The Field Disk Galaxy Population between z=1 and Today

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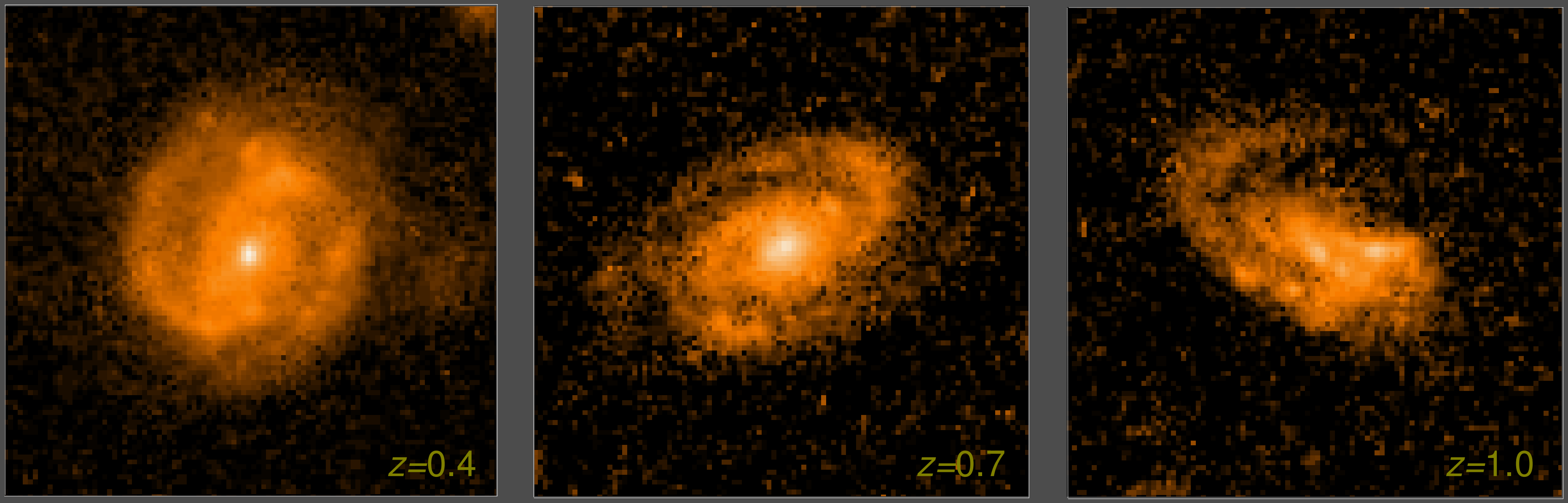


Motivation

We focus on field disk galaxies at $0<z<1$: cosmologically significant look-back times, but less frequent violent interactions than at $z>1$.

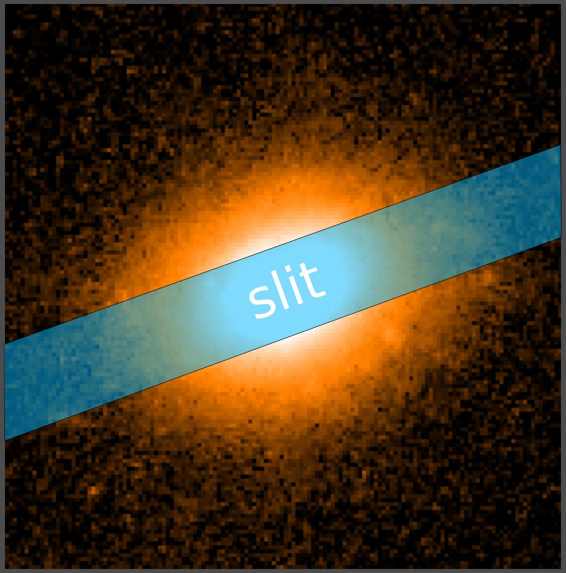
Some of the questions to be addressed:

- *What does the Tully-Fisher relation up to $z\sim1$ look like?*
- *How do the sizes of disk galaxies evolve?*
- *How do their stellar population properties evolve as a function of time and DM Halo mass?*

Our Sample

261 galaxies observed with VLT/FORS in the FORS Deep Field and William Herschel Deep Field (~100h in total). 2.5h to 10h integration time per object.

Slits aligned with major axes to get rotation velocity as function of radius
→ rotation curve, maximum rotation velocity V_{max}, total mass etc.



Additional HST/ACS imaging for derivation of disk inclination angle, disk scale length etc. Bulge-disk decomposition with GALFIT (Peng 2002)

