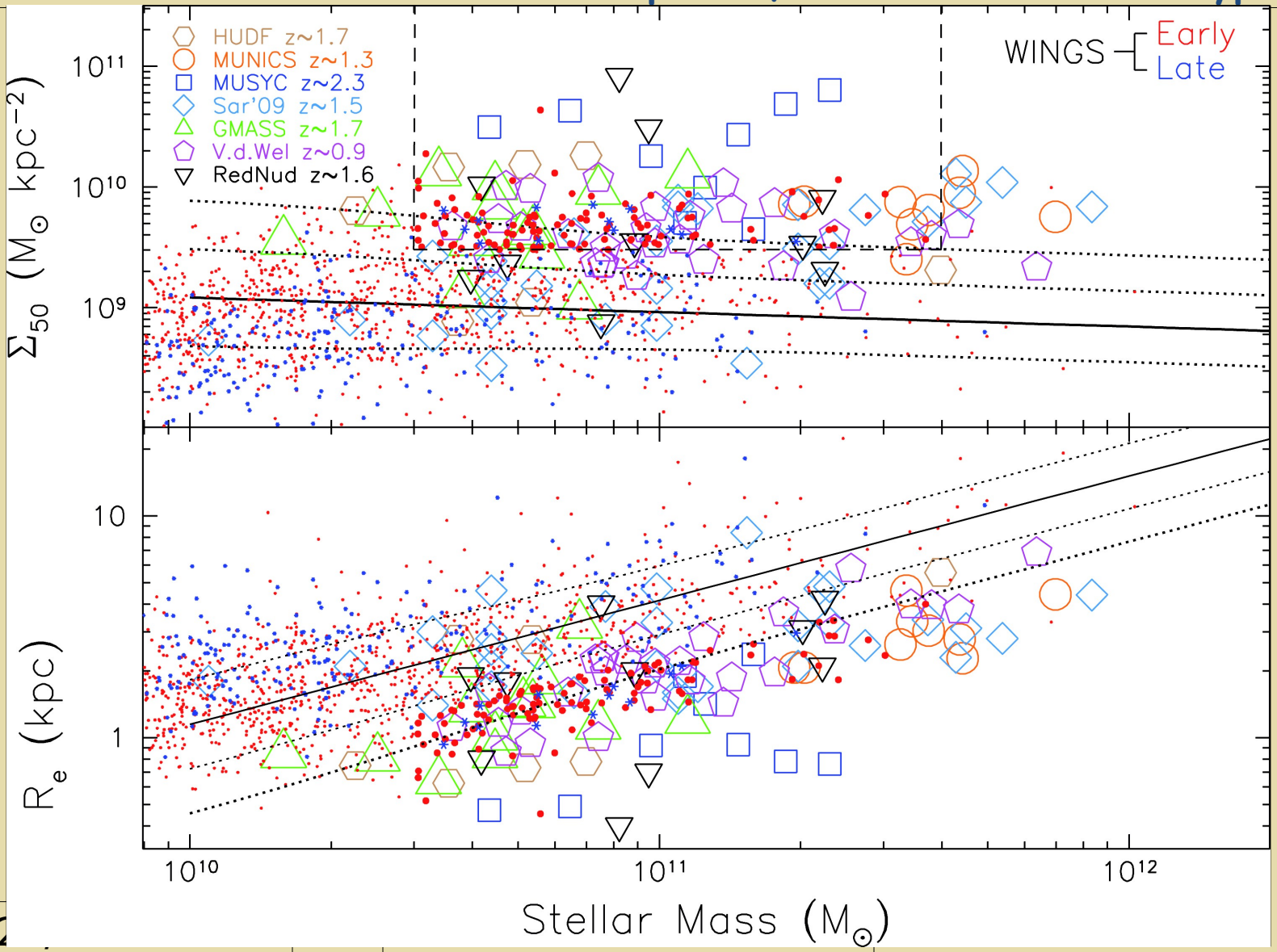

Superdense Massive Galaxies in WINGS

122 SDGs in 21 local clusters: 31 ellipticals, 78 S0s and 13 late-type.

Quantity	Value	RMS error
SDGs	122	11
SDGs C.C.	203.5	14.3
$\langle R_e \rangle$	1.61	0.29
$\langle n \rangle$	3.0	0.6
$\langle b/a \rangle$	0.54	0.18
$\langle M_* \rangle$	$8.7\times10^{10}M_\odot$	$2.5\times10^{10}M_\odot$
$\langle V_{abs} \rangle$	-20.68	0.37
$\langle Lw-age \rangle$	9.62	1.94
$\langle Mw-age \rangle$	12.02	1.28
Ellipticals frac. C.C.	22.8%	-
S0s frac. C.C.	67.3%	-
Late-type frac. C.C.	9.9%	-

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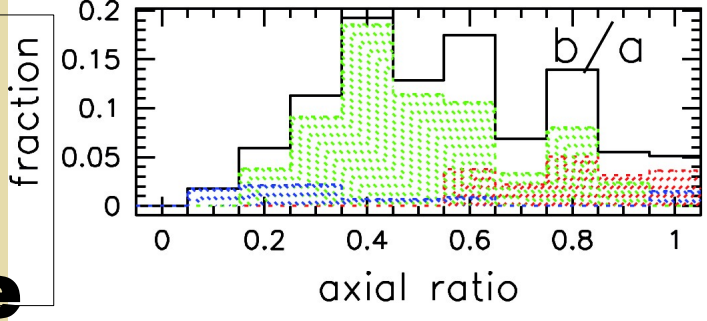
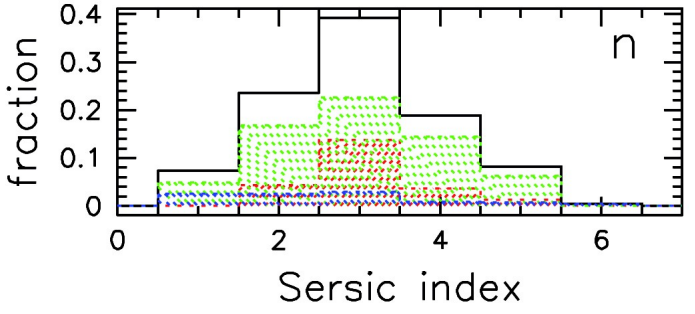
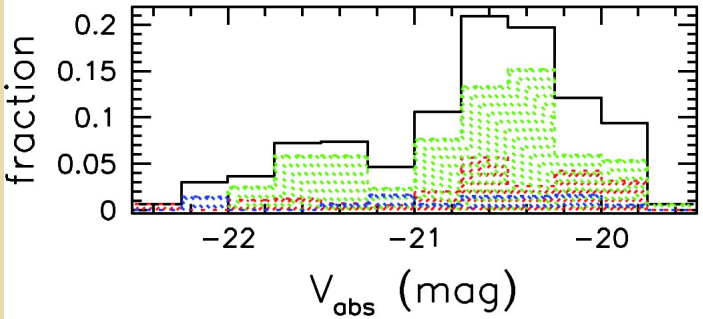
WINGS SDGs properties

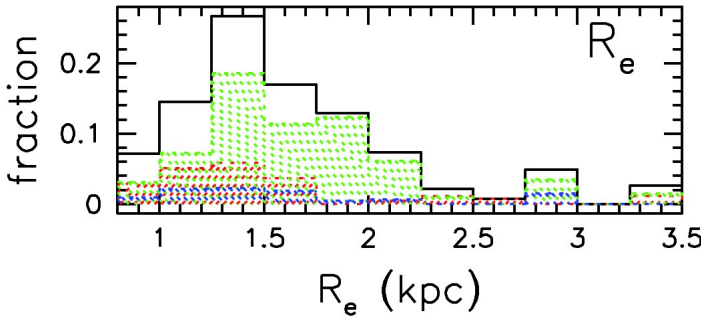
- Flattened
- Low n
- Low Re
- High luminosity
- Low CCD
- High mass
- High LD
- Old ages

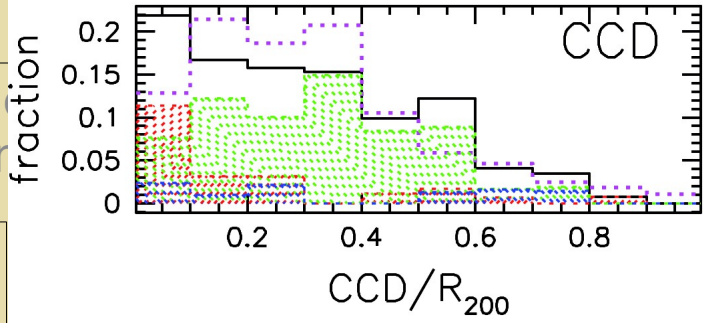
WHY ARE THEY NOT DETECTED?

