STELLAR POPULATIONS IN TYPE IA SUPERNOVA HOST GALAXIES AT INTERMEDIATE-HIGH REDSHIFT: STAR FORMATION AND HISTORIES

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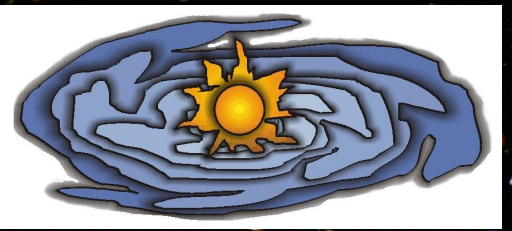


OUTLINE

INTRODUCTION

- The study of type Ia supernovae along a range of redshift was the key to discover the accelerated expansion of the universe
- This kind of supernova are very useful because they are standarizable using a relationship between the peak brightness, the width of their light curve and their color
- However, this standardization technique has been trained in the local universe that has solar metallicities and ages
- We want to study the effect of the stellar metallicity of the galaxies that host type Ia supernovae in the modulus distance of the supernova
- This work is a continuation of our project to study the metallicities of galaxies that host a type Ia supernovae (Moreno-Raya 2016a,b and Moreno-Raya 2018)

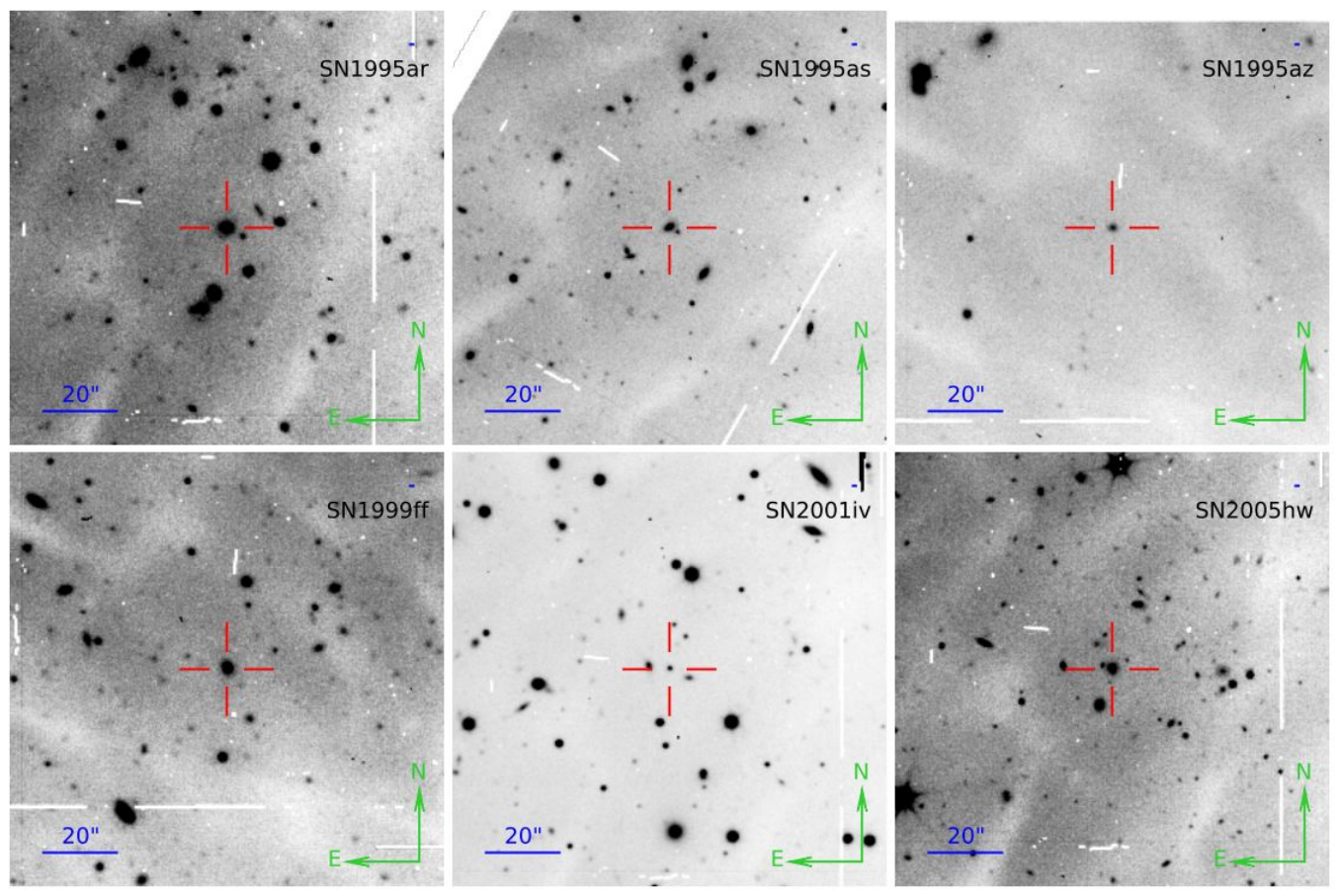

OBSERVATIONS

OBSERVATIONS

Our sample consists of galaxies that contain a type Ia SN.

