The Evolution of the Mass-Size relation to z = 3.5 in the GOODS-North Field

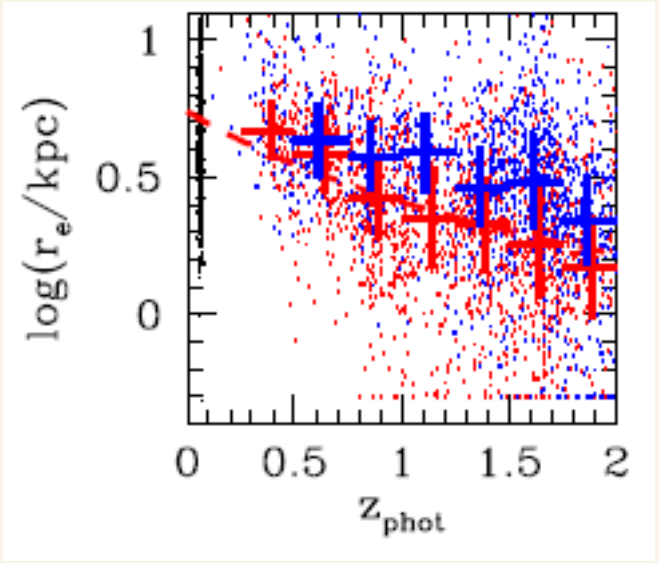
Moein Mosleh

THE EVOLUTION OF THE MASS-SIZE RELATION TO Z=3.5 FOR UV-BRIGHT GALAXIES AND SUB-MM GALAXIES IN THE GOODS-NORTH FIELD

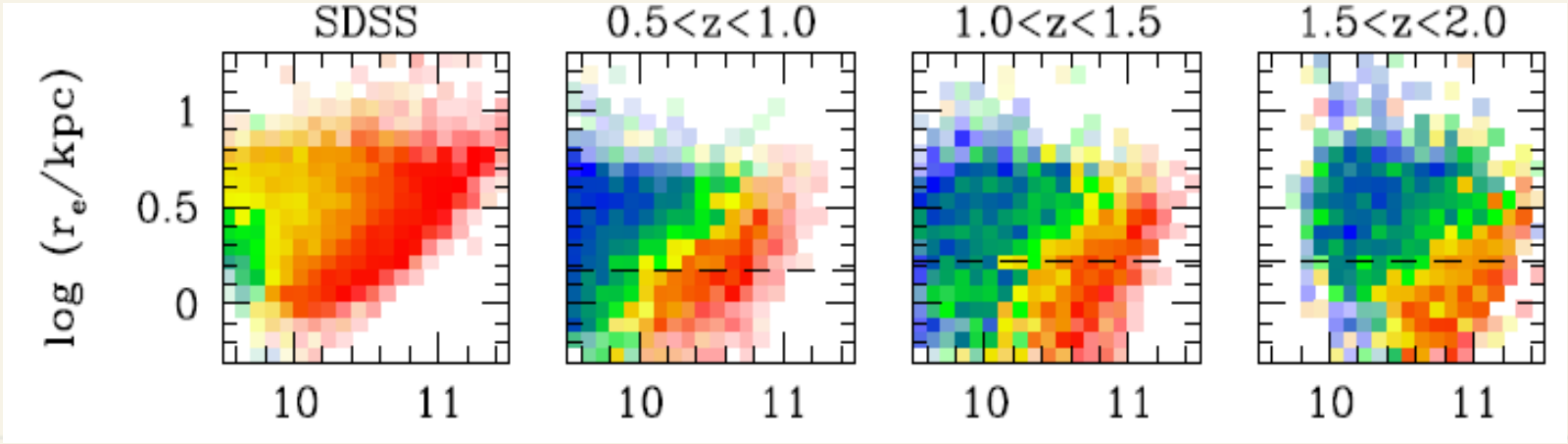
Moein Mosleh[1], Rik J. Williams [2], Marijn Franx [1], Mariska Kriek[3]

Introduction

- *Galaxies at high redshift have significantly smaller sizes than the local galaxies of similar masses*
- *Quiescent Galaxies are significantly smaller than star-forming galaxies of similar masses*
- *These studies are almost bases on Photometric redshift especially at high z*
- *Size measurements of Sub-mm or LBG galaxies at high z are also rare*



Williams et al. 2010



DESCRIPTION OF DATA

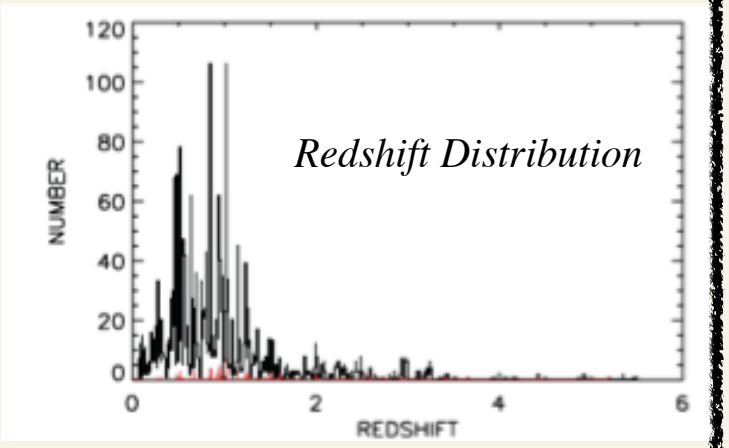
Using most complete spectroscopic catalog of galaxies in the GOODS-North Field. (Barger et al. 2008)

★ *Using U band (Capak et al. 2004)*

★ *ACS Magnitudes (F435w (B), F606W (V), F775W (I), F850LP (Z))*

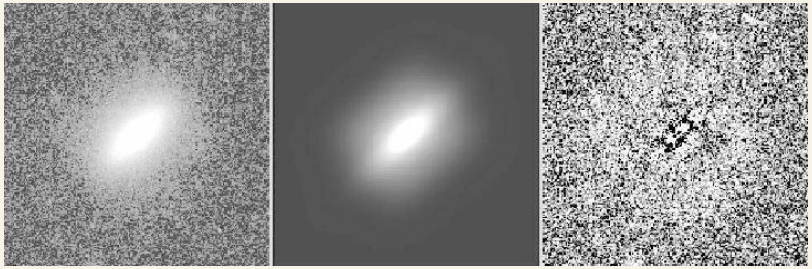
★ *Ks-band magnitudes from WIRCam (CFHT, 3.6 m) (6909)*