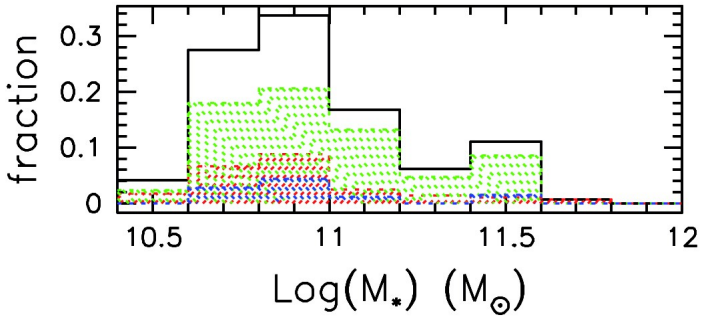


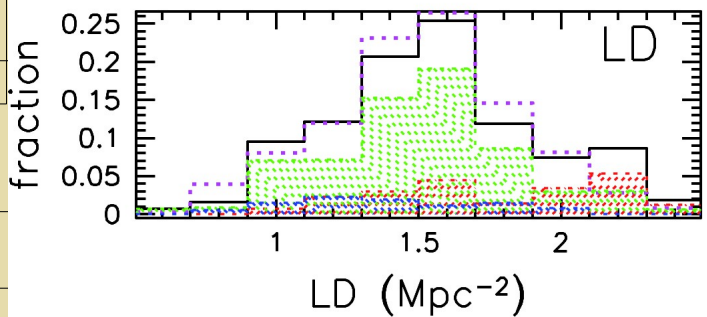


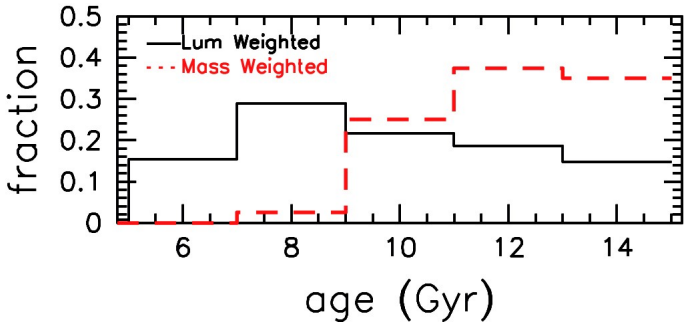












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Where are local compact galaxies?

SDSS Reloaded

Taylor+10: truly, some are there…

ON THE DEARTH OF COMPACT, MASSIVE, RED SEQUENCE GALAXIES IN THE LOCAL UNIVERSE

EDWARD N TAYLOR[1,2], MARIJN FRANX[1], KARL GLAZEBROOK[3], JARLE BRINCHMANN[1], ARJEN VAN DER WEL[4], AND PIETER G VAN DOKKUM[5]

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Draft version July 27, 2009

ABSTRACT

Using data from the Sloan Digital Sky Survey (SDSS; data release 7), we have conducted a search for local analogs to the extremely compact, massive, quiescent galaxies that have been identified at $z \gtrsim 2$. We show that incompleteness is a concern for such compact galaxies, particularly for *low* redshifts ($z \lesssim 0.05$), as a result of the SDSS spectroscopic target selection algorithm. We have identified 63 $M_* > 10^{10.7}$ $M_\odot$ ($\approx 5 \times 10^{10}$ $M_\odot$) red sequence galaxies at $0.066 < z_{\rm spec} < 0.12$ which are smaller than the median size–mass relation by a factor of 2 or more. Consistent with expectations from the virial

1.3% of galaxies are SDGs…

Our reliable spectroscopic data comes mainly from the south sample…

Number Densities

The volume covered by WINGS

$$V_{WINGS} = \frac{4\pi}{3}\left(R_2^3 - R_1^3\right)(1-\sin b) = 5.73\times10^7 Mpc^3$$

Criteria	WINGS $10^{-5}Mpc^{-3}$	Literature $10^{-5}Mpc^{-3}$
SDGs	1.31 ± 0.09	-
SDGs $M_* \geq 8\times10^{10}M_\odot$	0.46 ± 0.05	-
SDGs Lw $-$ age $\geq$ 10Gyr ($z = 1.5$)	0.57 ± 0.06	-
SDGs $R_e \leq$ 1.5kpc	0.68 ± 0.07	-
Quiescent, $3\times10^{10}M_\odot \leq M_* \leq 4\times10^{11}M_\odot$	1.55 ± 0.06	-
Quiescent $z \sim 2.5$, $M_* \geq 10^{11}M_\odot$	0.50 ± 0.06	Bez=3.6
Quiescent $z \sim 1.5$, $10^{10} \leq M_* \leq 10^{11}M_\odot$	1.66 ± 0.10	Cimatti=10
Quiescent $z > 1.5$, $M_* \geq 4\times10^{10}M_\odot$	1.80 ± 0.11	Wuyts=11
Quiescent $z > 1.5$, $M_* \geq 10^{11}M_\odot$	1.09 ± 0.08	Wuyts=4.5

EDisCS high-z clusters dataset

White+05 A&A,444,365

Multi-wavelength photometric and spectroscopic survey of galaxies in 20 fields containing galaxy clusters at $0.4<z<1$

We use 8 of these clusters with HST-ACS images F814W band and $\sigma_{clus}\sim700$km/s and $z\sim0.65$

EDisCS high-z

Superdense Galaxies

41% of EDisCS cluster galaxies are superdense

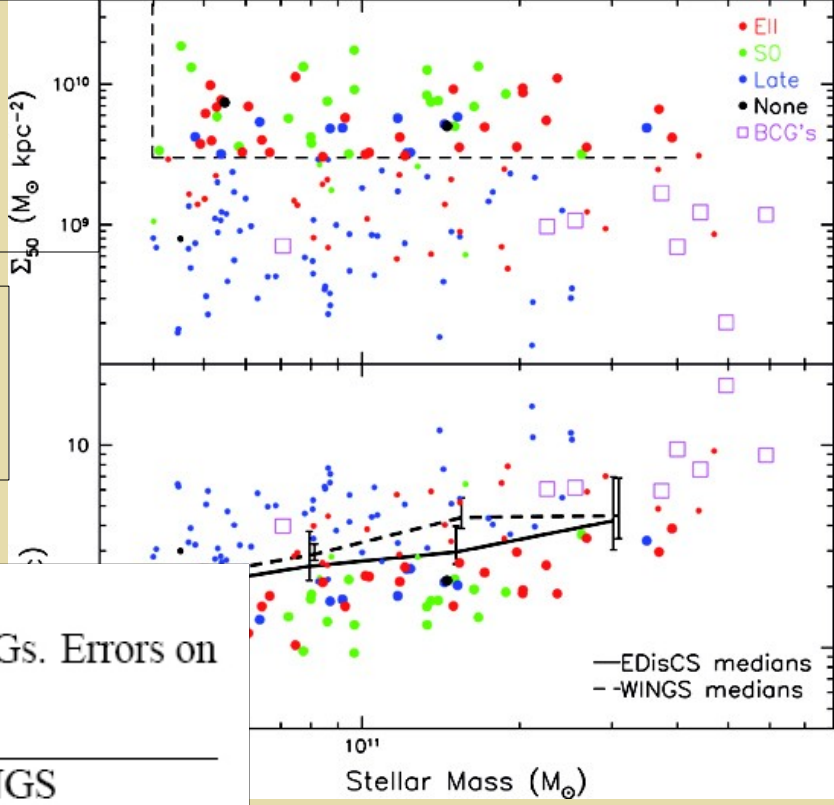

Table 1
Completeness corrected quantities of EDisCS and WINGS SDGs. Errors on the medians are reported too.

Quantity	EDisCS	WINGS
SDG fraction	41%	17%
Ellipticals	41%	28%
S0s	36%	64%
Late-type	20%	8%
Unknown morph.	3%	-
Eff. radius $\langle R_e \rangle$	1.70 ± 0.08	1.79 ± 0.04
Sersic index $\langle n \rangle$	3.71 ± 0.14	3.21 ± 0.09
Axial ratio $\langle b/a \rangle$	0.59 ± 0.11	0.62 ± 0.03
Stellar mass $\langle M_* \rangle$	$(1.08 \pm 0.08) \times 10^{11} M_\odot$	$(1.02 \pm 0.04) \times 10^{11} M_\odot$
$\langle Lw - age \rangle$	4.96 ± 0.20	10.43 ± 0.26
$\langle Mw - age \rangle$	7.96 ± 0.17	12.55 ± 0.17

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They are similar to WINGS and literature high-z studies SDGs

Conclusions (1)

1) Superdense galaxies are found in local clusters

2) Superdense galaxies are present in high-z clusters too, and are similar to the low-z ones.

