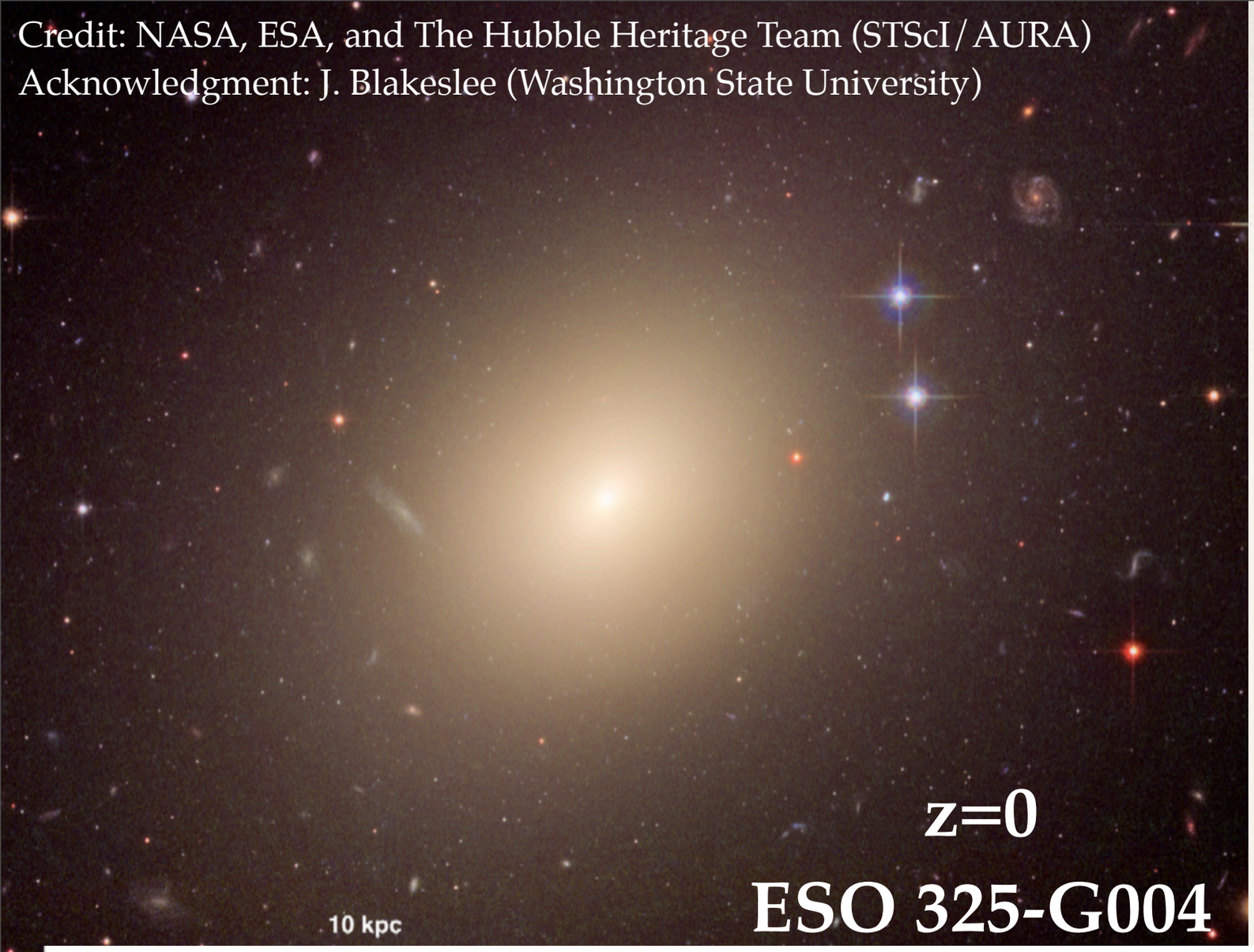
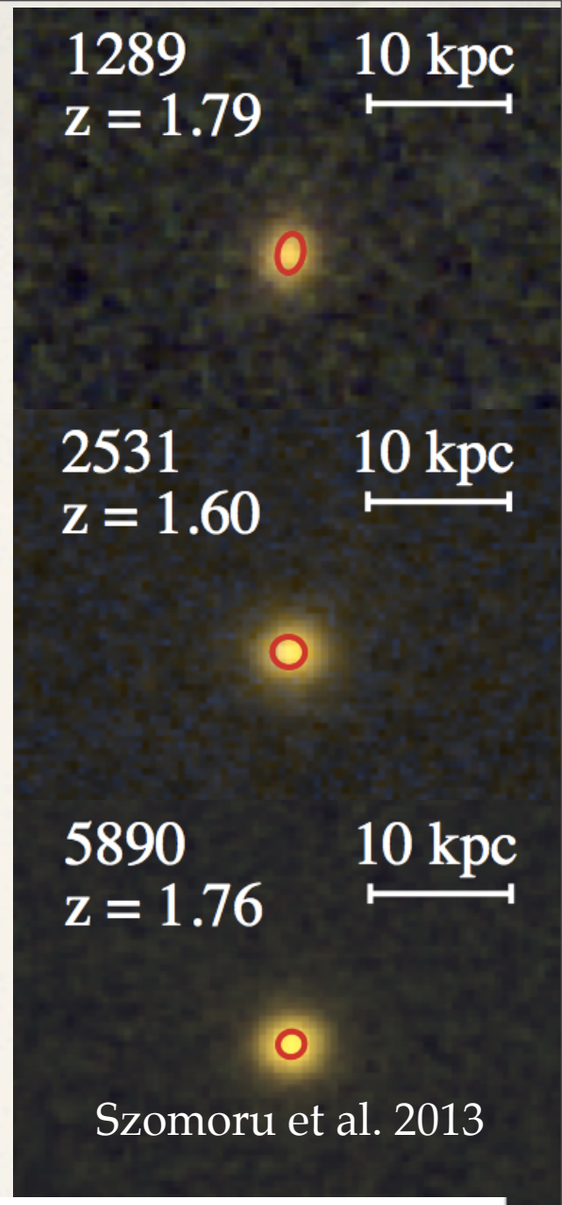
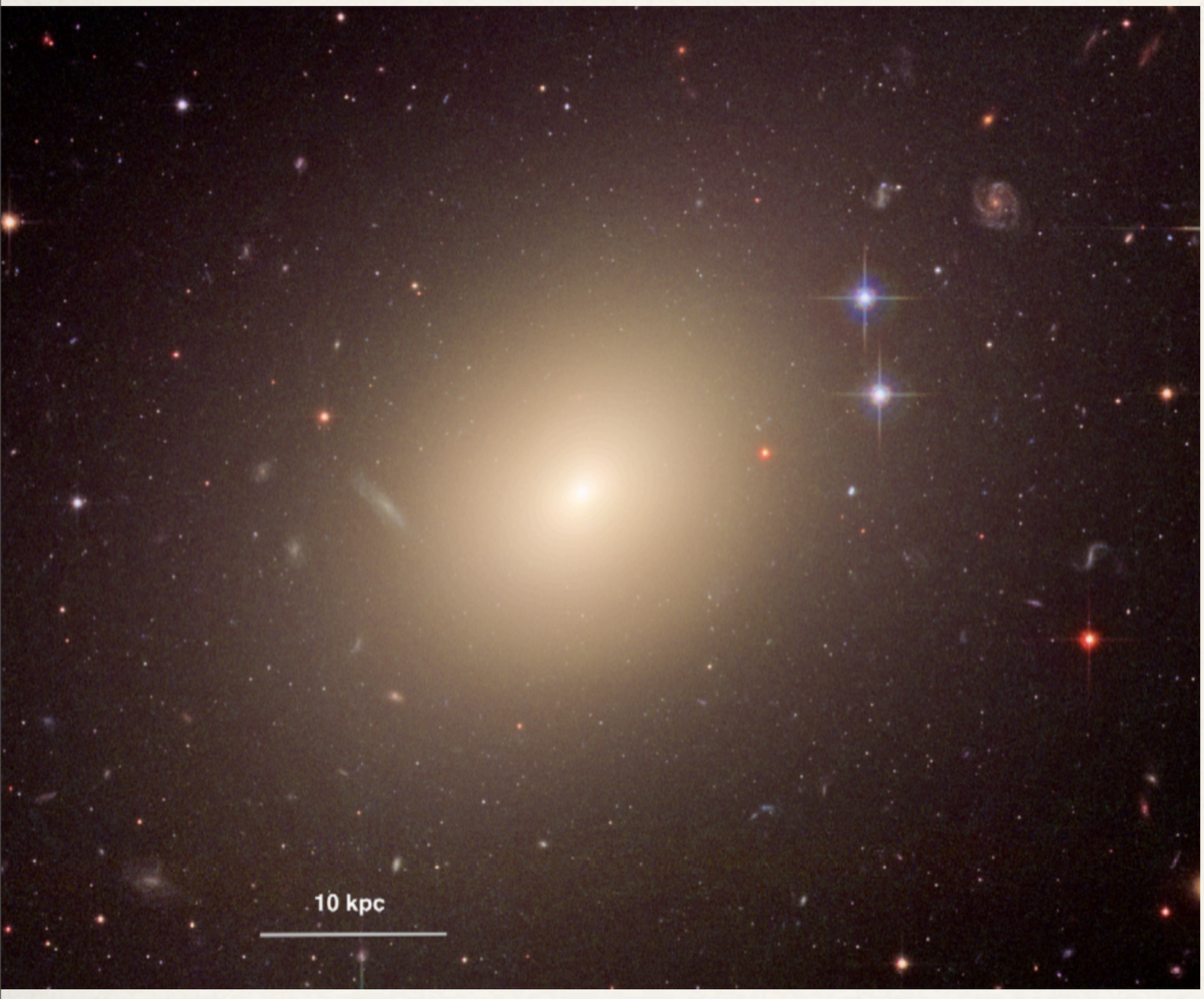


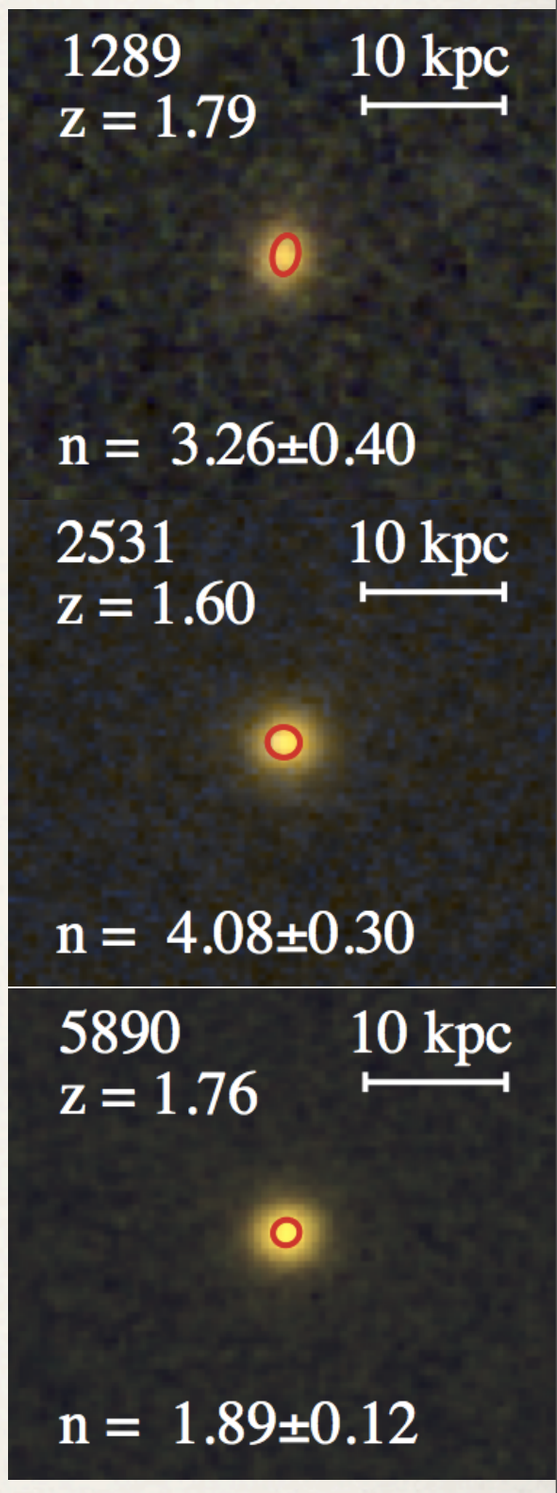

# Intermediate-redshift compact quiescent galaxies

**Ivana Damjanov (Harvard-Smithsonian CFA)**

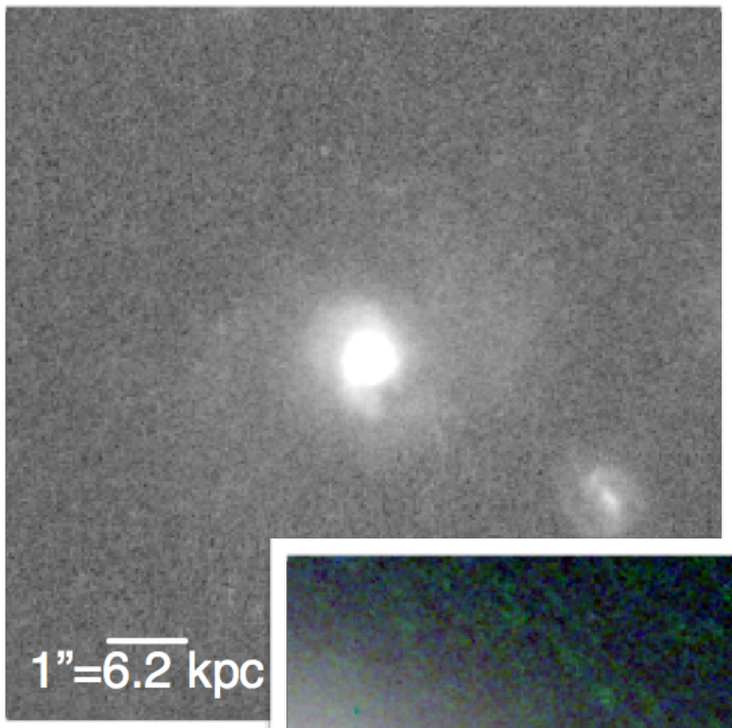
(with Margaret Geller (SAO), H. Jabran Zahid (SAO),
Igor Chilingarian (SAO),Ho Seong Hwang (SAO/KASI))

