

What can we learn from dry mergers?

Why bother...?!

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In the Beginning was T'n'T

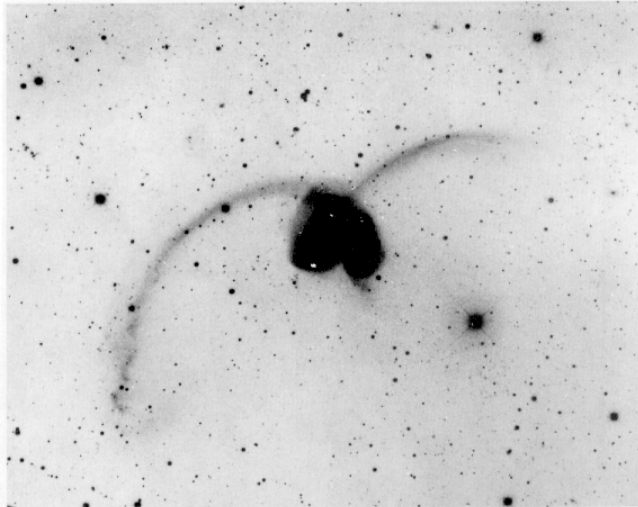


Figure 7-17. The interacting galaxies NGC 4038 and NGC 4039. Courtesy of D. F. Malin and Kitt Peak National Observatory.

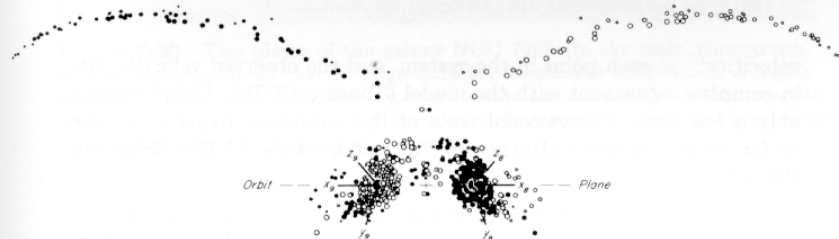
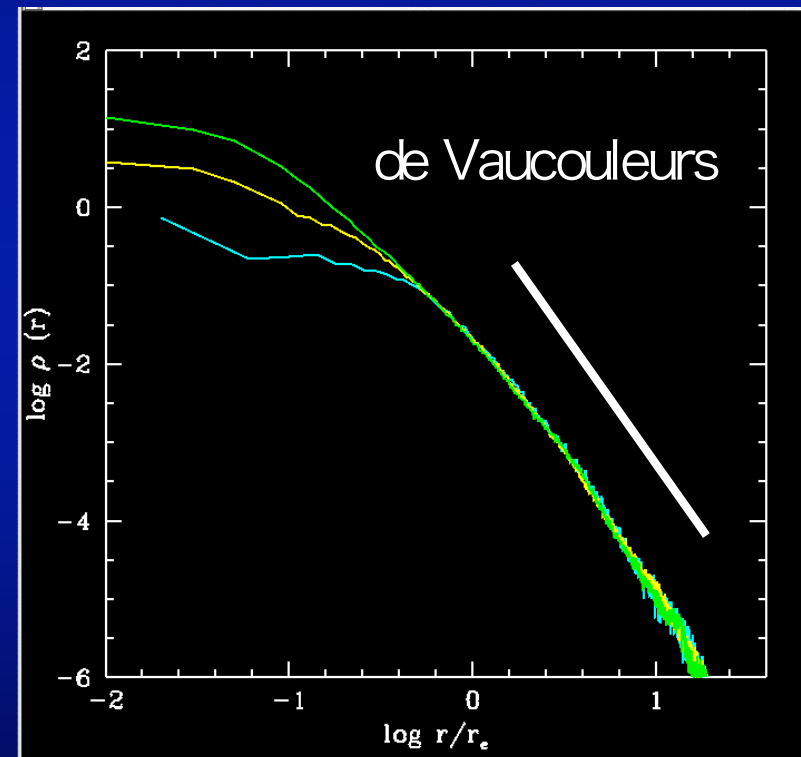


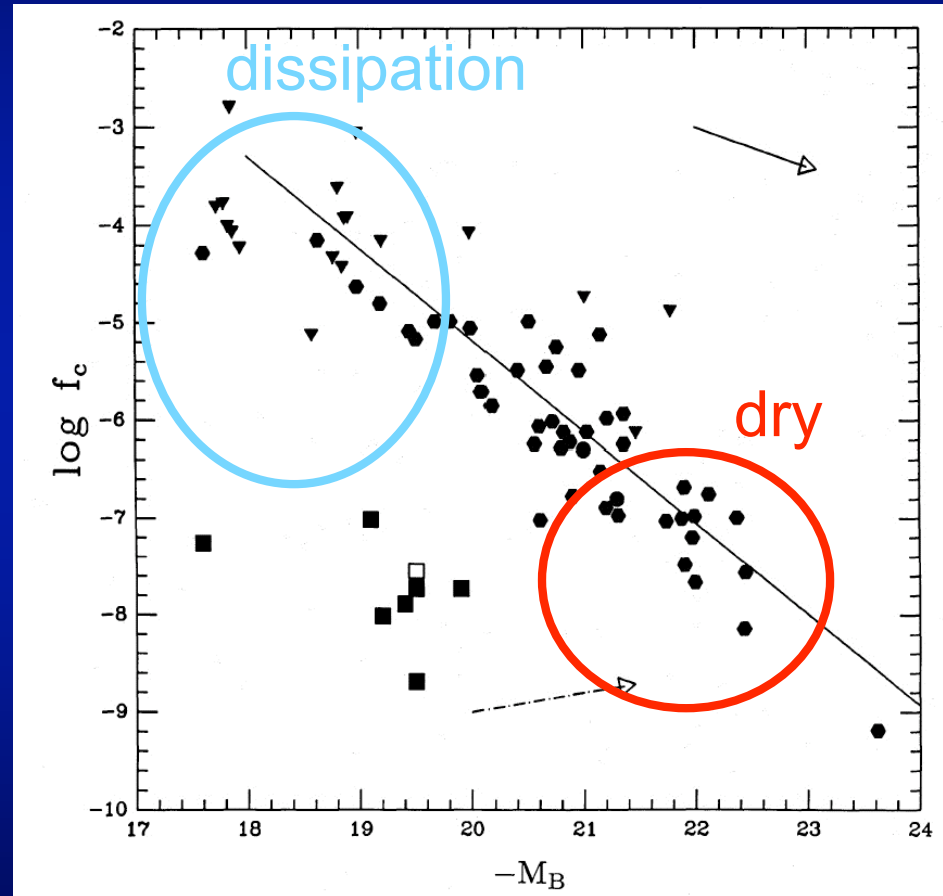
Figure 7-18. A model of the NGC 4038/4039 pair by Toomre and Toomre (1972). Reproduced by permission of *The Astrophysical Journal*.

Toomre & Toomre (1972)