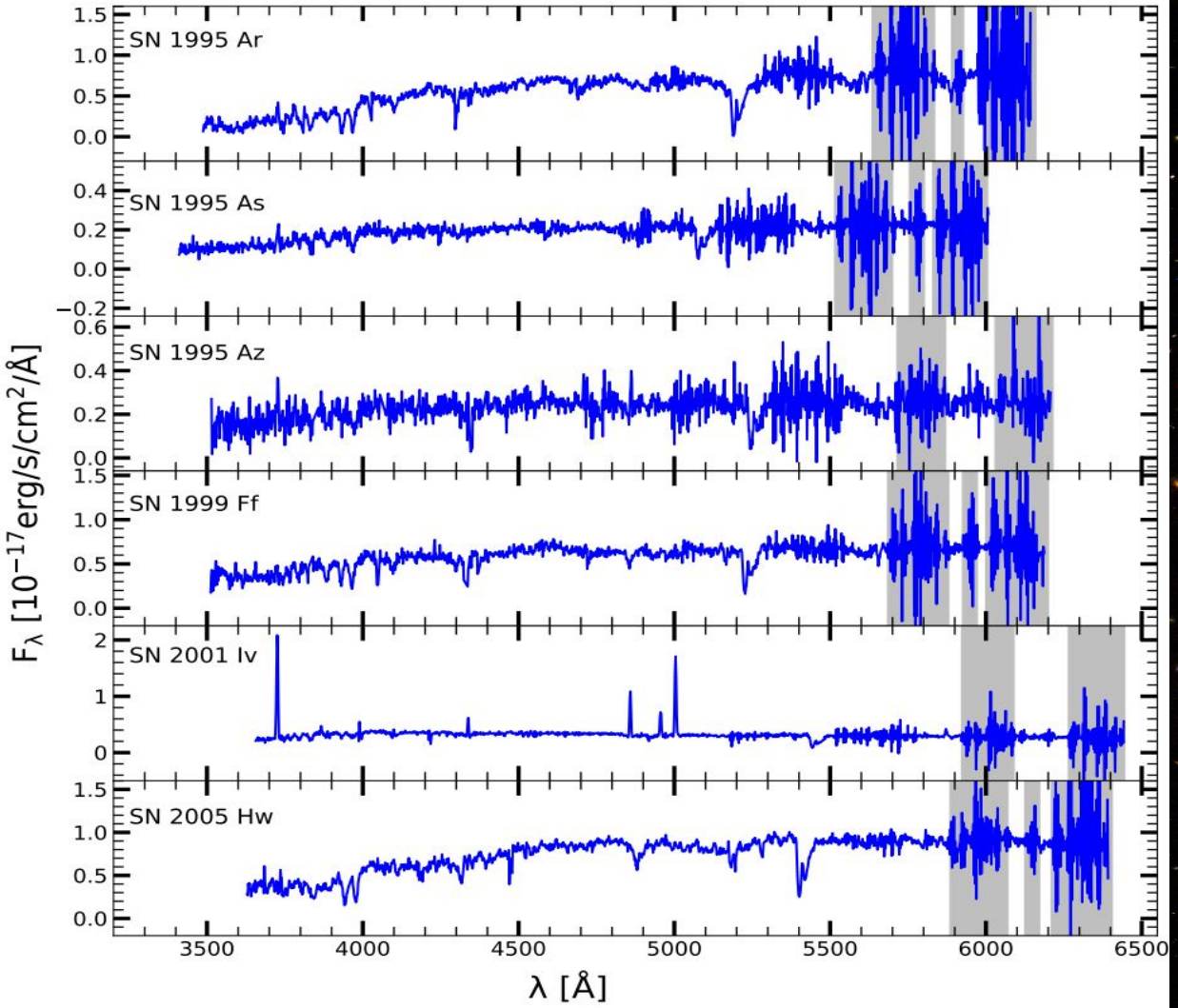
- 6 galaxies observed with OSIRIS,
- 654 galaxies of the survey SDSS and
- 19 galaxies observed in the COSMOS survey

OSIRIS SPECTRA



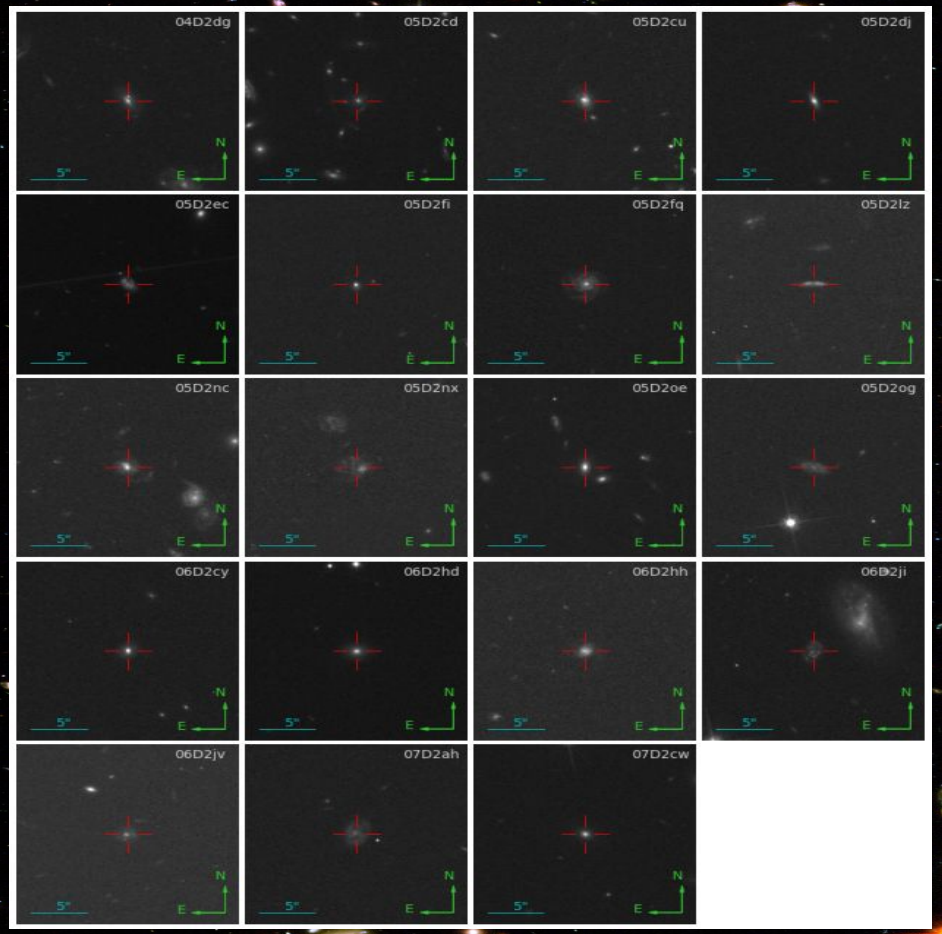
We have observed 6 galaxies in the redshift range of $0.4 < z < 0.5$ using the instrument OSIRIS in the R1000R grating

