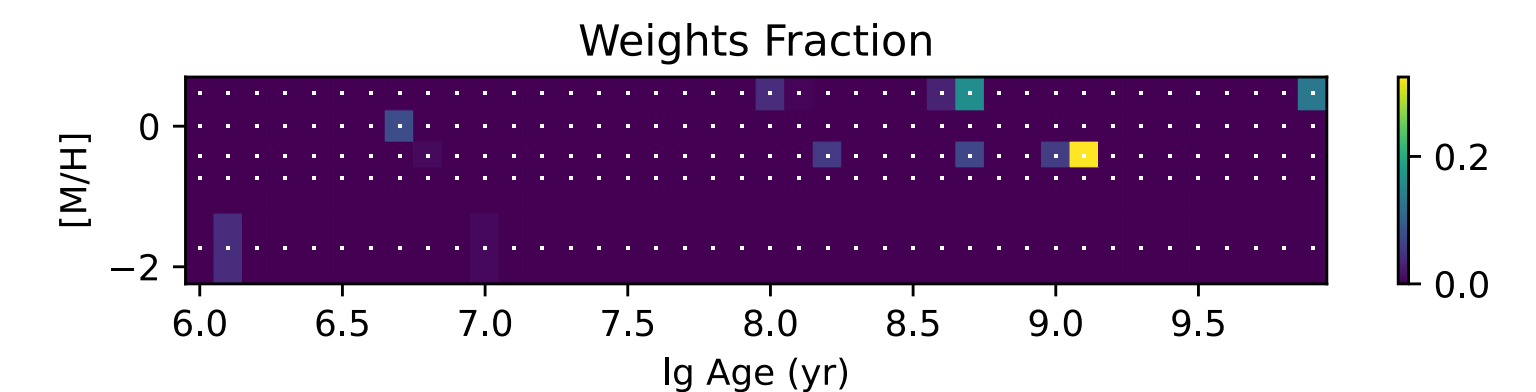
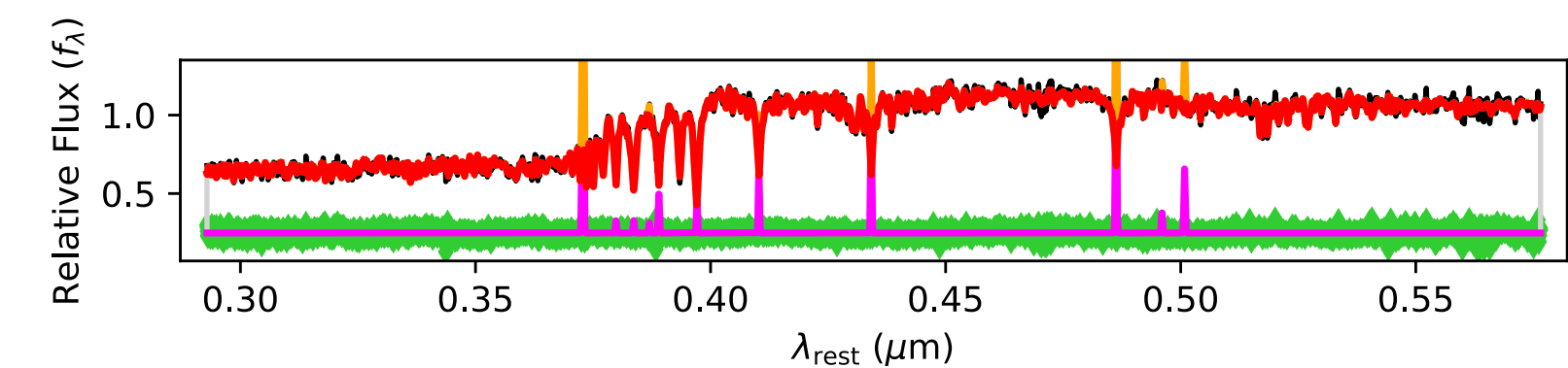
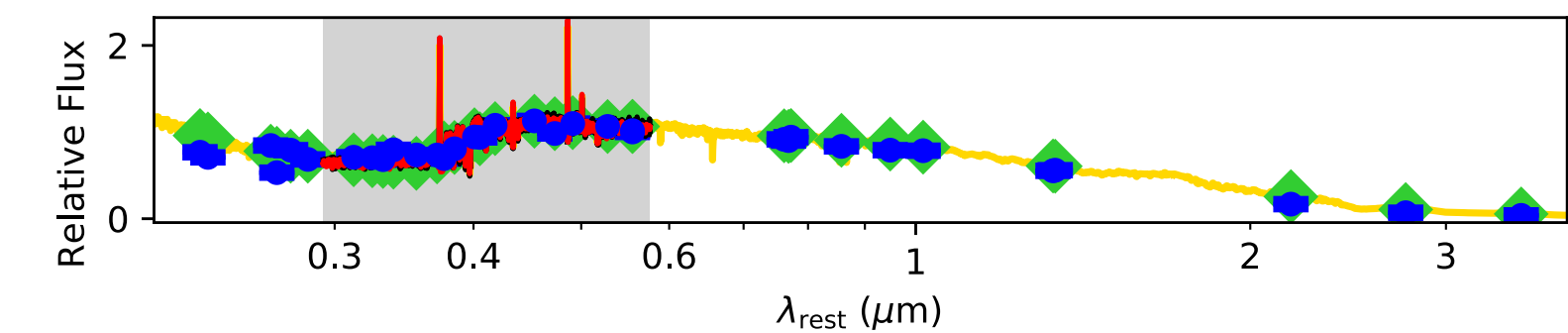


Leibniz-Institut für
Astrophysik Potsdam

Stellar angular momentum and star formation history of intermediate-redshift galaxies in MUSE surveys

Constanza Muñoz López
Email: cmunoz@aip.de



Garching, November 20, 2024

Introduction

Galaxies in the nearby Universe



Slow Rotators



Fast Rotators

- Lack of stellar ordered motion
- Typically massive galaxies
- Often found in dense environments
- Few evidence for recent/ongoing star formation
- Final product of galaxy evolution

- Dominated by stars with an ordered motion consequent with discs-like rotation

Local Surveys (ATLAS^{3D}, MaNGA, SAMI, MASSIVE ...): Cappellari et al. 2011, Emsellem et al 2011, Cappellari 2016, Brough et al 2017, van de Sande et al. 2021b, Wang et al. 2020, etc.

Intermediate-z (LEGA-C survey, small samples): Van der Marel & van Dokkum 2007, Van der Wel & van der Marel 2008, Guerou et al.2017, Bezanson et al.2018, etc.

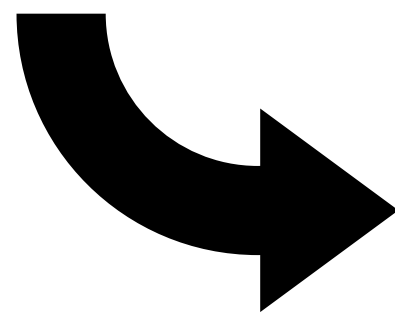
High-redshift samples (z: 1-3): Kinematics of galaxies studied mostly by their ionised gas content.

Introduction

Numerical simulations

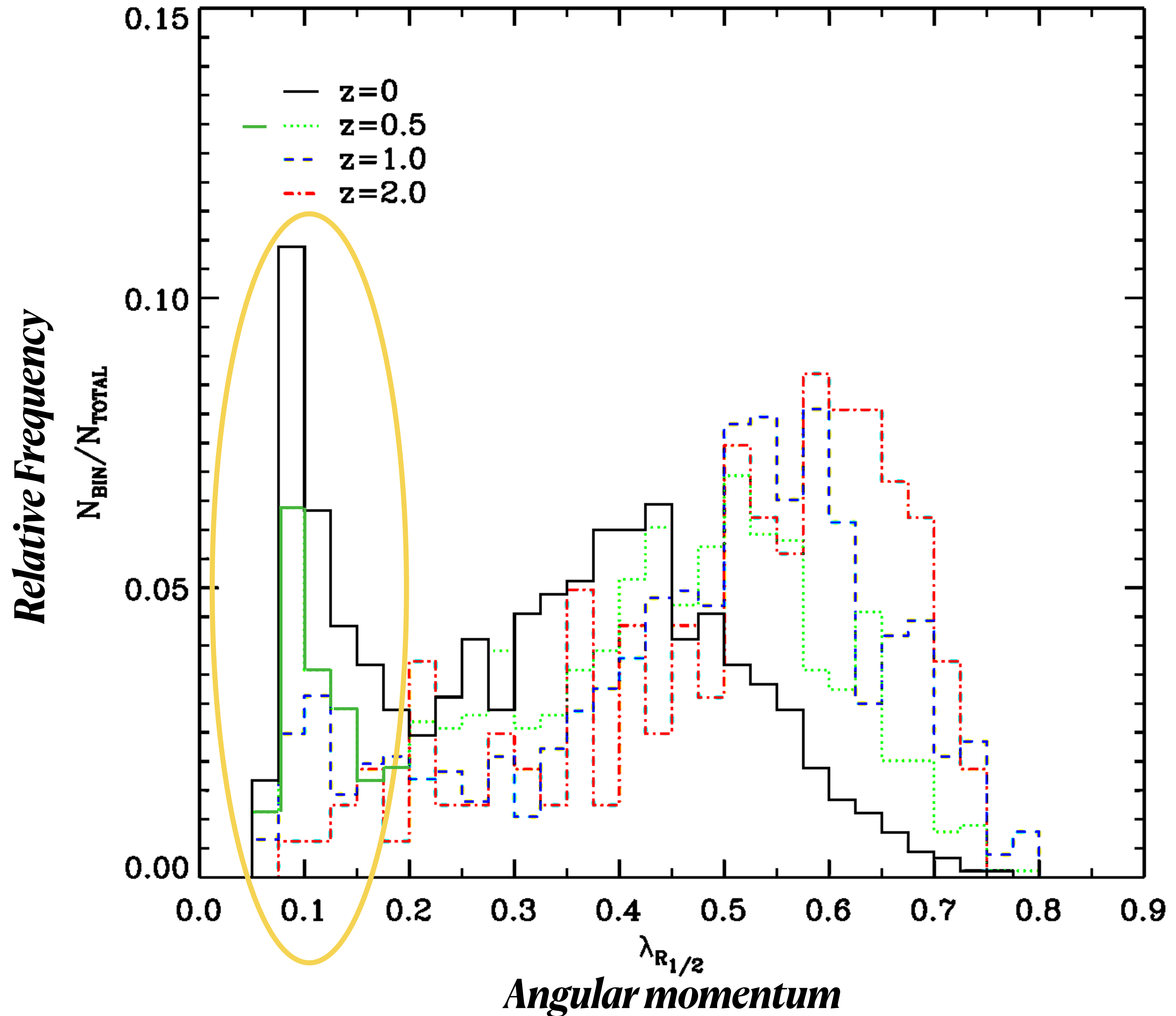
F. Schulze et al. 2018:

Evolution of Angular momentum
(*Magneticum Pathfinder* simulations)

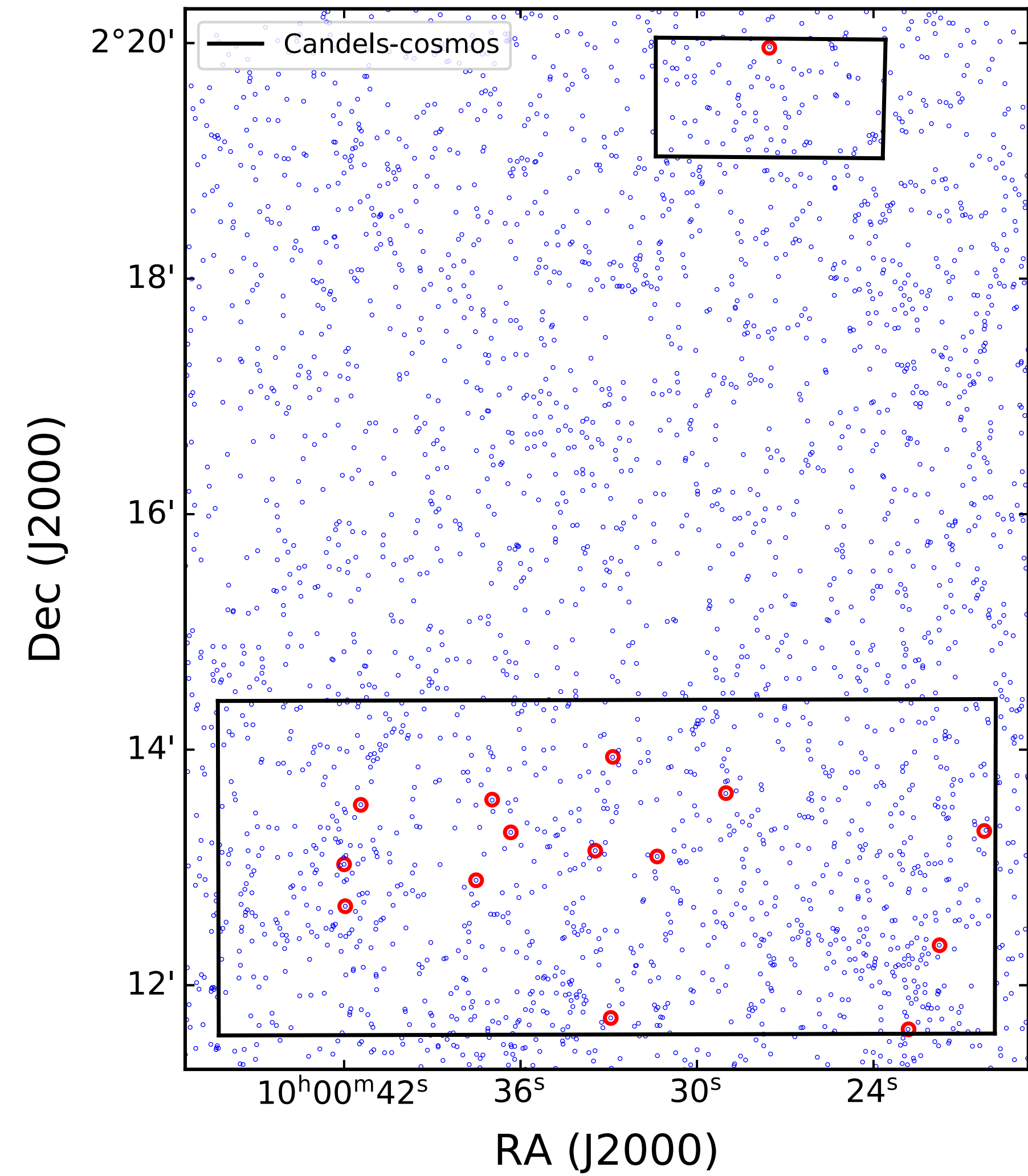
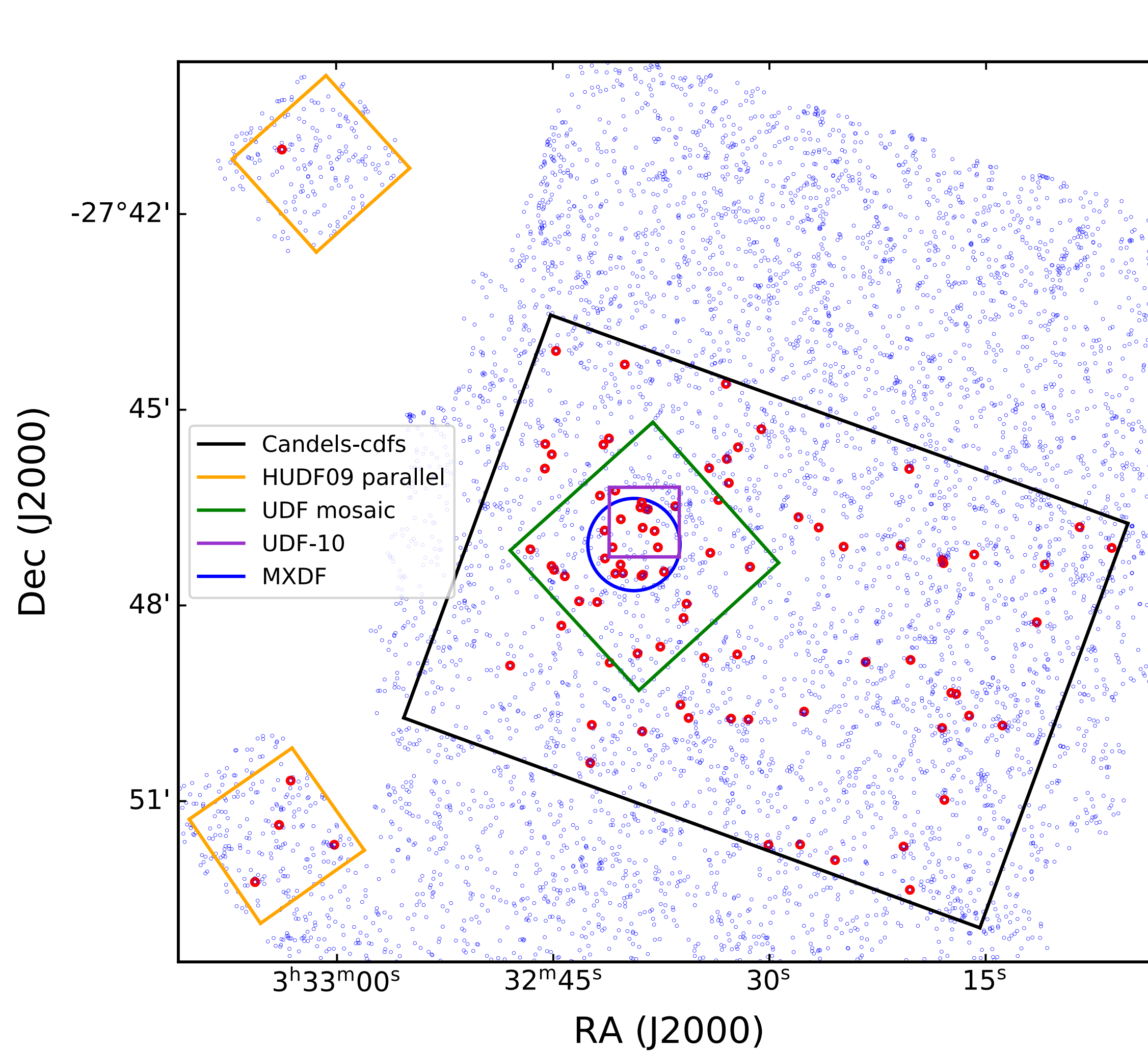