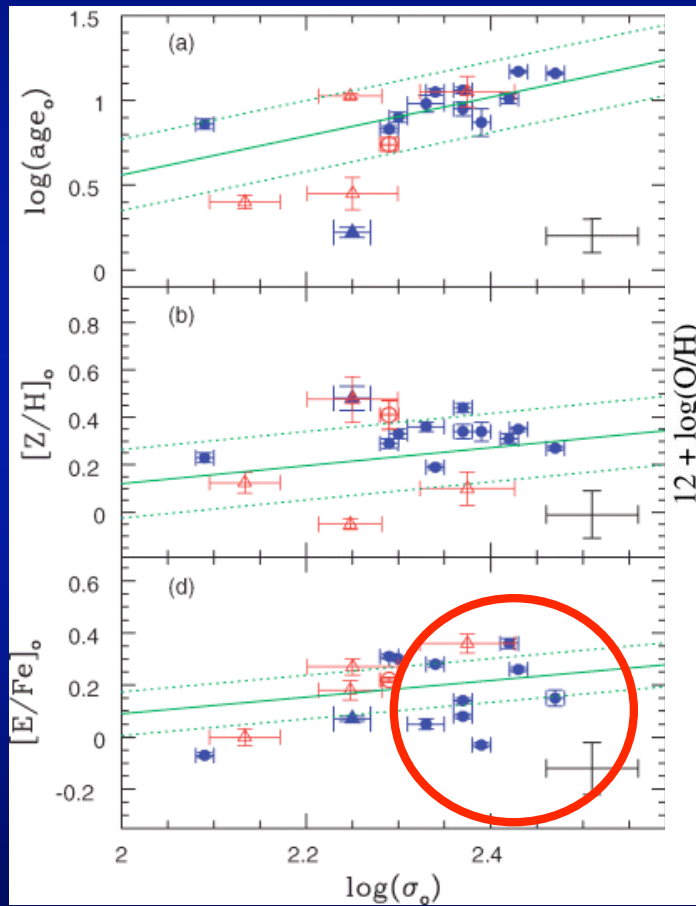
Phase Space Density

$$f_c \propto \frac{1}{\sigma_c r_c^2}$$

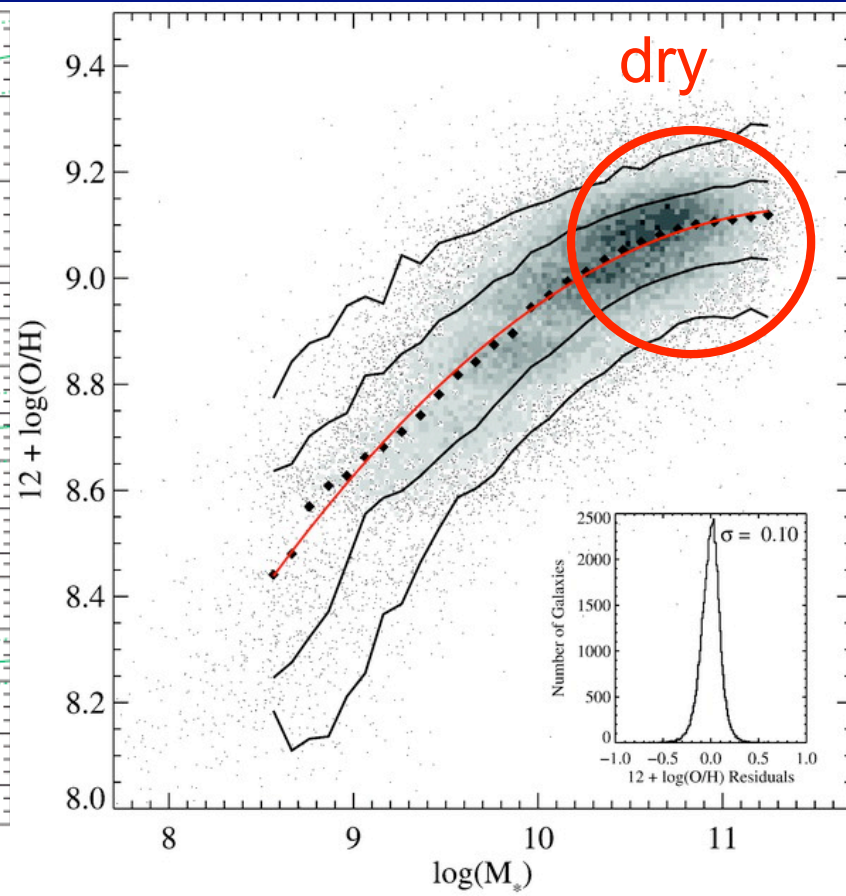


Carlberg (1986)

Scaling Relations



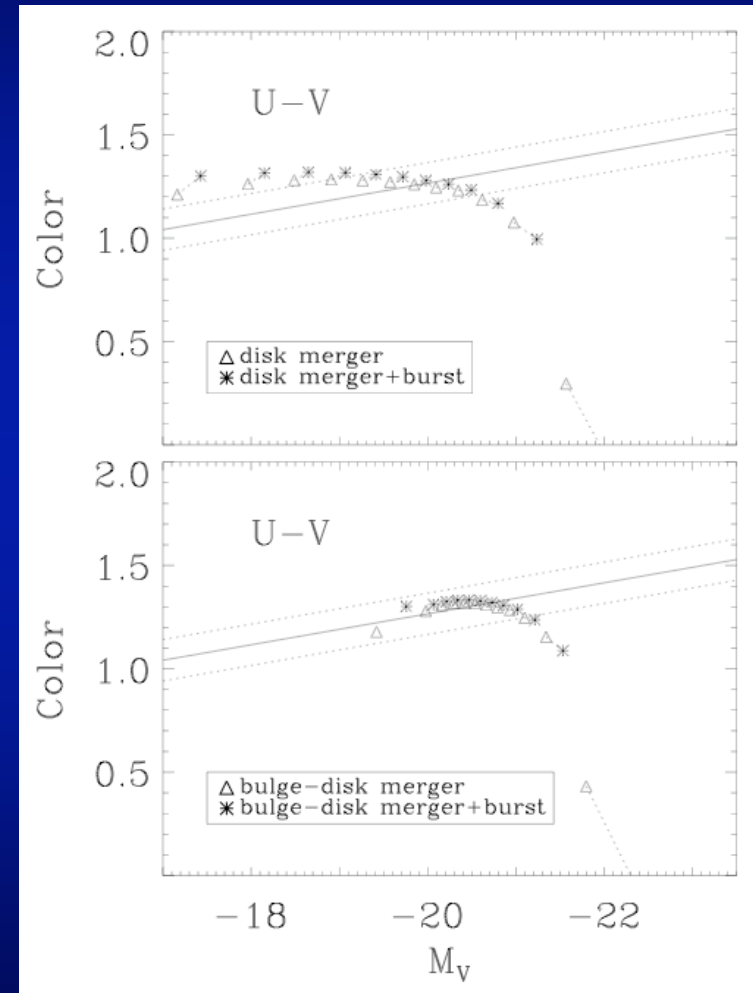
Reda et al. (2007)



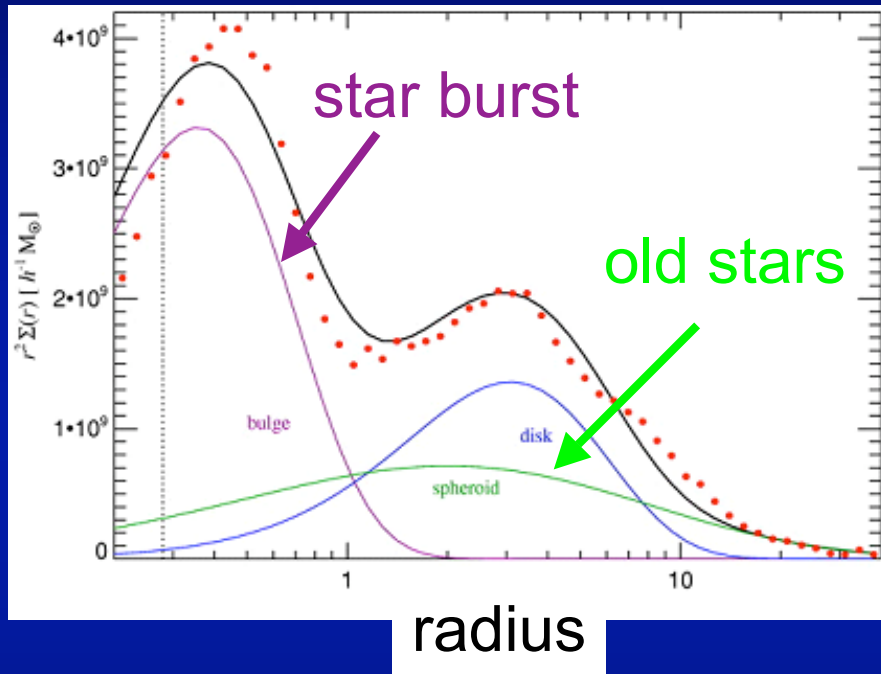
Tremonti et al. (2004)

Colours

- Only disc mergers older than 5 Gyr give consistent results with the CMR
- If recent mergers happened they had to be **dry**