★ *NUV – FUV from GALEX (1016)*



SIZES

- ✓ *Using GALFIT (Peng et al. 2002) to fit Sersic models*
- ✓ *Ks-band image from Subaru 8M Telescope*
- ✓ *FWHM ~ 0.5”*
- ✓ *Pixel scale = 0.12 arcsec/pixel*

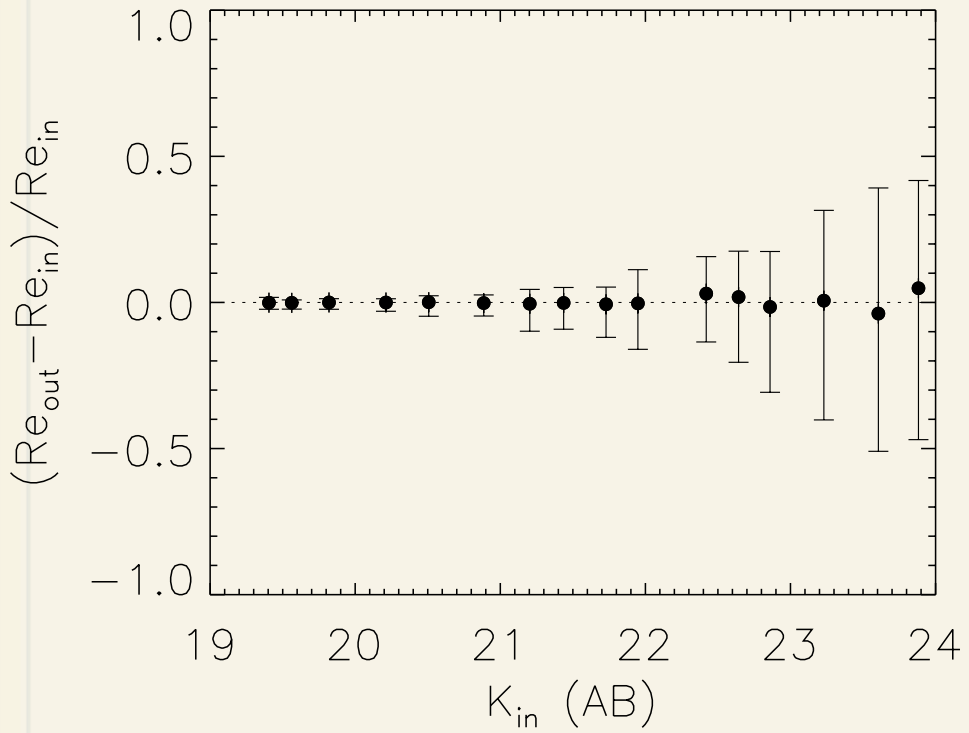


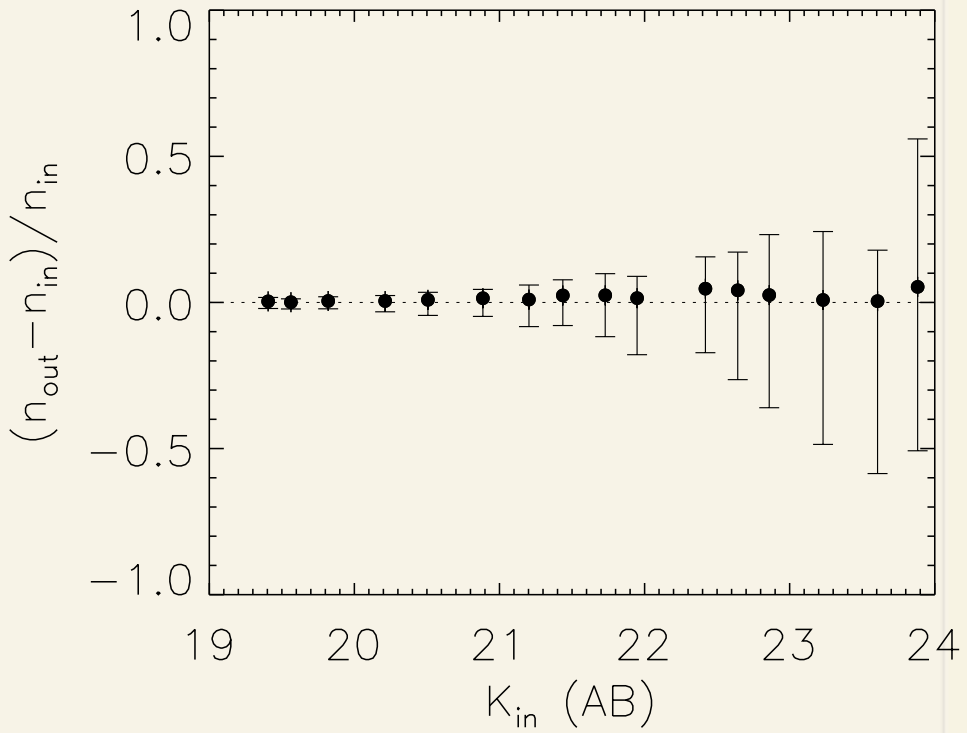
STELLAR MASS ESTIMATES

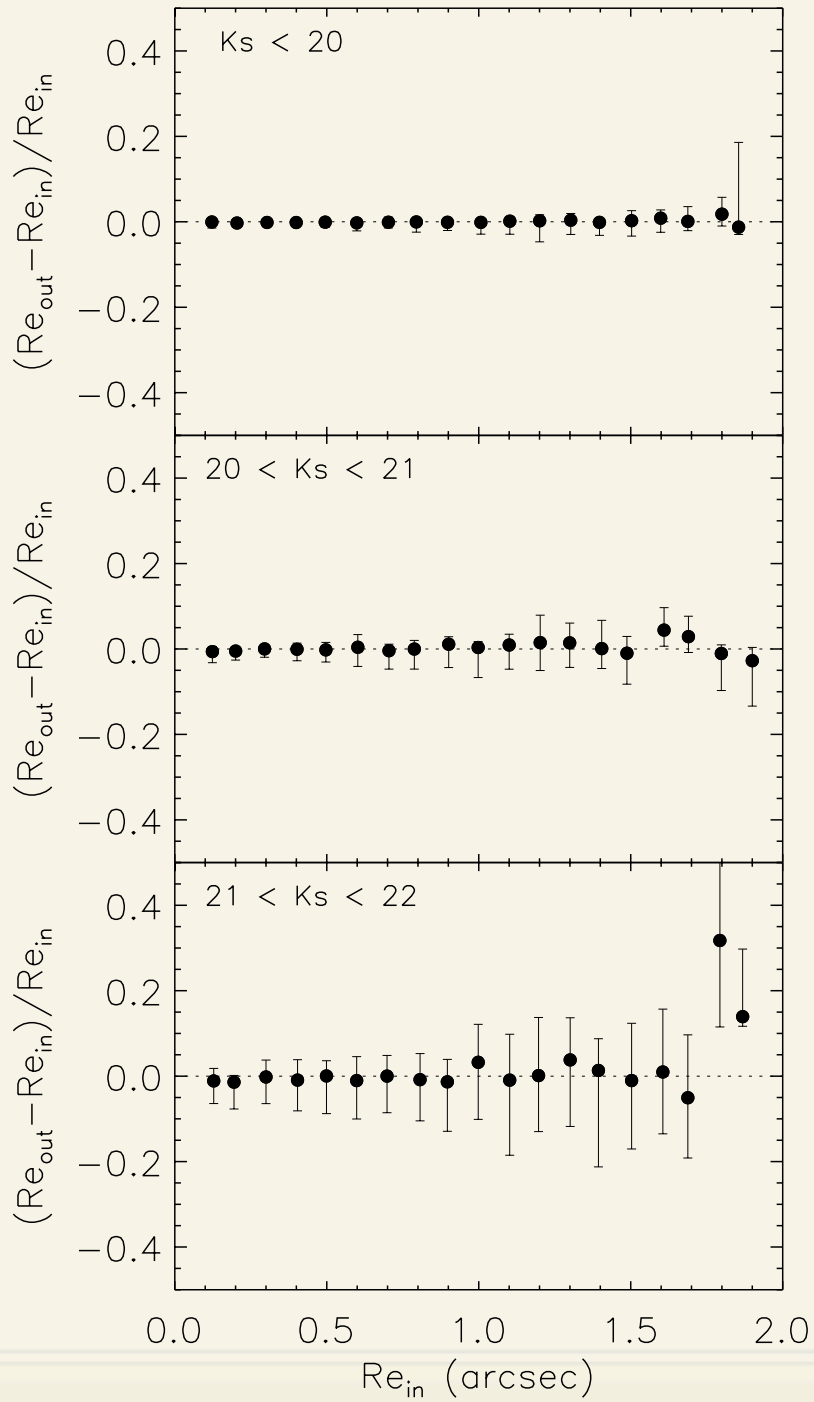
- ✓ *Using FAST (Fitting and Assessment of Synthetic Templates code) (Kriek et al. 2009)*
- ✓ *Using Salpeter IMF & Solar Metallicity*
- ✓ *Masses are corrected by a factor of -0.2 dex (for consistency with a Kroupa (2001) IMF)*
- ✓ *Bands: U, B, V , I, Z, Ks*

Simulations

Running simulation for testing the accuracy of parameter measurements







Simulations

SUB-SAMPLES

- *UV- Bright Galaxies :-*
  - *Lyman Break Galaxies (LBGs) ($2.7 < z < 3.4$)*
    Selected from Reddy et al. 2006
  - *BM/BX ($1.4 < z < 2.7$)*
    Selected from Reddy et al. 2006 Catalog
  - *GALEX/LBGs ($0.6 < z < 1.4$)*
    Selected by using (FUV-NUV) versus (NUV-F435W) color- color diagram
- *Sub-mm Galaxies (SMG)*
  Selected from samples of Chapman et al. 2005 & Pope et al. 2006
- *Star-forming BzK (sBzK) ($1.4 < z < 3.2$)*

TABLE 1
SUB-SAMPLES

Sample	Redshift	$log(M_*/M_\odot)$	No. of Sources
GALEX/LBG	$0.6 < z < 1.4$	8.8 - 11.0	105
BM/BX	$1.4 < z < 2.7$	9.8 - 10.8	41
LBG	$2.7 < z < 3.5$	10.2 - 10.8	5
SMG	$0.5 < z < 3.$	10.0 - 11.7	14
sBzK	$1.4 < z < 3.2$	9.8 - 11.7	70