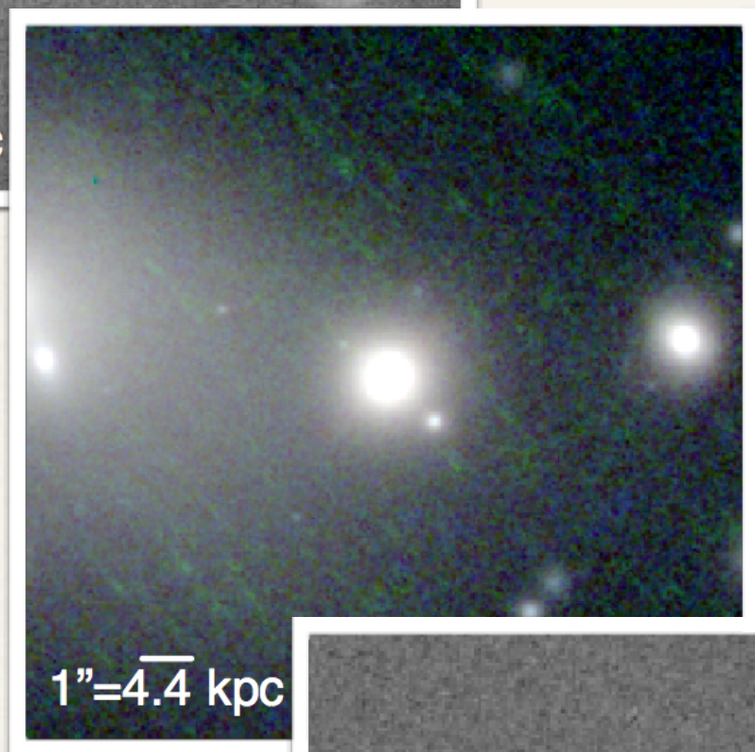

10 kpc

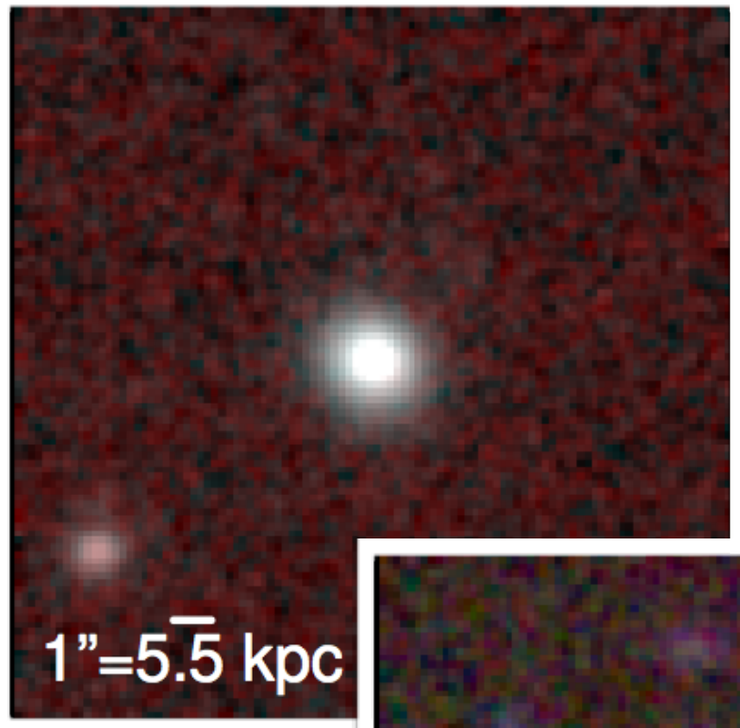
?

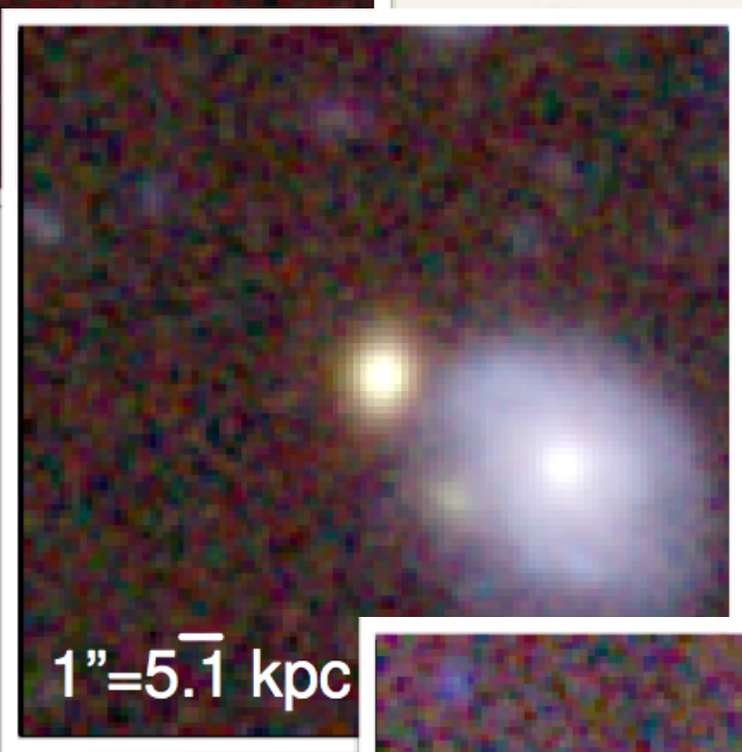

1289
z = 1.79
10 kpc
n = 3.26±0.40
2531
z = 1.60
10 kpc
n = 4.08±0.30
5890
z = 1.76
10 kpc
n = 1.89±0.12

?



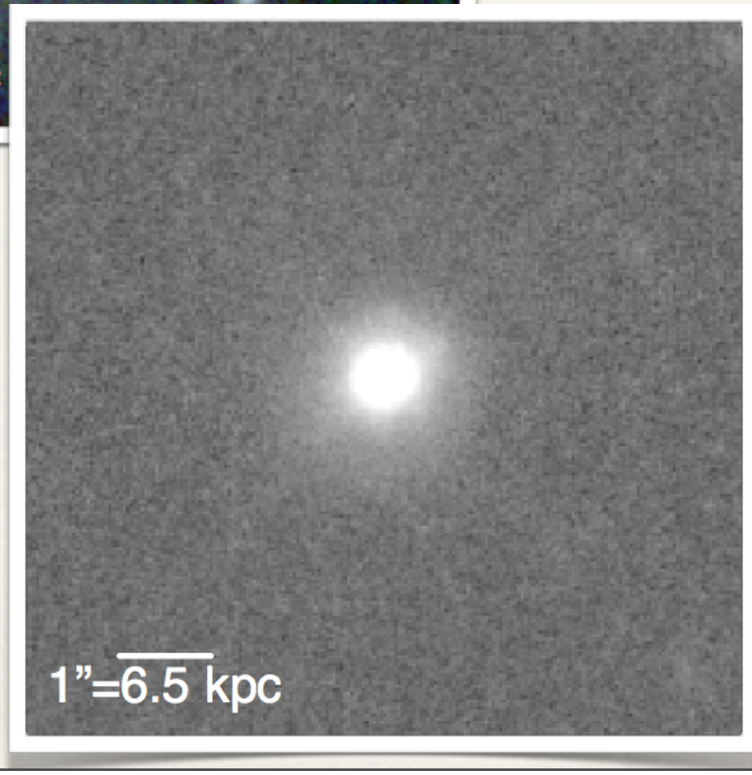



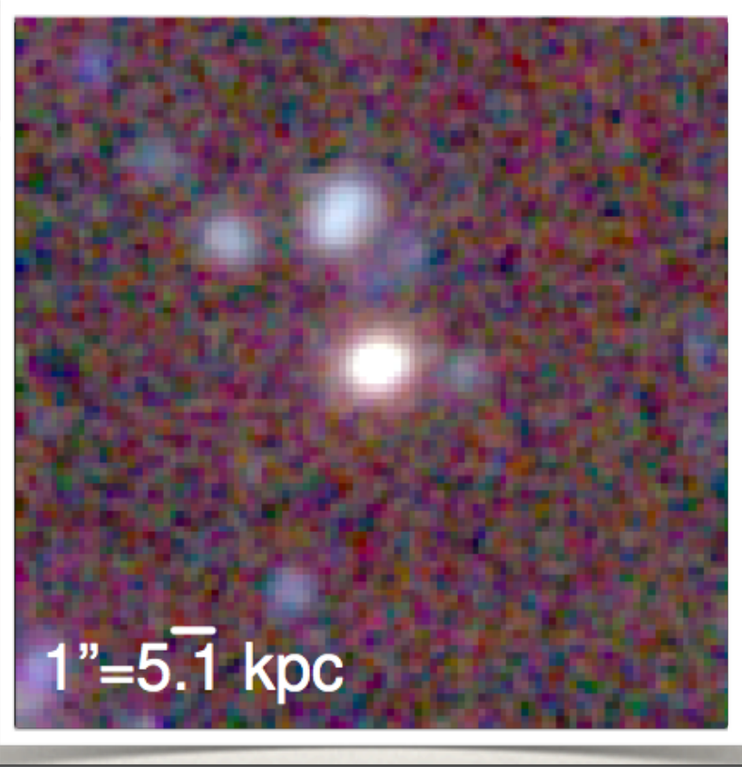




CFHT
Damjanov
et al. 2014

HST
Damjanov
et al. 2013



# A mystery

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- discovered at z>1.5 a decade ago (Daddi et al. 2005)...
- many many many studies confirmed the compactness...

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  - relics of high-z targets don't exist (Taylor et al. 2010)?
  - relics do exist (Valentinuzzi et al. 2010, Poggianti et al. 2013)?