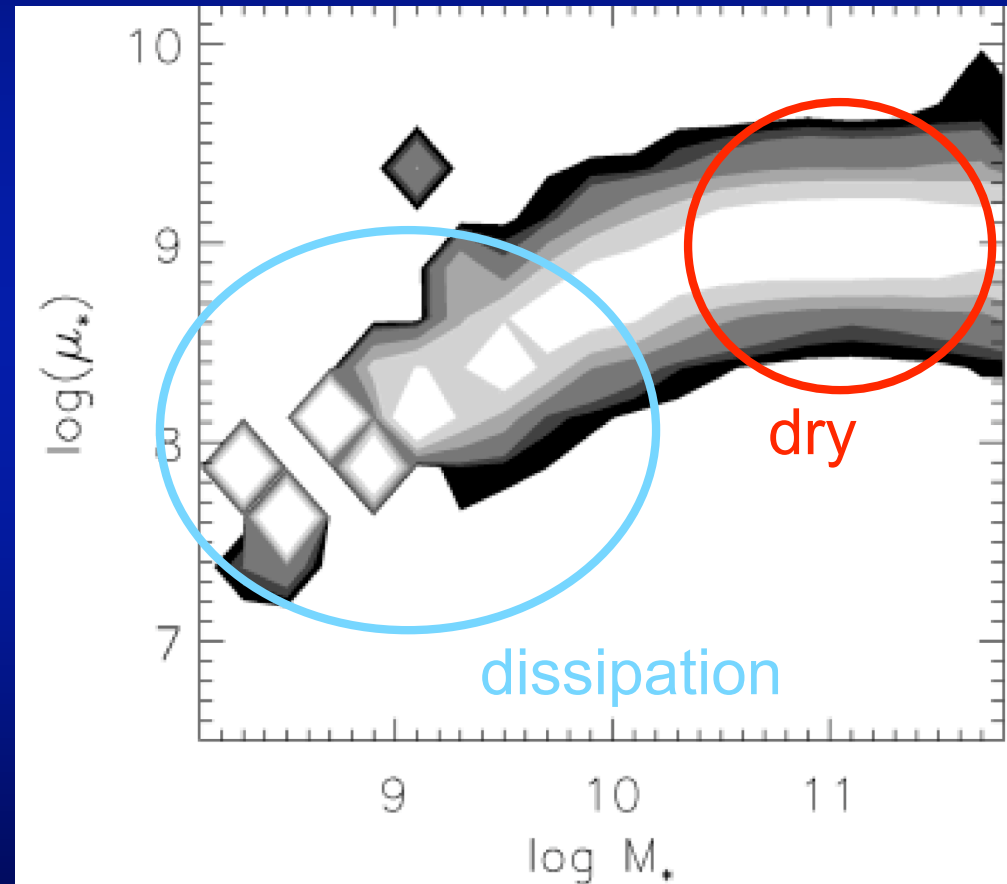
Sizes of Merger Remnants



Springel & Hernquist (2005)

$$\mu_* = \frac{0.5 M_*}{\pi R_e^2}$$

Early-Type

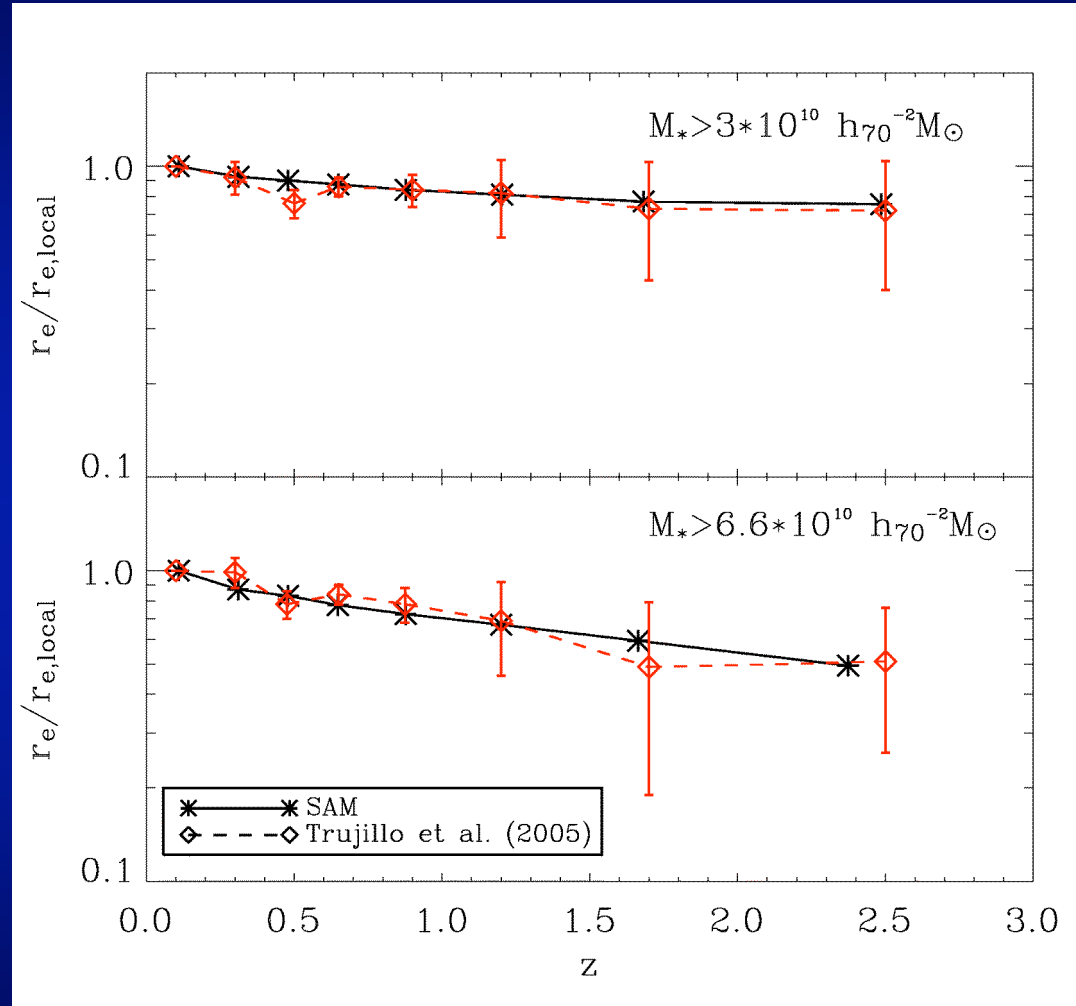


Kauffmann et al. (2003)

