Chemical evolution of star forming galaxies up to z~3.5 “AMAZE+LSD”

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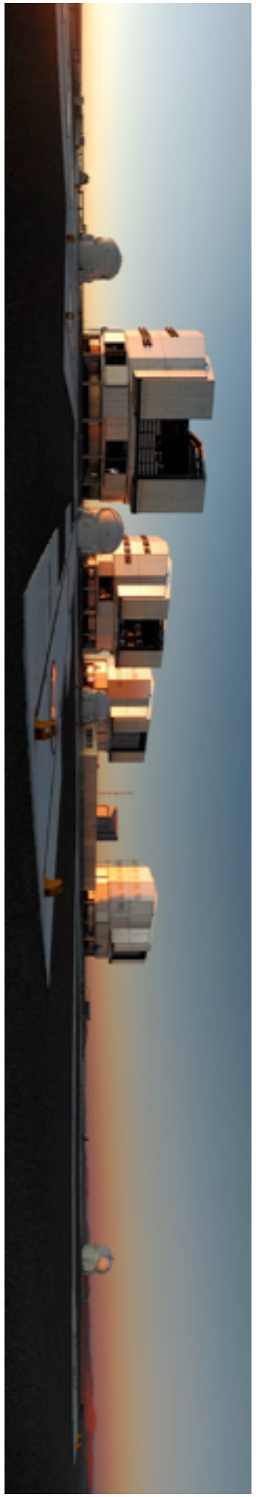


Outline

I AMAZE+LSD:

IFU Metallicity, Gas dynamics and SED fitting (UV-to Spitzer-MIPS bands).

II Evolution of the mass-metallicity relation.

III Evolution (deviations) respect to the FMR, What happens beyond z~2.5?

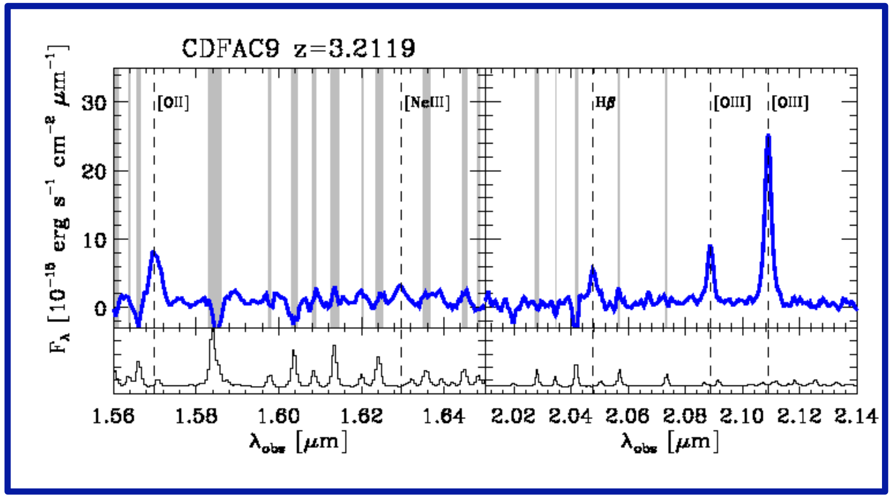
IV Galactic gradients at z~3.5, inverted respect to local galaxies.

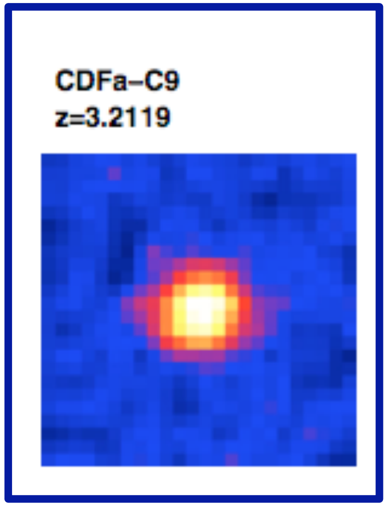
V Gas content, galaxy sizes and derived quantities.

VI Summary.

AMAZE Assessing the Mass-Abundance redshift[Z] Evolution

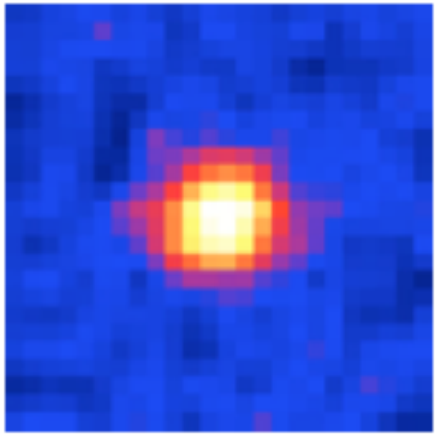
LSD Lyman-break galaxies Stellar populations and Dynamics

