Chemical evolution: Metallicity Gradients in Discs

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Chemical evolution and galaxy formation

Combining the chemical abundances and dynamical properties of baryons in galaxies is a powerful tool to understand how galaxies formed.

The treatment of chemical evolution within cosmological simulation (Mosconi et a. 2001, Lia et al. 2002) opens the possibility to follow the formation of structure and the evolution of chemical abundances in the gas and stellar components.

It is also a challenge for galaxy formation to reproduce chemo-dynamical patterns, since the physical processes take place act at different spatial and time-scales:

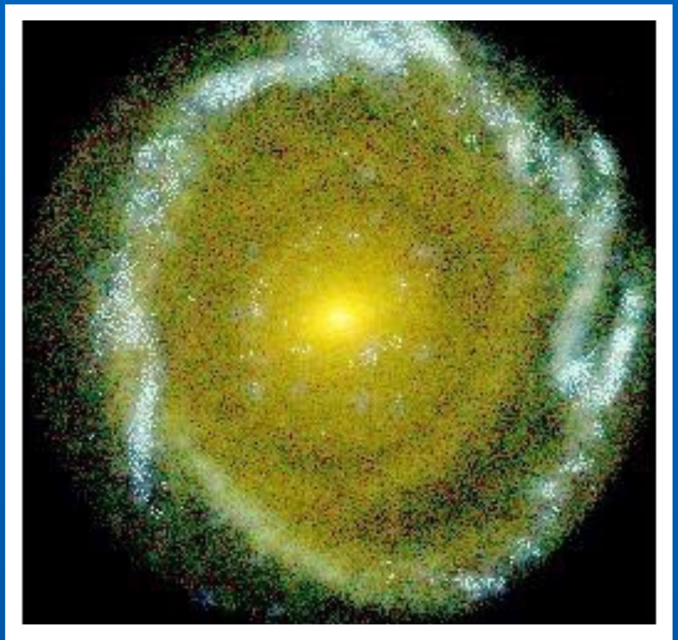
+ galaxy assembly
+ gas cooling
+ star formation and stellar evolution
+ feedbacks
+ environmental effects

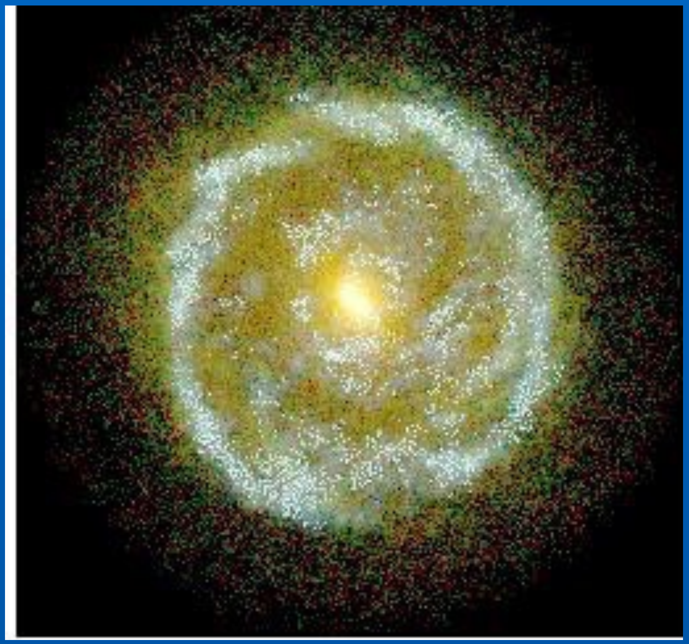
Metallicity profiles in disc galaxies:

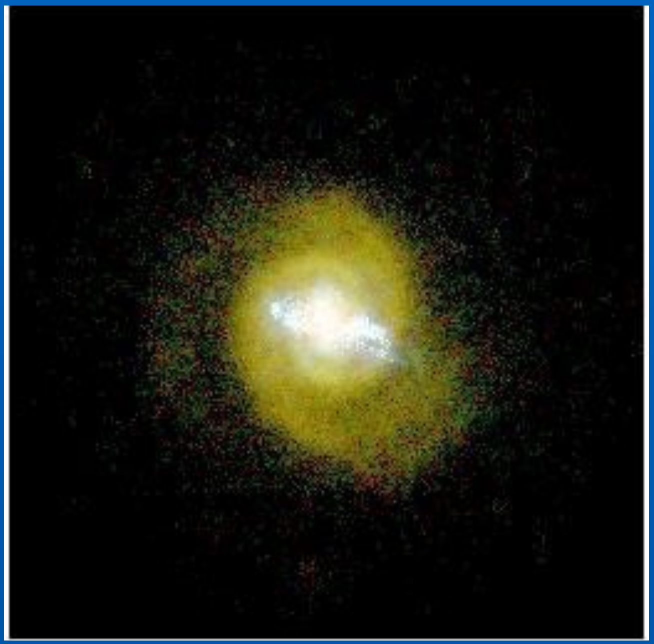
The ISM of disc galaxies show metallicity gradients in the gas-phase which have negative slopes (e.g.Zaristiky+1994; Garnett +1997; Sanchez etal 2014). Positive gradients are detected in interacting galaxies (e.g.Kewley+2006; Rupke+2010).

The stellar metallicity profiles are metallicity gradients in the stellar populations are now being revealed by surveys such as CALIFA.

The evolution of the gas-phase is still controversial with some observations suggesting steeper slopes at high redshifts. Numerical models provide trends which depend on the SN feedback models (Pilkington+12, Gibson+13, Machado+16).







We analyse gas-phase and stellar componentes of 37 discs formed within LCDM (Pedrosa & Tissera 2015;Tissera+2016)

Code: P-Gadet3 with SN feedback (Scannapieco+09), SNII and SNIa chemical yields.