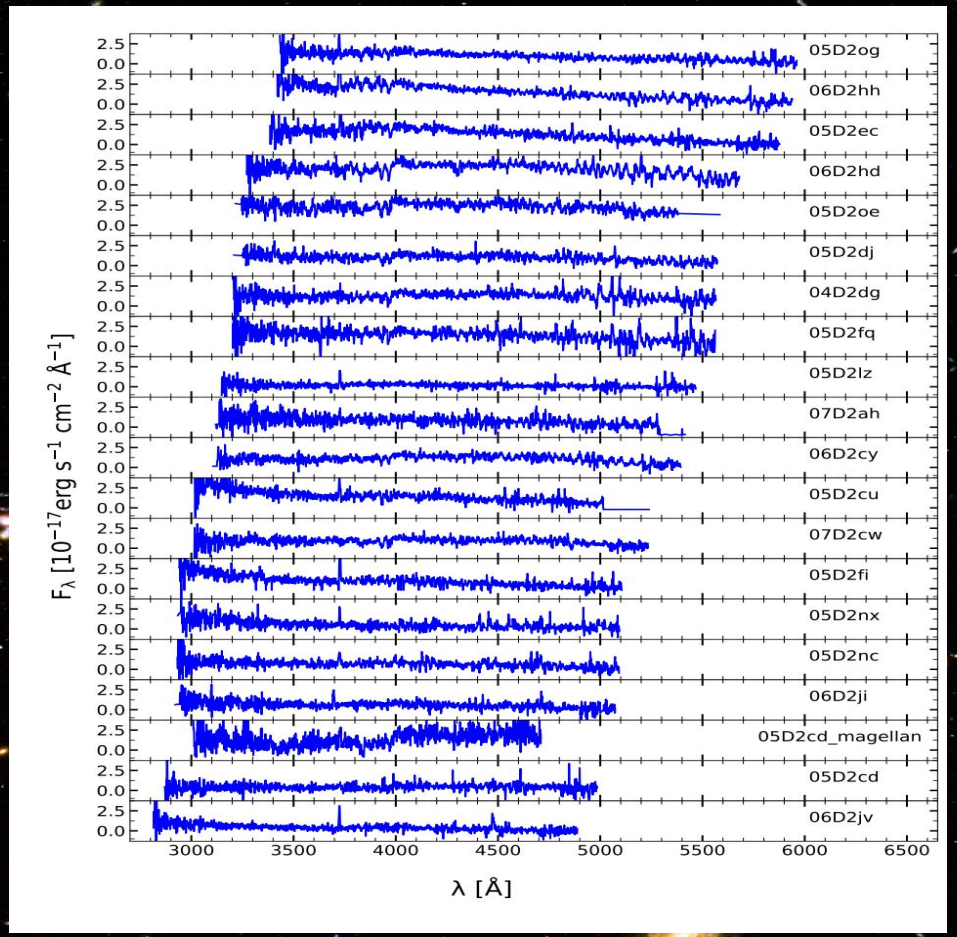
OSIRIS SPECTRA



We have reduced the obtained spectra using IRAF standard packages available for the bias subtraction, flat field correction, cosmic ray rejection and wavelength and flux calibration

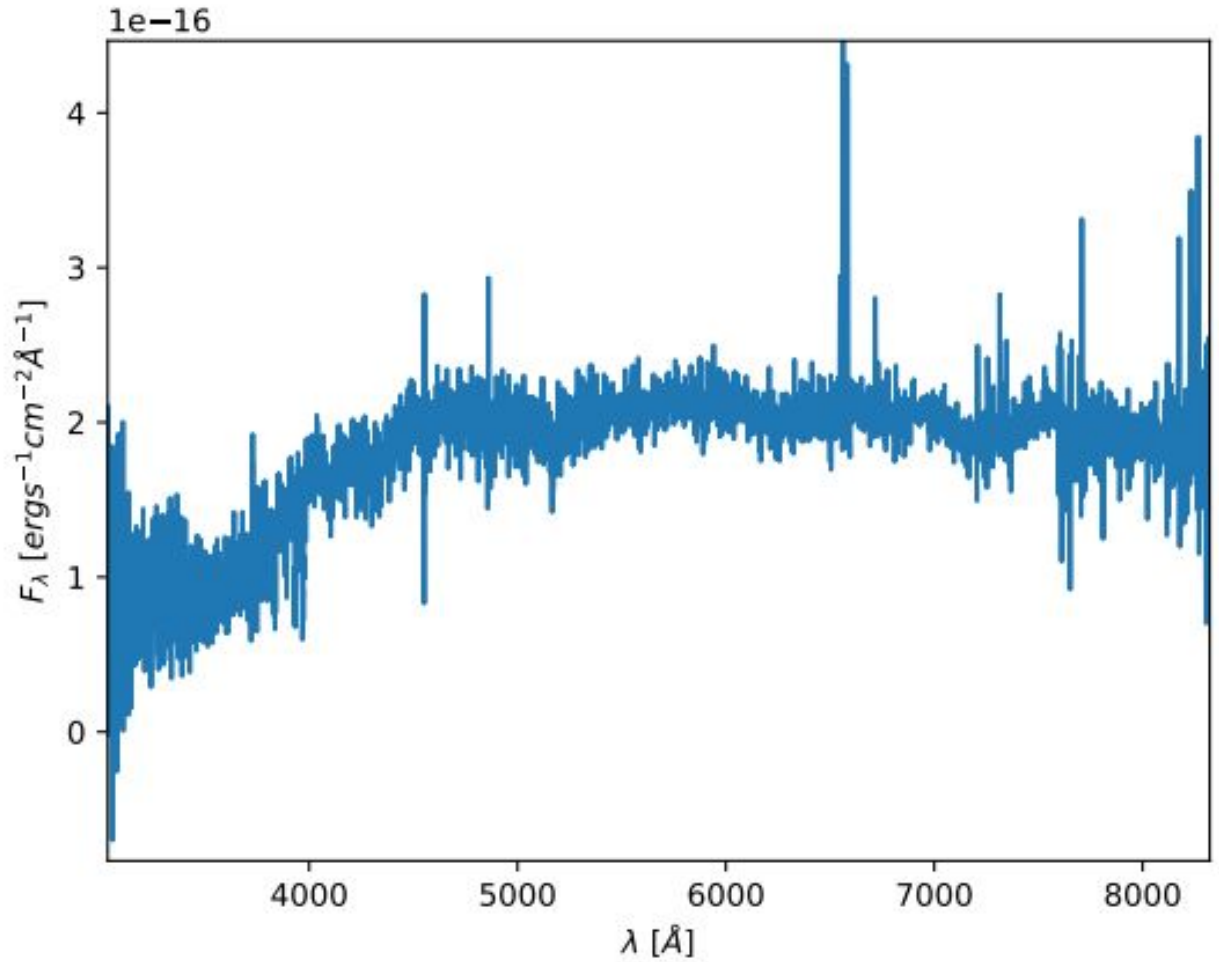
COSMOS SURVEY





We have added 19 galaxies from COSMOS survey in the redshift range of 0.5<z<1.0 (Lilly et al. 2007 and Trump et al. 2009)

SDSS



- To complete our sample we have added 654 galaxies of SDSS of low redshift $0.0<z<0.4$ (Ahumada et al. 2020)

SN DATA

- The data from the supernovae (stretch, color, magnitude) has been obtained from Sako et al. (2018), Suzuki et al. (2012) and Guy et al. (2007)
- In order to obtain the distance modulus to the supernovae we have used the characterization of Sako et al. (2018)


ANALYSIS

ANALYSIS OF THE SPECTRA

- To obtain the star formation histories and the properties of the stellar populations we have used HR-pyPopStar Millan-Irigoyen et al. (2021) new high resolutions SSPs as templates to analyse the observed spectra using FADO Gomes & Papaderos (2017)