Lagos et al. 2018:

EAGLE -> successive minor mergers are more
prone to lose spin and become slow rotators



Data: MUSE-Wide, UDF-mosaic and MXDF

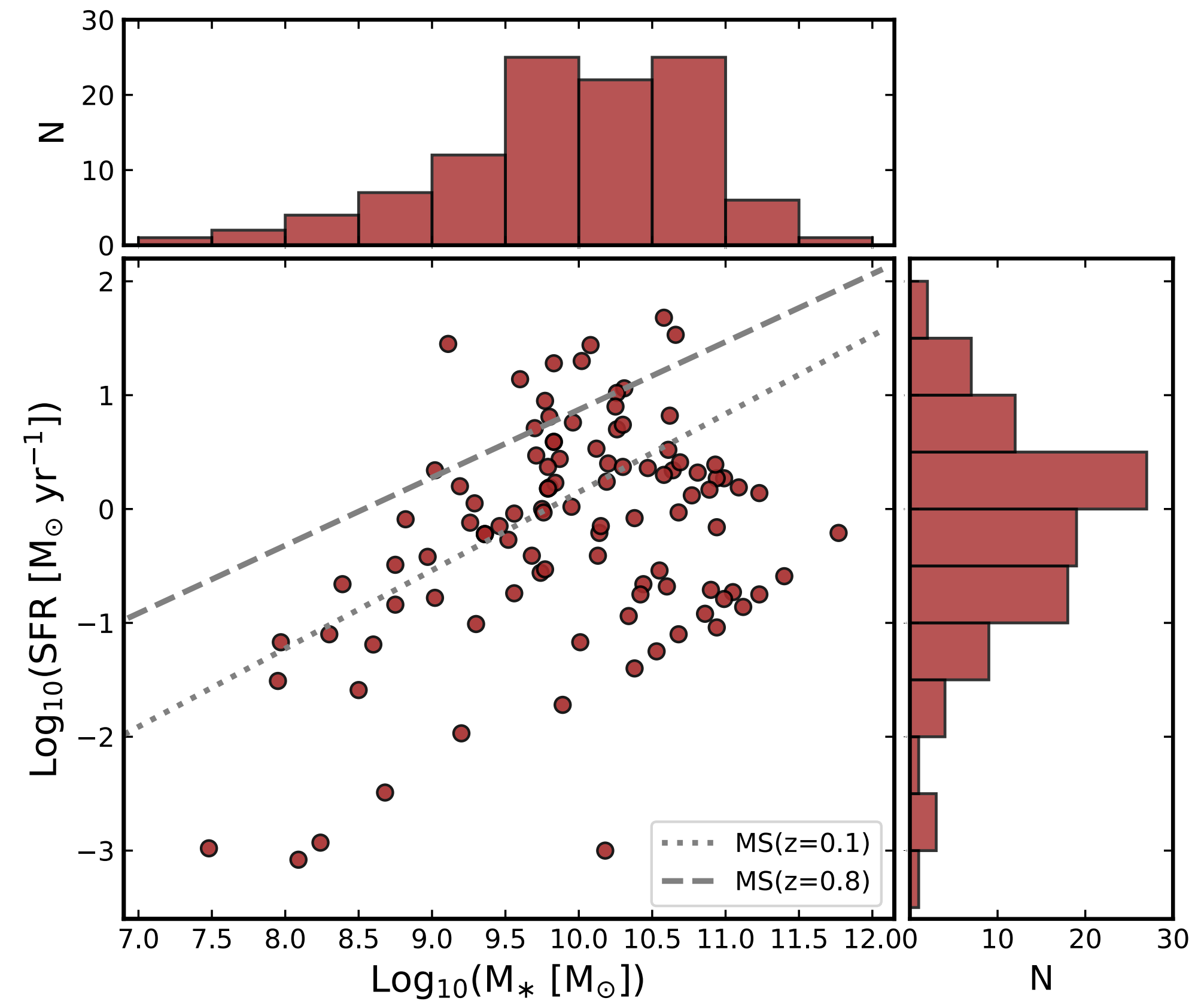
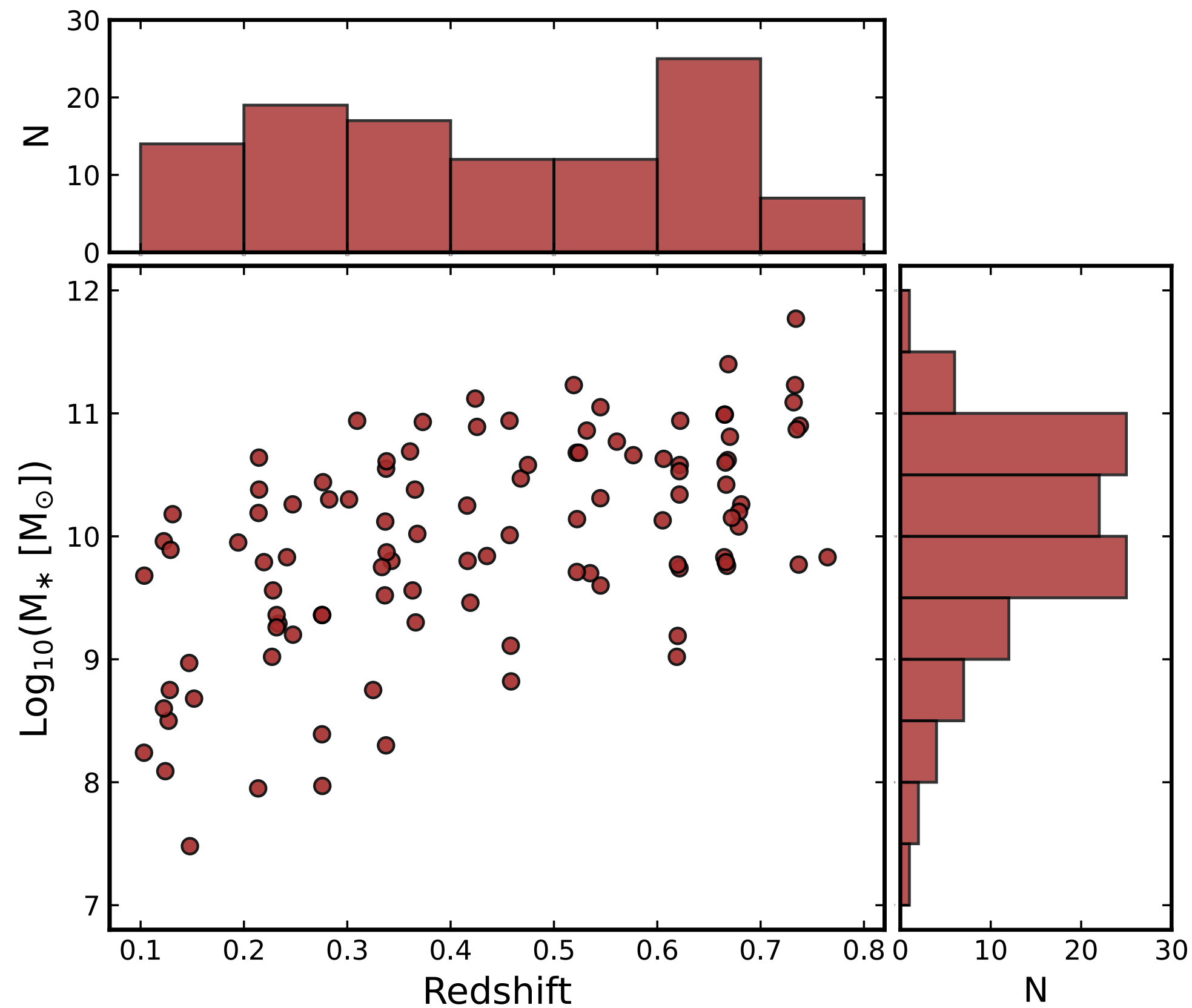


MUSE-Wide (Urrutia et al. 2019)

HUDF (Bacon et al. 2017, 2023)

MXDF (Bacon et al. 2023)

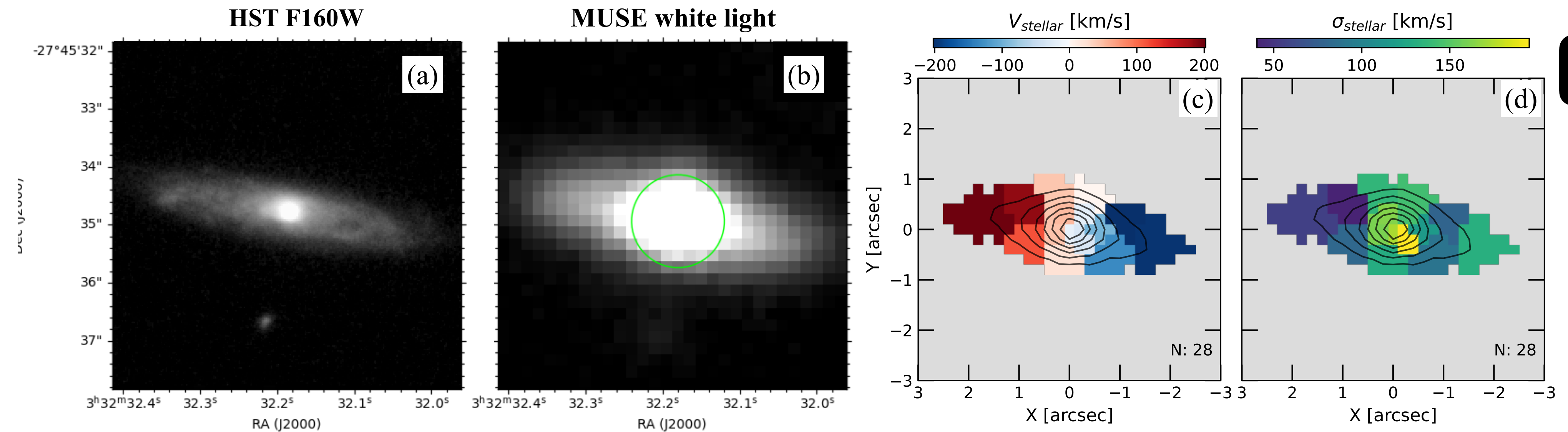
Galaxy Sample



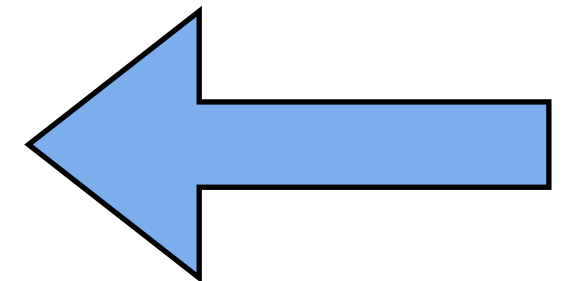
- Selection criteria:
 - Galaxies brighter than 24 mag in the F850LP/F160W HST filter.
 - Spectroscopic redshift lower than 1.2.
 - Spatial binning recipe following A. Gu  rou et al. 2017 (galaxies with $5 \geq \text{bins with } S/N > 8$)