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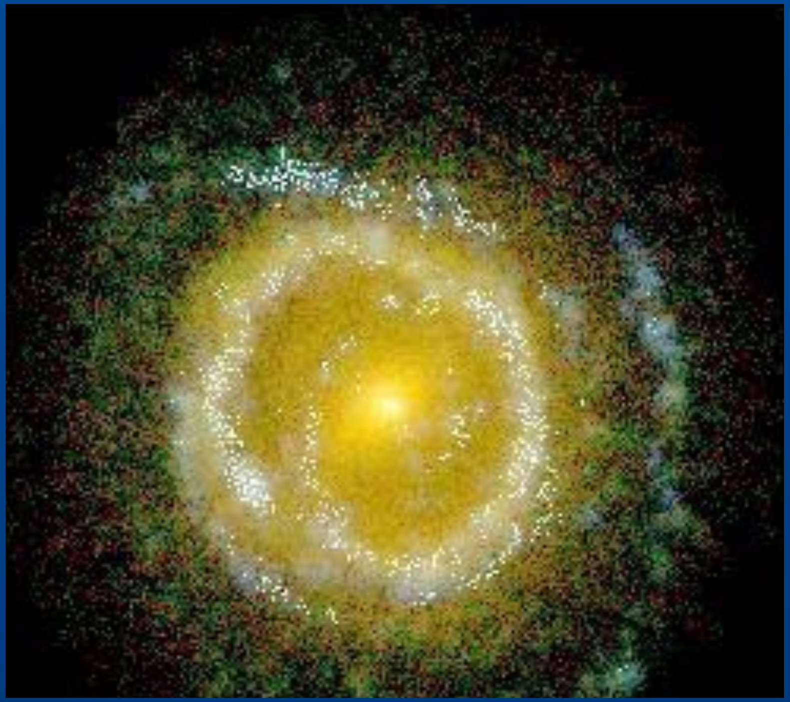
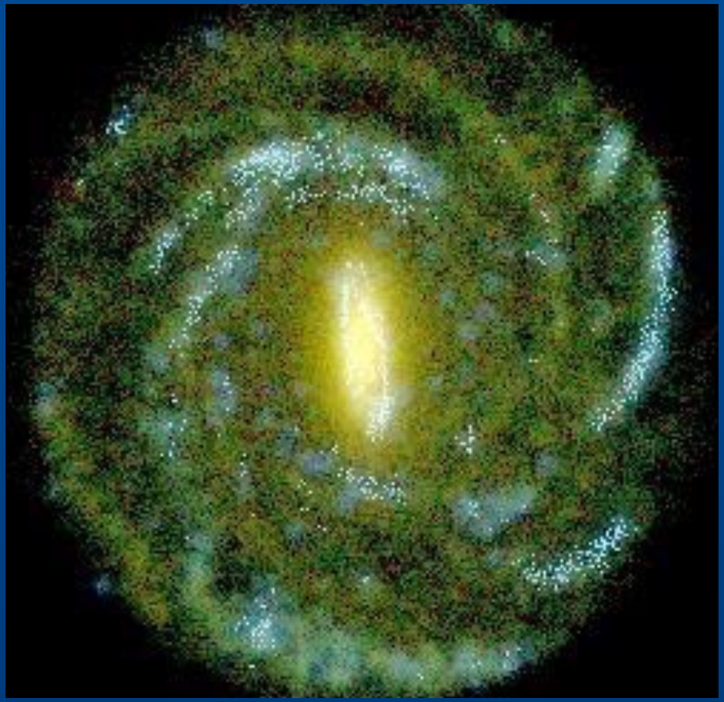
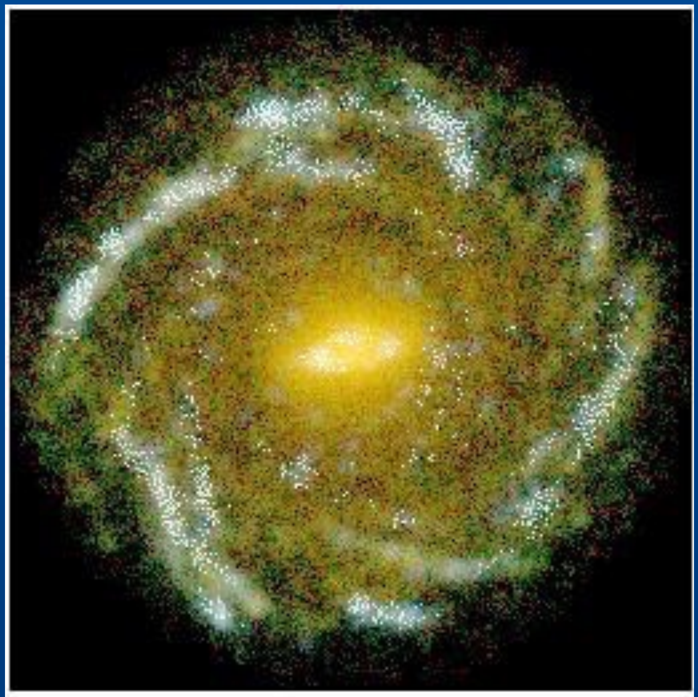
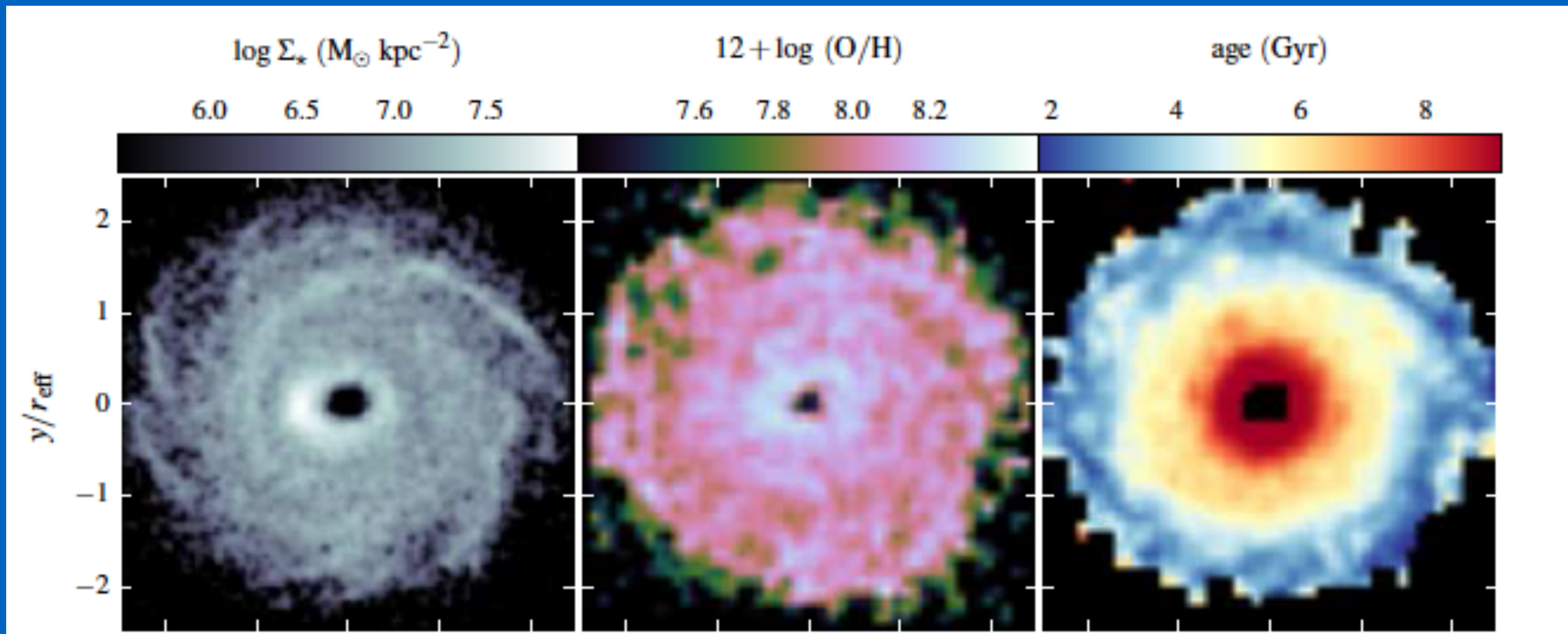
J. Vilchez (IAA), P. Sanchez-Blazquez (PUC), S. Sanchez (INAO), O. Snaith (Korea)