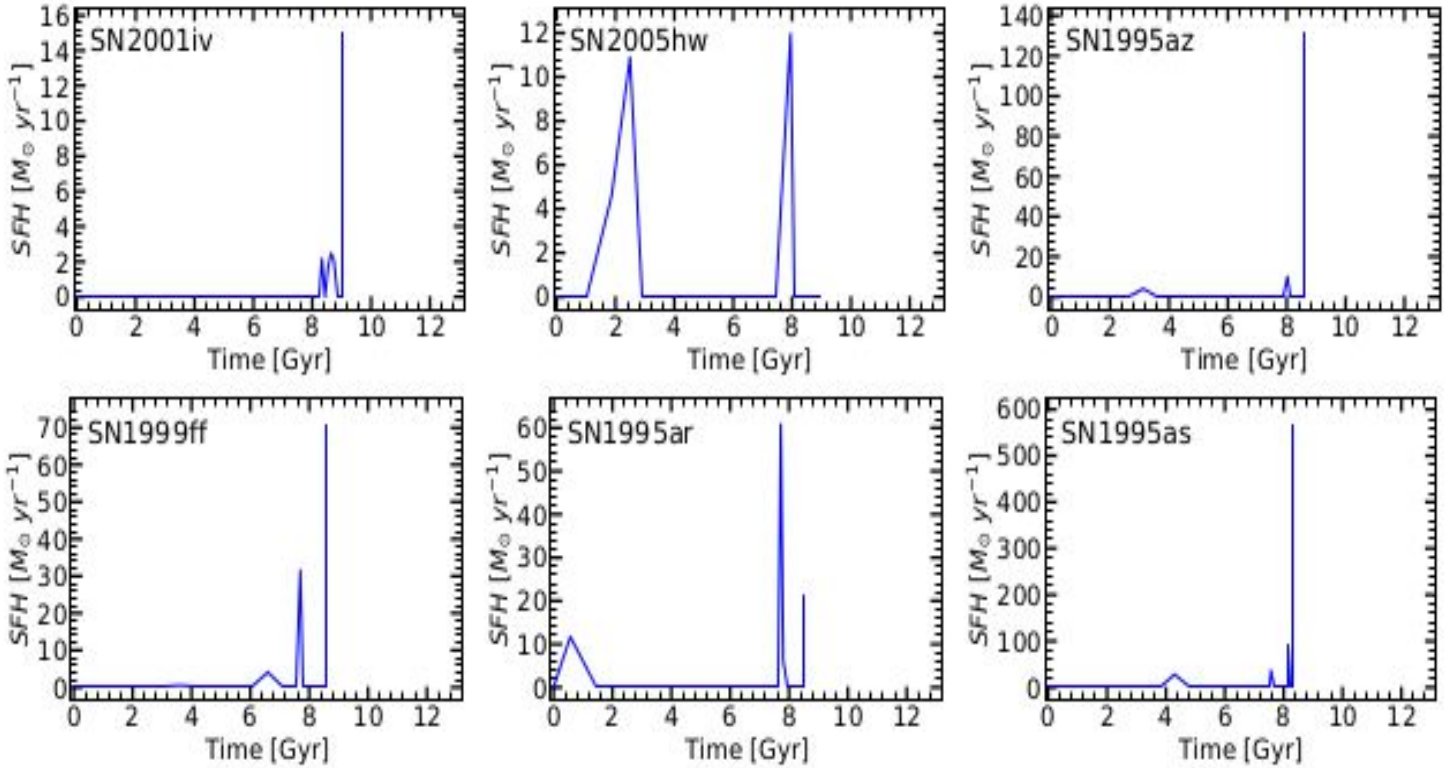
- We have made a special set of HR-pyPopStar SSPs that have a wider range of metallicities

- These SSPs use the stellar library of Munari et al. (2005) instead of Coelho (2014)

