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Galaxies Étoiles Physique et Instrumentation

The evolution of the baryonic Tully-Fisher relation

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&

the IMAGES Coll.

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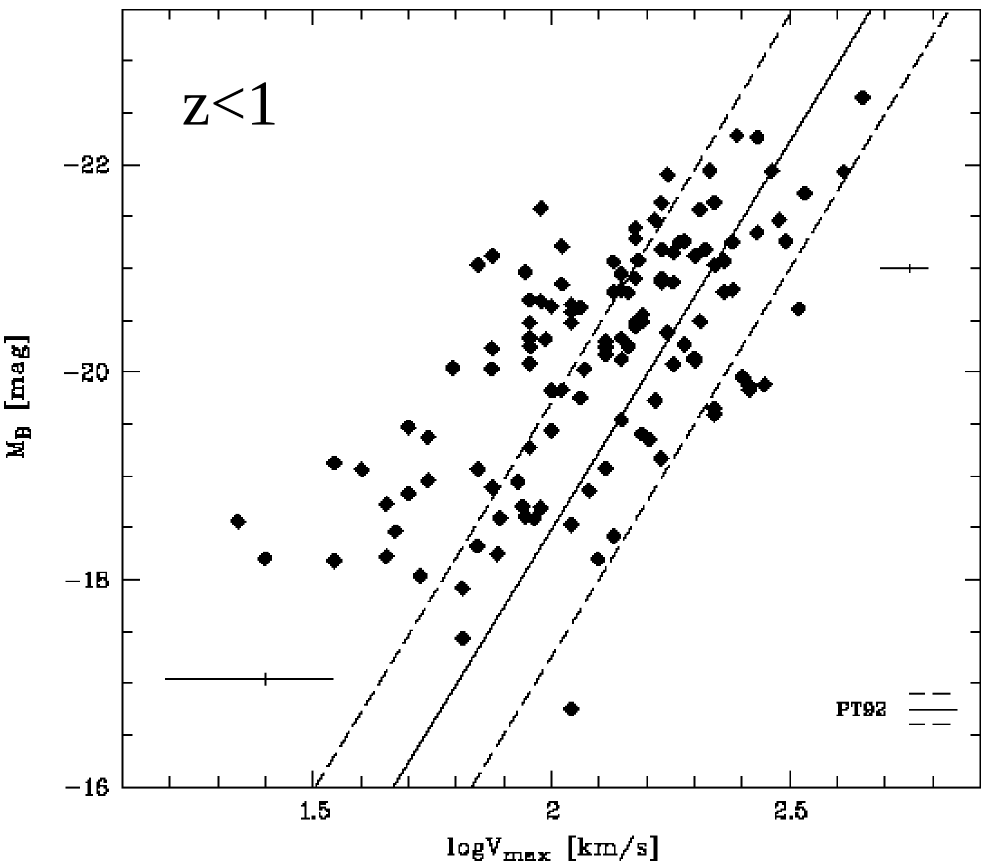
Does the TFR evolve, and how ?

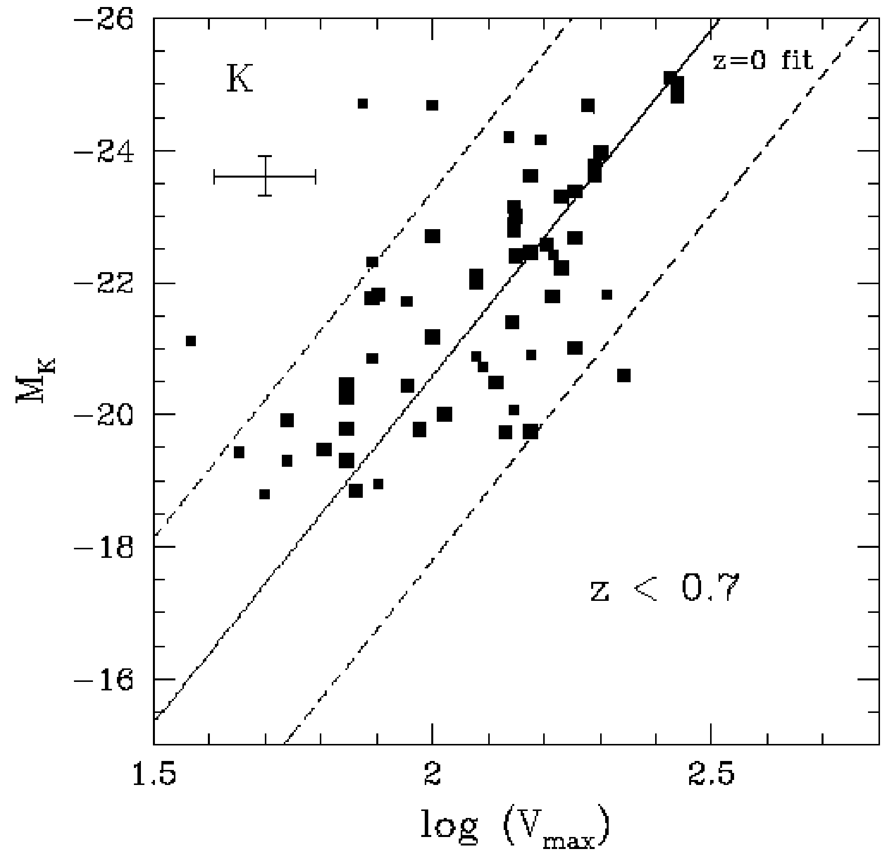
B-band, long-slit spectroscopy

K-band, long-slit

Böhm & Ziegler 2007



Conselice et al (2005)

