Dynamical Properties of Galaxies with Different Morphological Types

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The Interplay between Local and Global Processes in Galaxies,

Cozumel

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MAGNETICUM

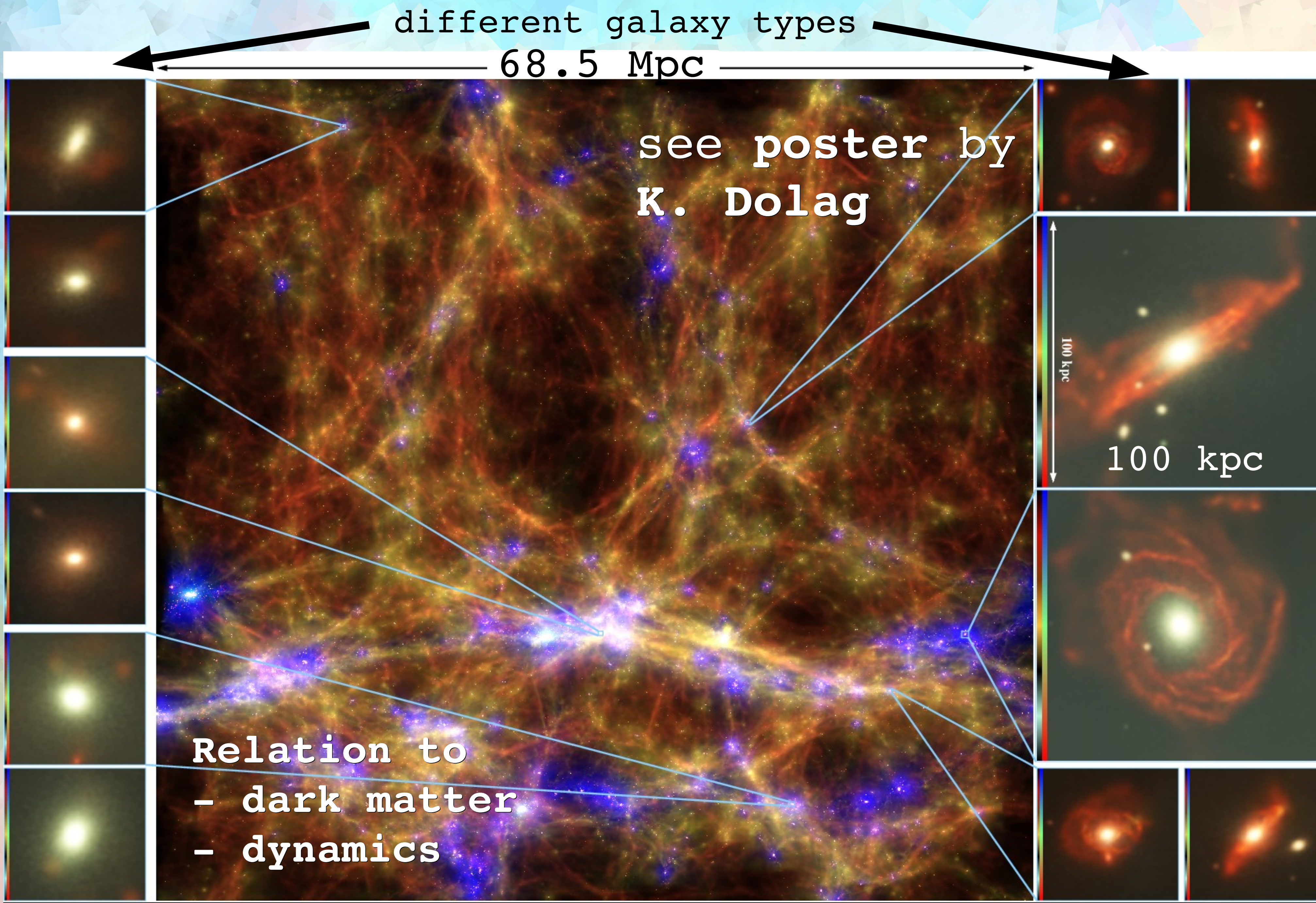
Leibniz-Rechenzentrum der Bayerischen Akademie der Wissenschaften

CAST Computational Astrophysics Group Munich University Observatory

C²PAP

Excellence Cluster Universe

The Magneticum Pathfinder Simulations



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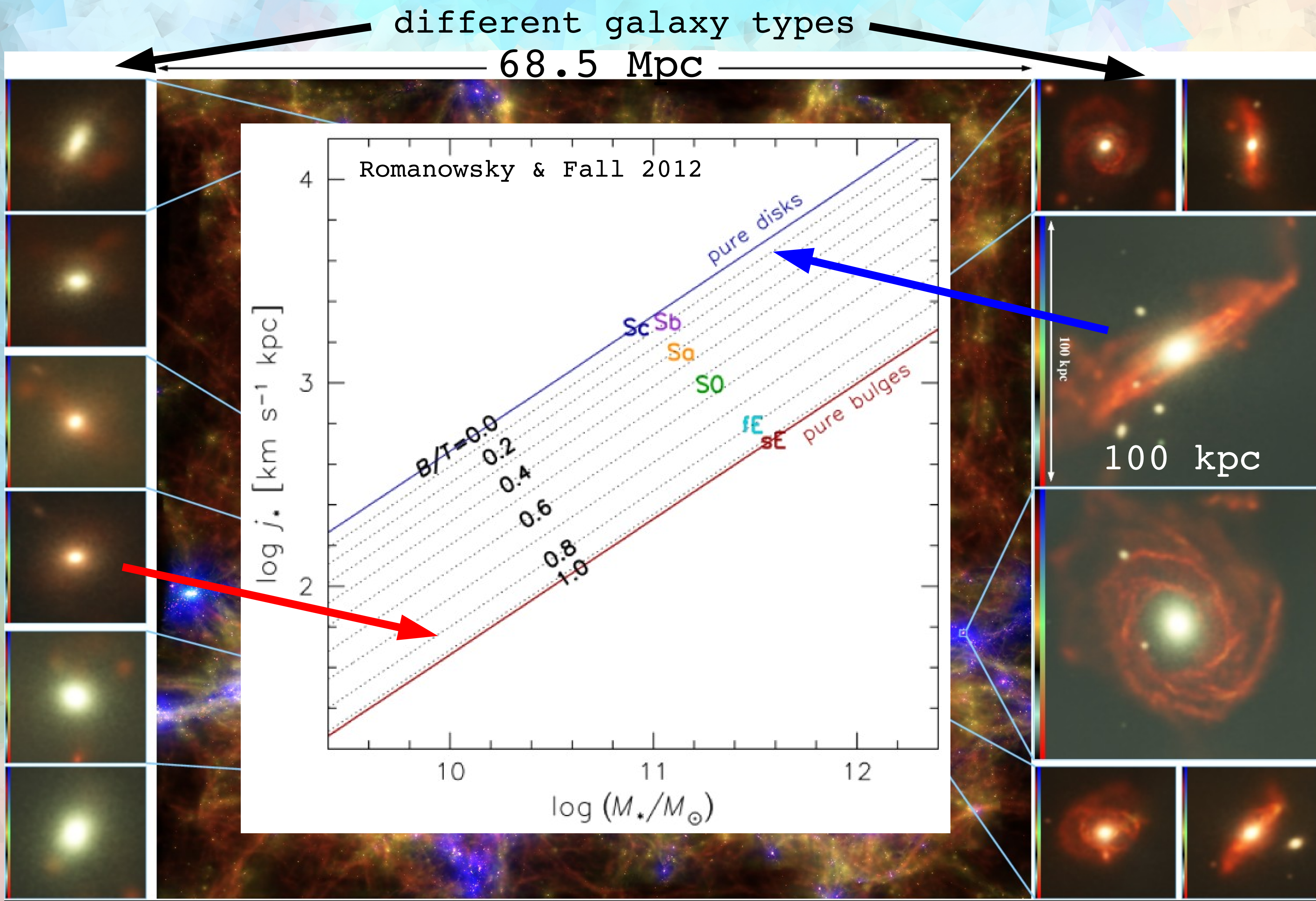