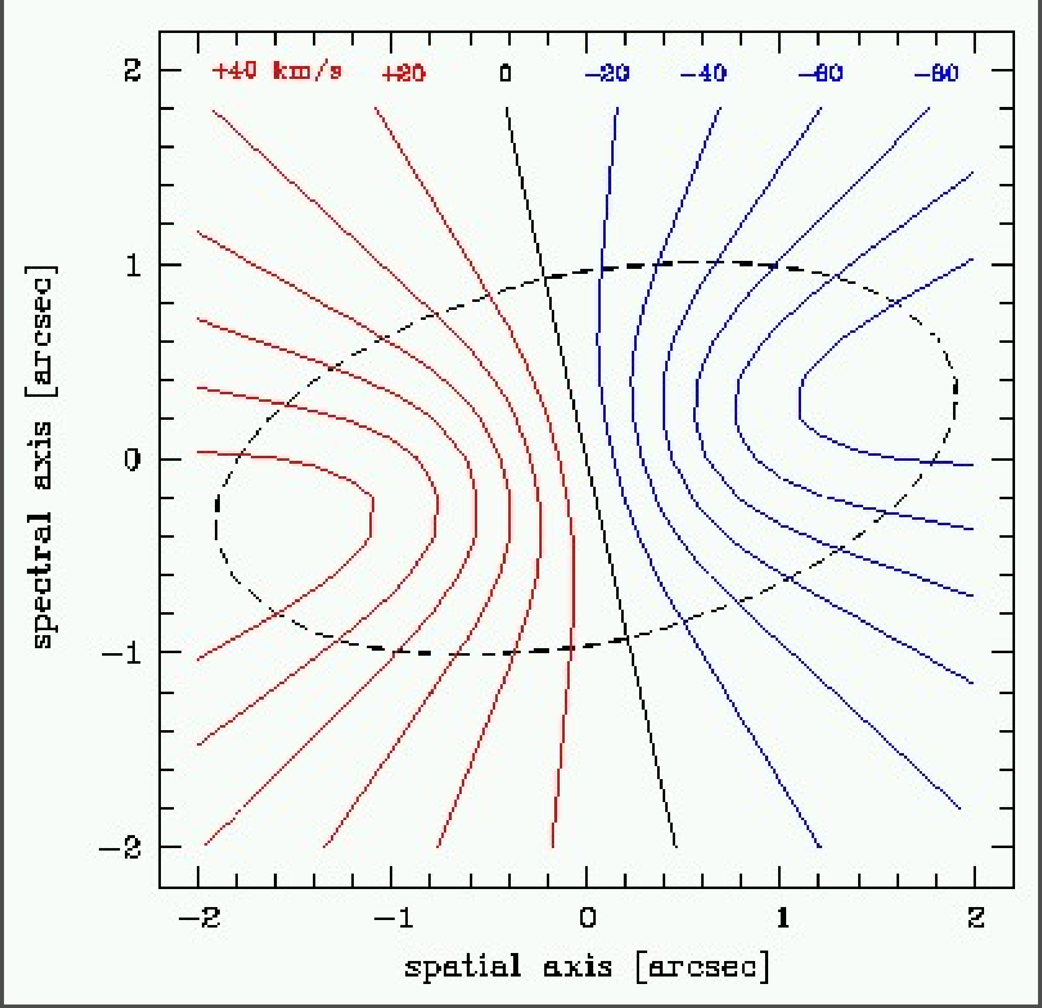
Synthetic Rotation Curves

1. Assume an intrinsic $V_{rot}(r)$

2. Simulate *intrinsic* 2-D rotation velocity field

3. Weight with exponential surface brightness profile (in direction of dispersion)

4. Convolve with Point Spread Function

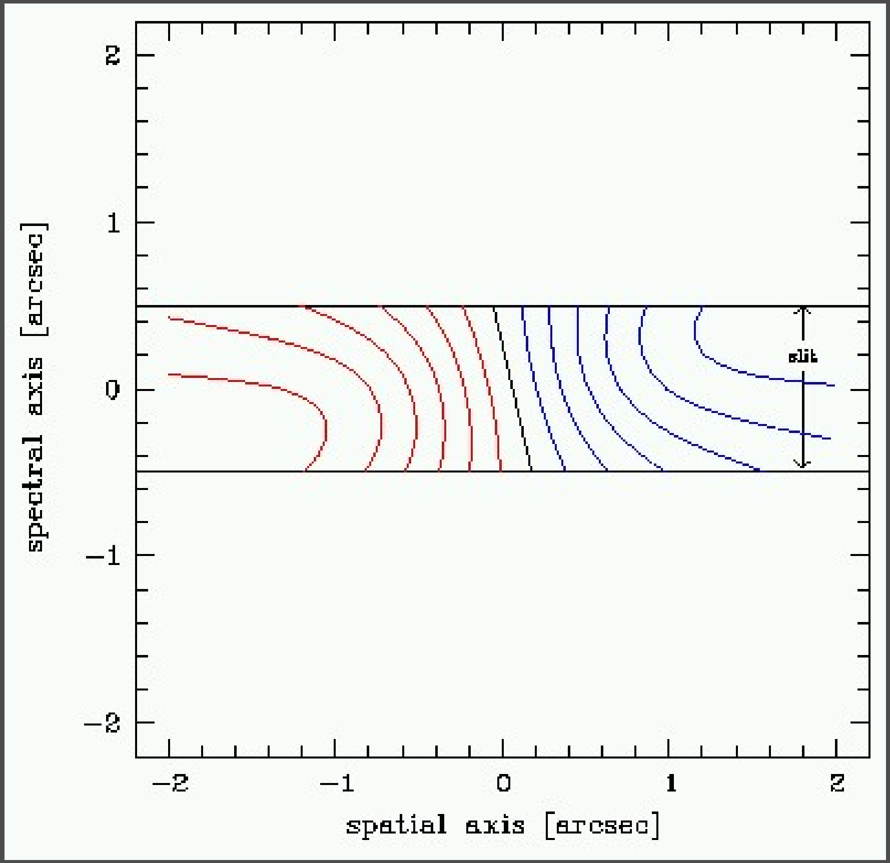


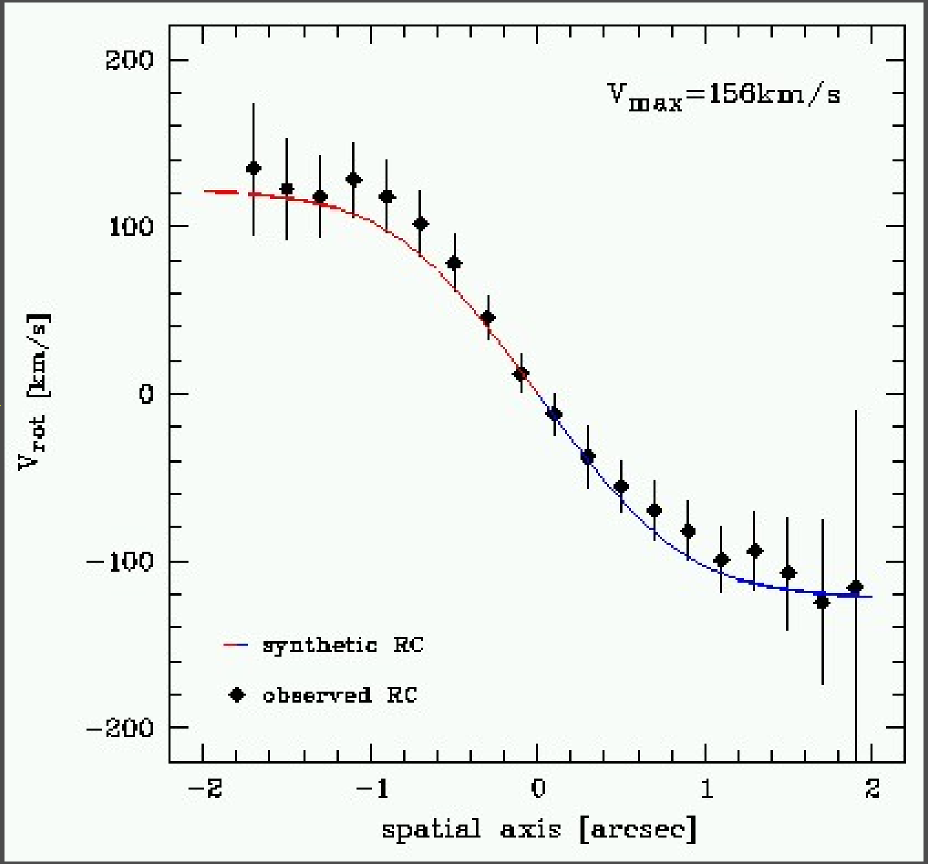
Example of simulated rotation velocity field
(solid lines: »iso-velocity« zones)

Synthetic Rotation Curves

5. Extraction from velocity field according to slit position & slit width (1arcsec) ⇒ synthetic rotation curve

6. Fit to observed rotation curve yields *intrinsic* V_{max}





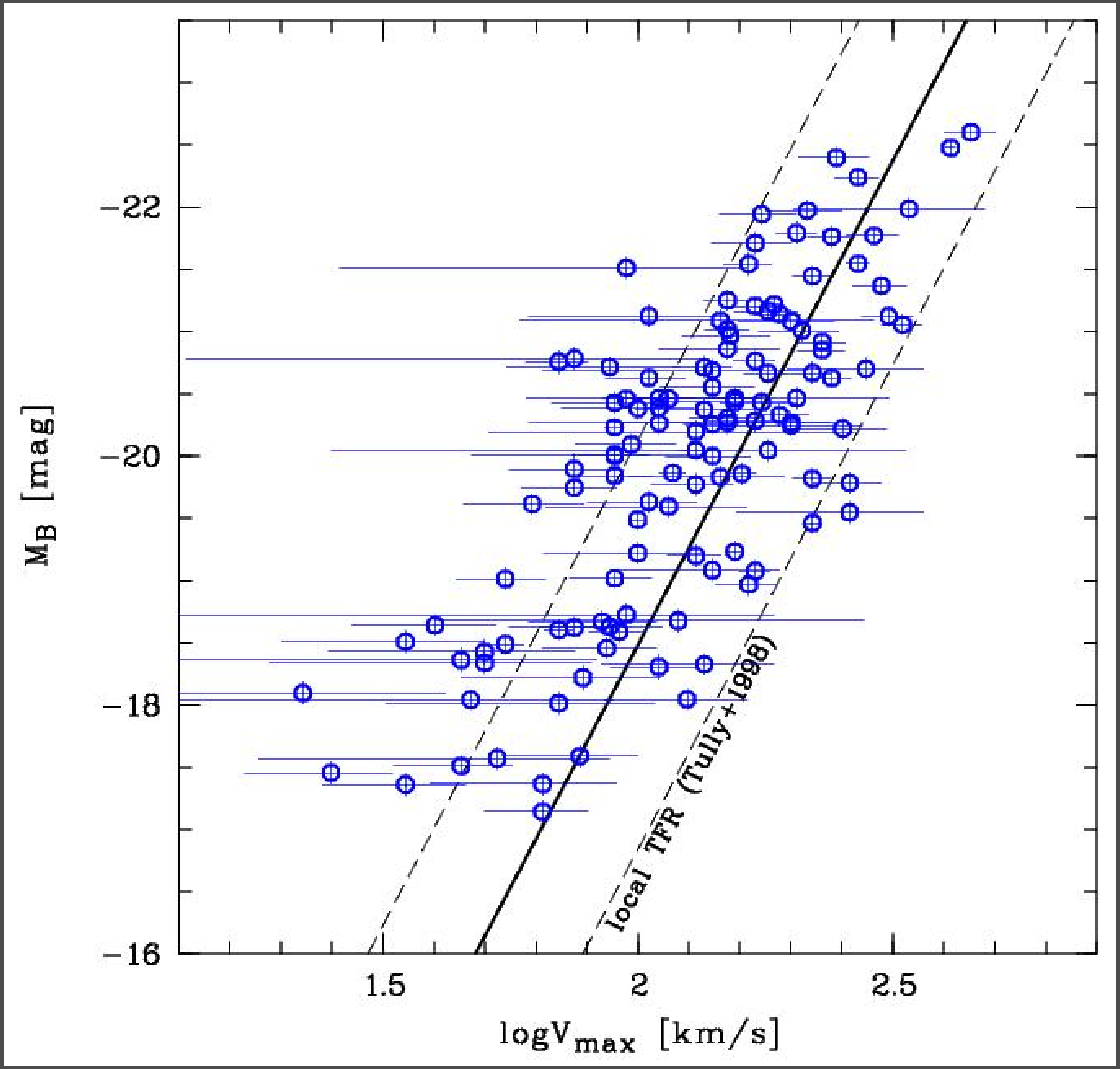
Results from V_{max}-Derivation

238 (out of 261) galaxies with spectroscopic redshifts

98 objects (41%) *rejected* from kinematic analysis
due to kinematic perturbations, low S/N, solid-body etc.

→ 140 galaxies with determined V_{max}
in the redshift range $0.05 < z < 0.97$, $\langle z \rangle = 0.43$,
look-back time 0.6 Gyr $< t_l <$ 7.6 Gyr, $\langle t_l \rangle$ = 4.5 Gyr
for $H_0 = 70$ km s^{-1} Mpc^{-1}, $\Omega_\lambda = 0.7$, $\Omega_m = 0.3$