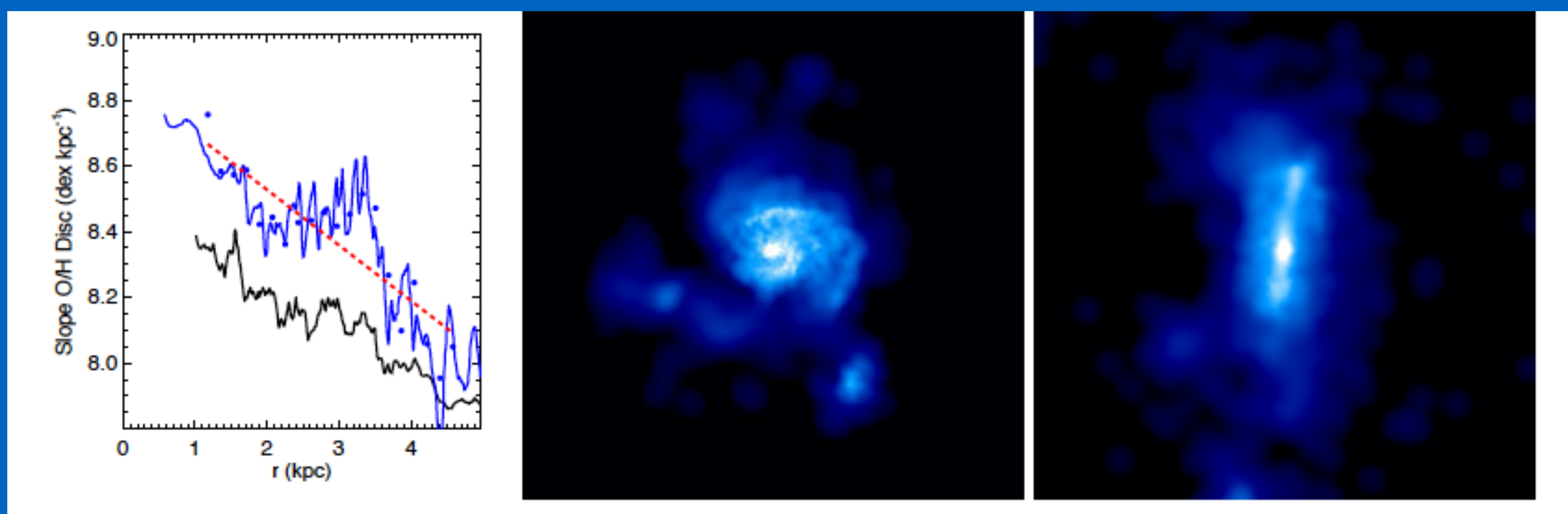




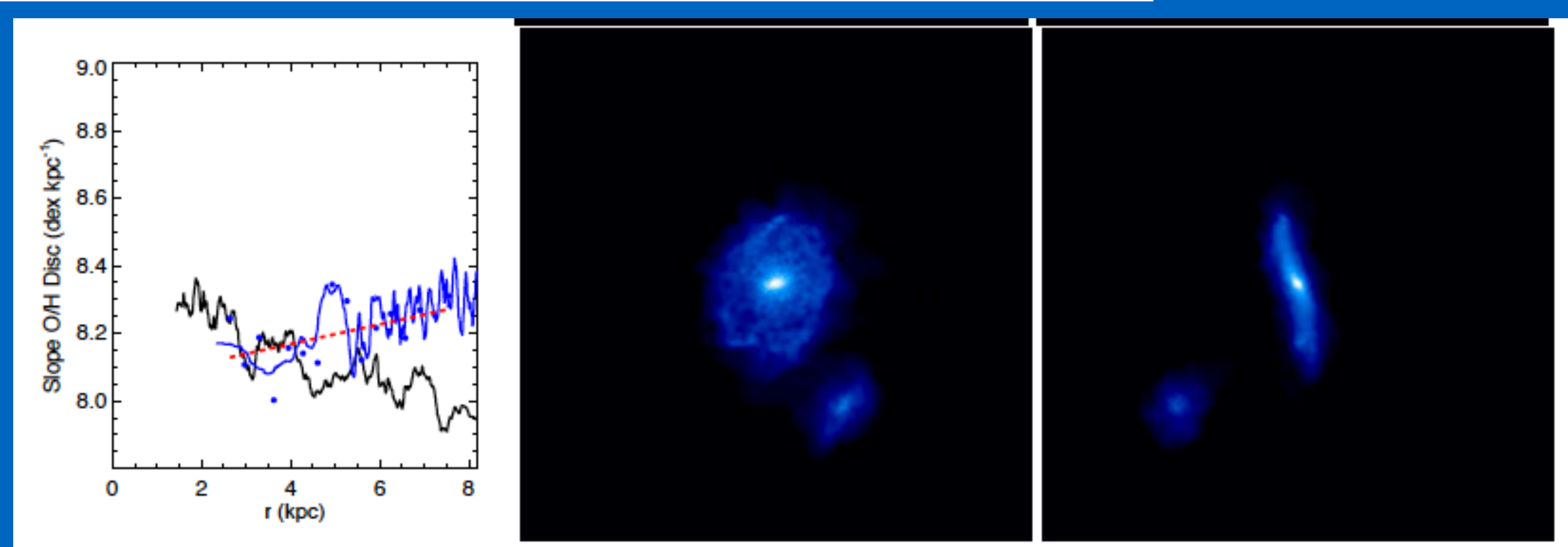
Courtesy of Lucas Bignone & J.Mateo-Muñoz