Size-Evolution

$$R_e(z) = R_{e,\text{local}}^{1/d}$$

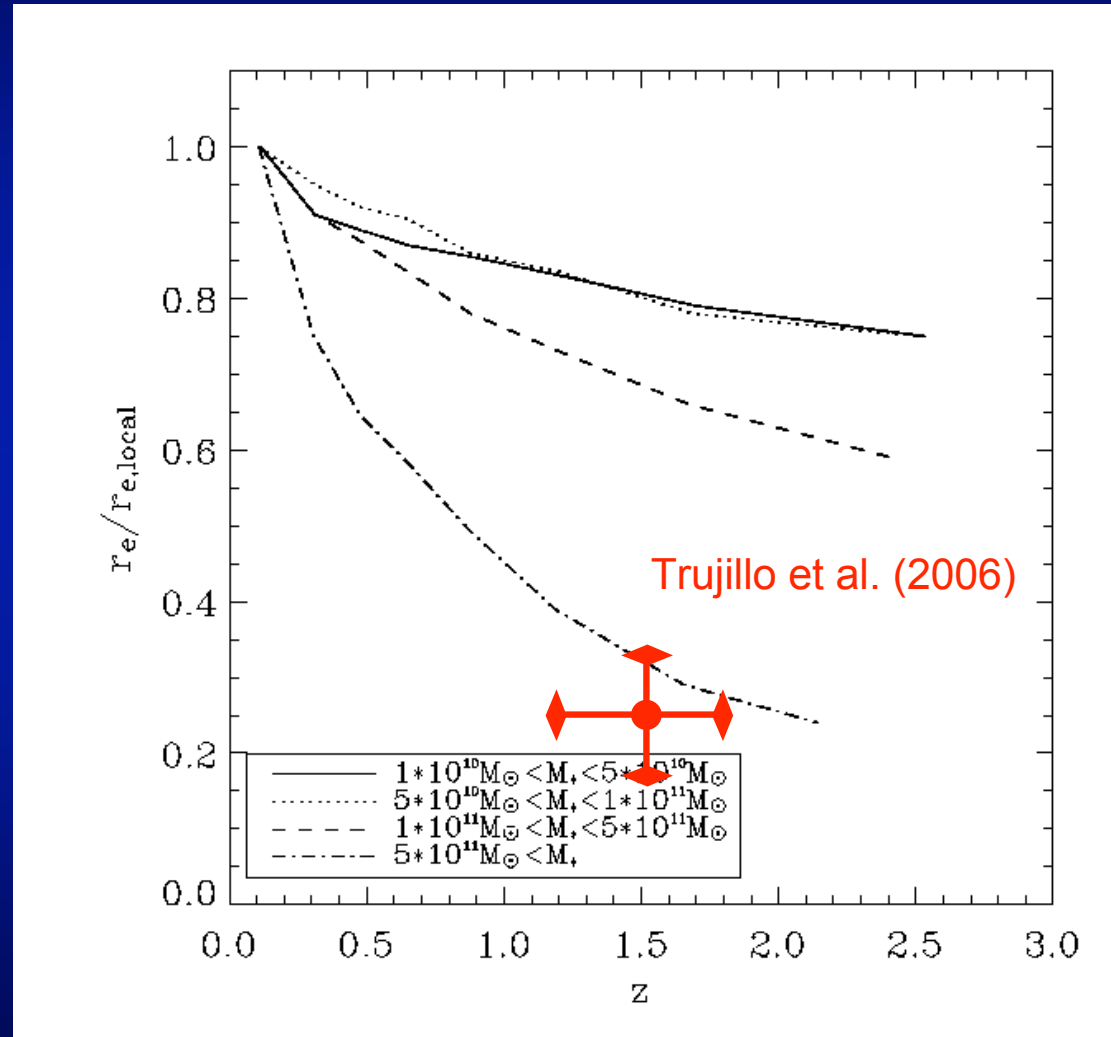
Massive ellipticals
show a stronger size-
evolution than less
massive ones
because **late**
formation is mostly
dry



Khochfar & Silk (2006b)

Size-Evolution

Massive galaxies could be **up to five times smaller** at high redshifts than now, because they are more likely to be formed during a gas-rich major merger.

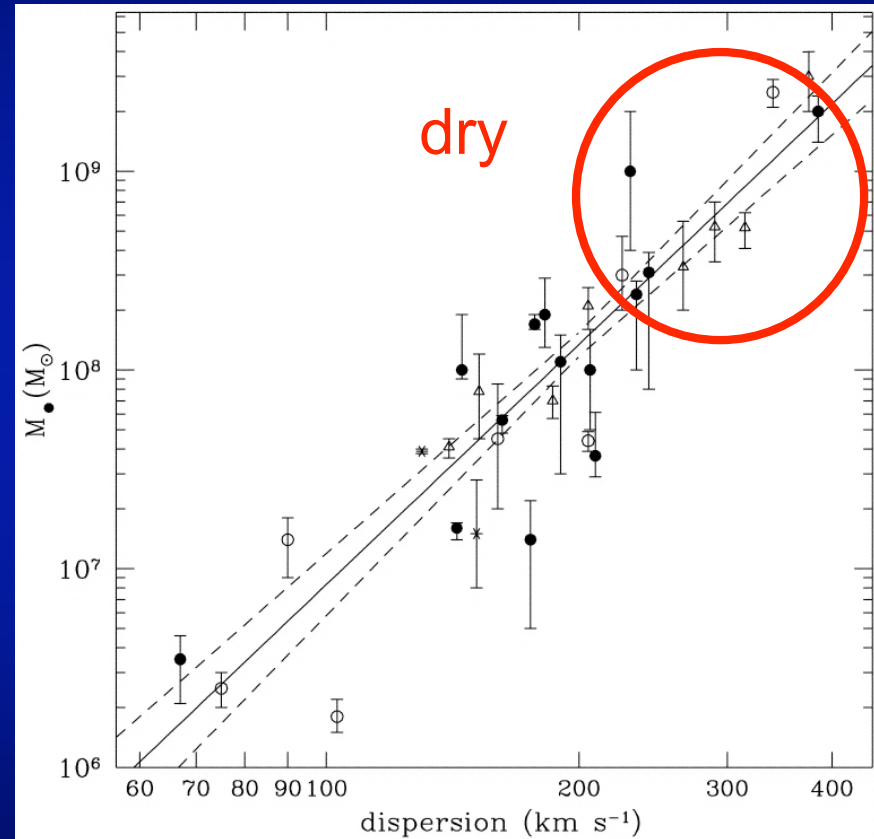


Scatter in Black Hole Masses

Dry mergers keep scatter
~ constant with L but not
necessarily with σ .

Wet mergers due to
feedback effects will result
in tighter scatter with σ .

Observations indicate
tighter scatter with L at the
high mass end.

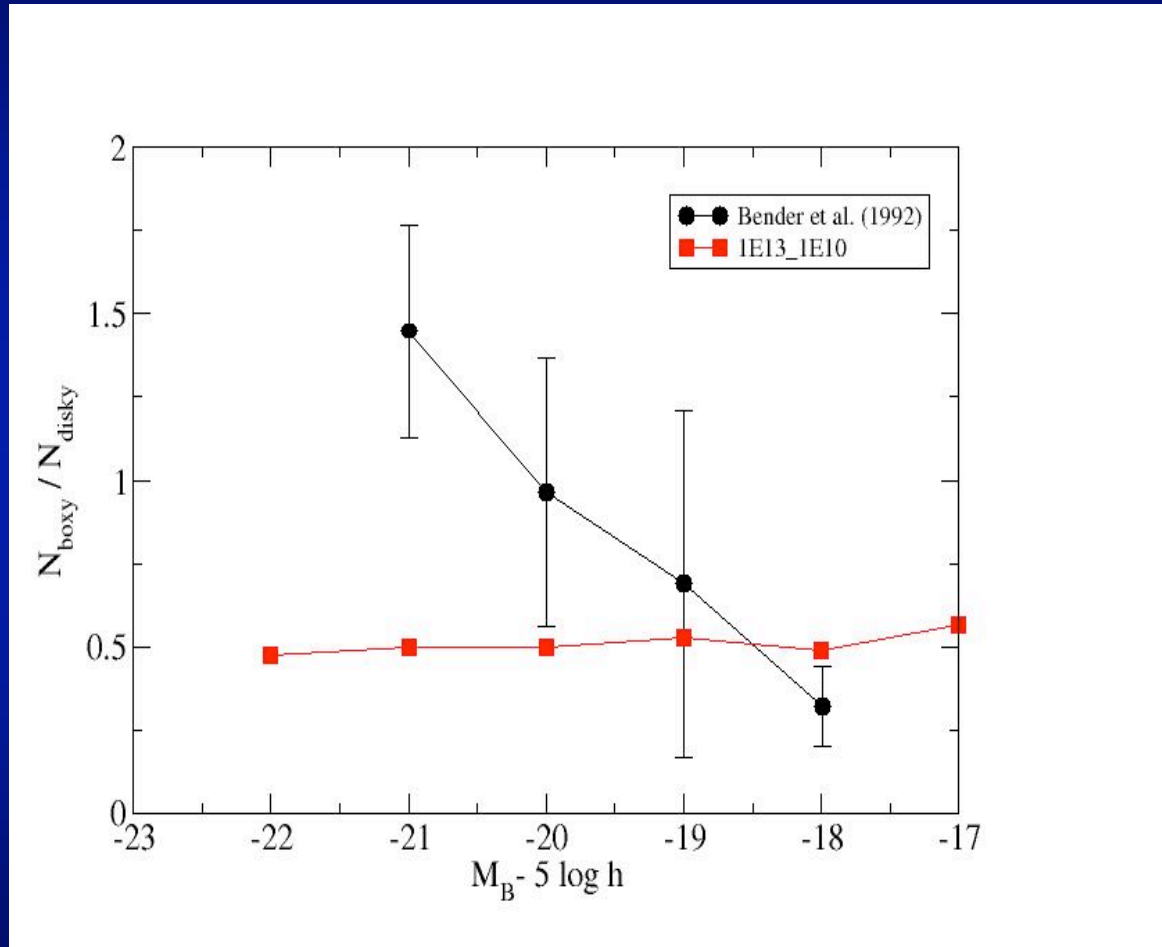


Tremaine et al. (2003)