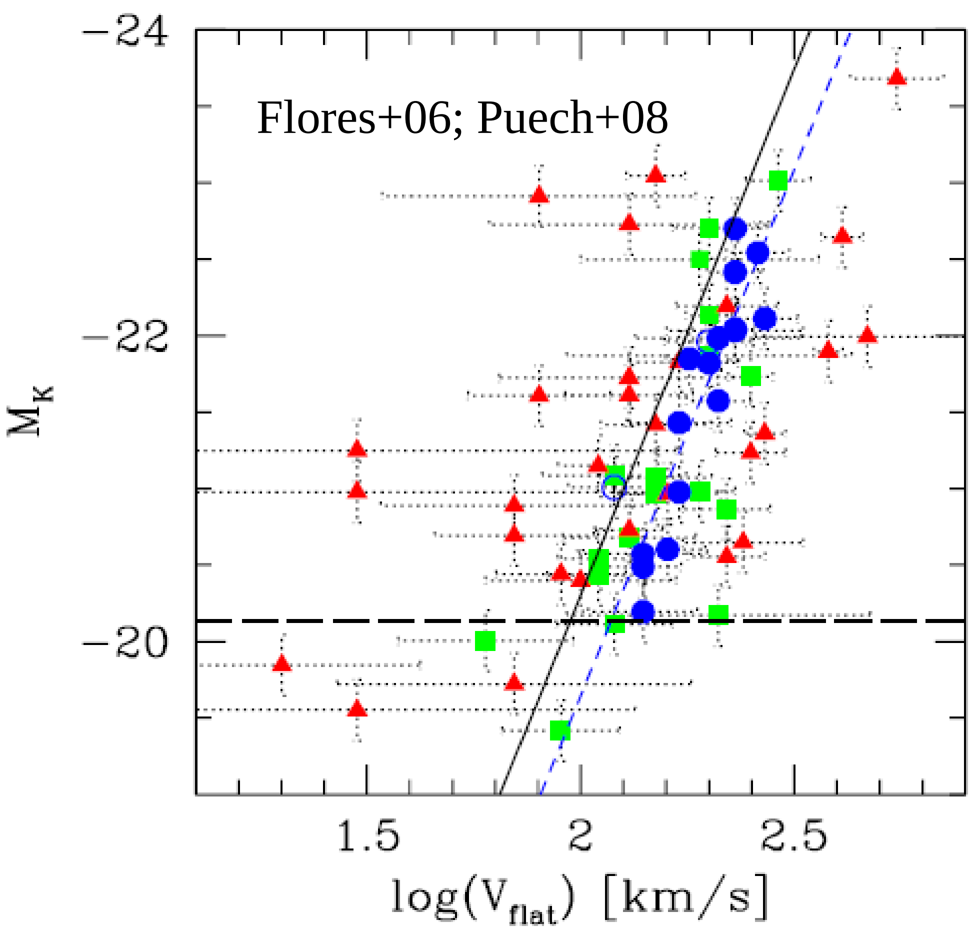


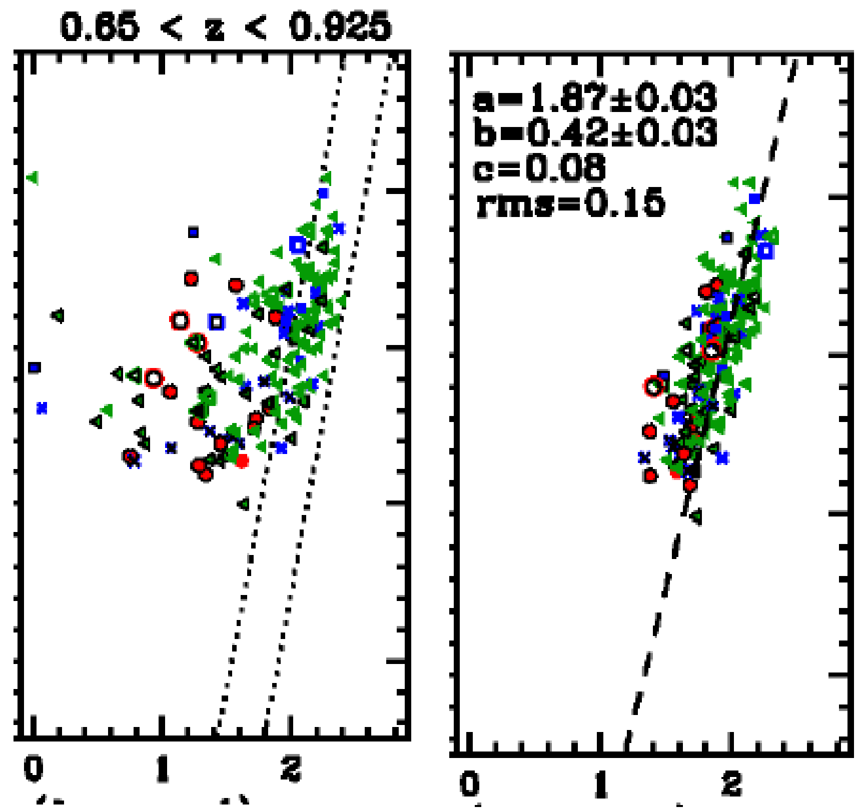
VLT/FORS – FDF/WHDF

KECK/LRIS (long slit)

K-band, FLAMES/GIRAFFE

Keck/DEIMOS – AEGIS/DEEP2





Kassin et al. 2007

Complex Kinematics
Perturbed Rotations
Rotating Disks

Local relation (SDSS galaxies; Hammer et al. 2007)

$$S_K^2 \equiv K V_{rot}^2 + \sigma_g^2$$

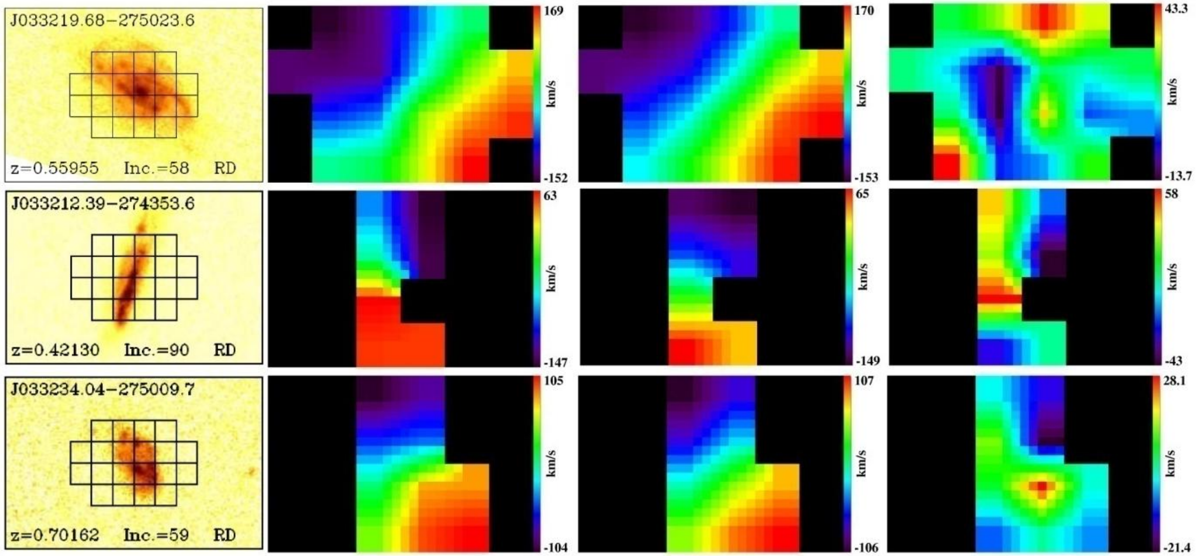
The IMAGES TFR

A representative sample of 63 M* emission line galaxies selected in 4 different fields of view (CFRS 3h & 22h, HDFS, CDFS)

❖ K-band absolute magnitudes: SED fitting; corrected for internal extinction (mass-dependent method + 0.04 mag for face-on galaxies, Tully et al. 1985, 1998)

❖ Stellar masses: from M_K and $(B\text{-}V)_{rest}$ (Bell et al. 2003) + diet salpeter IMF ➔ maximizes the stellar-mass estimates (Hammer et al. 2009b)

❖ Rotation velocities: deconvolved using Monte-Carlo simulations & best fit to V_{flat} (Puech+08)

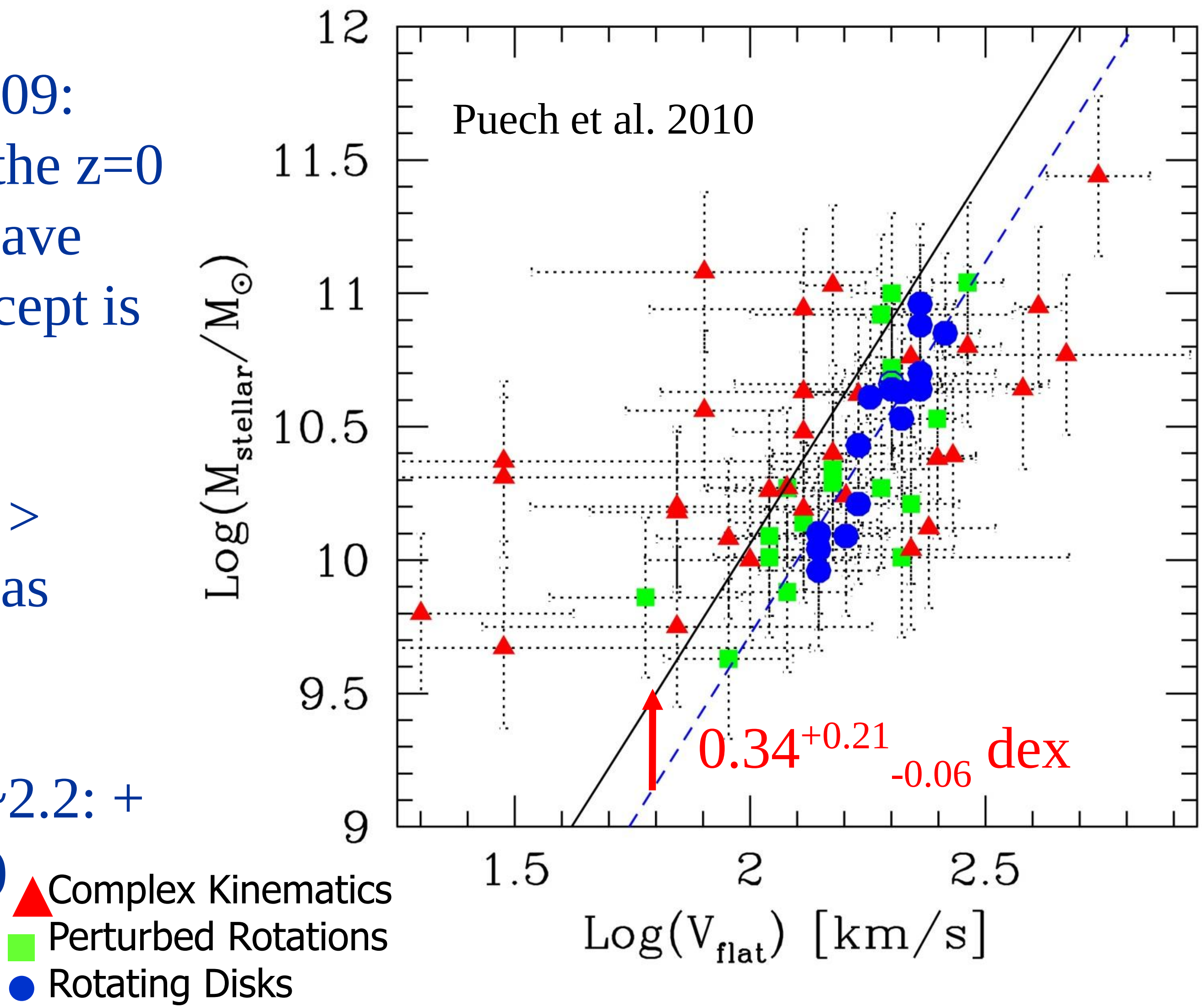


Stellar-mass TFR

- Permutation test of Koen & Lombard 2009: The probability that the z=0 and z~0.6 relations have same slope and intercept is << 1%

