REVEALING THE ASSEMBLY HISTORY OF DISK GALAXIES:

With the Evolution in The Tully-Fisher Relation to z~1.7

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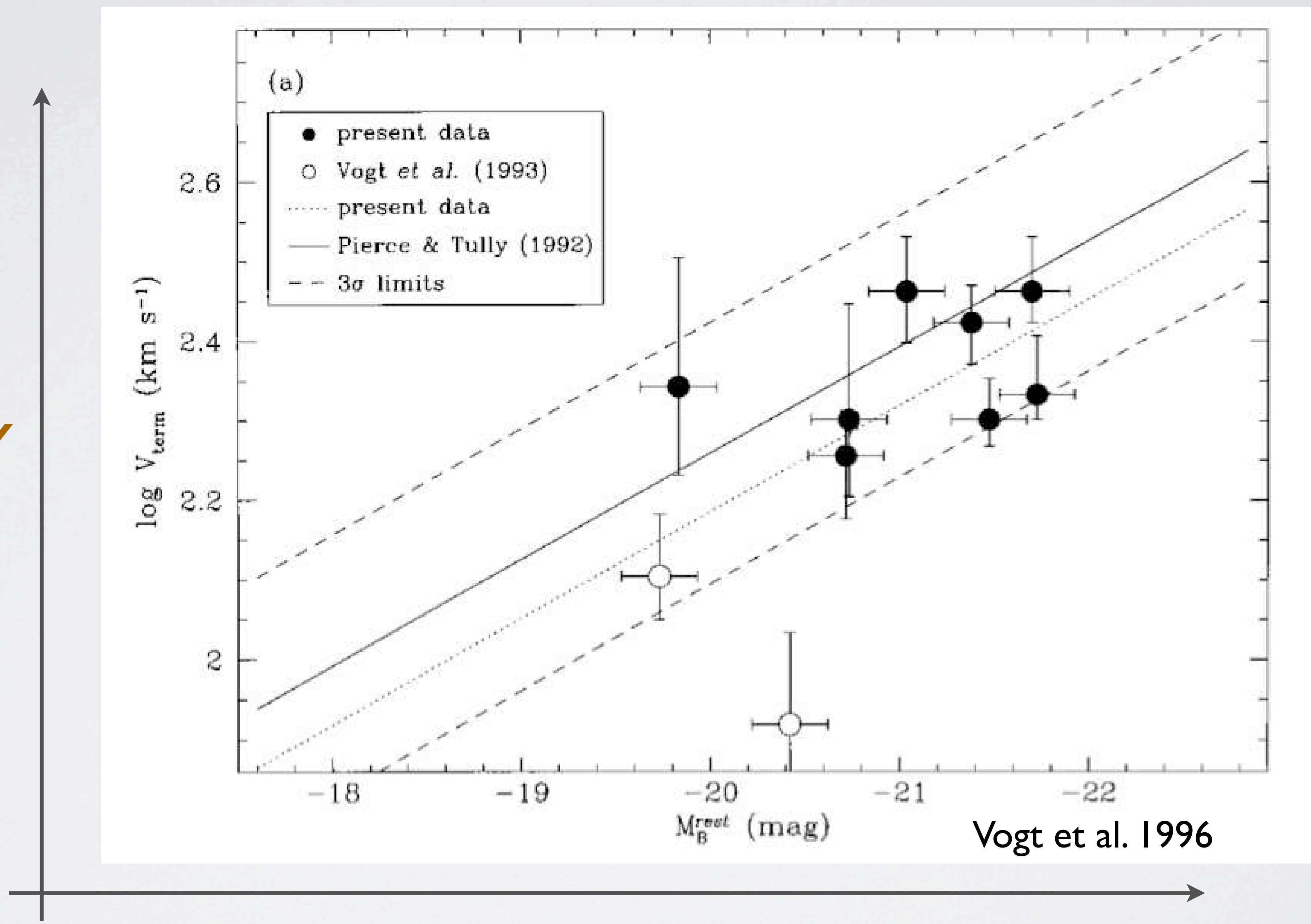
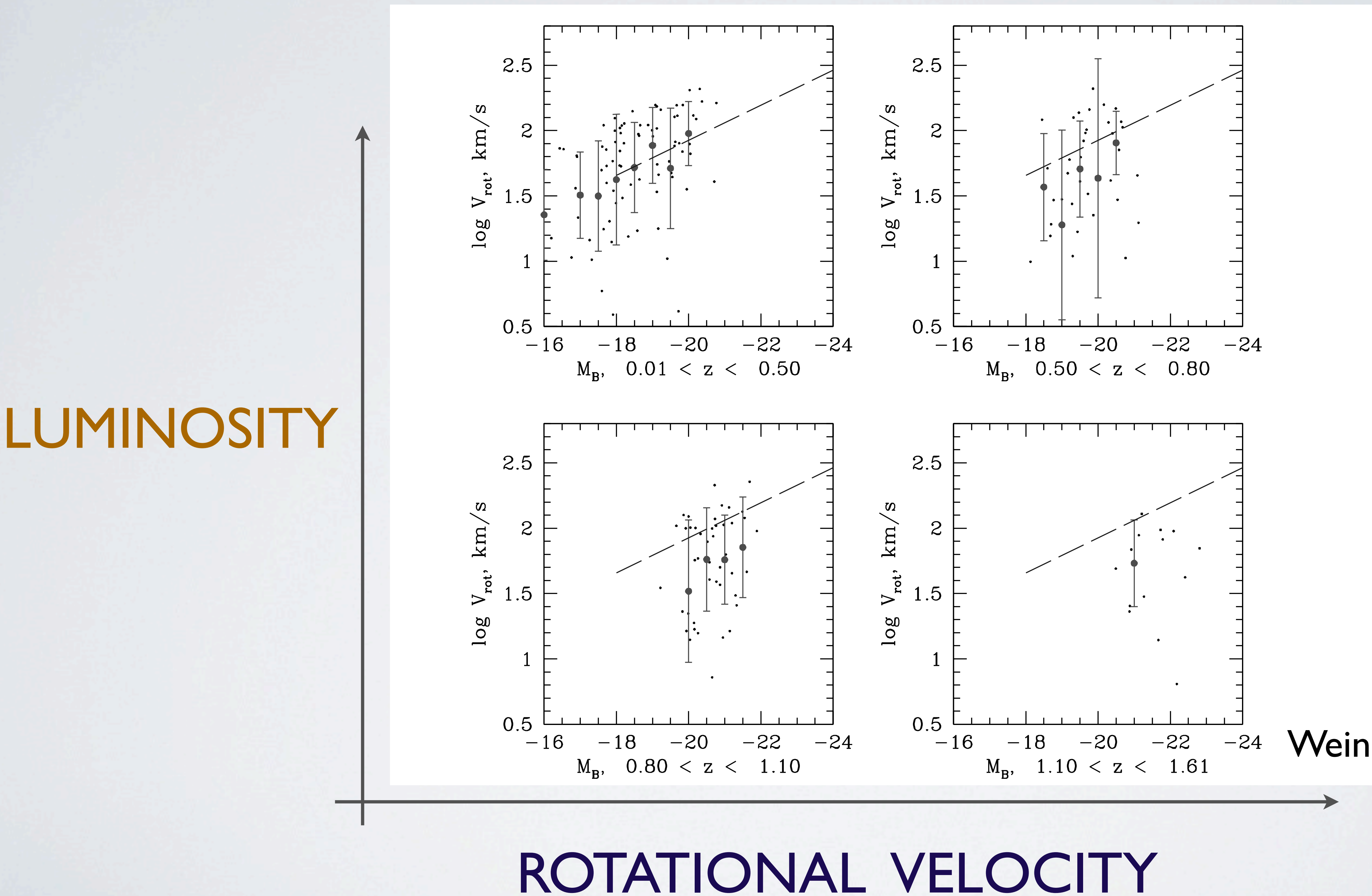
USING THE TULLY-FISHER RELATION TO CONSTRAIN OUR UNDERSTANDING OF DISK EVOLUTION