B-band Tully-Fisher diagram: local compared to z≈0.5



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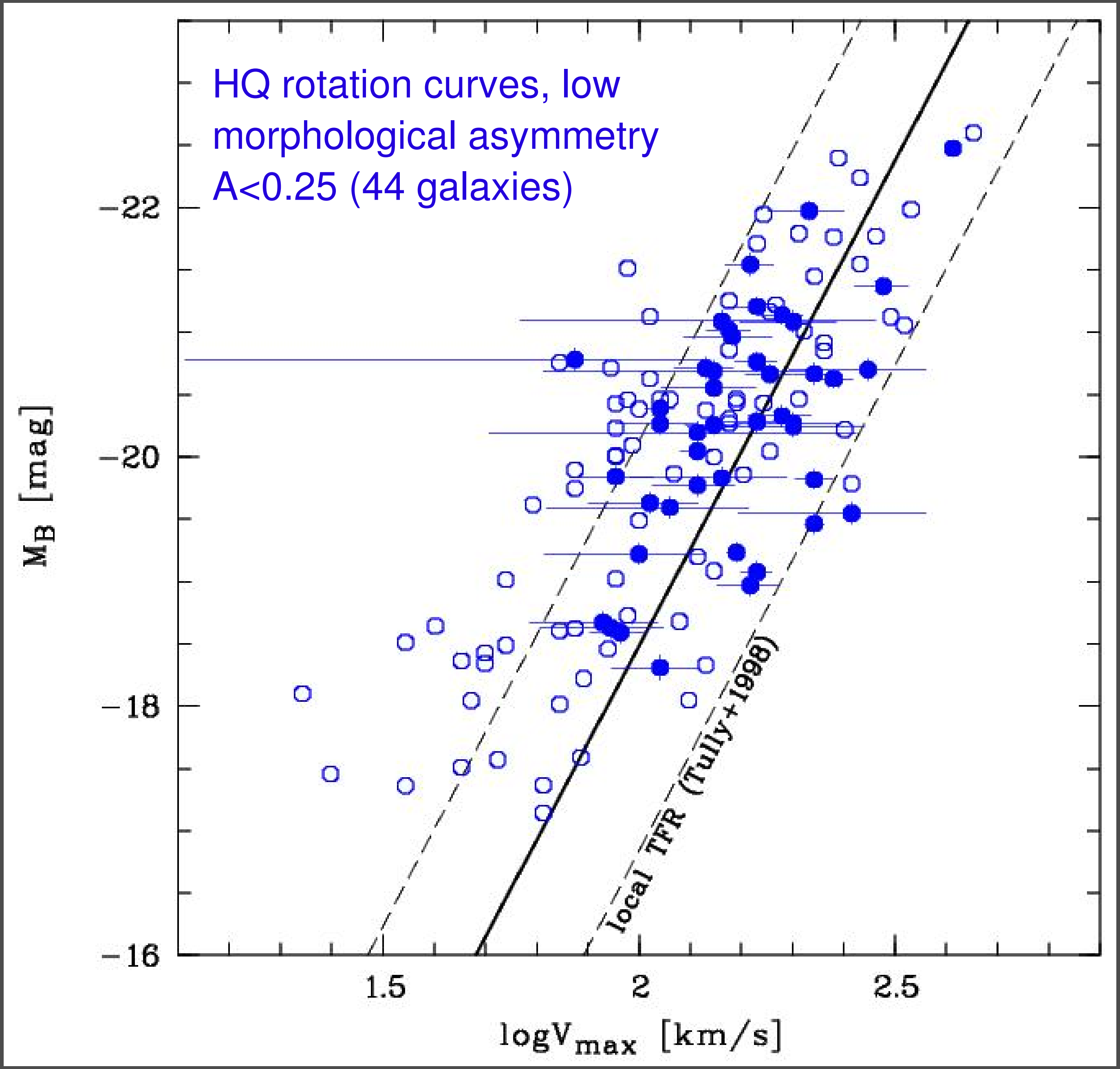
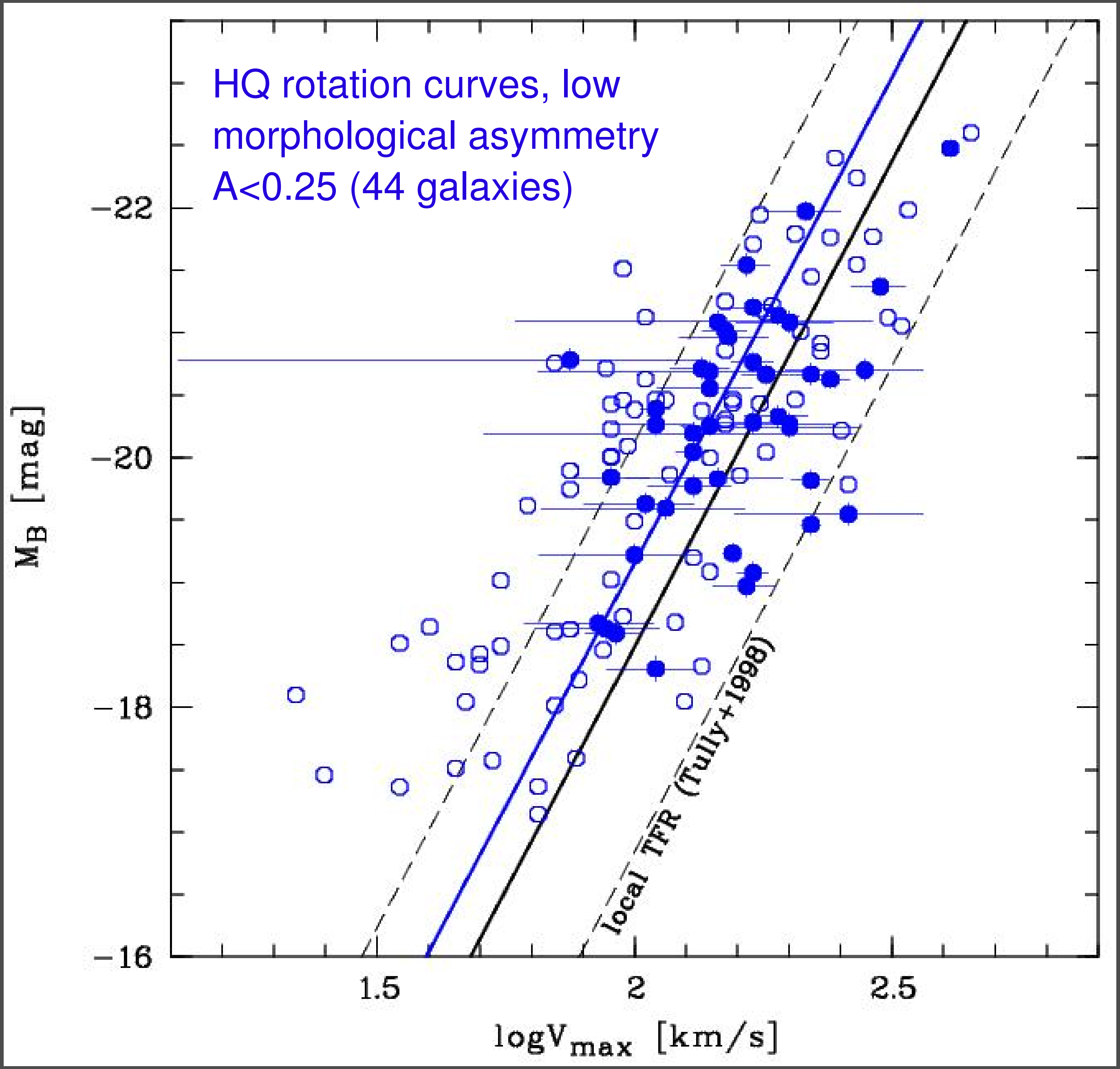
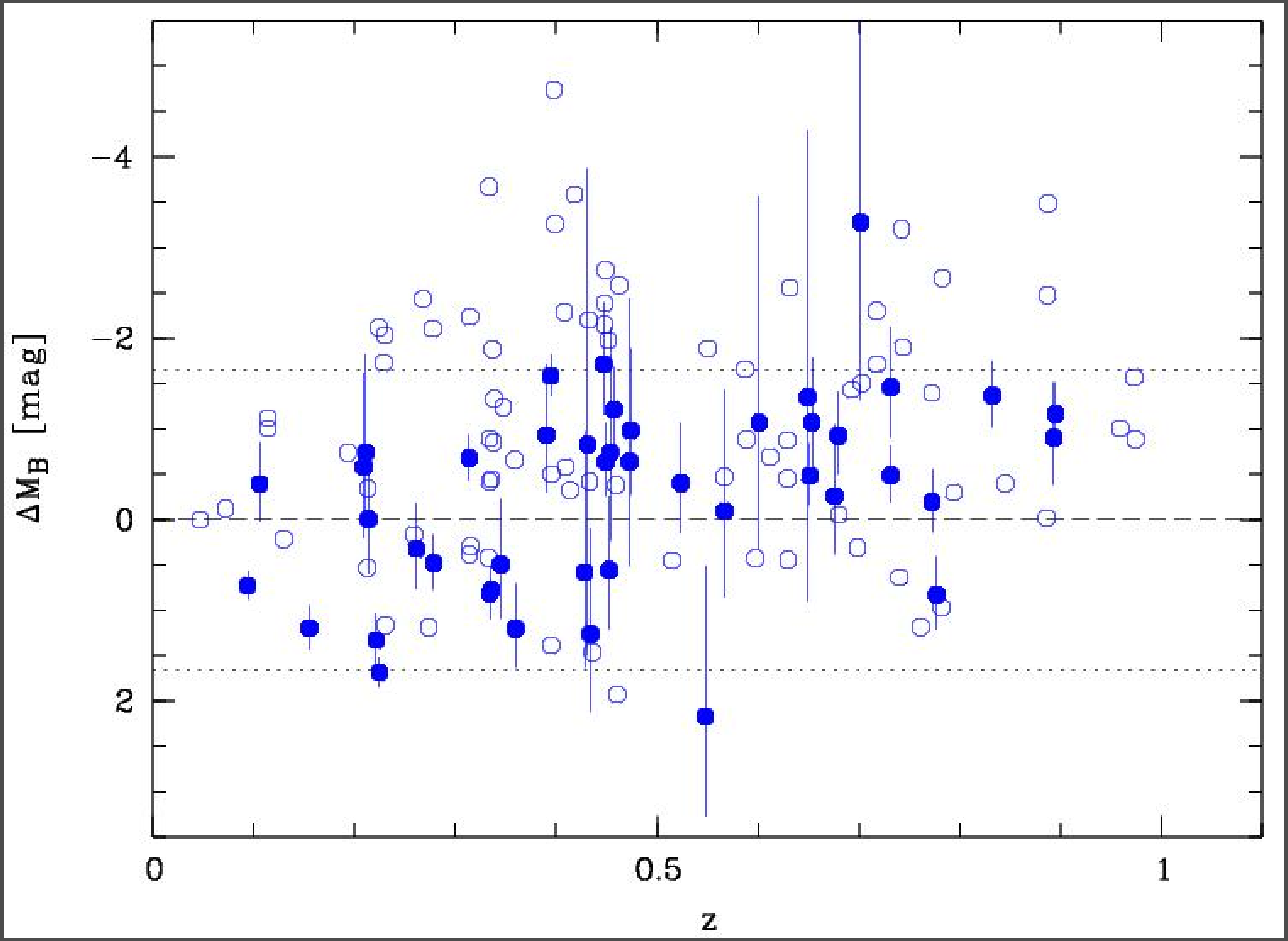