Sample: 106 galaxies with integrated $S/N \gtrsim 10$

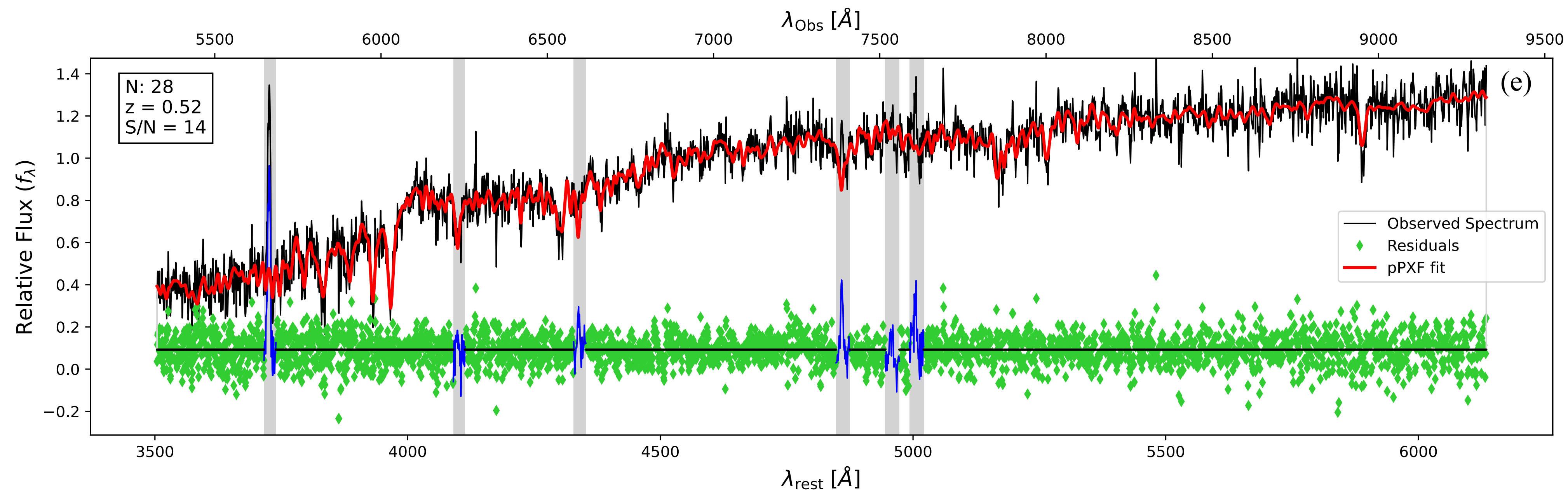
Galaxy Sample



Stellar kinematic galaxy maps

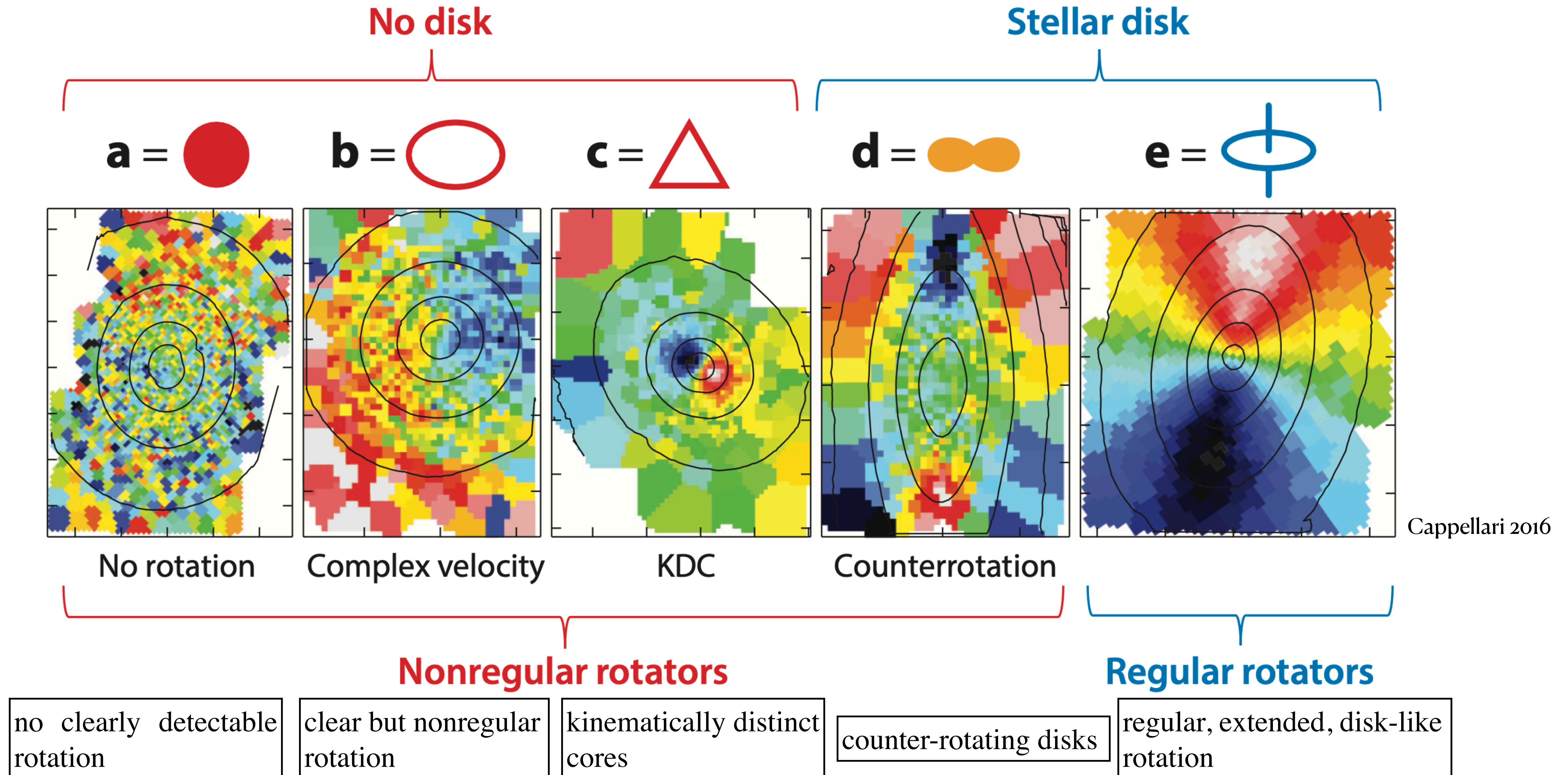


Voronoi tessellation
(Cappellari & Copin 2003)
+
pPXF (Cappellari & Emsellem
2004, Cappellari 2017)
+
Indo-US stellar library (Valdes
et al. 2004)



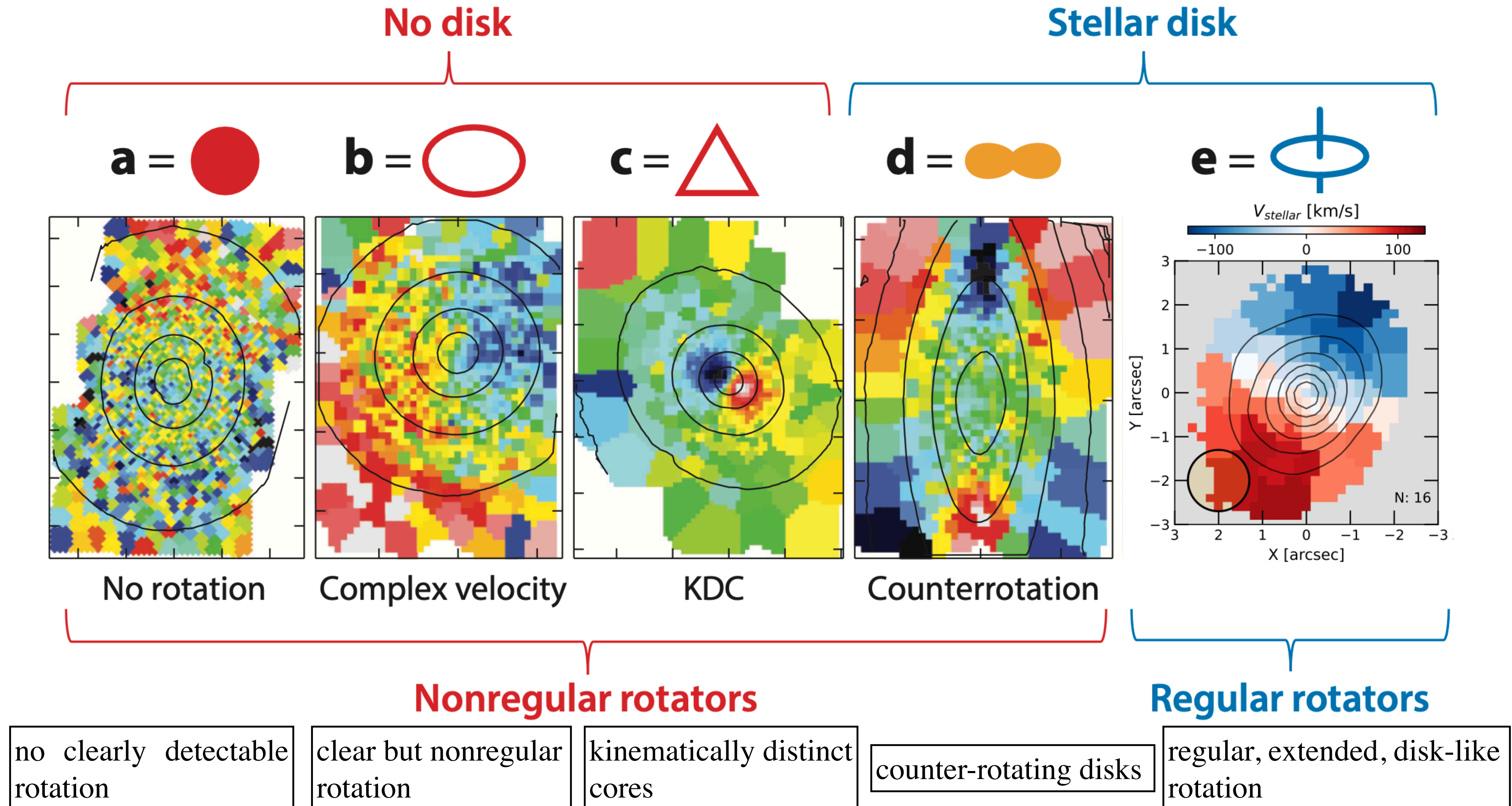
Results: stellar kinematics maps classification

The categorization is based on galaxies from ATLAS^{3D} survey (Krajnović et al. 2011) + KINEMETRY (Krajnović et al. 2006)



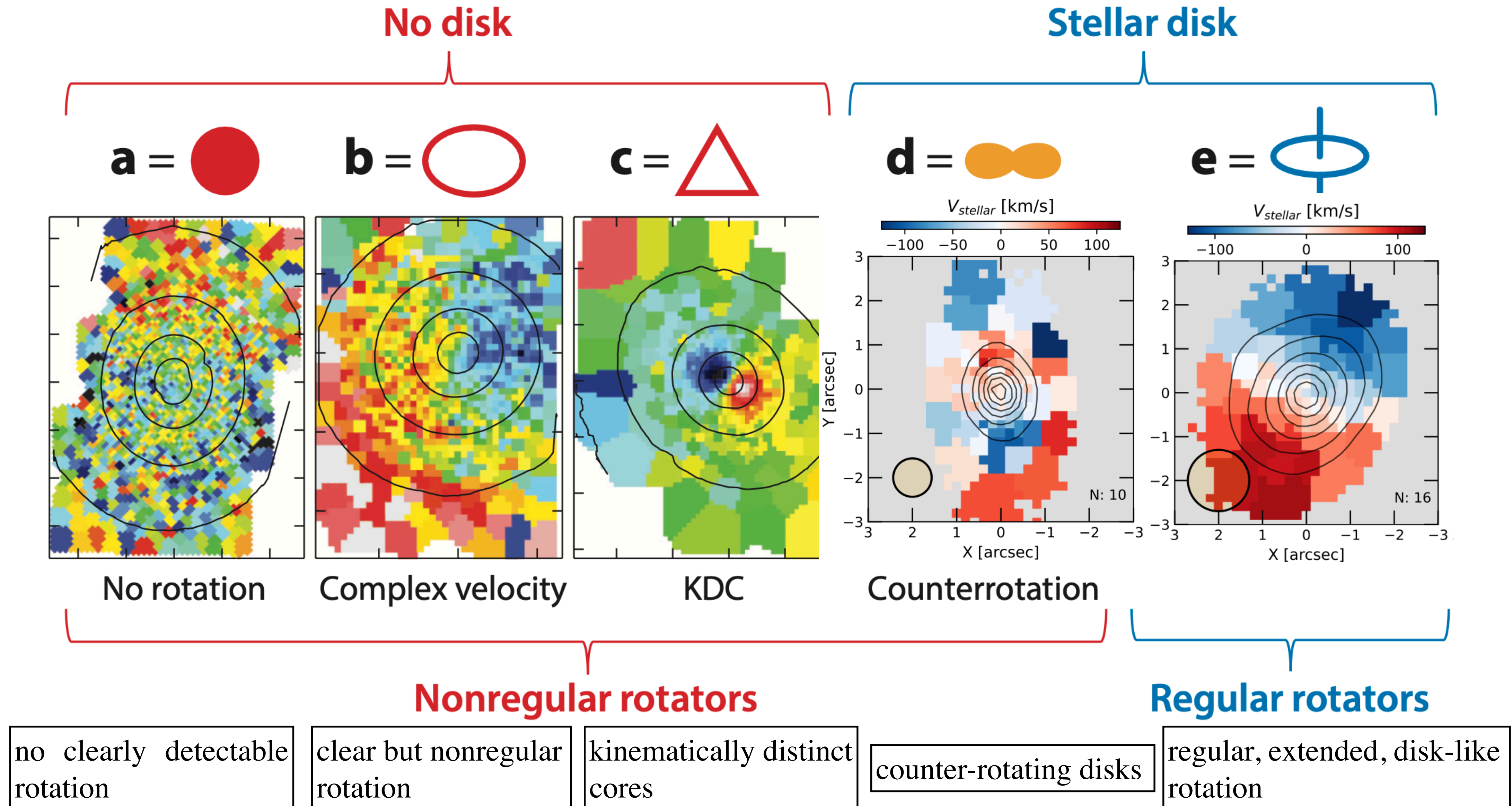
Results: stellar kinematics maps classification

The categorization is based on galaxies from ATLAS^{3D} survey (Krajnovic' et al. 2011) + KINEMETRY (Krajnovic' et al. 2006)



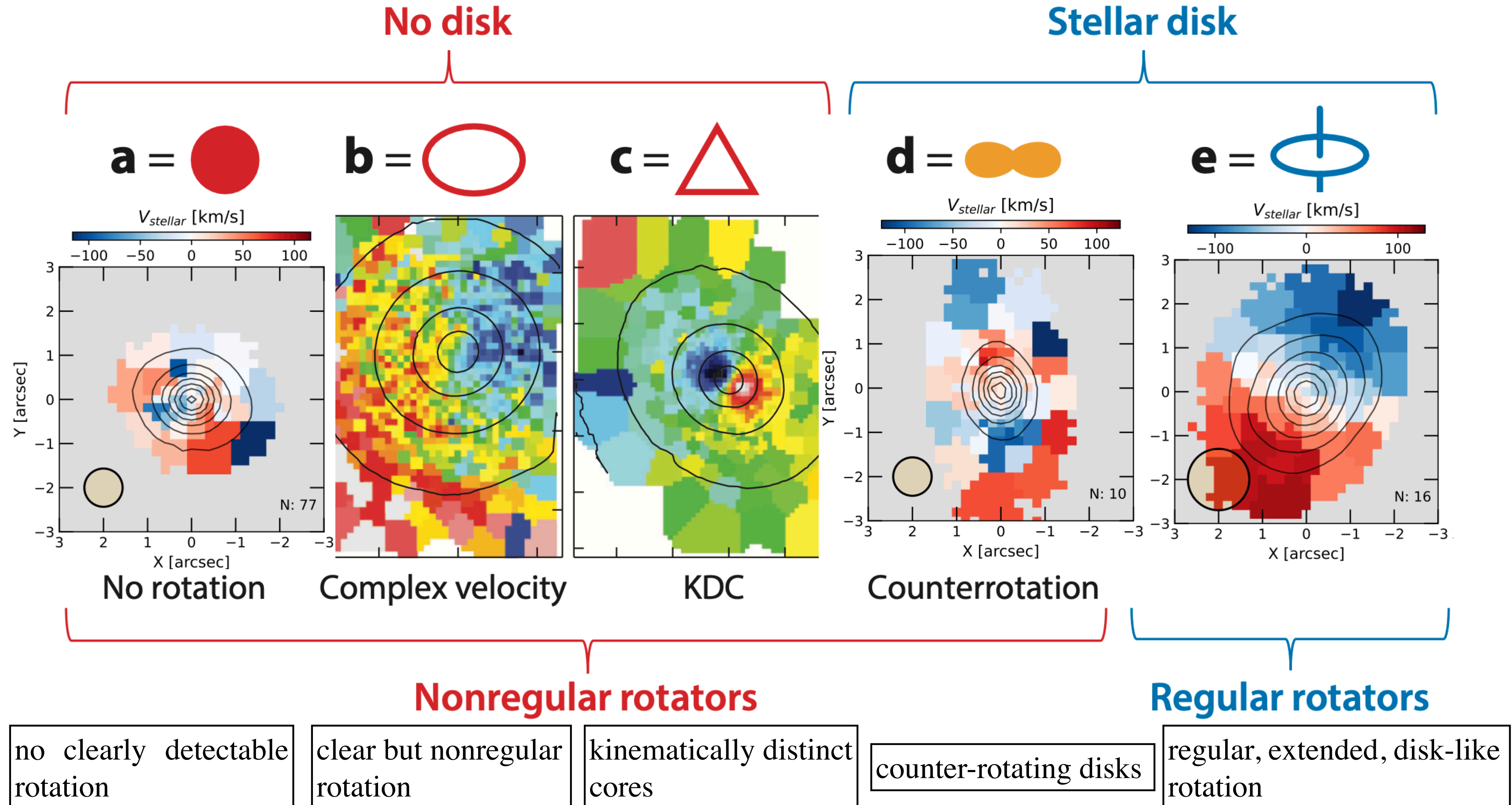
Results: stellar kinematics maps classification