LUMINOSITY



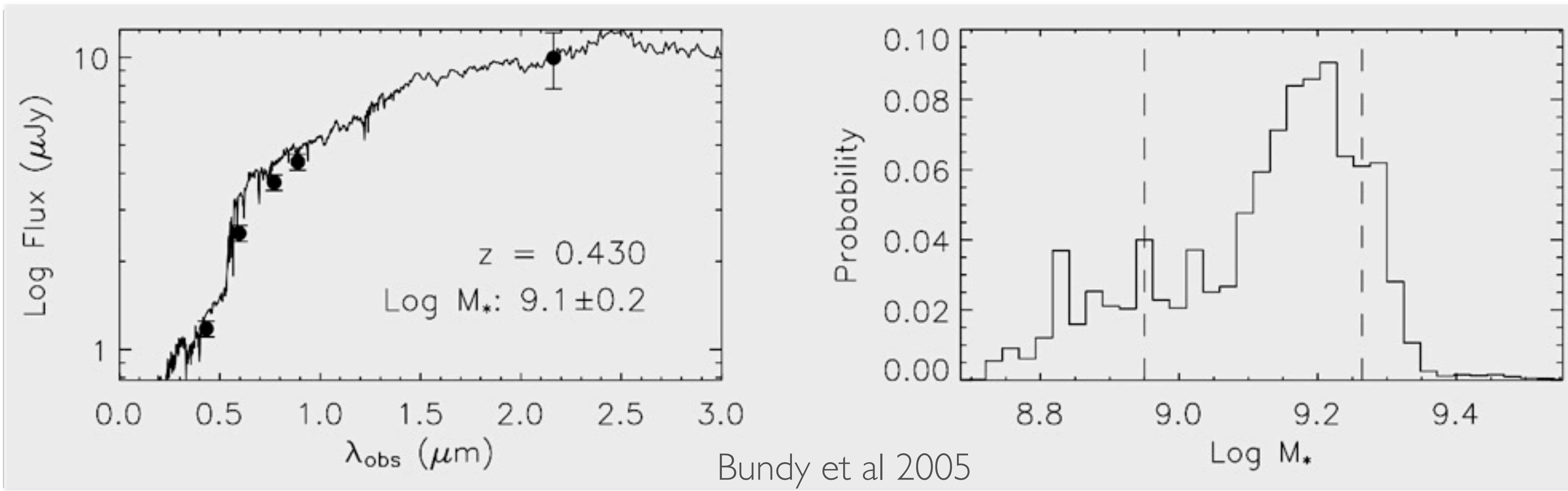
ROTATIONAL VELOCITY

USING THE TULLY-FISHER RELATION TO CONSTRAIN OUR UNDERSTANDING OF DISK EVOLUTION



Weiner et al. 2006

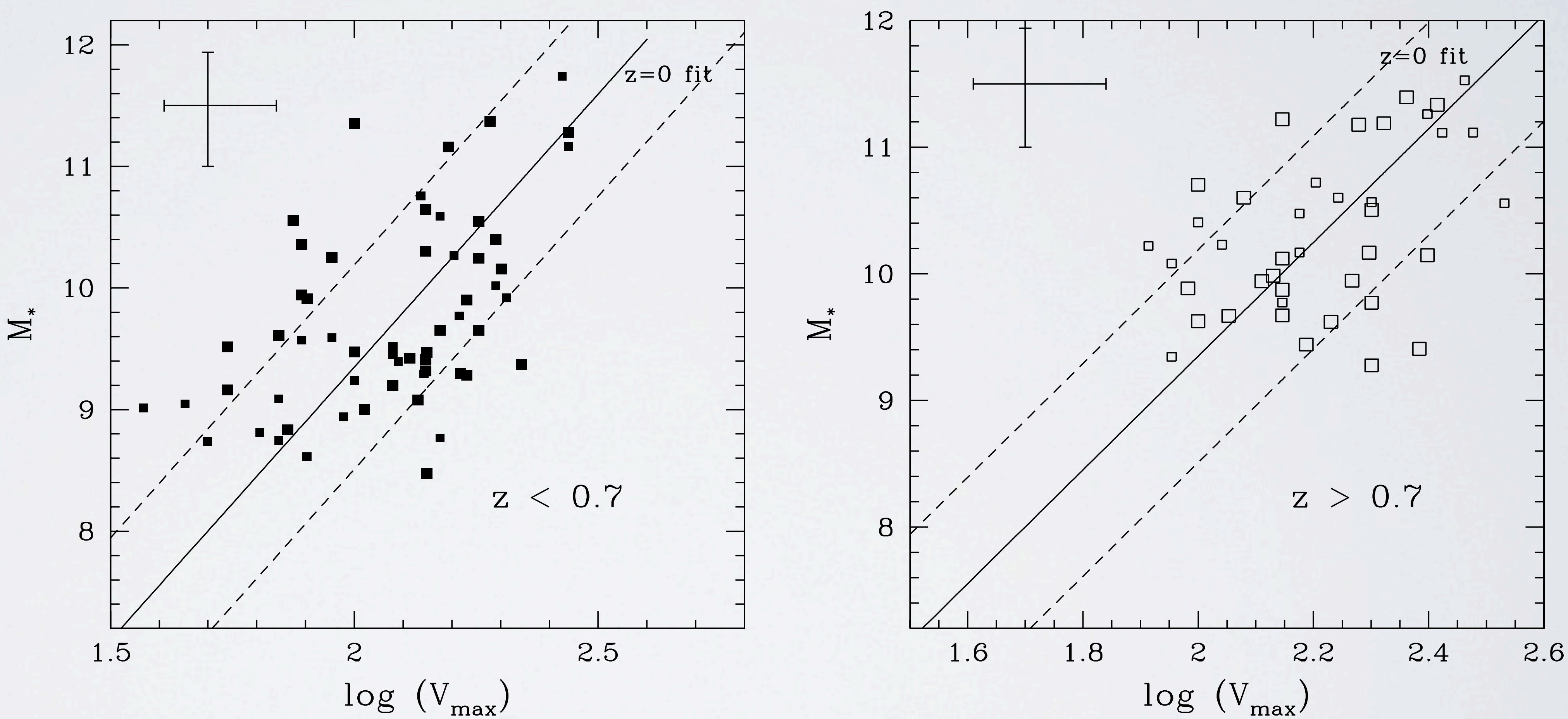
LUMINOSITY → STELLAR MASS



Bundy et al 2005

USING THE TULLY-FISHER RELATION TO CONSTRAIN OUR UNDERSTANDING OF DISK EVOLUTION

STELLAR MASS

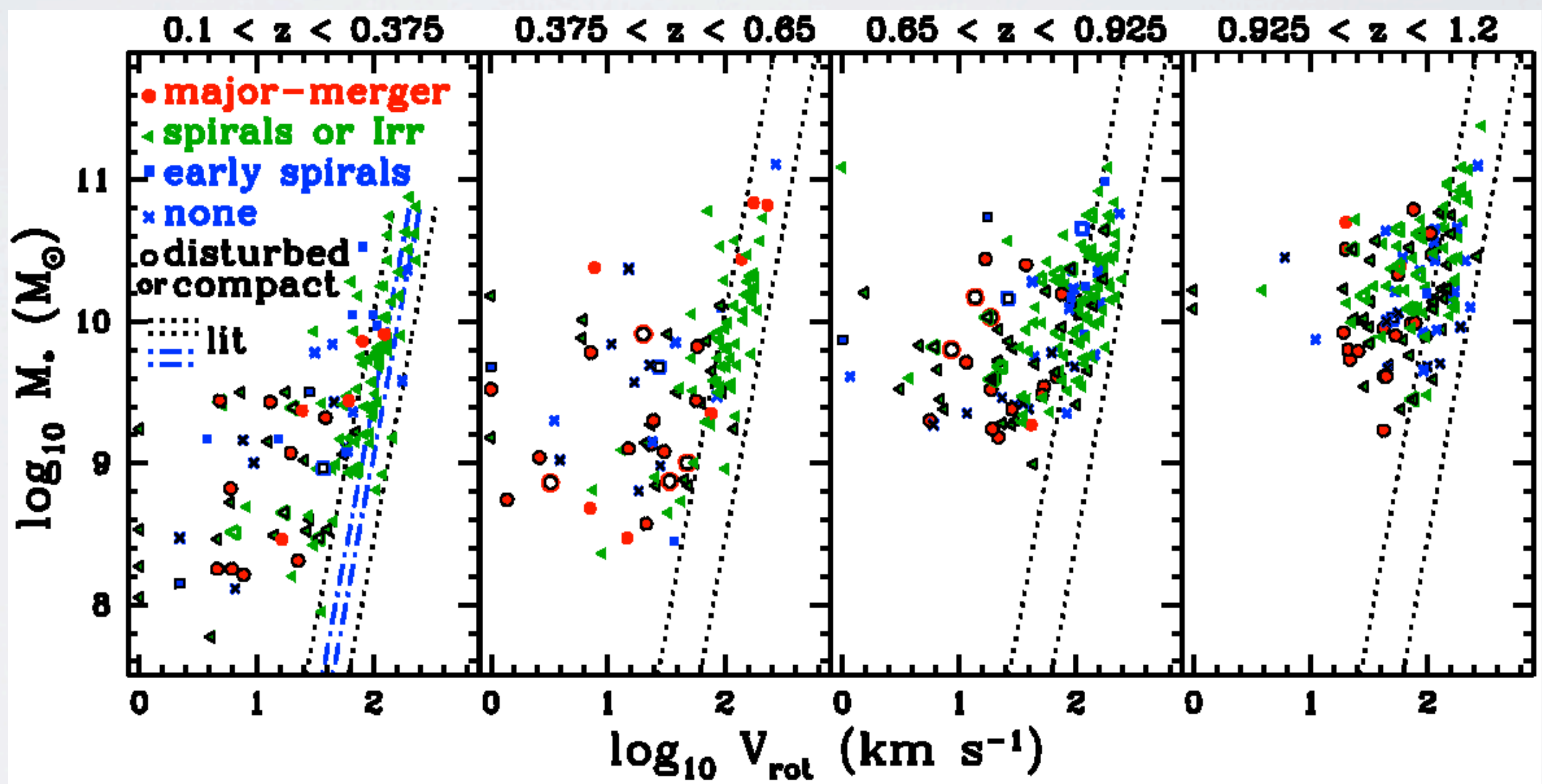


ROTATIONAL VELOCITY

Conselice et al. 2005