Distant sample TF scatter σ_{TF}=1.05 mag (~2× local value).
Average brightening ΔM_B=-0.68 mag by z≈0.5



B-Band TF offsets as a function of redshift



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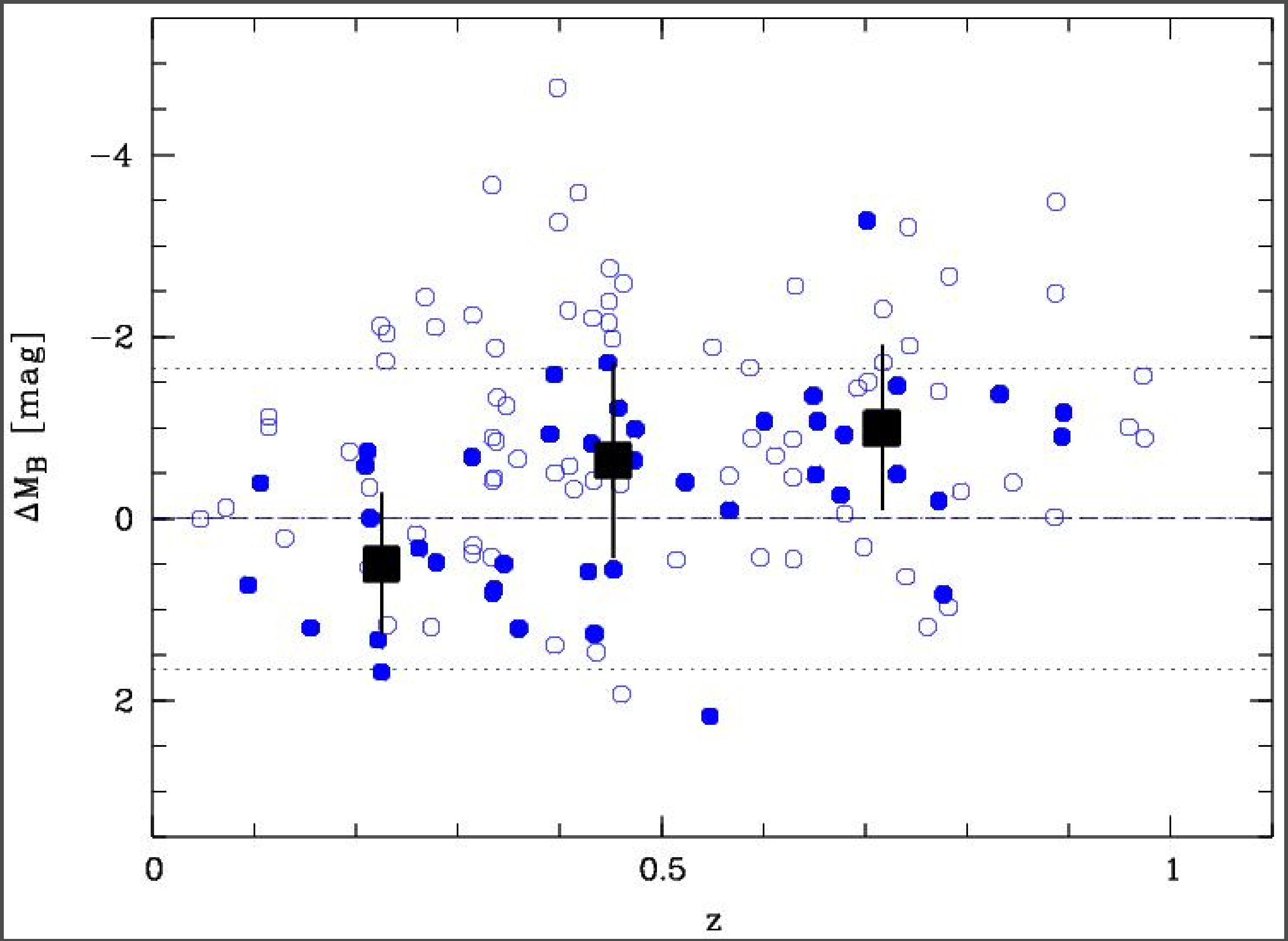

squares: median in 3 z-bins

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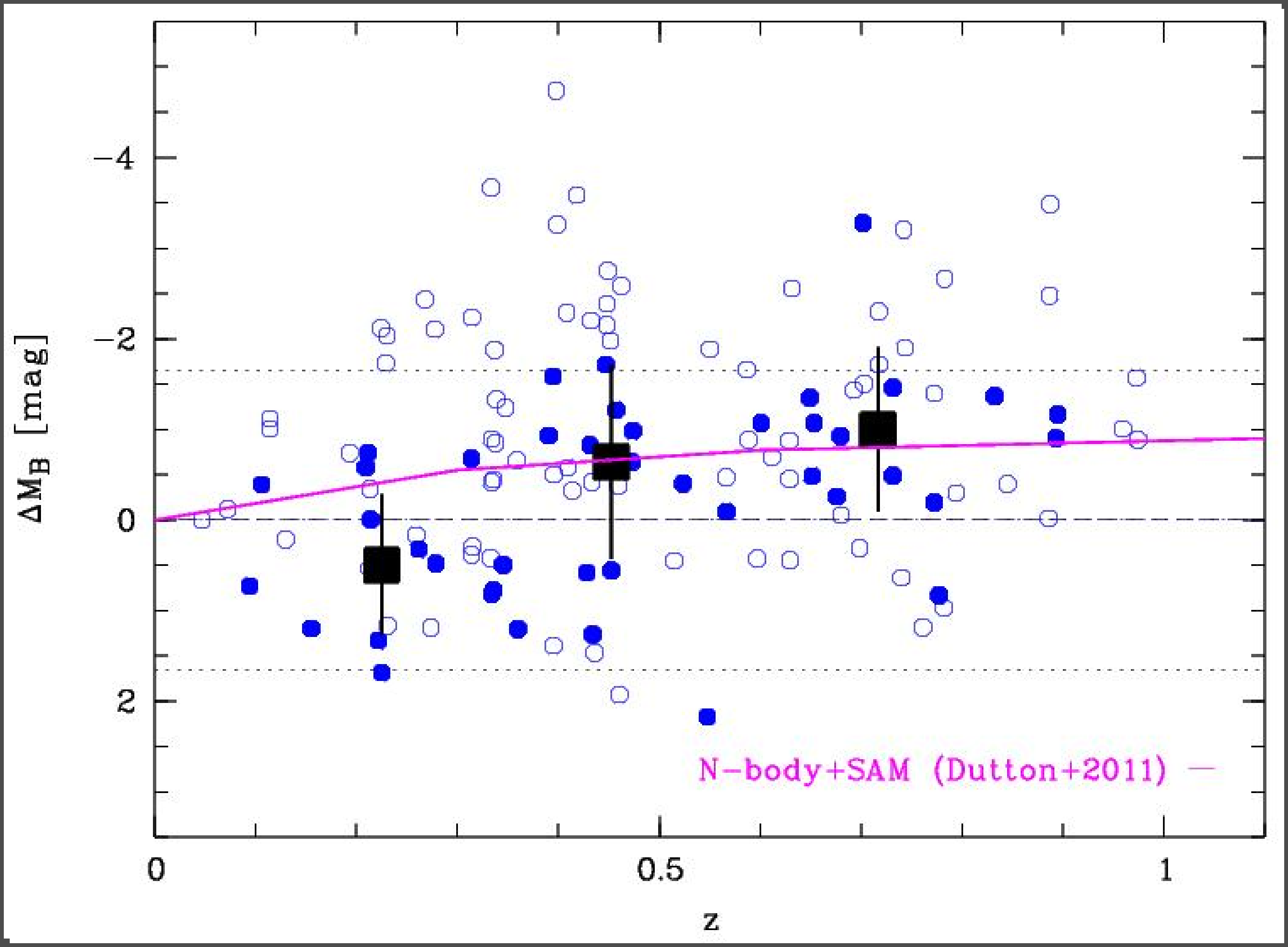