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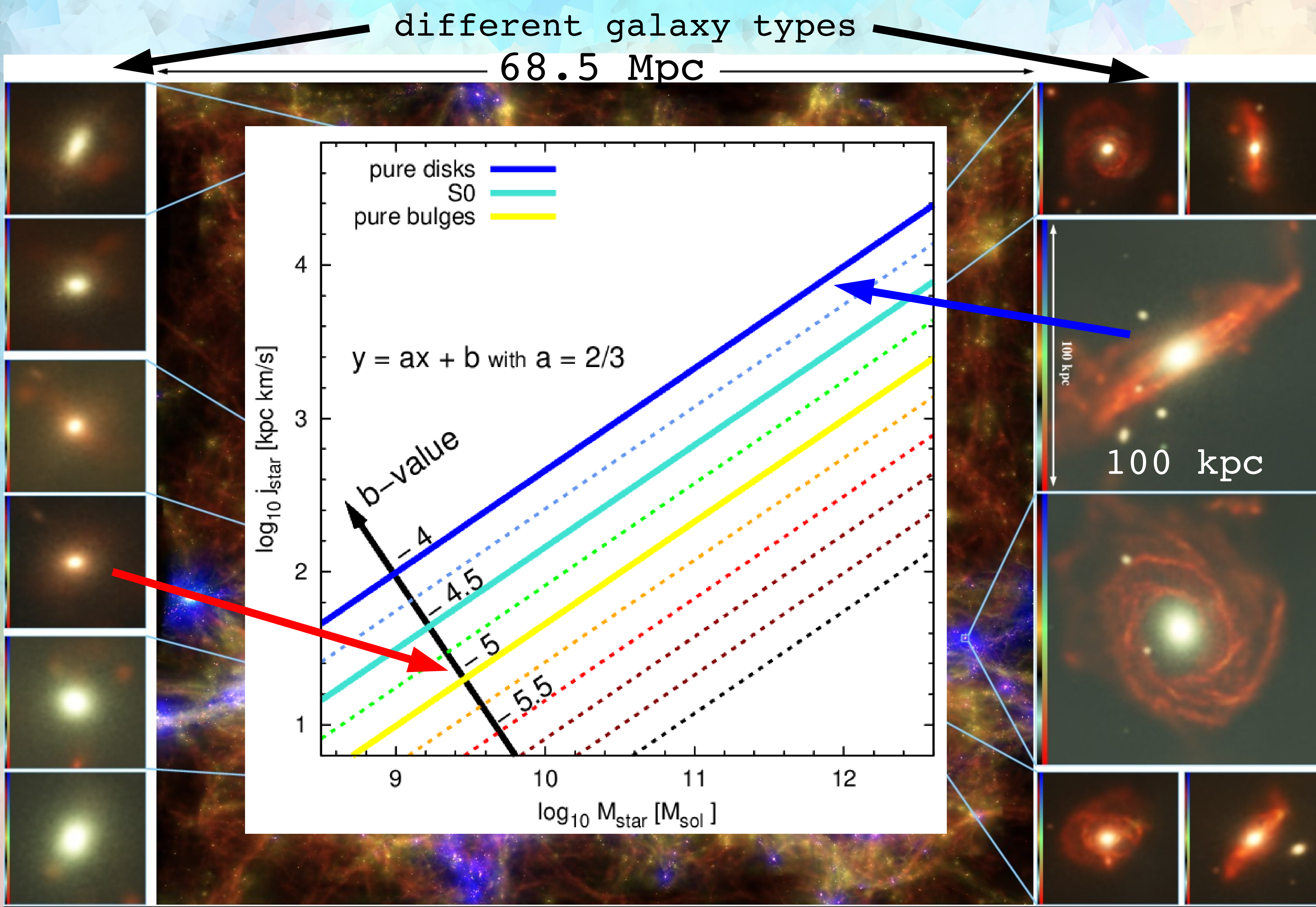
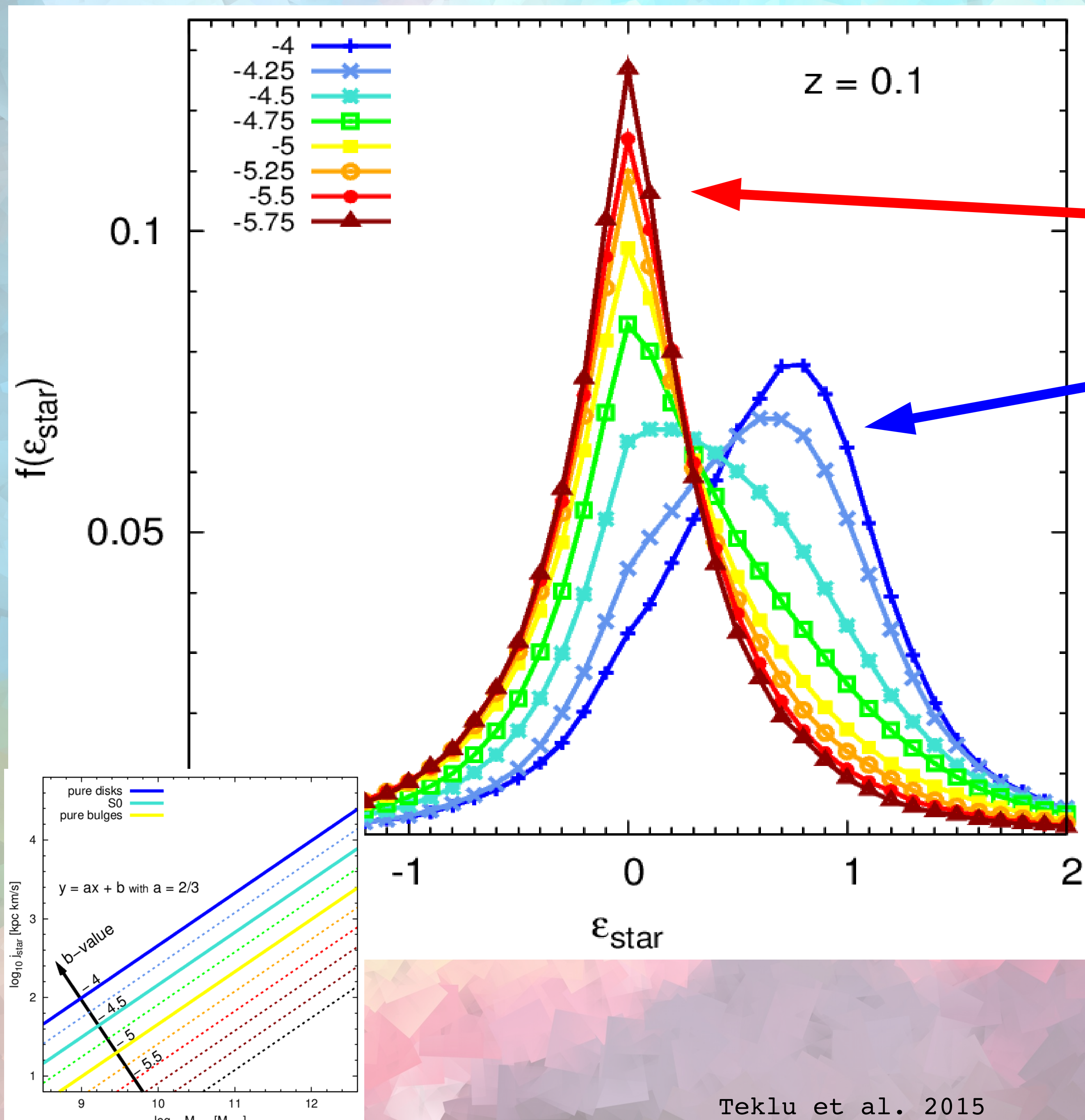


Classification

$$\varepsilon = \frac{j_z}{j_{\rm circ}} = \frac{j_z}{r V_{\rm circ}}$$

$$V_{\rm circ} = \sqrt{GM(r)/r}$$



ε = 0 → dispersion dominated

ε = 1 → rotation dominated

(e.g. Scannapieco et al. 2008)

Teklu et al. 2015

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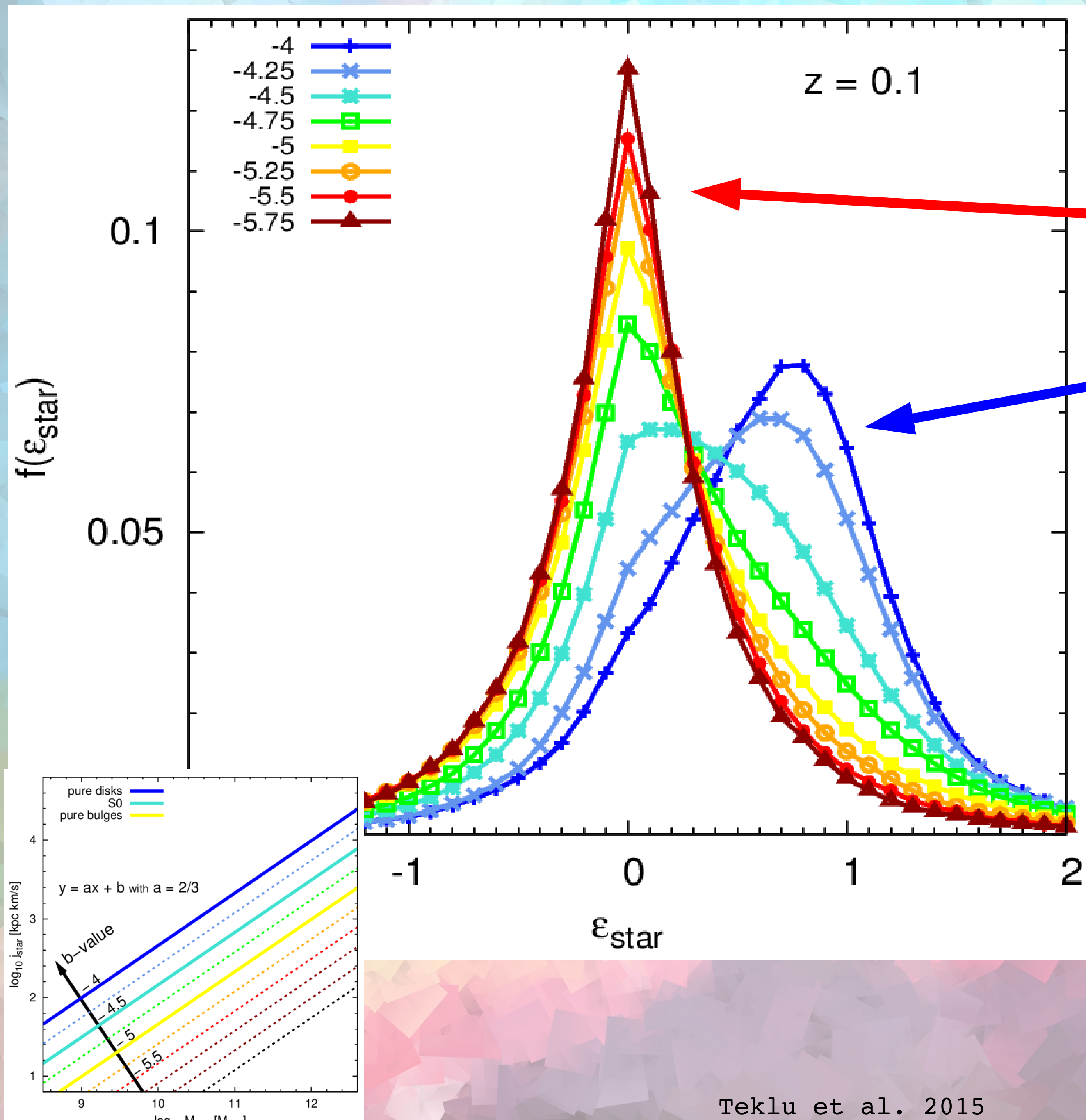