USING THE TULLY-FISHER RELATION TO CONSTRAIN OUR UNDERSTANDING OF DISK EVOLUTION

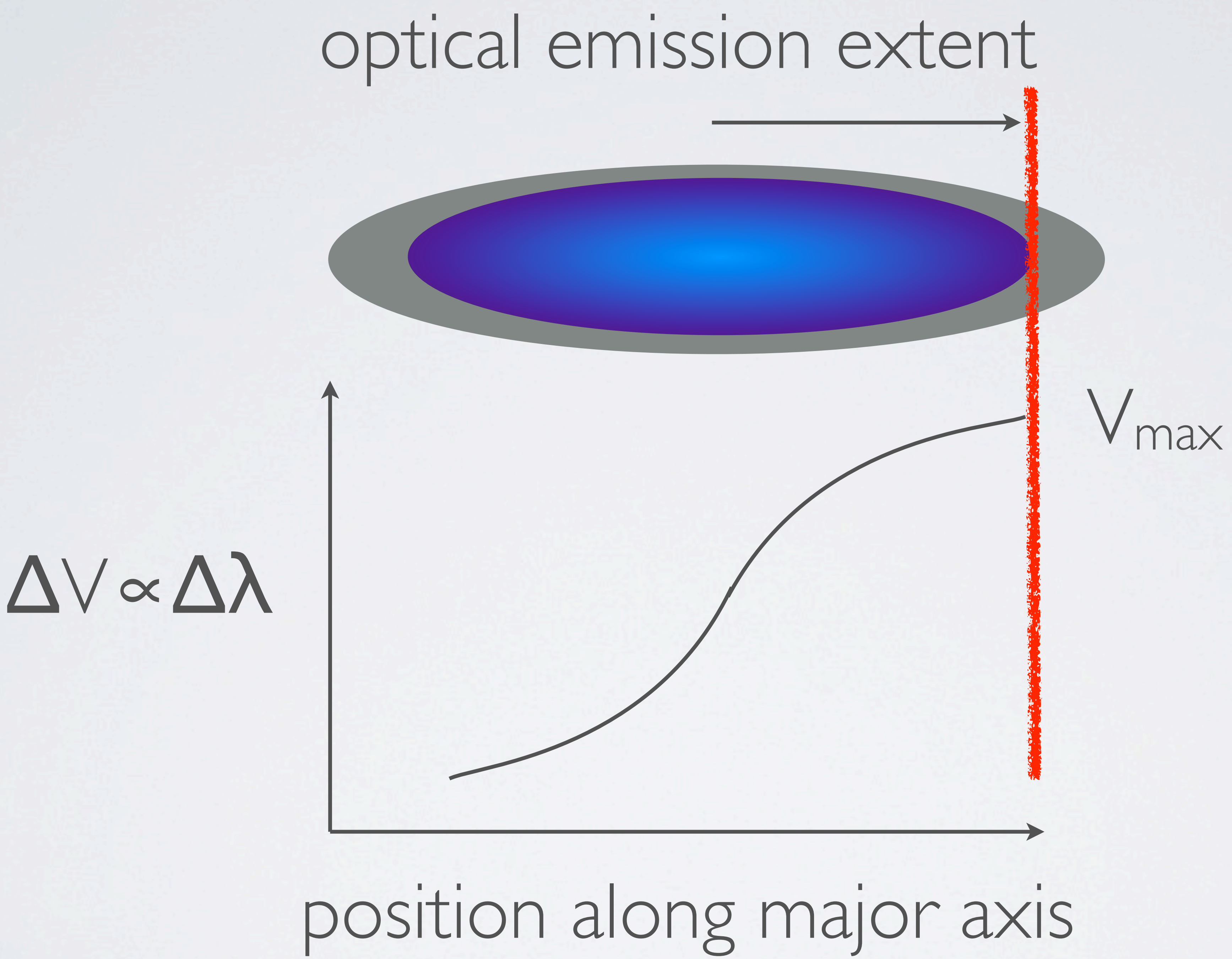
STELLAR MASS



Kassin et al. 2007

ROTATIONAL VELOCITY

ROTATIONAL VELOCITY



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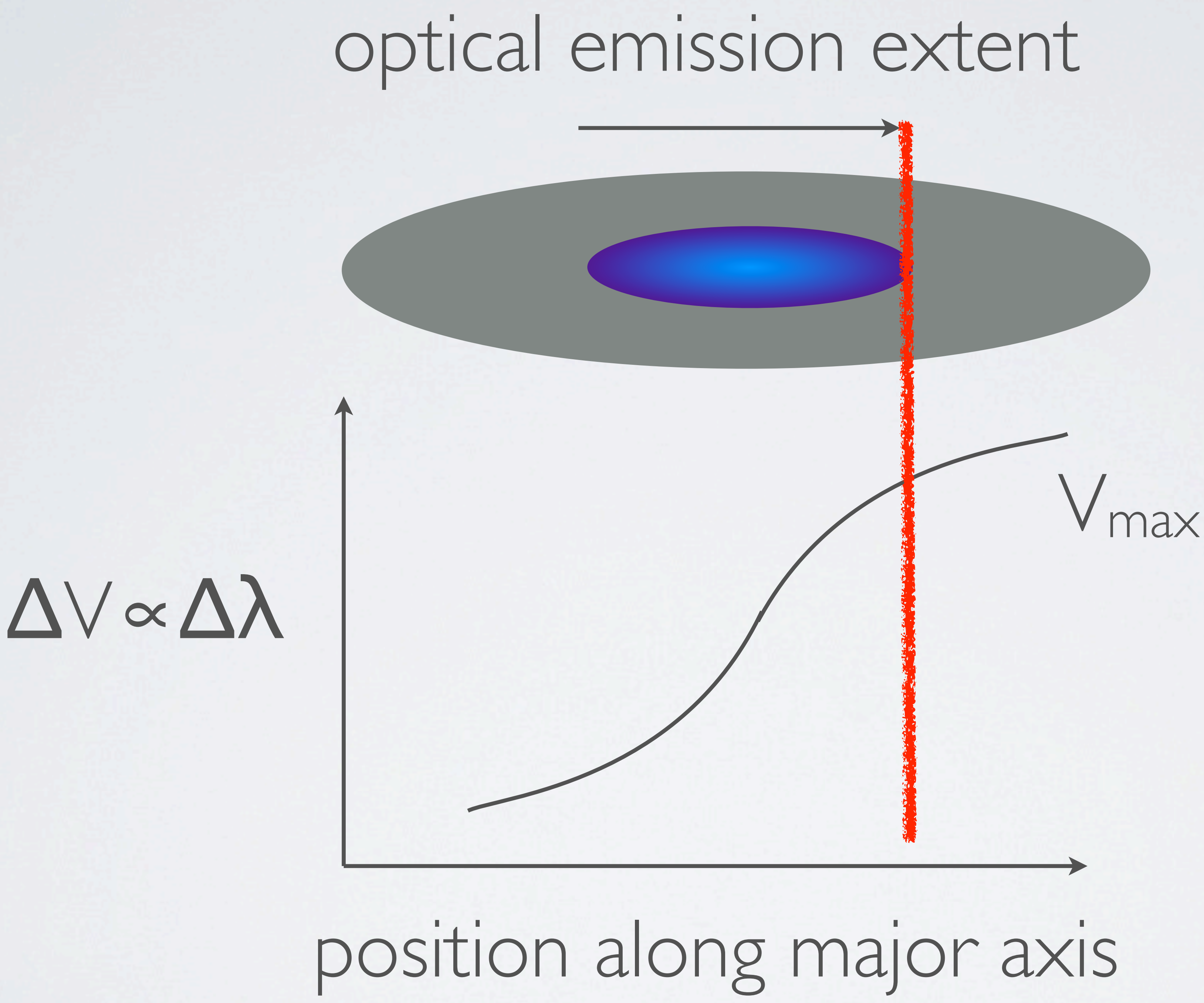
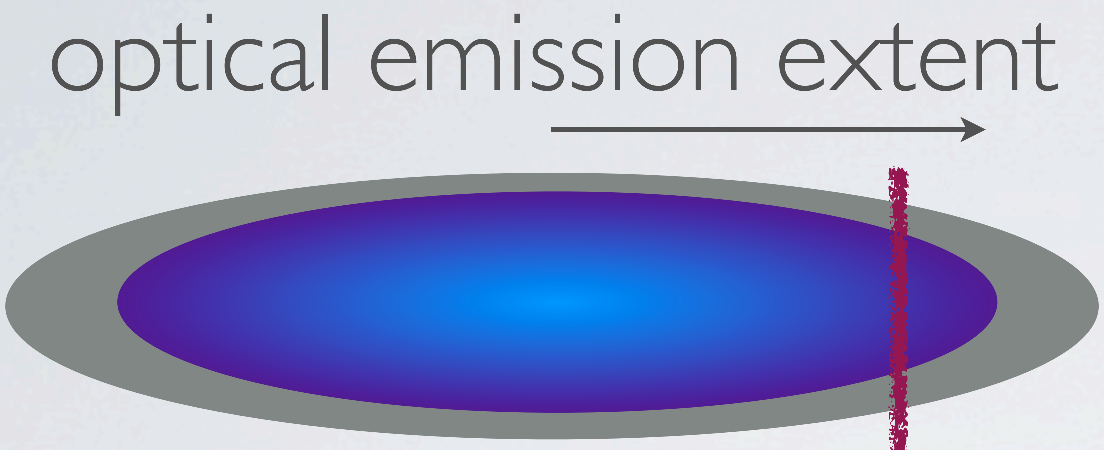
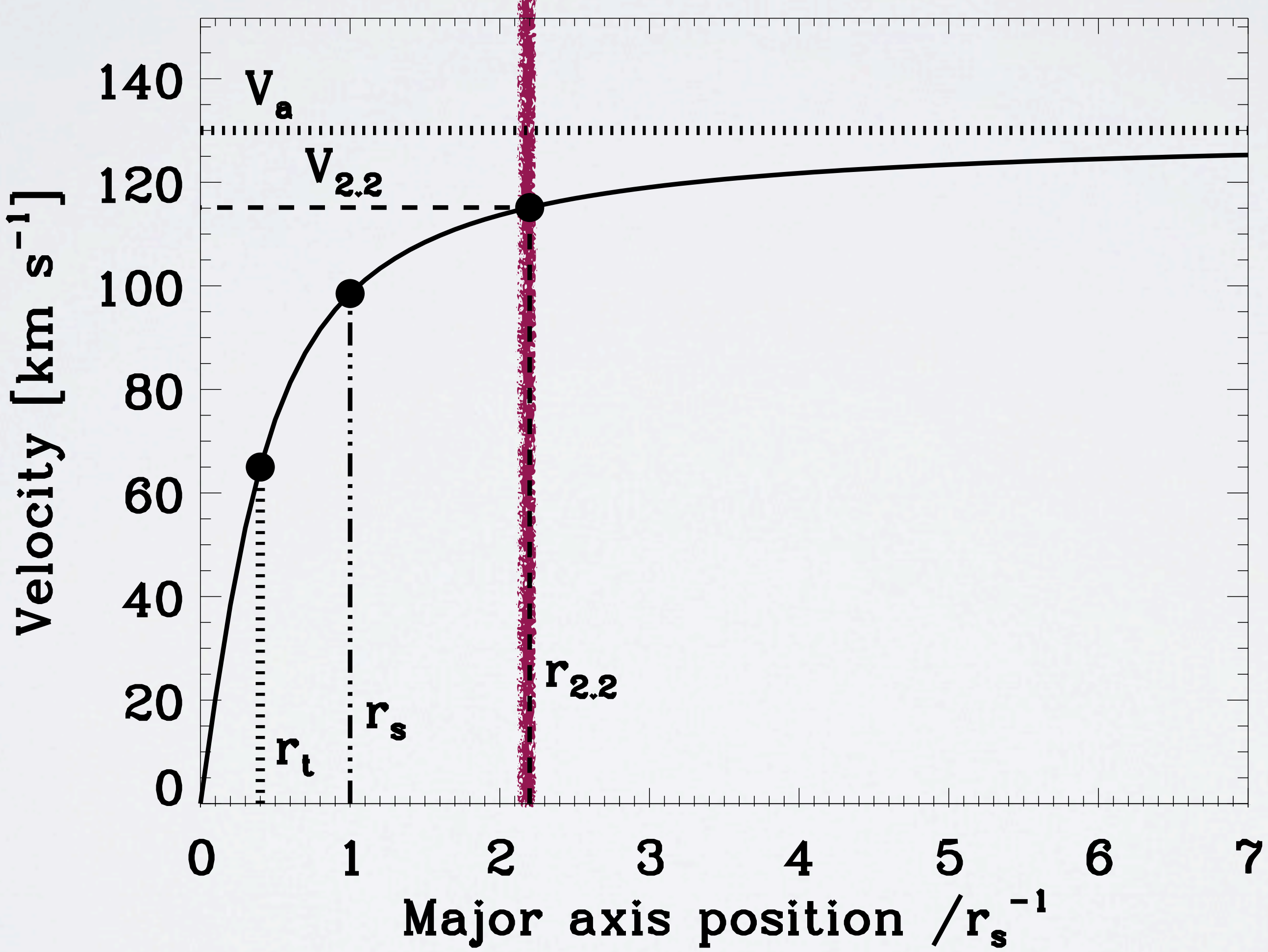


ROTATIONAL VELOCITY



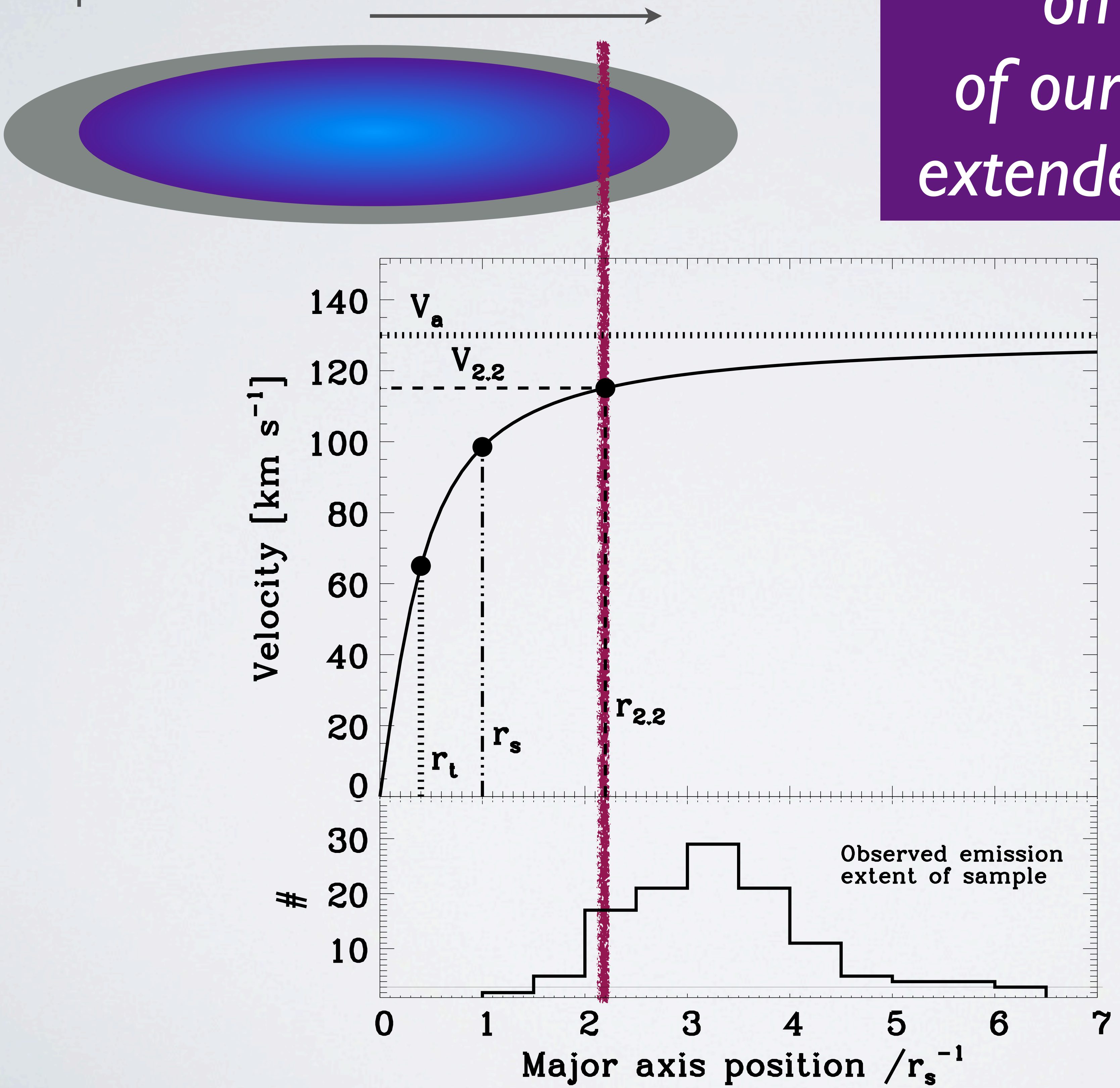
$$V = V_0 + \frac{2}{\pi} V_a \arctan\left(\frac{r - r_0}{r_t}\right),$$