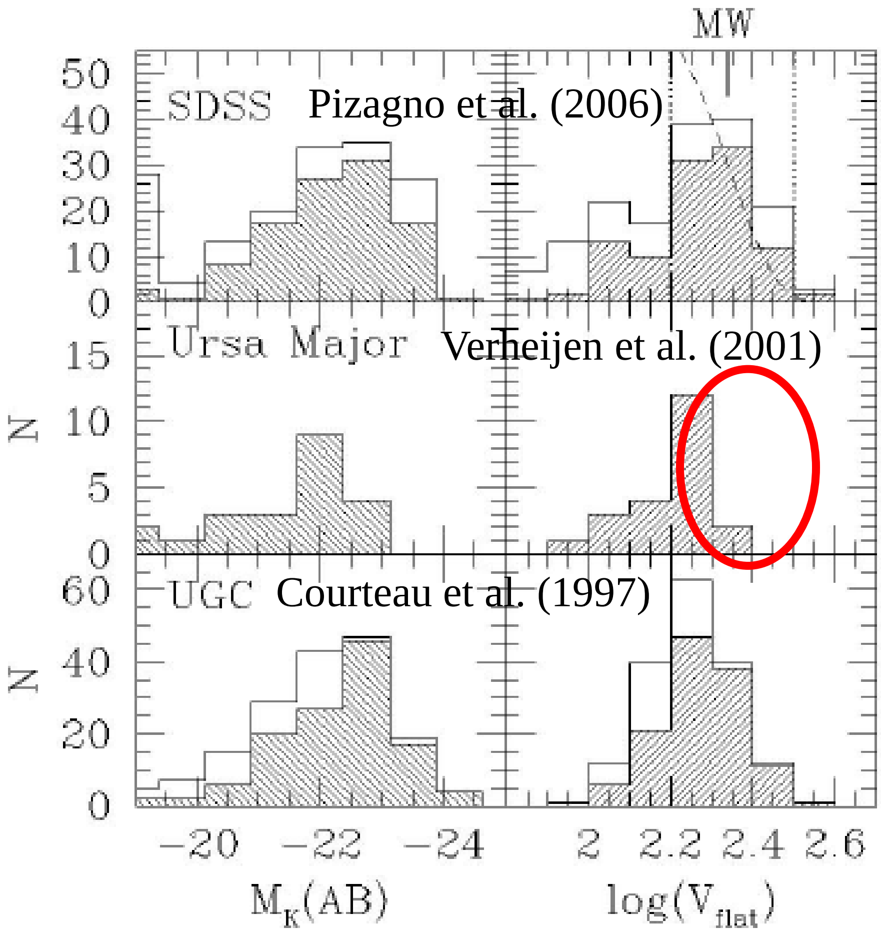
- For this prob. to be > 10%, one needs to bias Mstellar by 0.28 dex

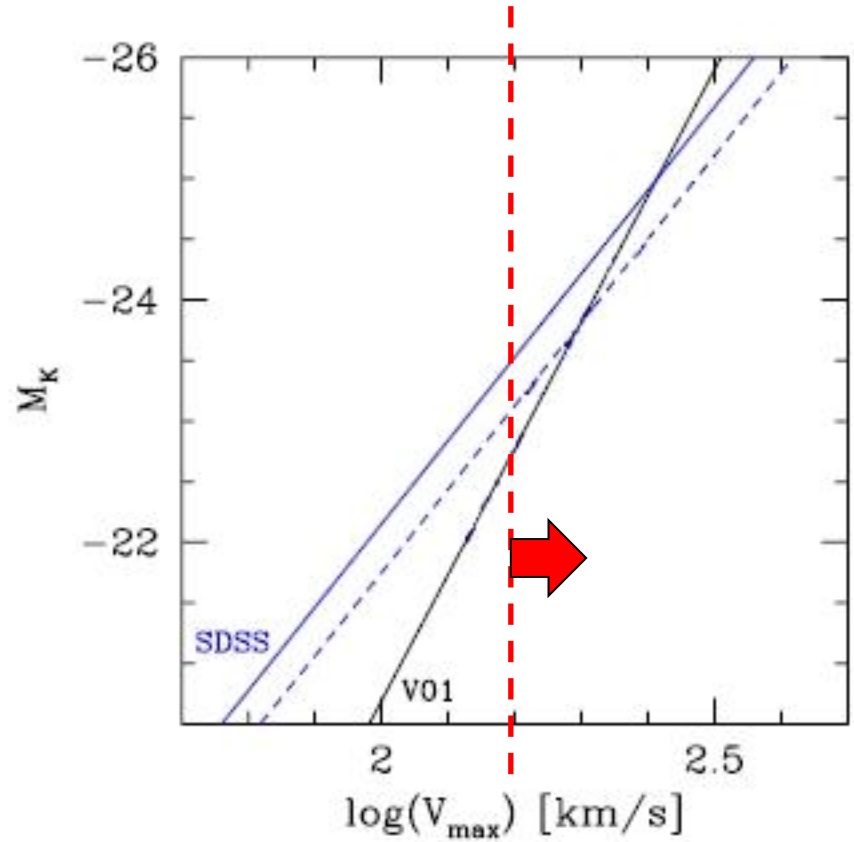
- See also SINS@ z~2.2: + 0.41dex (Cresci+09)