3) Low-z SDGs represent the 22% of the total cluster population with M*>3x1010Msol

Fare clic per modificare lo stile del sottotitolo dello schema

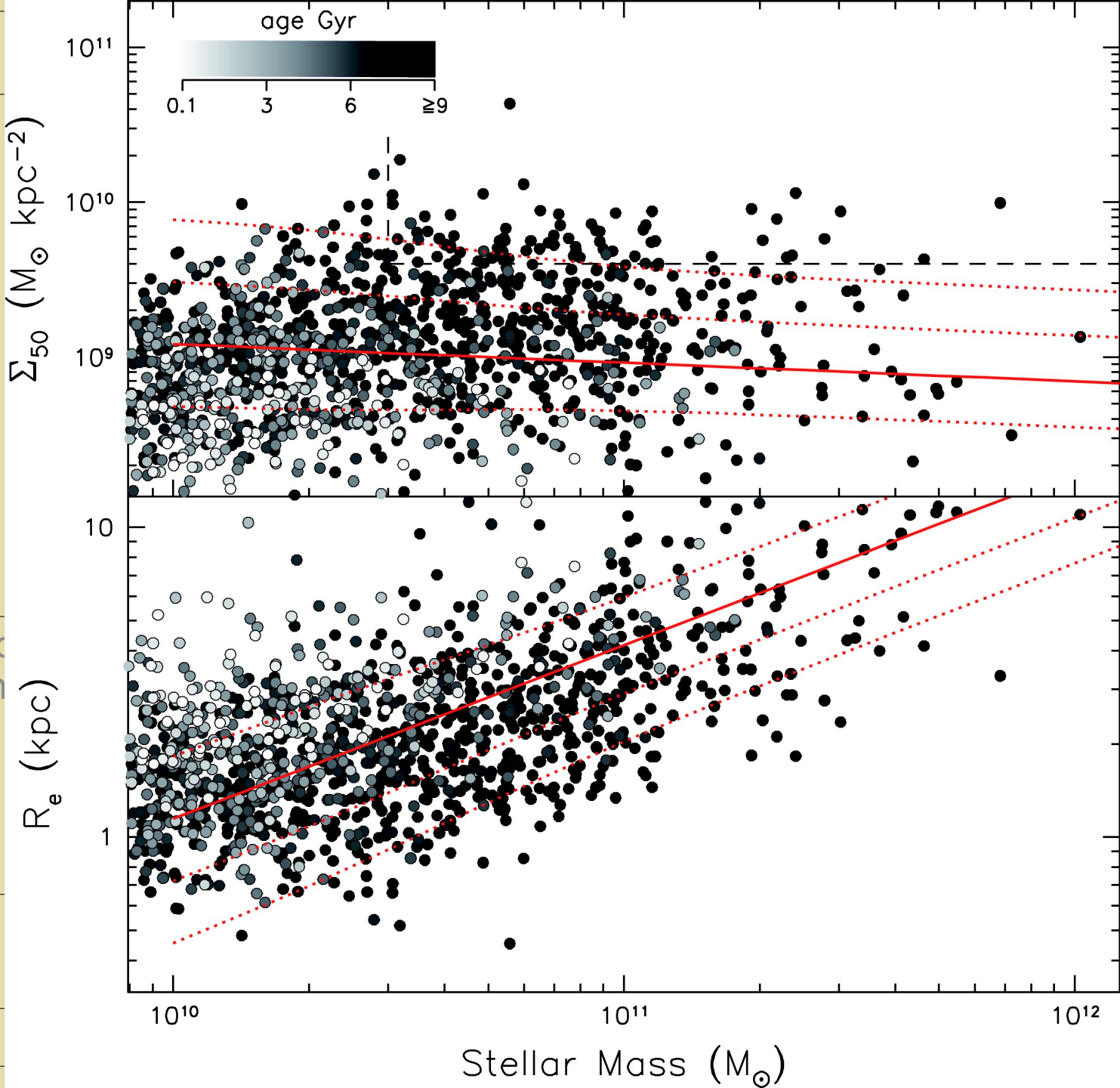
4) The fraction of SDGs is evolving with redshift.

Now let's focus on mass-size relations and size evolution!

Ages

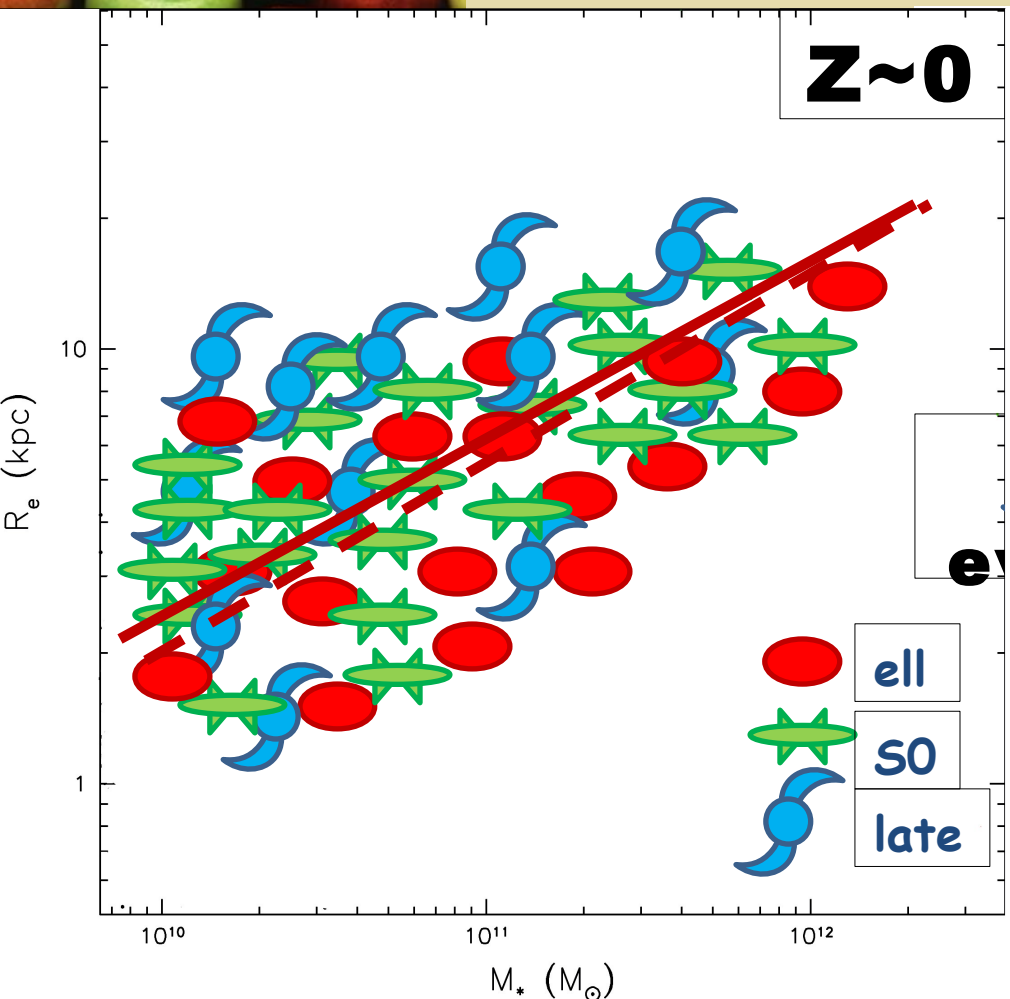
Combined effect of mass and size in determining the luminosity-weighted age.

Selecting galaxies to be old at a certain redshift is equivalent to select the more compact ones.