Size Evolution

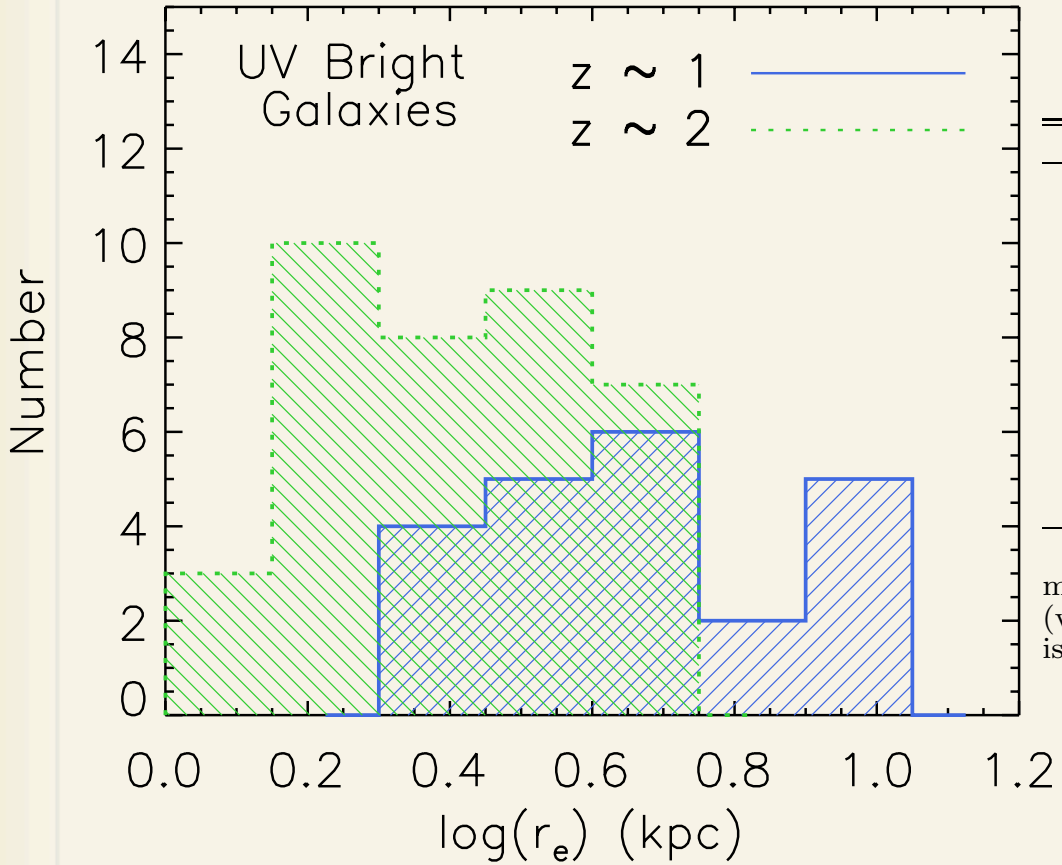


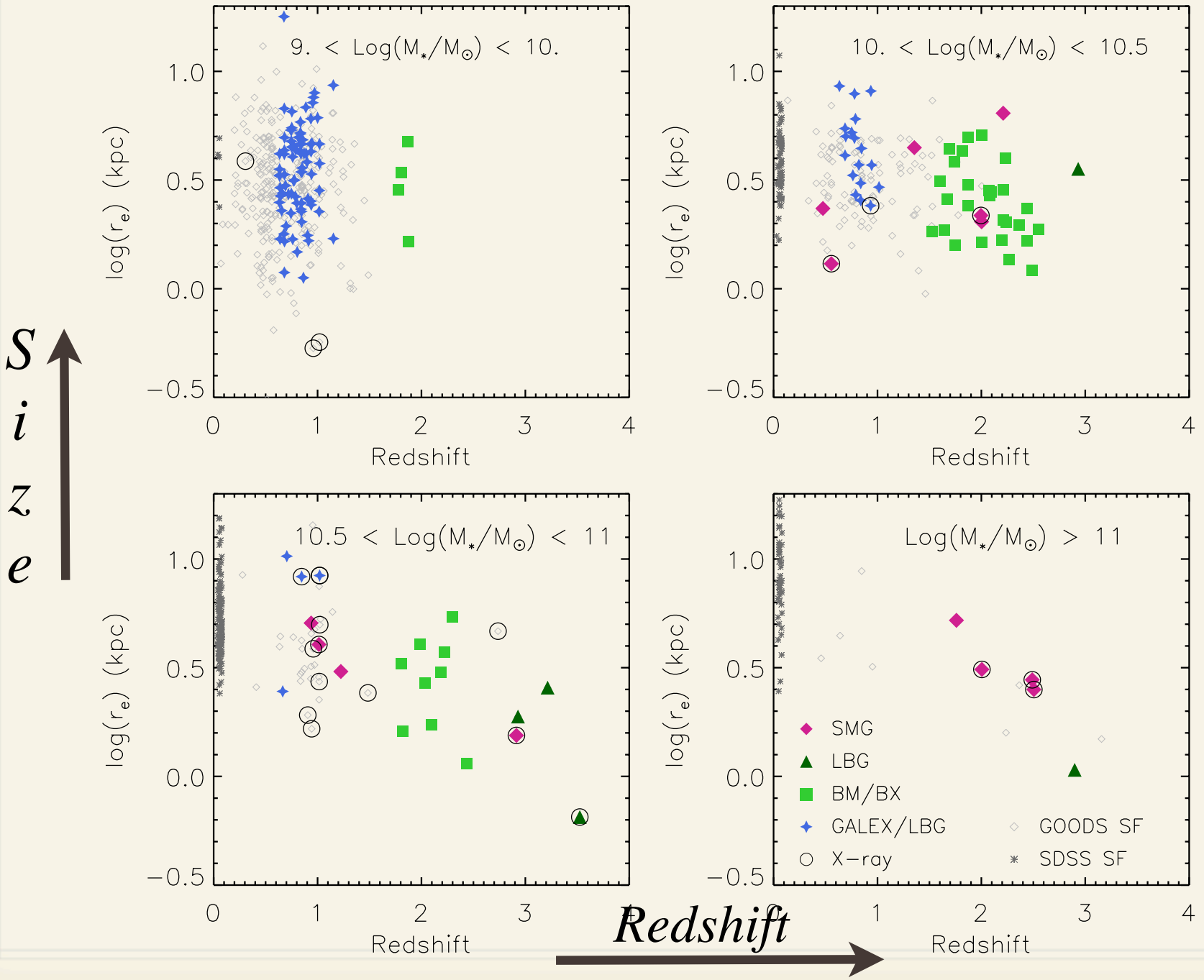
TABLE 3
MEDIAN SIZES OF DIFFERENT SAMPLES

Sample	Redshift	Size	$median(log(M_*/M_\odot)$
GALEX/LBG	$0.6 < z < 1.4$	4.42 ± 0.52	10.2 ± 0.3
BM/BX	$1.4 < z < 2.7$	2.68 ± 0.19	10.4 ± 0.2
LBG	$2.7 < z < 3.5$	2.22 ± 0.61	10.6 ± 0.2
CDFS	$0.5 < z < 1.5$	2.33 ± 0.1	10.4 ± 0.3
CDFS	$1.5 < z < 2.5$	2.40 ± 0.13	10.4 ± 0.3
CDFS	$2.5 < z < 3.5$	1.73 ± 0.18	10.4 ± 0.3
Quiescent(CDFS)	$0.5 < z < 1.5$	1.32 ± 0.07	10.5 ± 0.3
Quiescent(CDFS)	$1.5 < z < 2$	1.12 ± 0.32	10.7 ± 0.2
Quiescent(VD08)	$2 < z < 2.5$	0.9 ± 0.21	11.23
SMG	$0.5 < z < 3.$	2.90 ± 0.45	10.8 ± 0.5