Teklu et al. 2015

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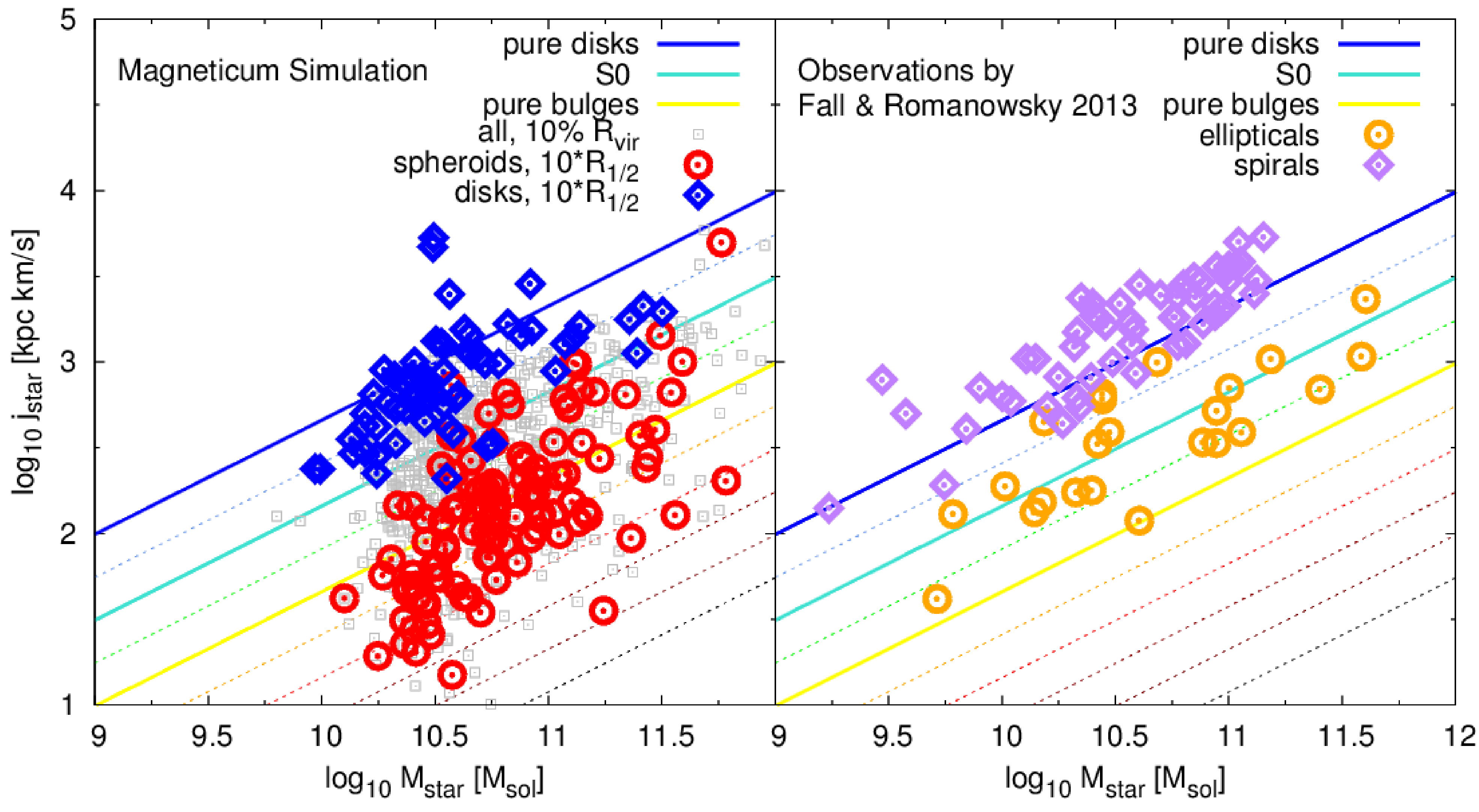
Criteria at z=0.1:

$f(|\varepsilon| \leq 0.4) \geqslant 0.6$ and $M_{\rm coldgas}/M_{\rm star} \leq 0.065$ → **Speroid**

$f(\varepsilon \geq 0.7) \geq 0.4$ and $M_{\rm coldgas}/M_{\rm star} \geq 0.215$ → **Disk**

Comparison to Observations

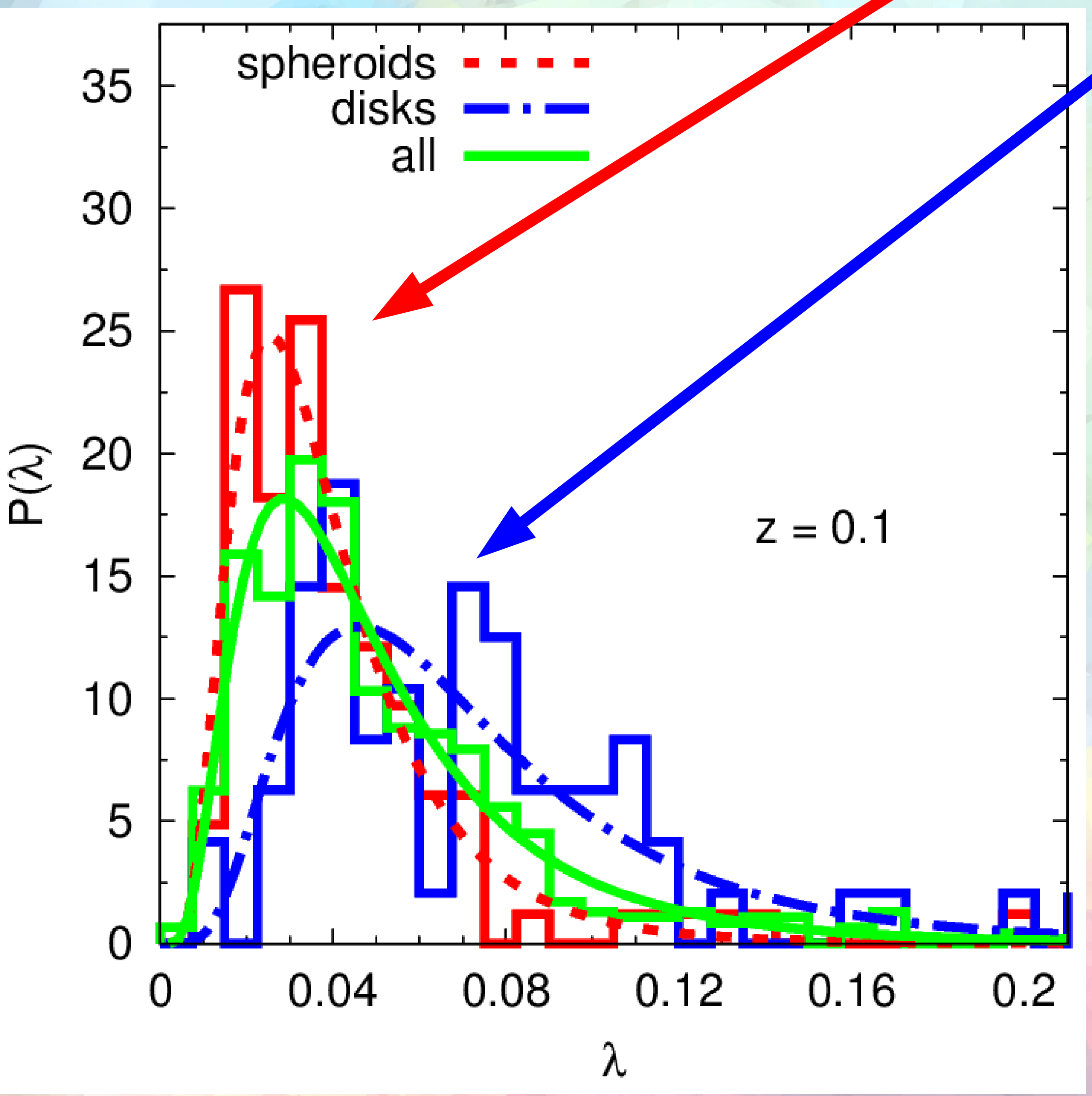
Simulation **Observation**



Spin Parameter of Host Halo

(including all components - DM, gas & stars)