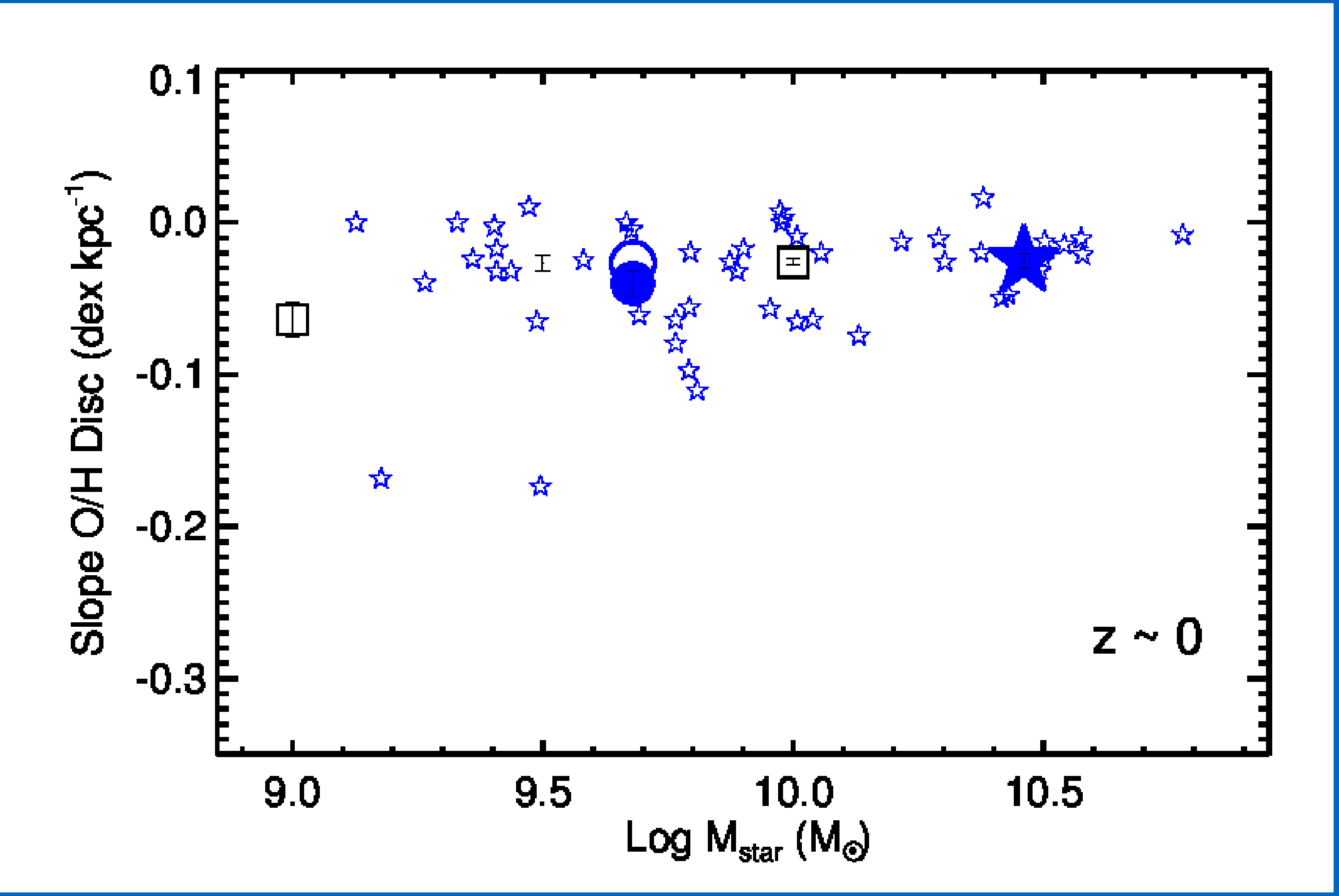
Stellar discs



Gas-phase discs



Gas-phase metallicity profiles



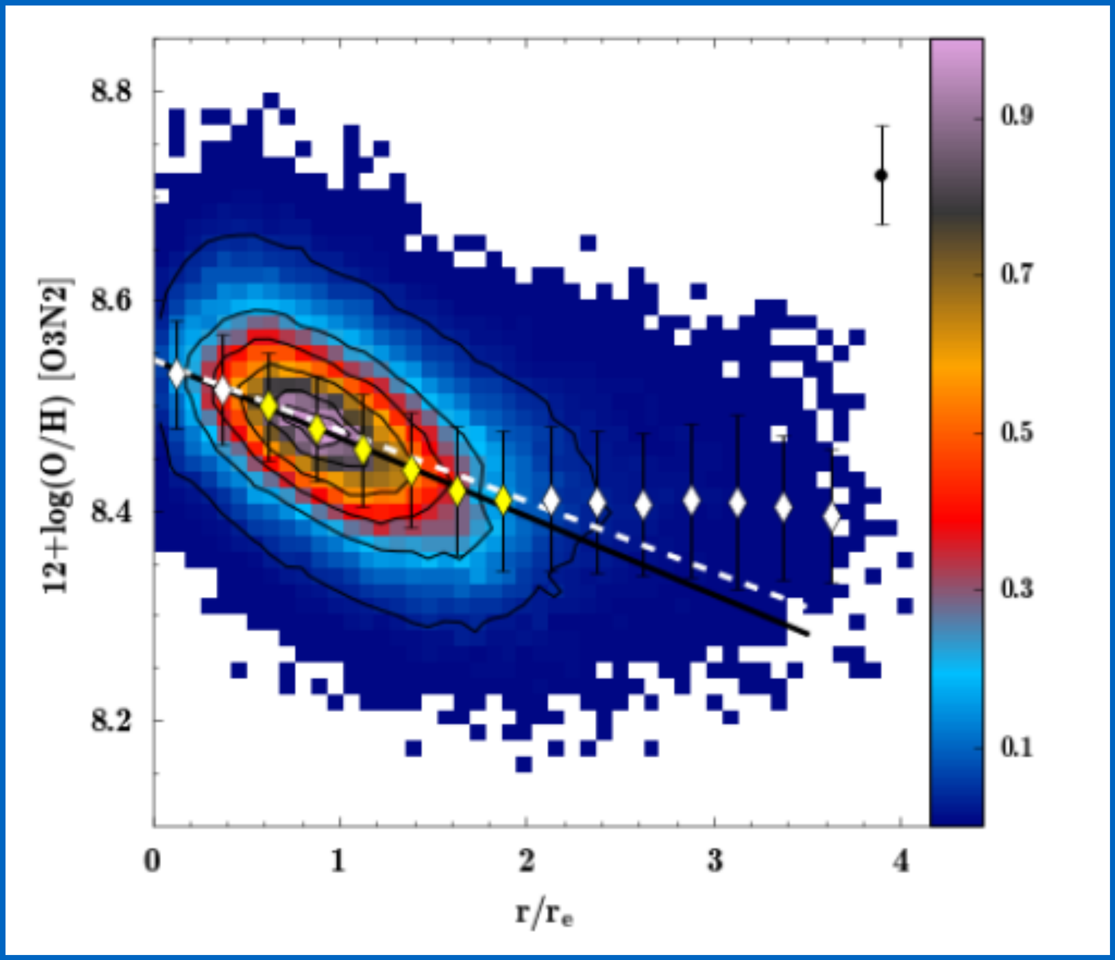
Mo < 10^{10} M_{star}	-0.041 ± 0.008
Mo > 10^{10} M_{star}	-0.025 ± 0.005

□ Ho et al. 2014 ☆ Median Slopes

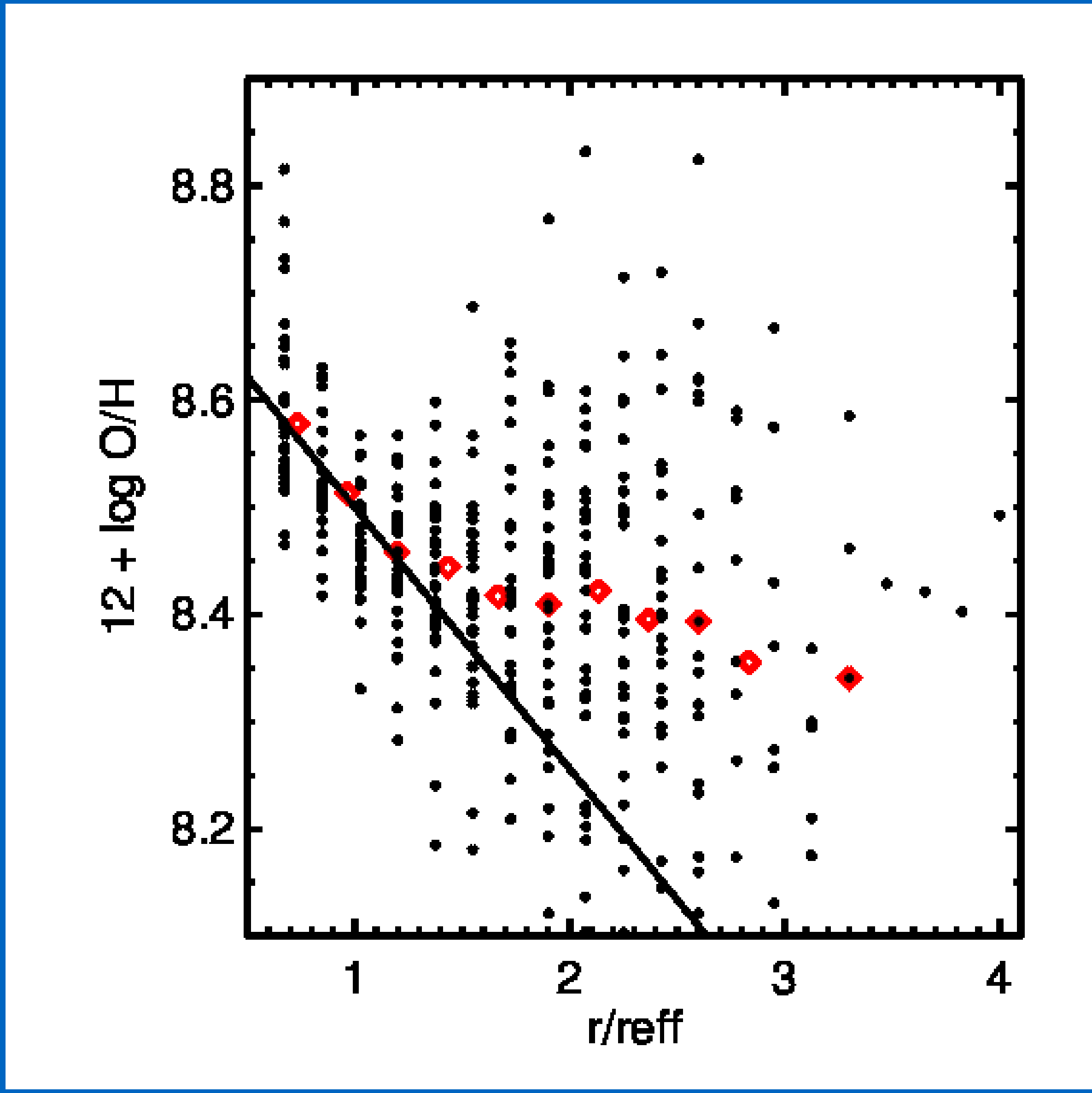
Gas-phase metallicity profiles

Normalized metallicity gradients are consistent with the existence of a benchmark metallicity gradient (Sanchez+2013;Ho+2014; Sanchez-Menguiano+2016)