The categorization is based on galaxies from ATLAS^{3D} survey (Krajnovic' et al. 2011) + KINEMETRY (Krajnovic' et al. 2006)



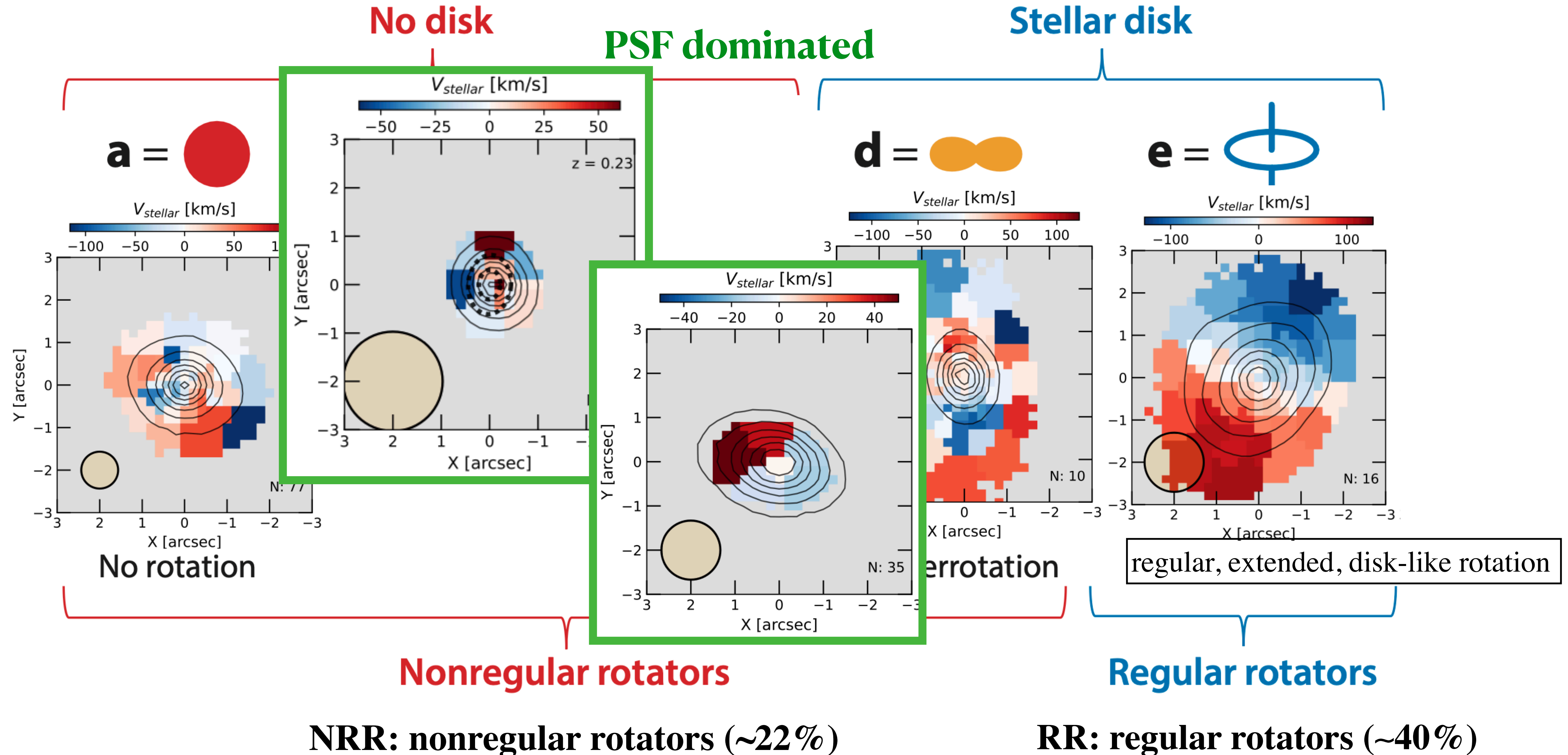
Results: stellar kinematics maps classification

The categorization is based on galaxies from ATLAS^{3D} survey (Krajnović et al. 2011) + KINEMETRY (Krajnović et al. 2006)



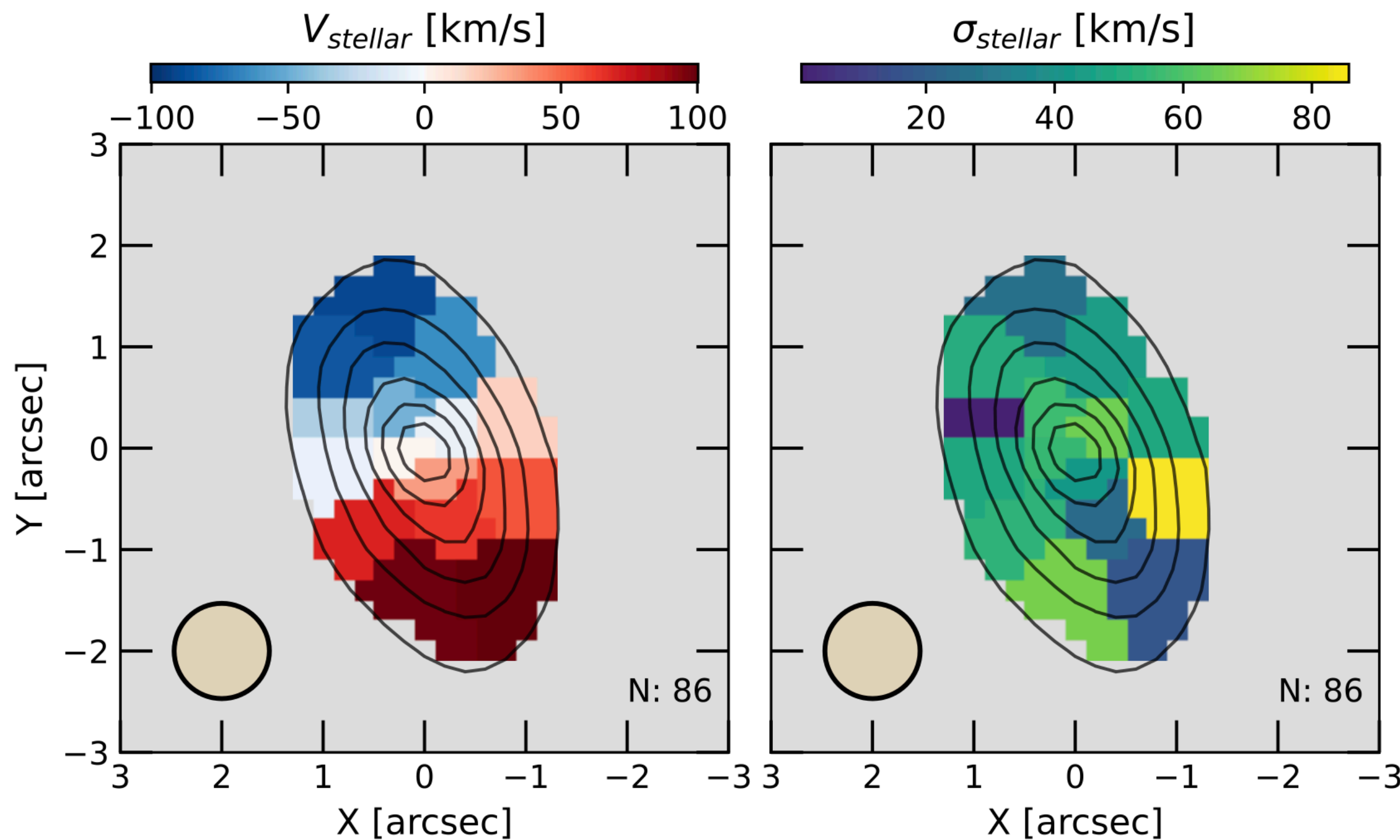
Results: stellar kinematics maps classification

The categorization is based on galaxies from ATLAS^{3D} survey (Krajnovic' et al. 2011) + KINEMETRY (Krajnovic' et al. 2006)



Stellar kinematics: the spin parameter λ_R

Emsellem et al. 2007



$$\lambda_R \equiv \frac{\langle R|V| \rangle}{\langle R\sqrt{V^2 + \sigma^2} \rangle} = \frac{\sum_{n=1}^N F_n R_n |V_n|}{\sum_{n=1}^N F_n R_n \sqrt{V_n^2 + \sigma_n^2}}$$

F_n : the flux

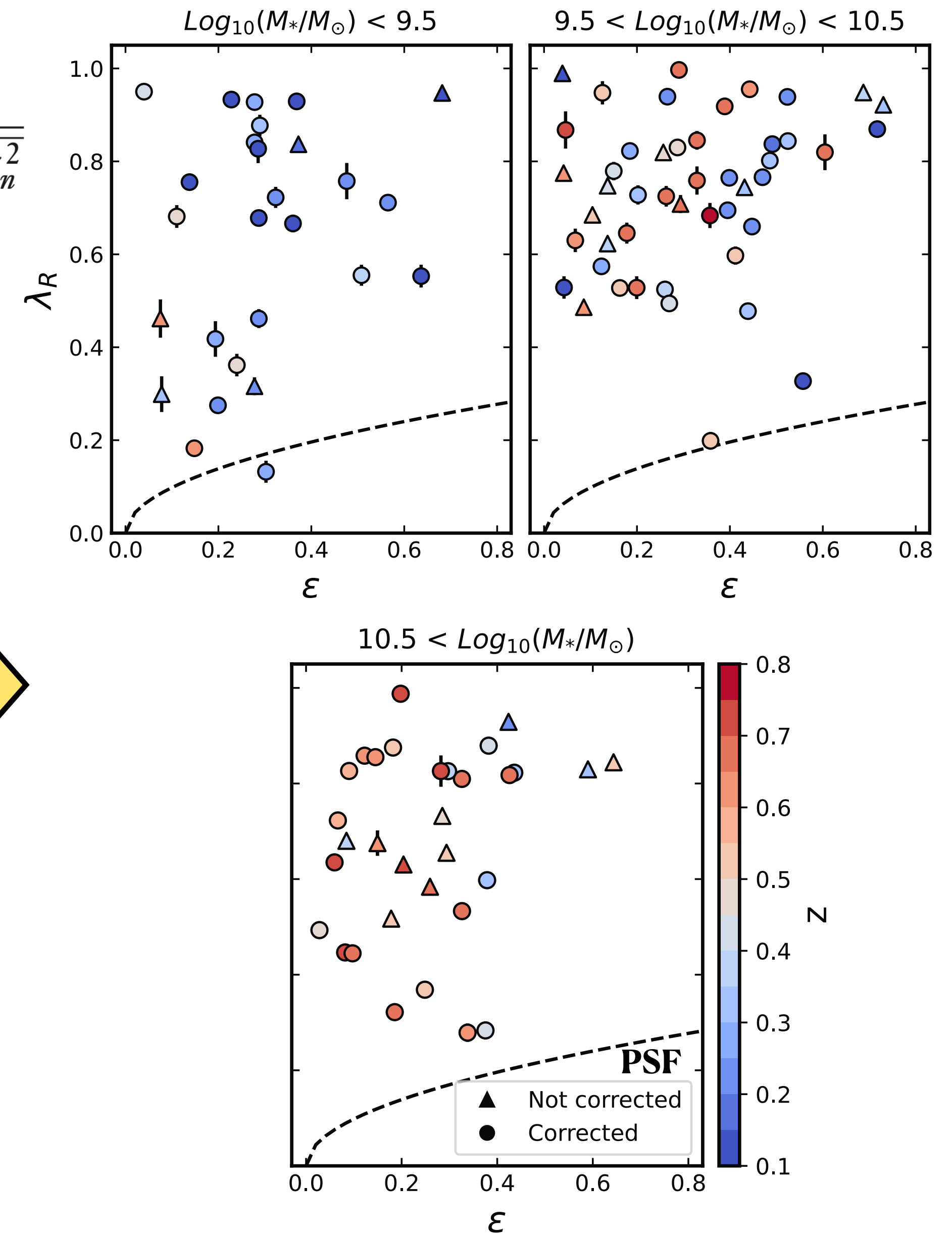
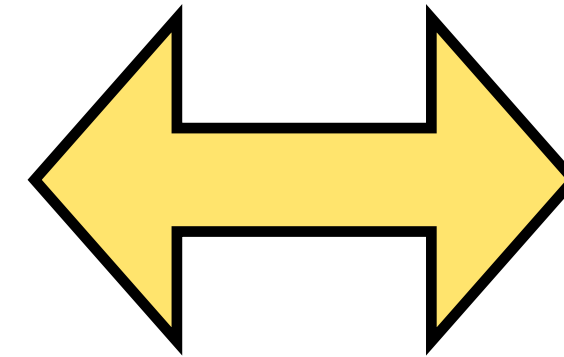
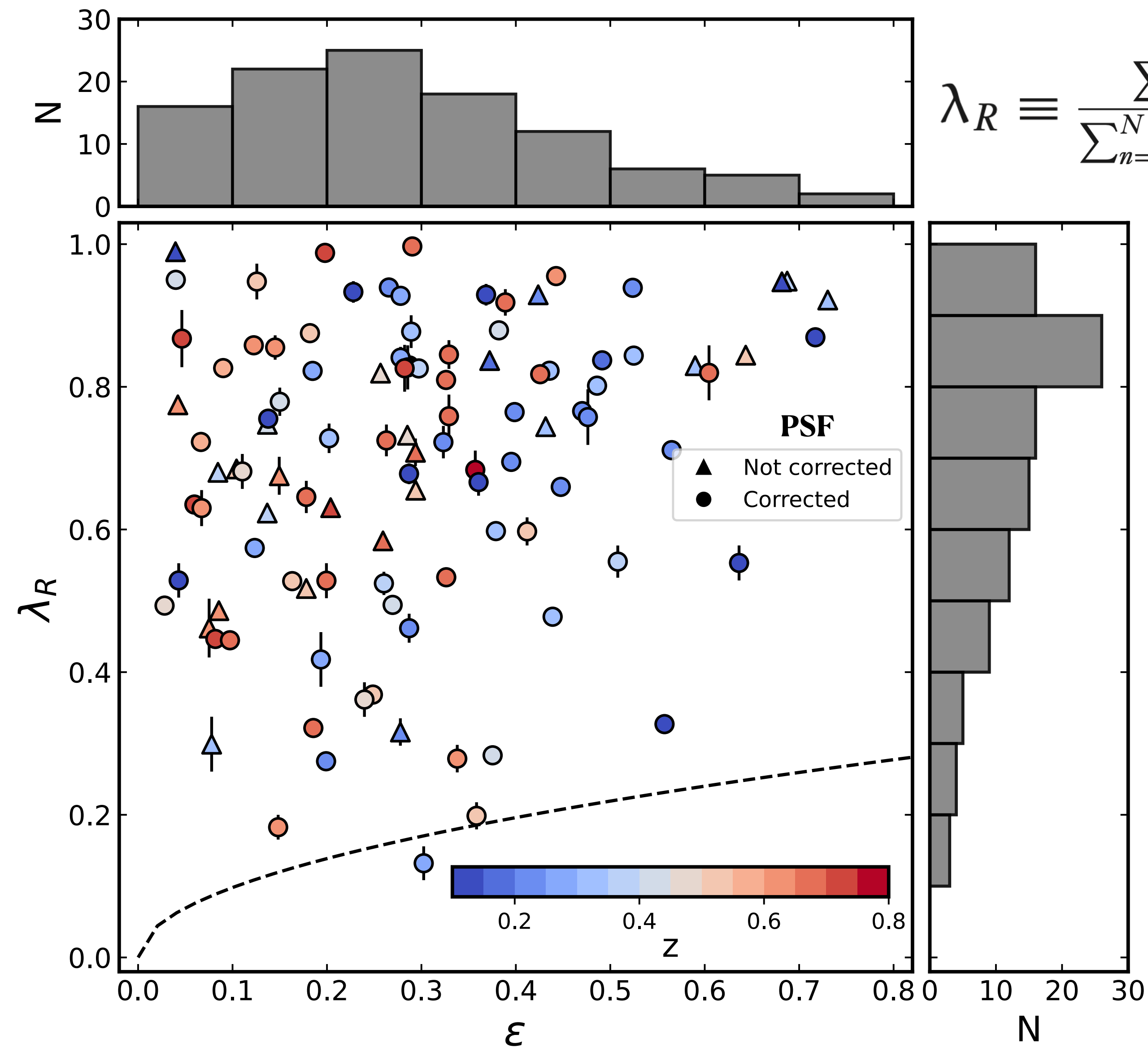
R_n : the distance to the center of the galaxy