Split-up into **spheroids** and **disks**!



$$\lambda = \frac{J\,|E|^{1/2}}{GM^{5/2}}$$

$$E = -GM^2/2\,R_{\rm vir}$$

(Peebles 1969/71, Mo et al. 1998)

Teklu et al. 2015

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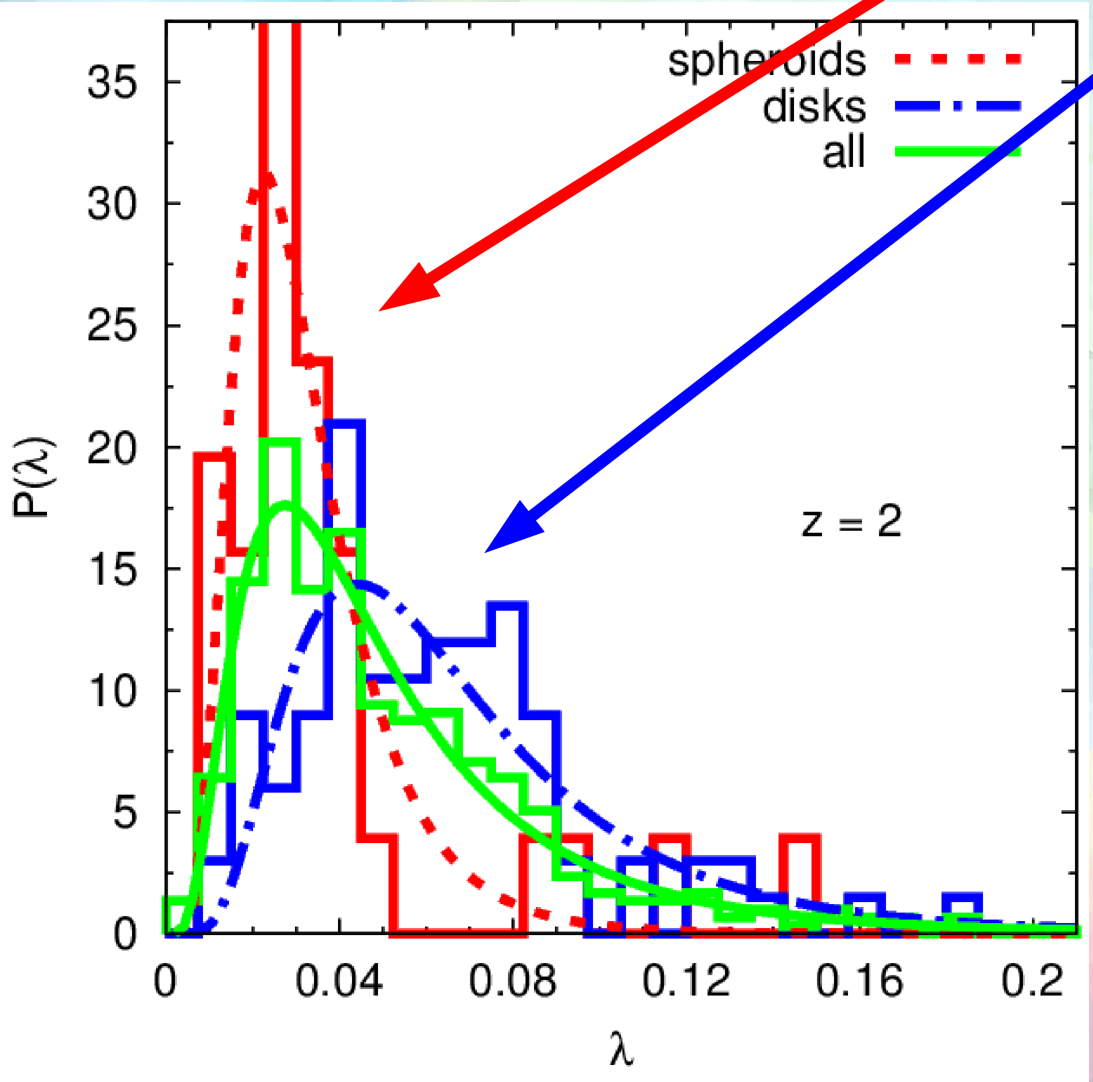

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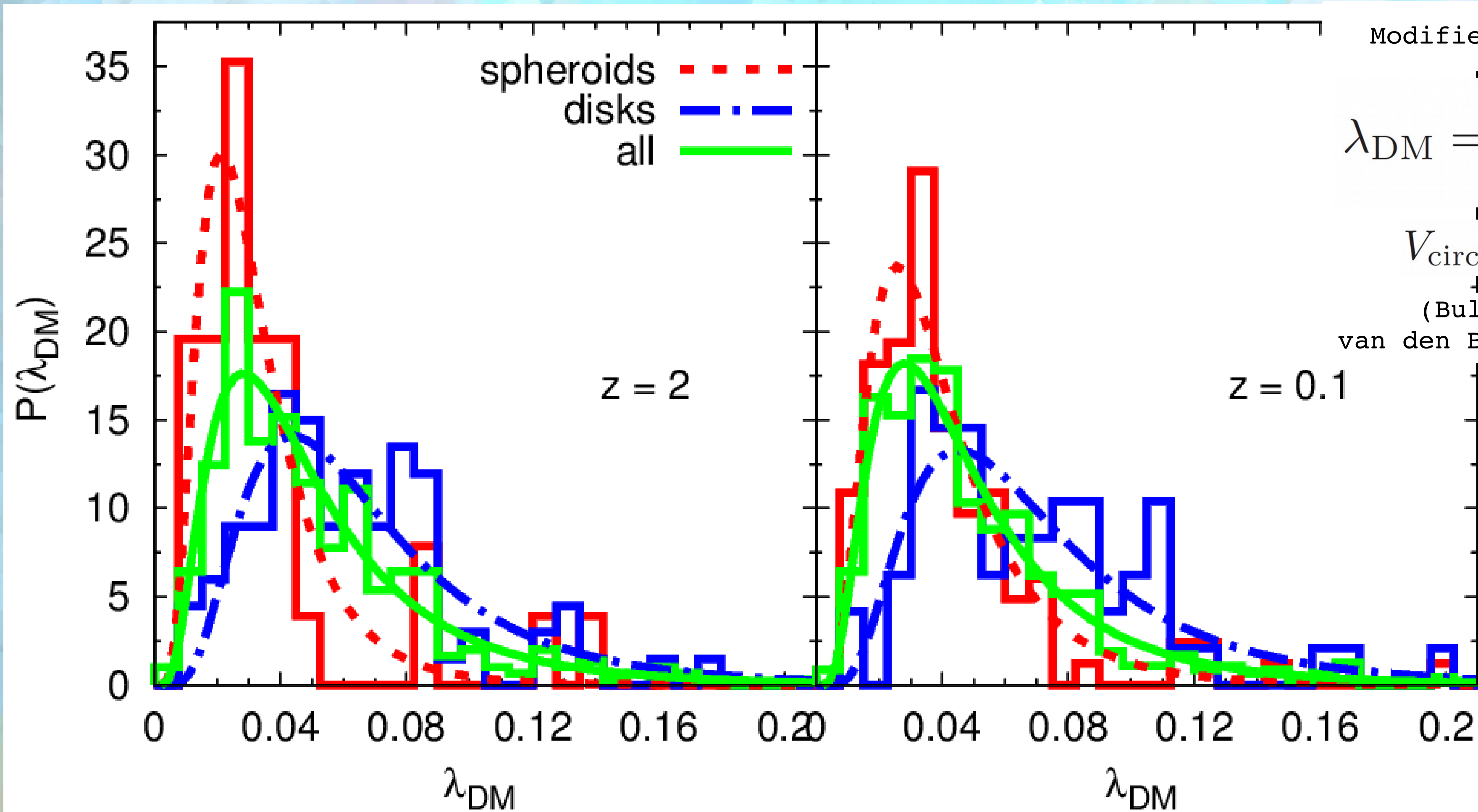
Already present at *z* = 2 !