Isophotal Shapes

1:1 => boxy
3:1 => disky

Model fails badly.
No trend with
luminosity

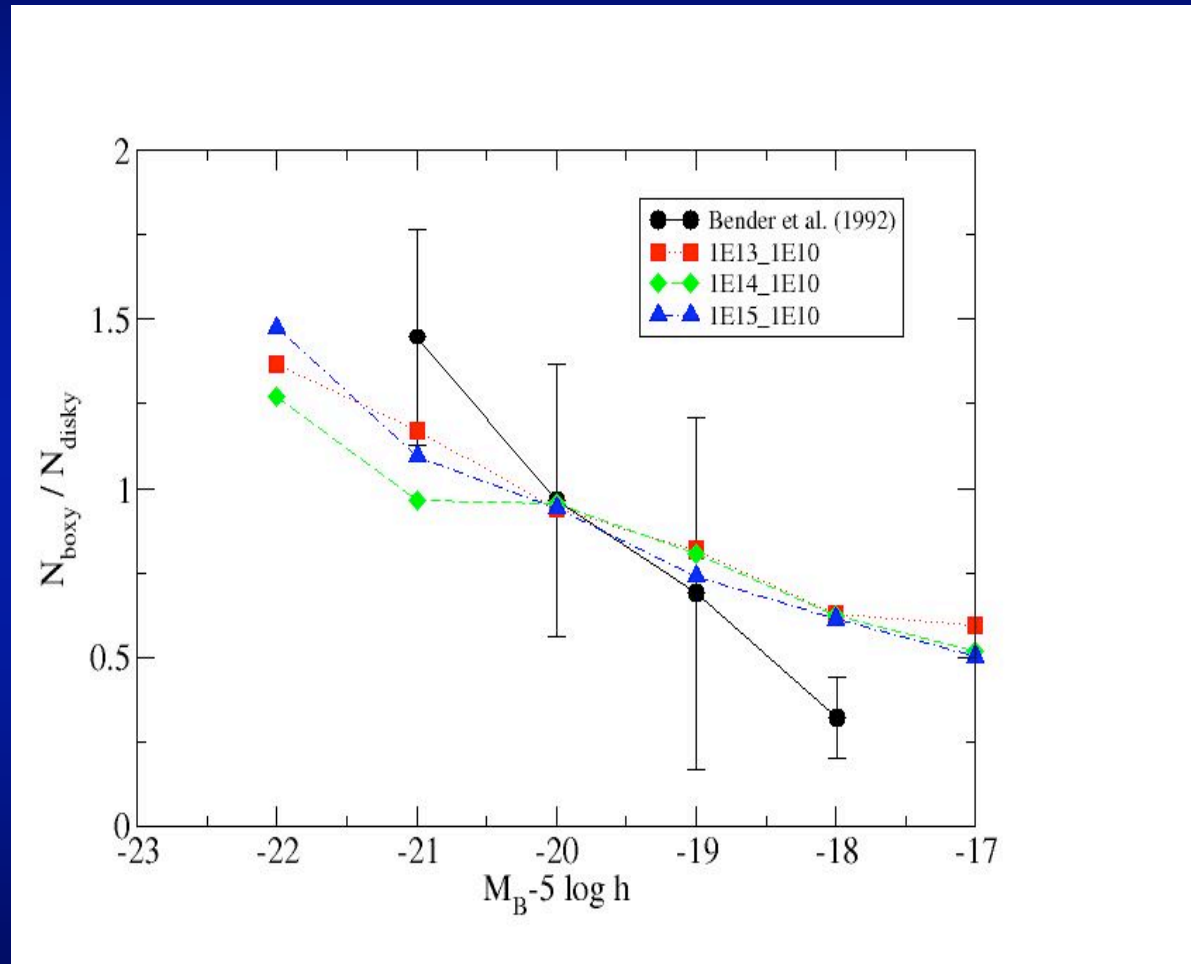


Khochfar & Burkert (2005)

Isophotal Shapes

Dry elliptical-elliptical
mergers => boxy

Reproduces right trend



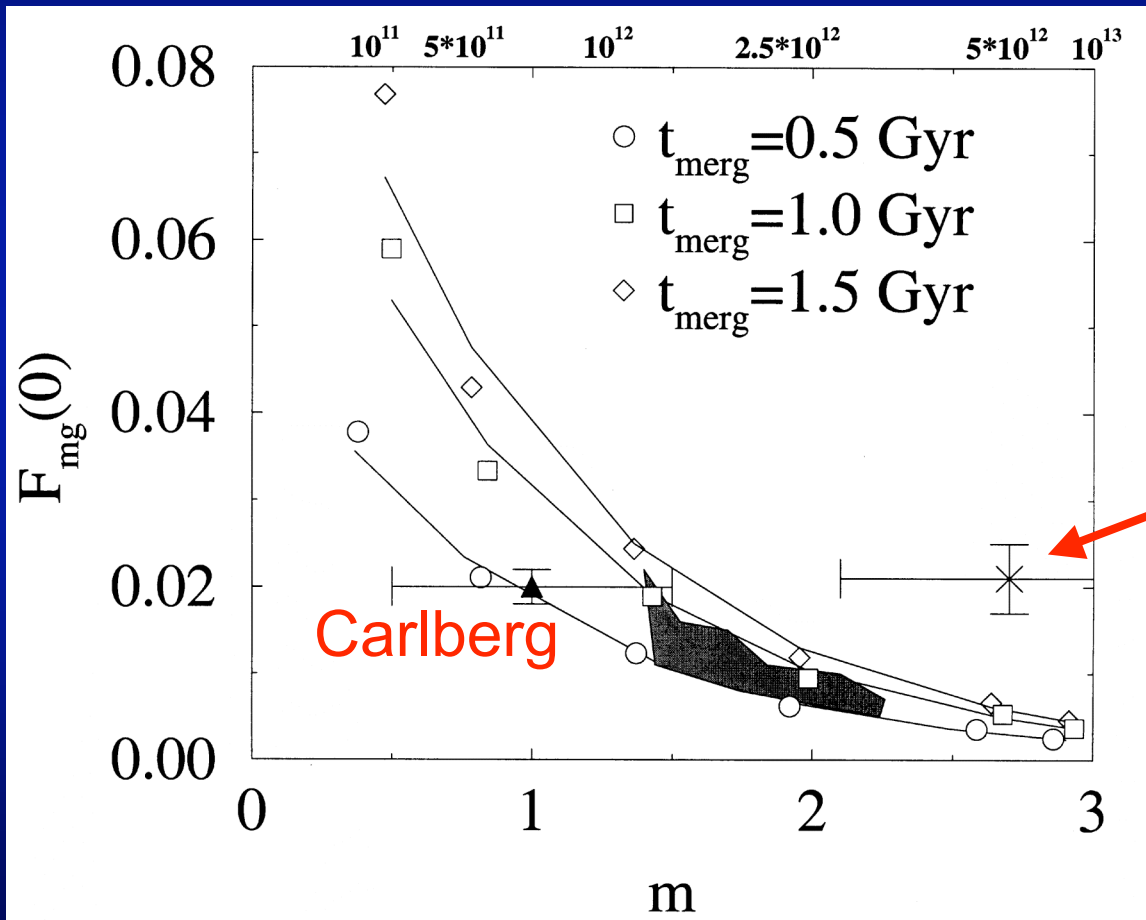
Khochfar & Burkert (2005)