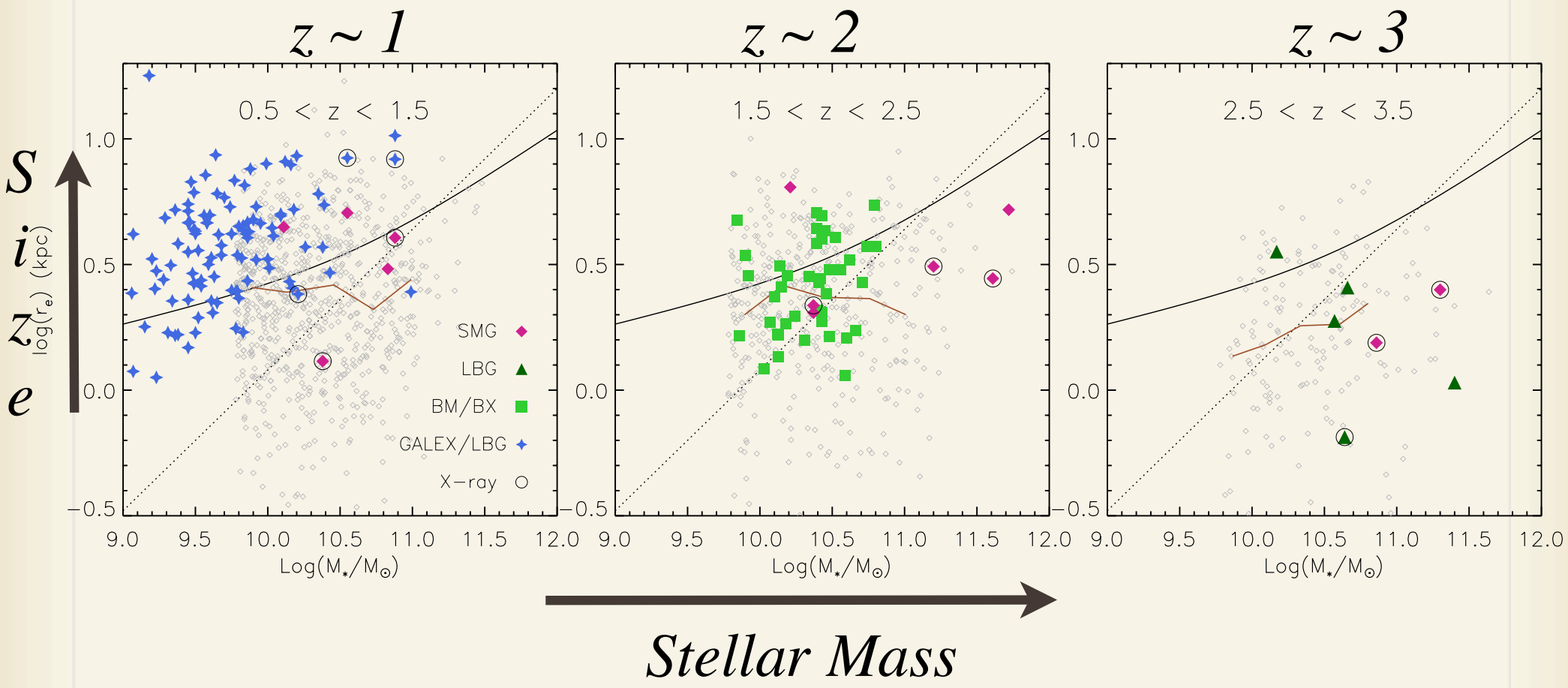
Notes. The median sizes of samples are for galaxies with stellar masses between $10^{10} - 10^{11} M_\odot$ except for the quiescent(VD08) (van Dokkum et al. 2008b) and SMG galaxies. The CDFS sample is all galaxies at the same stellar mass range in CDF-S field.

Sizes of UV-Bright galaxies evolve by a median factor of 0.60±0.08 between z ~2 to z~1