ROTATIONAL VELOCITY

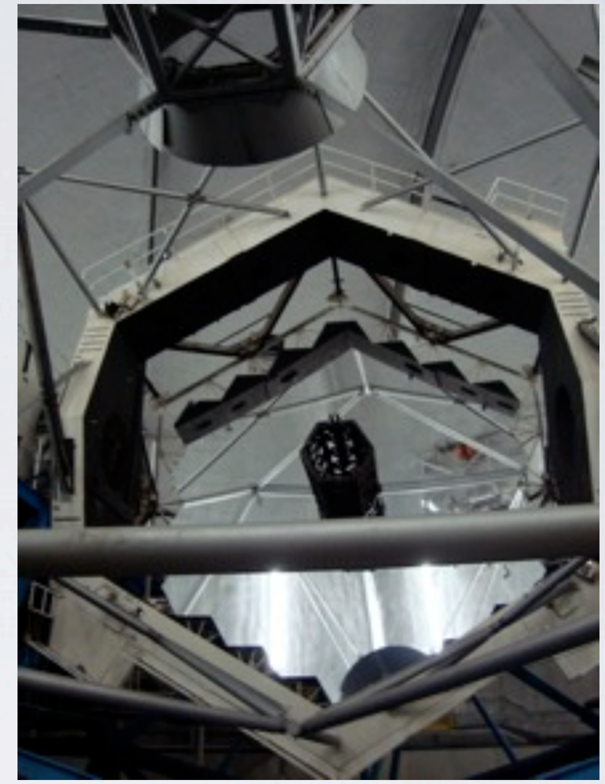
optical emission extent

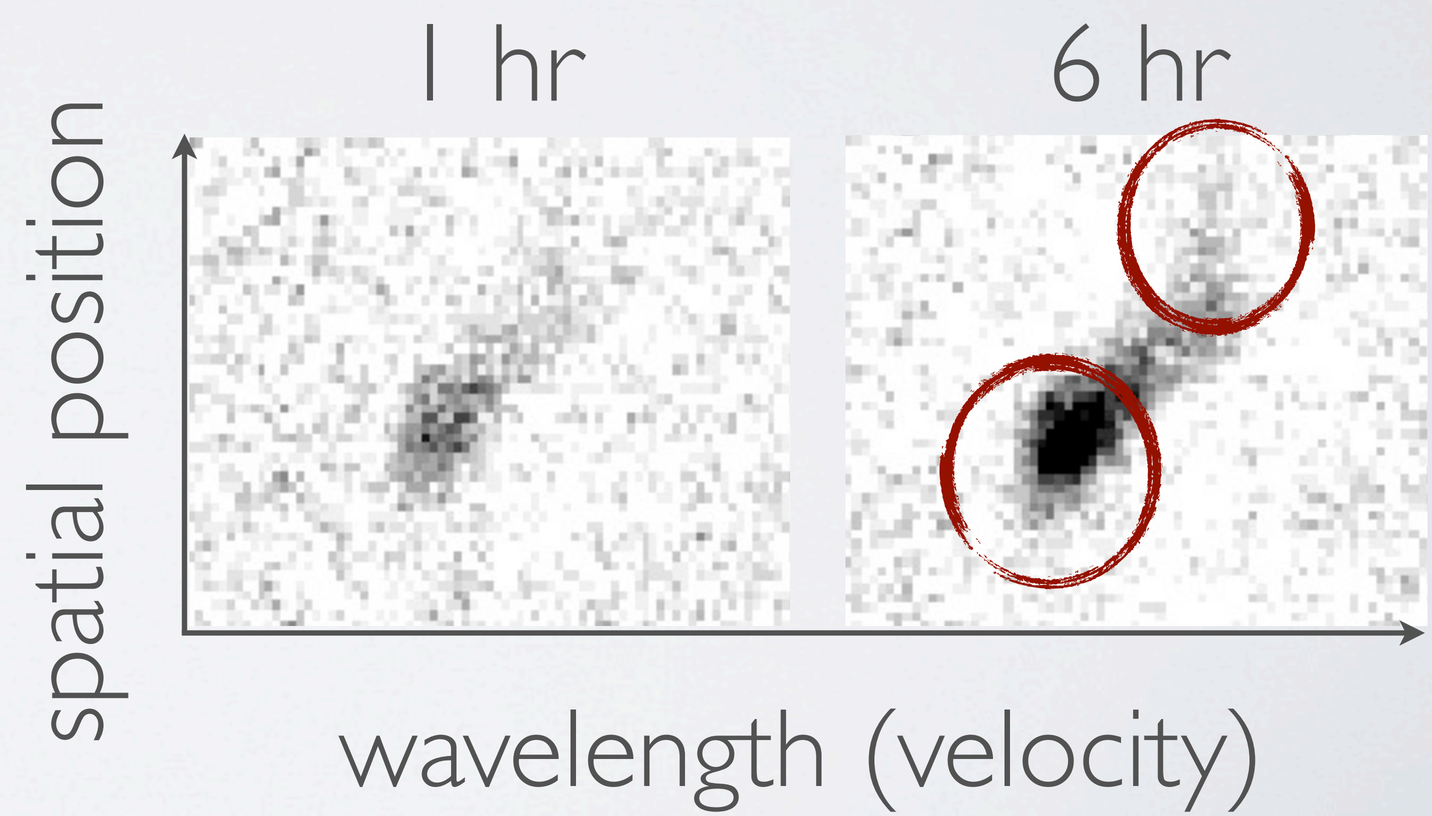
trace to $2.2r_s$ ($r_{2.2}$)
on ~ 90%
of our disks with
extended emission!



THIS STUDY

- 306 disks, including irregular and disturbed
- $0.2 \lesssim z \lesssim 1.7$
  - ➡ DEIMOS: $0.2 \lesssim z \lesssim 1$ (N = 236)
  - ➡ LRIS: $1 \lesssim z \lesssim 1.7$ (N = 70)
- $M_* \sim 10^{8.5\text{-}11.5}\ M_\odot$
- HST ACS, WFC3 and ground-based K_s
- **6-8 hours of exposure time**
- **63 passive, 73 compact emission, 171 extended emission**





MODELING ROTATION CURVES FROM DEIMOS (0.2≲z≲1)

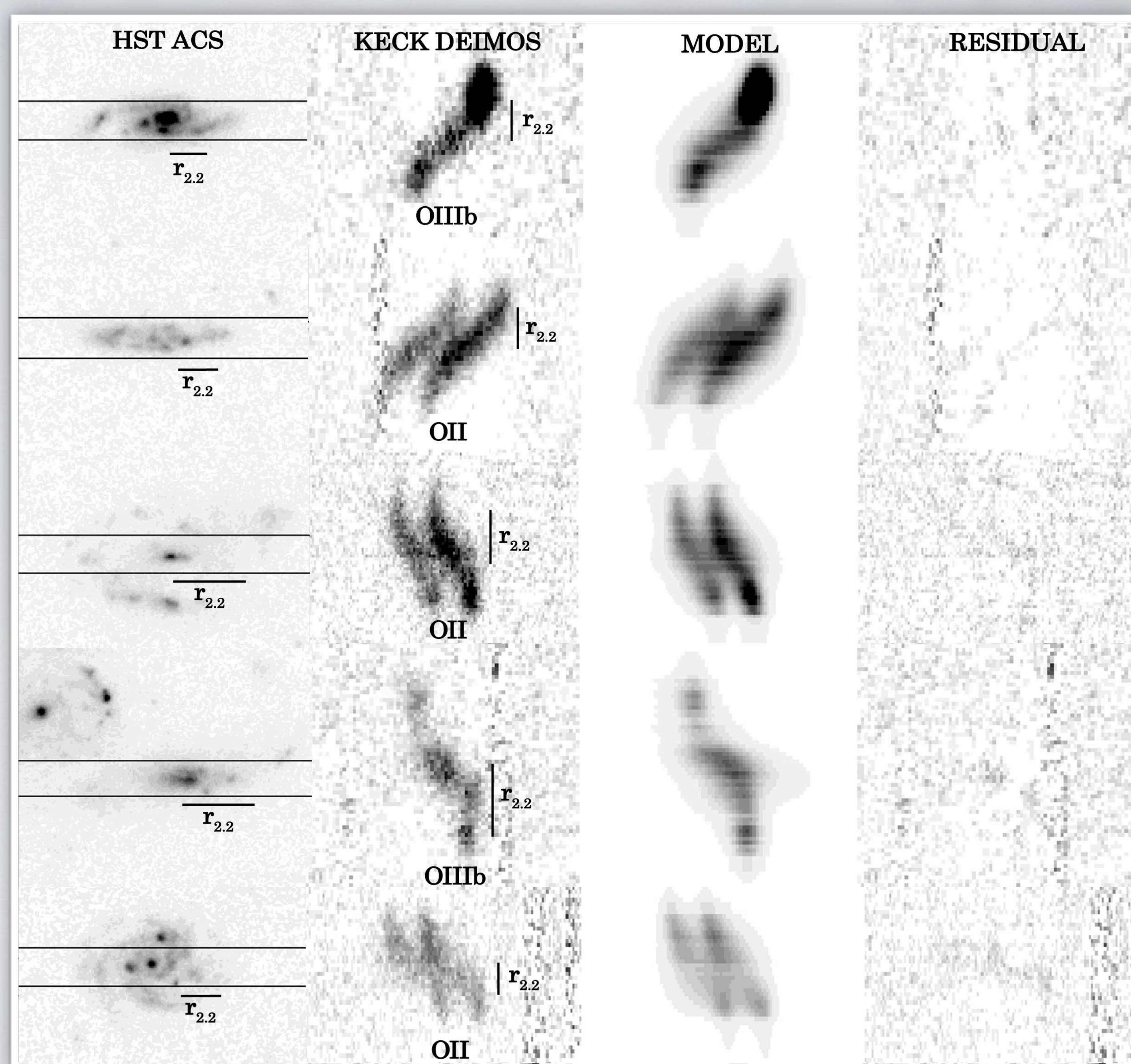
z~0.54

z~0.97

z~0.94

z~0.47

z~0.94



DISK SIZE AND PROJECTION

- disk scale length: $r_{2.2}$

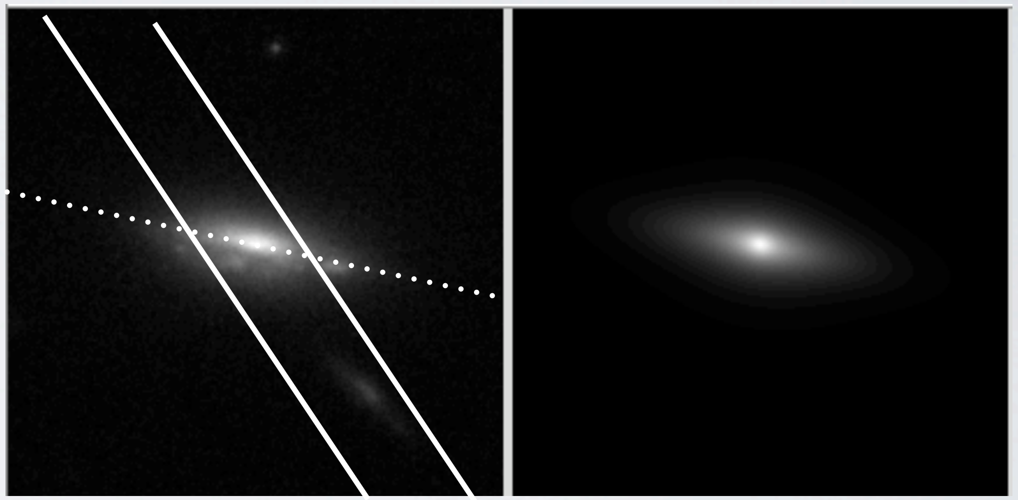
  Fit exponential disk
  (and BULGE when necessary)