Merger Rate

Field

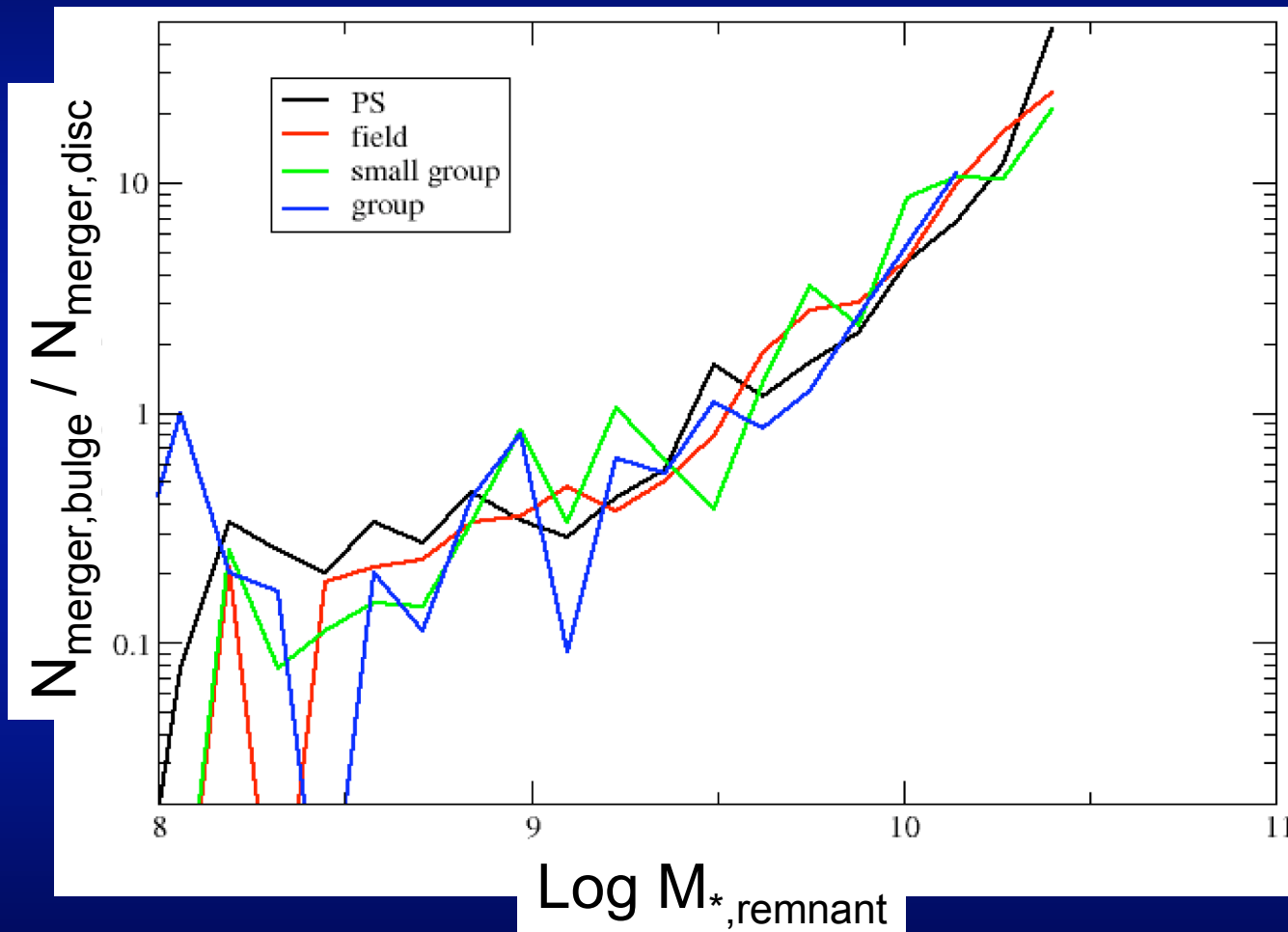
Environment

Group

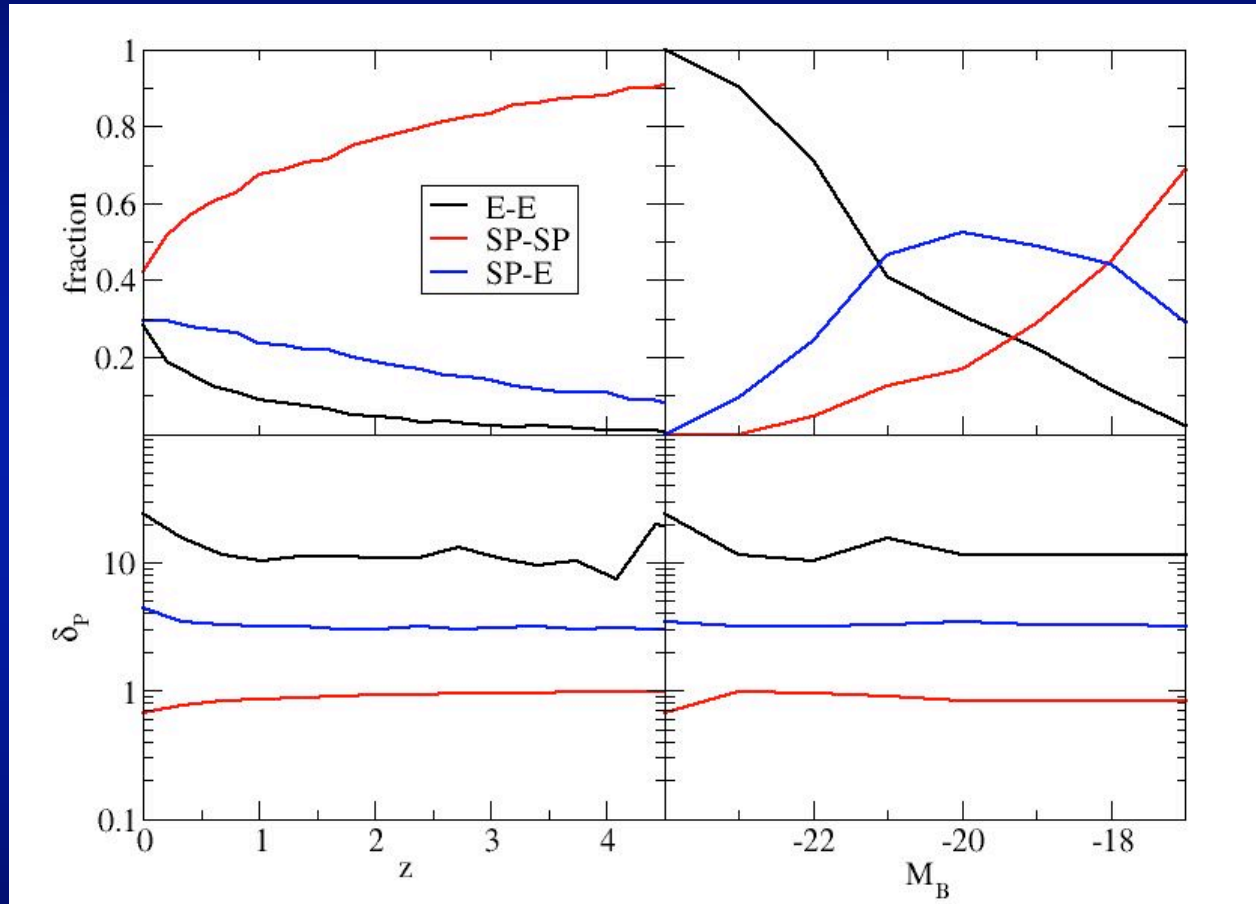


$$F_{mg}(z) = F_{mg}(0)(z + 1)^m$$

Dry Merger in Λ CDM

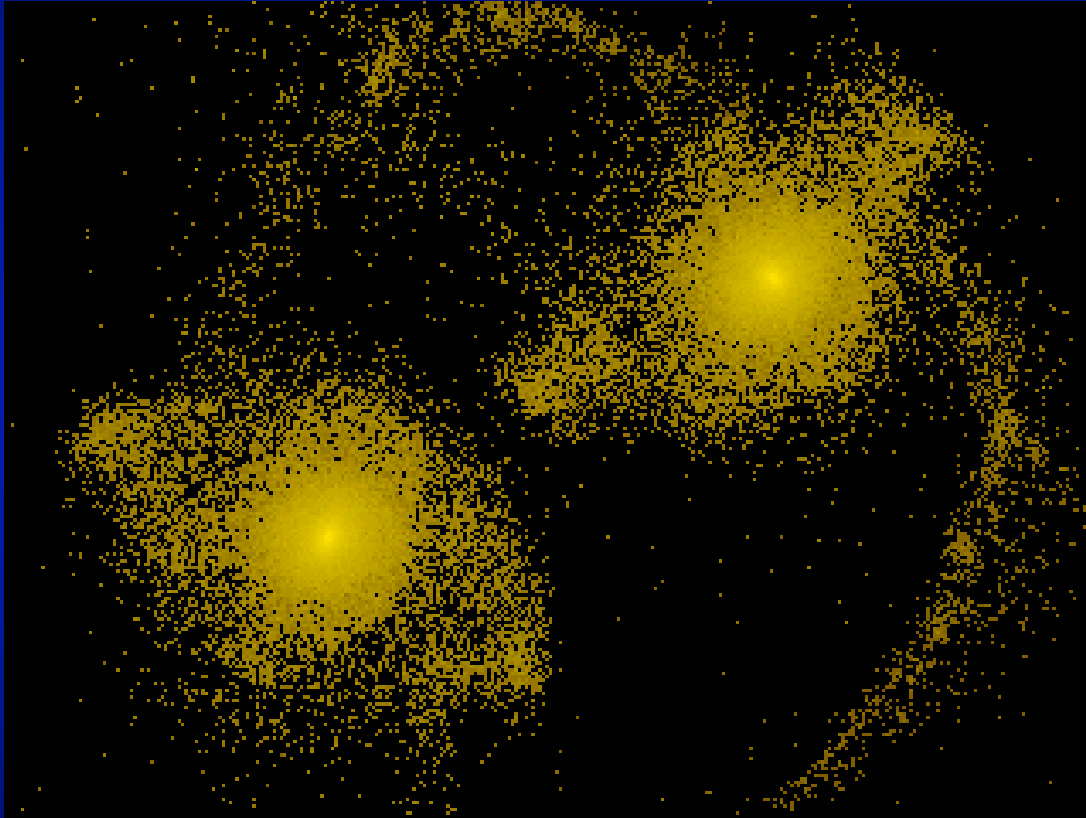


