Diversity of galactic discs at high z in cosmological simulations

Meghna Varma[1] , Maxime Trebitsch[1,2]

[1] Observatoire de Paris [2] Sorbonne Universite, Paris

Galactic discs were predicted to form at a later time. While recent observations have observed galactic disc at $z>6$, cosmological simulations have struggled to form galactic disc at such an early time.

To investigate how early discs form and to see what fraction of these high z galaxies have disc morphology, we use Obelisk, a high resolution hydryodynamical simulation $(\Delta x \simeq 35pc)$ a subvolume of the Horizon-AGN simulation.

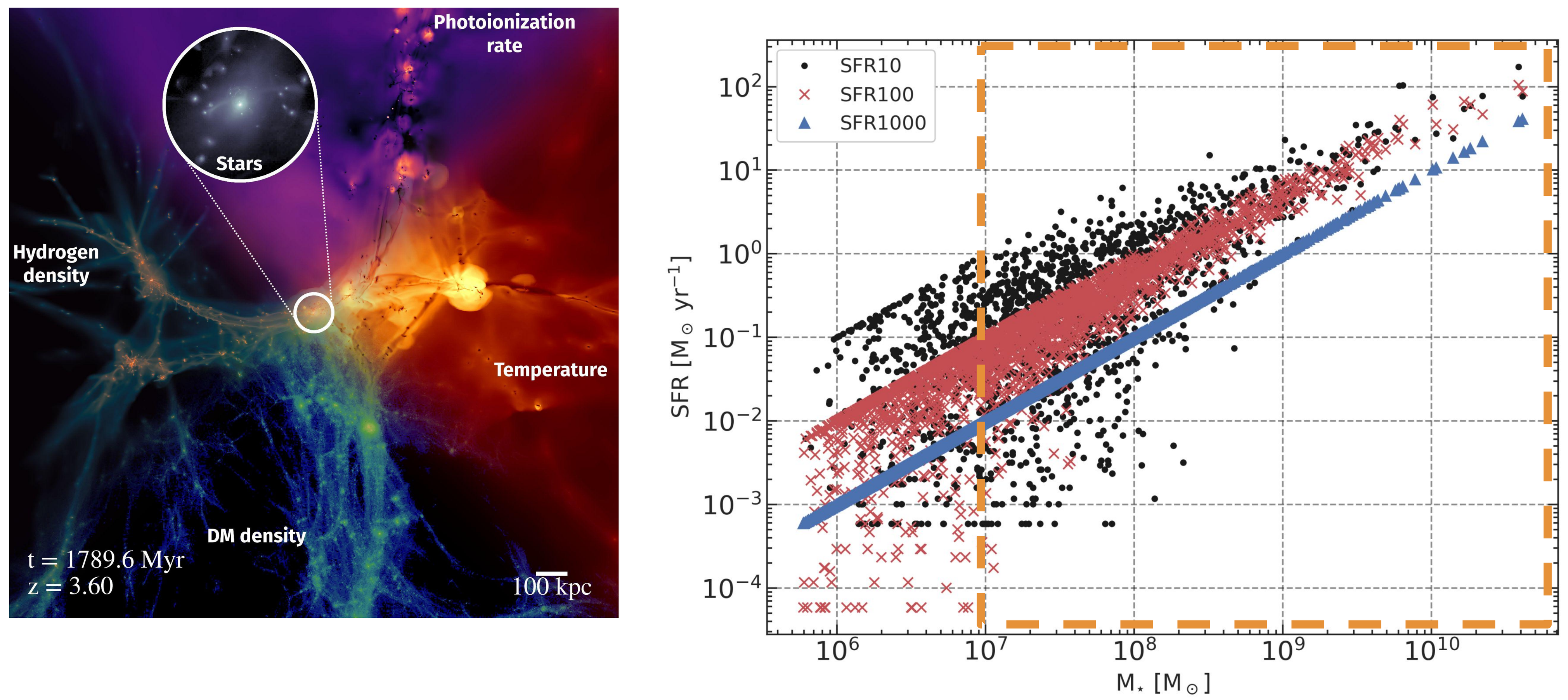

Fig 1: Left: Snapshot of Obelisk: illustration of the physics modelled. **Right:** Data sample. We analyse galaxies with $M_*/M_\odot > 1e7$