Log(age)	5.0-10.18
[M/H]	-2.0 – 0.0
Δλ	0.1
Wavelength coverage	3000- 10000 Å

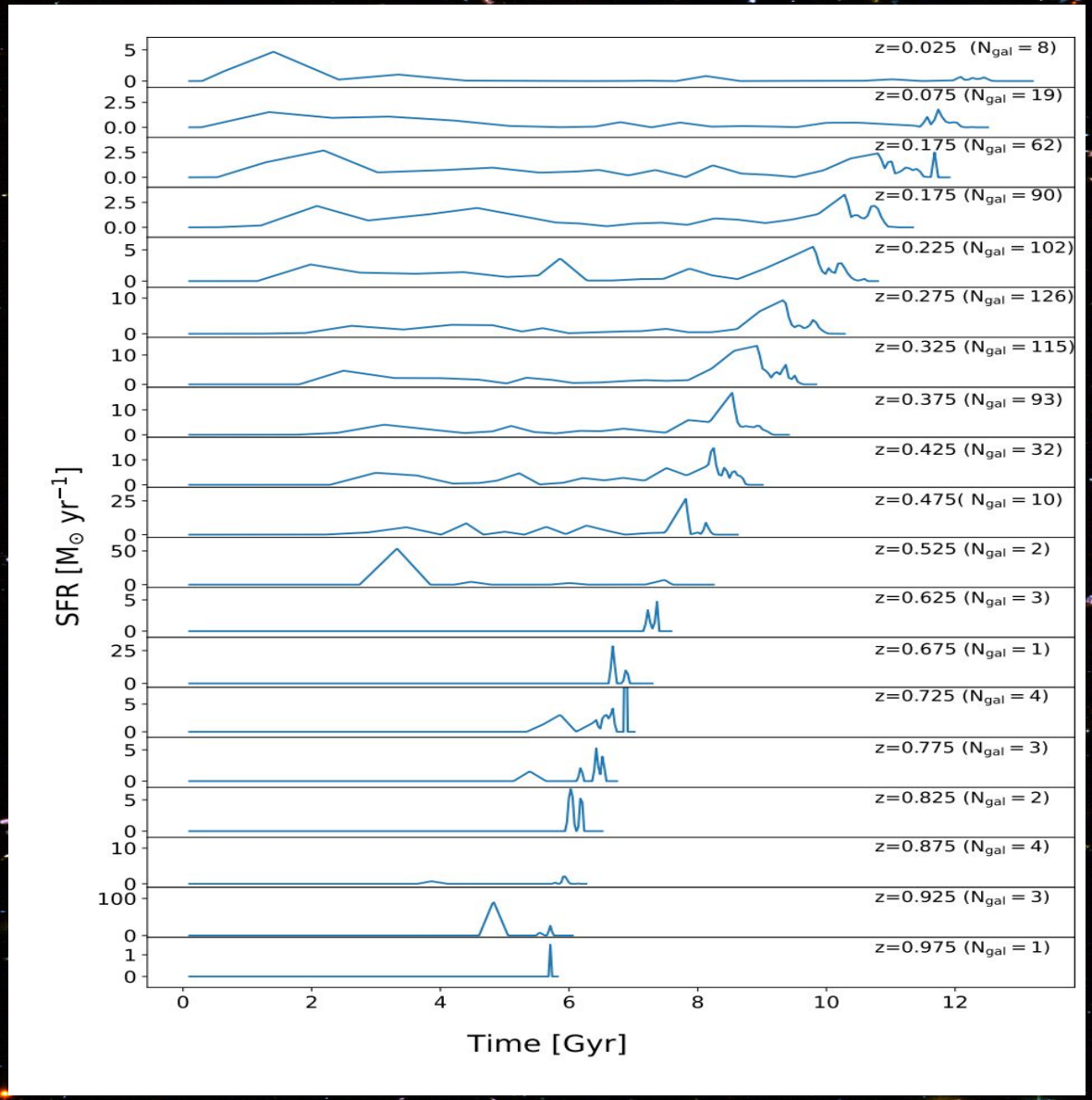
RESULTS

STAR FORMATION HISTORIES



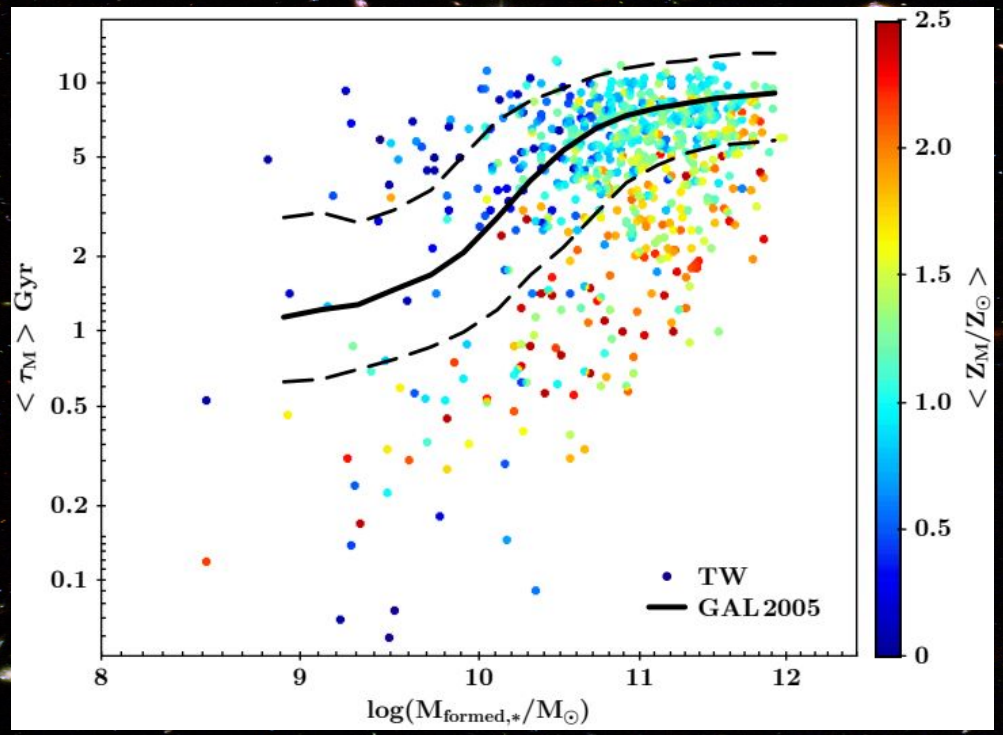
- We have obtained the Star Formation Histories (SFH) of the 6 galaxies observed with OSIRIS

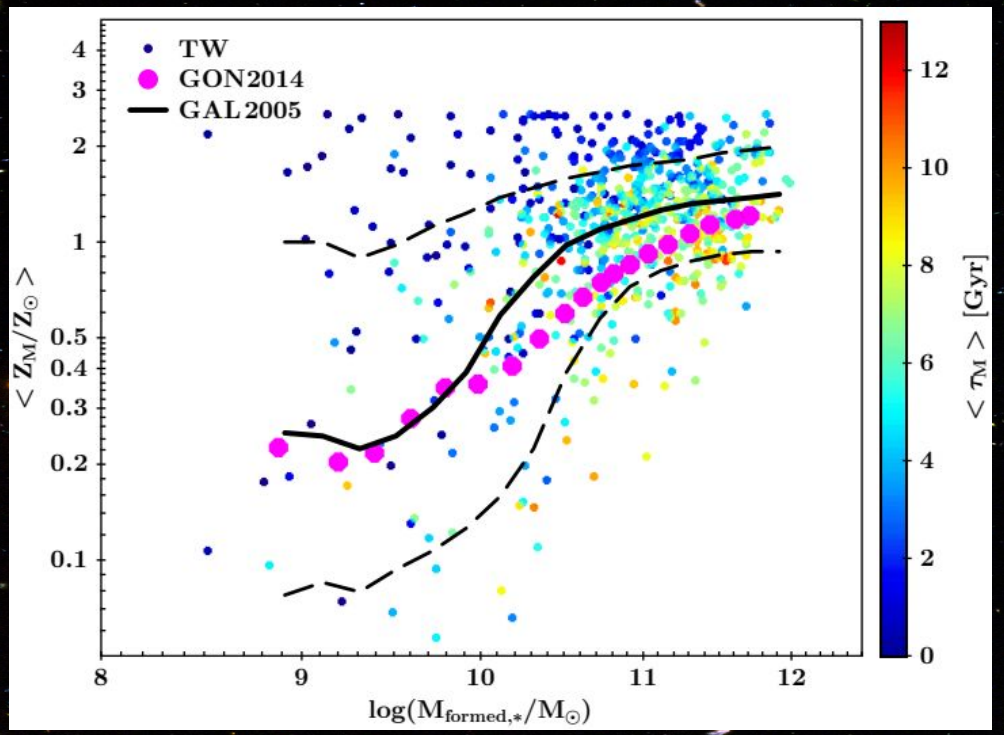
STAR FORMATION HISTORIES



- We have also obtained the Star Formation Histories for the complete set of galaxies
- We have made bins of redshift in steps of 0.05