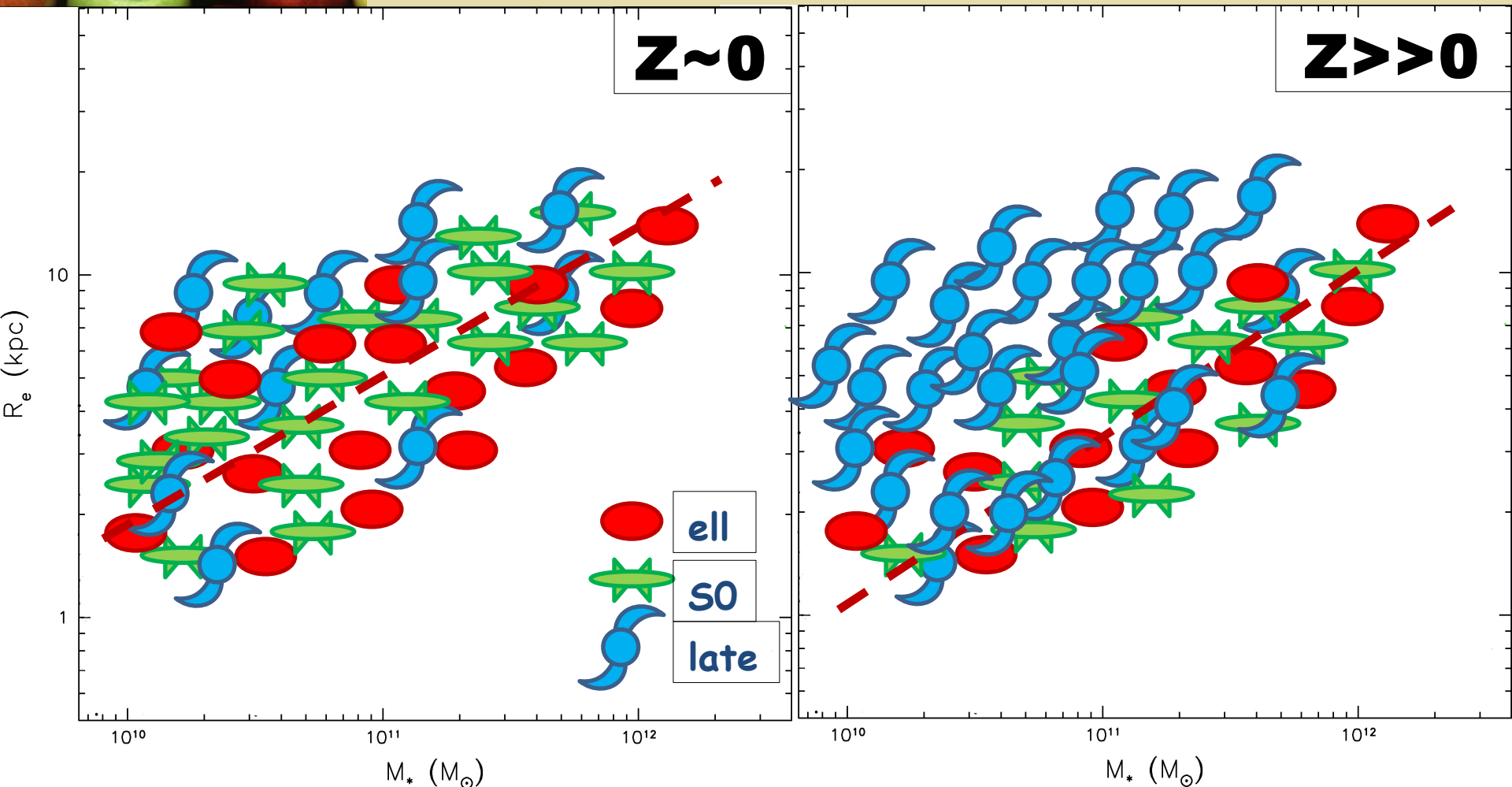
Are both the high- and the low-z samples APPLES?

Selecting passive galaxies at high-z, is just like selecting the most compact…



Are both the high- and the low-z samples APPLES?

We need to select low-z galaxies which where passive at the redshift we are looking at…

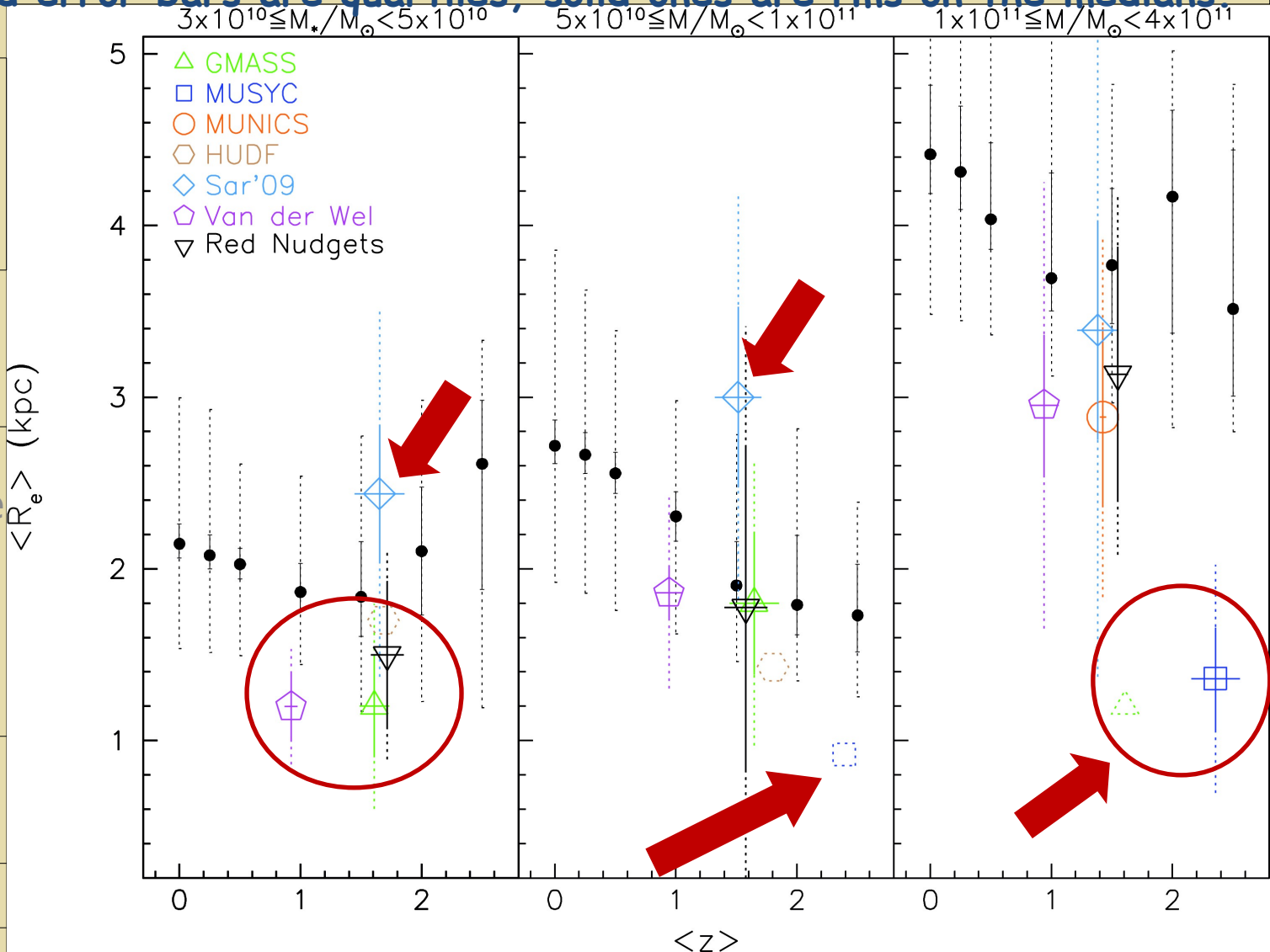


Fictitious evolution due to age effects

Median effective radius of WINGS galaxies that stopped forming stars (i.e. with luminosity-weighted ages) at least >1.5 Gyr before the observed redshift. Dotted error bars are quartiles, solid ones are rms on the medians.

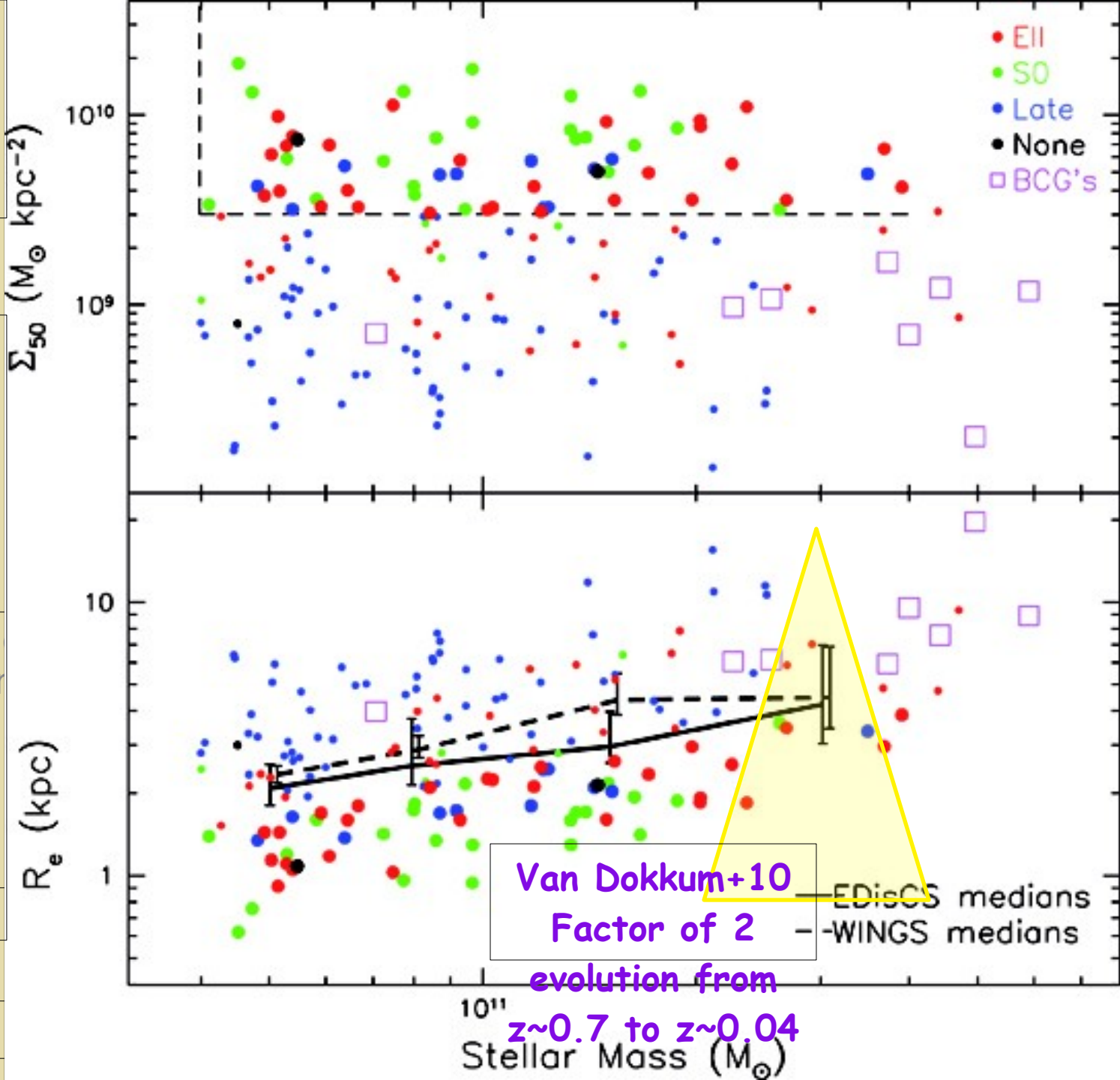
No need of size evolution !