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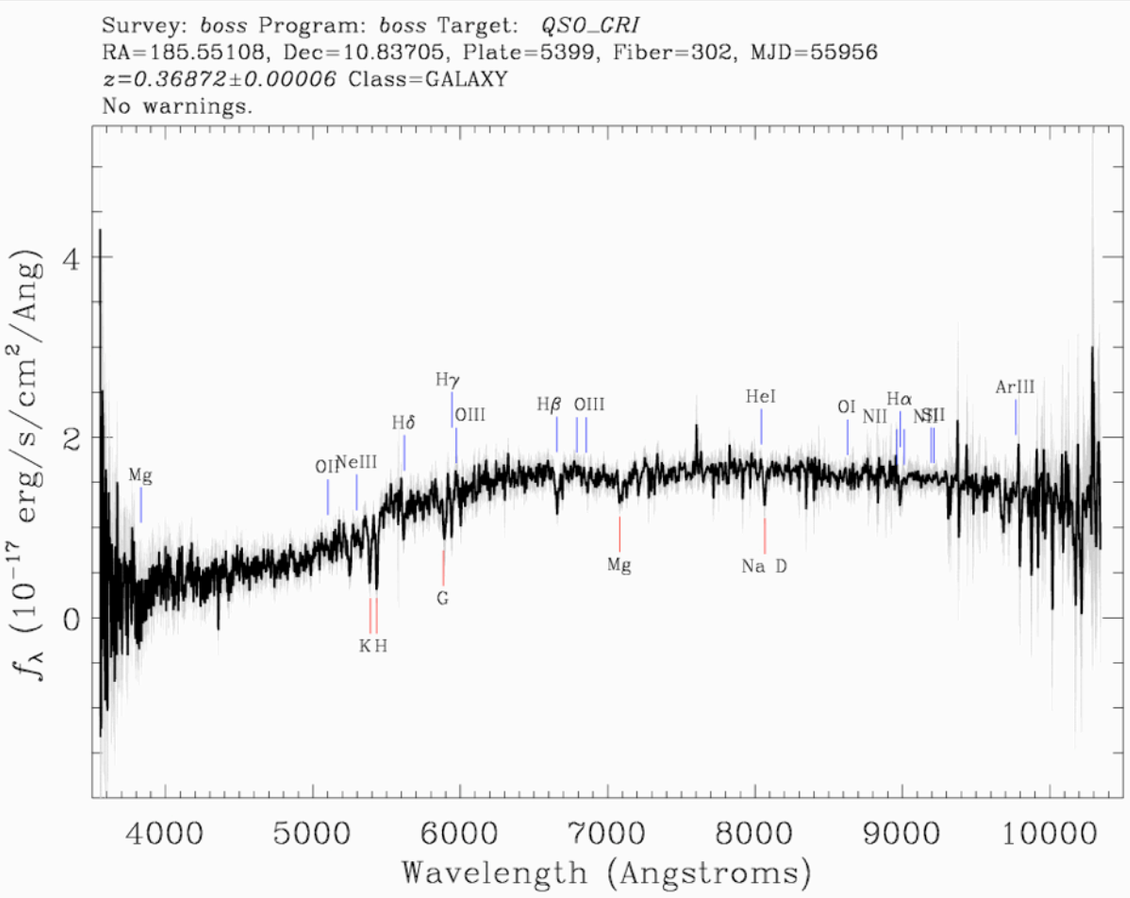
- **Intermediate-redshift regime - crucial!**