Size Evolution



Stellar Mass-Size Relation



Stellar Mass-Size Relation

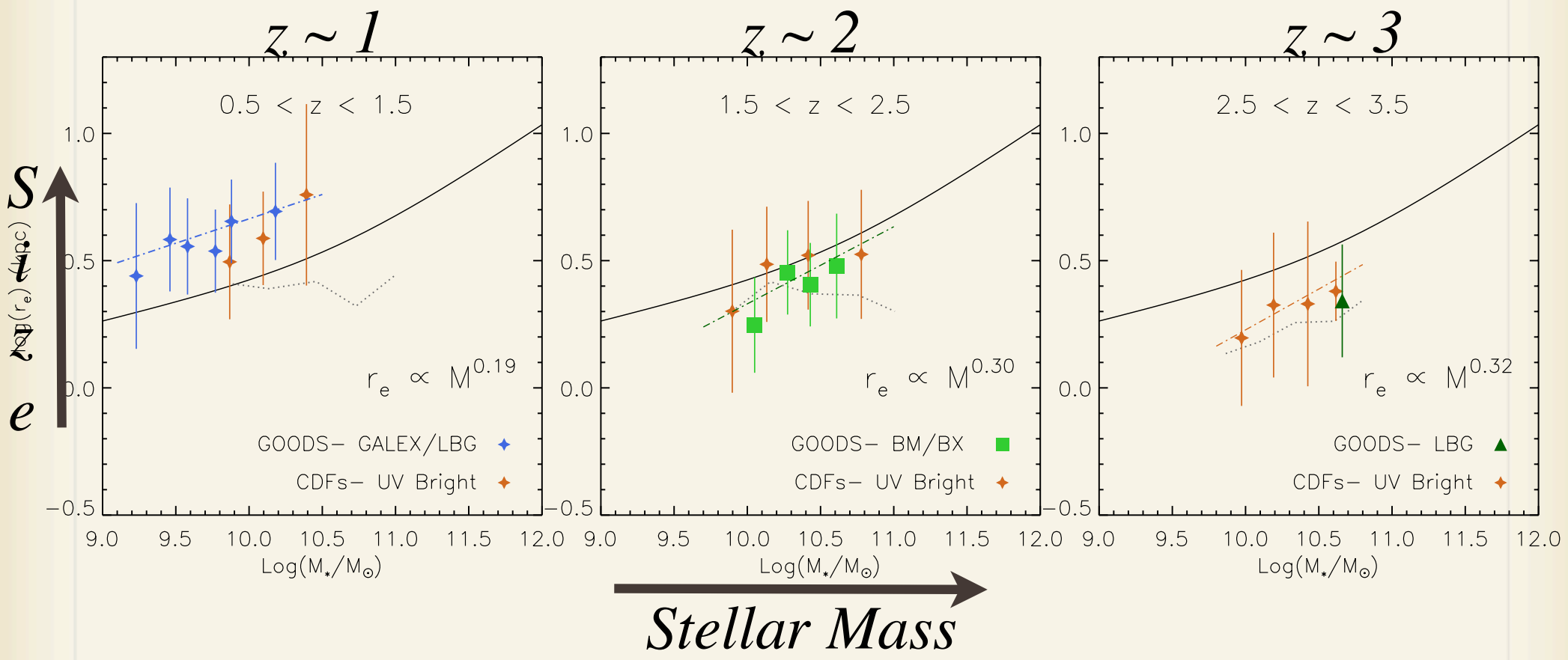
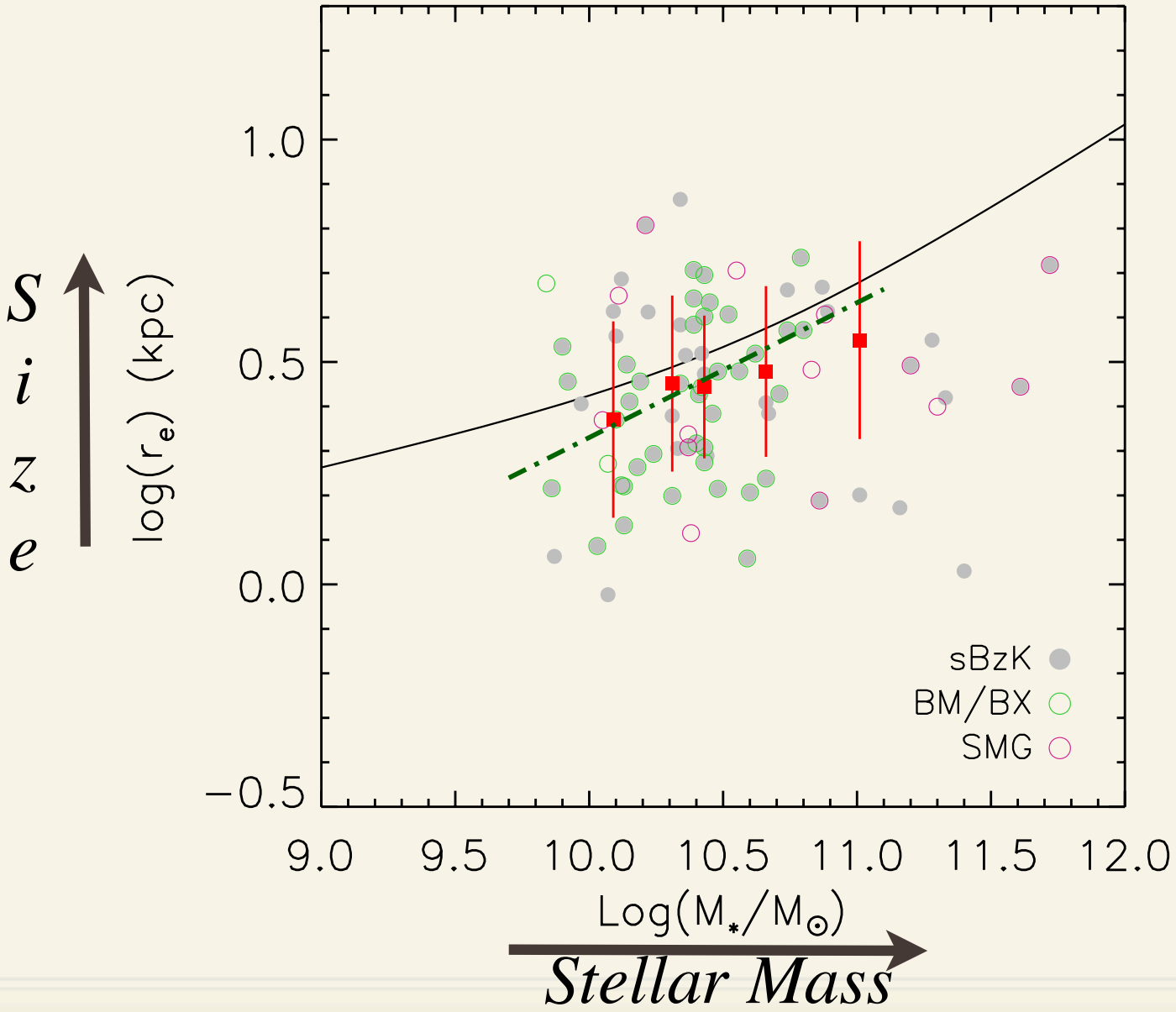