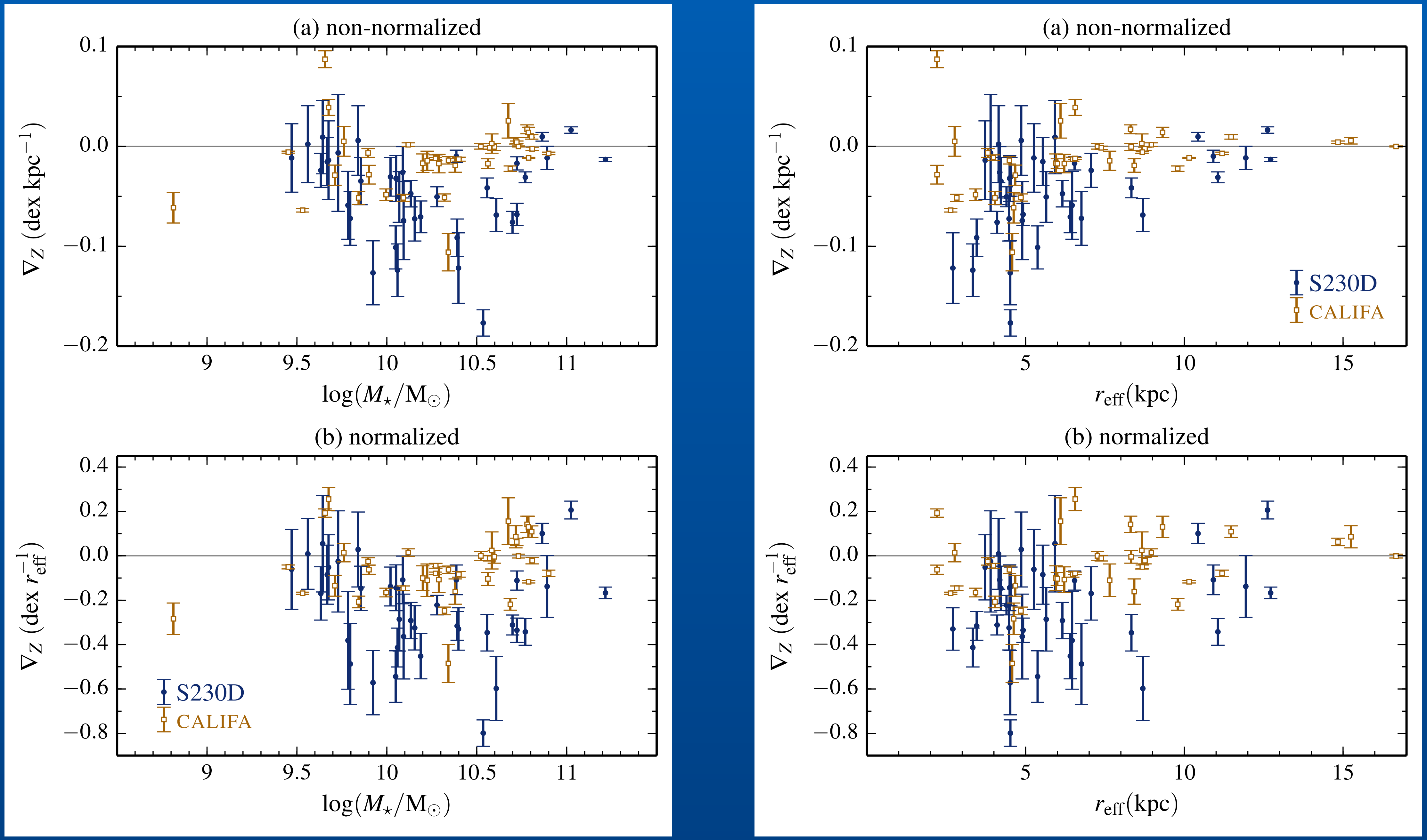
The simulated mean slope is ~ -0.19 (0.19)dex/reff