Morphological analysis

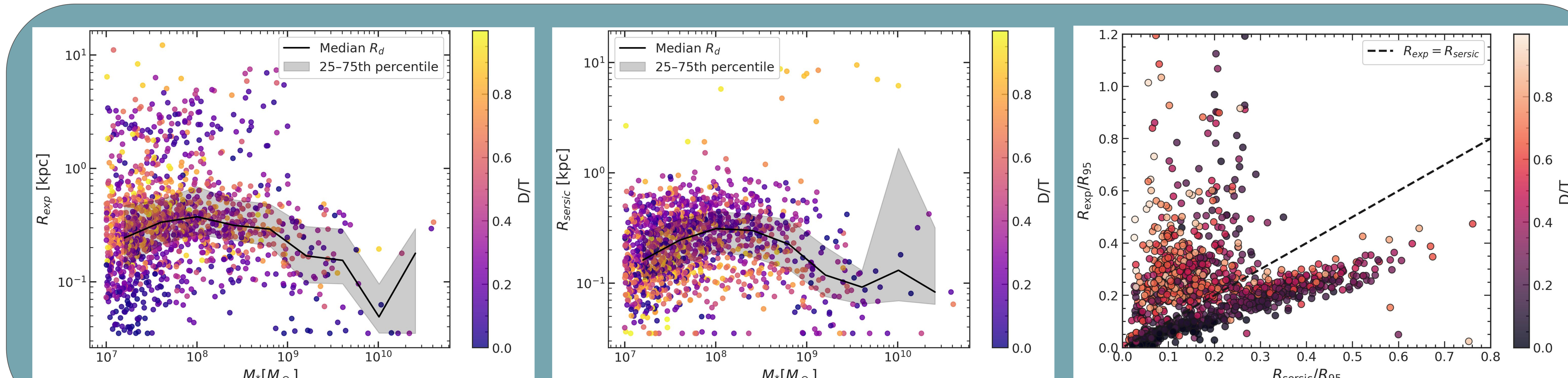

Fig 3: Left and Middle panel : scale length of exponential and Sersic component with Stellar mass. **Right:** size of central and extended part of galaxy

Conclusions

About half of the galaxies have D/T around 0.4. Massive galaxies are seen to be more compact in the central region. More extended galaxies show a greater rotational support. A detailed analysis can be employed through kinematic decomposition of stellar discs

SD profile fitting and kinematic analysis

Stars are projected onto a plane perpendicular to angular momentum and linearly binned into annuli between 35 pc and 1.5 R_{95} pc. Surface density of galaxy is fit by a combination of exponential profile and Sersic profile.

Fitting profile is given by:

$$\Sigma(R) = \Sigma(R_e)_{bulge} \exp\left[-\beta_n \left\{ \left(\frac{R}{R_e}\right)^{1/n} - 1 \right\} \right] + \Sigma_{0,disc} \exp\left(\frac{-R}{R_d}\right)$$

Surface density in each annular bin is computed as:

$$\Sigma(R_i) = \frac{1}{2\pi R_i\, dR_i} \sum_{j \in \text{annulus } i} m_j$$

Mass fractions of disc and bulge are obtained by integrating the corresponding SD profiles.

$$D/T = \frac{2\pi \int_0^\infty \Sigma_{\rm disc}(R)\, R\, dR}{2\pi \int_0^\infty \Sigma_{\rm disc}(R)\, R\, dR + 2\pi \int_0^\infty \Sigma_{\rm bulge}(R)\, R\, dR}$$

Rotational support is quantified by measuring rotation-to-dispersion ratio as a function of R. For this, rotational velocity v_θ and dispersion σ profile is computed in each bin.