RDs grew up by a factor ~ 2 in stellar-mass since z~0.6

Local TFR

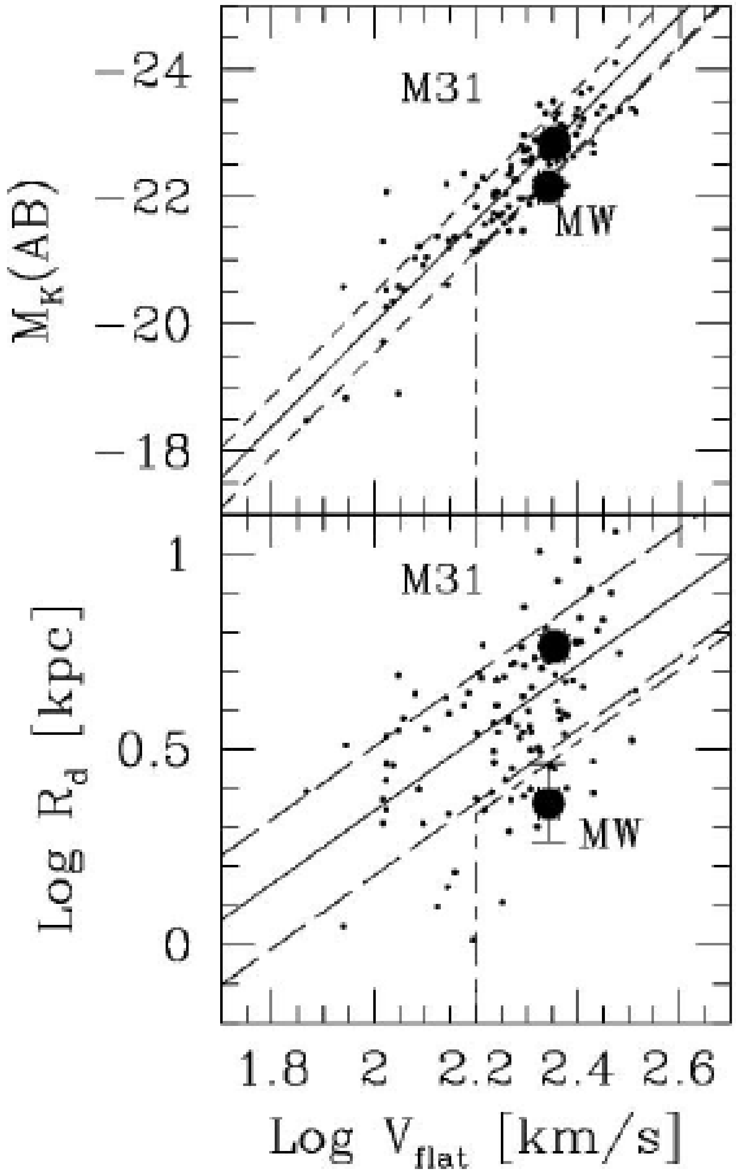




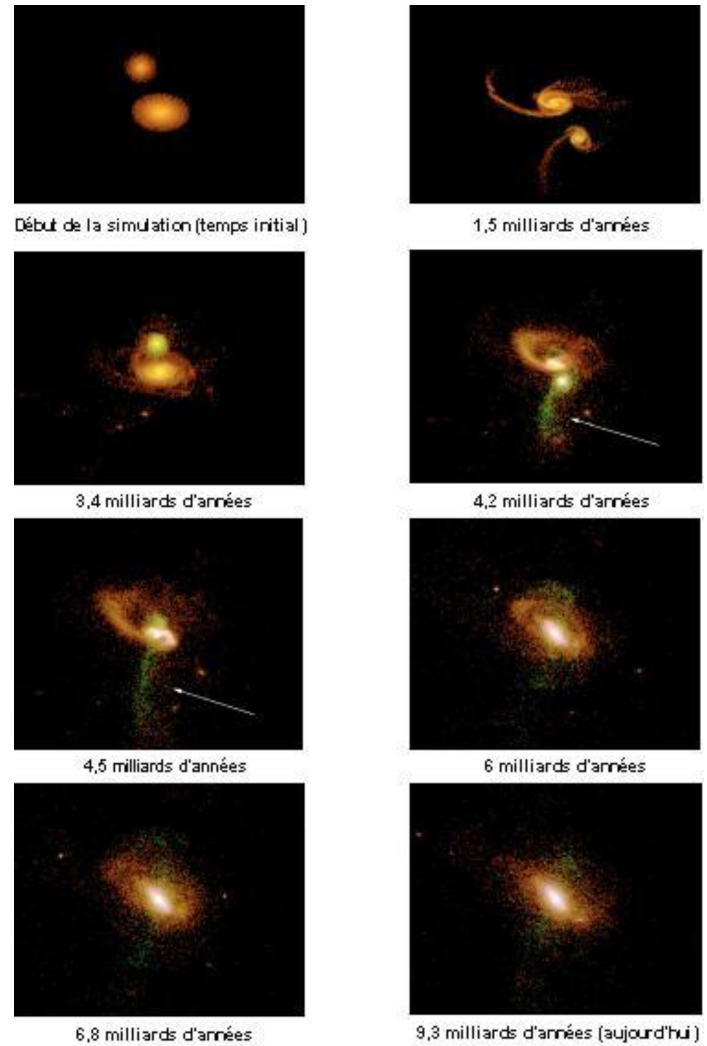
Hammer et al. (2007)

Same impact at z~2.2 (Cresci et al. 2009):
~0.4 dex / Ursa Major (Bell & de Jong 2001)
~0.6 dex / SDSS (Pizagno et al. 2006)

MW vs. M31



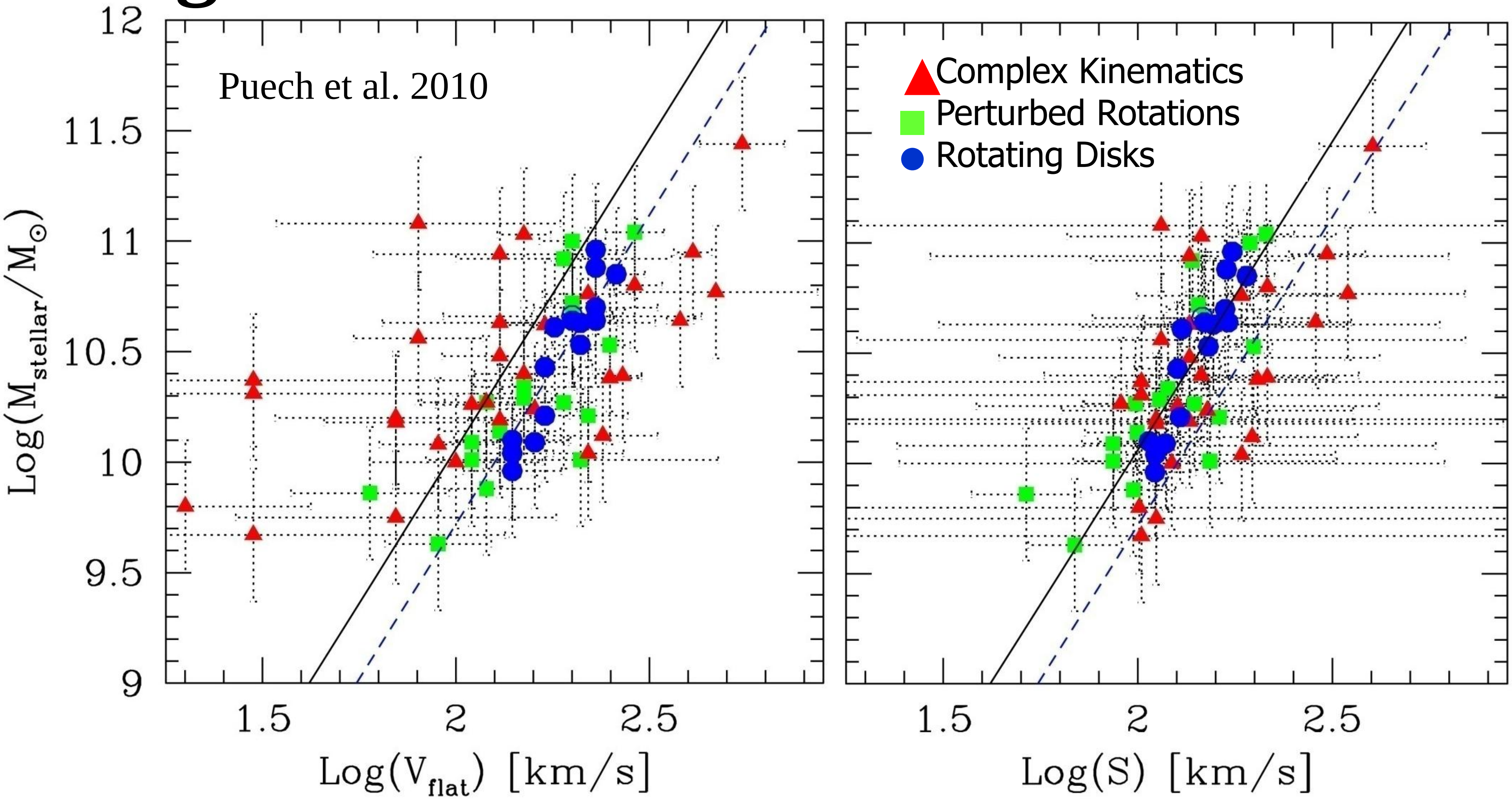
Hammer et al. (2007)



See Poster (Fouquet et al.)

Hammer et al. (2010)

Origin of the scatter in the distant TFR



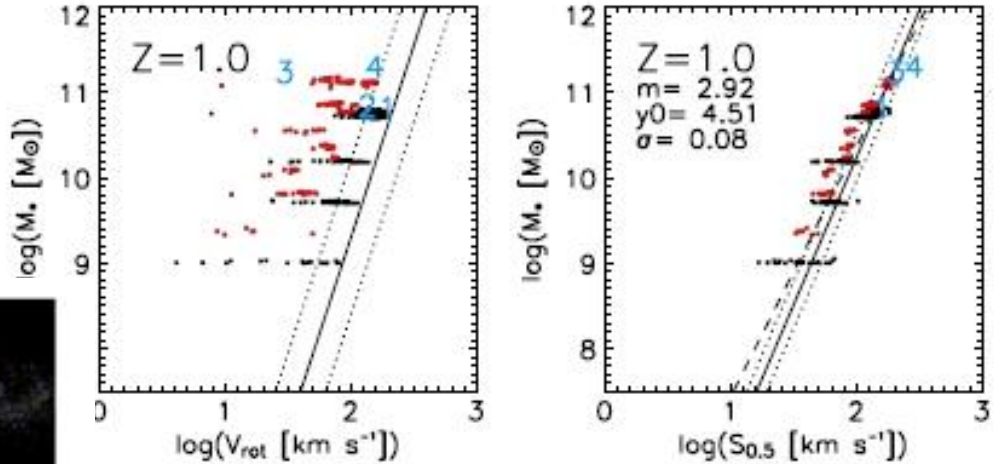
Scatter divided by a factor 2 using *S*

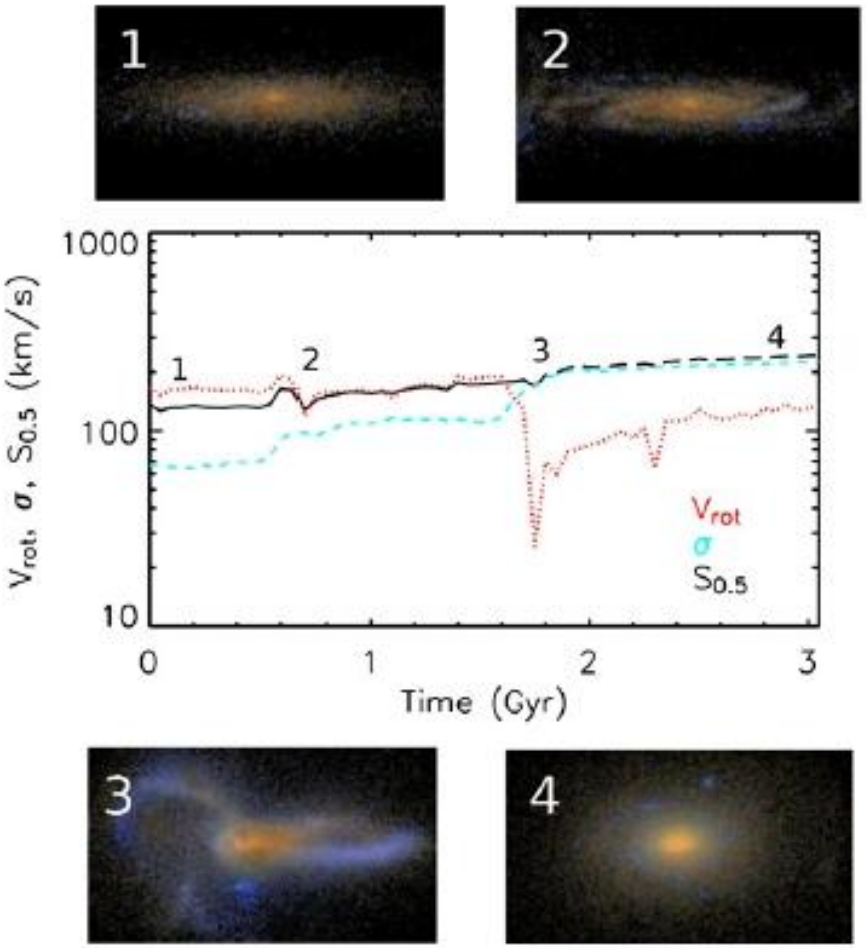
$$S = \sqrt{0.5 \times V_{rot}^2 + \sigma^2}$$