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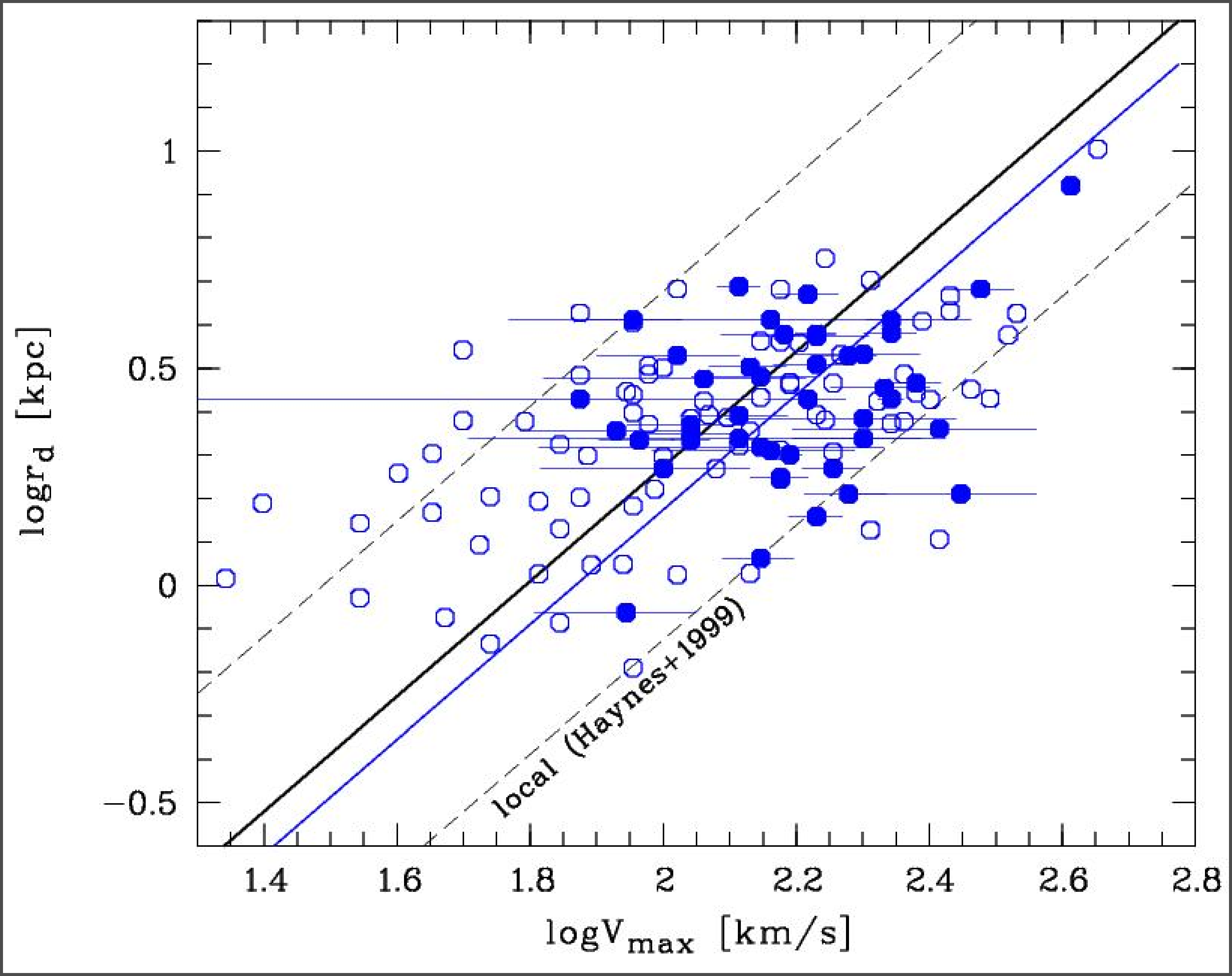
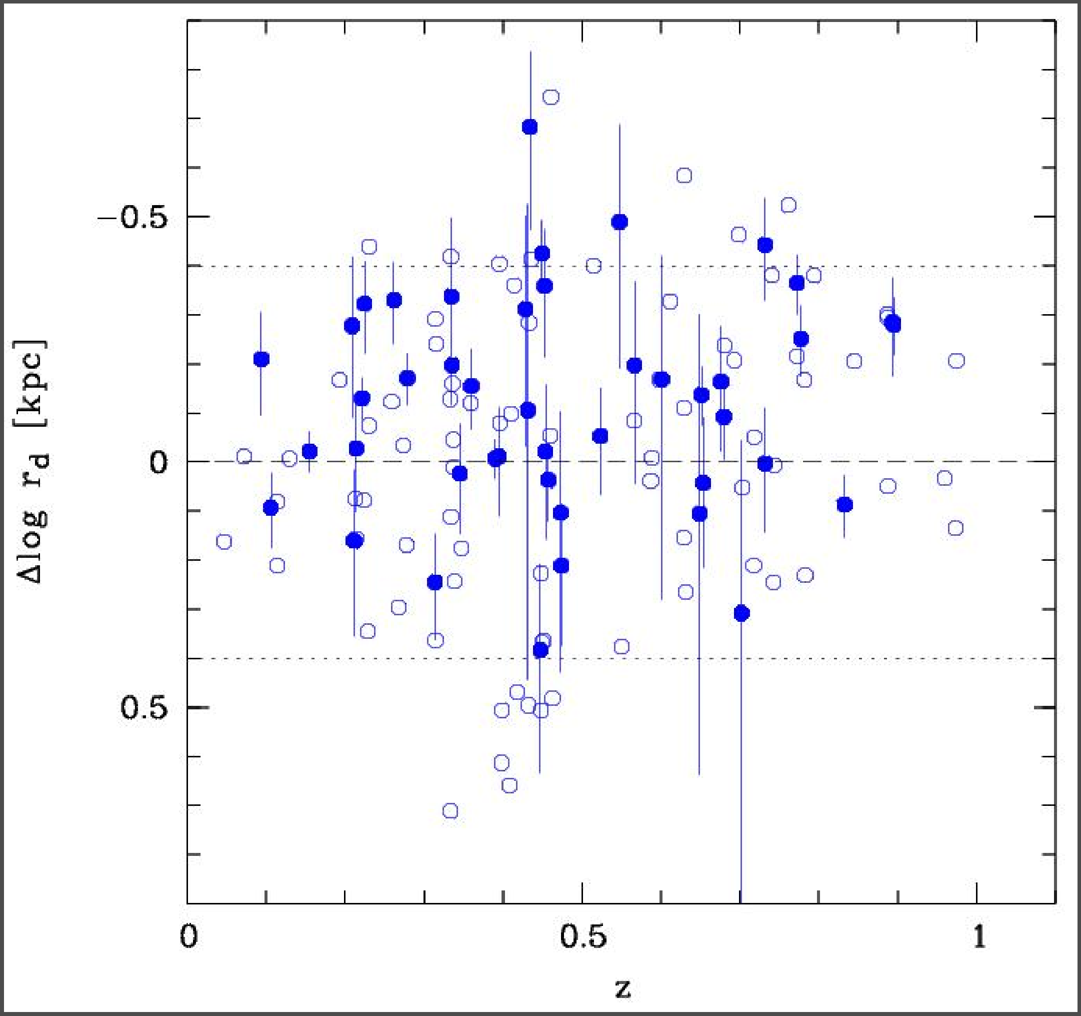
Velocity-size relation: local vs. z ≈ 0.5



Disk Sizes

Disk sizes at given V_{max} mildly decrease towards higher redshifts



Smaller than locally ↑

Larger than locally ↓

Offsets $\Delta \log r_d$ from *local* V_{max}-r_d relation
Dashed/dotted: local relation & 3σ scatter

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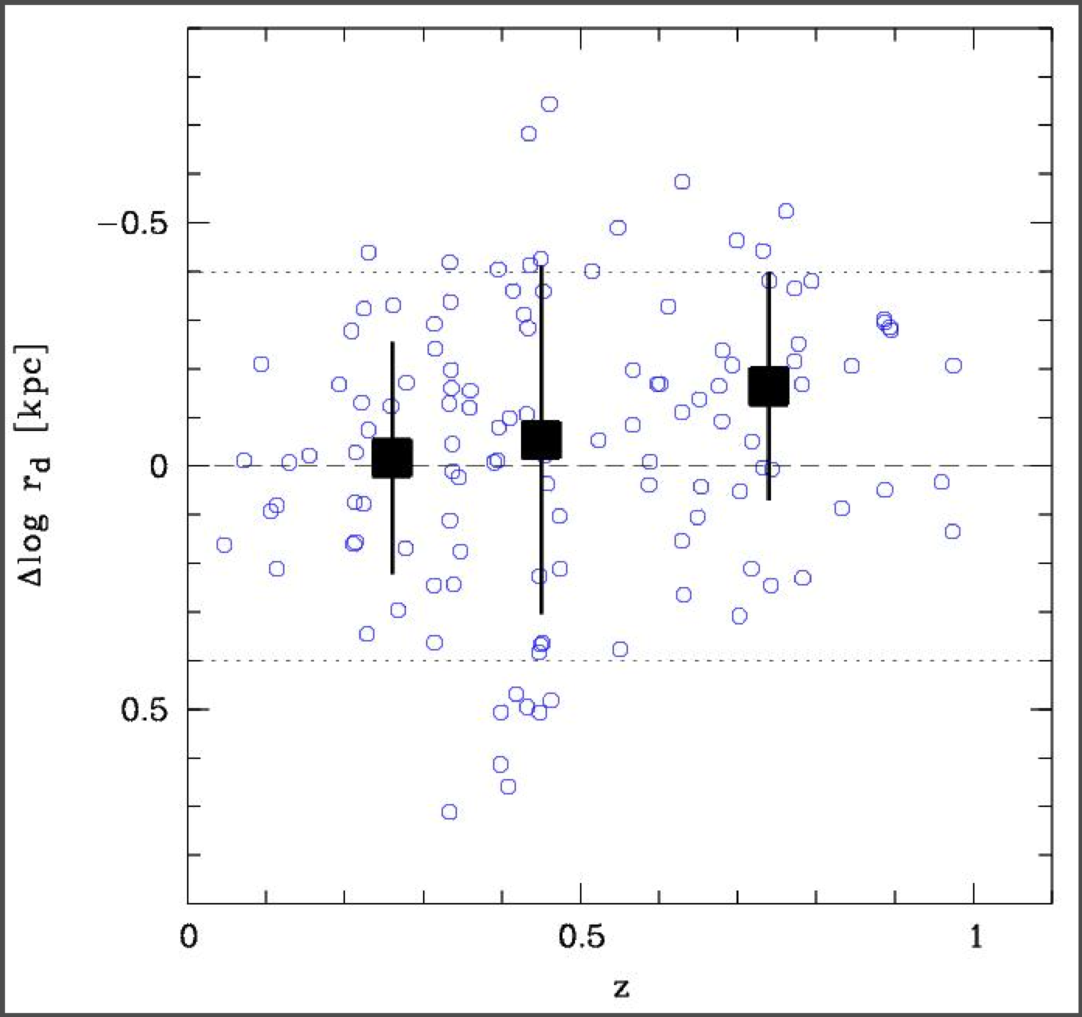