V_n : the mean stellar velocity

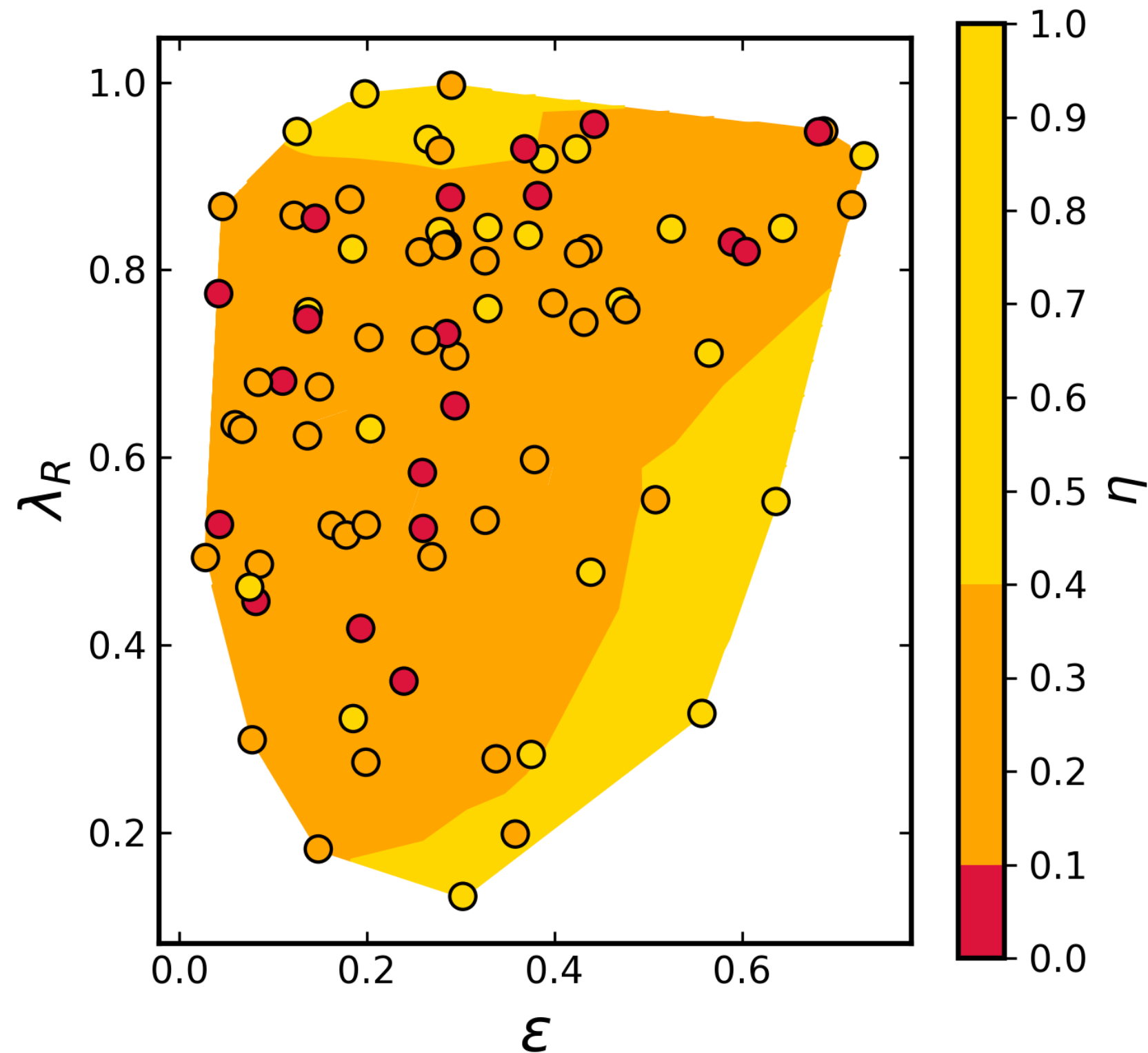
σ_n : velocity dispersion of the n th pixel

λ_R was corrected by PSF/seeing (Graham et al. 2018, Harborne et al. 2020)

Stellar kinematics: the spin parameter λ_R



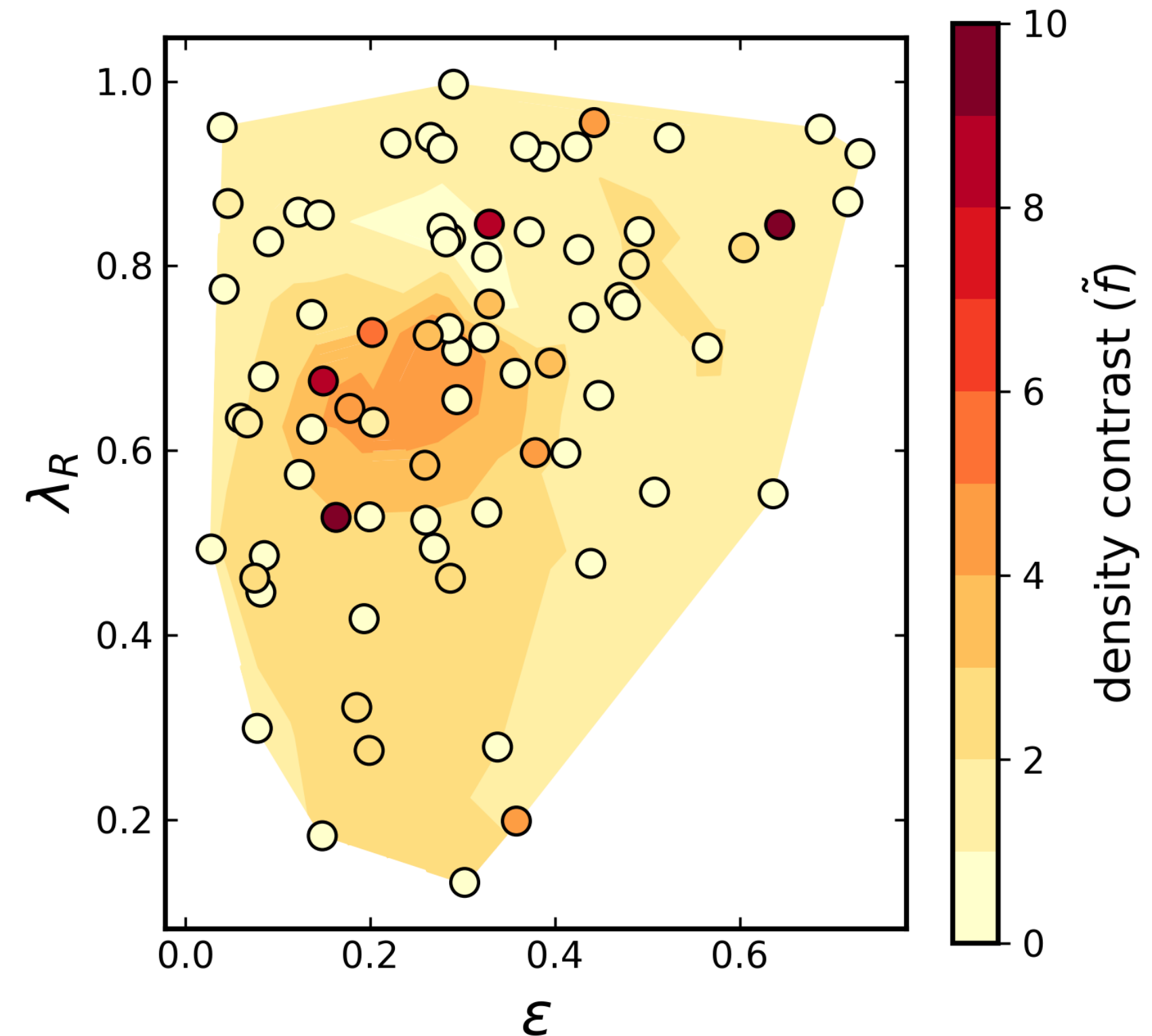
Results: Environment indicators



How dynamically tied a galaxy is to its group

$$\eta = \frac{|\Delta v|}{\sigma_g} \frac{\Delta r}{R_{200}}$$

Global density estimator
(Noble et al. 2017)



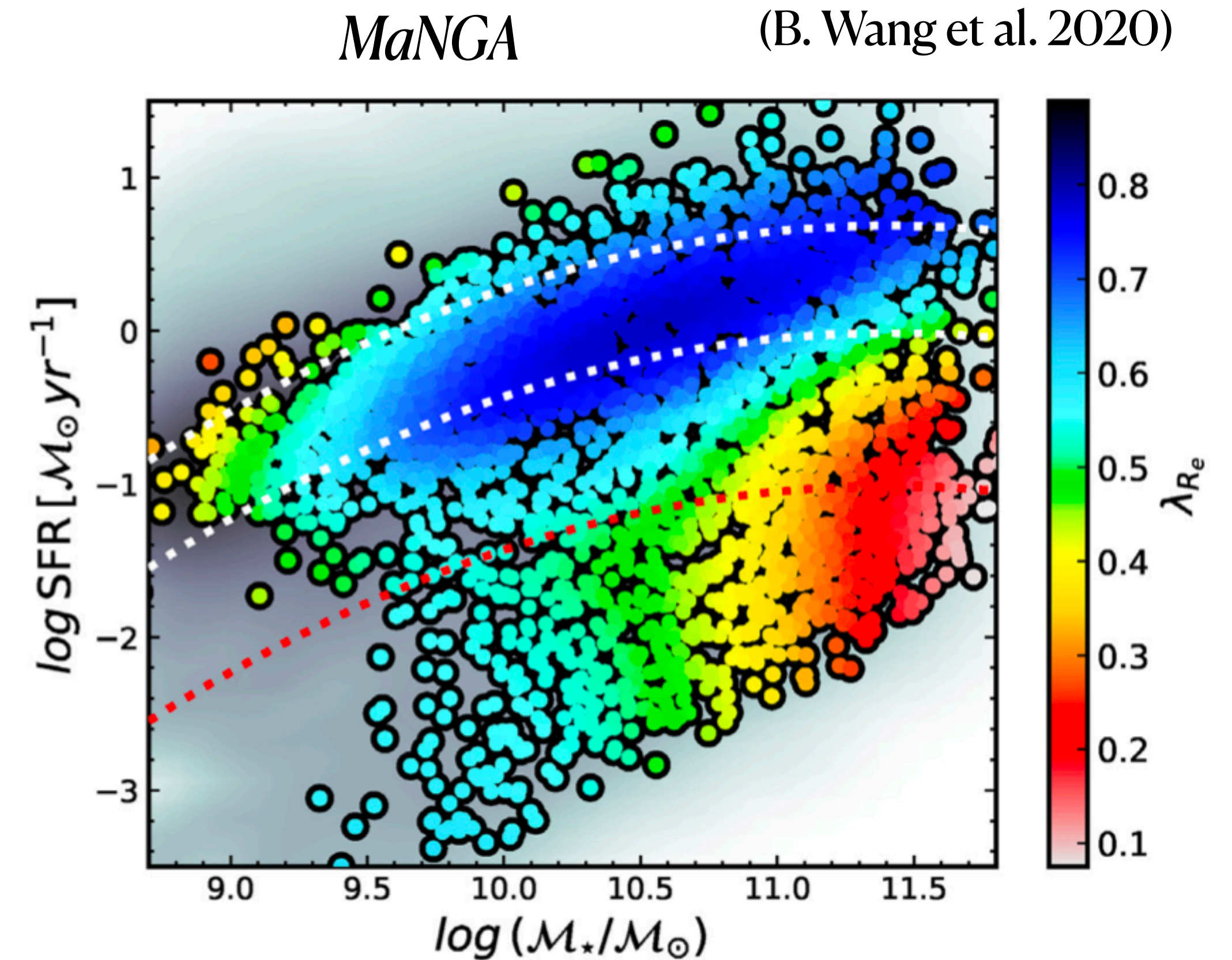
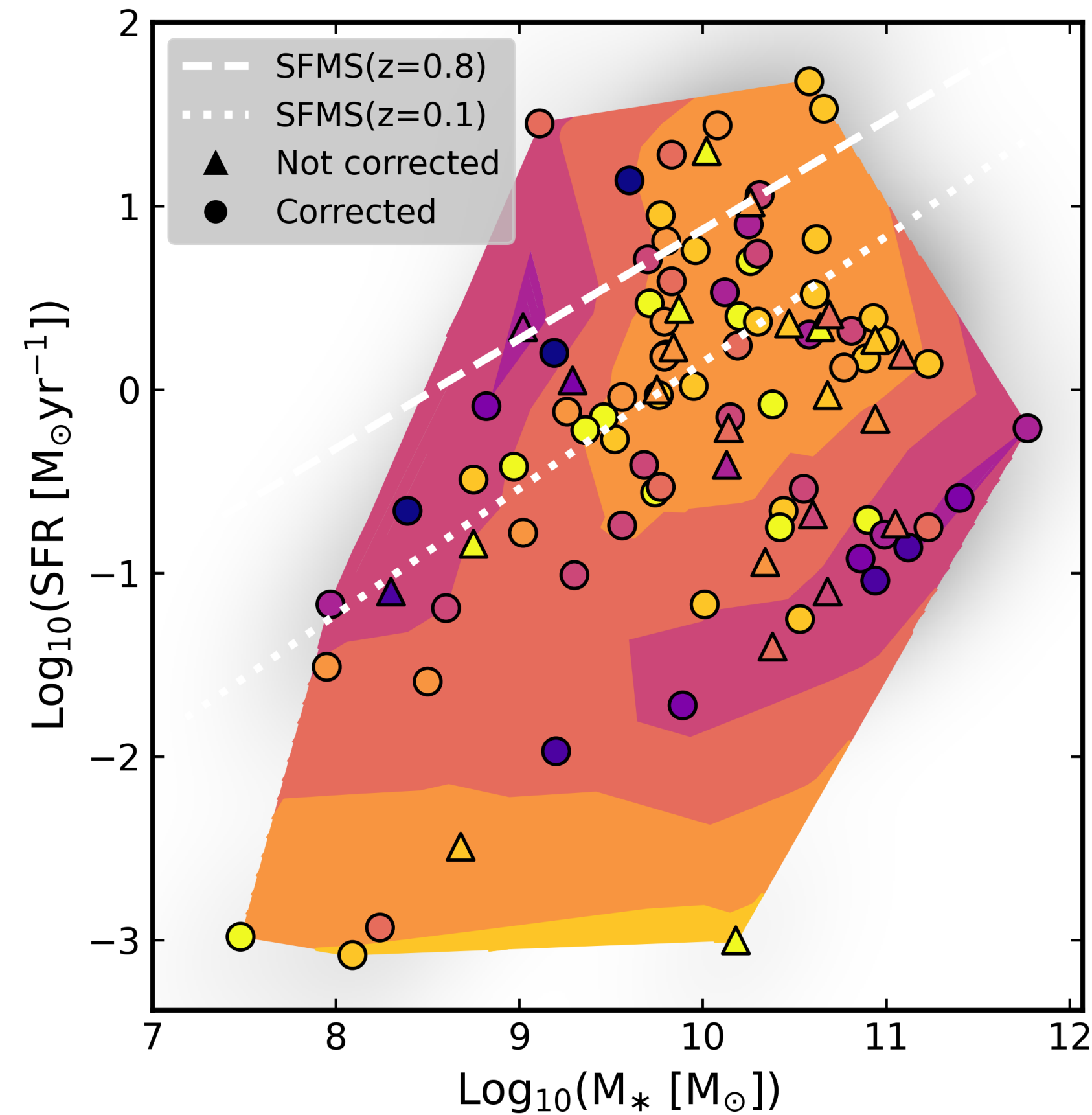
$$\langle f \rangle = \langle 1/a \rangle$$