Fare sche



EDisCS Clusters z~0.7

Median sizes of high-z cluster galaxies are generally consistent (total size evolution 1.18) with the local ones.
A maximum offset of a factor of 1.5 at the 1 sigma level at M*~2x1011Msol



BCGs

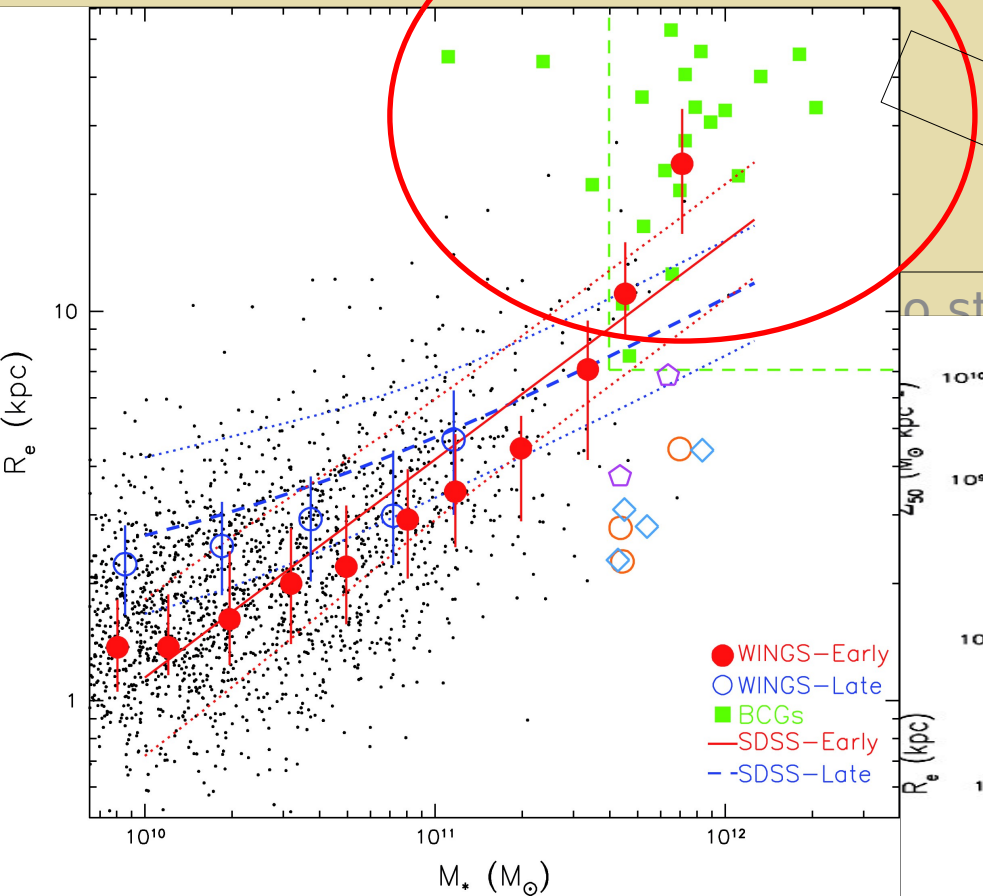
Mass and size evolve of a factor of 2 and 4 respectively, from z~0.7 to z~0.04

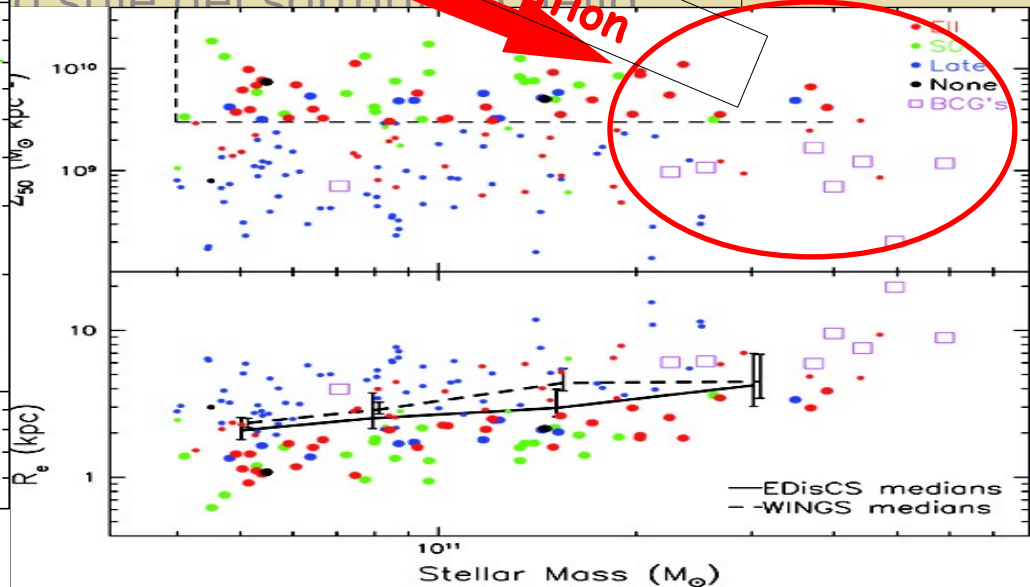
Evolution is compatible with other observations (Bernardi09)

Evolution is compatible with models (De Lucia&Blaizot07)