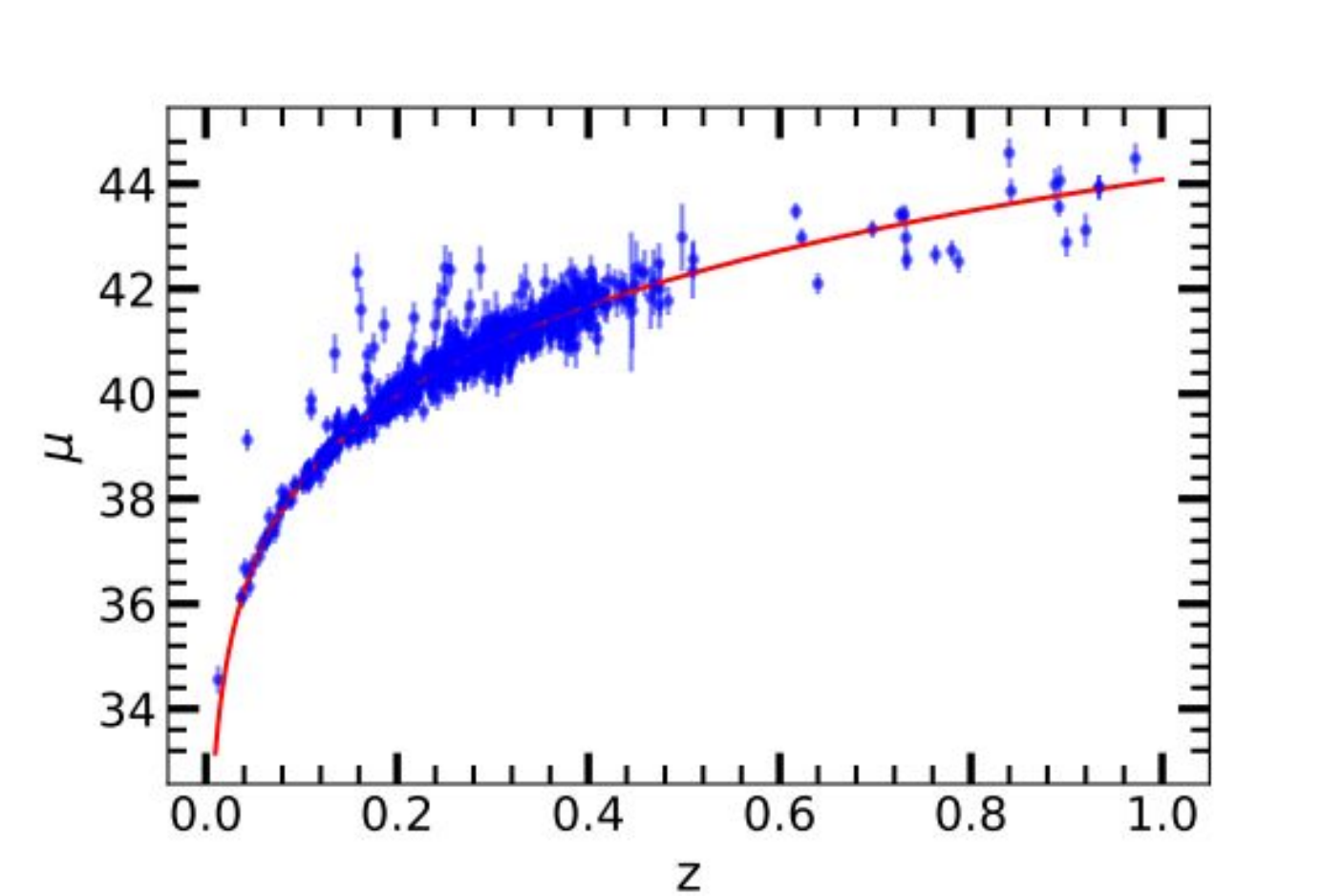
GALAXY PARAMETER CORRELATIONS





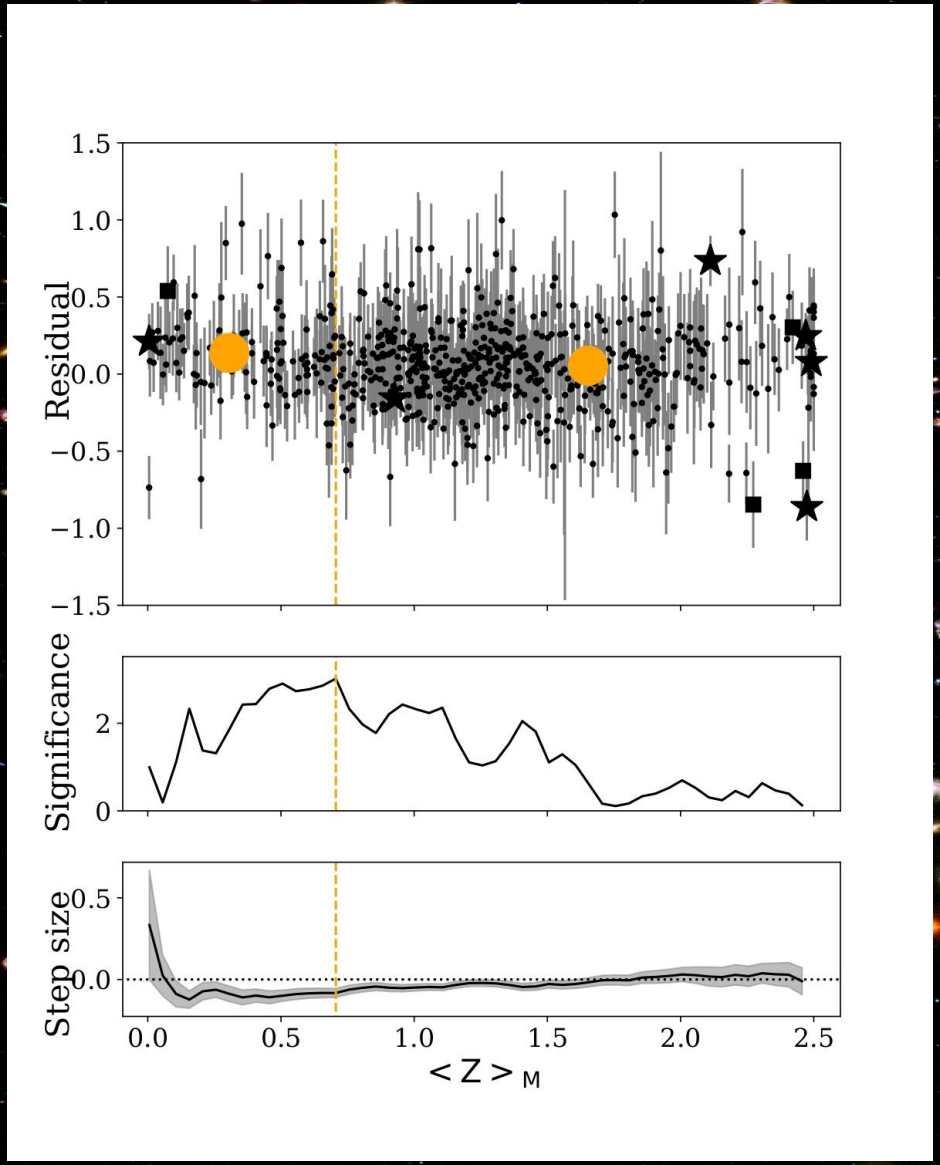
- Correlations between the galaxy parameters our galaxies have younger stellar populations than Gallazzi et al. (2005)
- The differences may be caused by the use of different SSPs used as templates, Gallazzi et al. (2005) used Bruzual & Charlot (2003)
- We have also compared with the mass-metallicity relation obtained by Gonzalez-Delgado et al. (2014)