- inclination

$$V_{corr} = \frac{V_{obs}}{(\sin i)} \qquad i = \cos^{-1}\sqrt{\frac{(b/a)^2 - q_0^2}{1 - q_0^2}}$$

- position angle offset between slit and major axis

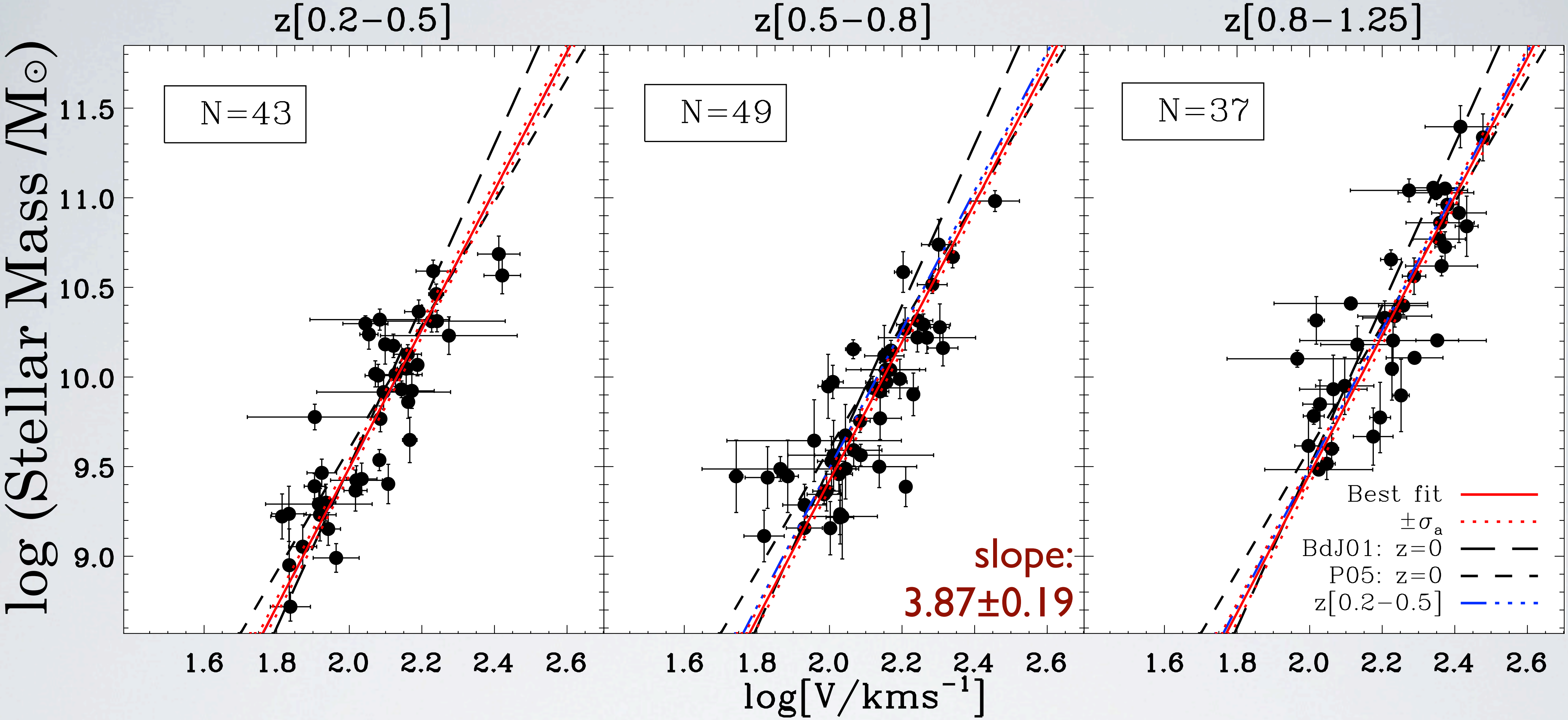
$$V_{corr} = \frac{V_{obs}}{\cos(\Delta PA)}$$