Dry Mergers in Λ CDM



Khochfar & Burkert (2003)

Dry Mergers

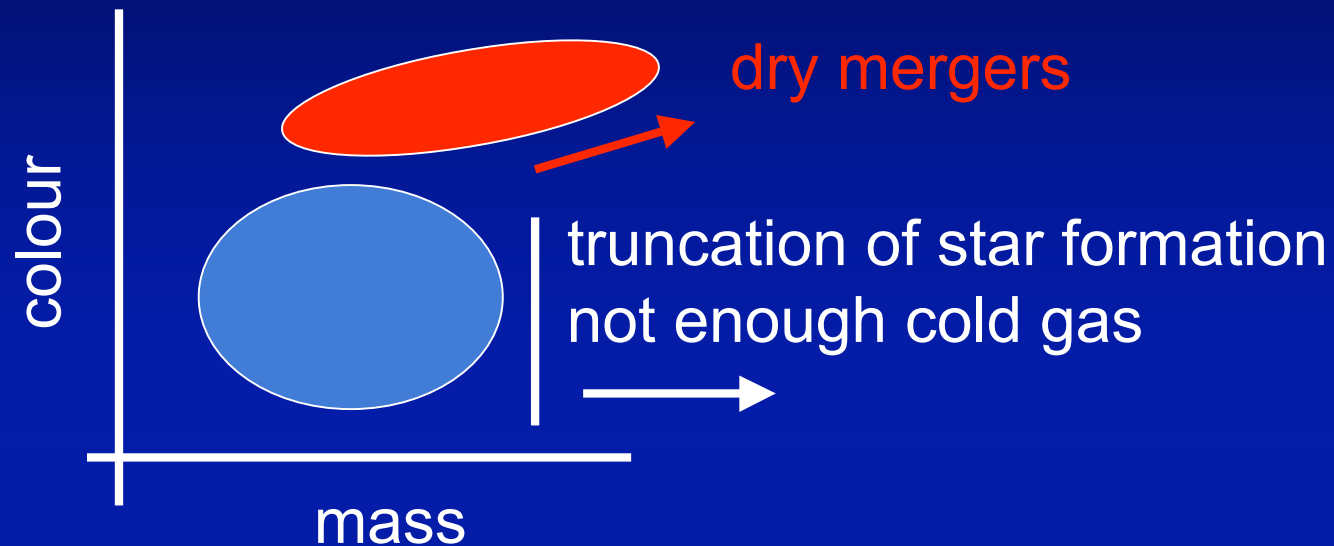


Simulation by Naab



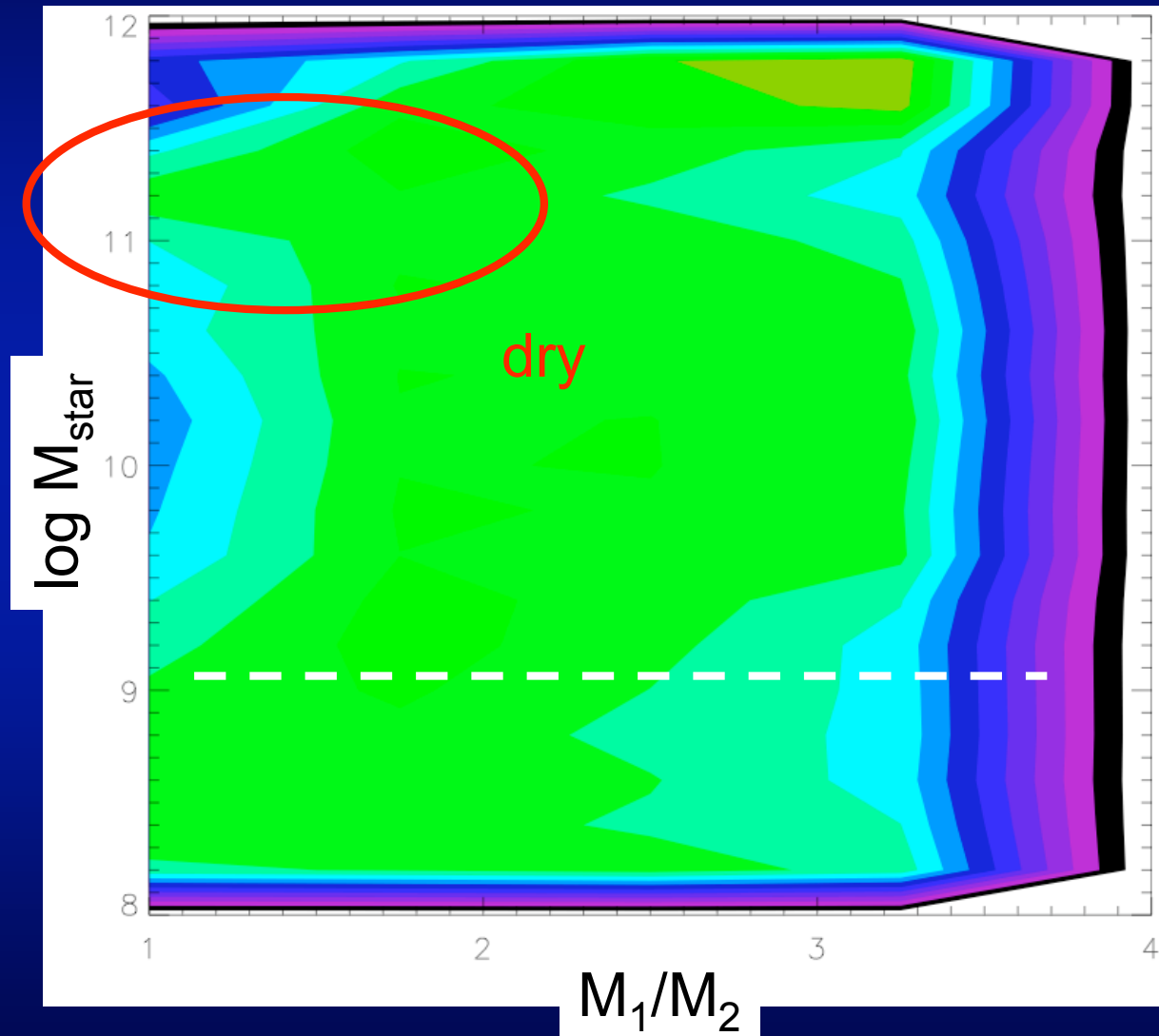
Van Dukkum et al. (2005)

Why should dry mergers occur?