$$\sigma = \sqrt{\frac{\sigma_\rho^2 + \sigma_\theta^2 + \sigma_l^2}{3}}$$

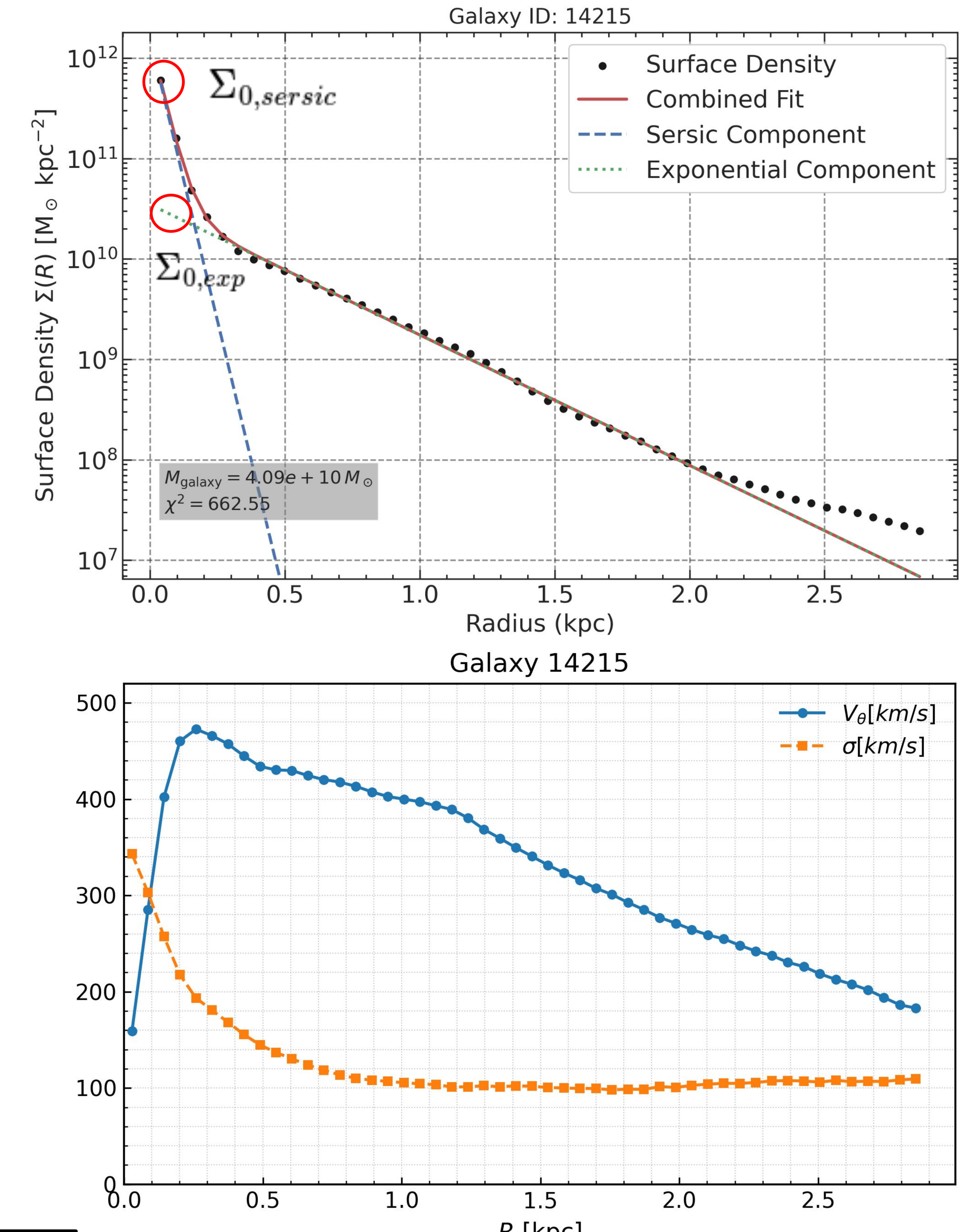

Fig 2 : Top: SD fitting of the most massive galaxy in the data. **Bottom:** Rotation curve and dispersion profile of the same galaxy.