GALFIT

Peng et al. 2010

Miller et al. 2011, *ApJ*, 741, 115

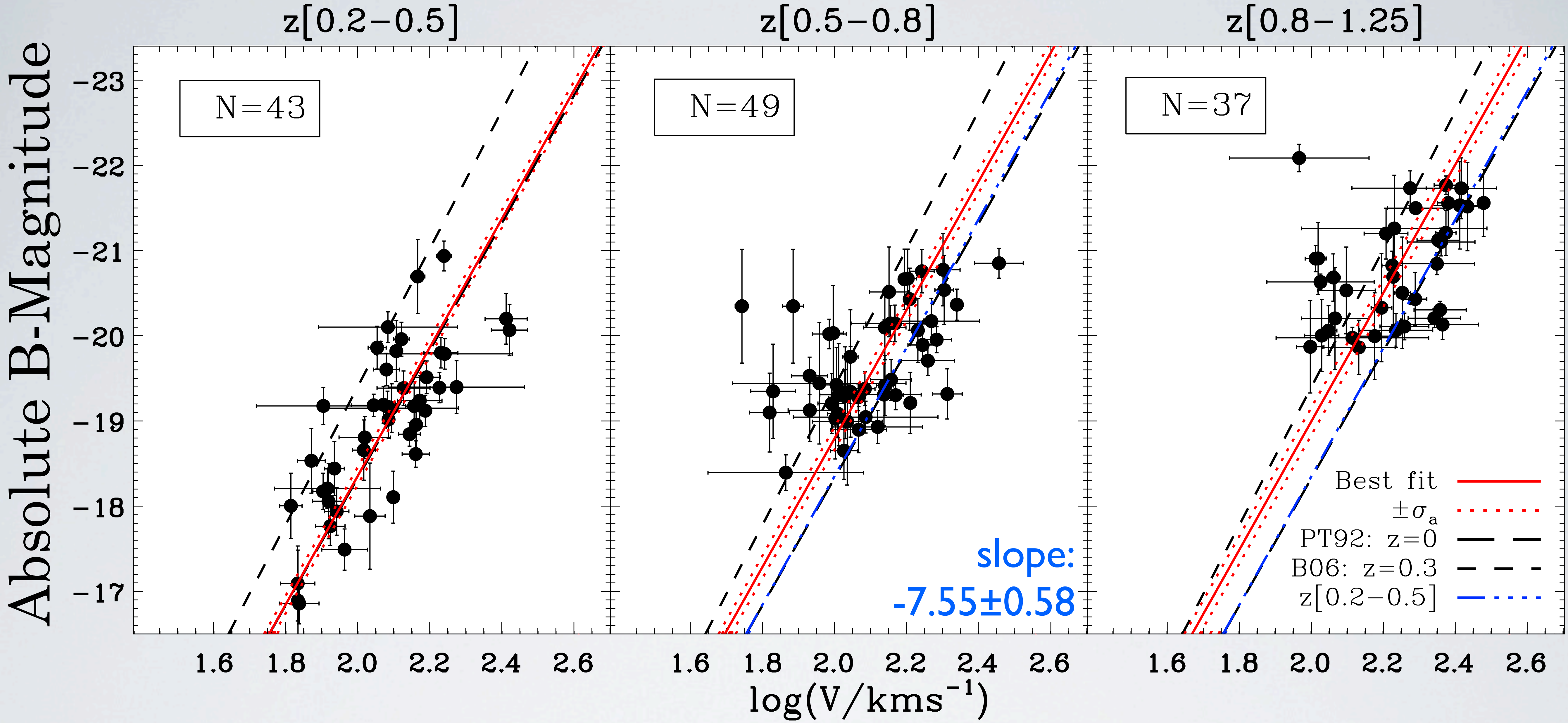


σ_{int} ~ 0.05 dex in V/km s^{-1}
~ 0.2 dex in M/M$_\odot$

ΔM$_*$ ~ 0.04 ± 0.07 dex
from ⟨z⟩~1 to ⟨z⟩~0.3

STELLAR MASS TULLY-FISHER RELATION WELL-ESTABLISHED AT z~1

Miller et al. 2011, *ApJ*, 741, 115

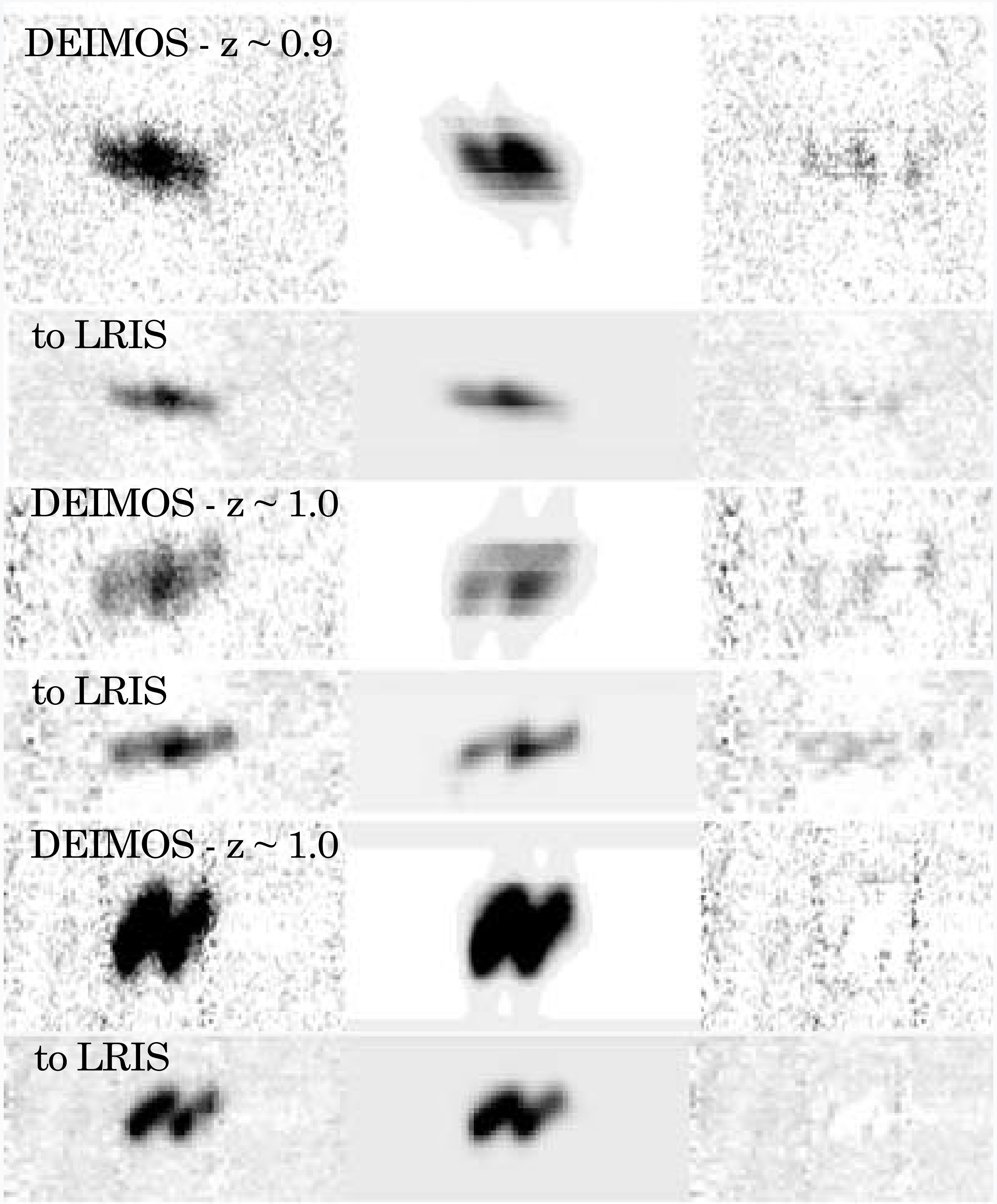


σ_{int} ~ 0.05-0.09 dex V/km s^{-1}
~ 0.4-0.7 mag

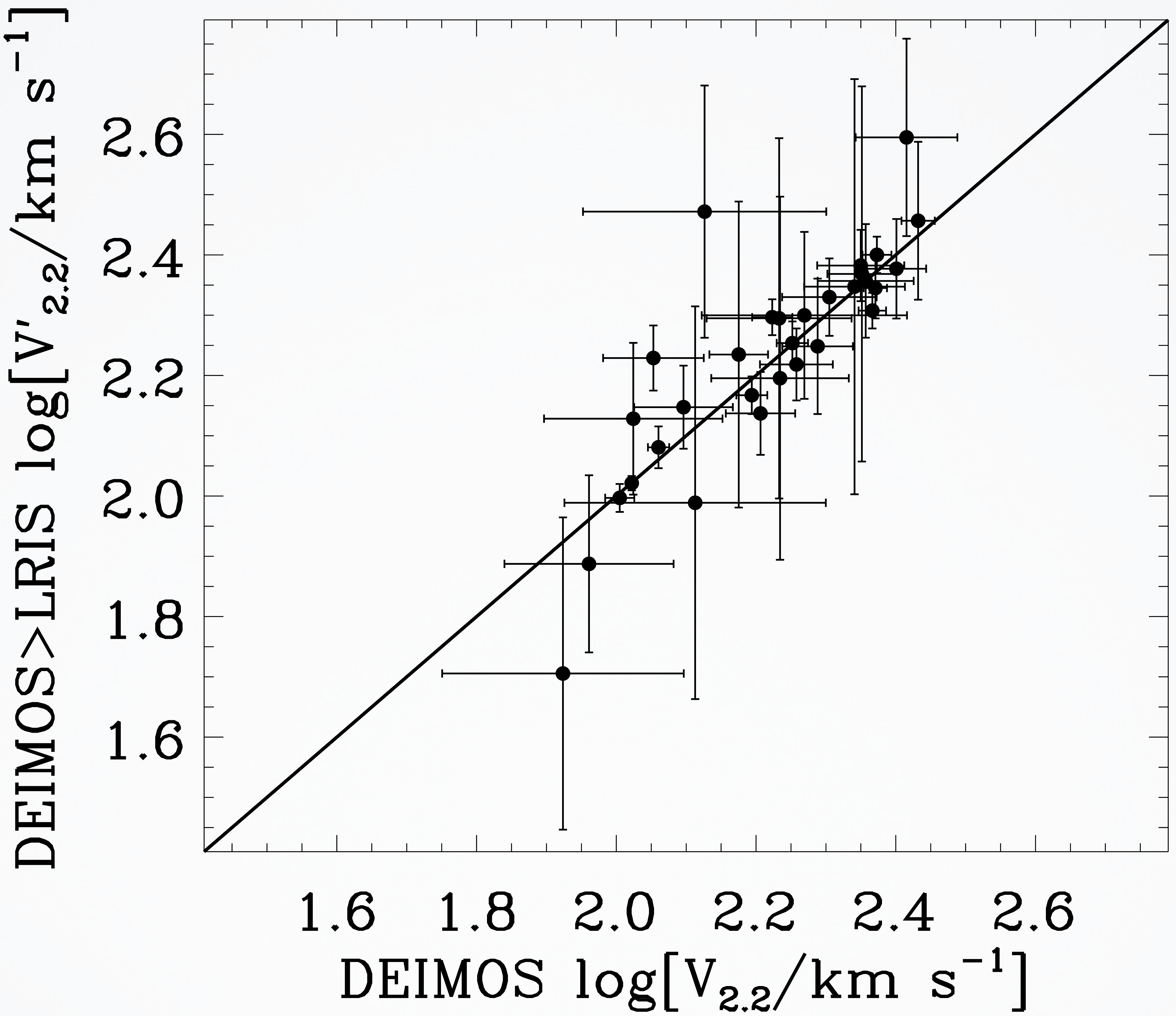
ΔM_B ~ 0.85 ± 0.28 dex
from ⟨z⟩~1 to ⟨z⟩~0.3