Teklu et al. 2015

Spin Parameter of the DM-component



Modified Spin Parameter:

$$\lambda_{\rm DM} = \frac{j_{\rm DM}}{\sqrt{2} R_{\rm vir} V_{\rm circ}}$$

$$V_{\rm circ} = \sqrt{GM/R_{\rm vir}}$$

(Bullock et al. 2001, van den Bosch et al. 2002)

Implications:

- interplay between baryons and DM

or

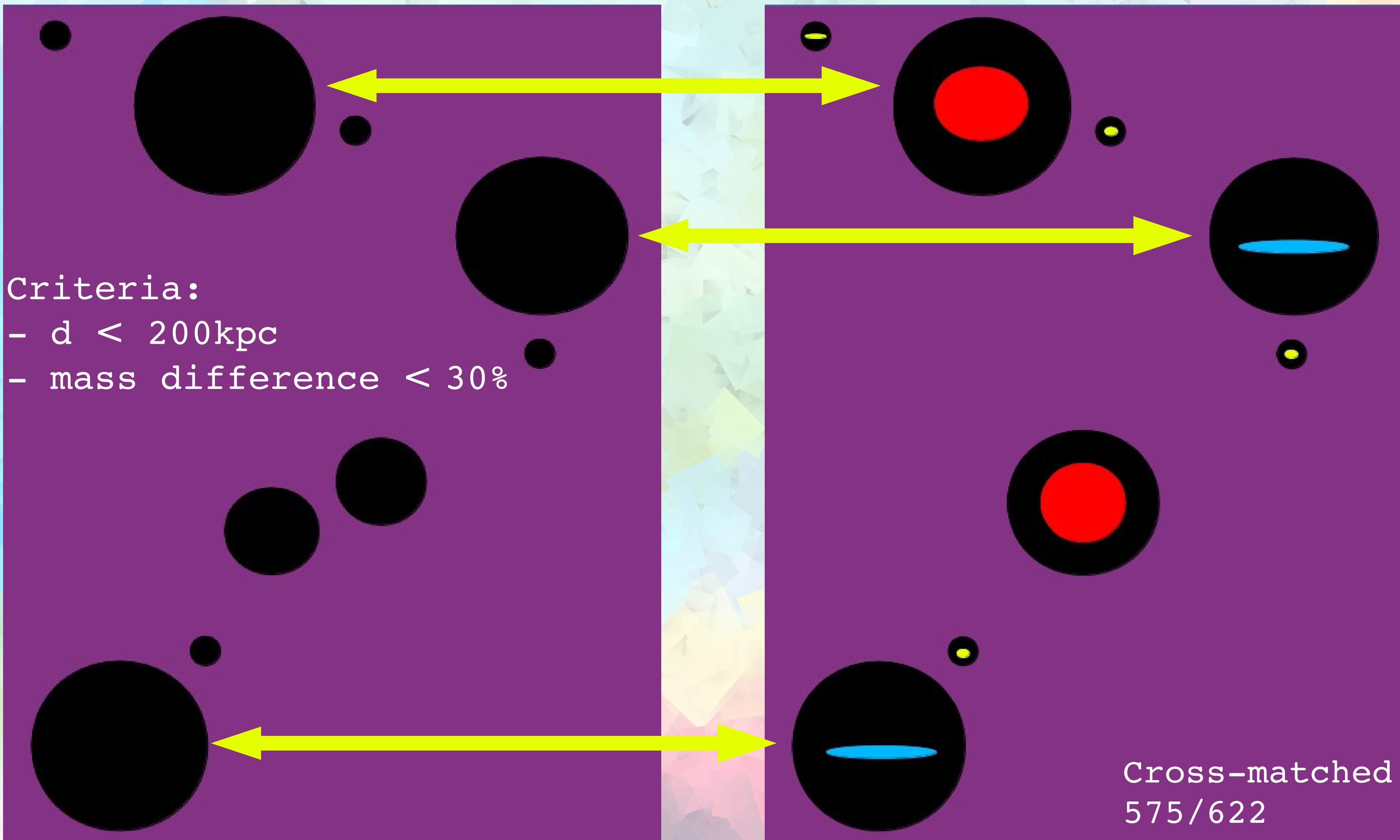
- due to different formation histories

Teklu et al. 2015

Cross-Matching Halos DM-only vs. Hydro

DM-only run

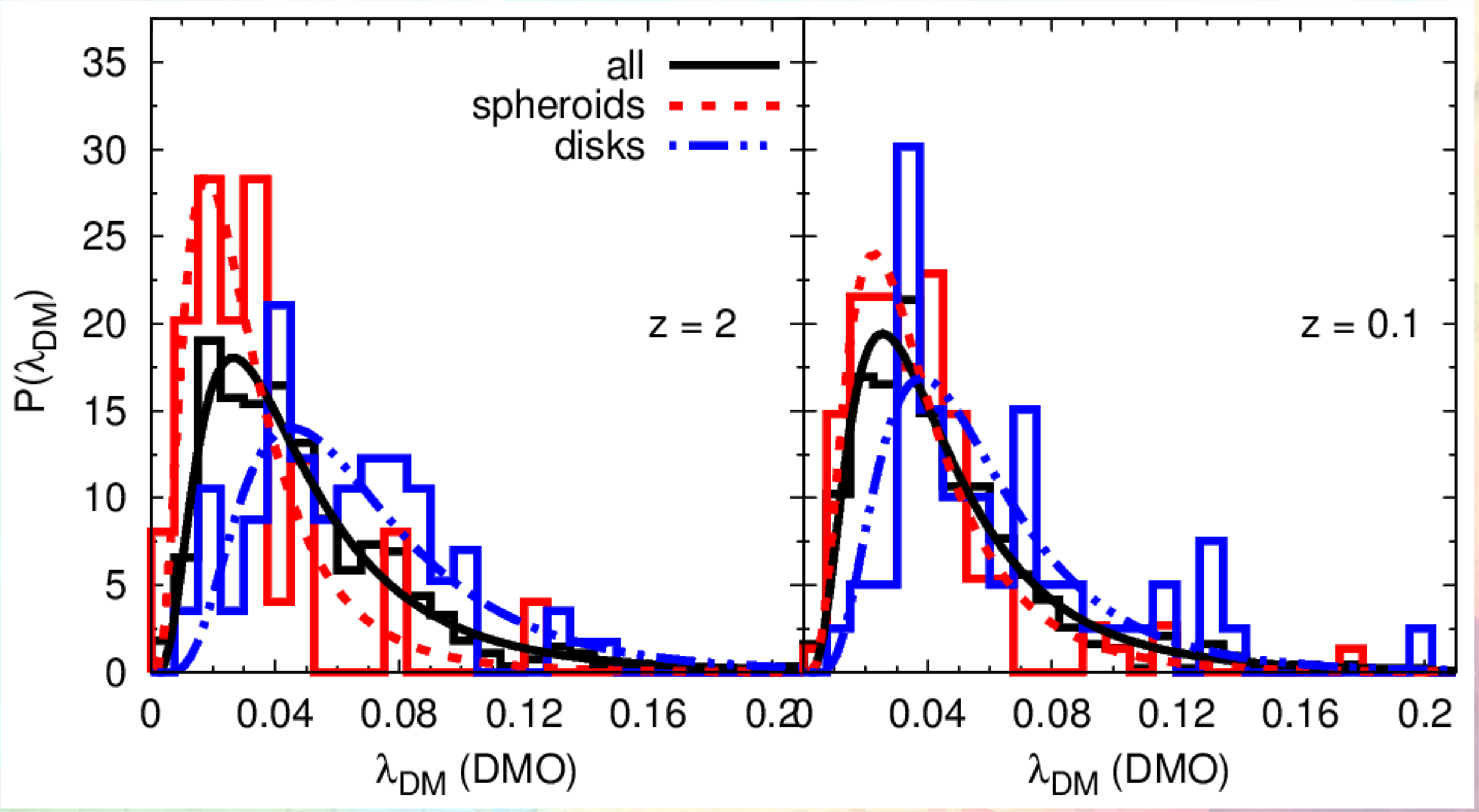
Hydro run



λ

classification

Spin Parameter of DM-only Halos



Even here is a split-up of different galaxy types
→ morphology a result of formation history/environment?