Consistent with Whiley+08 and Hopkins+10

Mass and size evolution



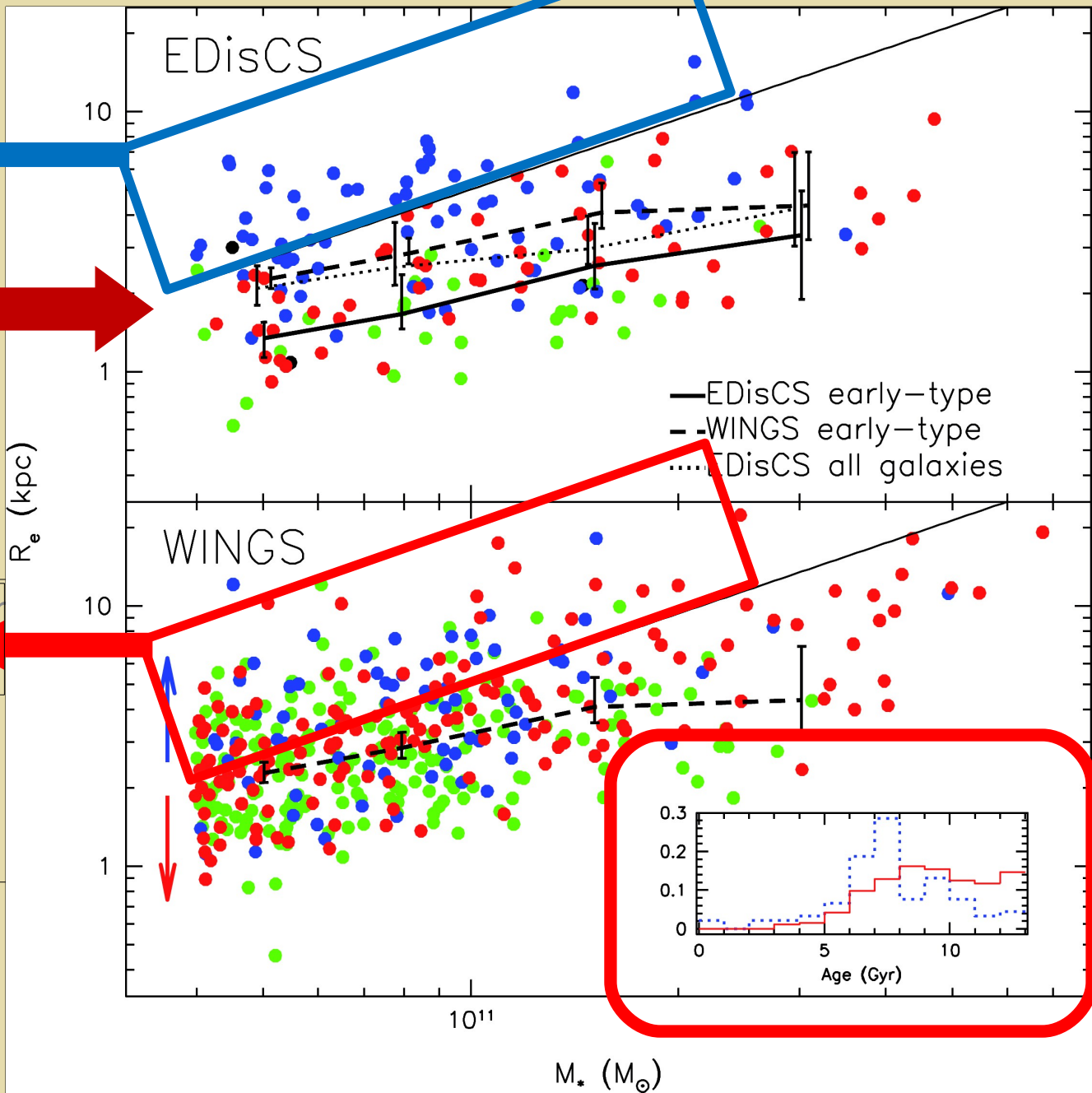


The morphological change

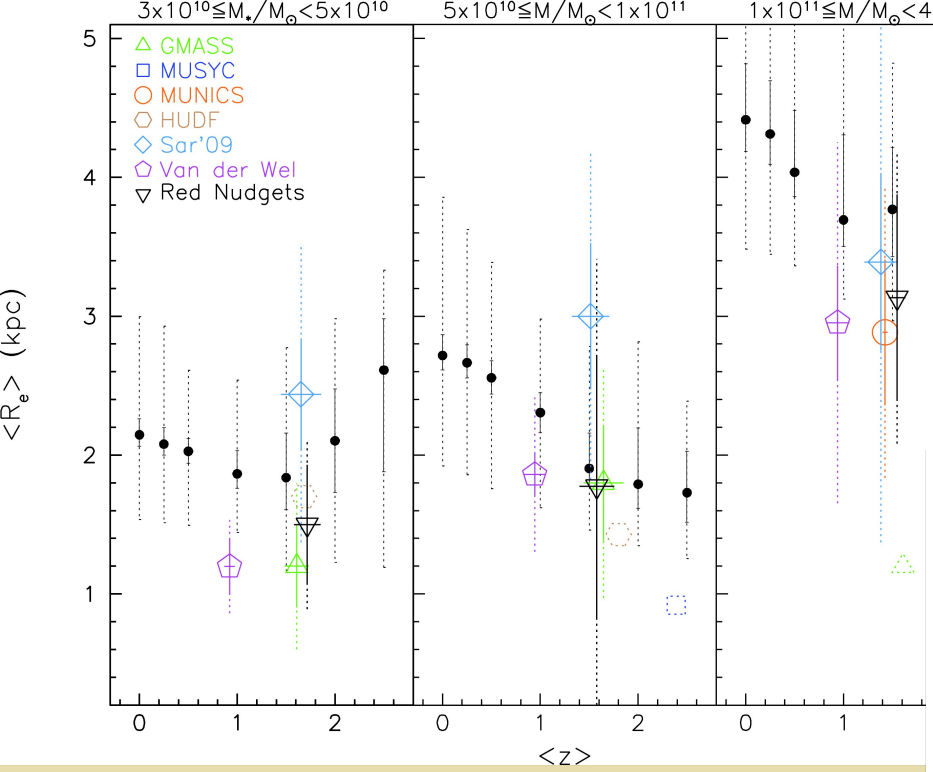
Only late-types in EDisCS

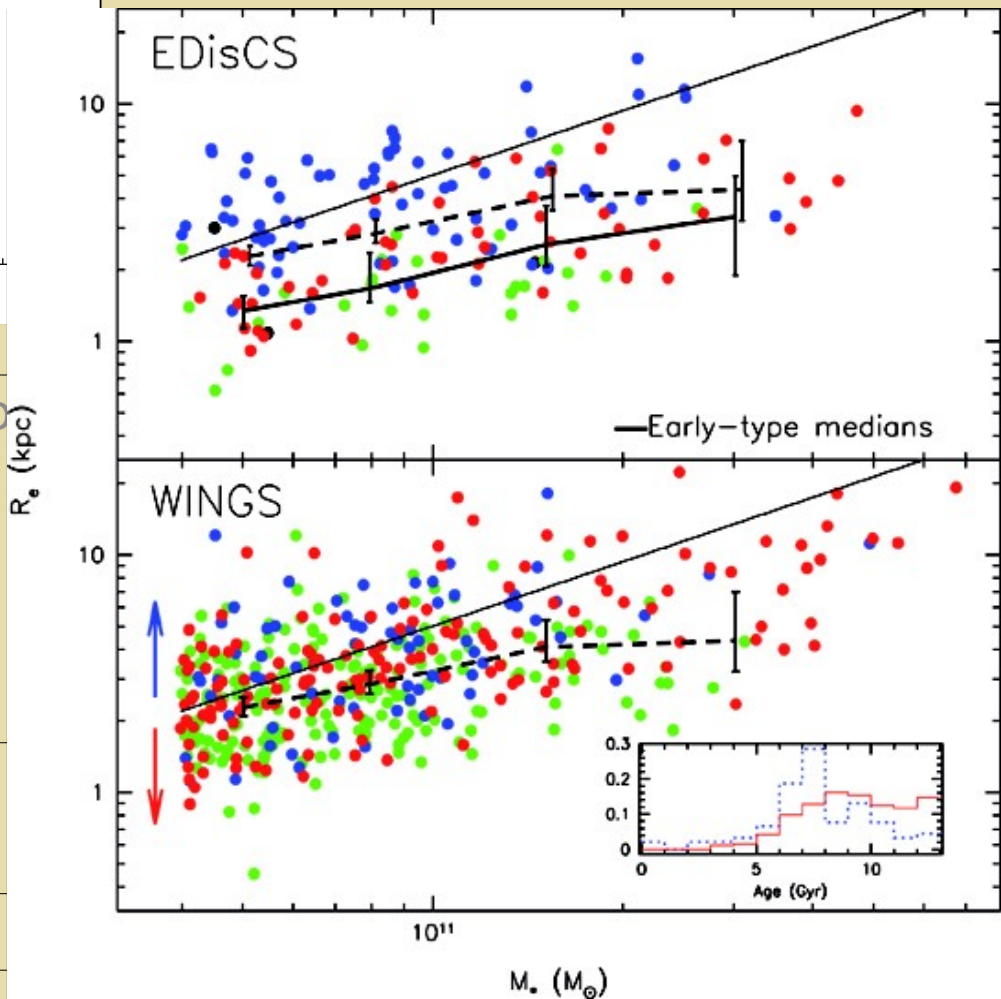
Size evolution???