TABLE 2
BEST FITS POWER LAW PARAMETER FOR THE STELLAR MASS - SIZE RELATION

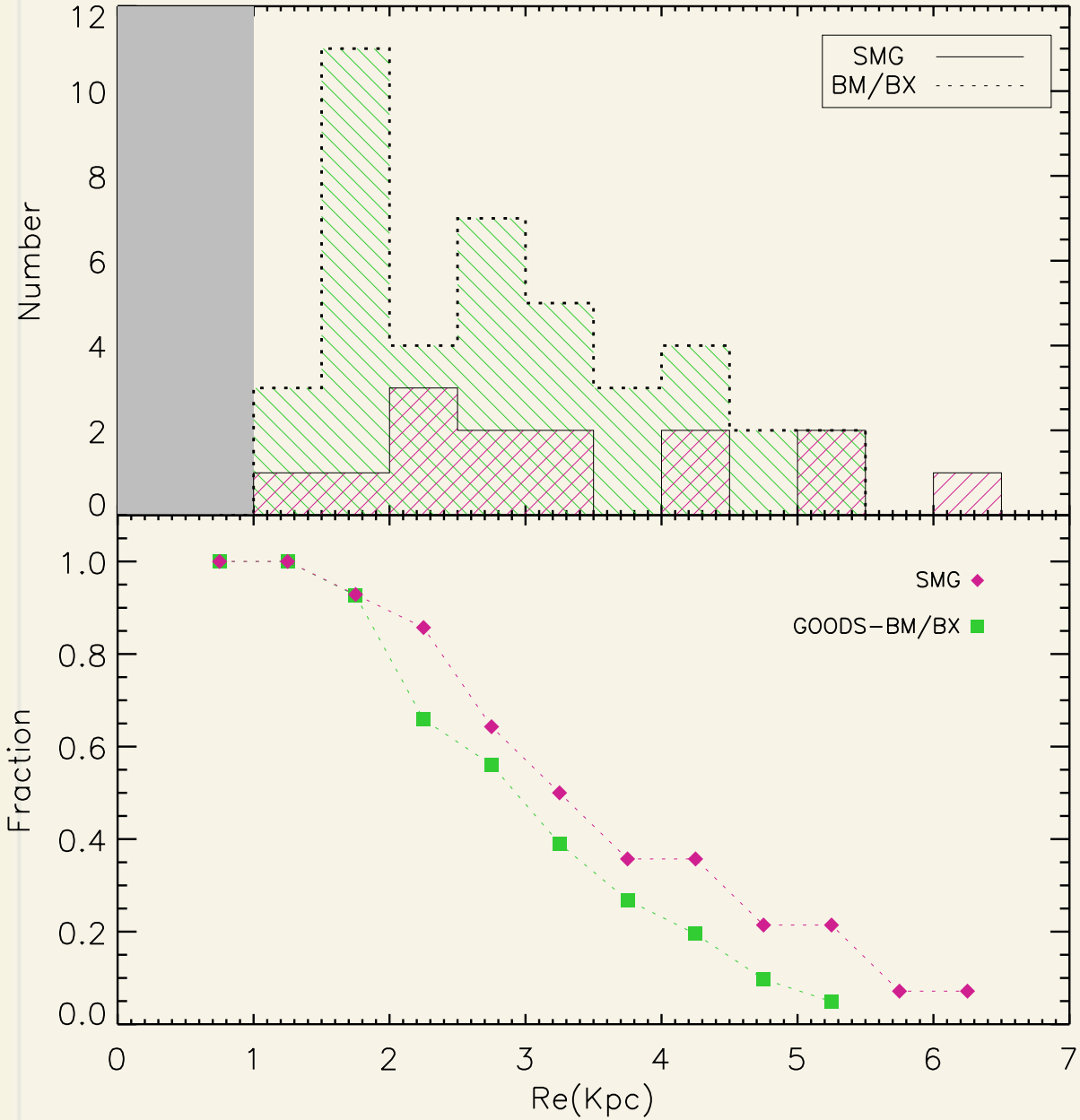
Sample	Redshift	α
GALEX/LBG	$0.6 < z < 1.4$	0.19 ± 0.05
BM/BX	$1.4 < z < 2.7$	0.30 ± 0.06
CDFs-UV Bright	$2.5 < z < 3.5$	0.32 ± 0.06
sBzK	$1.4 < z < 3.2$	0.31 ± 0.09

Note. Power law parameter α is defined as $r_e \propto M^{\alpha}$.