# Compact candidates in SDSS/BOSS

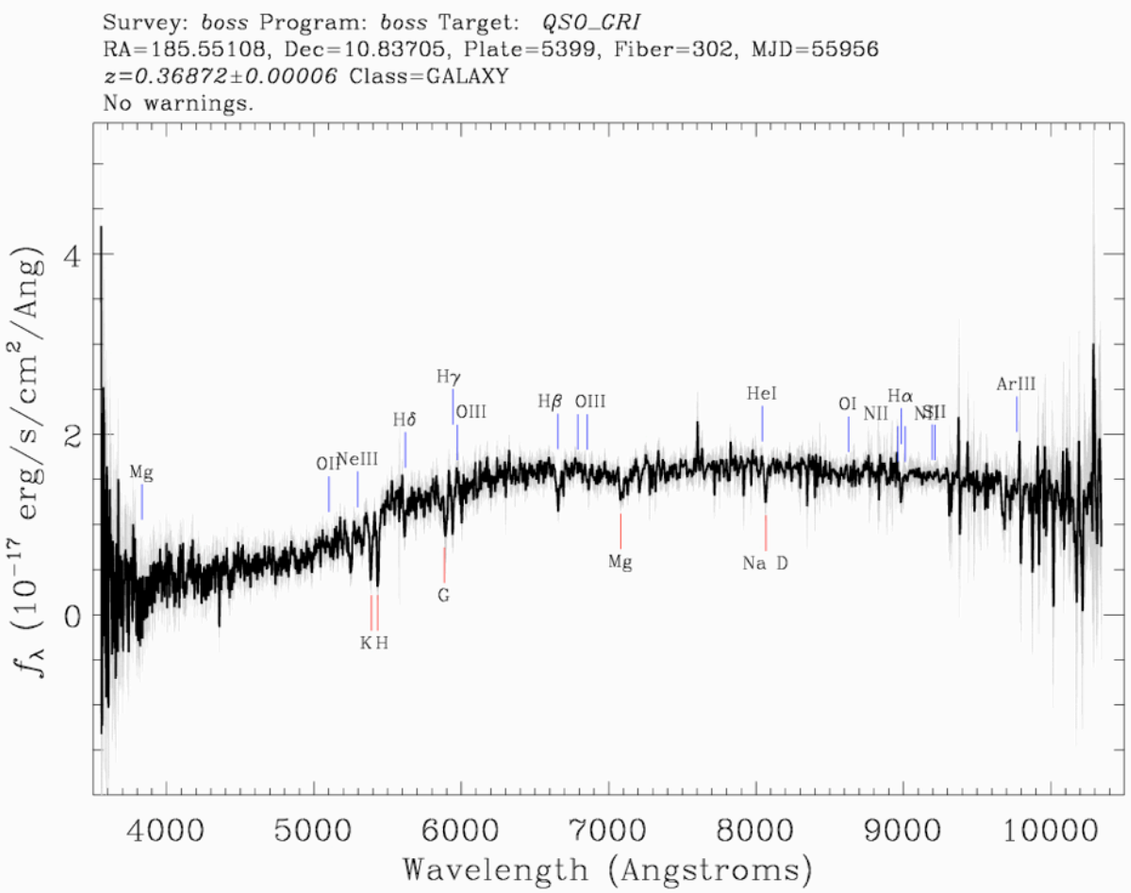
## Spectroscopy



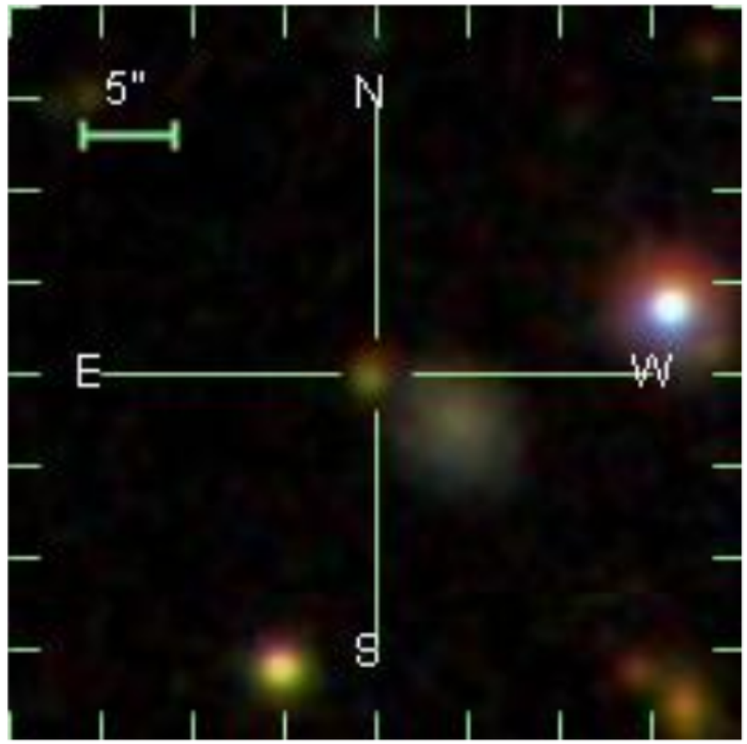

Passive GALAXY at z~0.37

# Compact candidates in SDSS/BOSS

## Spectroscopy




## Imaging

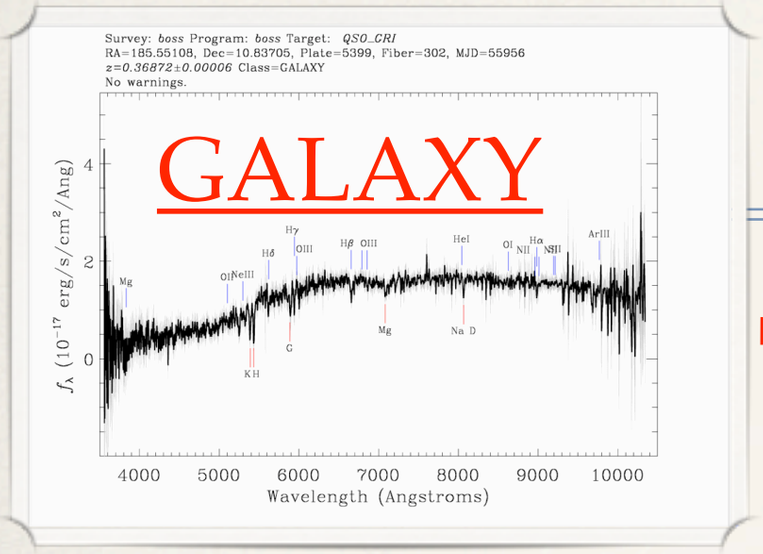



**Object Type (type):**STAR

Passive GALAXY at z~0.37

classified as a STAR

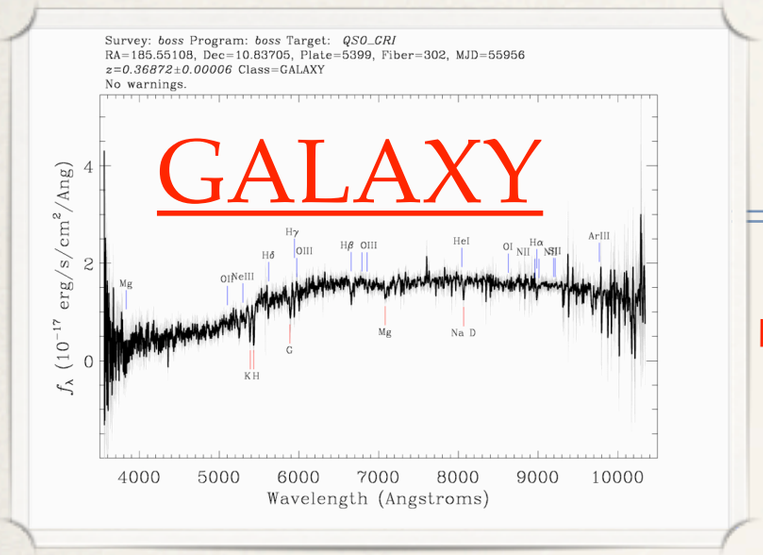
# SDSS/BOSS targets are compact





**Spectroscopy** **Imaging**

# SDSS/BOSS targets are compact

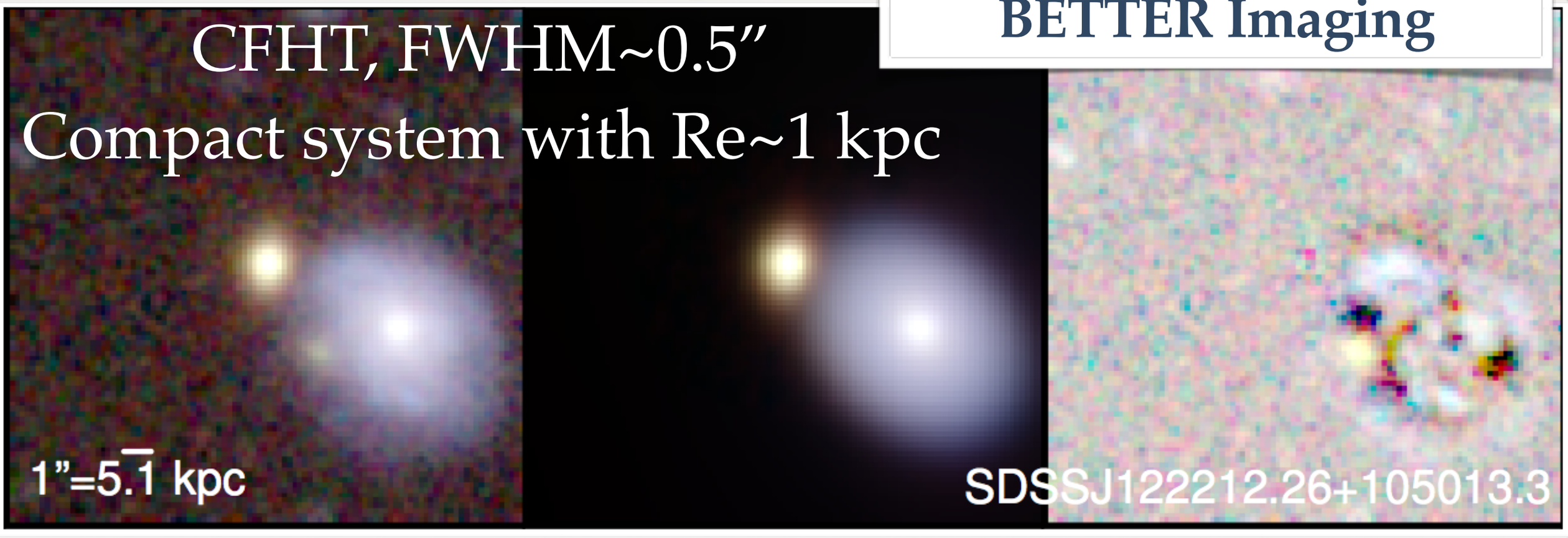




**Spectroscopy**

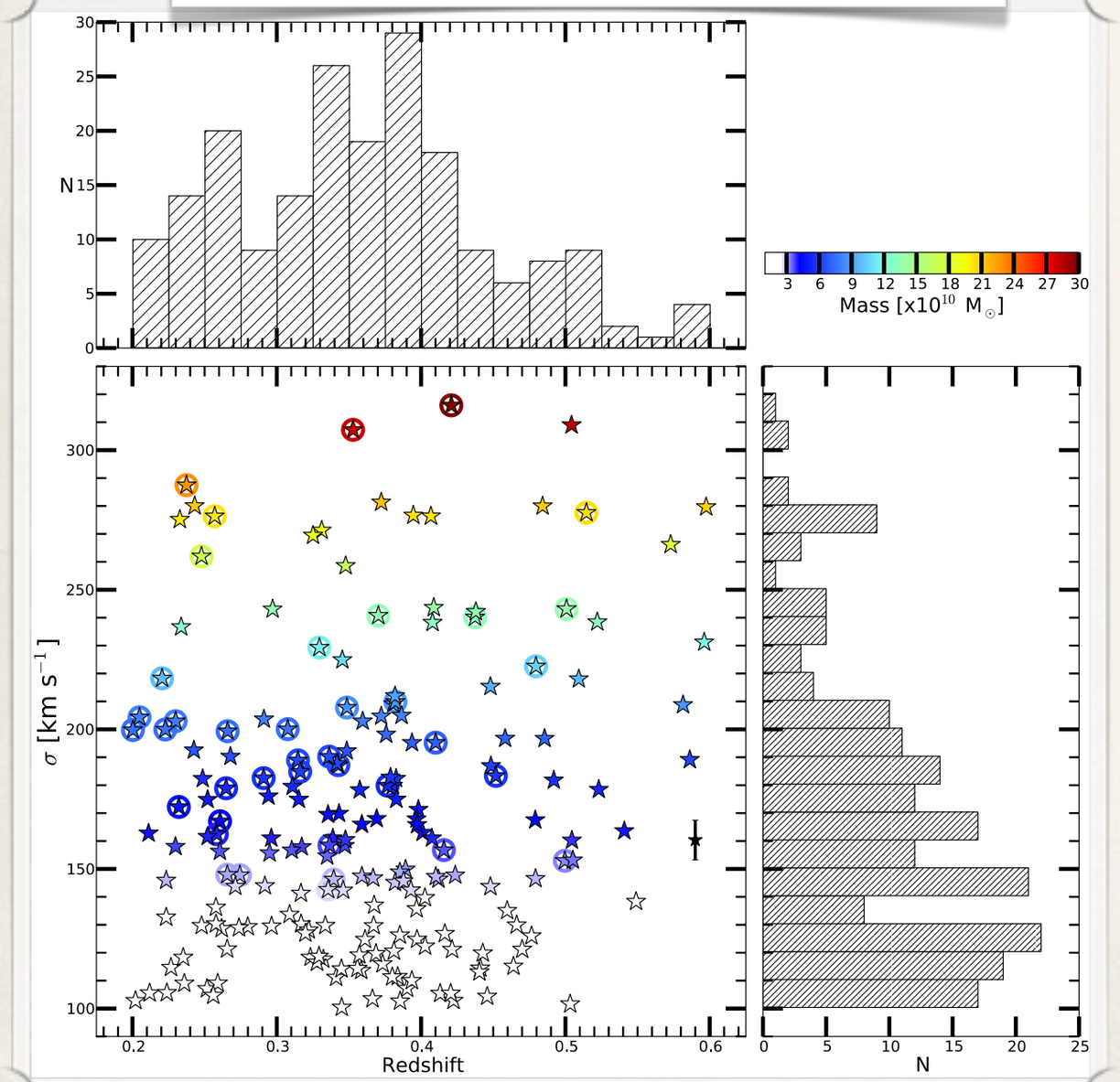
**Imaging**

**BETTER Imaging**



# BOSS: 198 compact quiescent candidates at 0.2<z<0.6

## Damjanov et al. 2014



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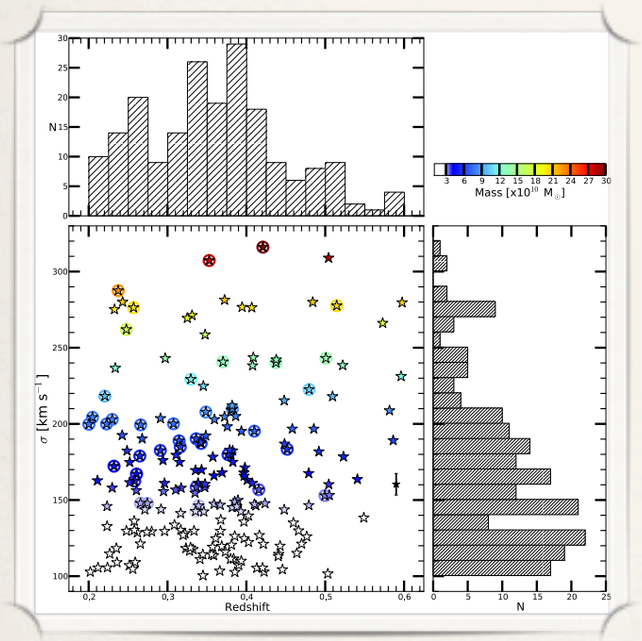
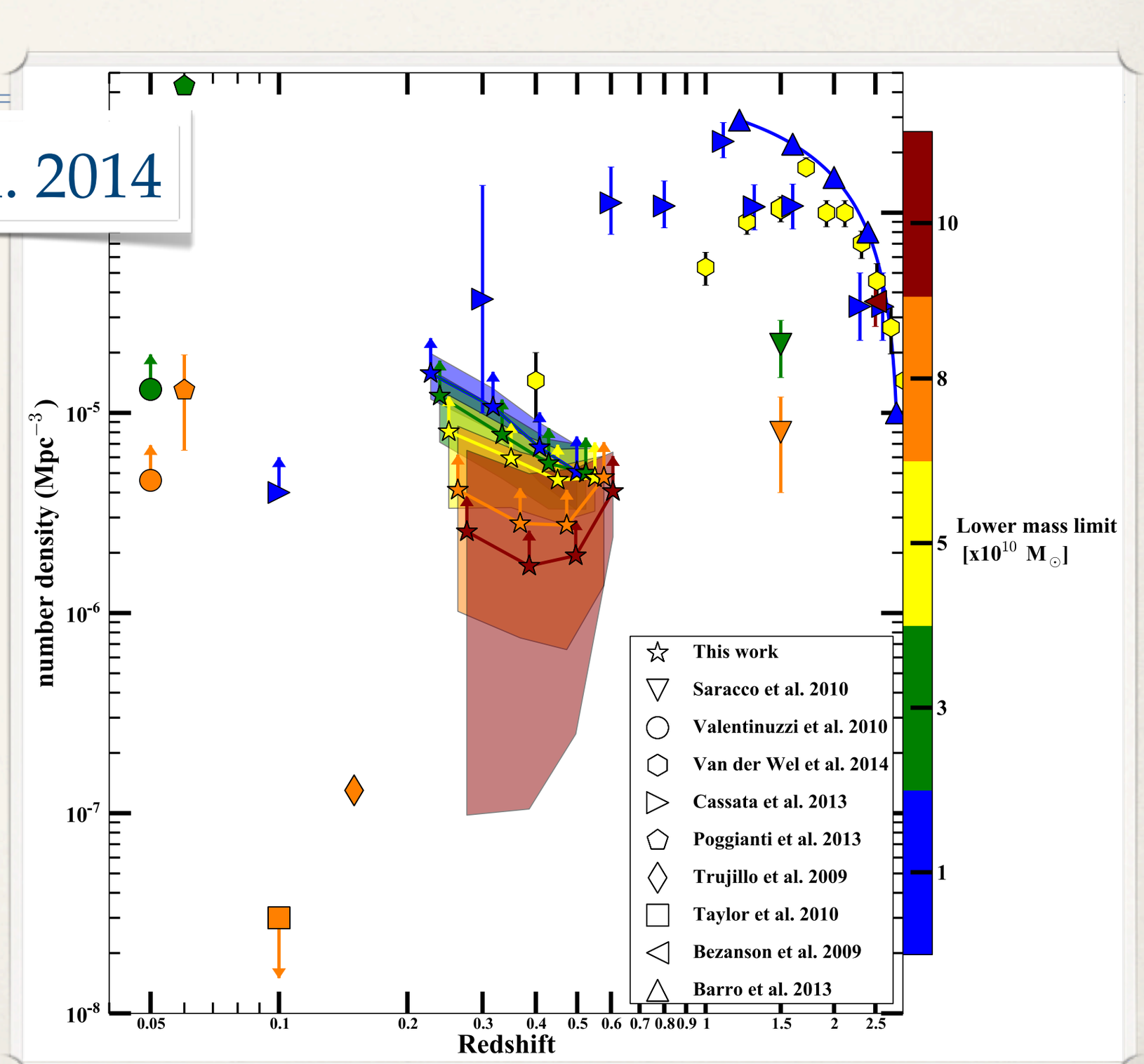
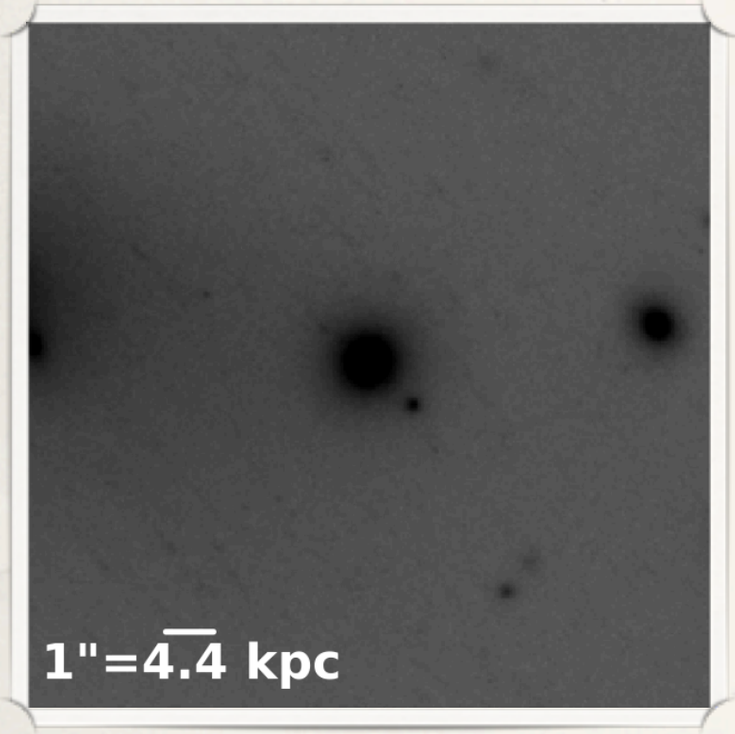