78% of early-types in WINGS



Selection effects





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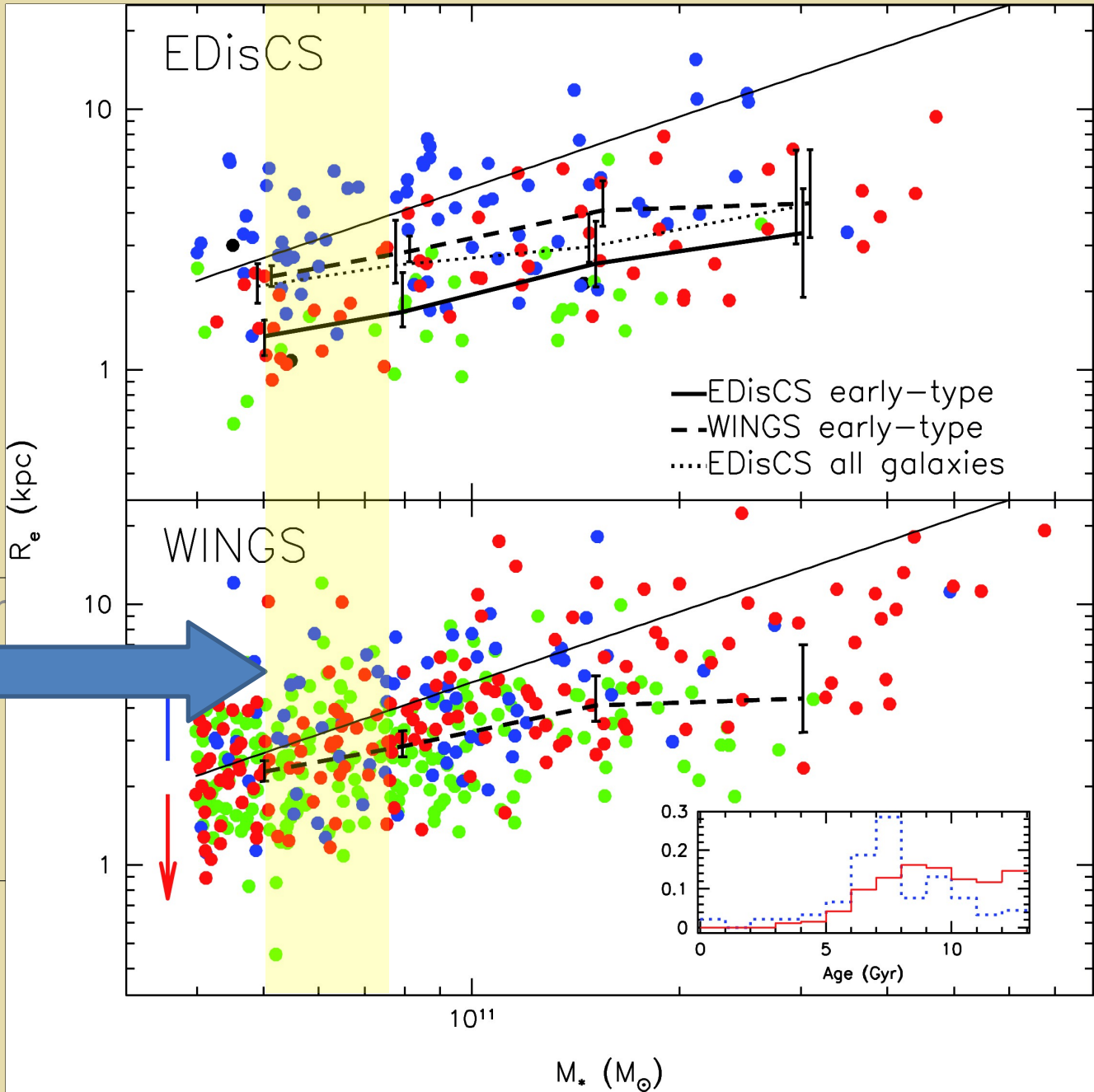
Both star formation activity and morphology can rapidly change in the hostile cluster environment. If not properly taken into account, those mechanisms can introduce biases when comparing high- with low-z samples.

Mass selected samples… a note….



Feeding of large late-type galaxies which are increasing mass through star formation.

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Conclusions (2)

1) Local and high-z mass-size relations are compatible between each other (factor of 1.18)

2) Luminosity-weighted age selection effects must be taken into account, as they can mimic a fictitious evolution of size with redshift

3) Morphology selection effects are at least as important as age-selection effects.