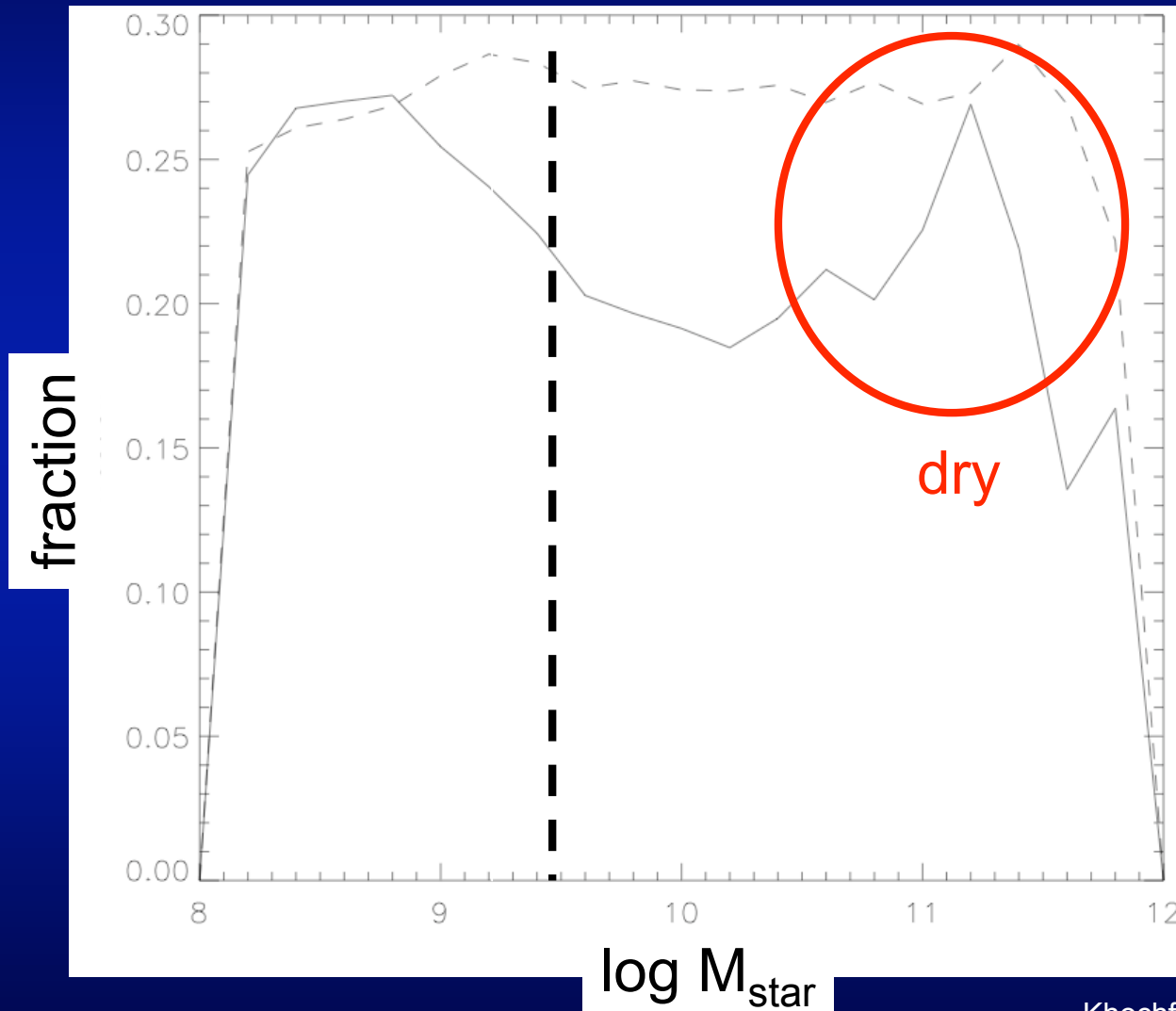


- **AGN feedback** (Croton et al. (2005); Bower et al. (2006); Ciotti & Ostriker (2007))
- **Environmental effects** (Khochfar & Ostriker (2007))
- **Shut-off mass scales** (Cattaneo et al. (2006))

Dry merger how to find them?

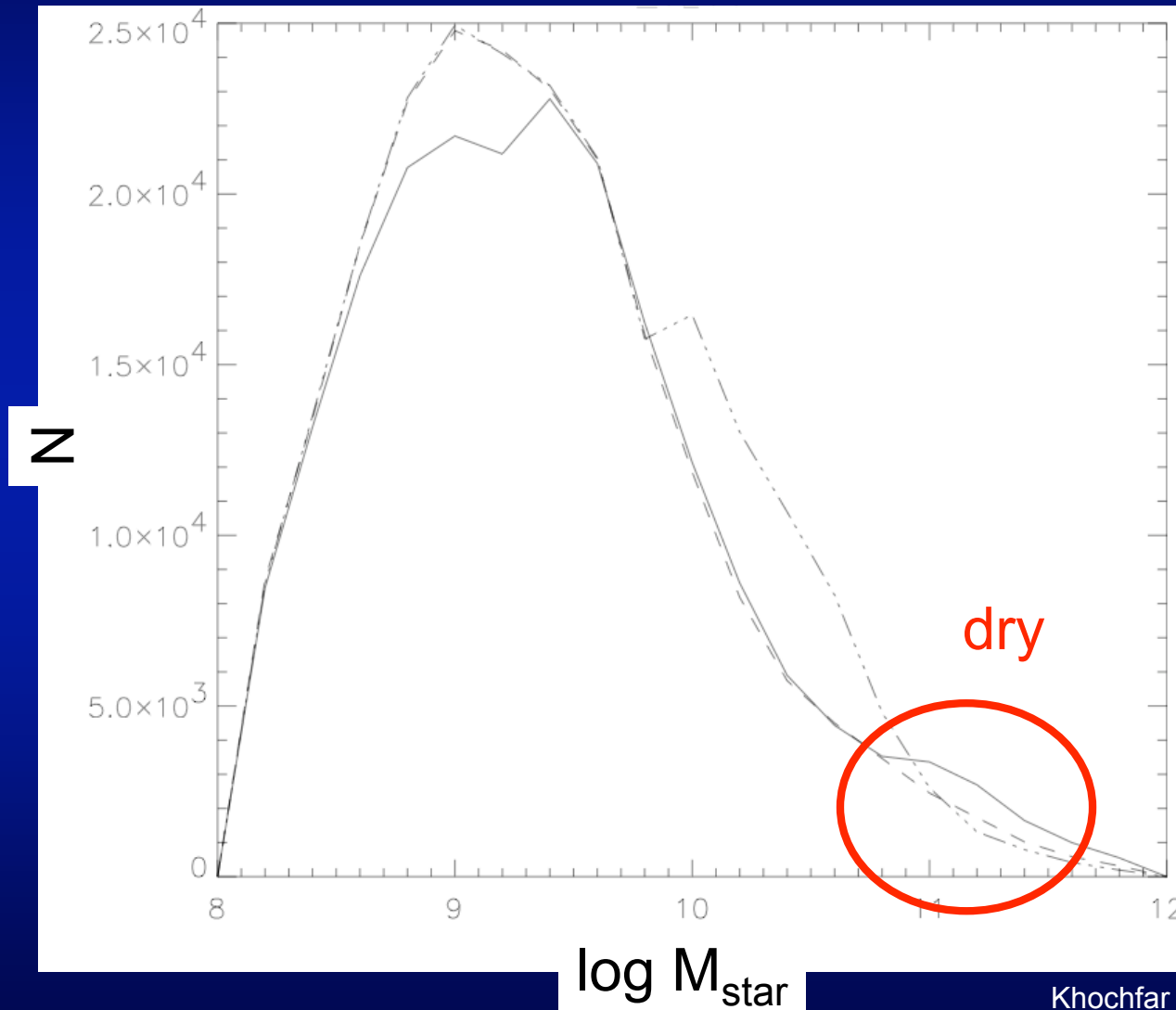


Dry merger how to find them?



Khochfar et al. (2007)

Dry merger how to find them?



Khochfar et al. (2007)

Summary

- Dry mergers are important for the most massive galaxies
- Dry mergers trace shutdown of star formation => give insight in the physical process behind it
- Enhanced equal mass mergers are a sign of dry mergers