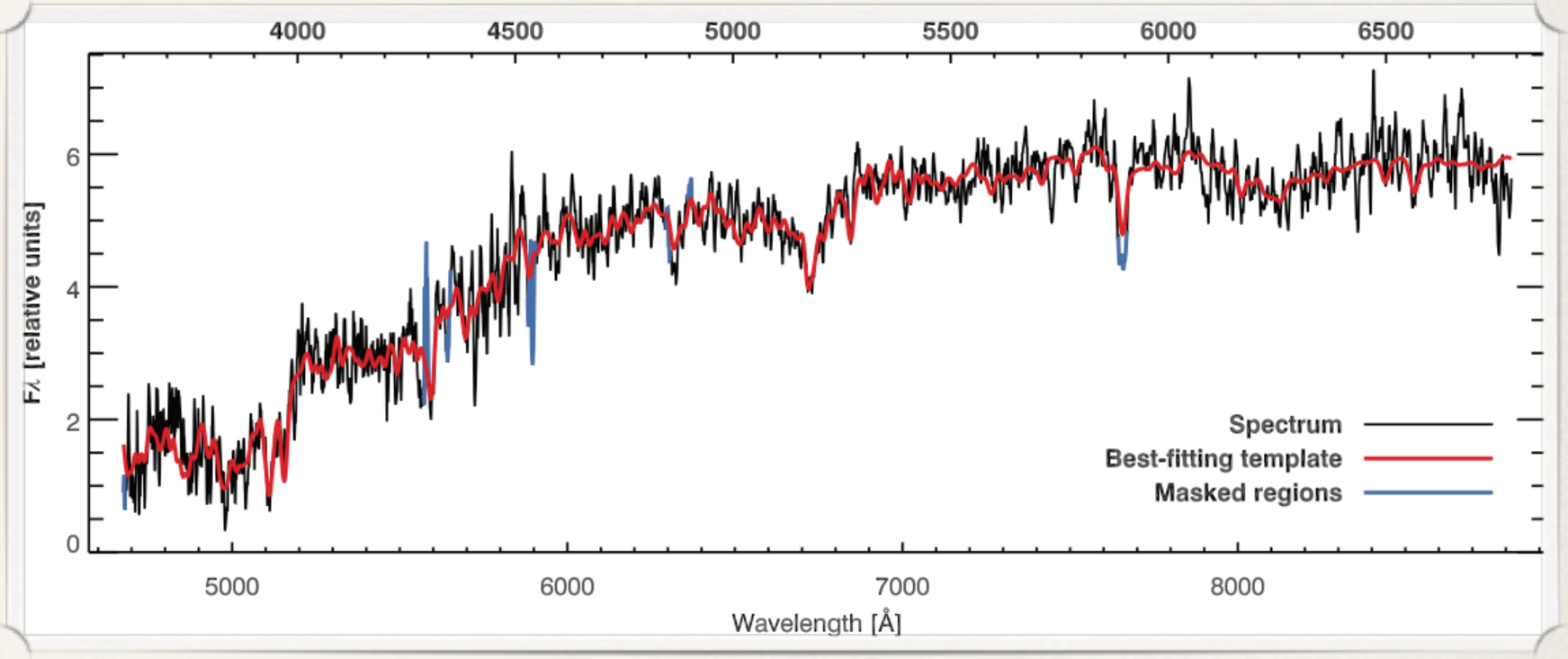



# Ages

## HST/ACS F814W




## SDSS spectrum




## Damjanov et al. 2013

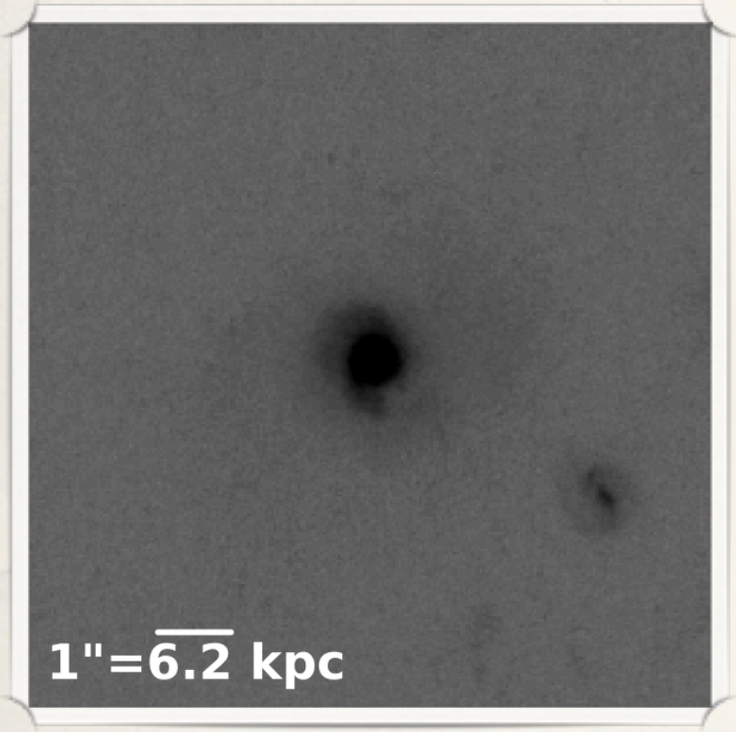
$Z_{obs}=0.29$

$Z_{form}>3$

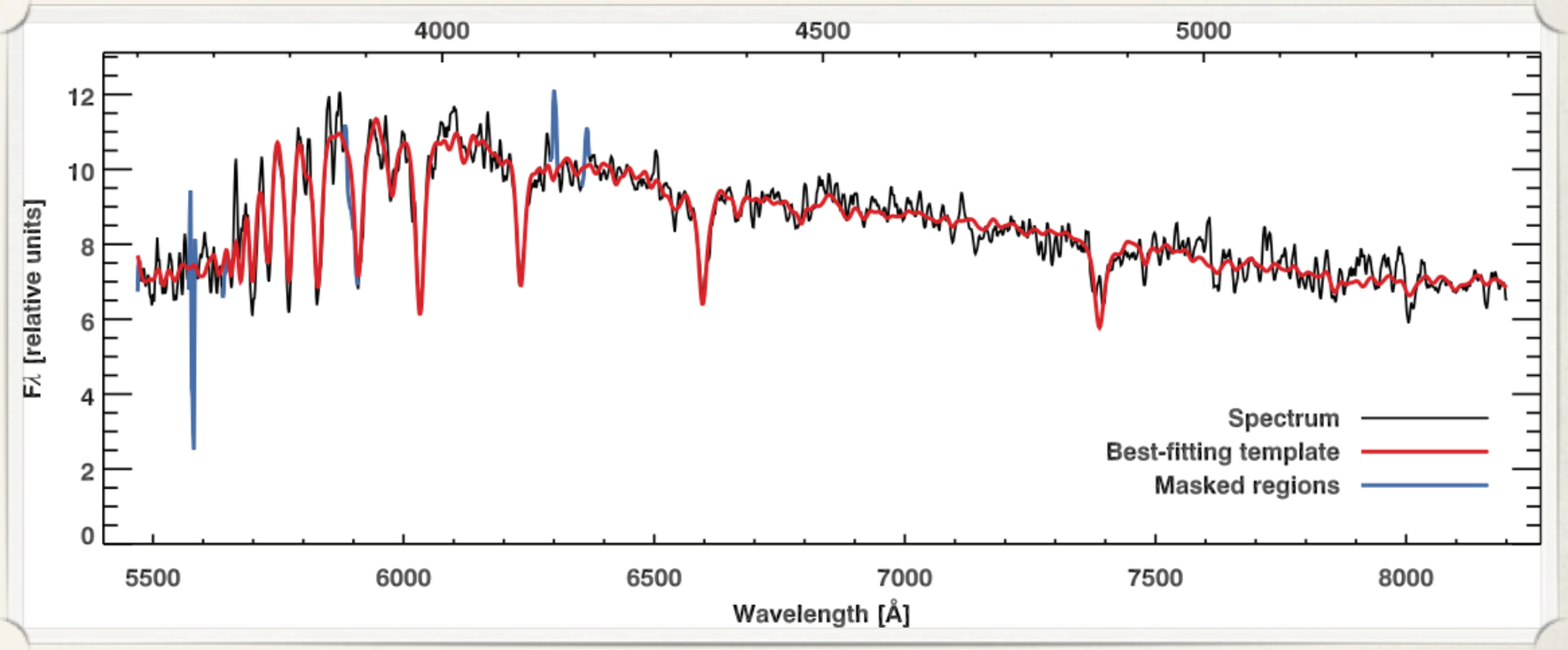
**Old...**

# Ages

## HST/ACS F814W




## SDSS spectrum




## Damjanov et al. 2013

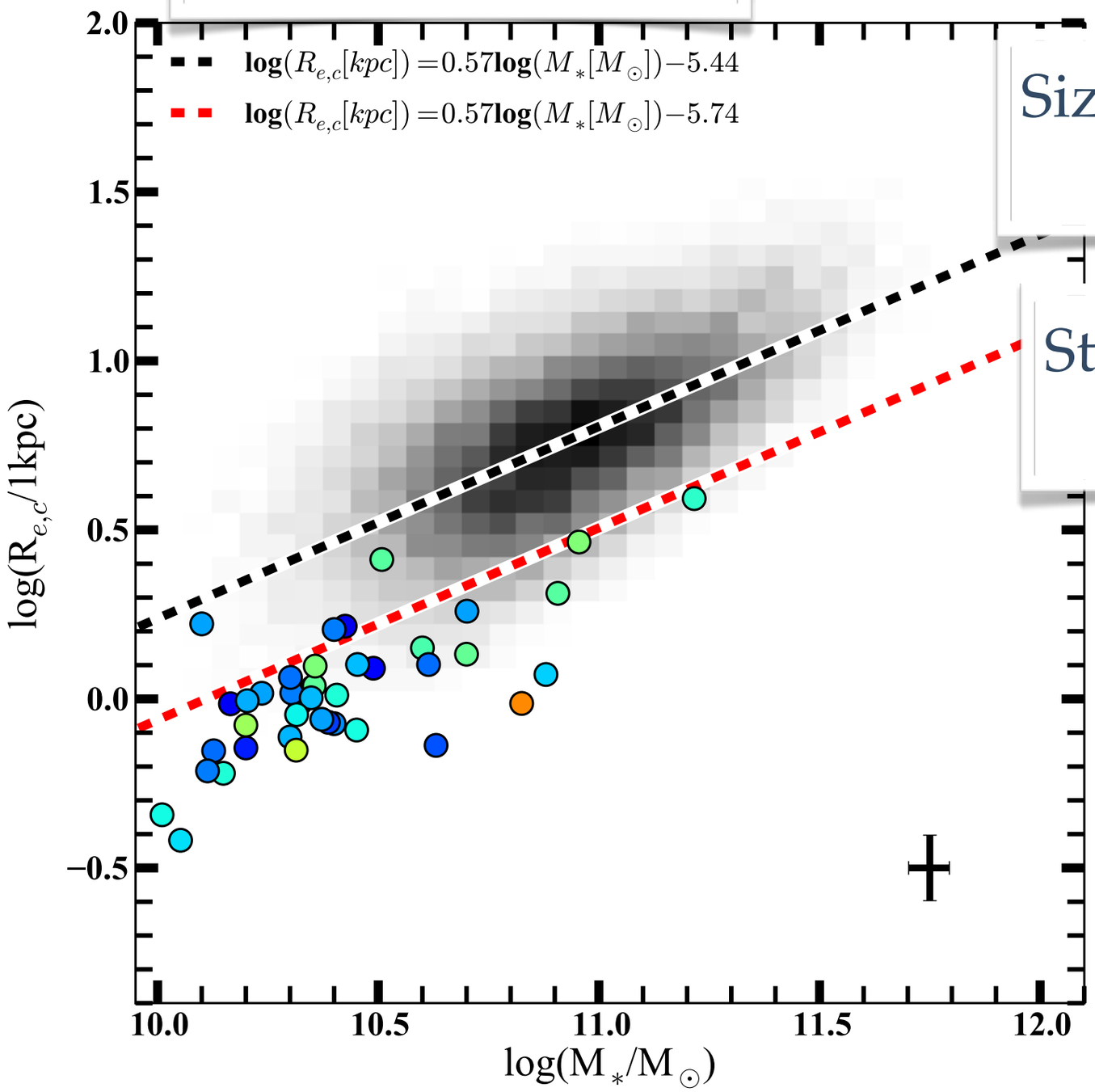
$Z_{obs}$=0.51

$Z_{form}$<0.8

**... and young!**

# COSMOS field

SDSS point sources

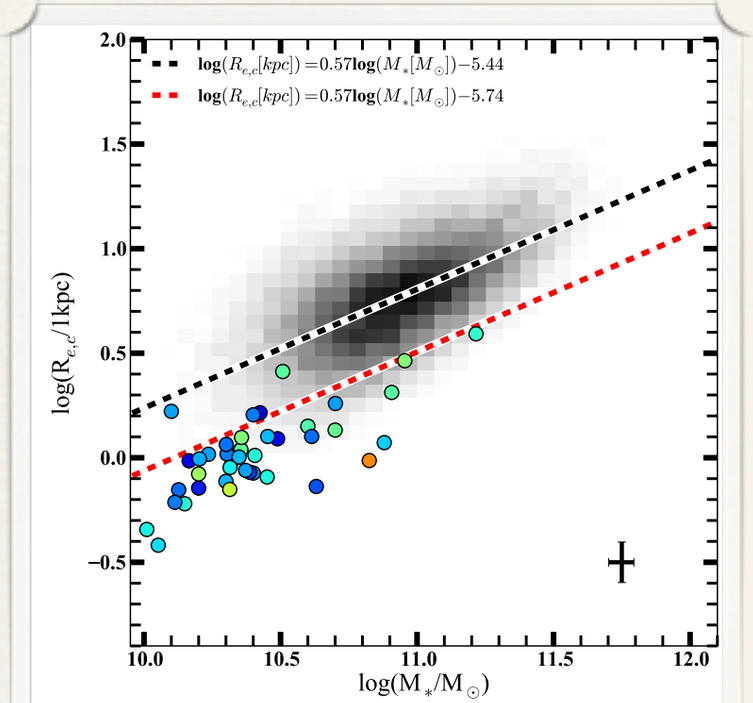



Sizes - GALFIT, single Sérsic profile (Damjanov et al. 2015)

Stellar masses - UltraVista catalog (Ilbert et al. 2013)