$$(\tilde{f} = f / \langle f \rangle)$$

Measures environment overdensities

Local density estimator
(Shi et al. 2021)

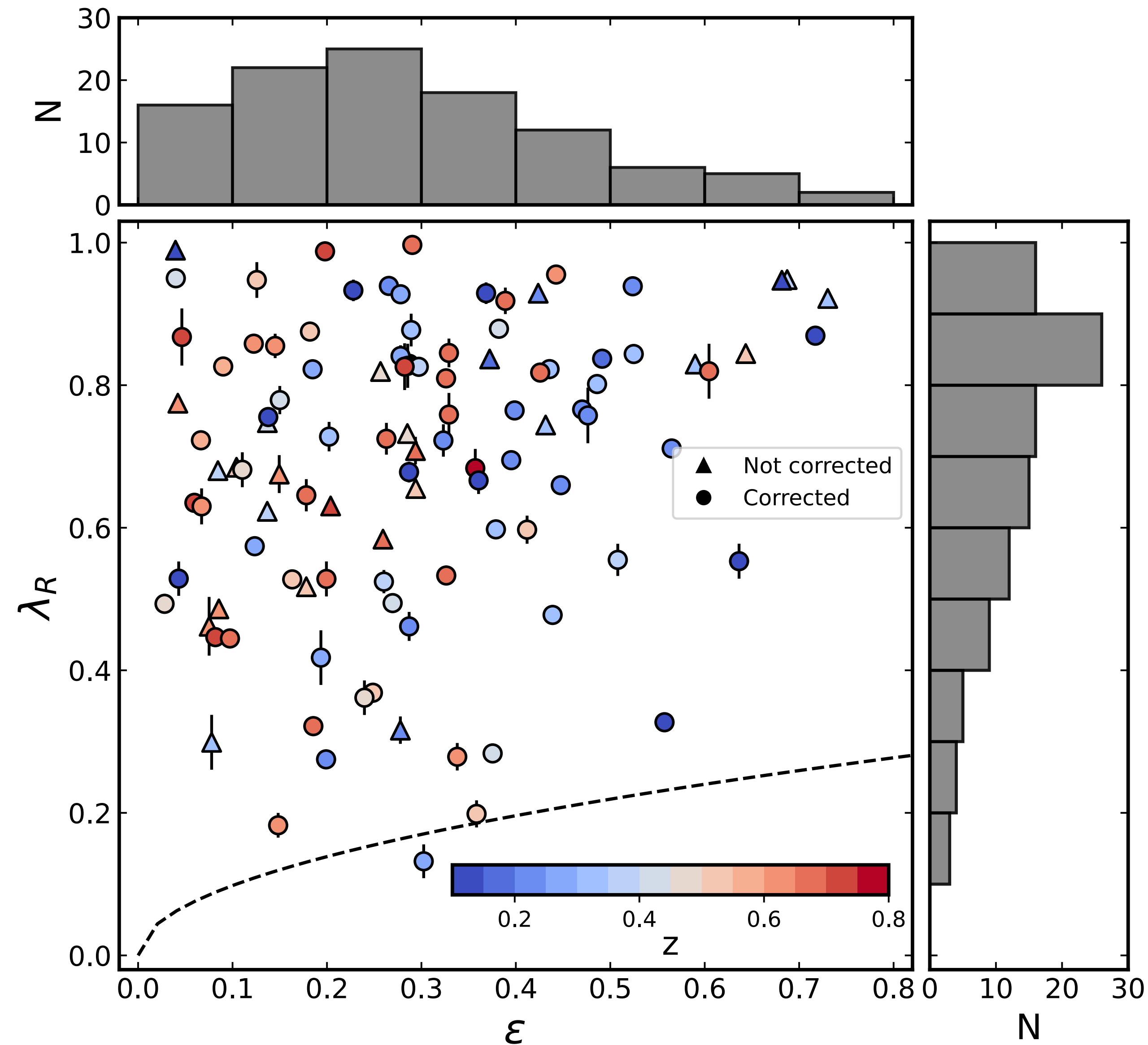
Stellar angular momentum and star formation rate (SFR)



(small sample, few galaxies at any given redshift, low S/N and small sizes)

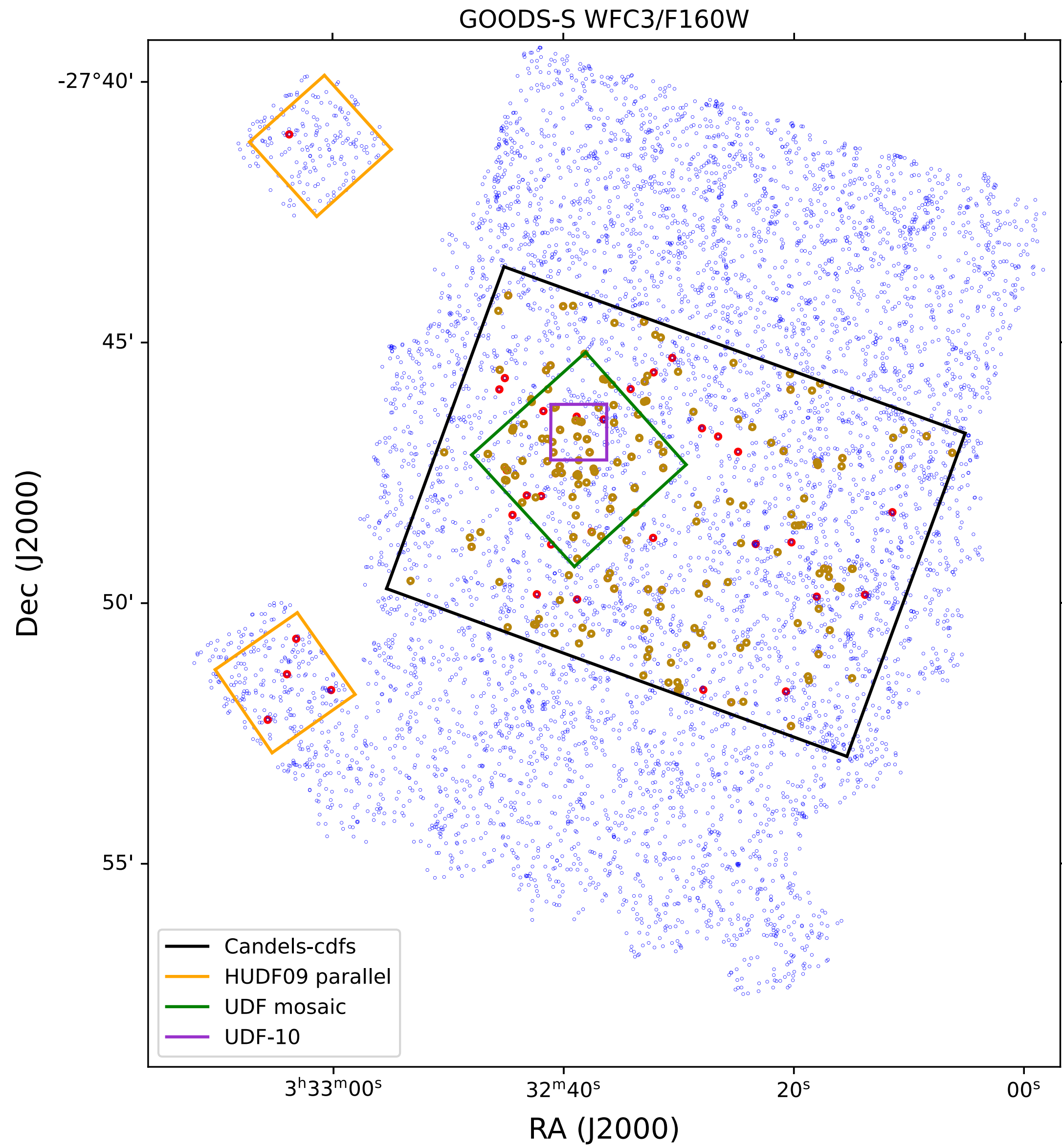
There is a hint that quiescent galaxies or galaxies with low levels of star formation have lower values of angular momentum.

Conclusions

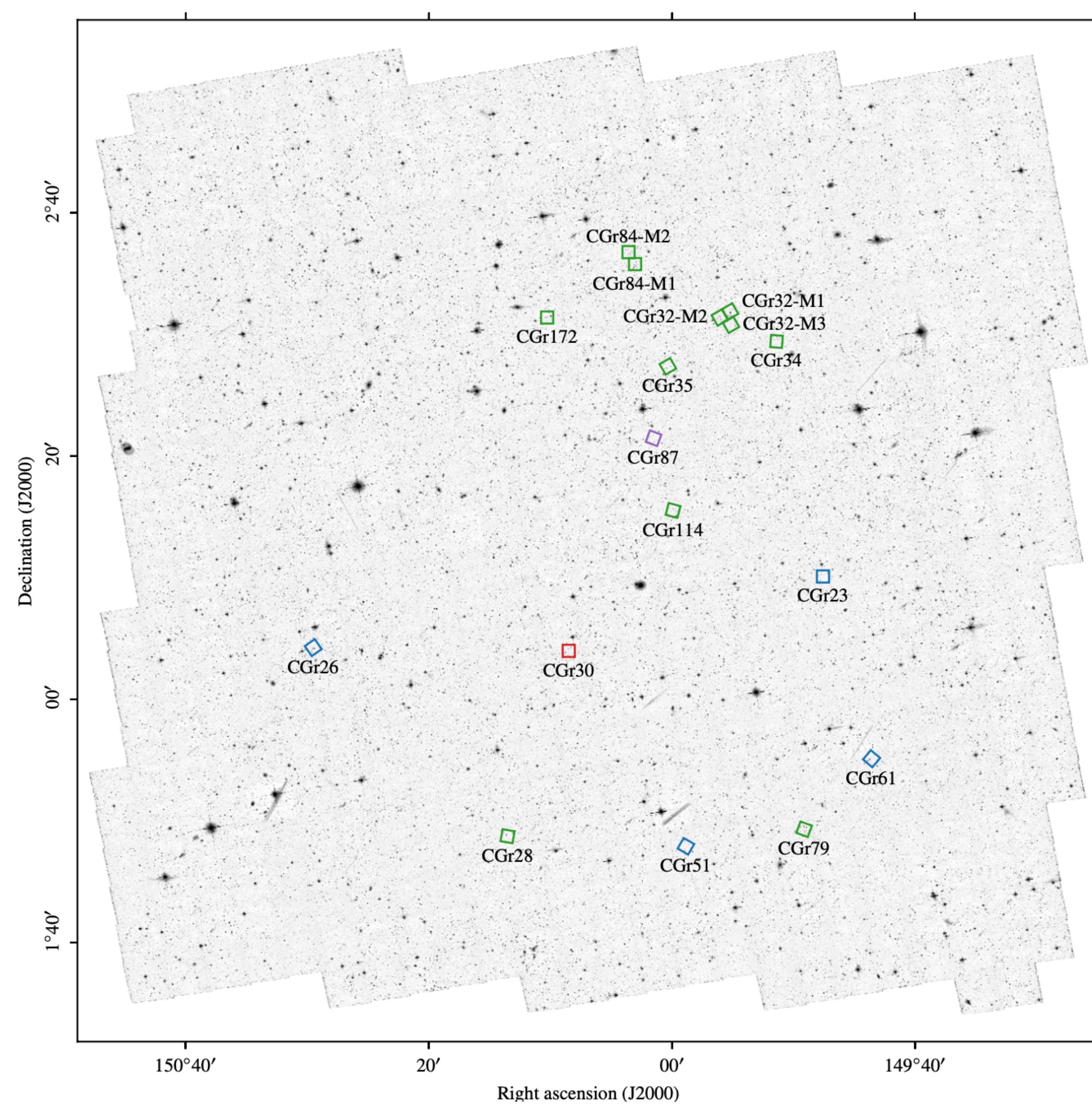
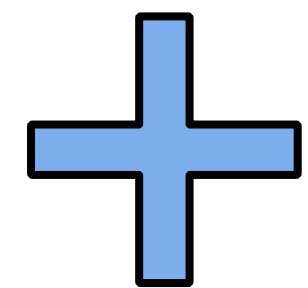


- We measured the spin parameter for 106 galaxies in various MUSE surveys.
- Majority of galaxies are regular rotators (RR) ($\sim 40\%$).
- No evolution seen the λ_R and redshift.
- Sample is dominated by round galaxies
- The environment does not have a strong influence on λ_R , but also that we are not probing very dense regions.