Weiner+06; Kassin+07

Origin of the scatter in the distant TFR

Covington+09



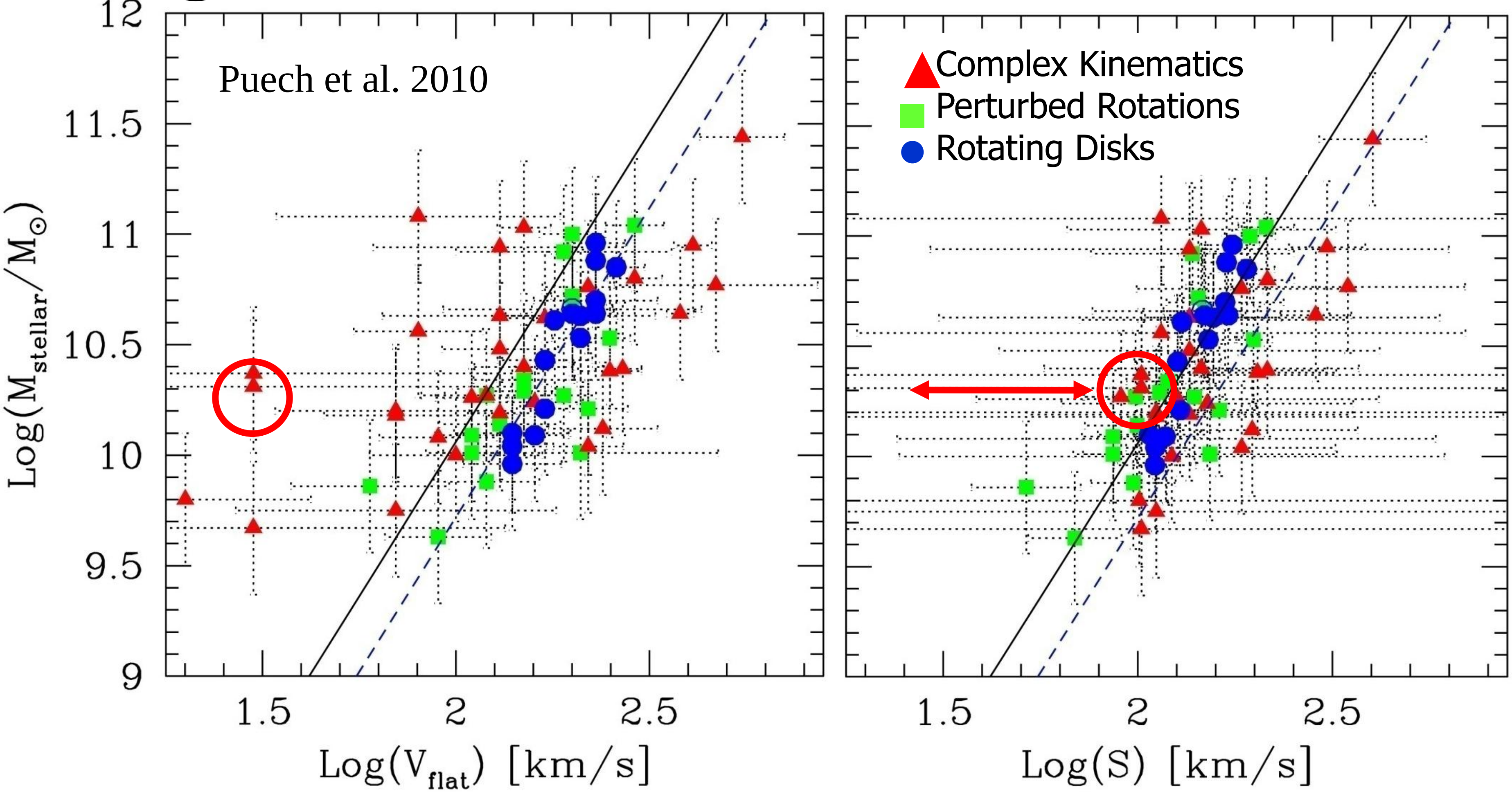


Simulations of major mergers:

➔shocks in the gaseous phase

➔ energy transfered from bulk to random motions

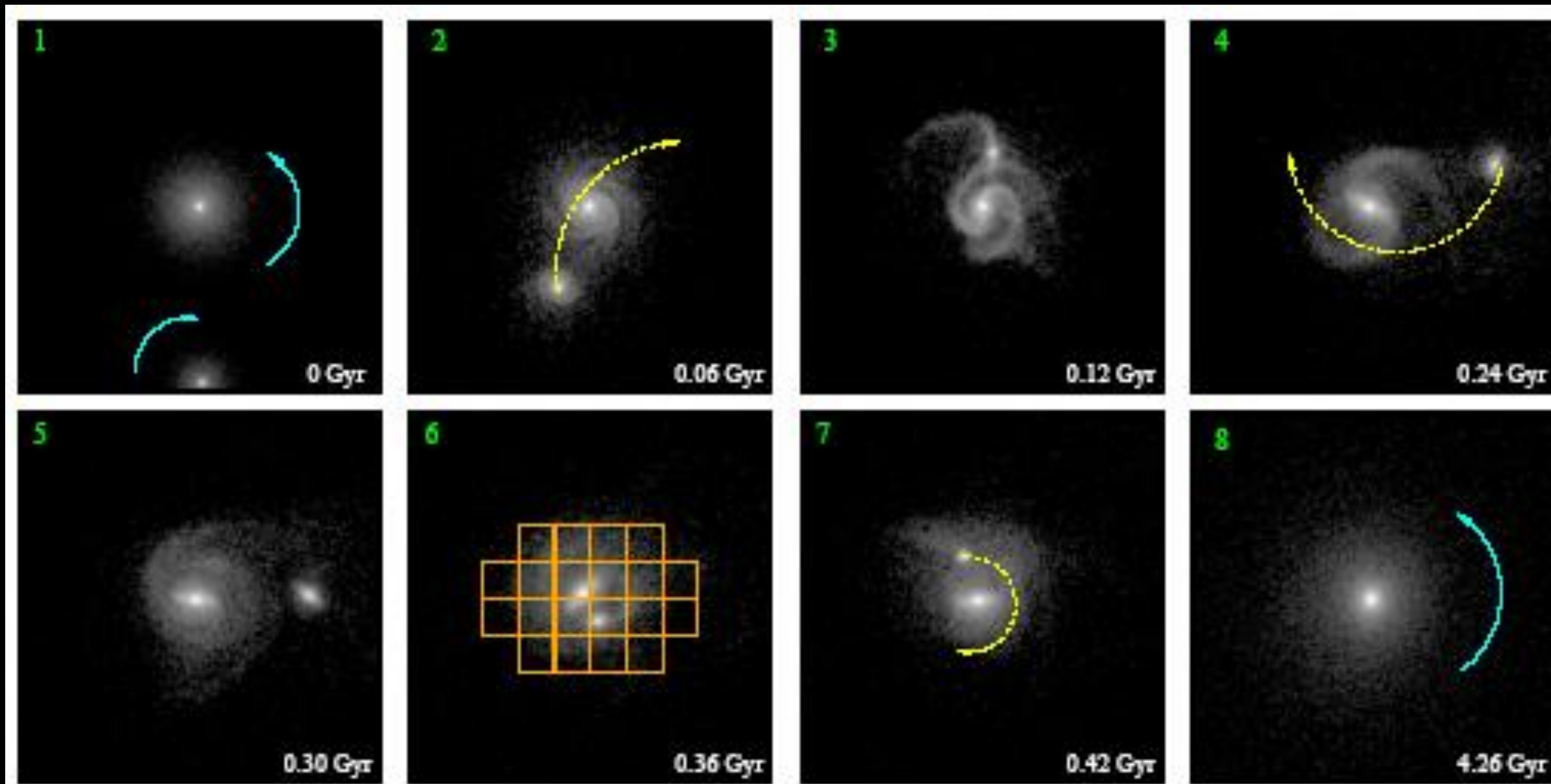
Origin of the scatter in the distant TFR