Stellar mass size relation for star forming *sBzK* galaxies



Sizes of Submm Galaxies



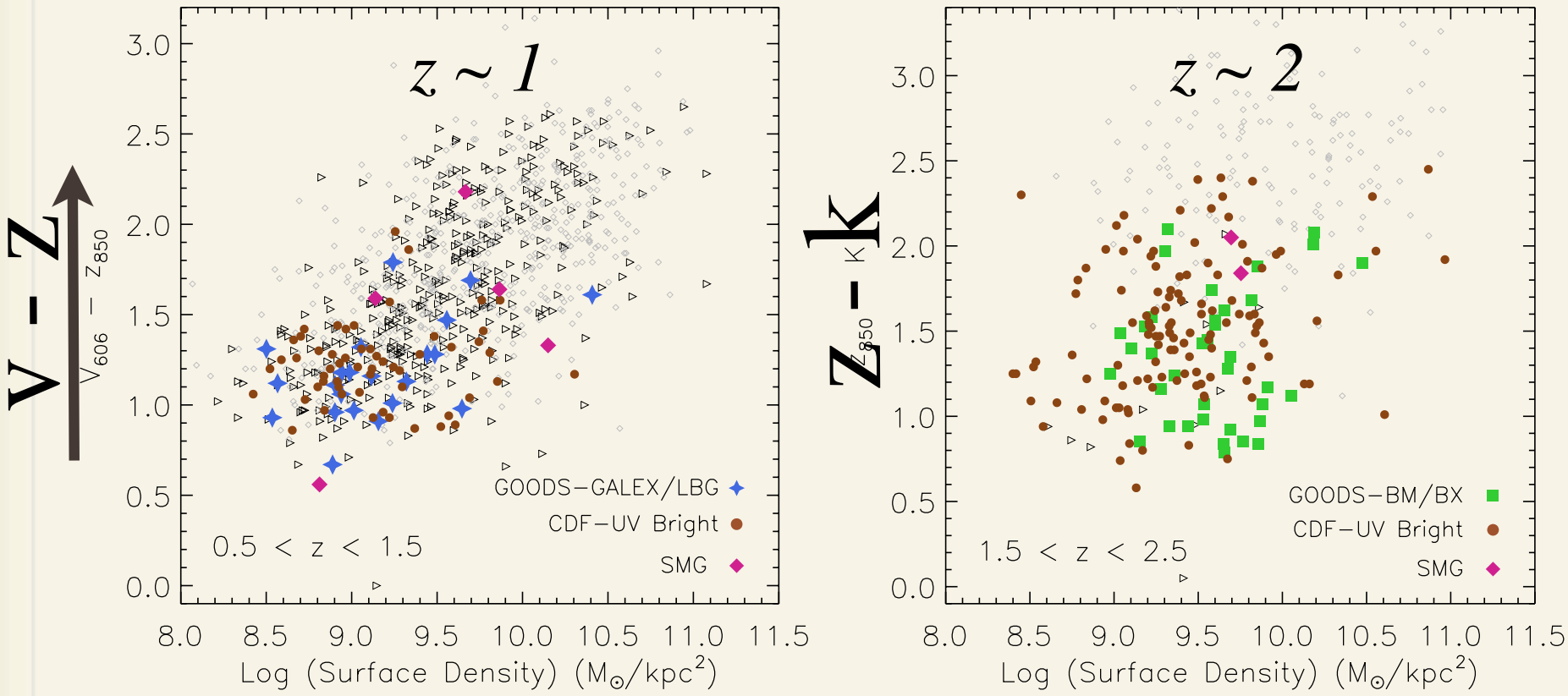
$10 < log(M_*/M_\odot) < 11$

$\bar{\text{SMG}}\text{s} = 2.65 \pm 0.56$

$\text{BM/BX} = 2.68 \pm 0.19$

Color - Surface Density

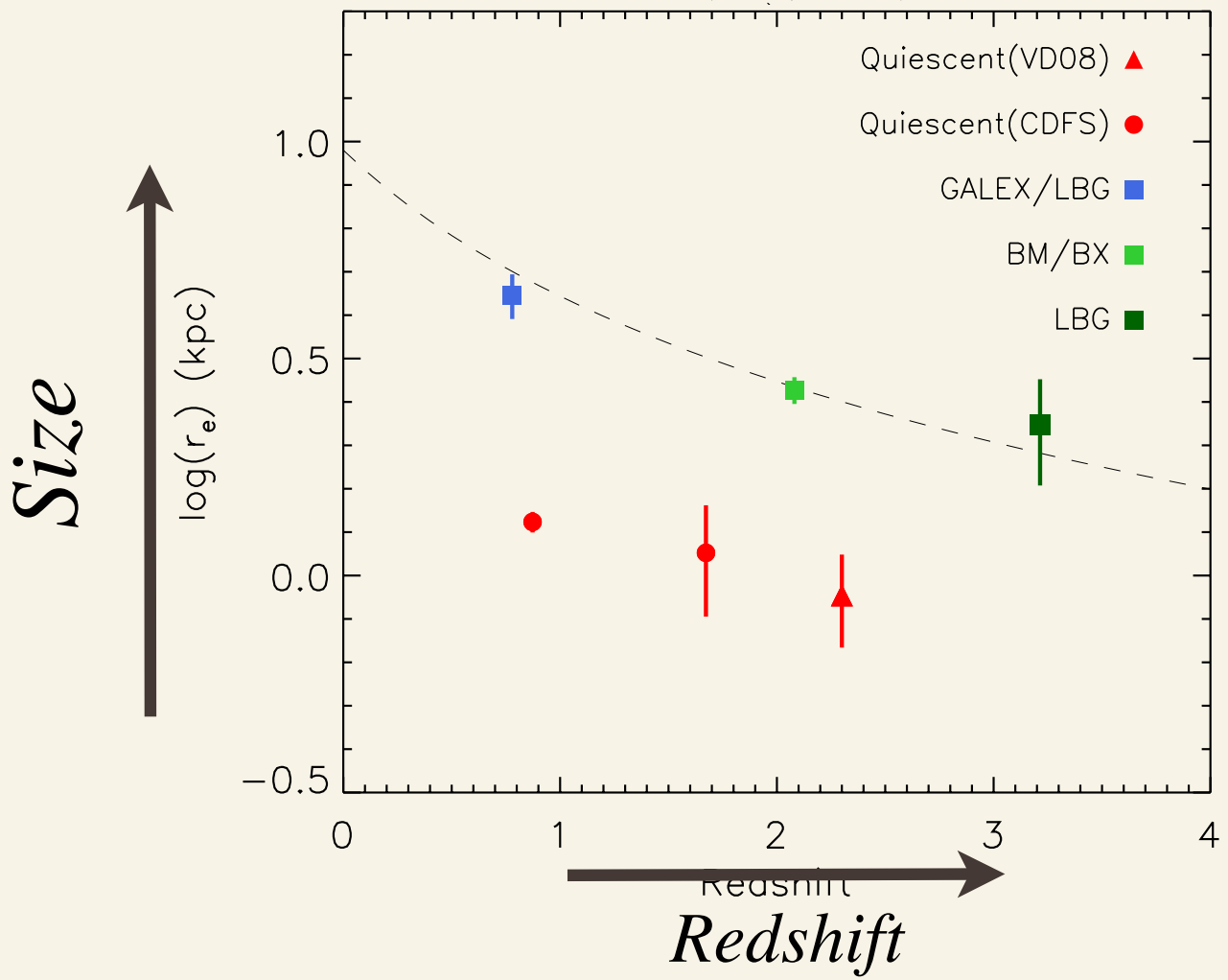
$$10 < log(M_*/M_\odot) < 11$$



Stellar Mass Surface Density

Conclusion

$10 < log(M_*/M_\odot) < 11$



UV-bright galaxies evolve as $r_e \propto (1+z)^{-1.11\pm0.13}$

Summary

- *Quantifying the size mass evolution of galaxies without potential uncertainties of photometric redshift.*
- *UV-Bright galaxies evolve strongly with redshift.*
- *UV-Bright galaxies are significantly larger than quiescent galaxies. At the same mass, the median difference is 0.45 ± 0.09.*
- *The LBG, BM/BX and GALEX/LBG samples show smooth evolution with redshift.*
- *The SMGs have half-light radii similar to UV-Bright galaxies of the same mass.*

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arXiv: 1011.3042v1