Sanchez-Menguiano+2016

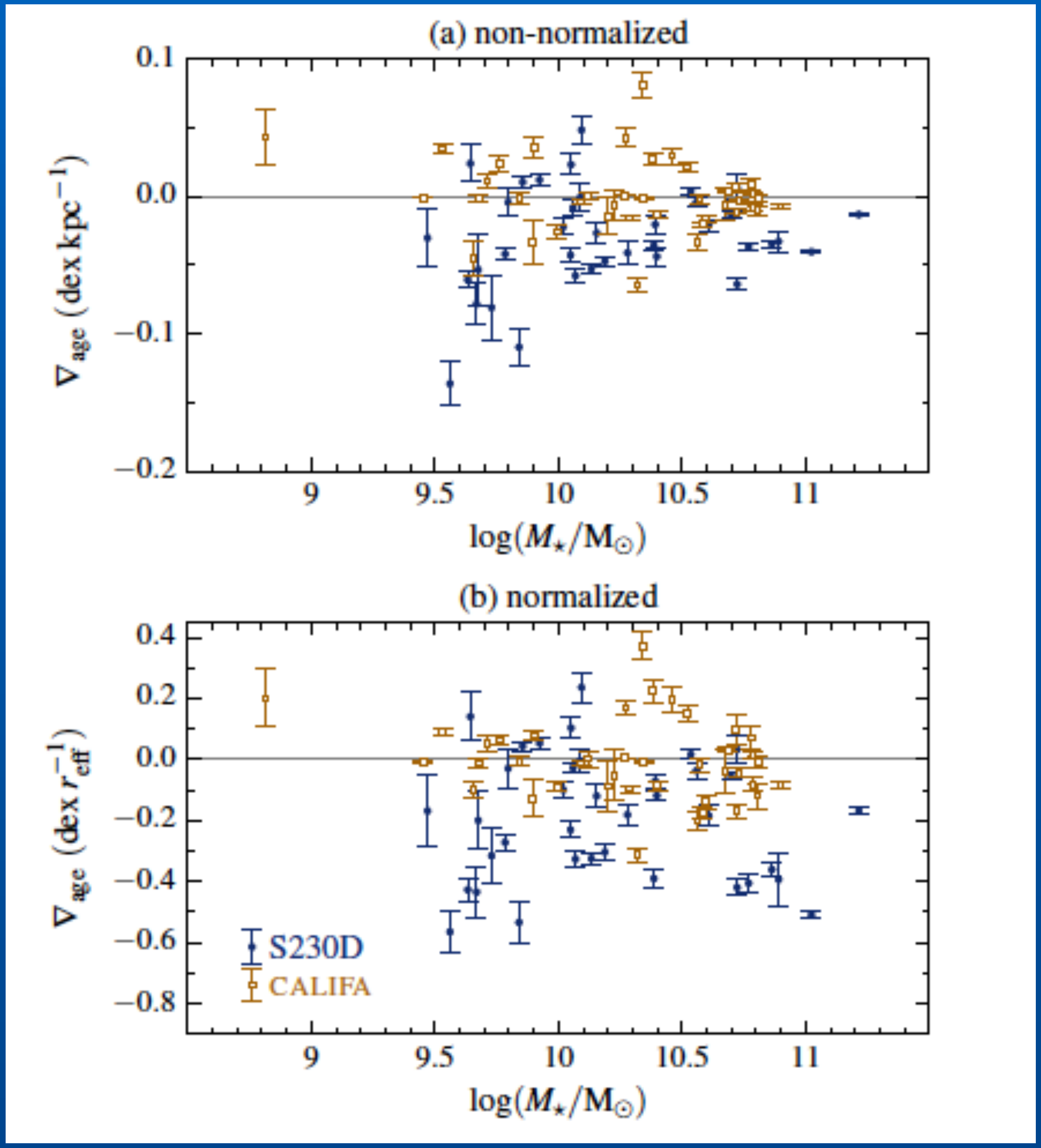


Metallicity gradients of the disc stellar populations



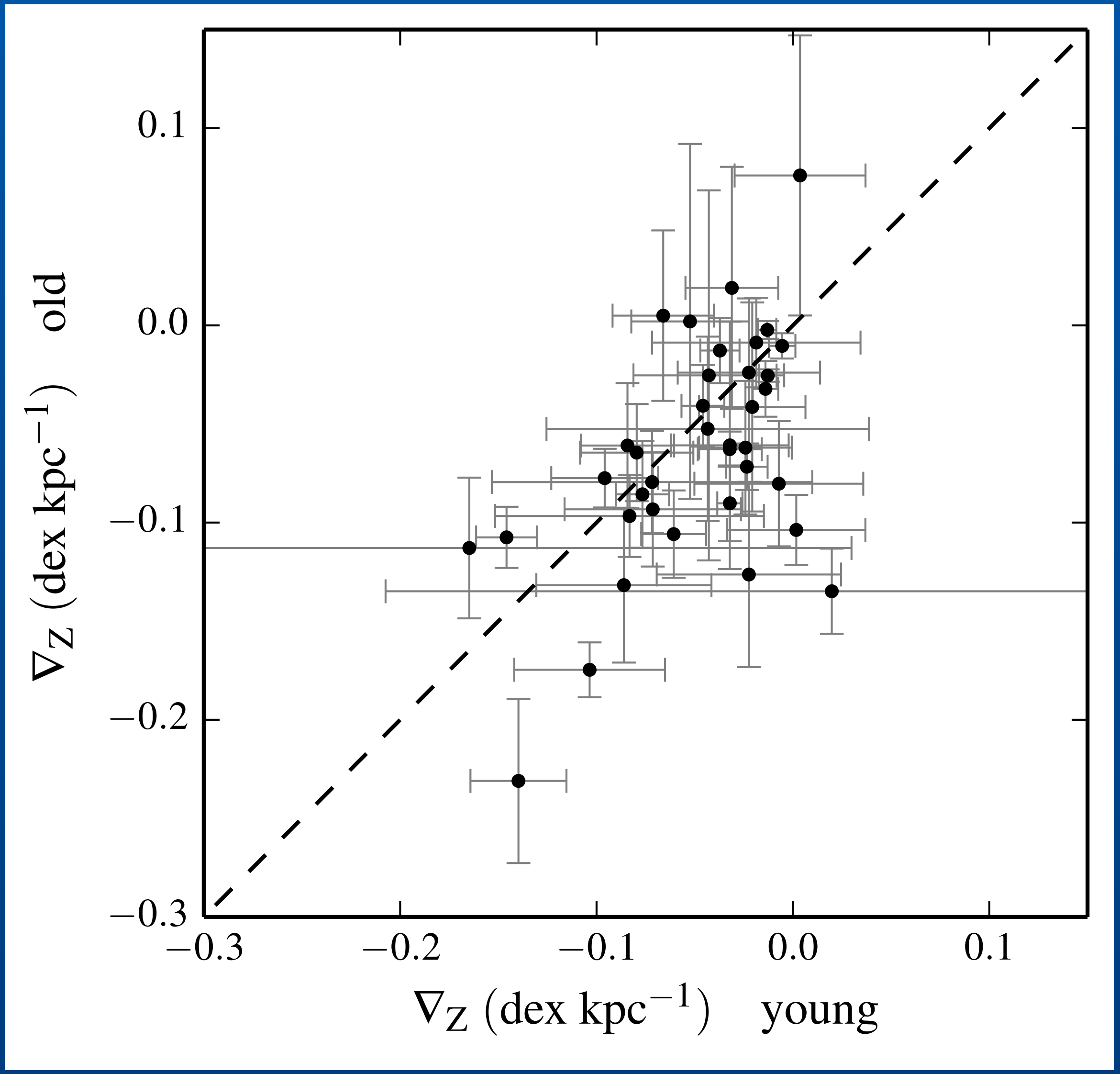
Tissera+2016 submitted

Age gradients