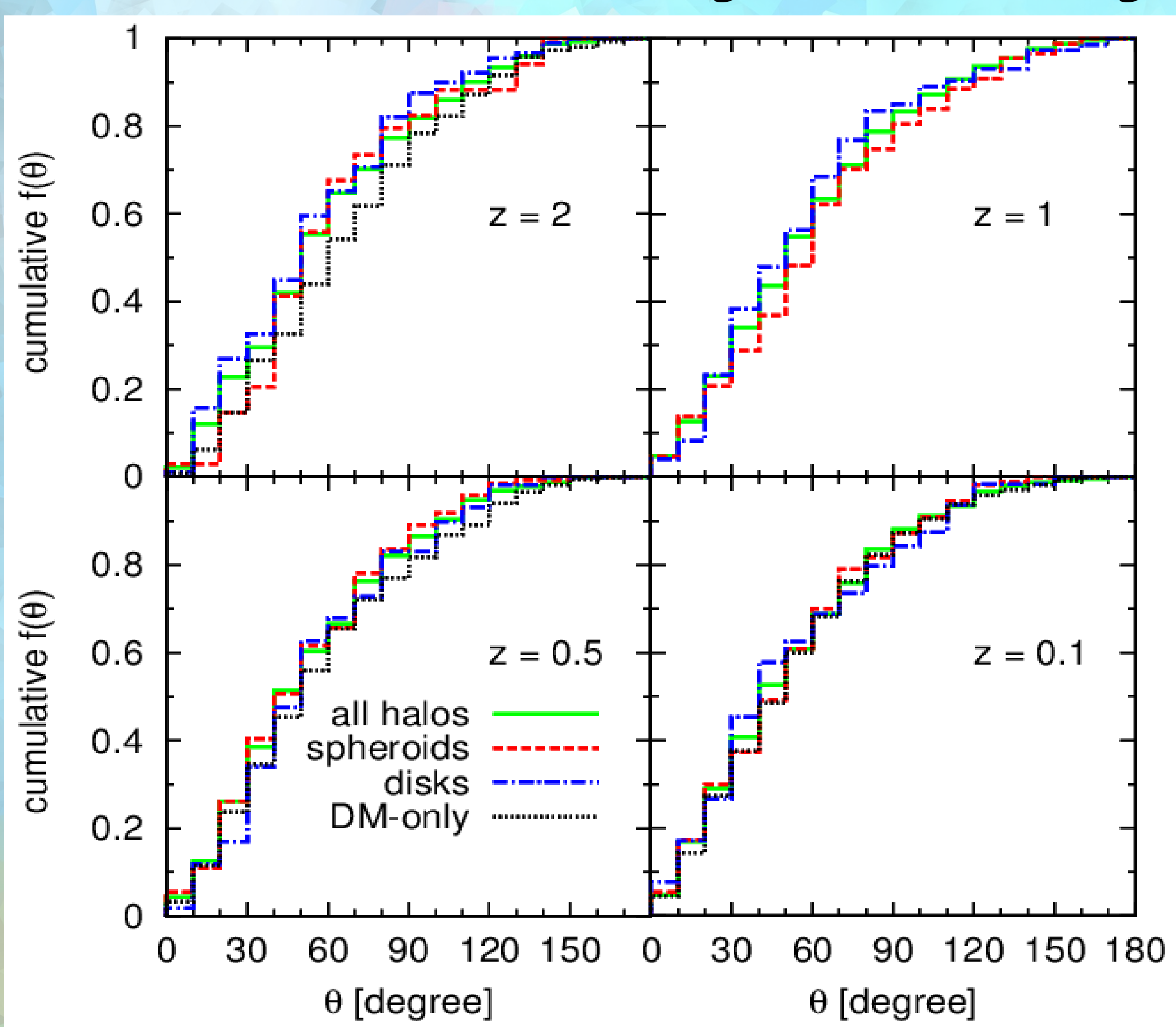
Teklu et al. 2015

Summary and Conclusion

- Our simulated disks and spheroids populate different regions in the M_{star}-j_{star}-plane, in agreement with observations
- Disks have higher median spin parameter compared to spheroids
- There are also spheroids with high λ (for detailed study see Schulze et al., in prep.)
- Even in DM-only a split-up of λ-distribution

→ Formation history and environment shape simultaneously galaxy type and halo

Alignment Angles



$$\cos(\theta) = \frac{\boldsymbol{J}_i \cdot \boldsymbol{J}_j}{|\boldsymbol{J}_i| \cdot |\boldsymbol{J}_j|}$$

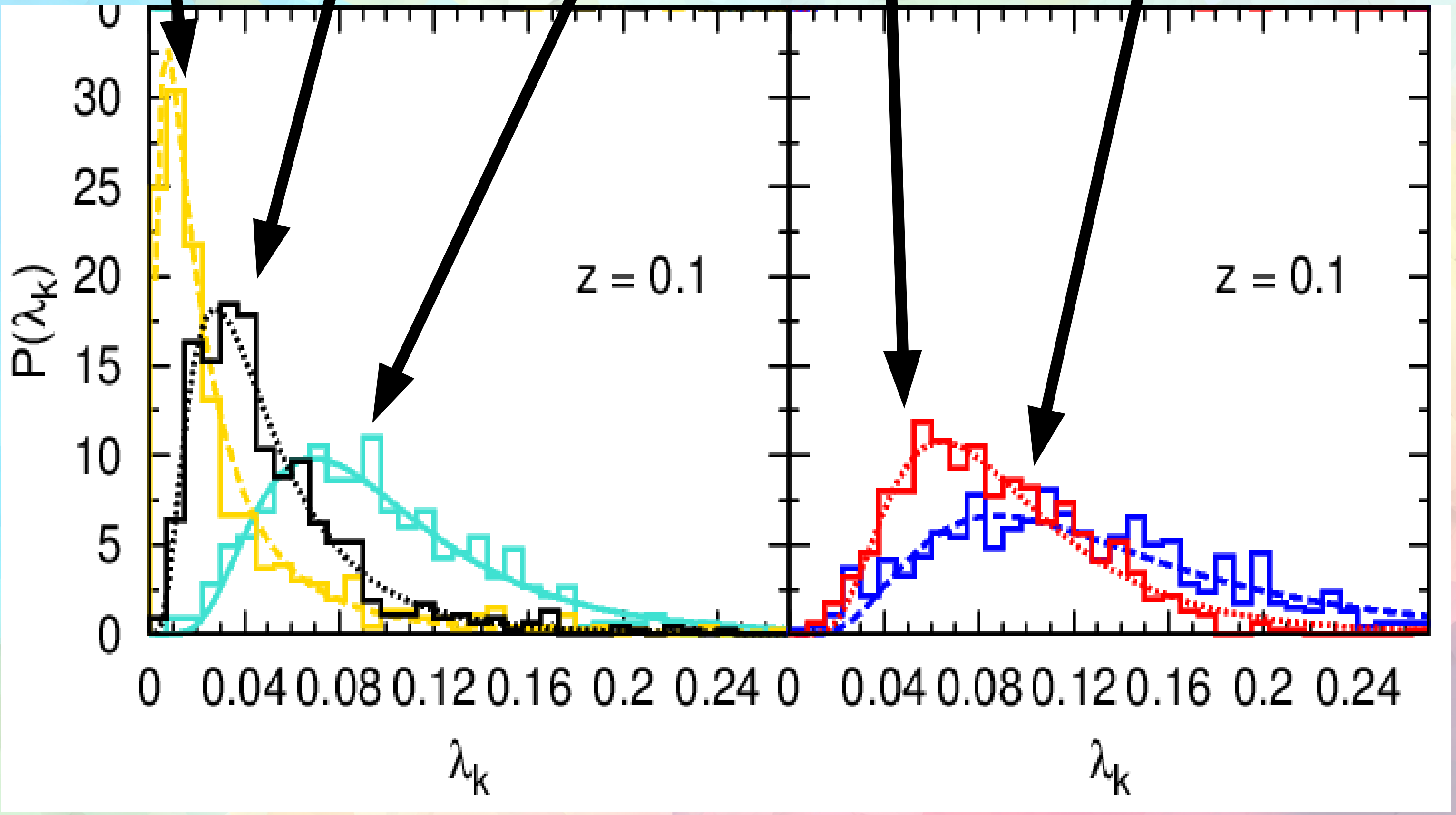
In the hydro run DM components (inner part with total halo) are better aligned than in DM-only run → influence of baryons on DM

Teklu et al. 2015

Spin Parameter of Different Components

Split-up of:

stars, DM and **gas** | **hot** and **cold** gas



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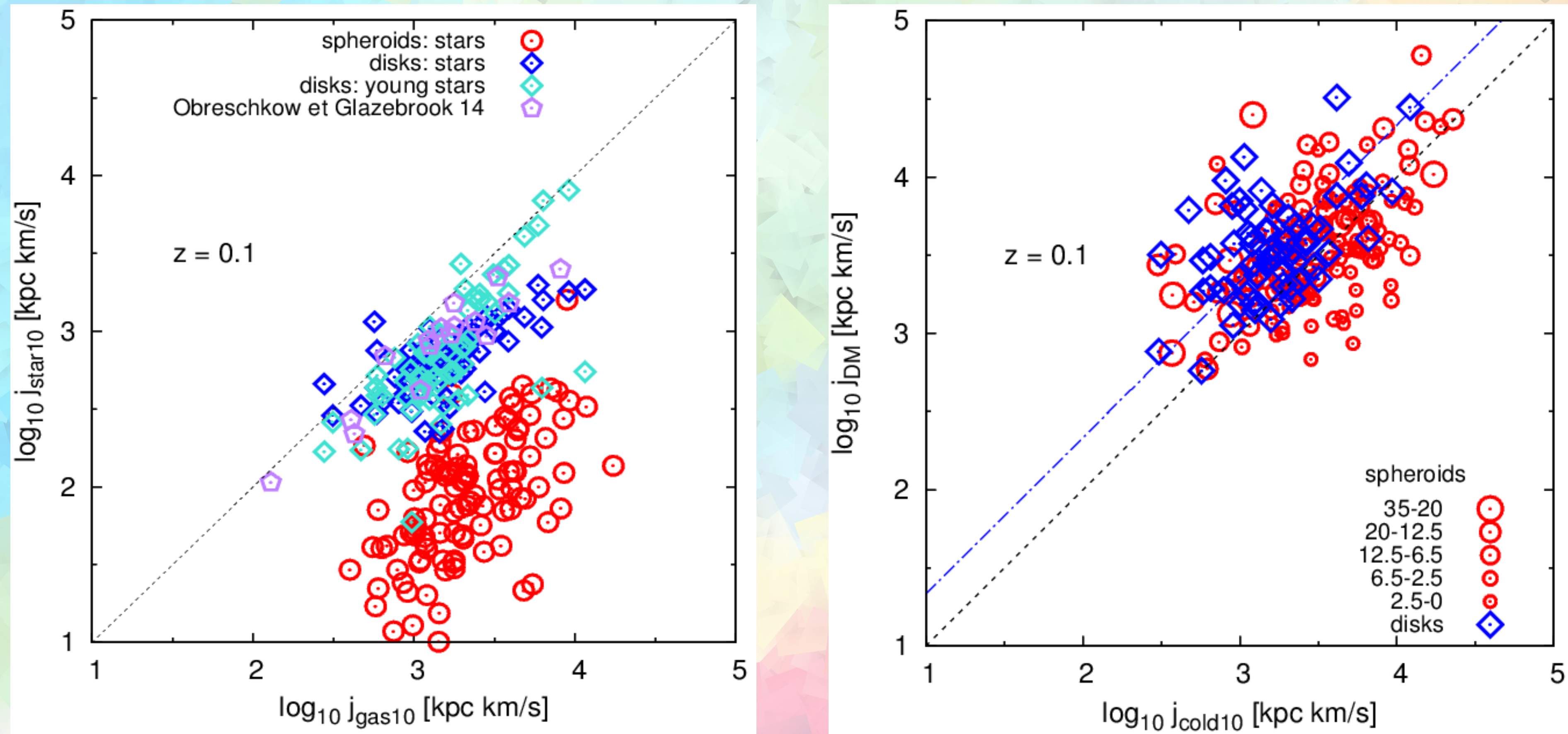
how disk components (stars and gas) trace,
how halo and disk (dm and gas) trace...