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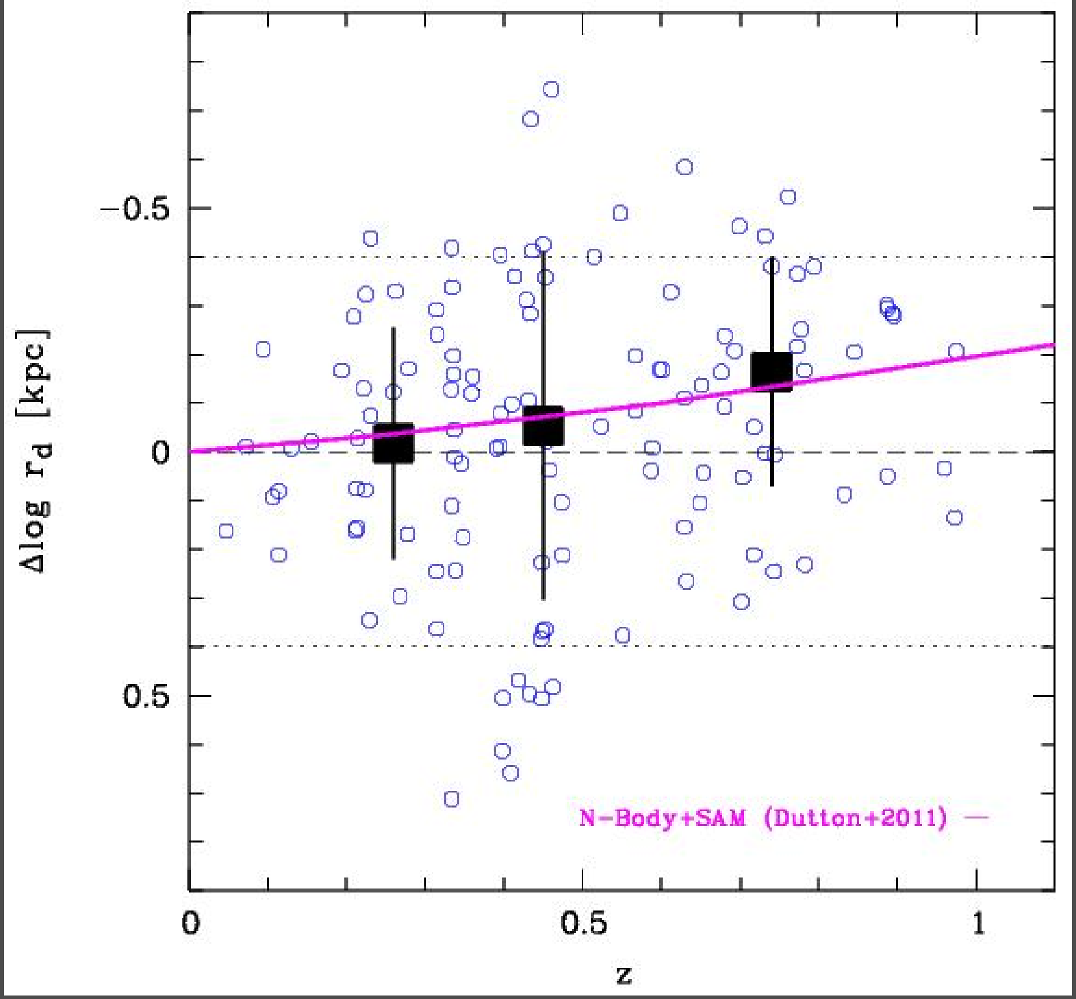

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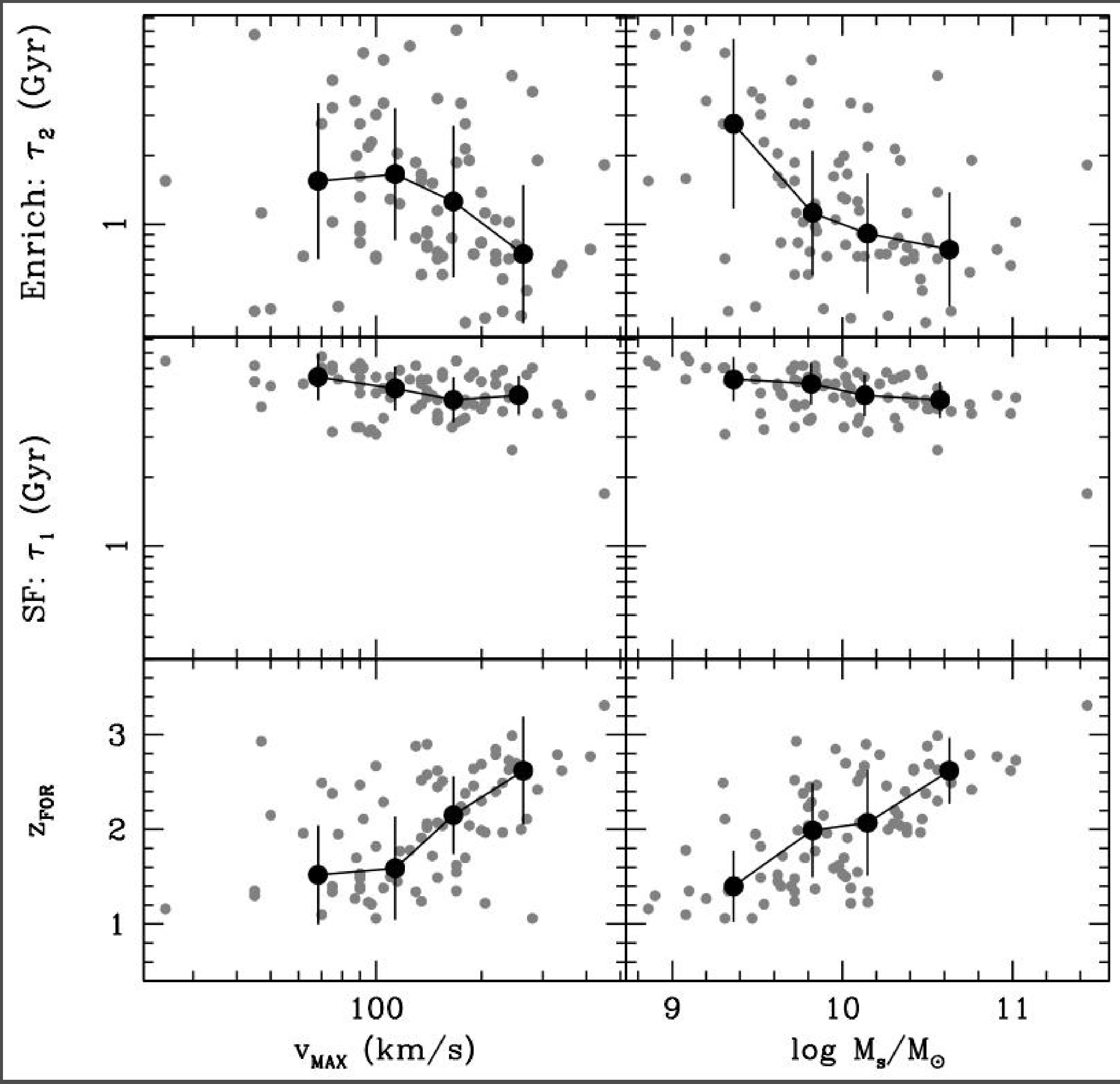
Stellar Populations