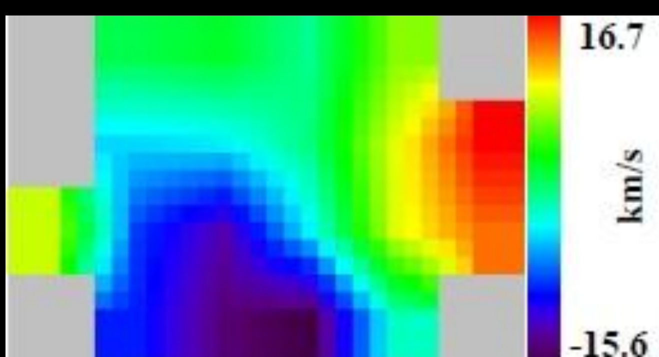


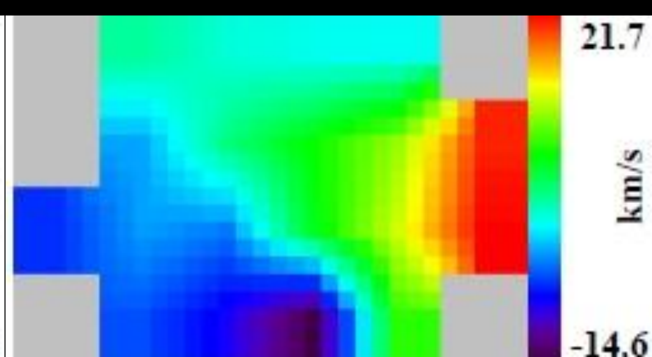
$$S = \sqrt{0.5 \times V_{rot}^2 + \sigma^2}$$

Observational evidence of the transfer of energy:

Peirani et al. (2009)

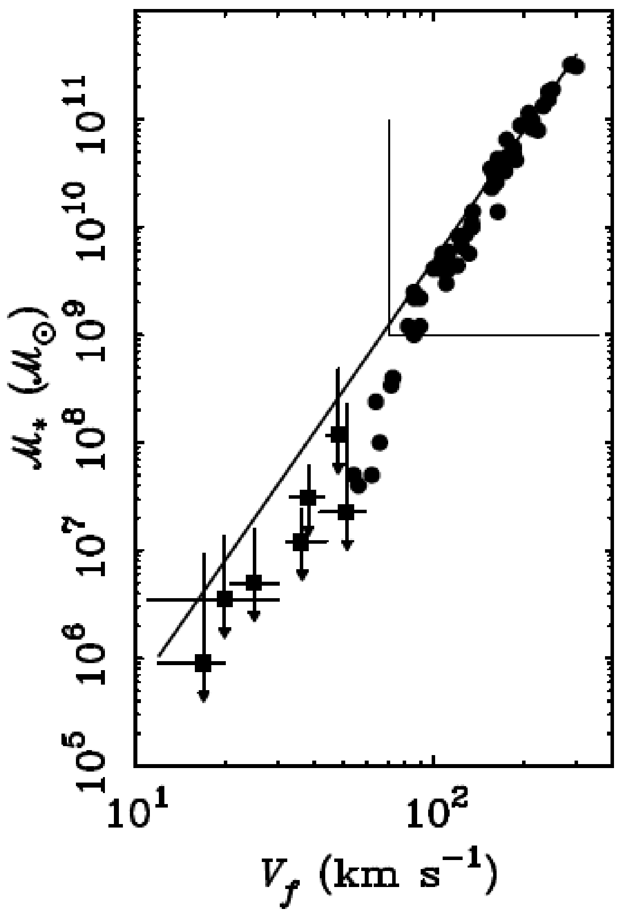




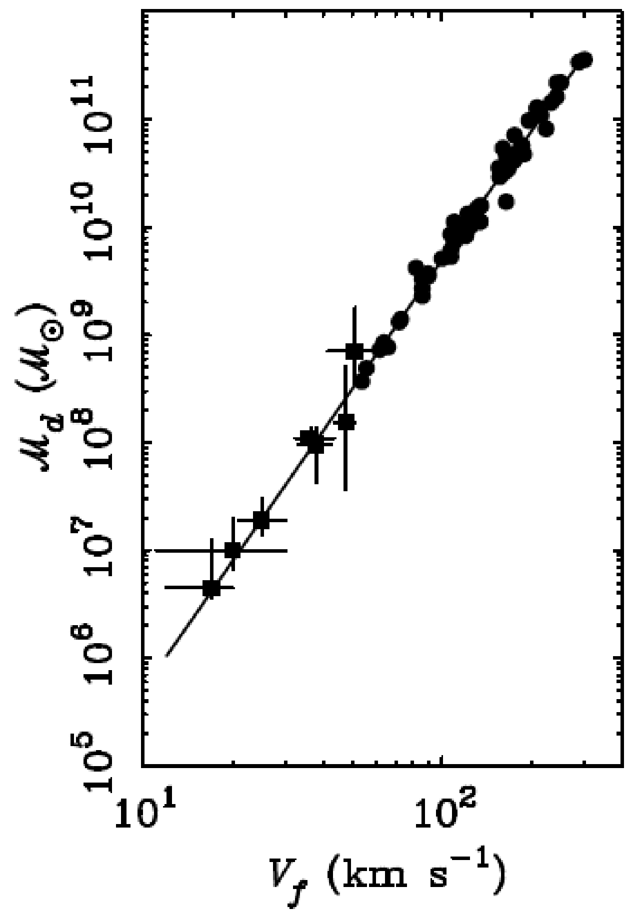


Peirani et al. 2009

Baryonic Tully-Fisher Relation



Stars only



Stars + gas

McGaugh (2005) – Stark et al. (2009)

Gas Masses

Inversion of the Schmidt-Kennicutt law (K98): $\Sigma_{SFR} = 2.5 \times 10^{-4} \Sigma_{gas}^{1.4}$