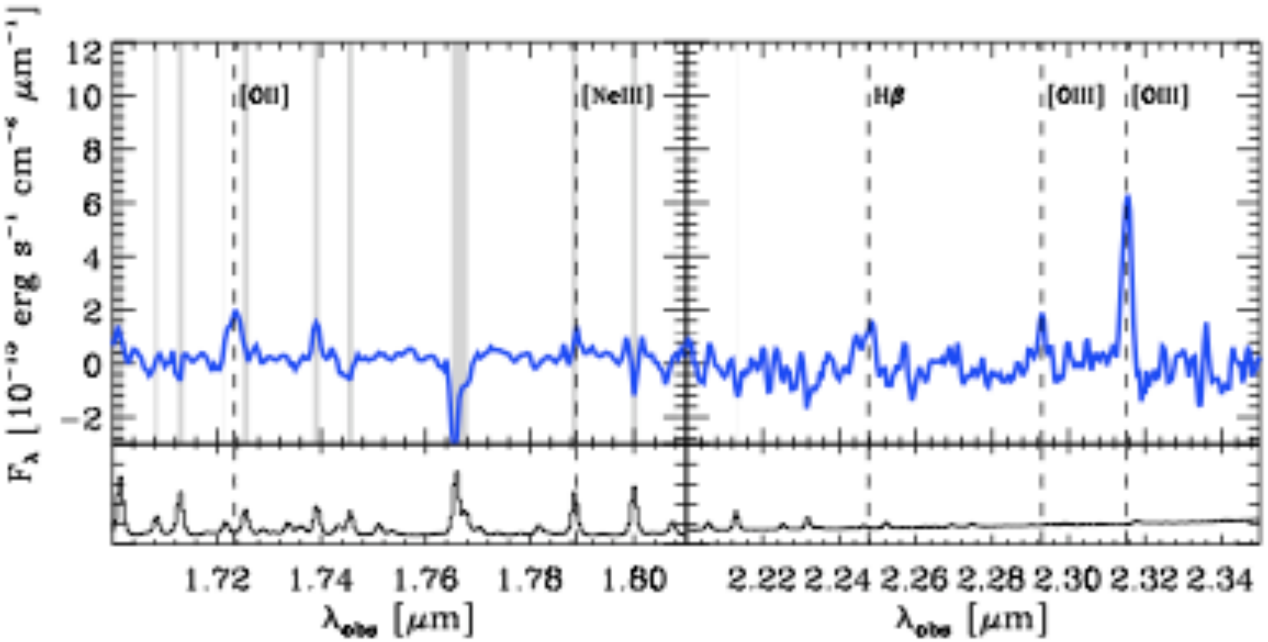




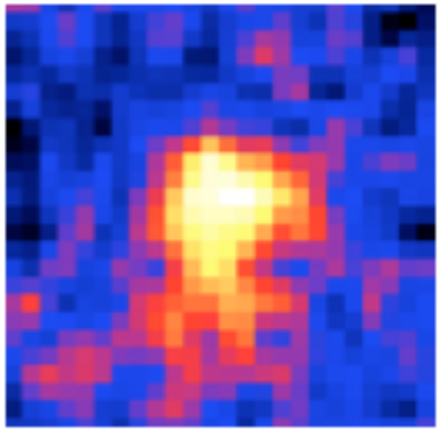
Object	sample	R.A. (1)	Dec. (1)	z / scale(kpc/″) (2)	Texp(min)
SSA22a-M38	AMAZE	22:17:17.7	+00:19:00.7	3.294/7.48	400
SSA22a-C16	AMAZE	22:17:32.0	+00:13:16.1	3.068/7.65	350
CDFS-2528	AMAZE	03:32:45.5	-27:53:33.3	3.688/7.18	350
SSA22a-D17	AMAZE	22:17:18.9	+00:18:16.8	3.087/7.64	250
CDFA-C9	AMAZE	00:53:13.7	+12:32:11.1	3.212/7.54	250
CDFS-9313	AMAZE	03:32:17.2	-27:47:54.4	3.654/7.21	250
CDFS-9340(4)	AMAZE	03:32:17.2	-27:47:53.4	3.658/7.20	250
CDFS-11991	AMAZE	03:32:42.4	-27:45:51.6	3.661/7.25	450
3C324-C3	AMAZE	15:49:47.1	+21:27:05.0	3.289/7.49	150
DFS2237b-D29	AMAZE	22:39:32.7	+11:55:51.7	3.370/7.43	250
CDFS-5161	AMAZE	03:32:22.6	-27:51:18.0	3.66017.20	300
DFS2237b-C21	AMAZE	22:39:29.0	+11:50:58.0	3.403/7.40	200
SSA22a-aug96M16	AMAZE	22:17:30.9	+00:13:10.7	3.292/7.48	250
Q1422-D88	AMAZE	14:24:37.9	+23:00:22.3	3.752/7.13	250
CDFS-6664	AMAZE	03:32:33.3	-27:50:7.4	3.797/7.11	500
SSA22a-C36	AMAZE	22:17:46.1	+00:16:43.0	3.063/7.65	100
CDFS-4414	AMAZE	03:32:23.2	-27:51:57.9	3.471/7.34	350
CDFS-4417(4)	AMAZE	03:32:23.3	-27:51:56.8	3.473/7.34	350
CDFS-12631	AMAZE	03:32:18.1	-27:45:19.0	3.709/7.17	250
CDFS-13497	AMAZE	03:32:36.3	-27:44:34.6	3.413/7.39	150
CDFS-14411	AMAZE	03:32:20.9	-27:43:46.3	3.599/7.25	200
CDFS-16272	AMAZE	03:32:17.1	-27:42:17.8	3.619/7.24	350
CDFS-16767	AMAZE	03:32:35.9	-27:41:49.9	3.624/7.24	300
Cosmic eye(5)	AMAZE	21:35:12.7	-01:01:42.9	3.075/(5)	200
Abell1689-1(5)	AMAZE	13:11:30.0	-01:19:15.3	3.770/(5)	300
Abell1689-2(5)	AMAZE	13:11:25.5	-01:20:51.9	4.868/(5)	400
Abell1689-4(5)	AMAZE	13:11:26.5	-01:19:56.8	3.038/(5)	240
SSA22b-C5	LSD	22:17:47.1	+00:04:25.7	3.117/7.61	240
SSA22a-C6	LSD	22:17:40.9	+00:11:26.0	3.097/7.63	280
SSA22a-M4(4)	LSD	22:17:40.9	+00:11:27.9	3.098/7.63	280
SSA22a-C30	LSD	22:17:19.3	+00:15:44.7	3.104/7.62	240
Q0302-C131	LSD	03:04:35.0	-00:11:18.3	3.240/7.51	240
Q0302-C171	LSD	03:04:44.3	-00:08:23.2	3.34/7.44	240
DSF2237b-D28	LSD	22:39:20.2	+11:55:11.3	2.938/7.75	240
Q0302-M80	LSD	03:04:45.7	-00:13:40.6	3.416/7.39	240
DSF2237b-MD19	LSD	22:39:21.1	+11:48:27.7	2.616/7.99	200