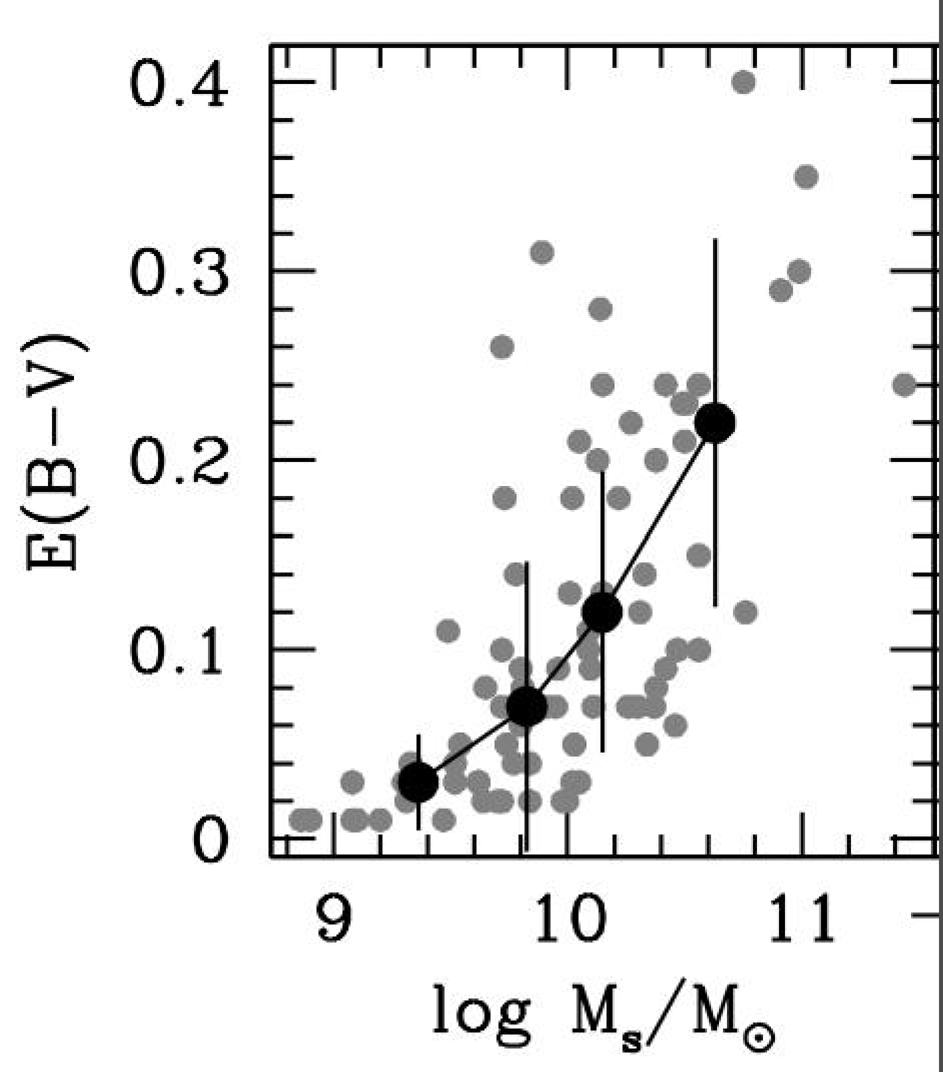
Single-zone models fitted to observed optical+NIR colors from deep imaging.
Four free parameters:
- formation redshift z_{FOR}
- SF timescale τ_1
- enrichment timescale τ_2
- intrinsic reddening E(B-V)

Best-fit models indicate downsizing. Possibly a combined effect of SN feedback and UV background (e.g. Governato+2009)



Ferreras & Böhm, MNRAS, in prep.

Instrinsic dust reddening



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→ mass-dependency similar to local spirals (e.g. Tully+1998)

Summary

- Spectra of 261 disk galaxies at $0.1 < z < 1.0$ taken
- 140 rotation curves usable for derivation of V_{max}
- Distant disks more luminous than local counterparts (Tully-Fisher offset $\Delta M_B = -0.7$ mag at $z \approx 0.5$)
- Evidence for disk growth (by ~60% since z=1 at fixed V_{max})
- Stellar populations evolve according to downsizing scenario

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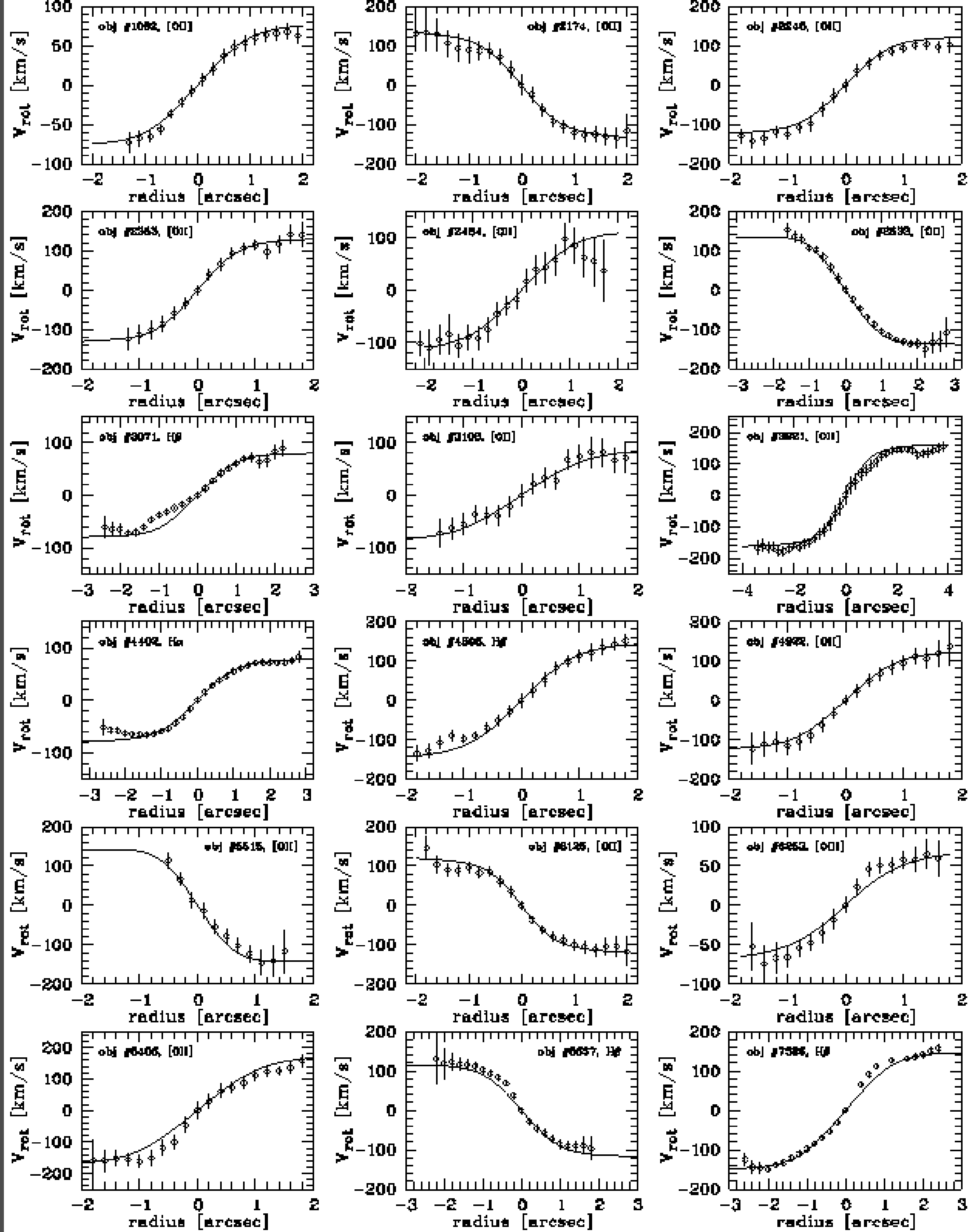
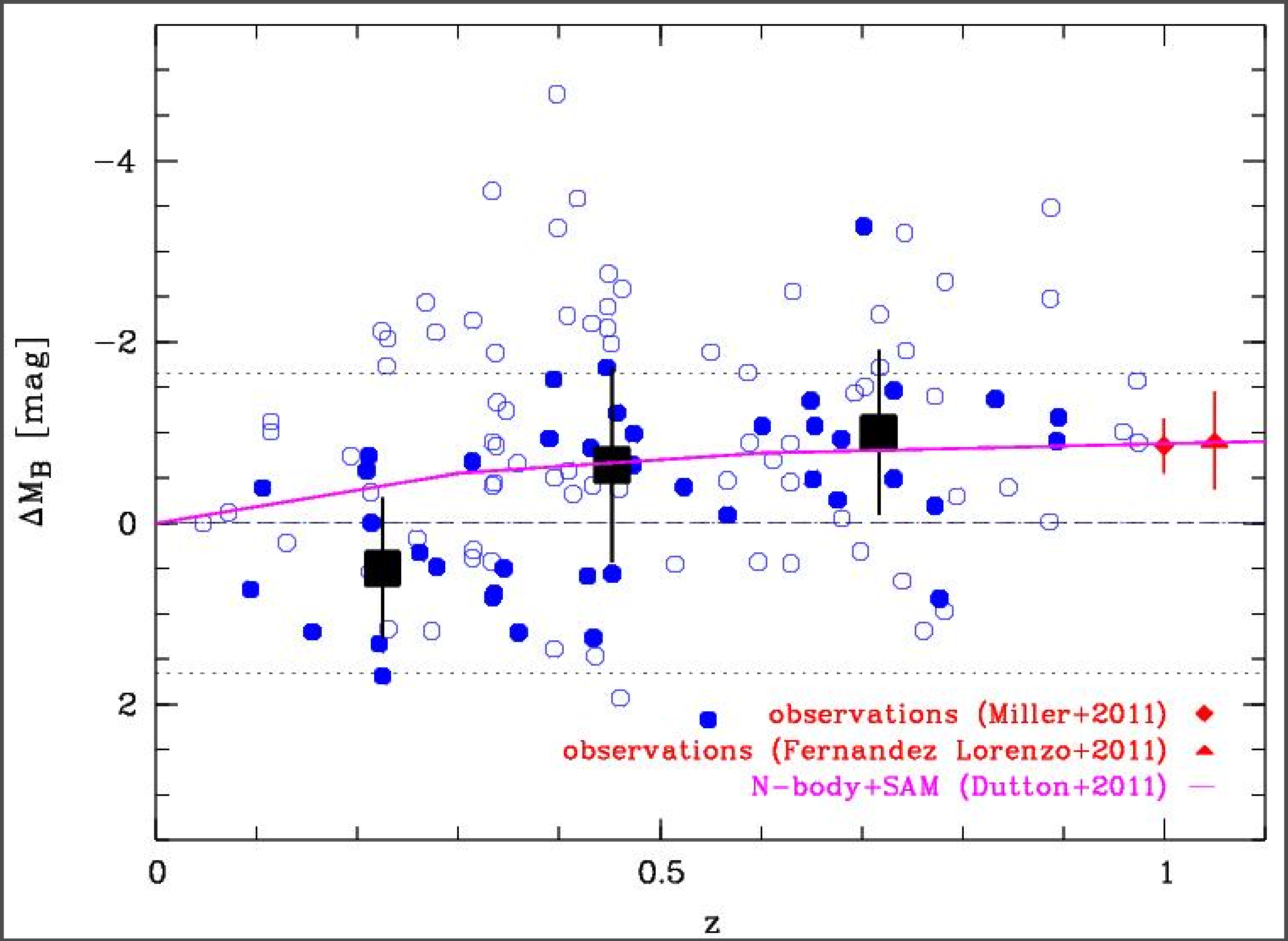
Examples of rotation curves from our sample