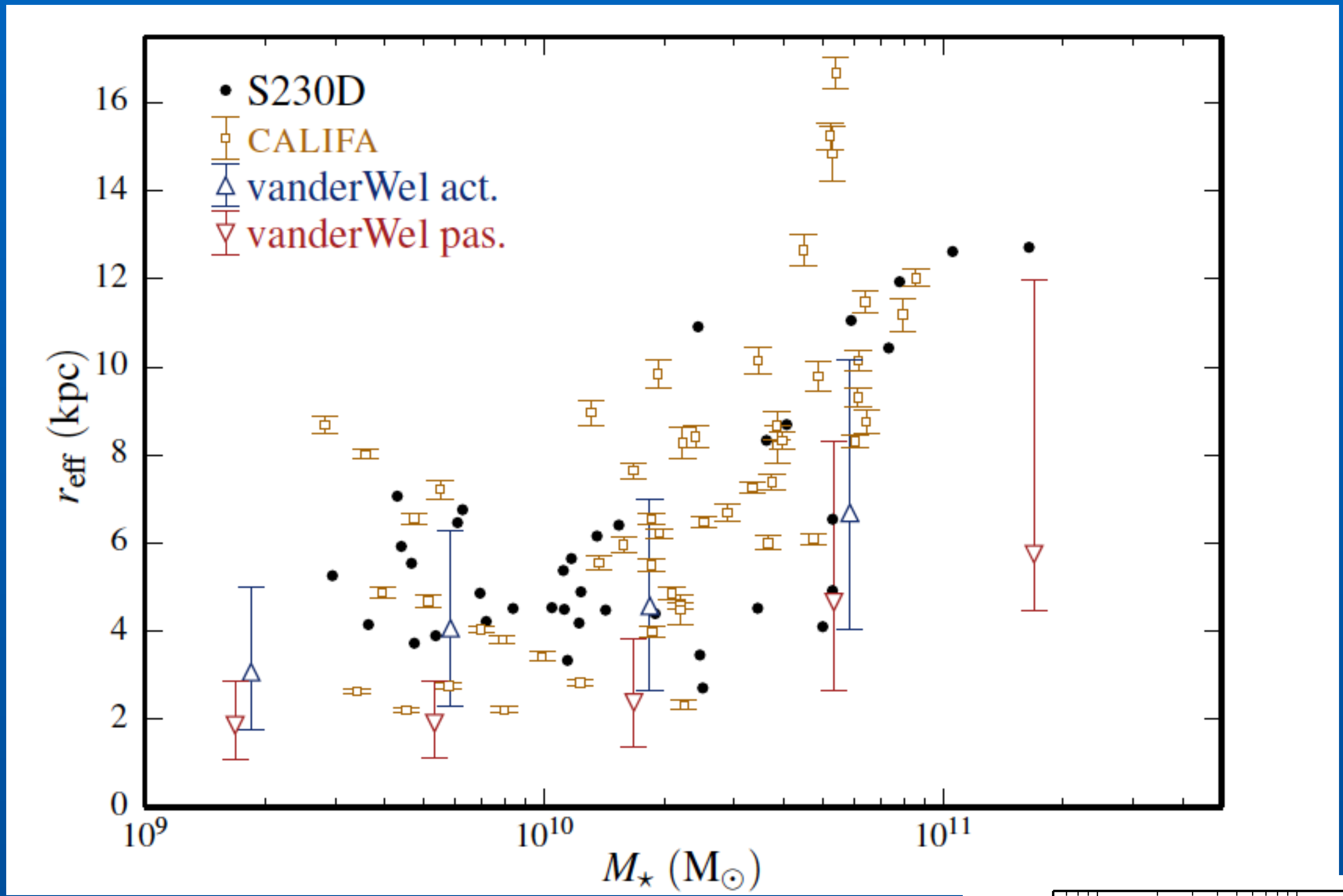


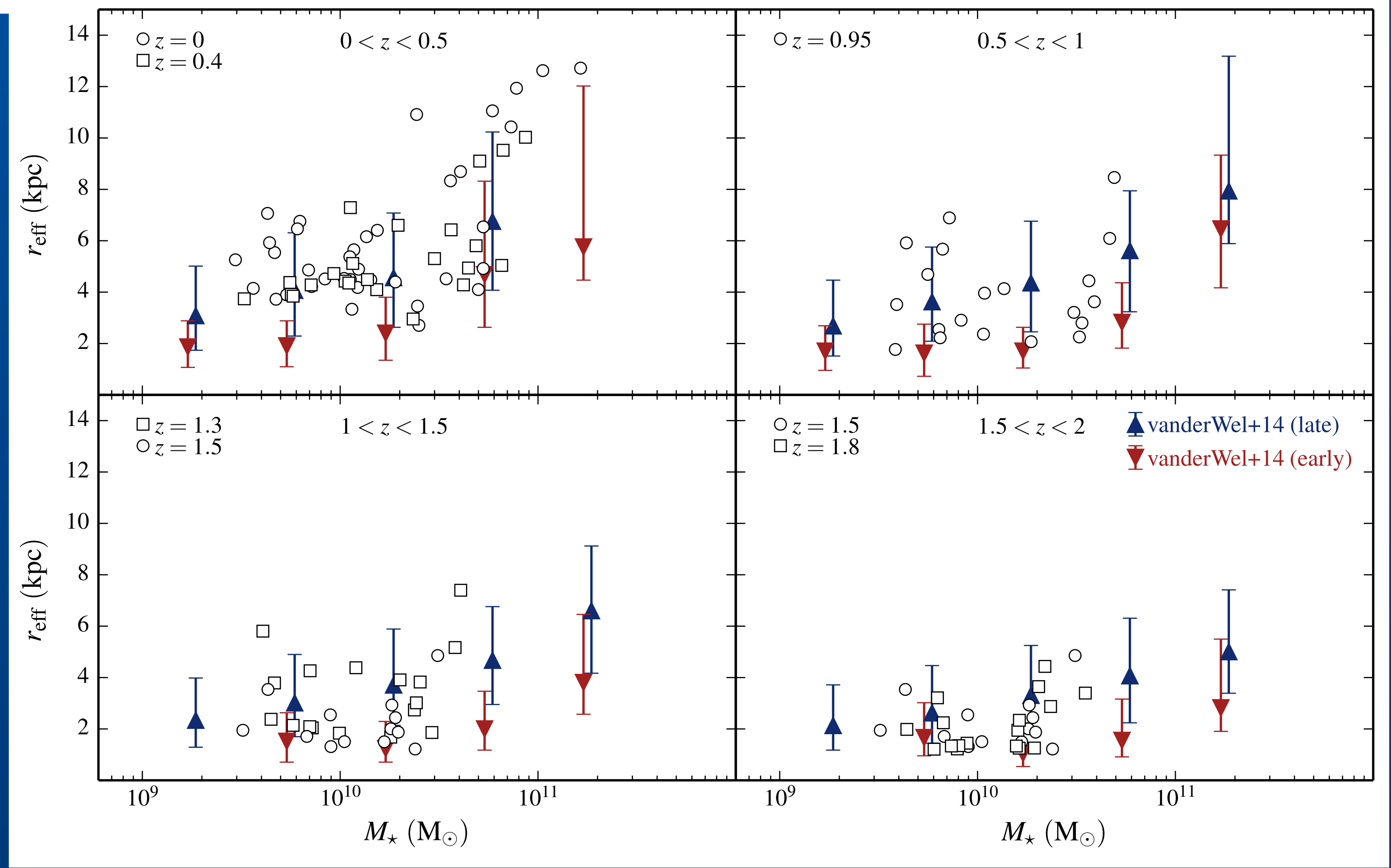
Age profiles seem to be steeper in the simulated discs.

Old SPs have slightly steeper metallicity gradients than the young SP (~0.02 dex).