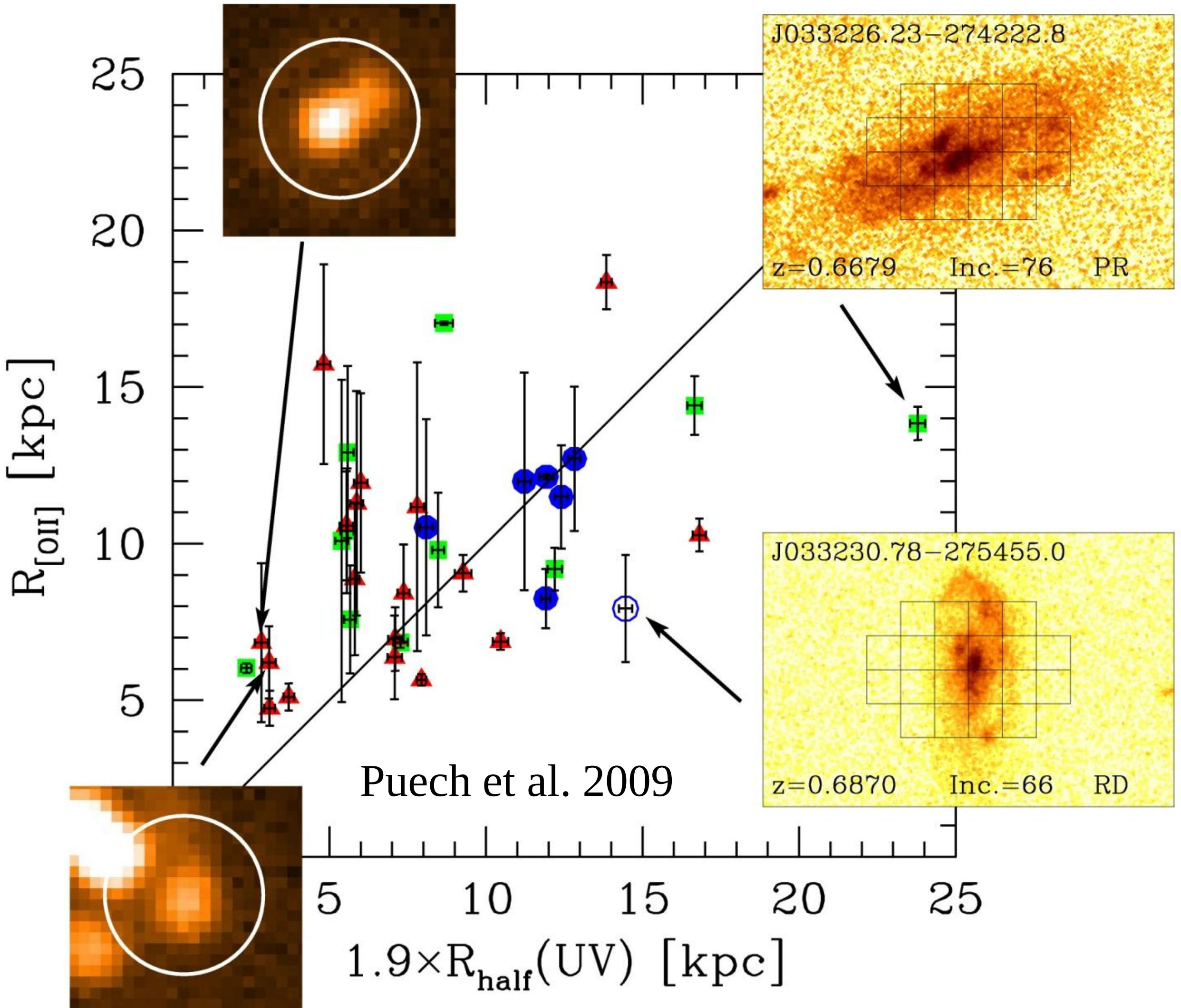
$SFR = SFR_{UV} + SFR_{IR}$

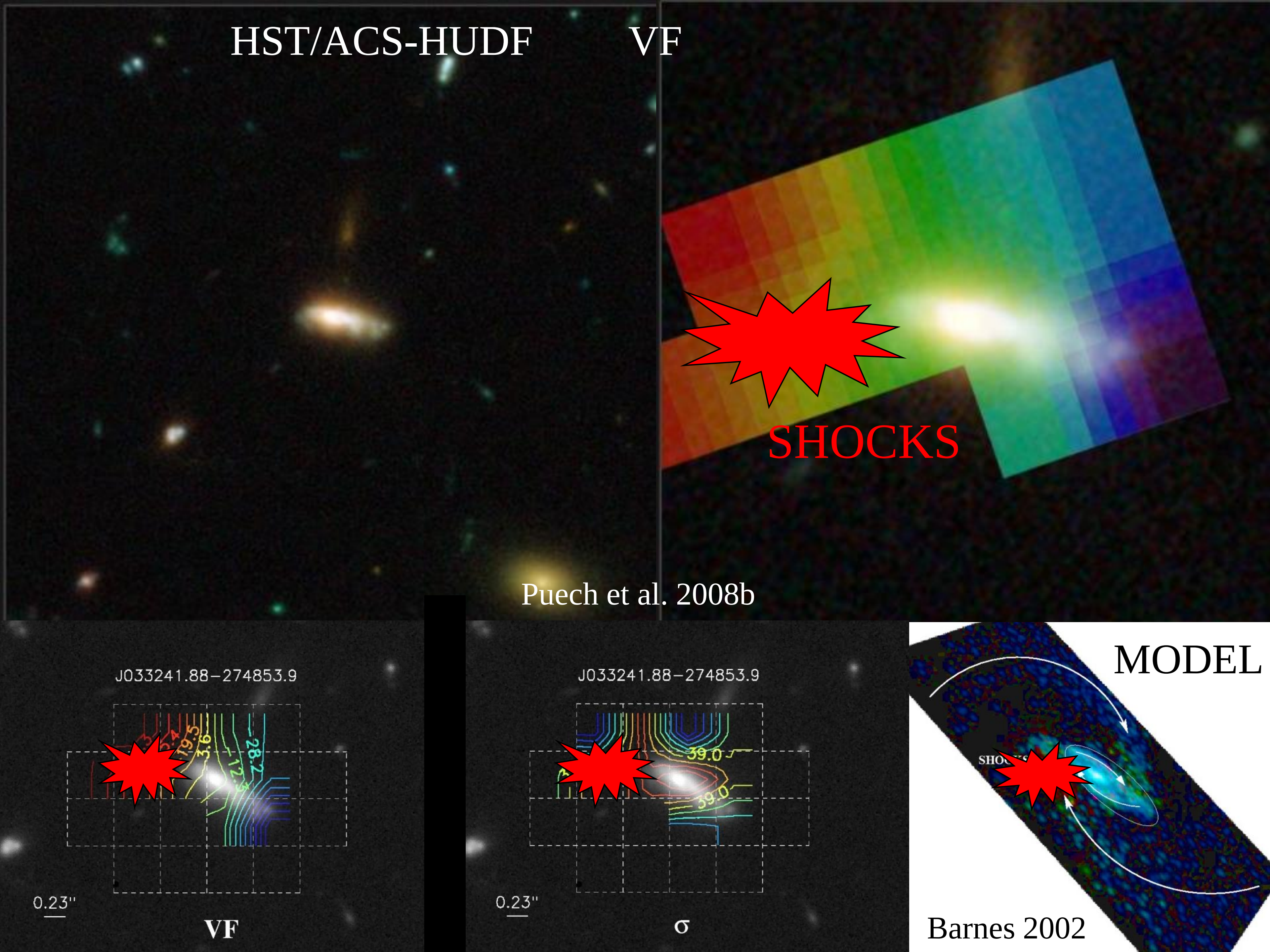
R_{gas} from GIRAFFE [OII] maps

Deconvolved from IFU pixel grid & seeing using Monte-Carlo simulations

$\langle R_{gas}/R_{UV} \rangle \sim 1.3$
(see also Bamford+07)

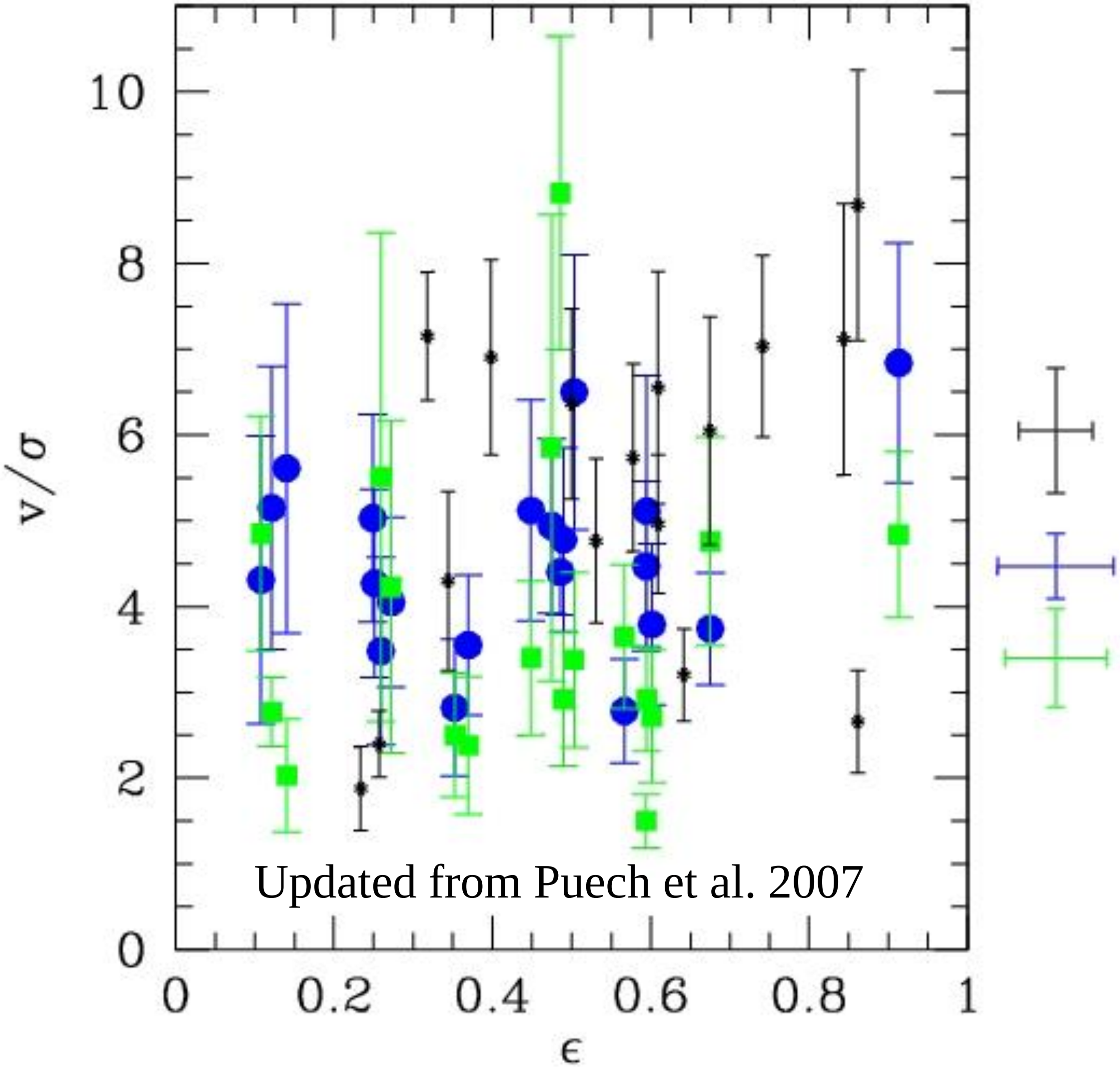
Gas extents farther than UV light




HST/ACS-HUDF
VF
SHOCKS
Puech et al. 2008b
J033241.88−274853.9
19.5
3.6
12.3
28.2
0.23"
VF
J033241.88−274853.9
39.0
39.0
0.23"
σ
MODEL
Barnes 2002

Dynamical support of the gaseous disks

- Gaseous disks are heated compared to local disks
  ➔ SHOCKS?
- Suggest gas (re)accretion and/or minor mergers (Puech+07b)
- Similar average V/σ in the SINS survey at z~2.2 (Forster-Schreiber et al. 2009). See also Epinat+09