# COSMOS field

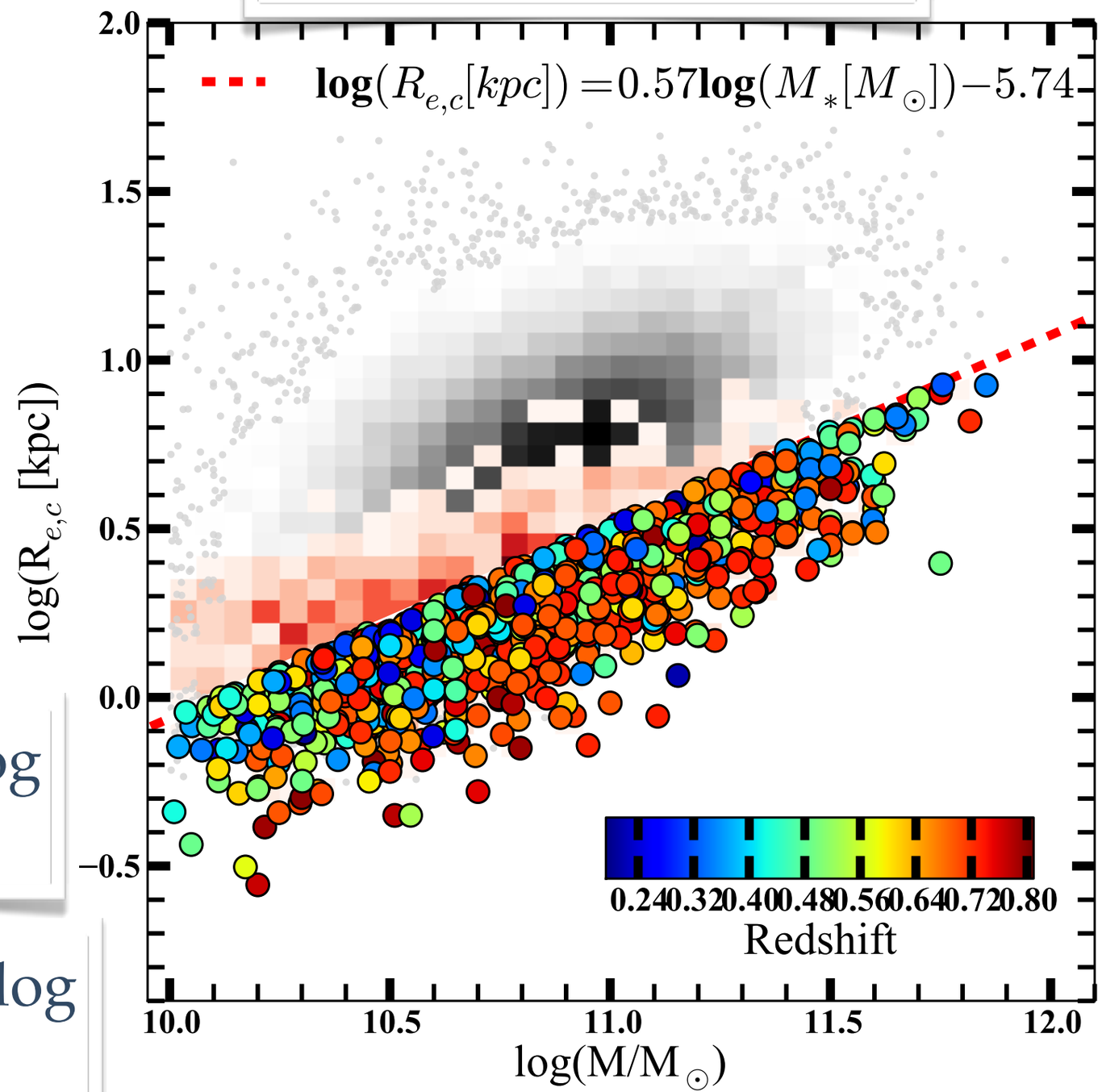
## SDSS point sources




Sizes - GIM2D, Zurich catalog (Sargent et al. 2007)

Stellar masses - UltraVista catalog (Ilbert et al. 2013)

## All quiescent galaxies

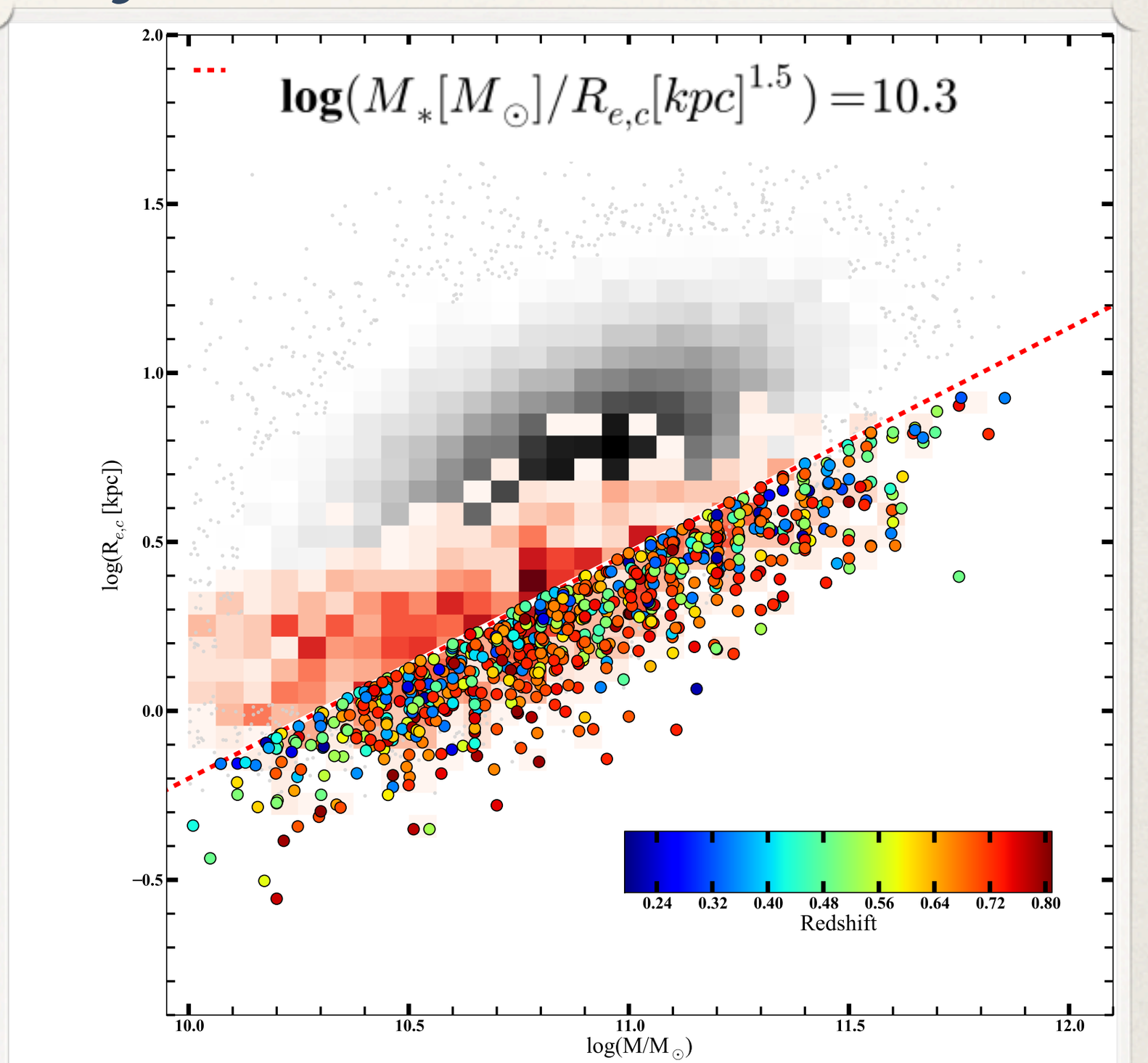


# Number density

**COSMOS field**

Damjanov et al.
2015, Paper I,
arXiv: 1501.04976

Barro et al. 2013
Poggianti et al. 2013



# Number density

**Observational effects**

# Number density

## Observational effects

**<u>Corrections</u>:**

1. spectroscopic incompleteness

2. magnitude limit of redshift surveys and reliable size measurements

# Number density

## Observational effects

**<u>Corrections</u>:**

1. spectroscopic incompleteness

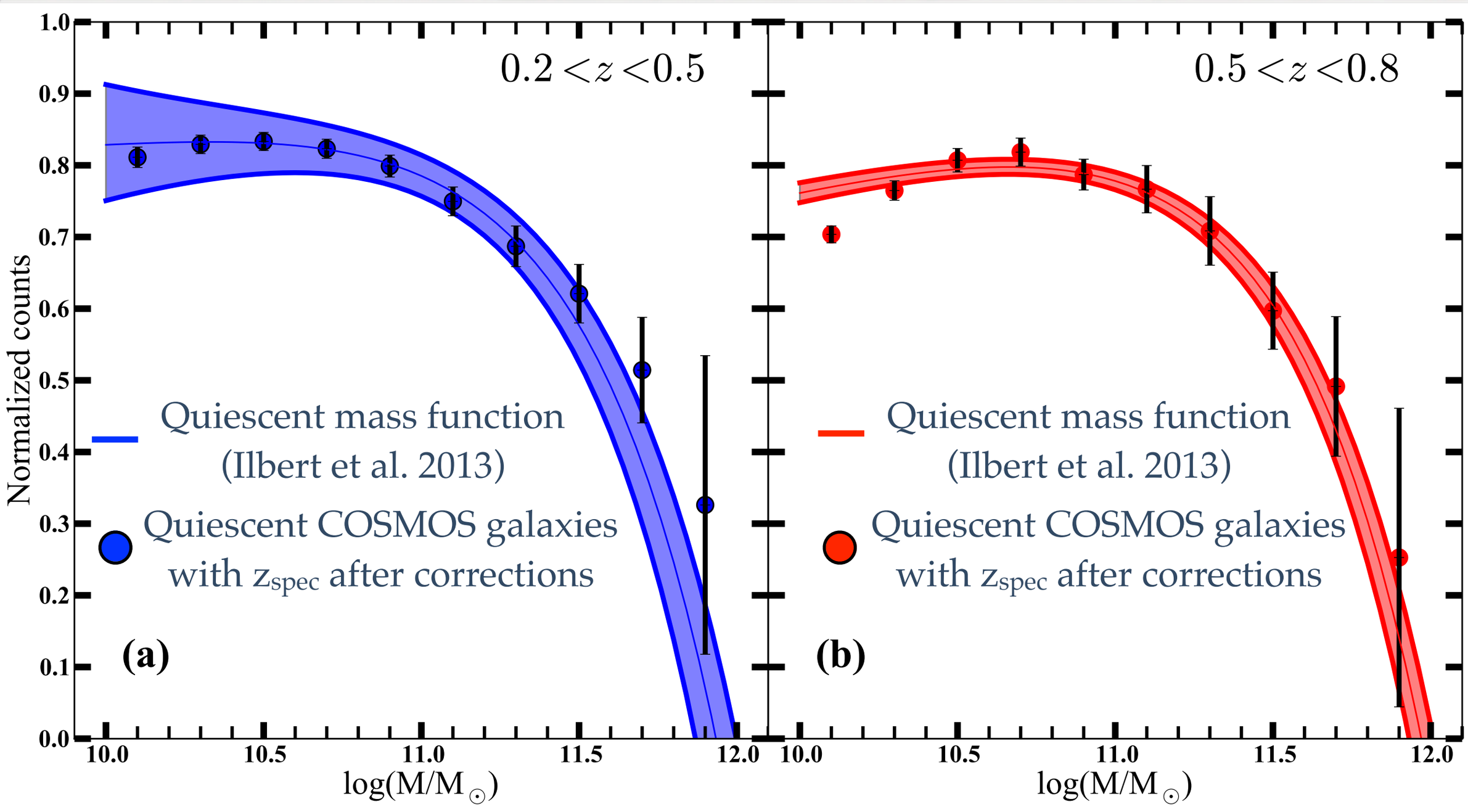
2. magnitude limit of redshift surveys and reliable size measurements