Star formation history of intermediate-redshift galaxies in MUSE surveys



MUSE-Wide footprint



MAGIC sample (Epinat et al. 2023)

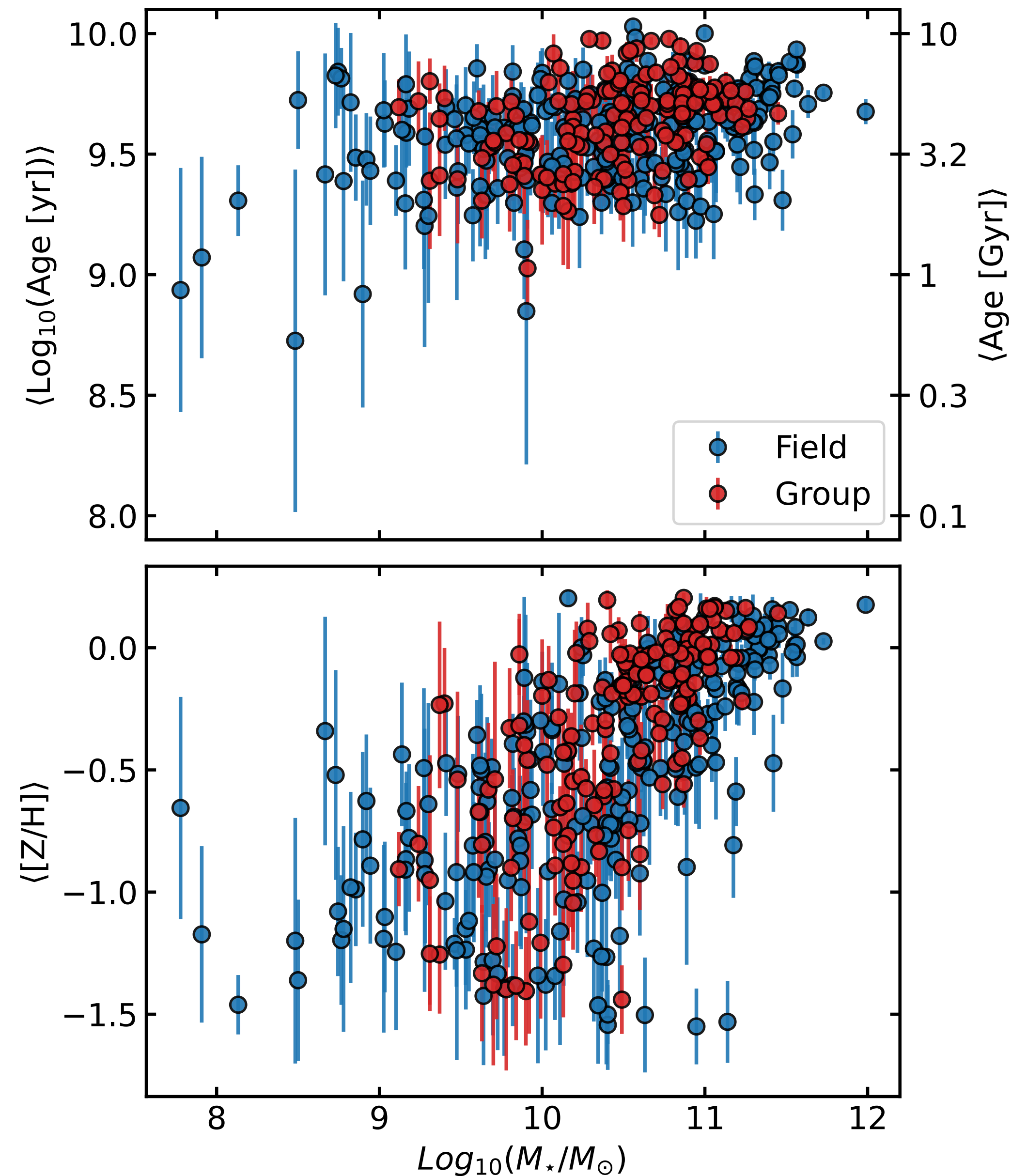
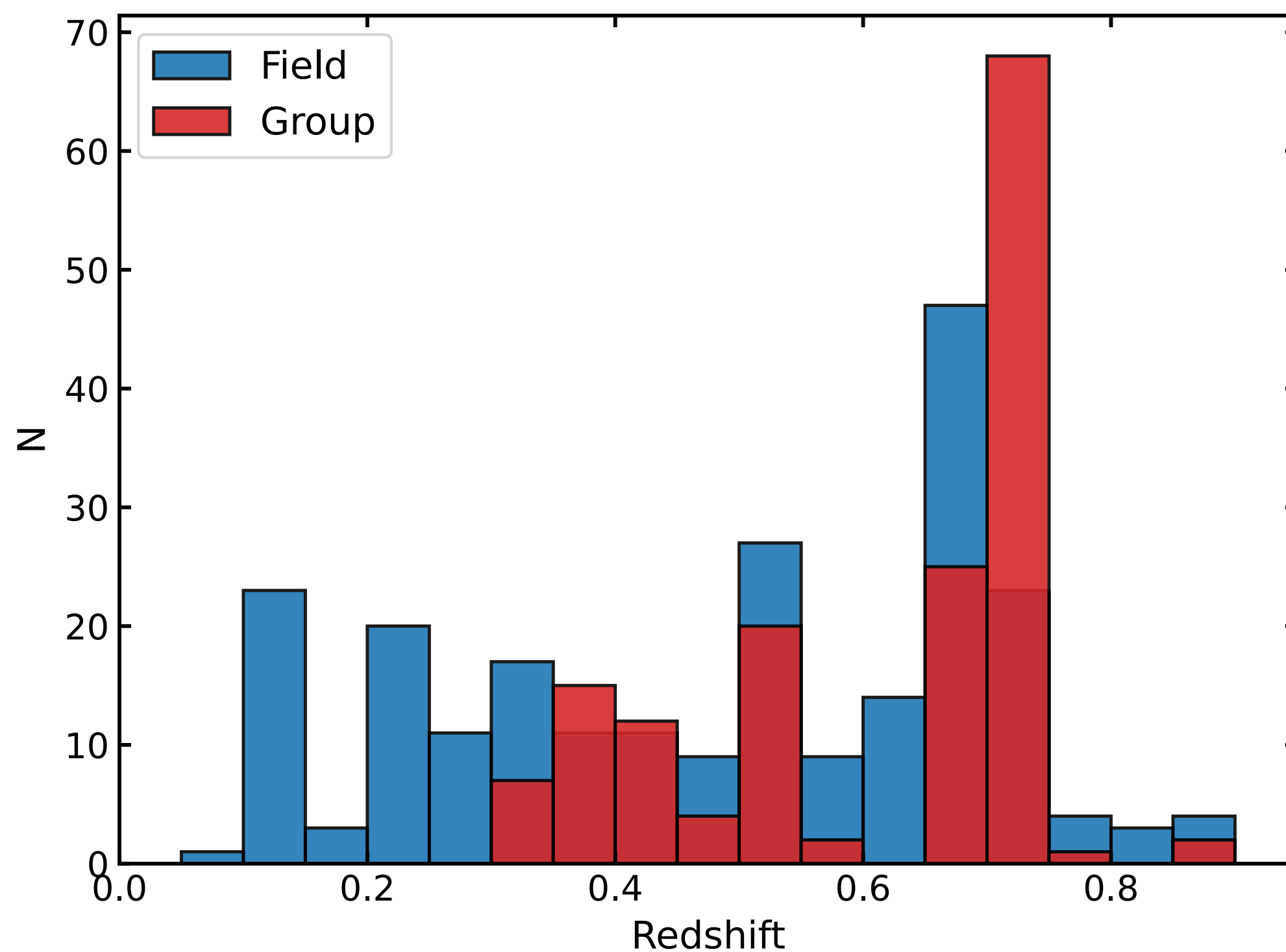
Sample and stellar population parameters

Sample (393 galaxies)

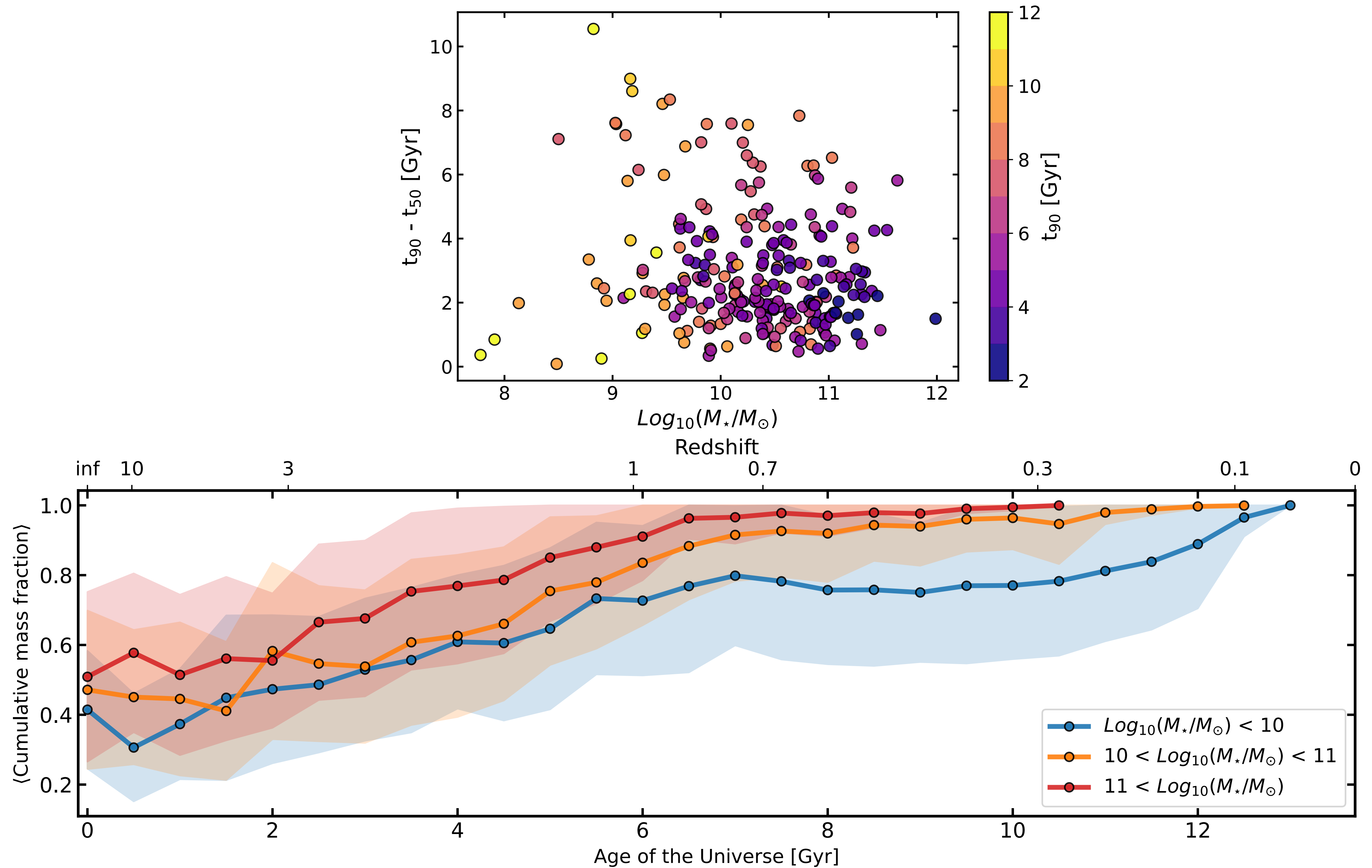
MUSE-Wide footprint: 218 galaxies

MAGIC footprint: 175 galaxies

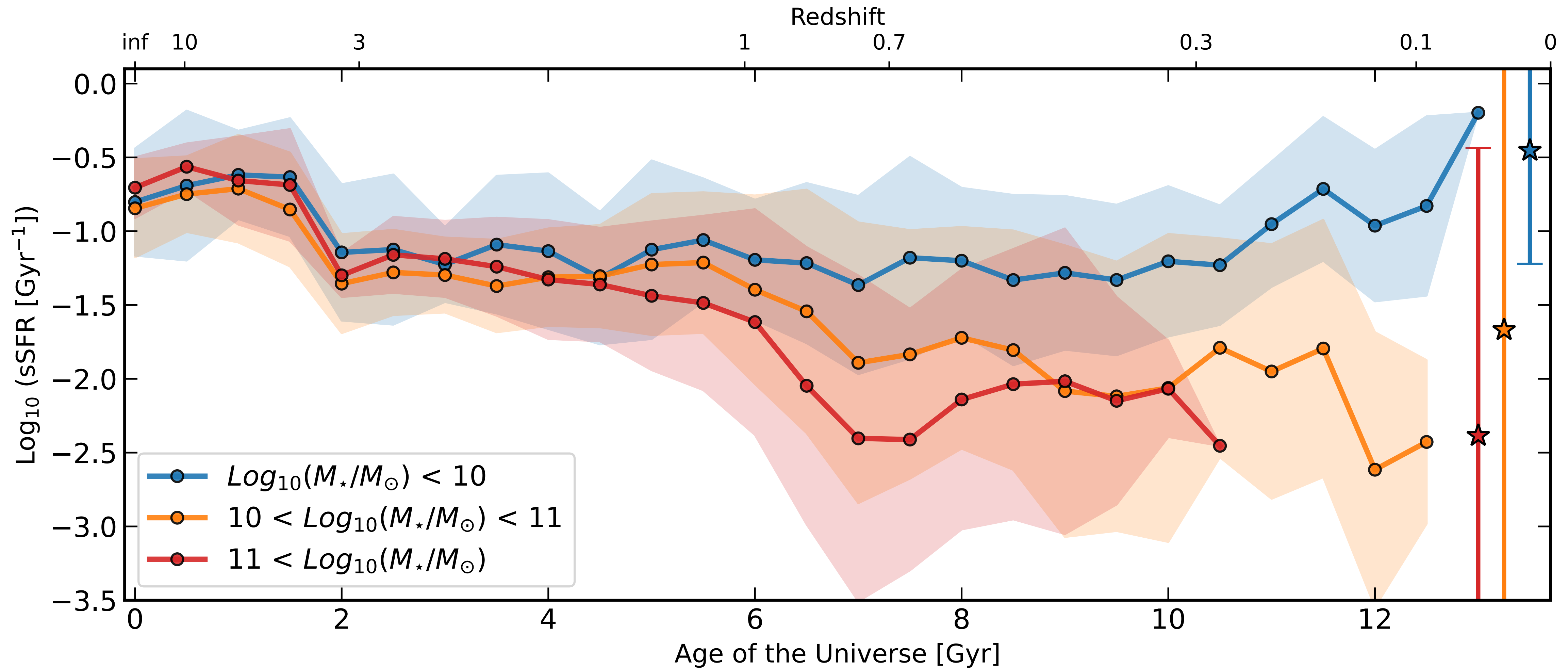
Redshift range: $0 < z < 0.9 \Leftrightarrow$ Cosmic time $\sim 6.3 - 13.7$ Gyr