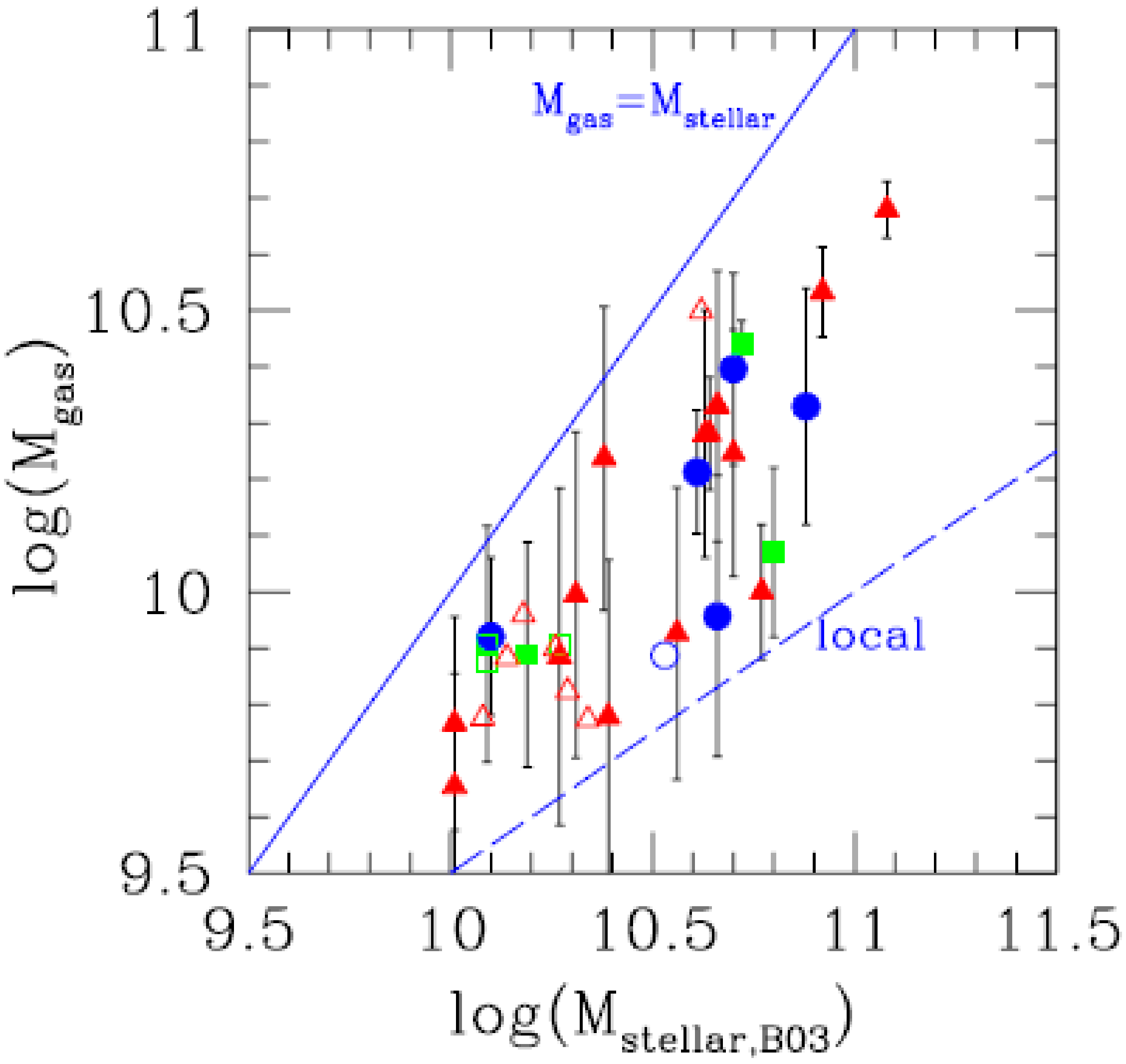


Dynamical imprint of merger-induced shocks?

Baryonic content at z~0.6

Evolution M-Z relation (Rodrigues+08)
+
closed-box model:
Mean gas fraction
<μ>~30%

Inversion of SK law:
Median <μ>=31±1%



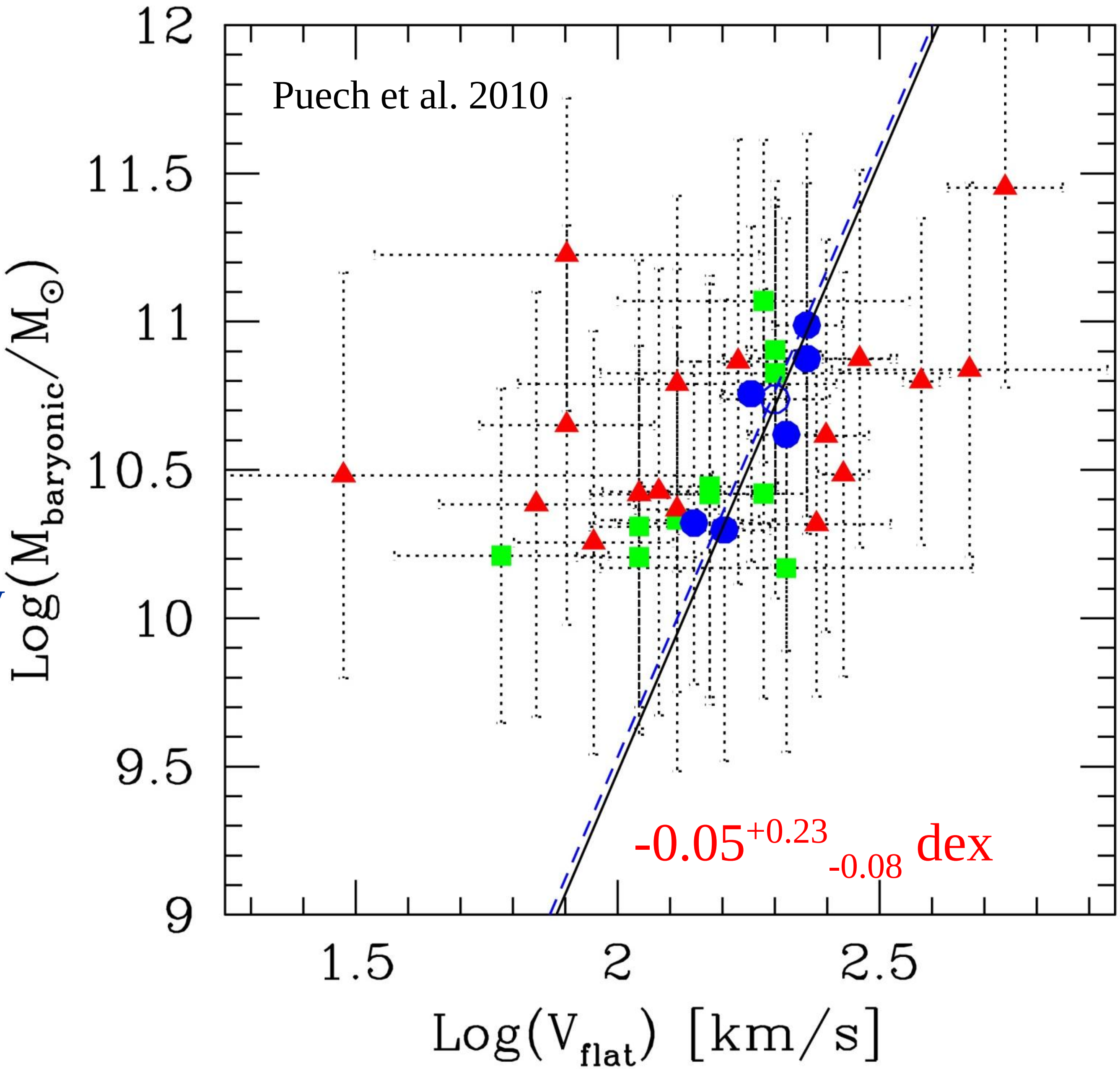
Hammer et al. 2009b

Baryonic TFR at z~0.6

No significant evolution in slope or zero point within random and systematic uncertainties

Reservoir of gas already gravitationally bound to galaxies

No need for external gas accretion: consistent with cold flows vanishing at z<1.5 (Puech 2010)



Conclusion

Stellar-mass Tully-Fisher Relation:

✓ Consistent with no evolution in slope or scatter (for RDs)

✓ First detection of a shift of +0.34 dex in zero point between z~0.6 and z=0 for the smTFR

✓ Evidences for scatter driven by transfer of energy between bulk and random motions through major merger-driven shocks

Gas content:

✓ Ionized gas radius > UV radius, especially for compact systems

✓ Source of ionization: Outflows ruled out ➔ no radiation source available ➔ merger-induced shocks?

Baryonic TFR:

✓ No significant evolution in slope and zero point.

➔ No need for external gas accretion: re-accretion of gas expelled away during mergers (already seen in V/σ?)