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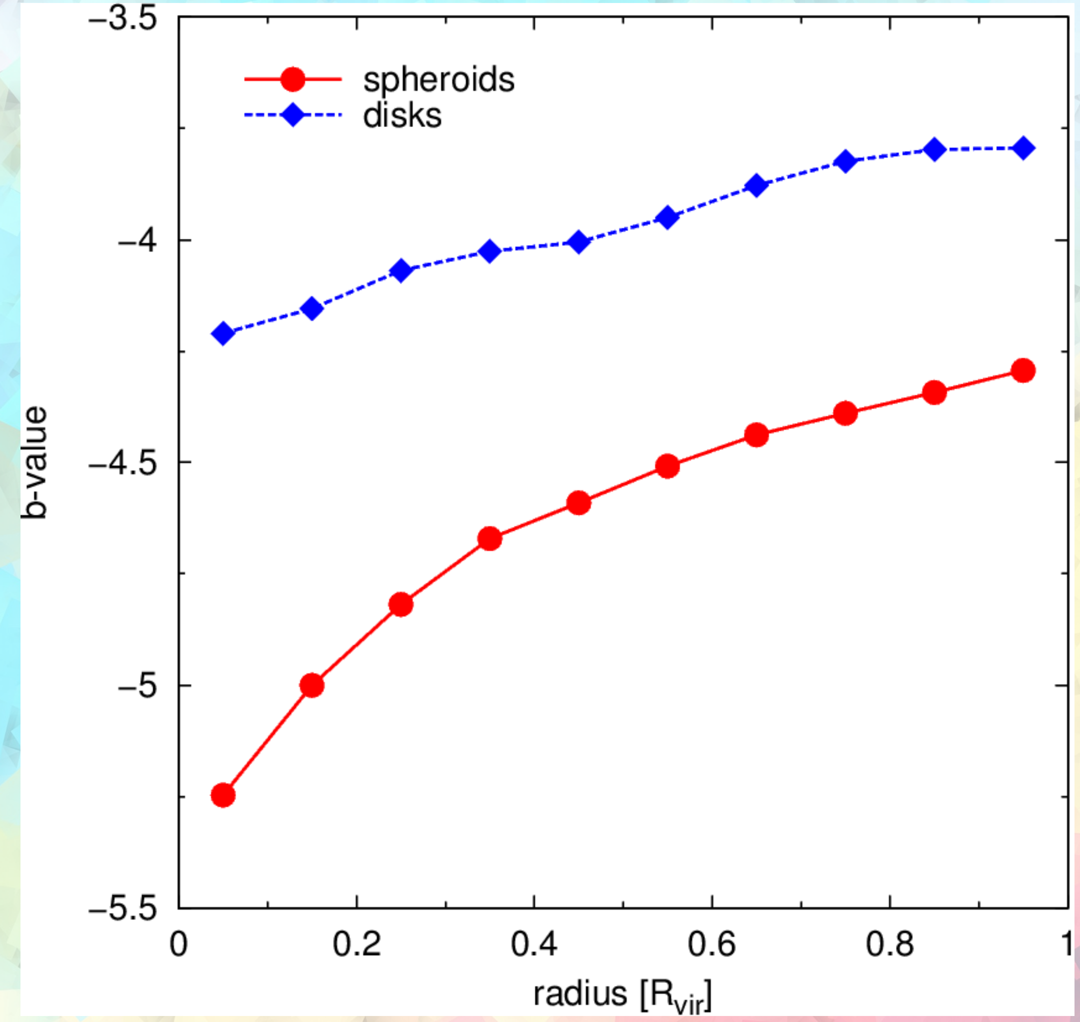
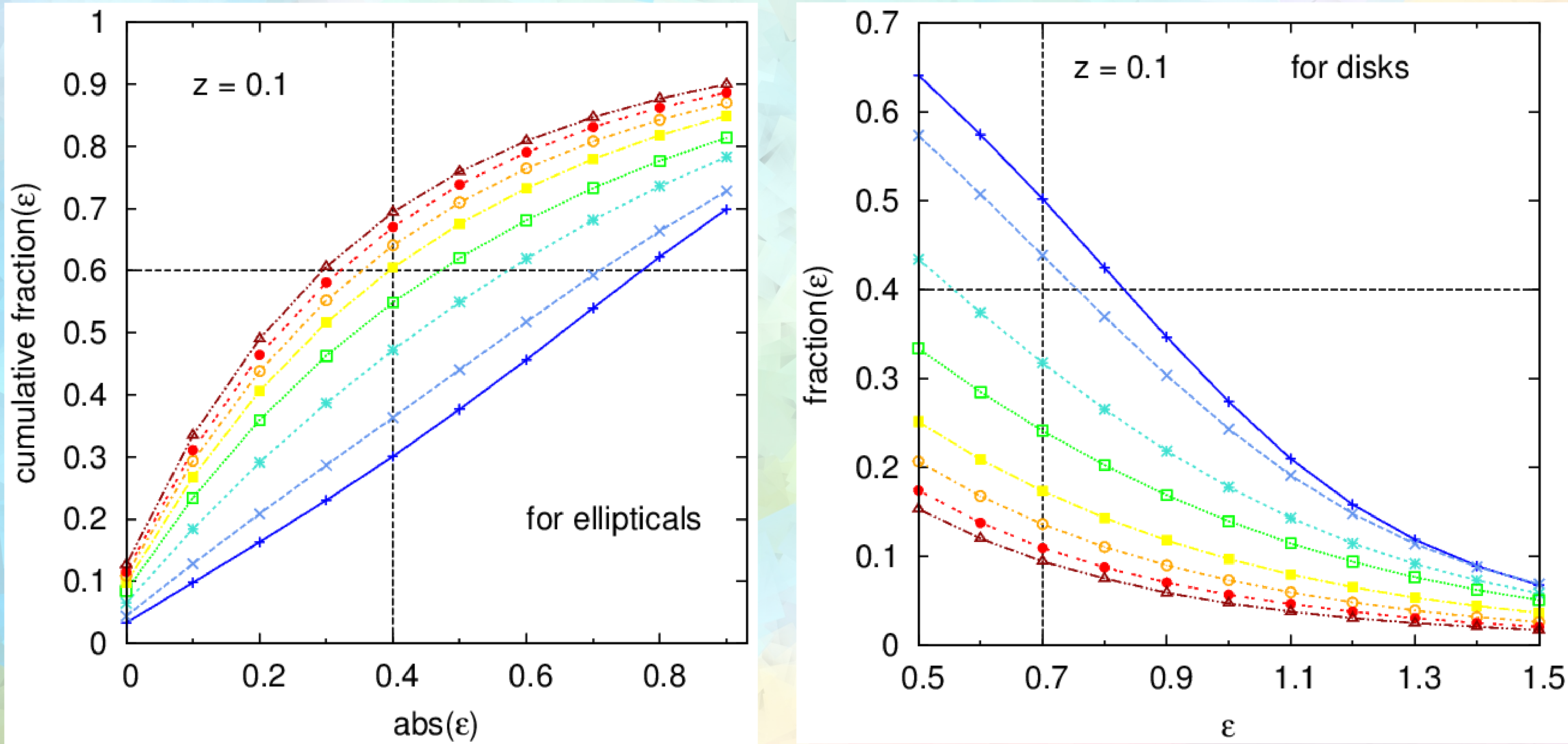
The Dependence of the b-value on Radius



For spheroidal galaxies the measurment of the b-value is strongly **radius-dependend**