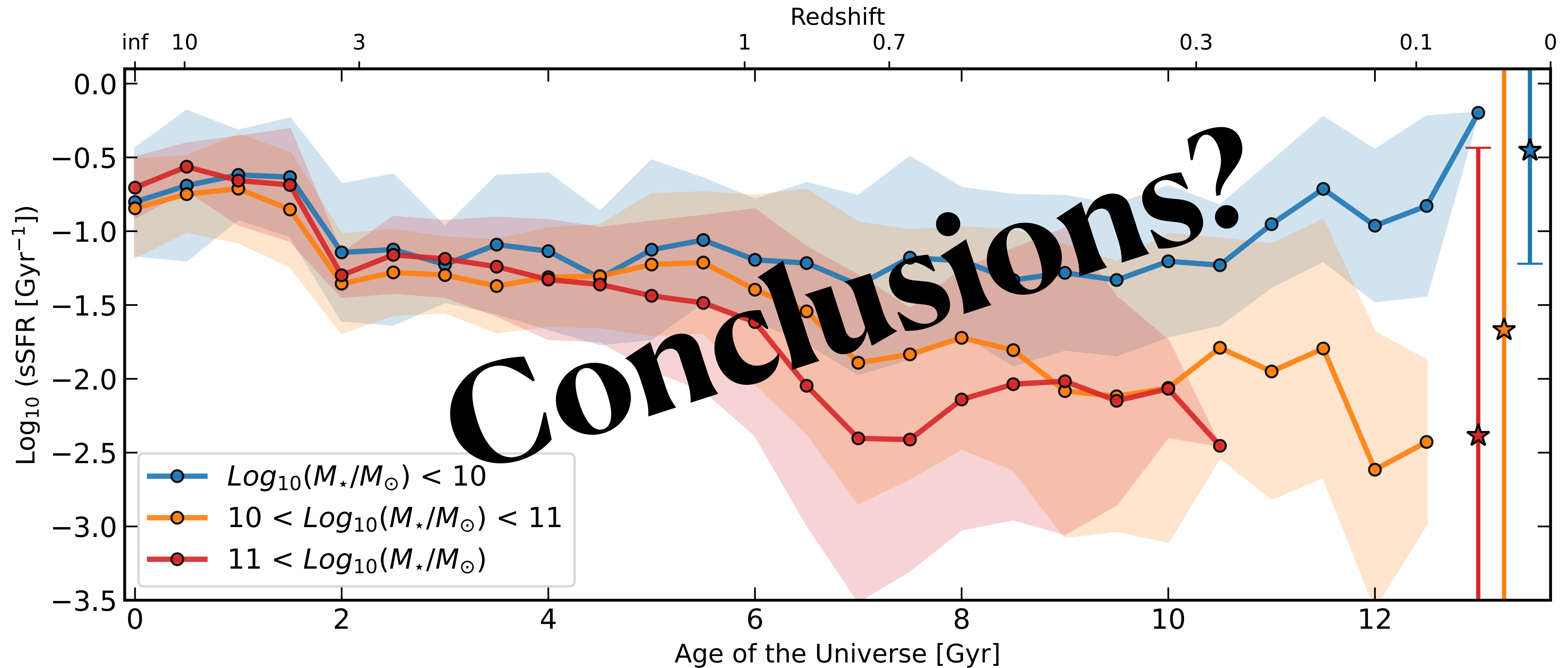
Star formation history of intermediate-redshift galaxies



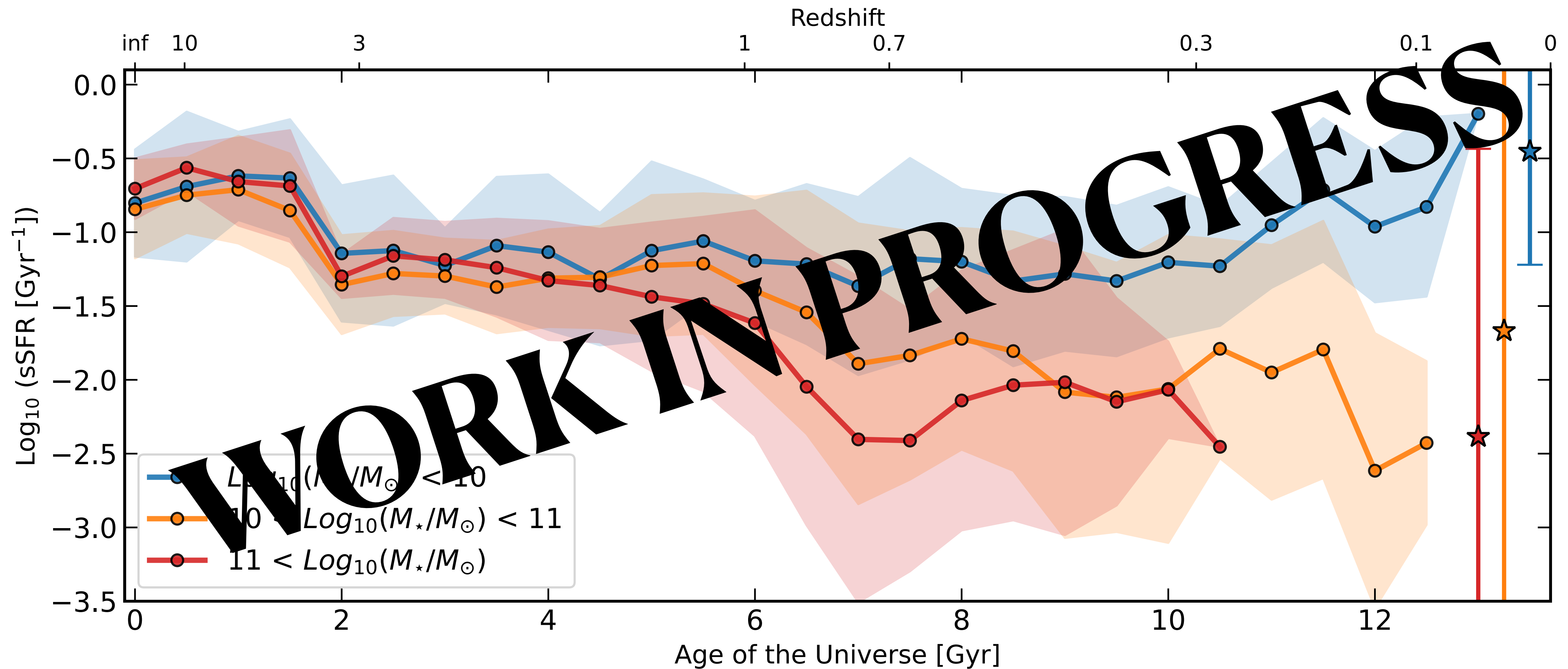
Specific star formation rate $sSFR = SFR/M_*$



Specific star formation rate $sSFR = SFR/M_*$

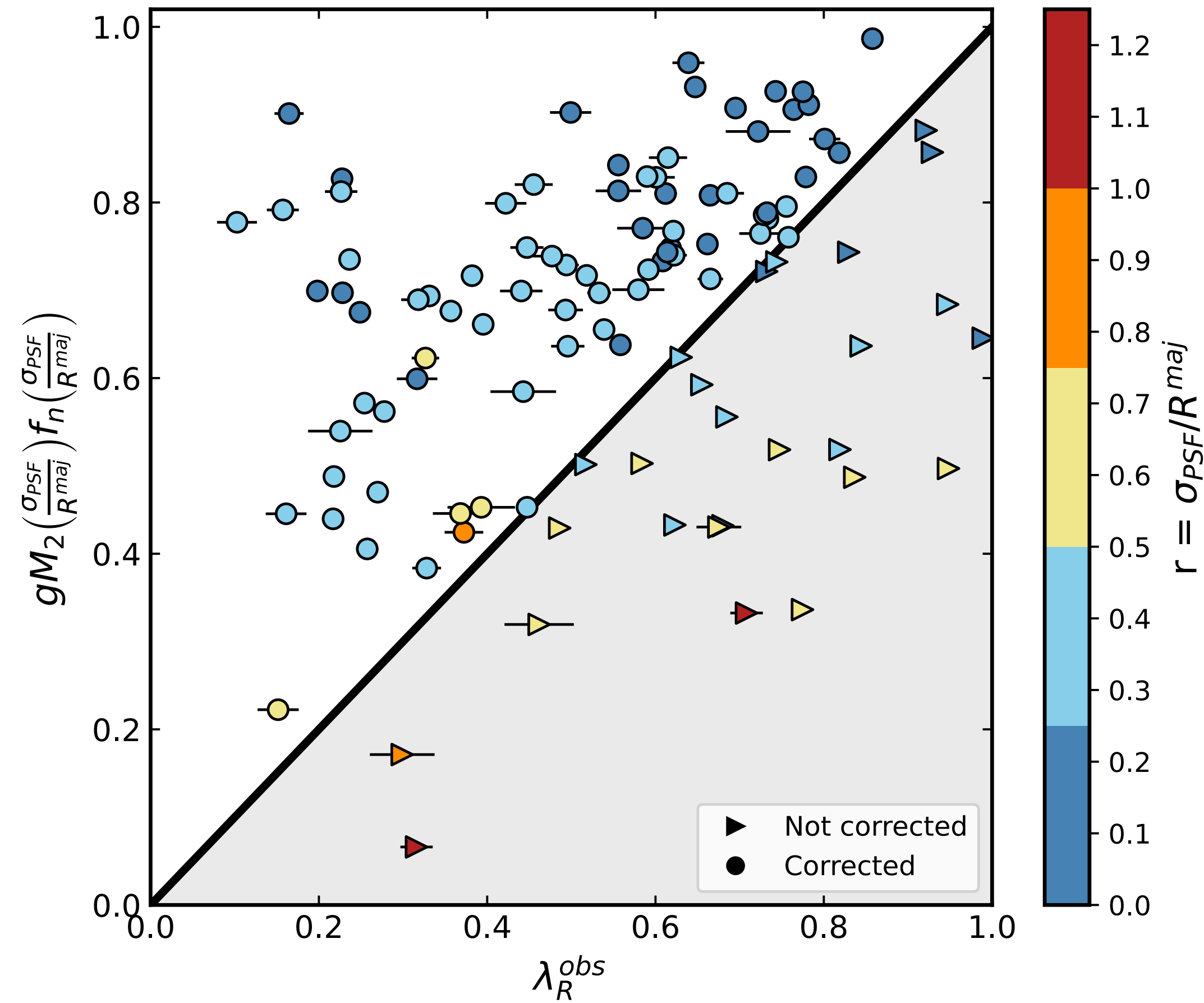


Specific star formation rate $sSFR = SFR/M_*$

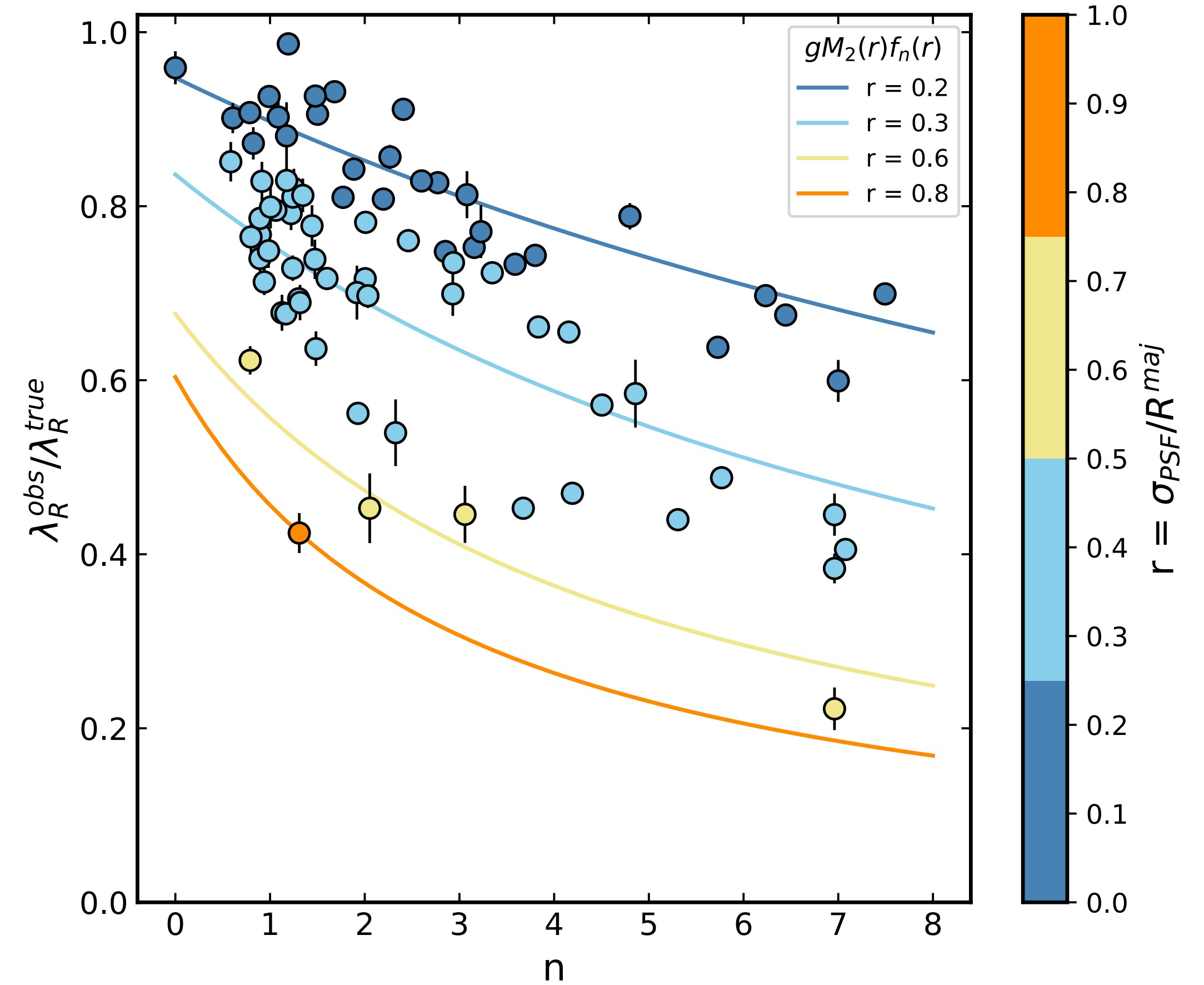


Backup slides

Graham et. al 2018: Atmospheric seeing correction for λ_R



$$\lambda_{\text{Re}}^{\text{obs}} = \lambda_{\text{Re}}^{\text{true}} gM_2\left(\frac{\sigma_{\text{PSF}}}{R_{\text{e}}^{\text{maj}}}\right) f_n\left(\frac{\sigma_{\text{PSF}}}{R_{\text{e}}^{\text{maj}}}\right)$$



where

$$gM_2\left(\frac{\sigma_{\text{PSF}}}{R_{\text{e}}^{\text{maj}}}\right) = \left[1 + \left(\frac{\sigma_{\text{PSF}}/R_{\text{e}}^{\text{maj}}}{0.47}\right)^{1.76}\right]^{-0.84}$$

and

$$f_n\left(\frac{\sigma_{\text{PSF}}}{R_{\text{e}}^{\text{maj}}}\right) = \left[1 + (n-2) \left(0.26 \frac{\sigma_{\text{PSF}}}{R_{\text{e}}^{\text{maj}}}\right)\right]^{-1}$$

Measured (observed) stellar angular momentum (λ_R)