HUBBLE DIAGRAM



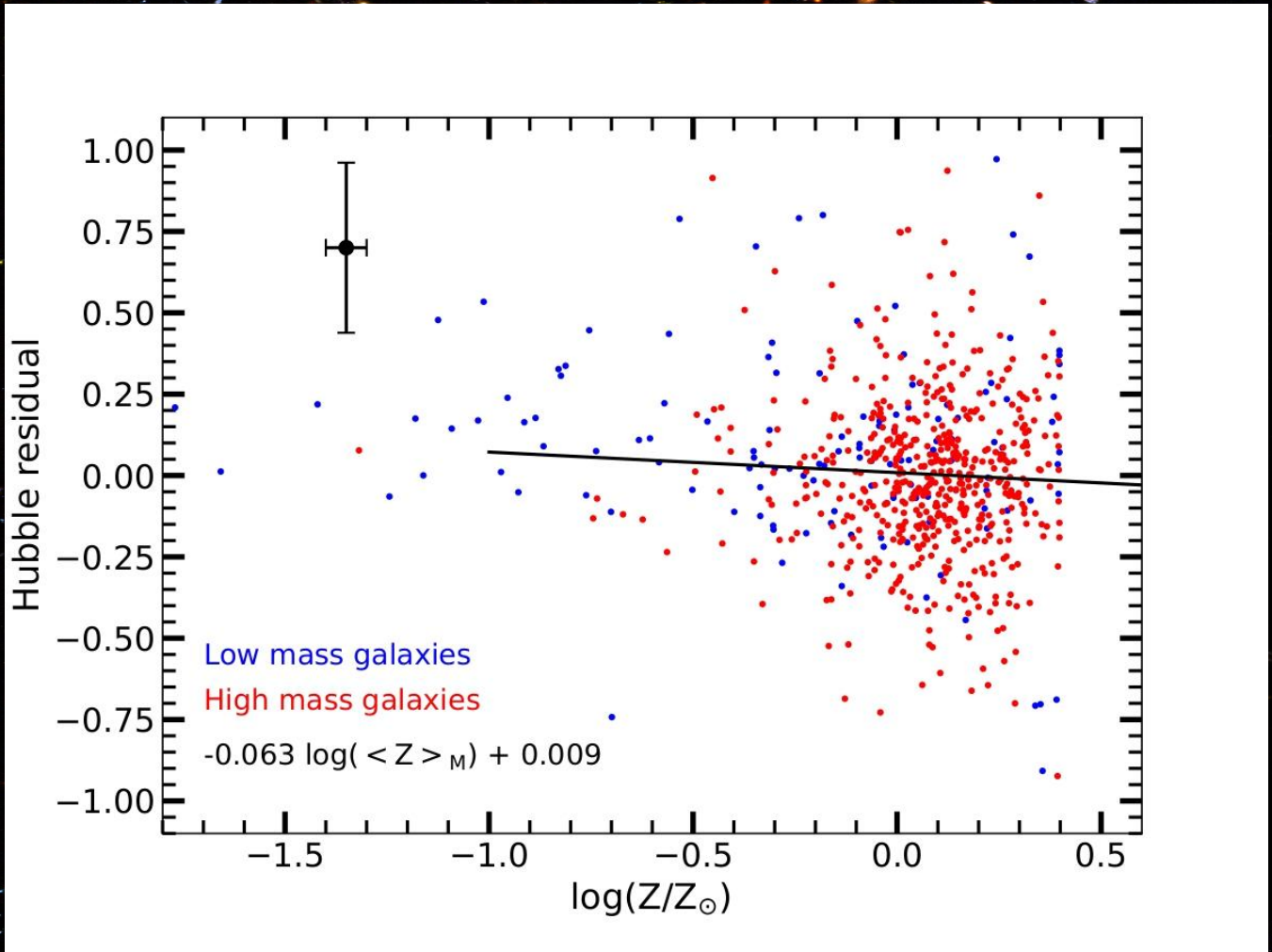
- We have computed the Hubble Diagram using a flat Λ-CDM cosmological model with $\Omega_M = 0.315$ and H_0=70 Km/s/Mpc to obtain the distance modulus of each galaxy, and then to compute the Hubble residual of each galaxy

HUBBLE RESIDUAL CORRELATIONS



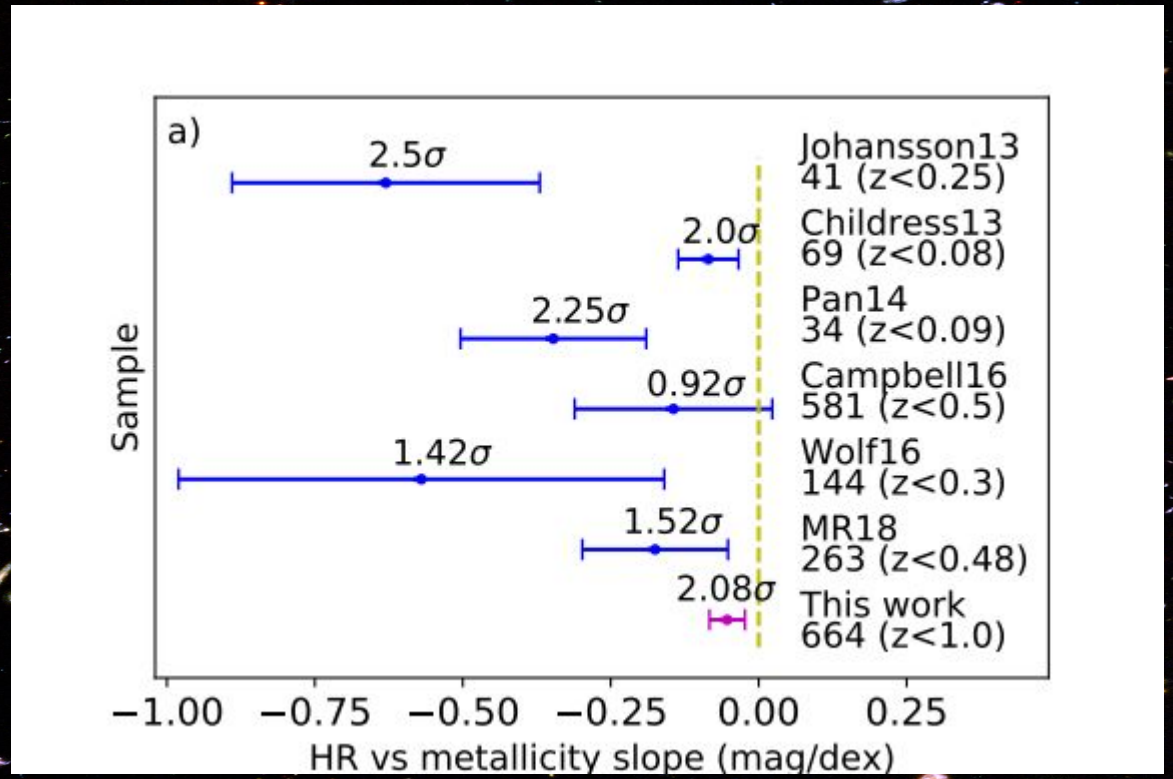
- In order to see if there is a different trend in galaxies of low mass and high mass we have divided the galaxies in two