Mass fraction and kinematics analysis

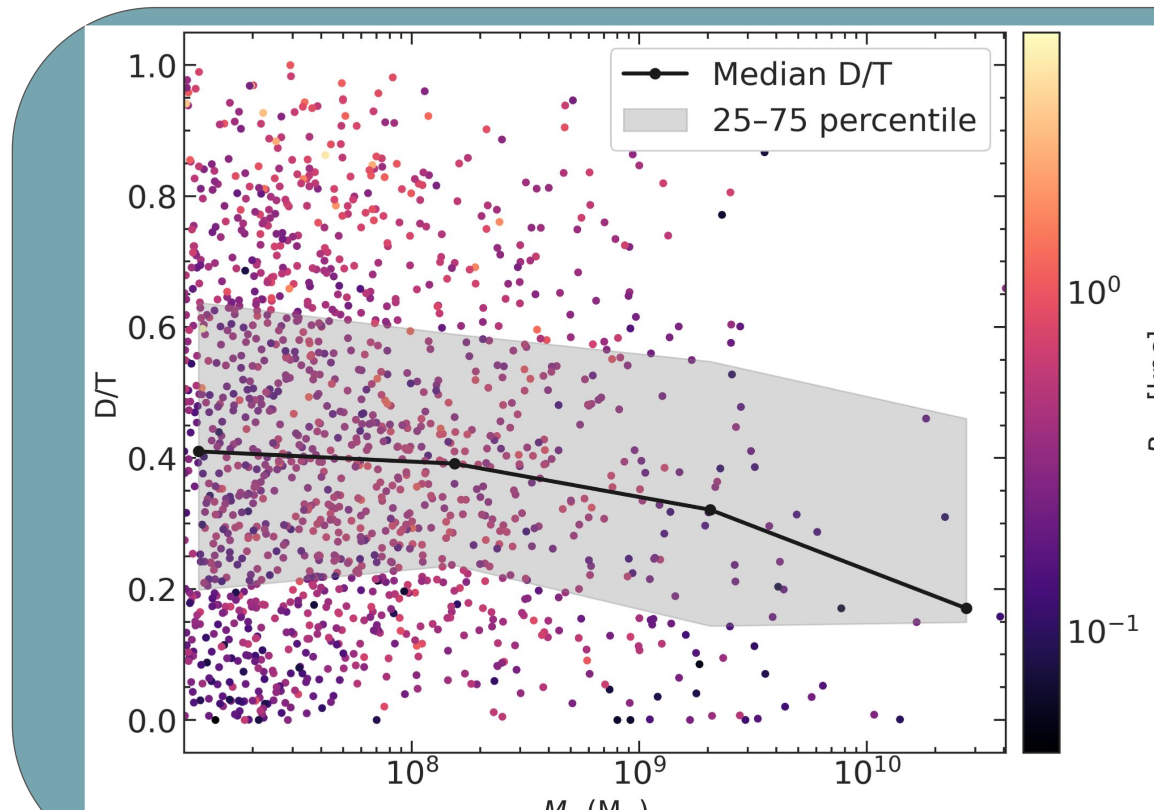

Fig 4: Mass fraction of the disc component

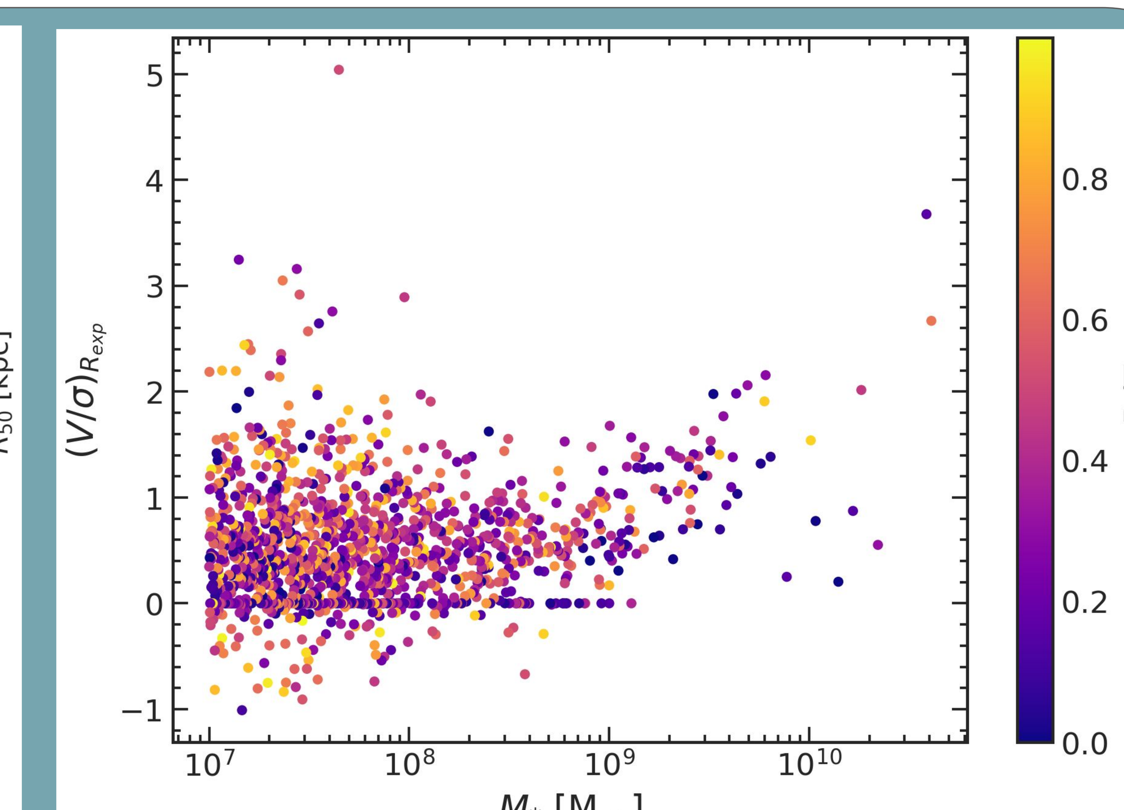

Fig 5: Rotational support of galaxies at 2.16 R_{exp}

Contact: meghna.varma@obspm.fr