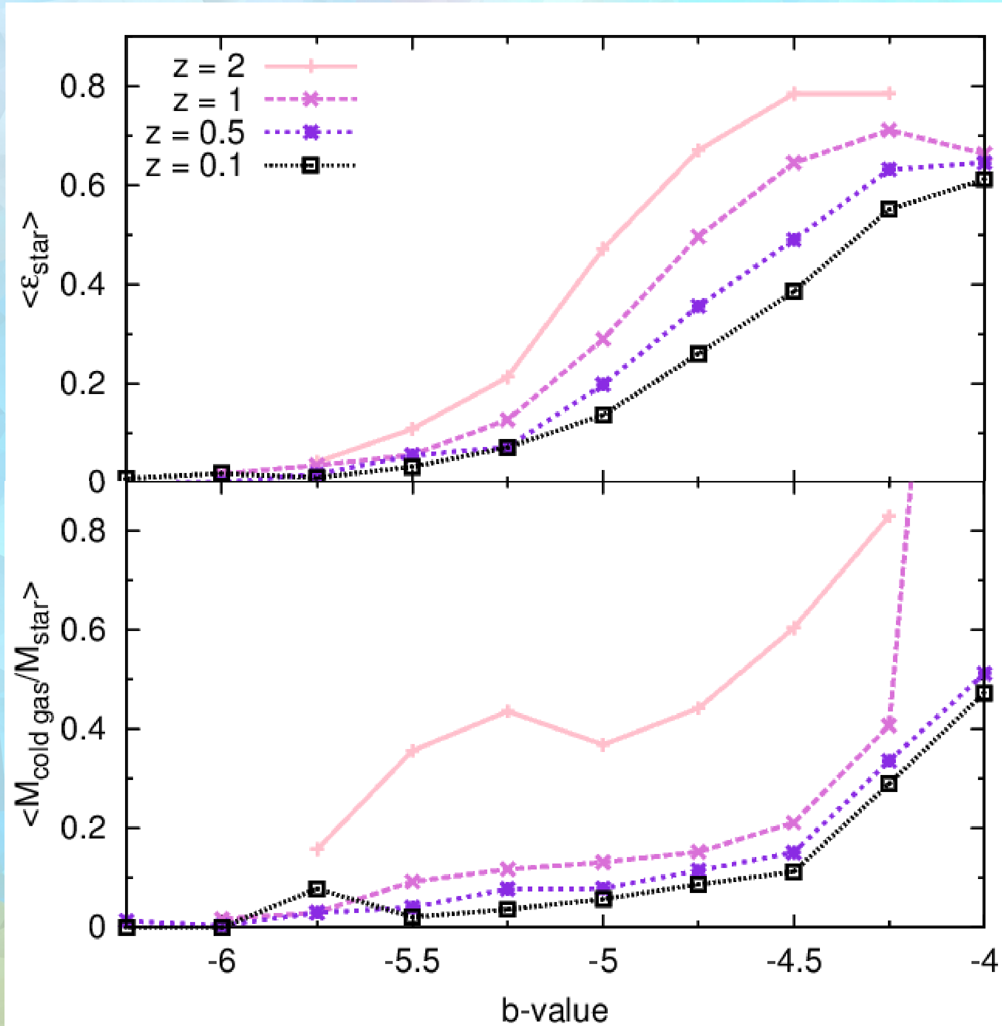
Teklu et al. 2015

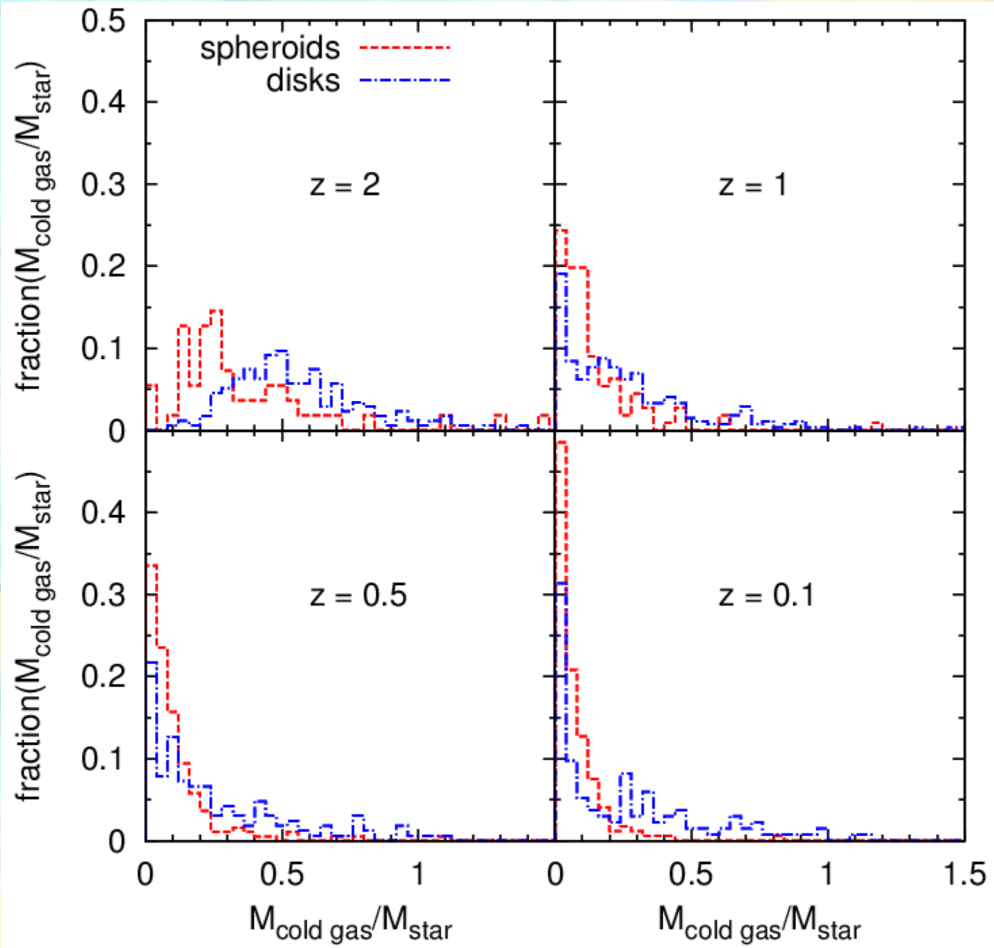
Threshold for epsilon-Classification



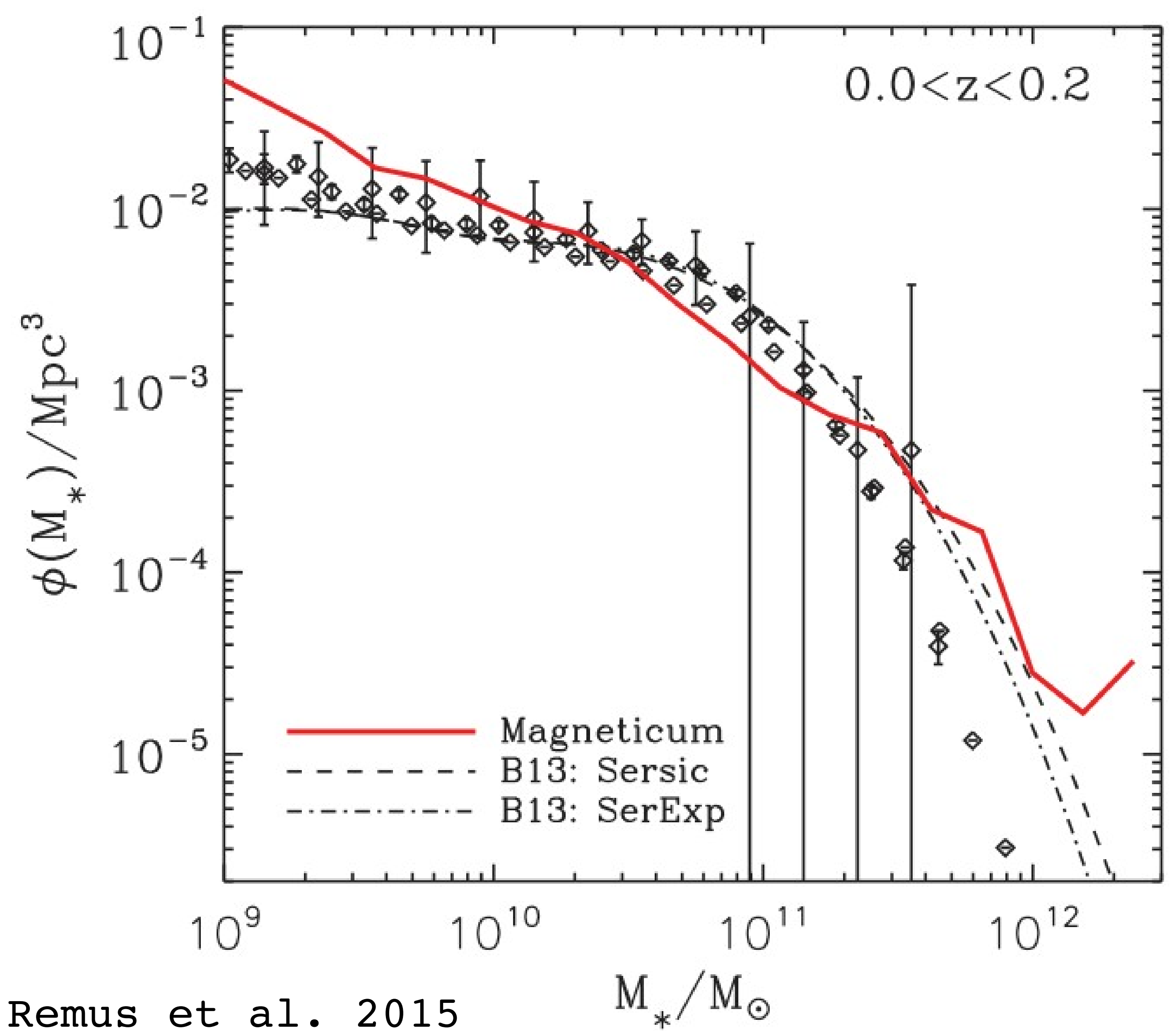
Teklu et al. 2015

Gas Fractions





Stellar Mass Functions



Remus et al. 2015