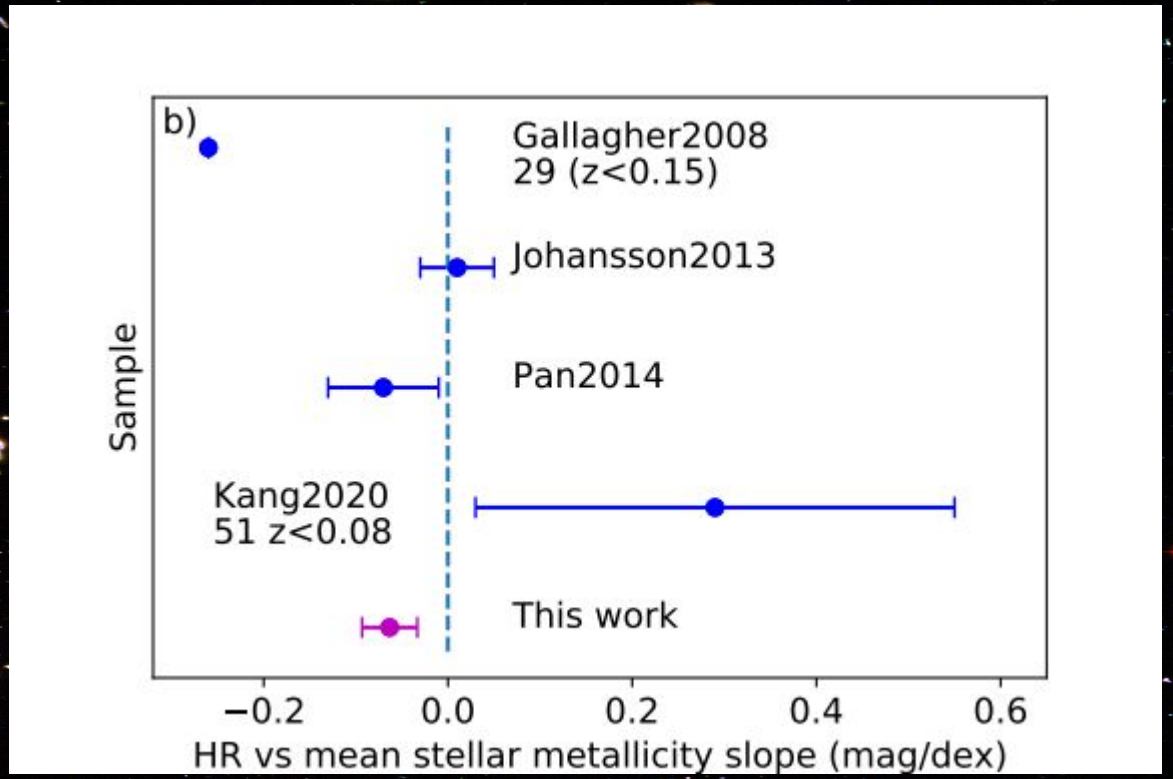
HUBBLE RESIDUAL CORRELATIONS



- We have done a linear regression to obtain the correlation between the Hubble Residuals and the stellar metallicity of the whole sample, low mass galaxies and high mass galaxies

COMPARISON WITH OTHER AUTHORS





- WE HAVE COMPARED WITH OTHER AUTHORS OF THE LITERATURE THAT HAVE MEASURED GAS PHASE ABUNDANCE AND/OR STELLAR METALLICITY
- WE OBTAIN A SIMILAR VALUE TO CHILDRESS ET AL. (2013) WHEN WE COMPARE WITH SLOPES OBTAINED USING GAS PHASE ABUNDANCE AND SIMILAR TO PAN ET AL. (2014) WHEN WE COMPARE WITH ANALYSIS DONE USING STELLAR METALLICITY

CONCLUSIONS

- We have used 6 galaxies observed with OSIRIS with 19 galaxies of cosmos survey and 654 galaxies of SDSS that contain a supernovae
- We find that our galaxies have younger populations than Gallazzi et Al. 2005 that can be attributed to the SSP used as templates
- We have found a correlation between the Hubble residual and the mean stellar metallicity in accordance to other studies done in a smaller redshift range

HUBBLE RESIDUAL CORRELATIONS

HR vs	Parameter	
Data	slope	significance
$< \tau_M >$ low mass	0.001 ± 0.010	0.085
$< \tau_M >$ high mass	0.004 ± 0.004	0.961
$< \tau_M >$ all sample	-0.001 ± 0.004	0.373
$< \tau_L >$ low mass	-0.007 ± 0.014	0.770
$< \tau_L >$ high mass	-0.006 ± 0.005	1.315
$< \tau_L >$ all sample	-0.0104 ± 0.0044	2.430
$< Z_M >$ low mass	-0.059 ± 0.042	1.414
$< Z_M >$ high mass	-0.021 ± 0.024	0.883
$< Z_M >$ all sample	-0.052 ± 0.020	2.686
$log(< Z_M >)$ all sample	-0.063 ± 0.031	2.080
$M_{*,current}$ all sample	-0.061 ± 0.019	3.359

DISTANCE MODULUS CALCULUS

$$\mu_{\text{obs}} = -2.5 \log x_0 - M + \alpha x_1 - \beta c,$$