B-MAG TULLY-FISHER RELATION LESS FUNDAMENTAL AT z~1

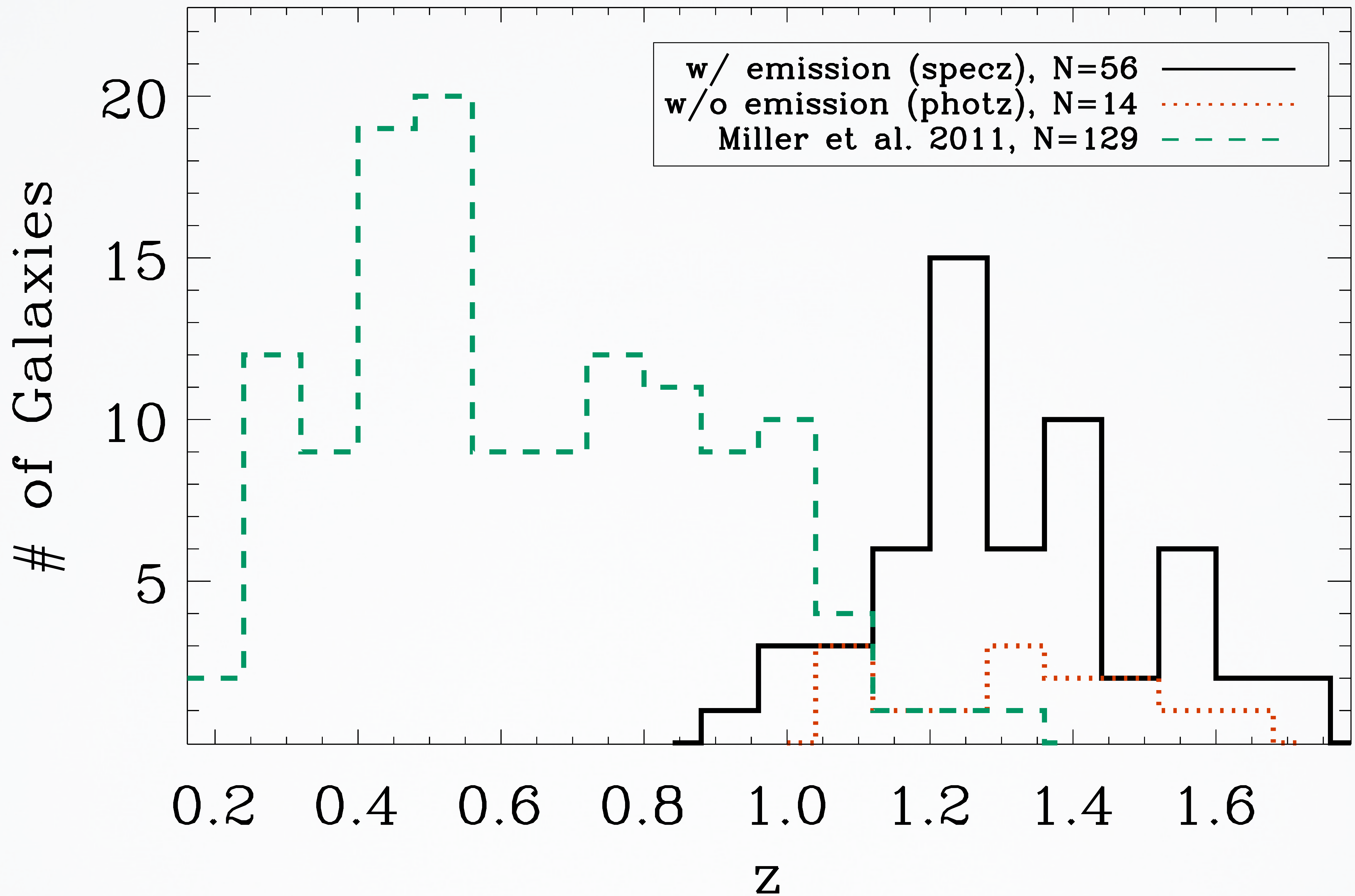
PUSHING TO HIGHER REDSHIFT



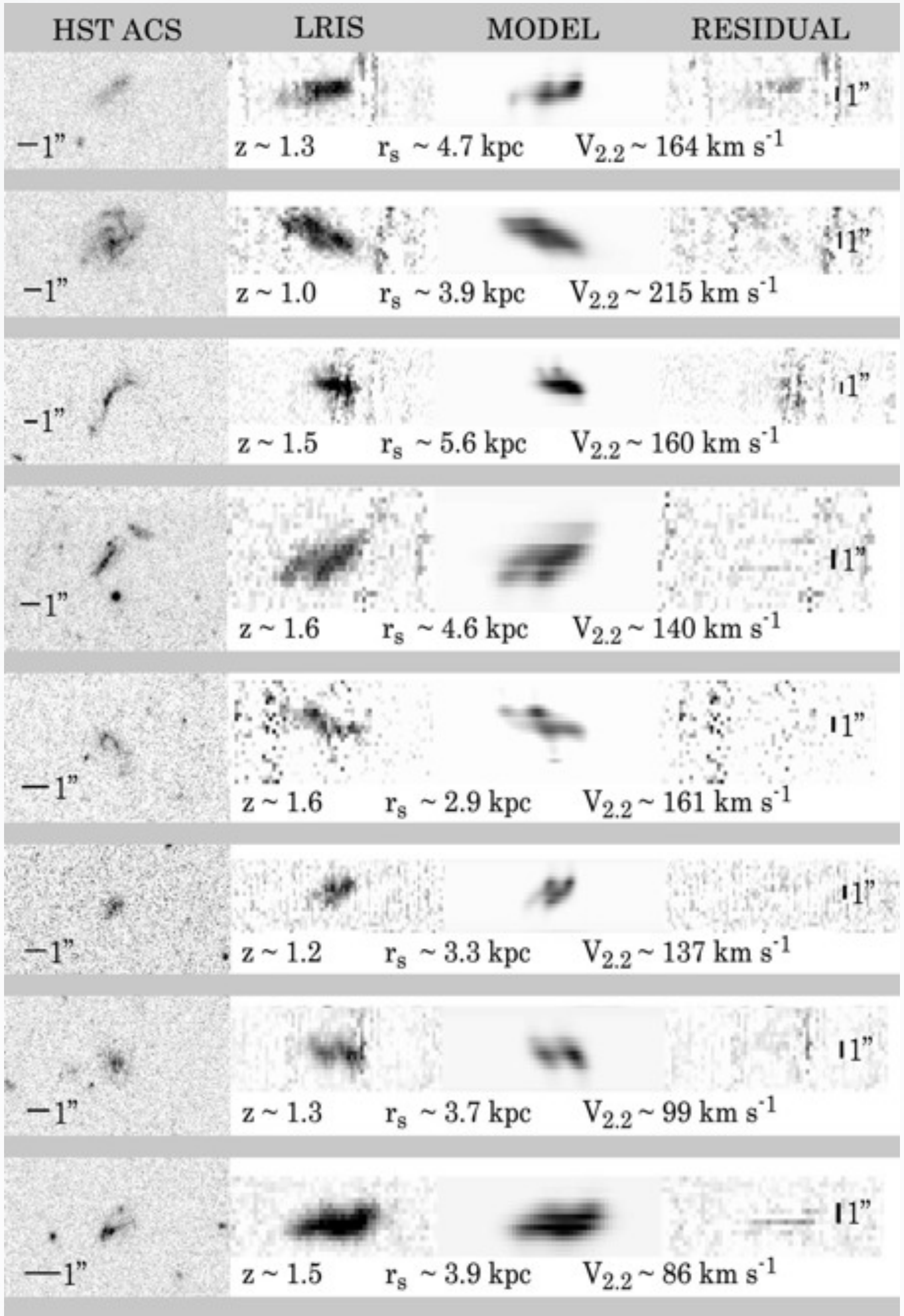
PUSHING TO HIGHER REDSHIFT



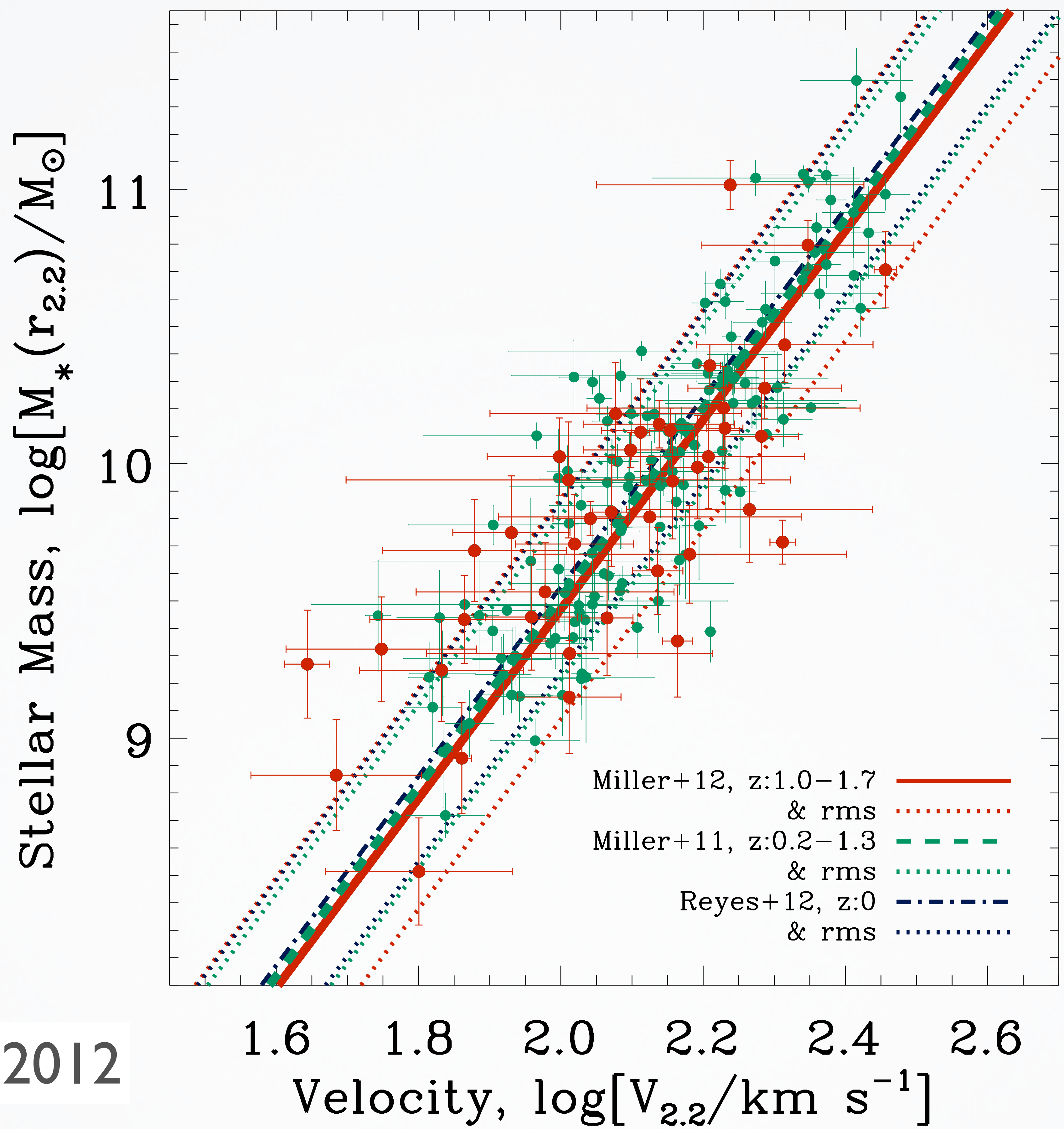
PUSHING TO HIGHER REDSHIFT



PUSHING TO HIGHER REDSHIFT

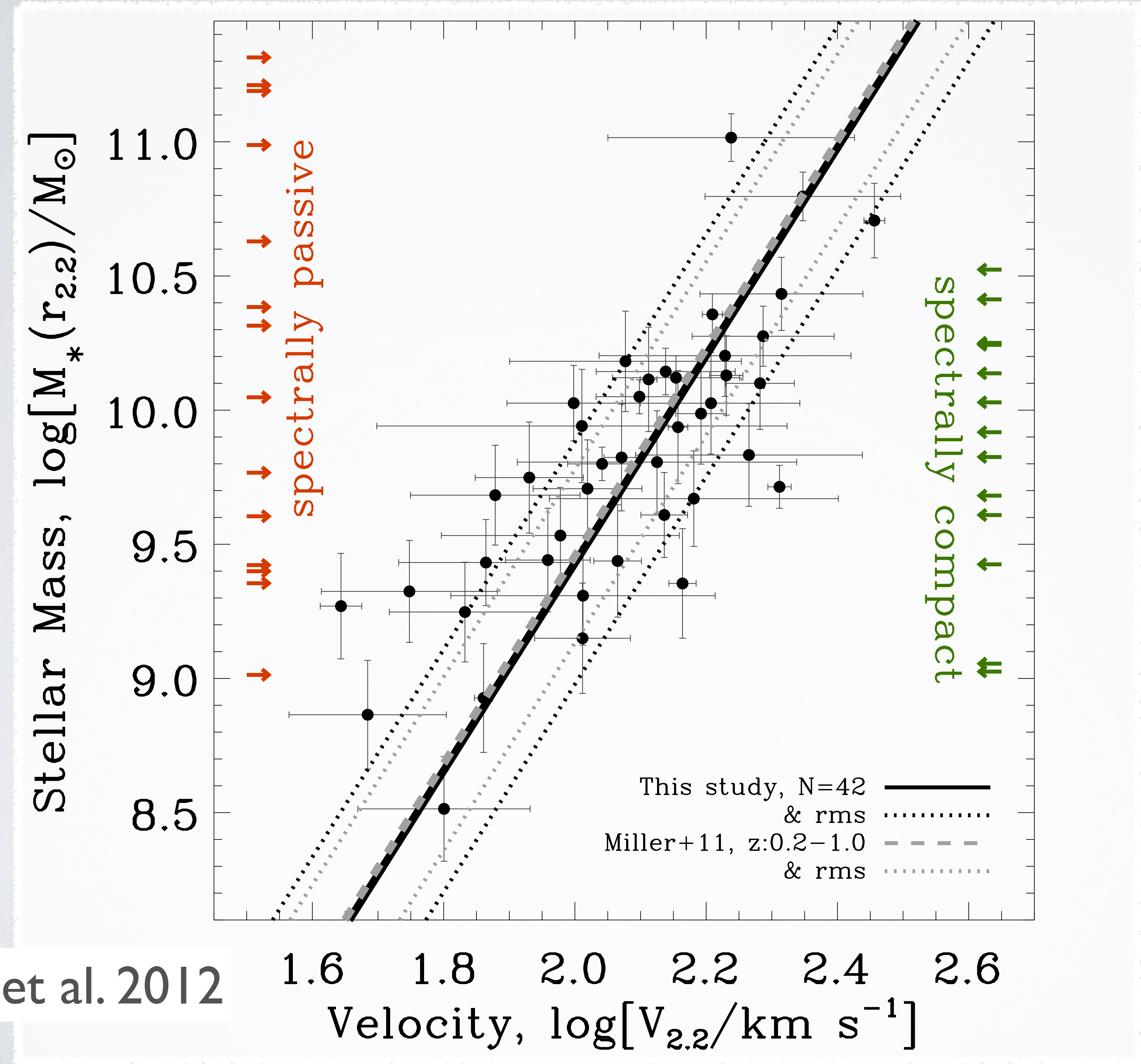


PUSHING TO HIGHER REDSHIFT

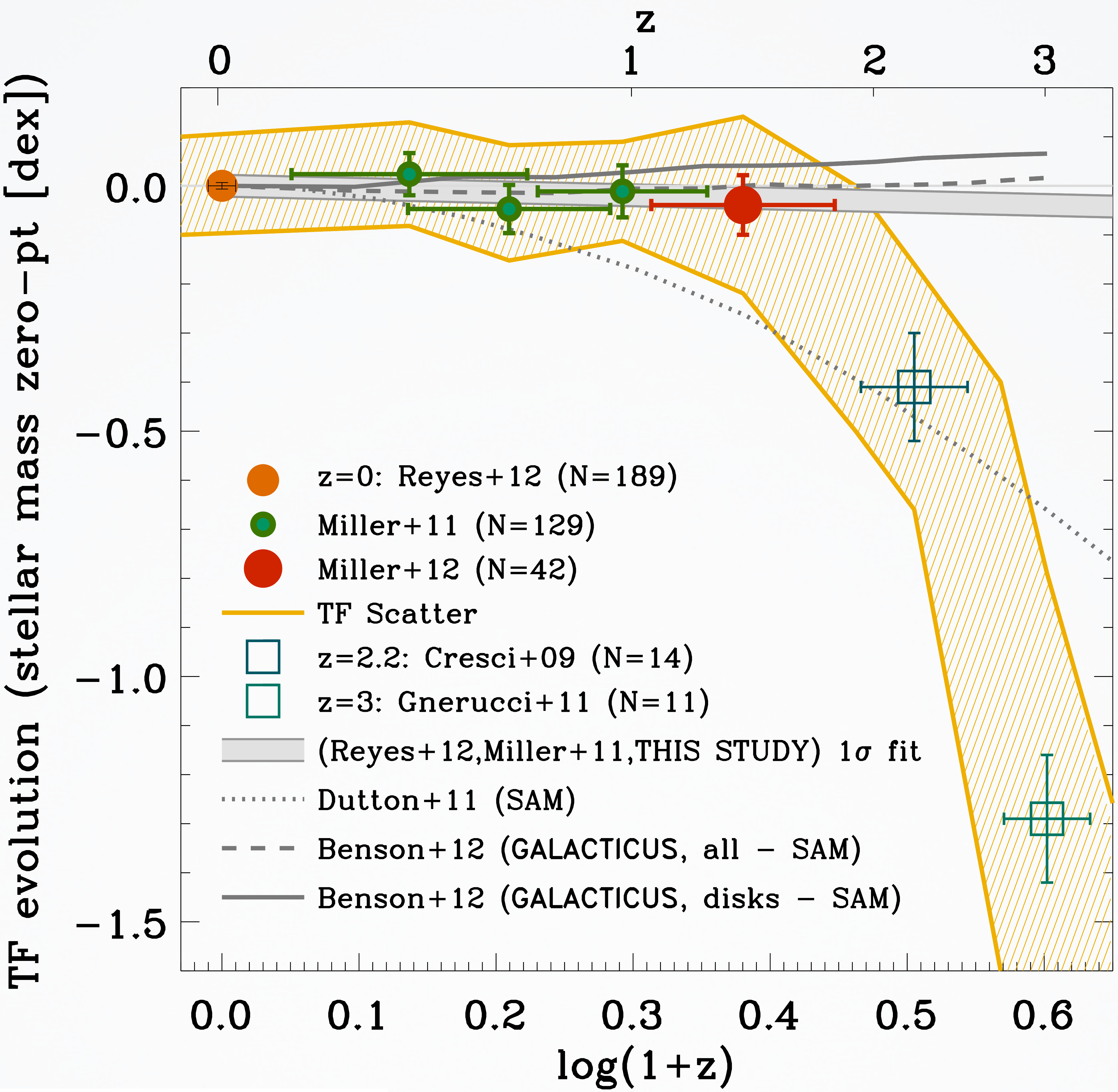


Miller et al. 2012

PUSHING TO HIGHER REDSHIFT (1≲z≲1.7)