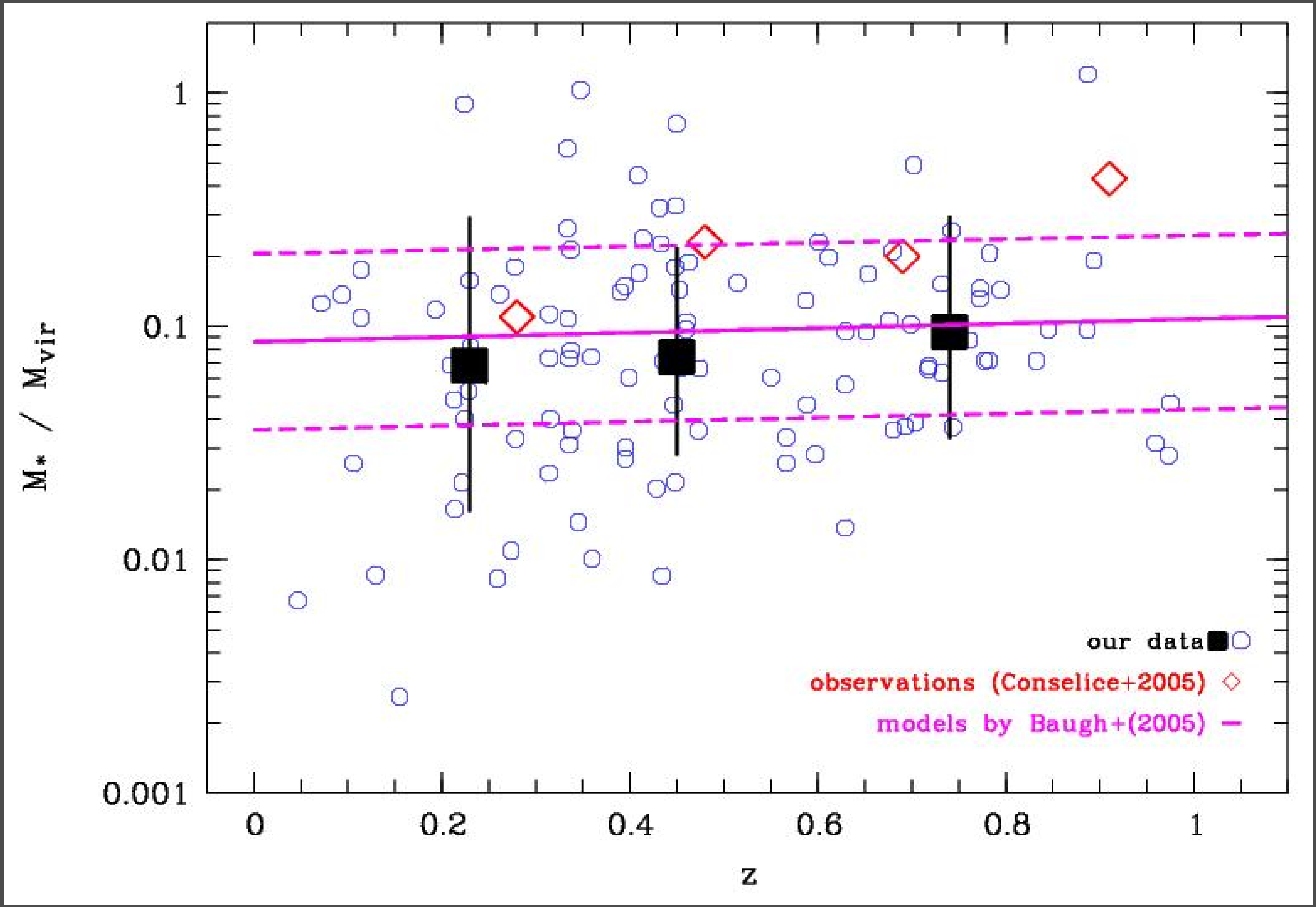


B-Band TF offsets as a function of redshift

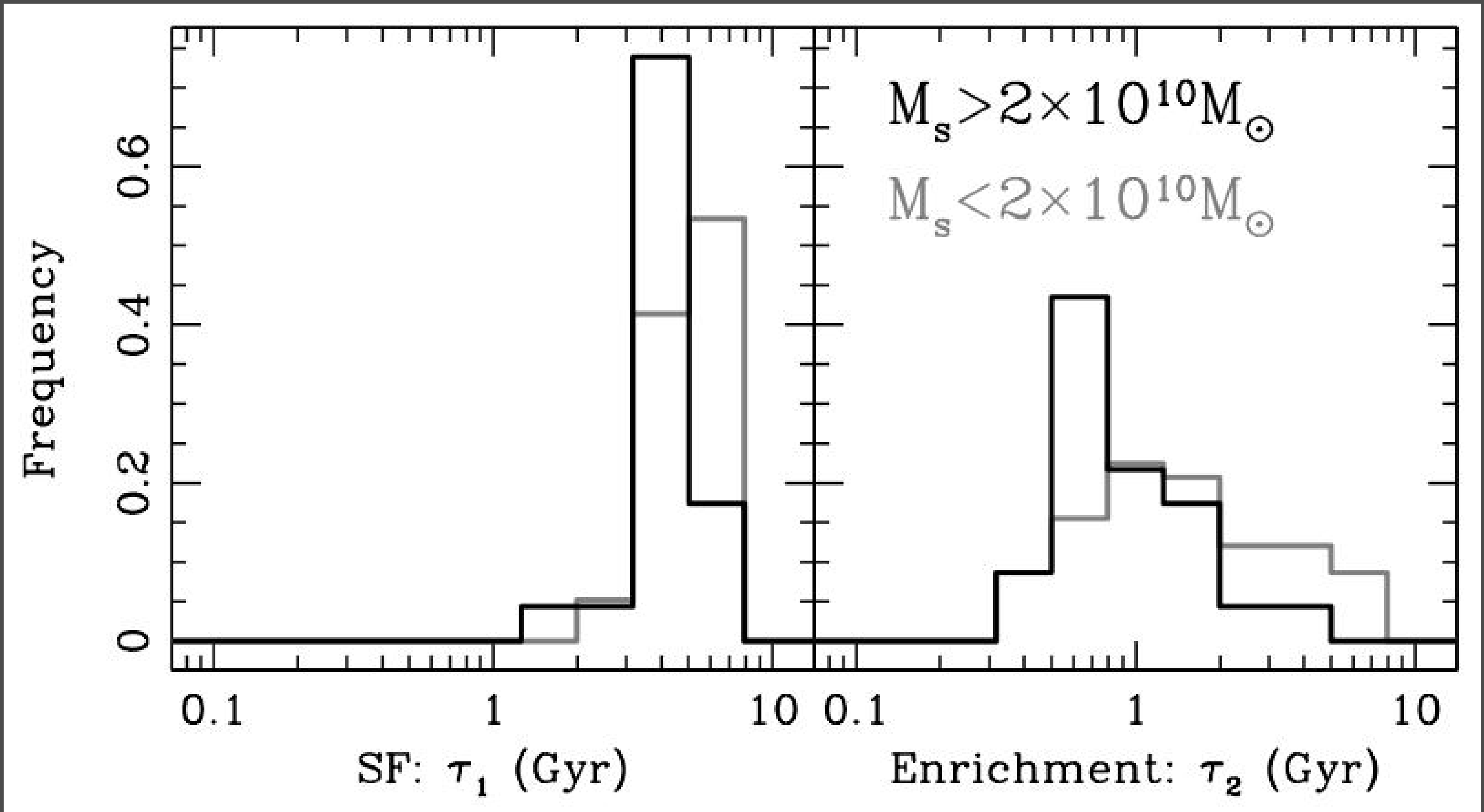


squares: median in 3 z-bins

Stellar mass fractions



Best-fit model timescales for low- and high mass disks



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New Data

15 massive spiral galaxies with significant bulge components at z ≈ 0.4 (PI A.Böhm). 10 hrs on target with VLT/FORS2

Main aims:

- Determine bulge velocity dispersion σ_v
- Construct distant σ_v - V_{max} relation: evidence for bulge mass evolution?
- Mass decomposition of rotation curves into DM Halo, disk and bulge