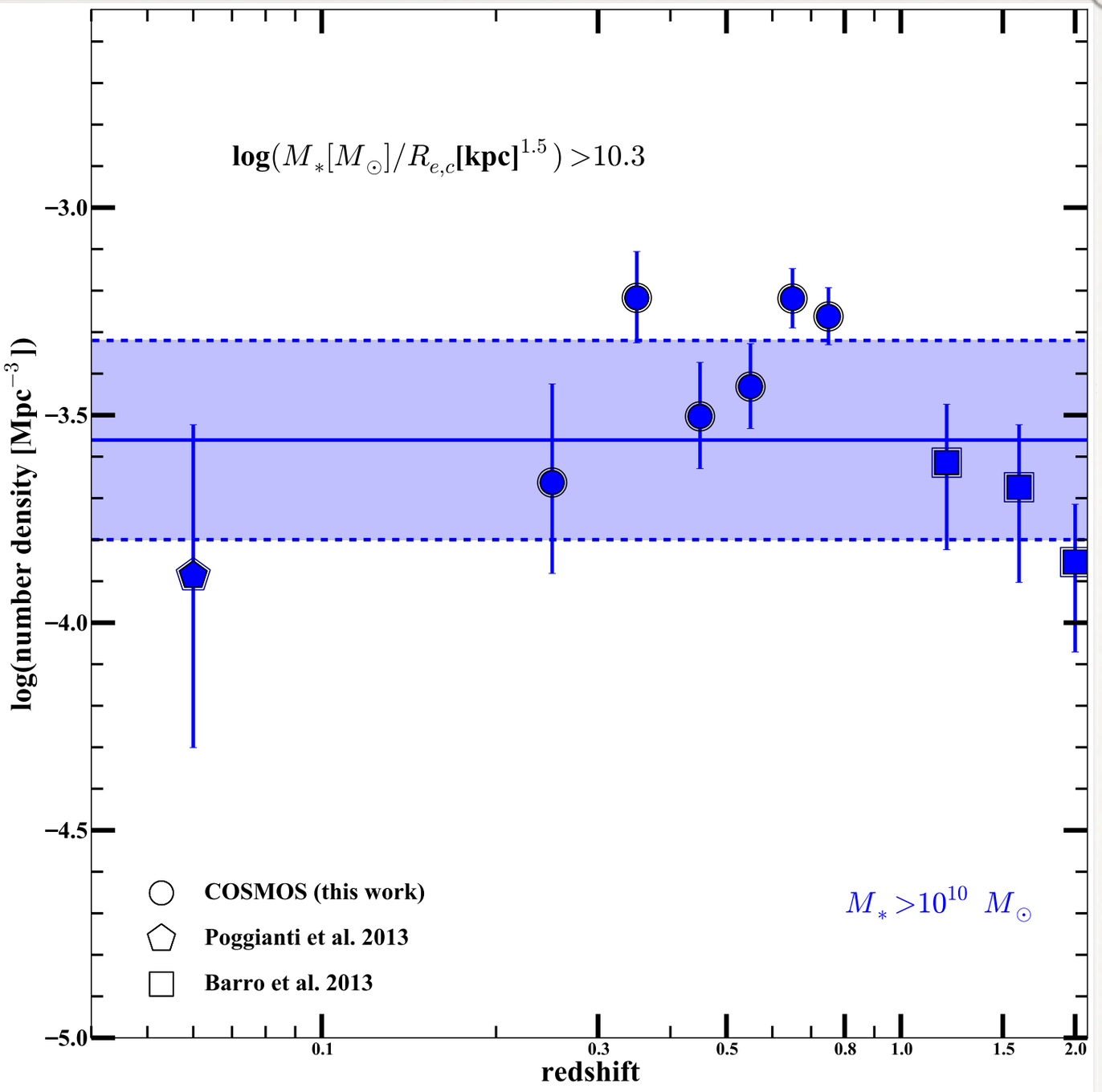
**<u>Test</u>:**

reconstruction of the observed mass function
with corrected parent sample

# Number density

**Observational effects**

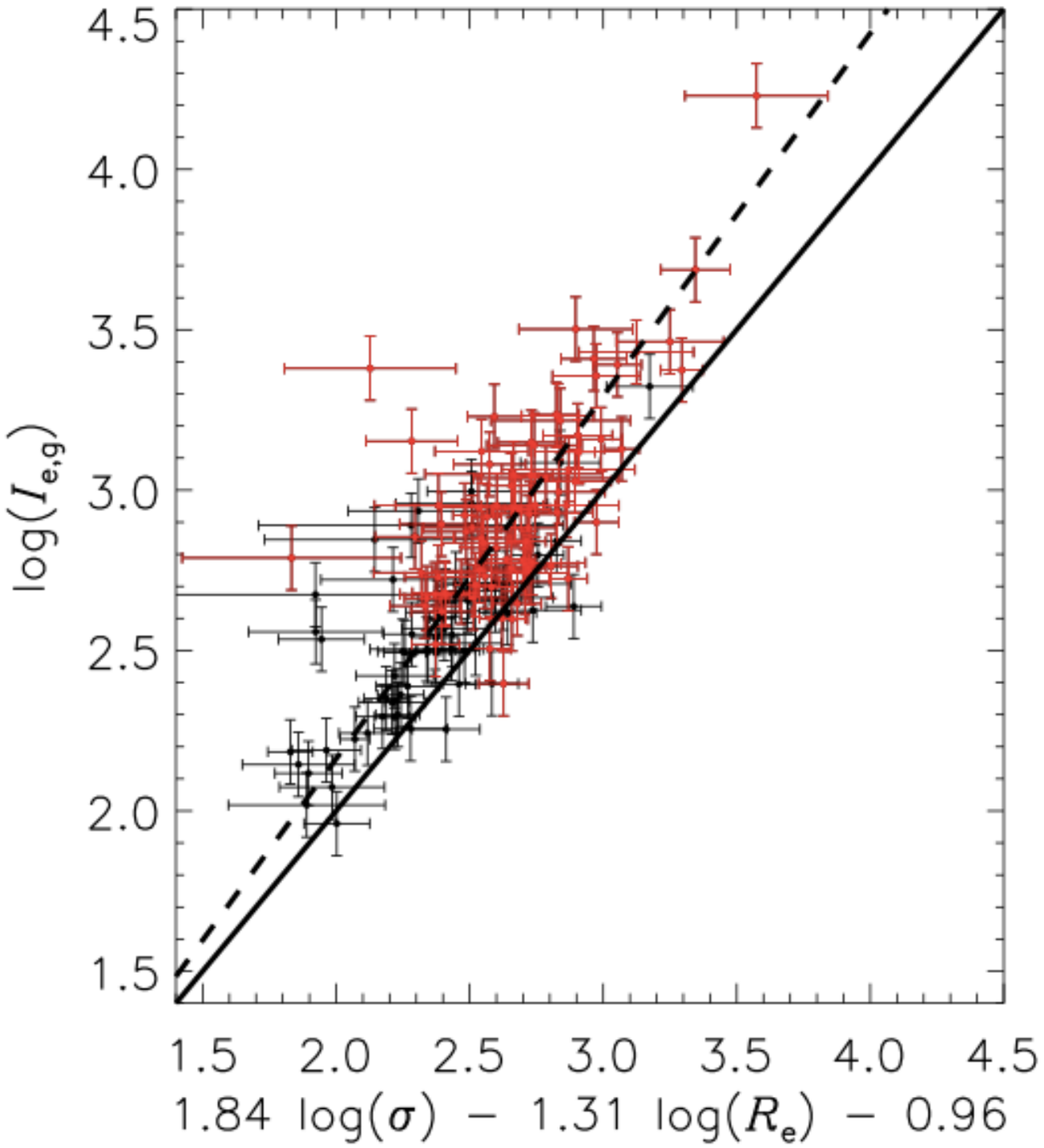





# Constant number density

(Damjanov et al. 2015, Paper I, arXiv: 1501.04976)

# Fundamental plane




**observed**

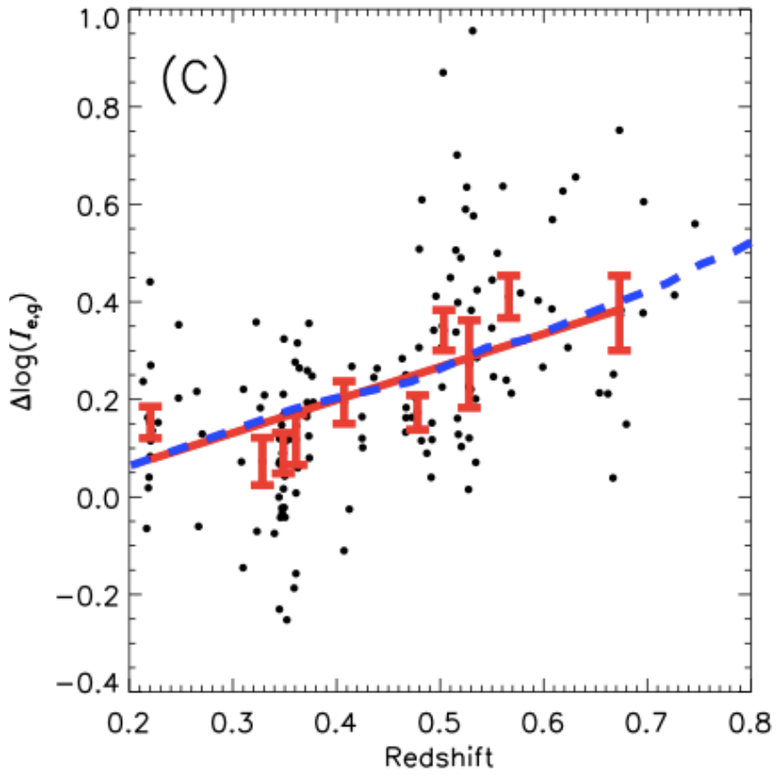
+ compacts at 0.2<z<0.8

+ quiescent at z=0 (Hyde & Bernardi 2009)

**COSMOS field**

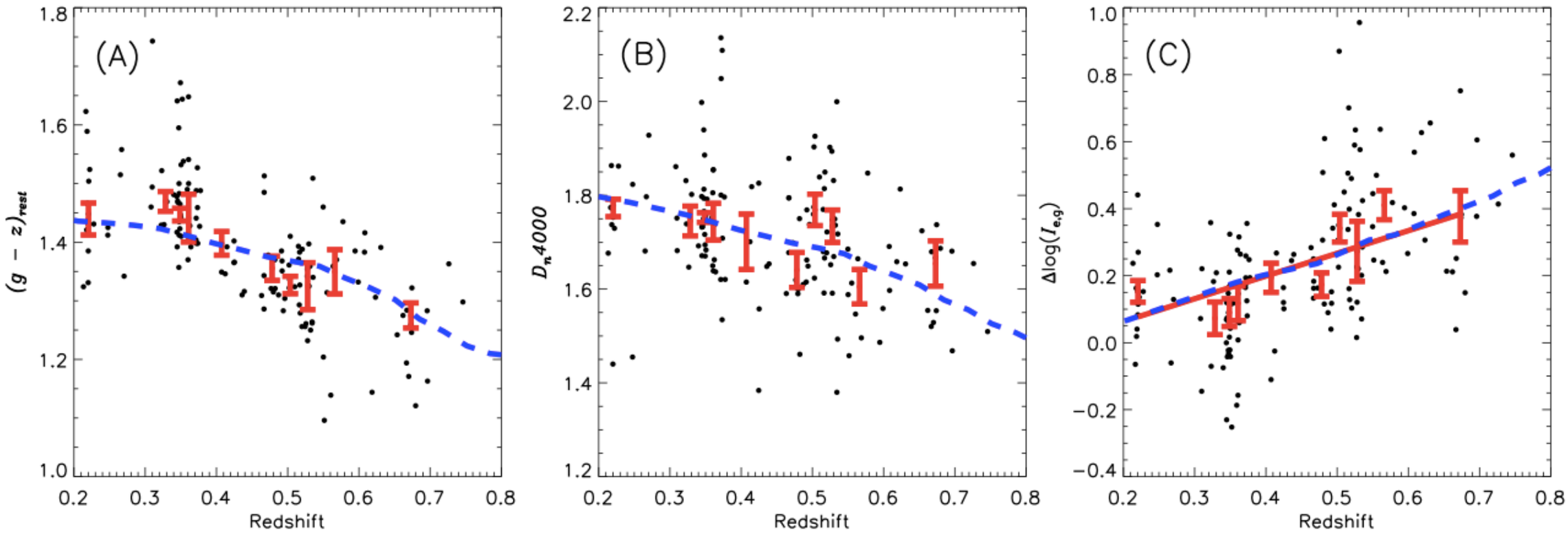
Zahid et al. 2015, Paper II, arXiv: 1501.04977

# Fundamental plane - passive evolution




- compact galaxies at 0.2<z<0.8 in the COSMOS field
- Quiescent model with $z_{form}$=1.7 and quenching at z=1.3
- Median observed values in redshift bins