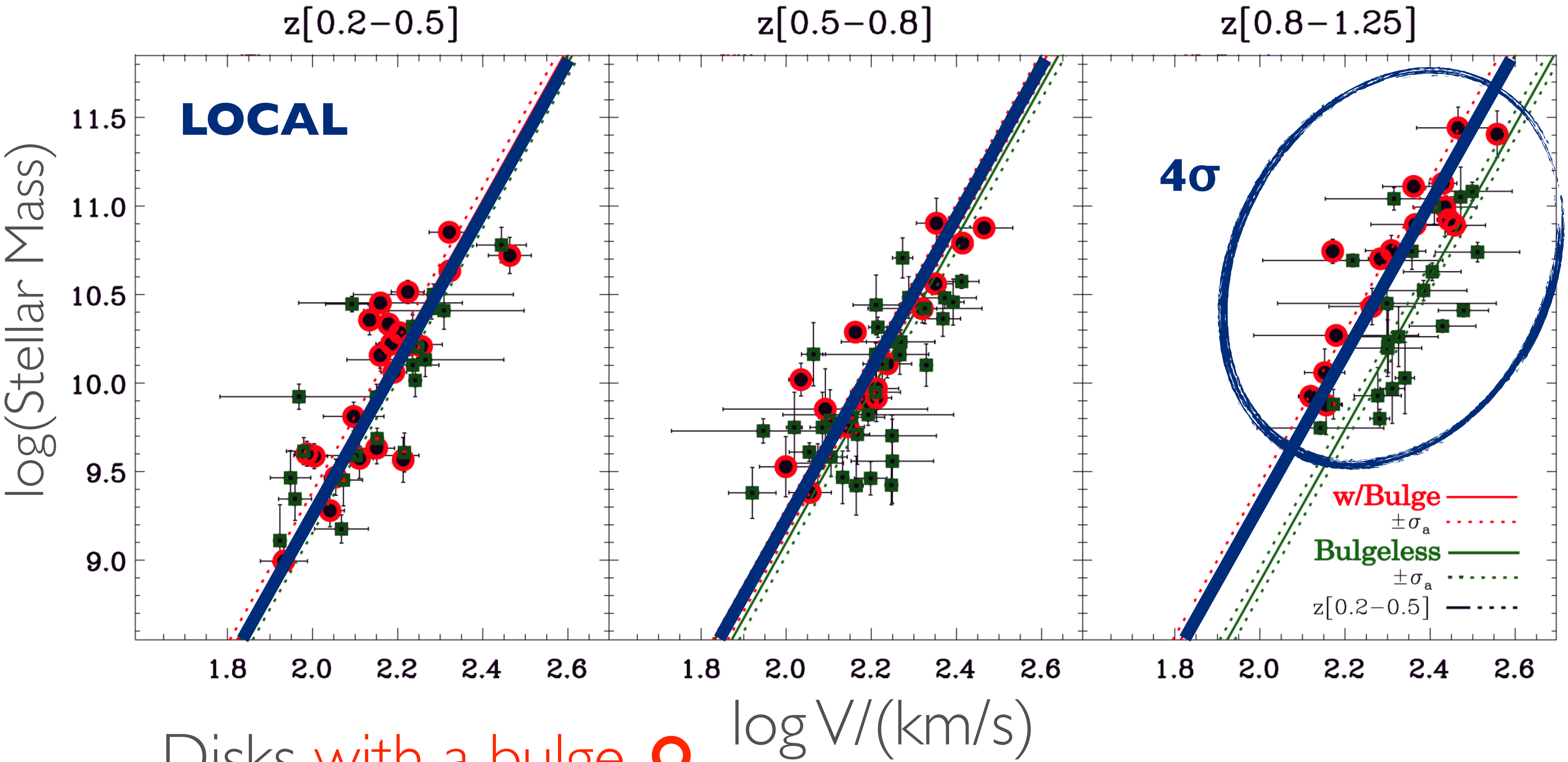


Miller et al. 2012



Miller et al. 2012

EVOLUTION *WITHIN* THE TULLY-FISHER RELATION?



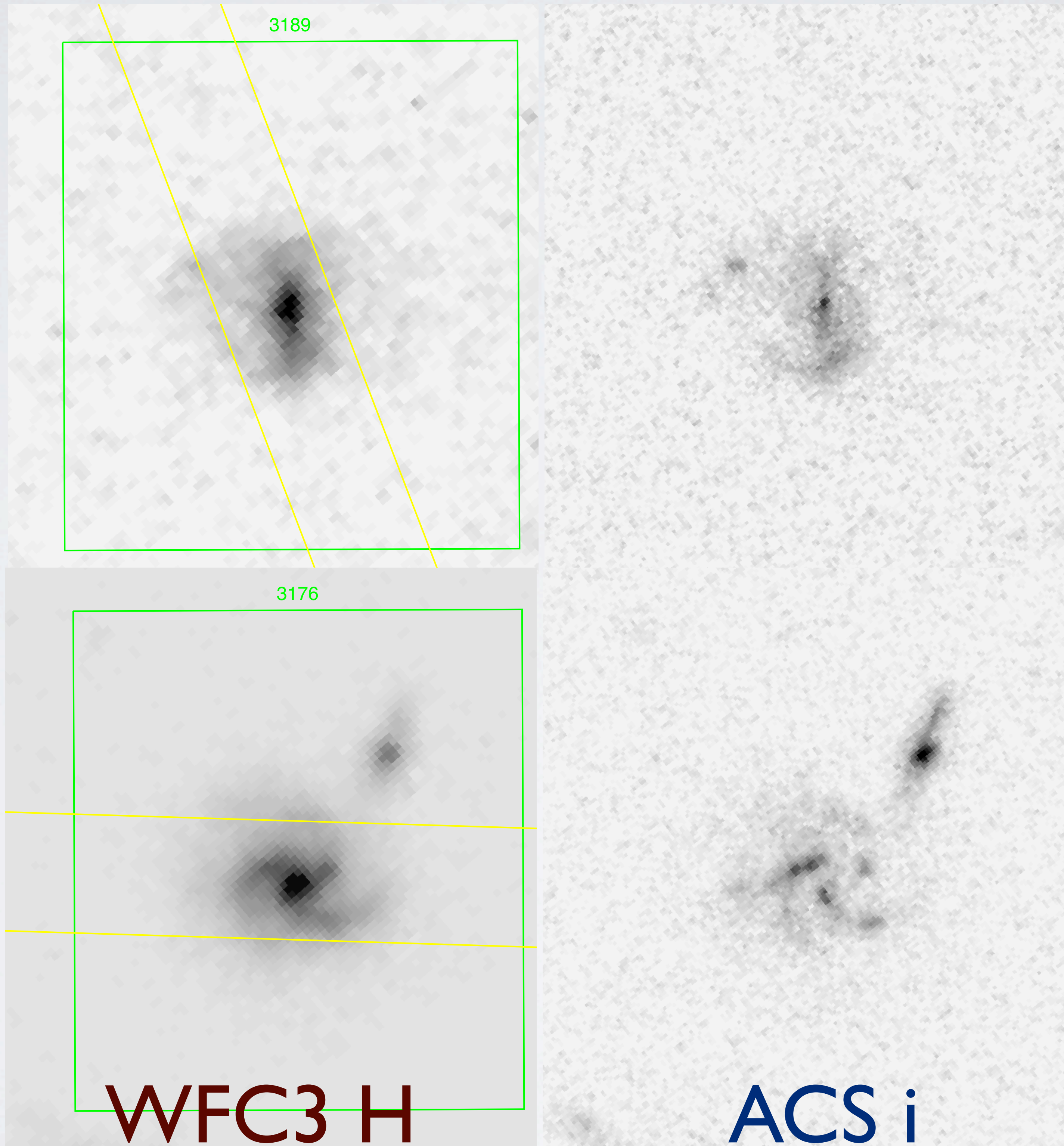
Disks with a bulge ○
Disks without a bulge ■

Bulgeless disks offset in *stellar mass* or *velocity*?

Miller et al. 2012 (in prep)

MORPHOLOGICAL BAND-PASS SHIFTING

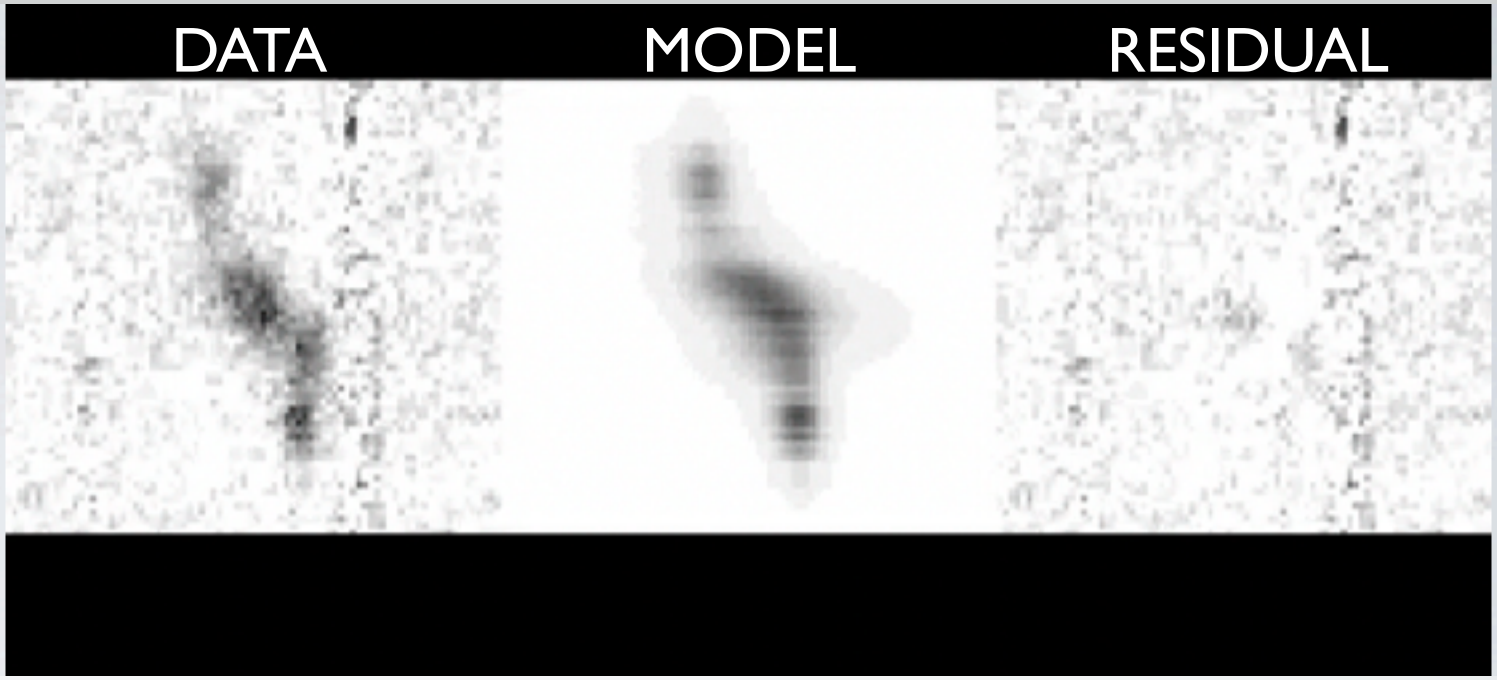
z > 1



SUMMARY

Miller et al. 2011, *ApJ*, 741, 115

arXiv:1201.4386



1) **171 rotation curve measurements from $0.2 \lesssim z \lesssim 1.7$** with HST imaging

2) **Stellar Mass Tully-Fisher relation tightly in place by z~1**

3) **Little evolution in relation since z ~ 1.7** (~10 Gyr lookback time)

- zero-point shift $\Delta M_* \sim 0.02 \pm 0.02$ dex
- up to 60% increase in scatter at $1 \lesssim z \lesssim 1.7$

4) **Baryons constitute 50-100% of dynamical mass within $r_{2.2}$**

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