4) BCG and BCG-like galaxies do evolve in size with redshift significantly

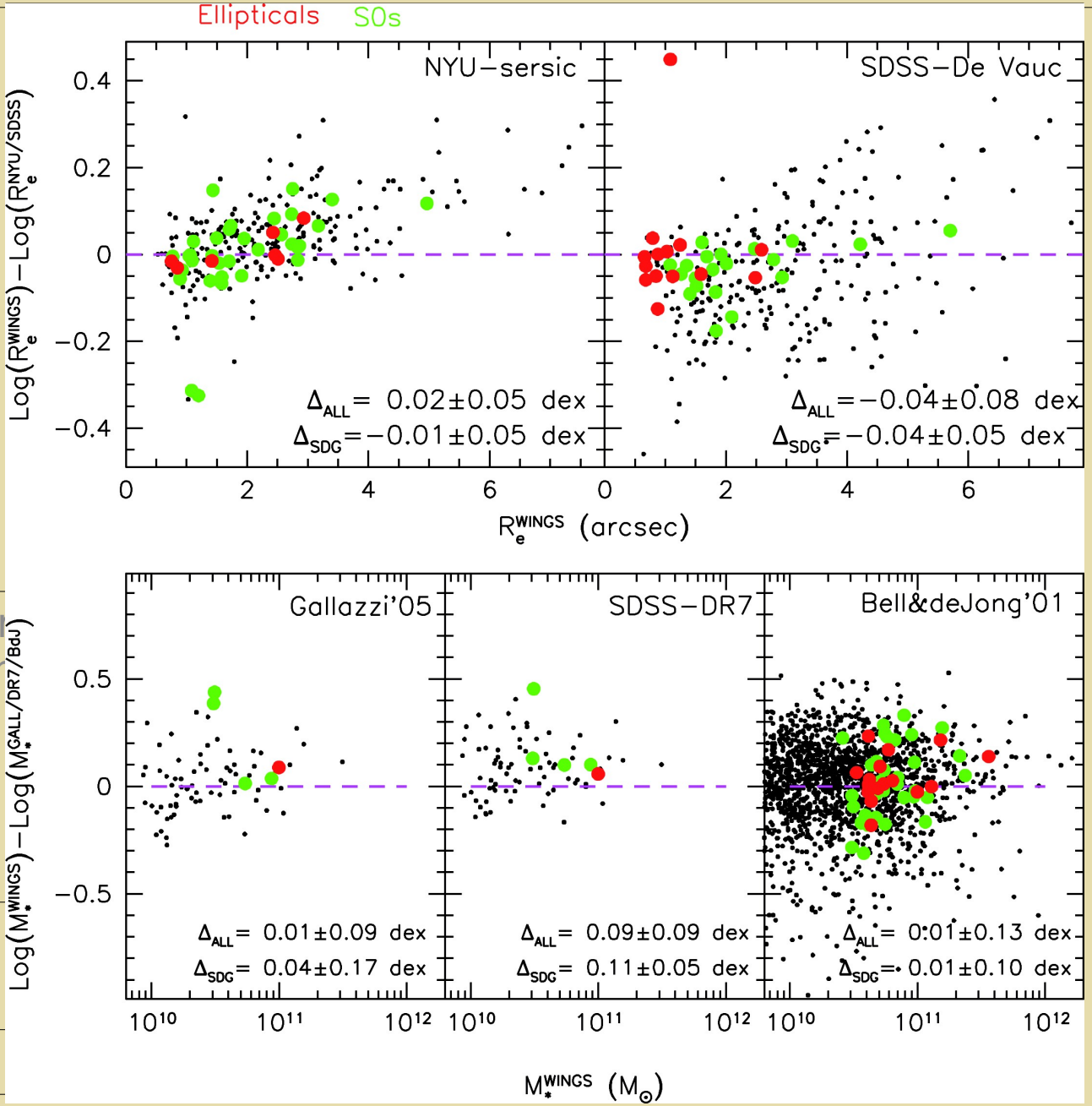
Mio figlio
a z~3

fra poco
sarò papà…

Fare clic per modificare lo stile del sottotitolo dello schema

Un grazie superdenso a tutti quanti

WINGS checks



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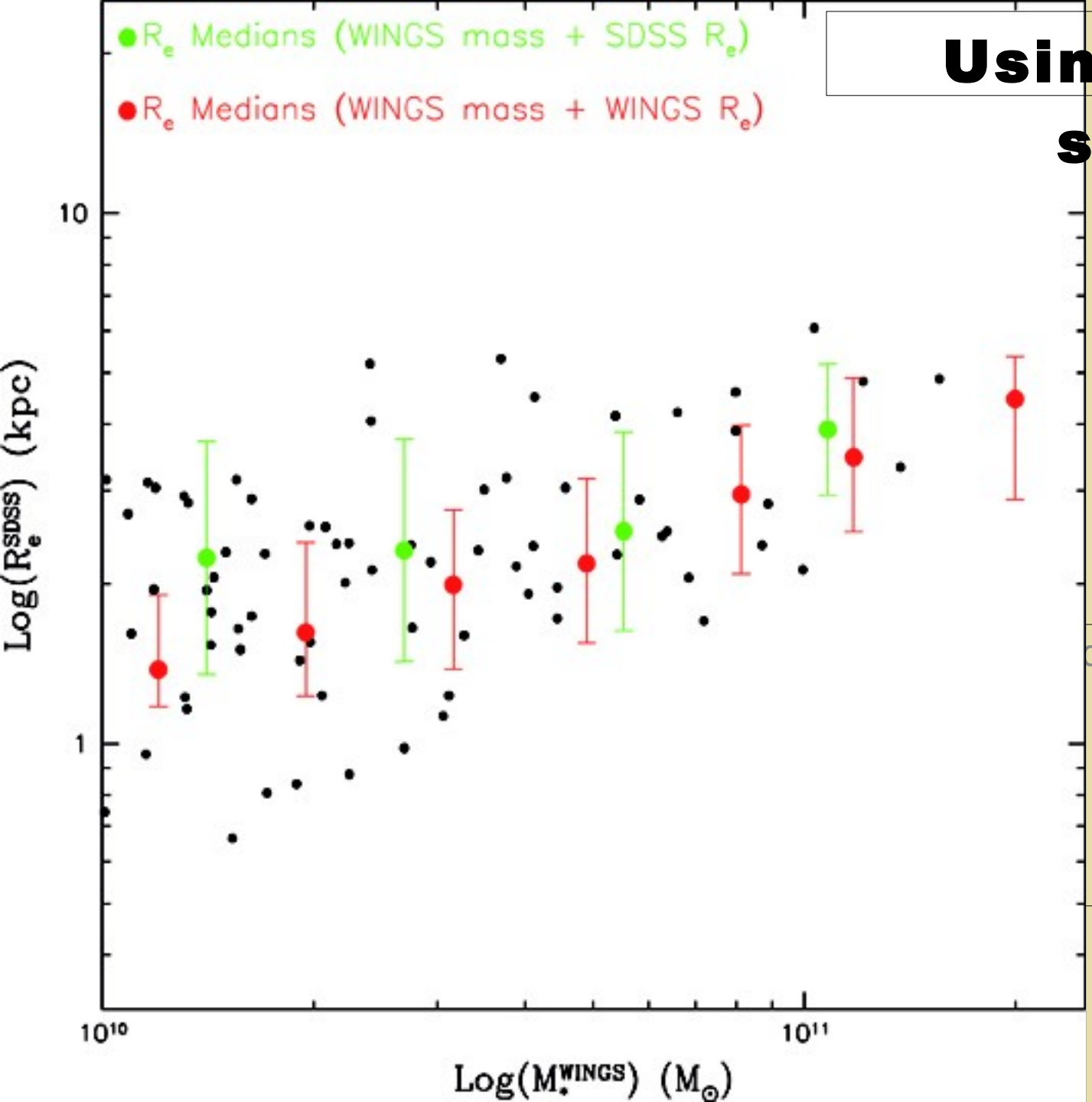
Using SDSS sizes



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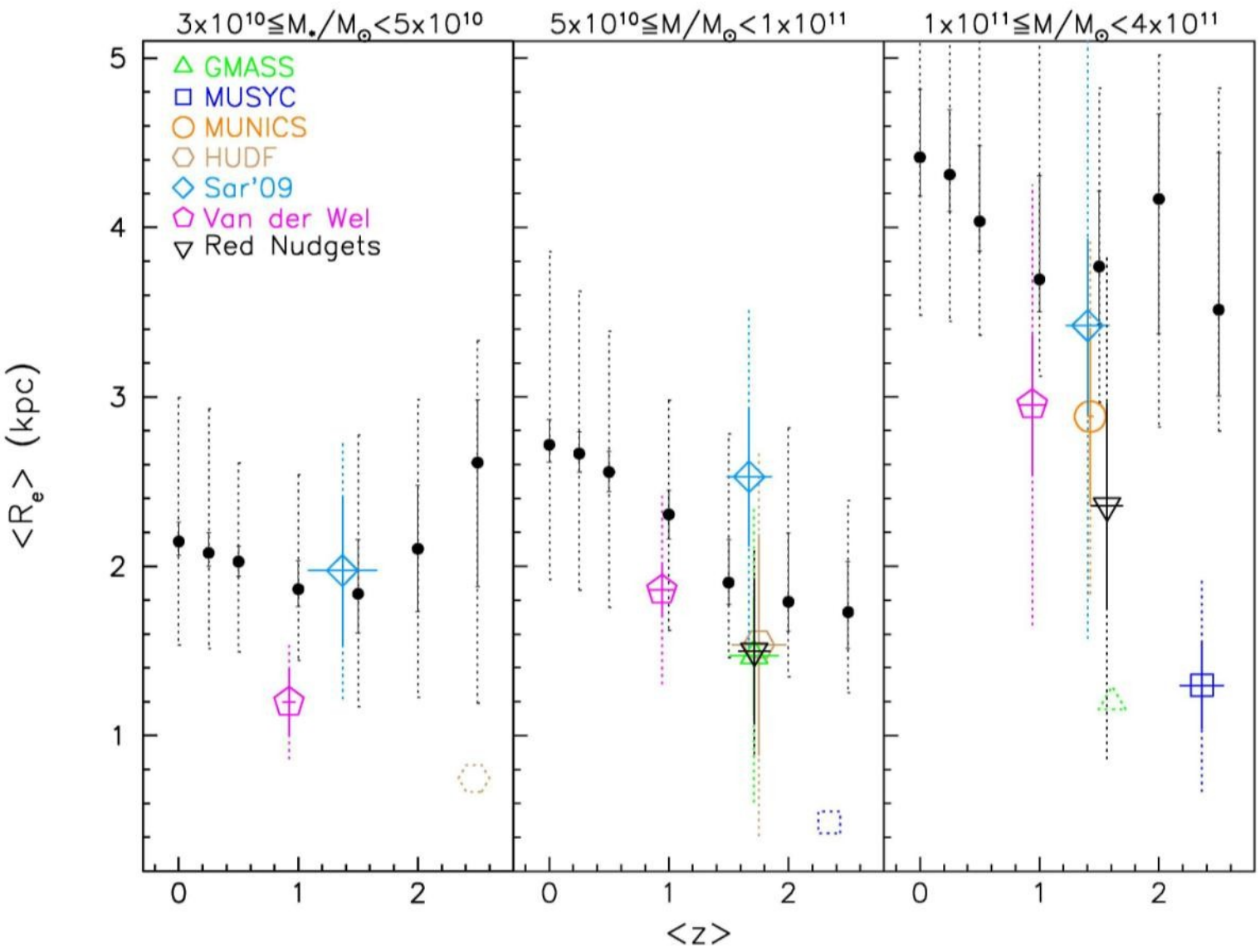
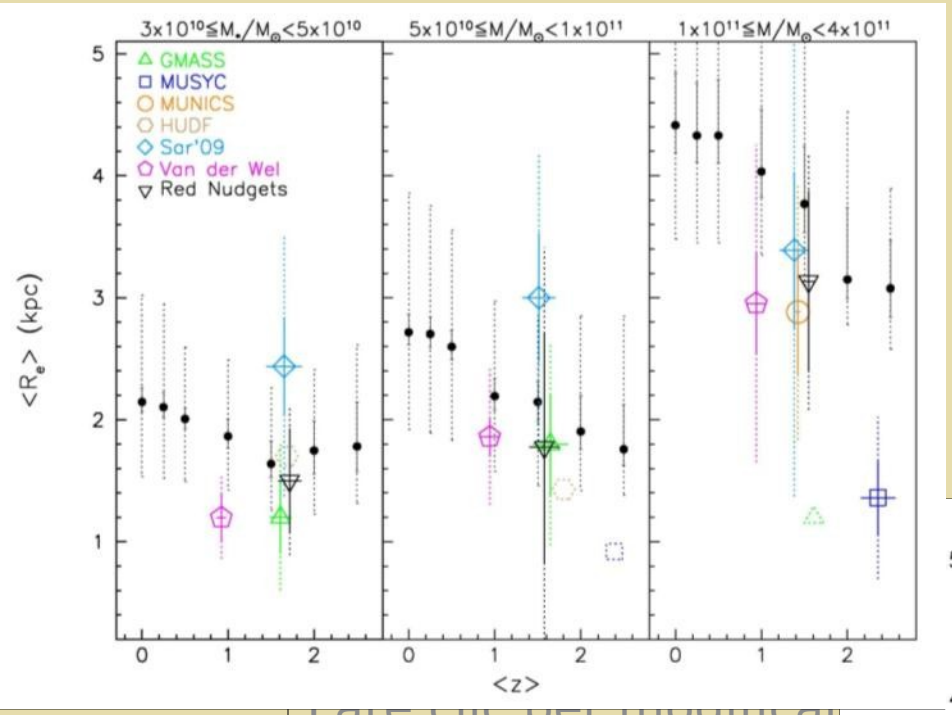
Using BC03 instead of MA05



Choosing a single metallicity bin



Z=0.0

2

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schema

Z=0.0

5