# Fundamental plane - passive evolution




- compact galaxies at $0.2<z<0.8$ in the COSMOS field
- Quiescent model with $z_{form}=1.7$ and quenching at $z=1.3$
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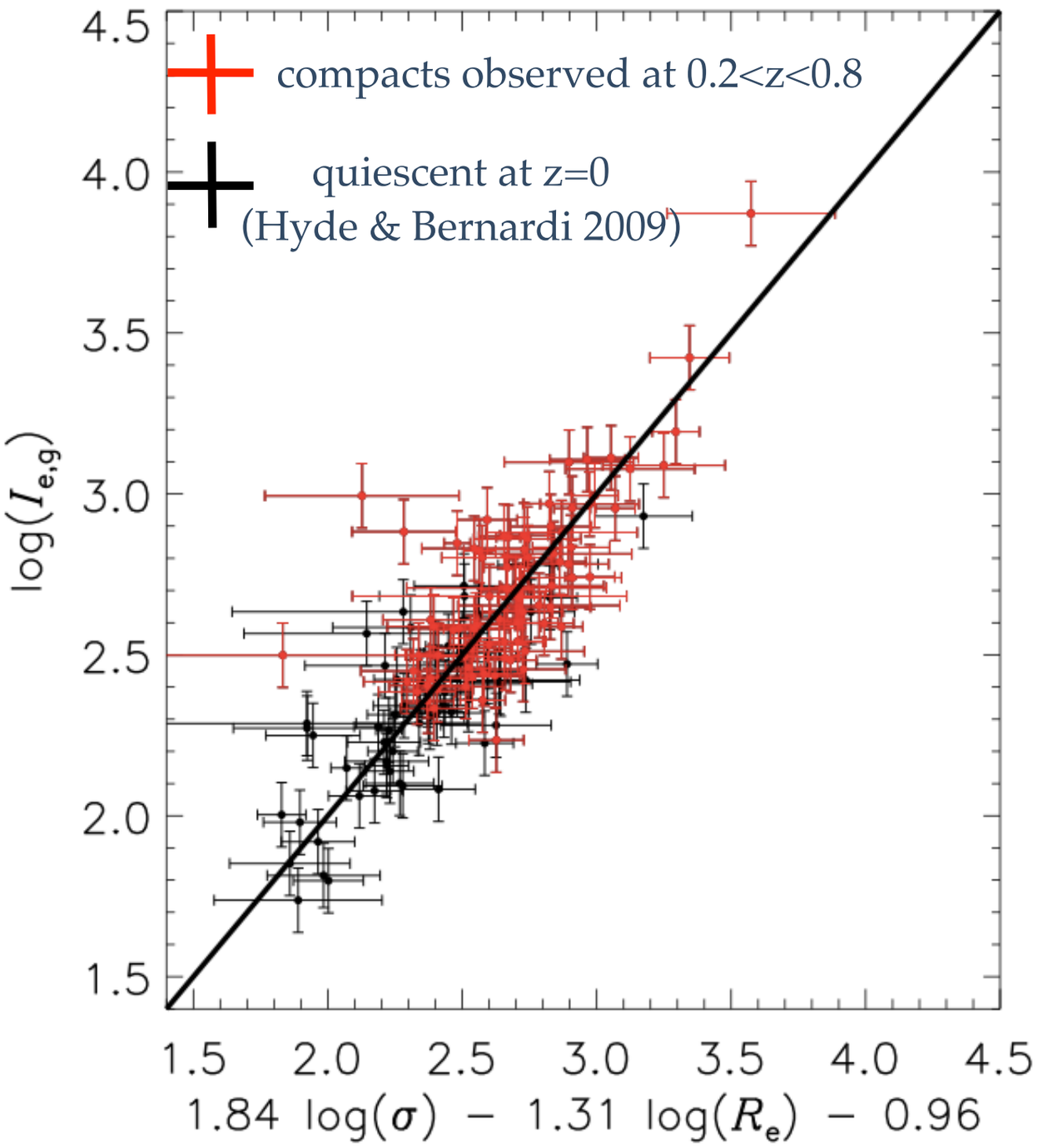
# Fundamental plane

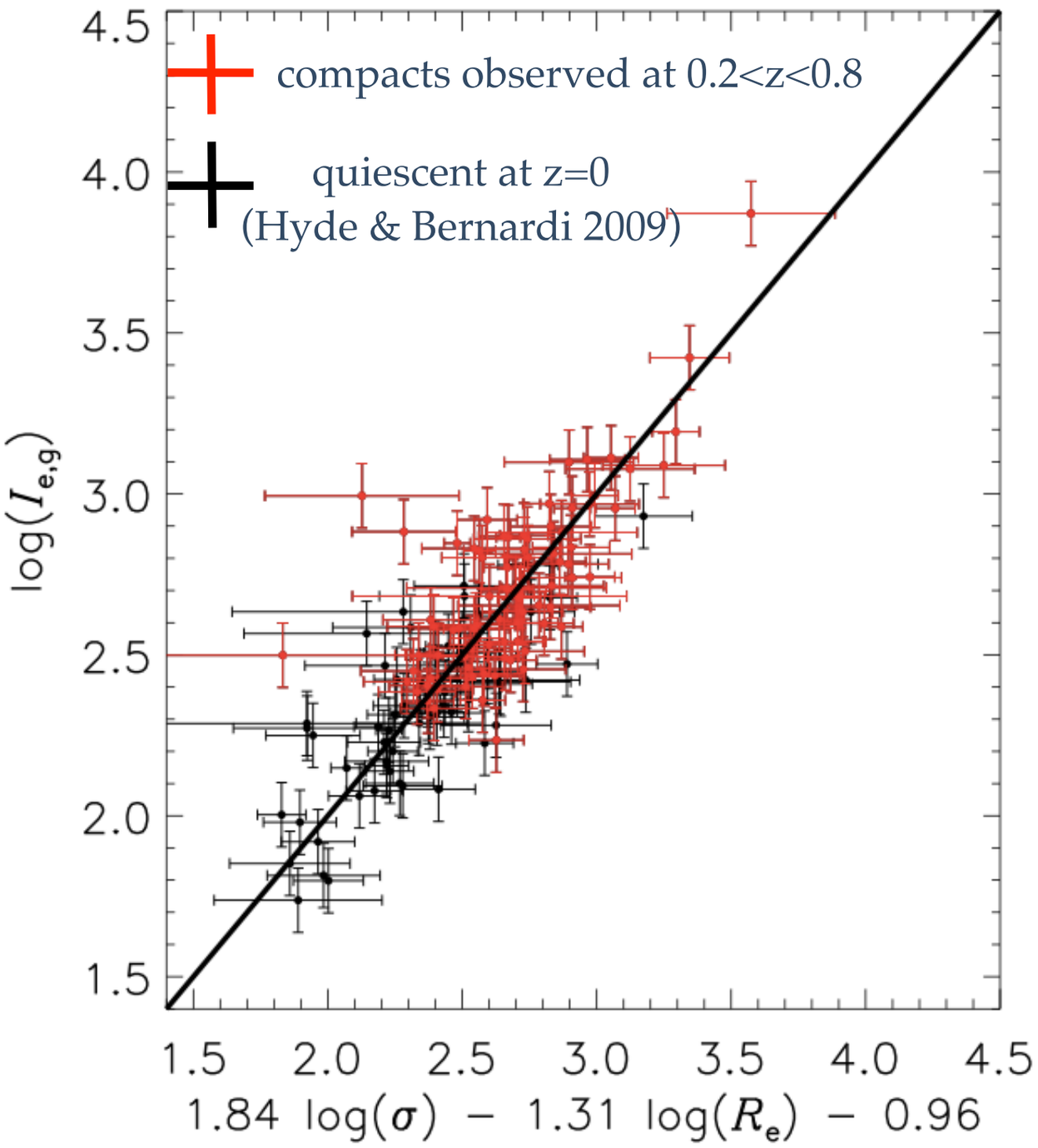



**after correction**

**COSMOS field**

Zahid et al. 2015, Paper II, arXiv: 1501.04977

# Fundamental plane




**after correction**

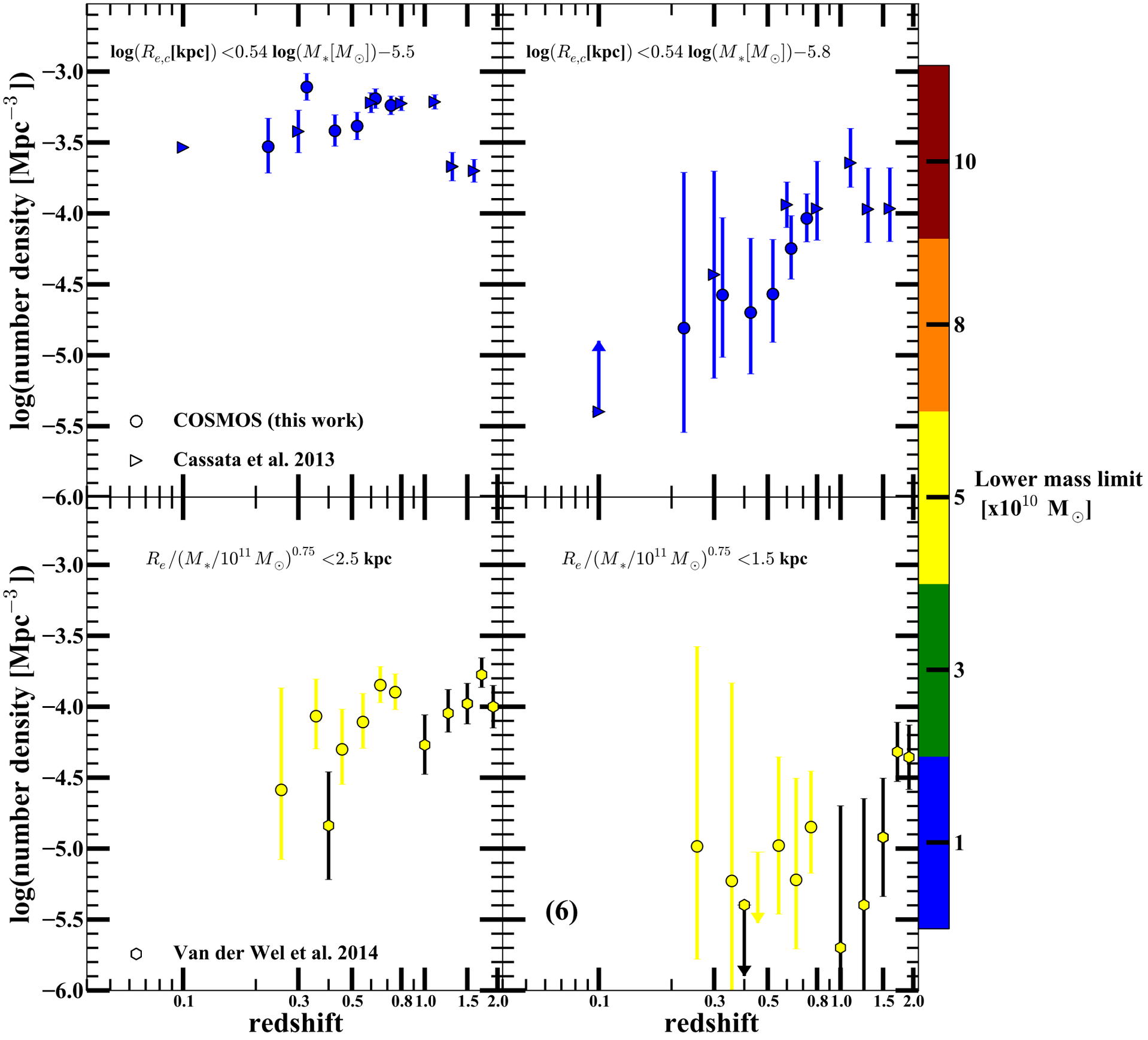
**COSMOS field**

Zahid et al. 2015, Paper II, arXiv: 1501.04977

**Compacts are on the z~0 Fundamental Plane**

# Conclusions

- Compact quiescent galaxies are abundant at intermediate redshift.
  - Q: What is happening at redshift z=0? How important is it that we cannot find z>2 relics in SDSS data? What does it tell us?
- There are both young and old compact systems.
  - Q: How do they assemble at lower z? Can it be the same mechanism as at high z?
- The number density is constant. Deviations from constancy found in overdense regions.
  - Q: If they grow, do they also assemble at low z (see above)? Which ones form at low z? How is this related to environment?
- Compacts lie on the fundamental plane of local quiescent population
  - Q: Are compact systems at all redshifts just a tail of the distribution of quiescent population or are they special class of objects?


log($R_{e,c}$[kpc]) <0.54 log($M_*[M_\odot]$)−5.5
log($R_{e,c}$[kpc]) <0.54 log($M_*[M_\odot]$)−5.8
log(number density [Mpc$^{-3}$])
−3.0
−3.5
−4.0
−4.5
−5.0
−5.5
−6.0
COSMOS (this work)
Cassata et al. 2013
$R_e/(M_*/10^{11}\,M_\odot)^{0.75}$ <2.5 kpc
$R_e/(M_*/10^{11}\,M_\odot)^{0.75}$ <1.5 kpc
10
8
5
3
1
Lower mass limit
[x10$^{10}$ M$_\odot$]
Van der Wel et al. 2014
(6)
0.1
0.3
0.5
0.8
1.0
1.5
2.0
redshift