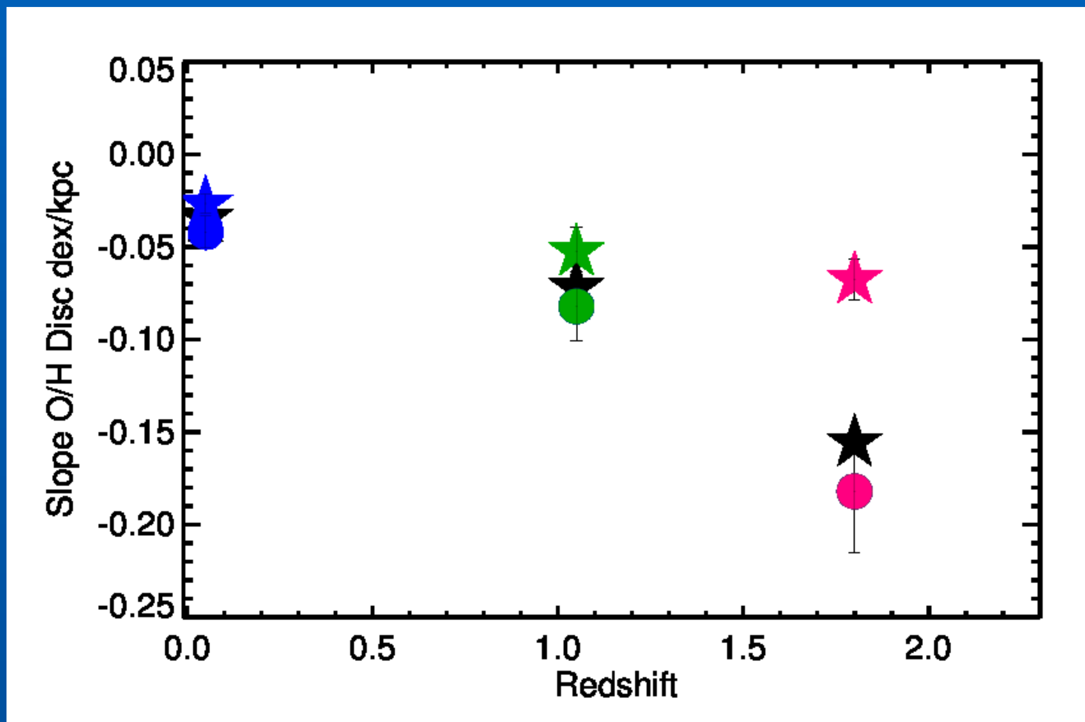


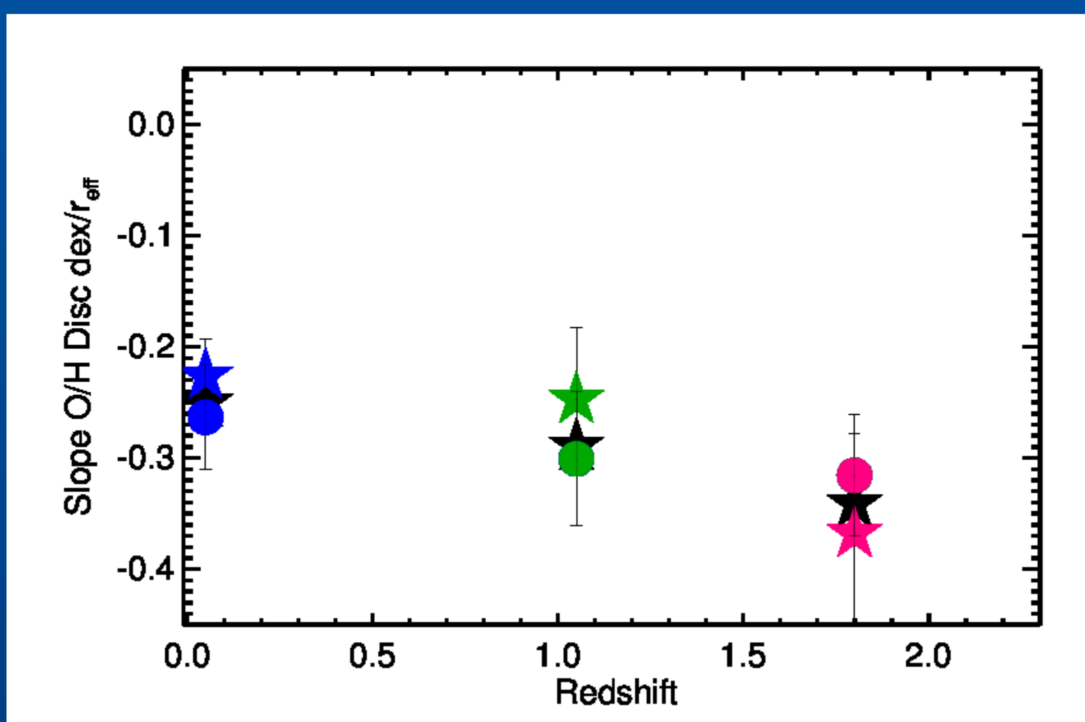
Half-mass radius of the simulated discs

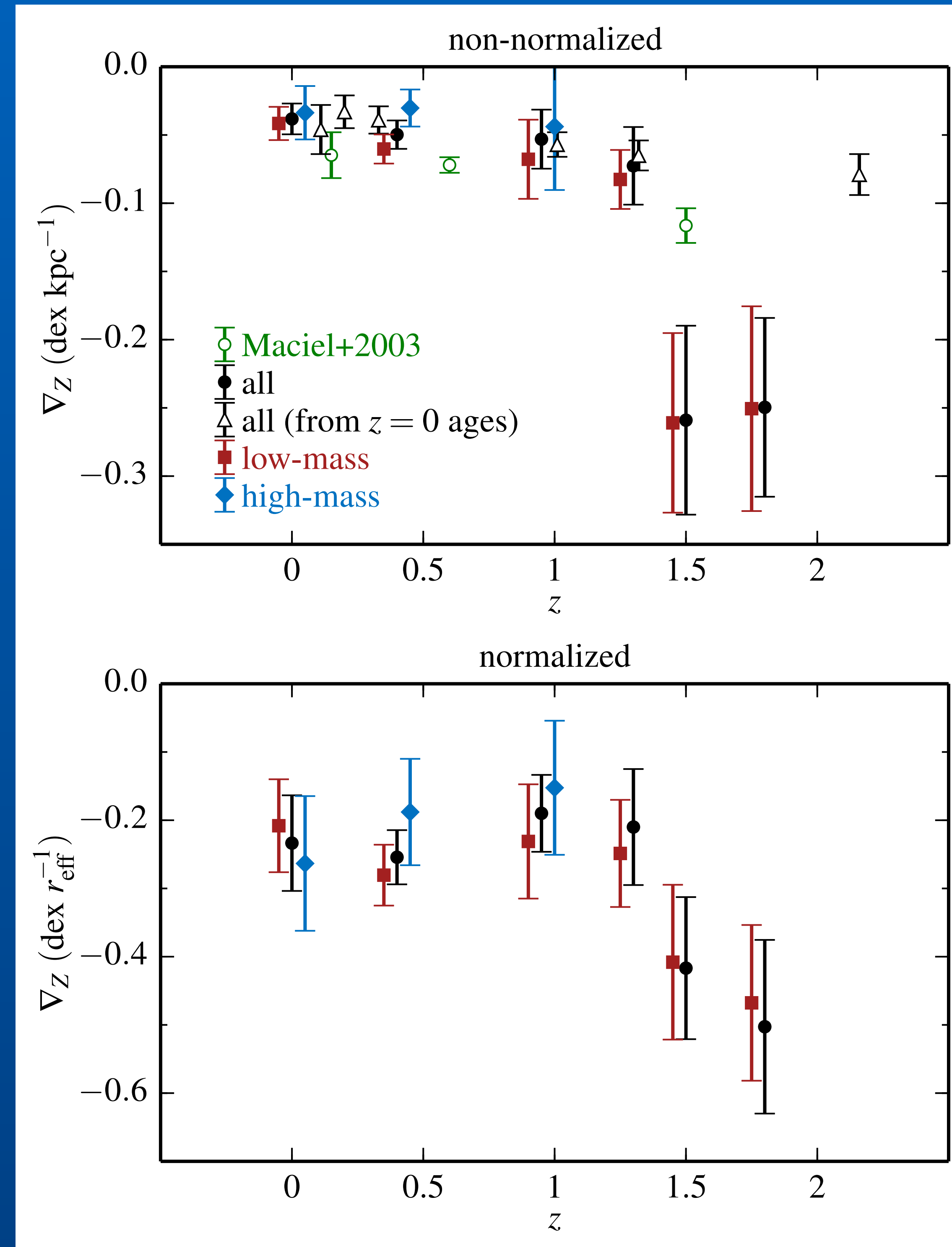




The evolution of the metallicity gradients

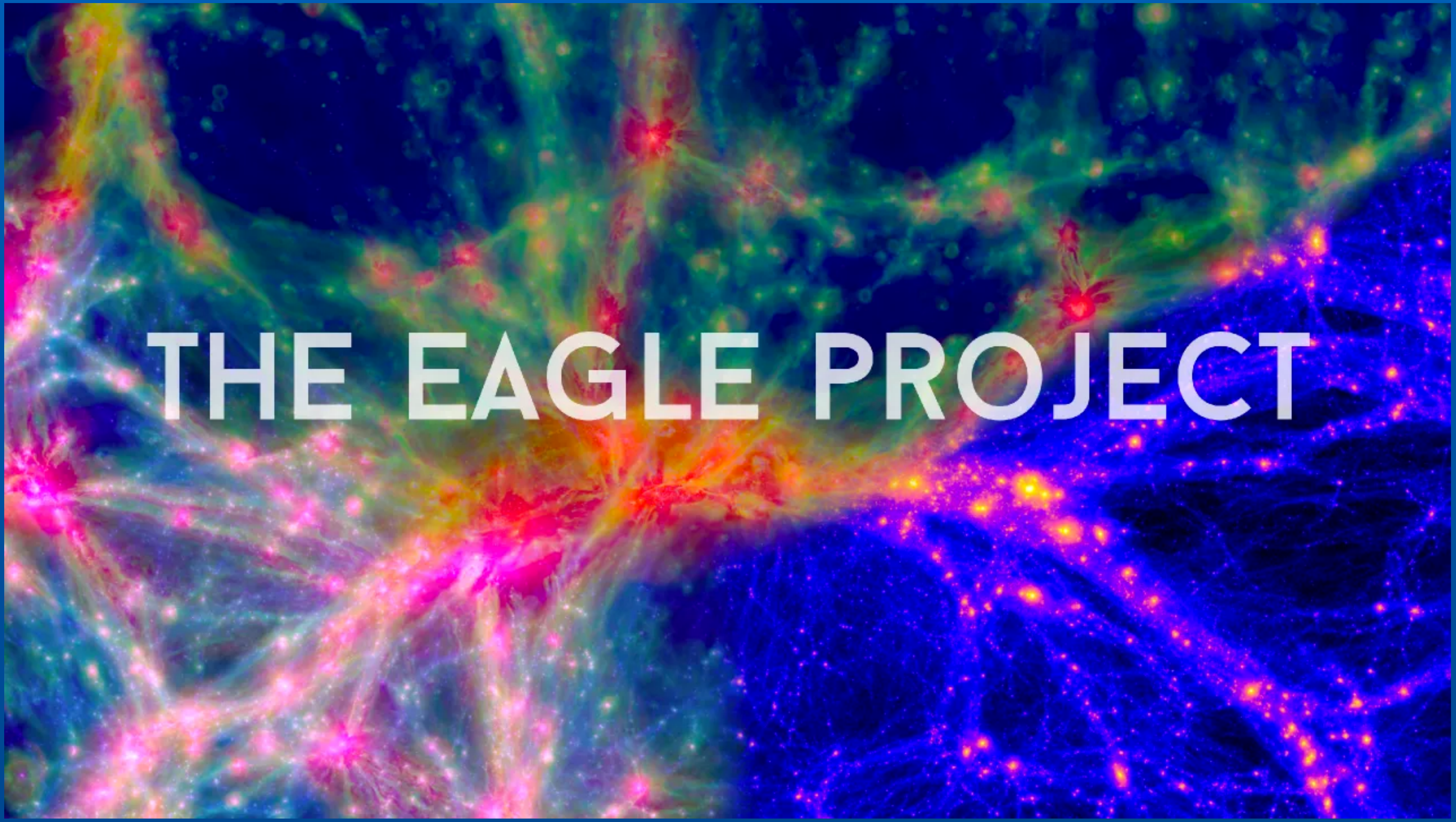






Evolution of the gas-phase gradients ~0.04 dex (z=0-1)

Evolution of the SP gradients ~0.03 dex (z=0-1)
From the old/young stars at z=0 ~0.02 dex



coming out soon

Conclusions

Simulated discs formed inside-out, conserving specific angular momentum and have characteristic radii in agreement with observations.

What can be reproduced on average?
+Metallicity gradients in the gas phase and SPs at z=0.
+The half-mass radius as a function of stellar mass.
+There is 'benchmark metallicity gradient' in the gas-phase at z ~0.
+The SPs show a characteristic metallicity gradients up to z ~1.

What is not reproduced?
+Simulated age profiles are steeper.
+Discs seems younger in outer parts compared to observed estimations.
+For z > 1 metallicity profiles are steeper.

On-going work:

+We are cross correlating the properties of the SP and gas-phase metallicity profiles and follow back the history gas from where stars formed in the discs.
+We are extending the analysis to Eagle simulation: larger sample to get more robust statistical trends.