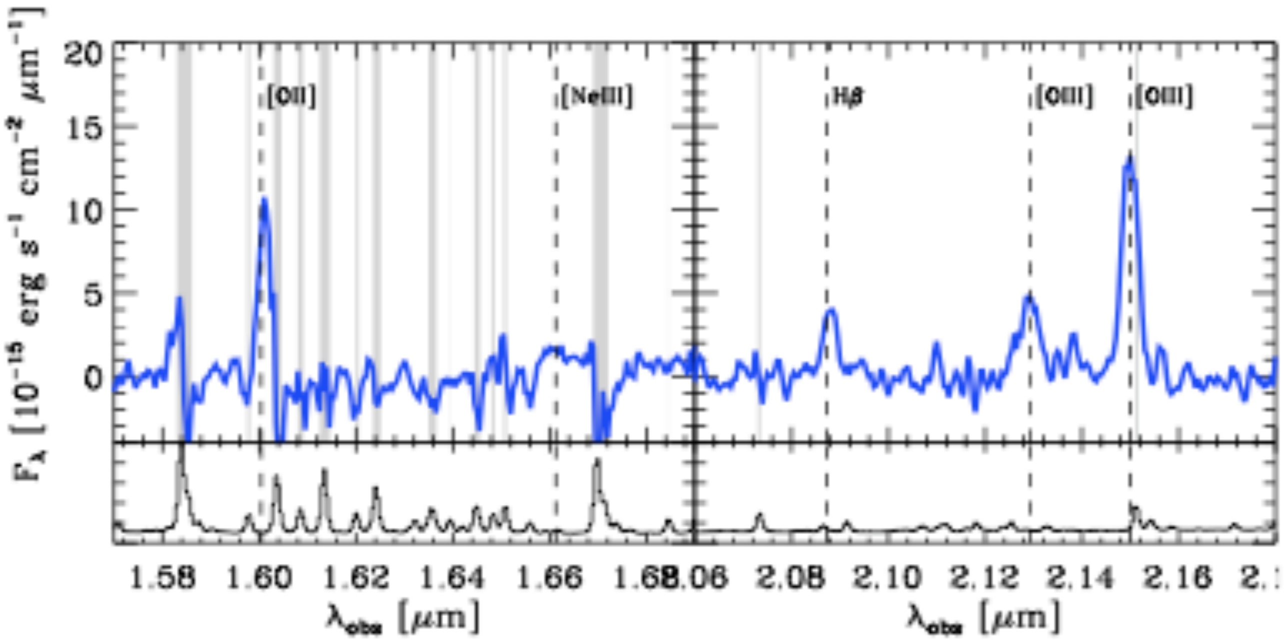
CDFS16767
z=3.6241



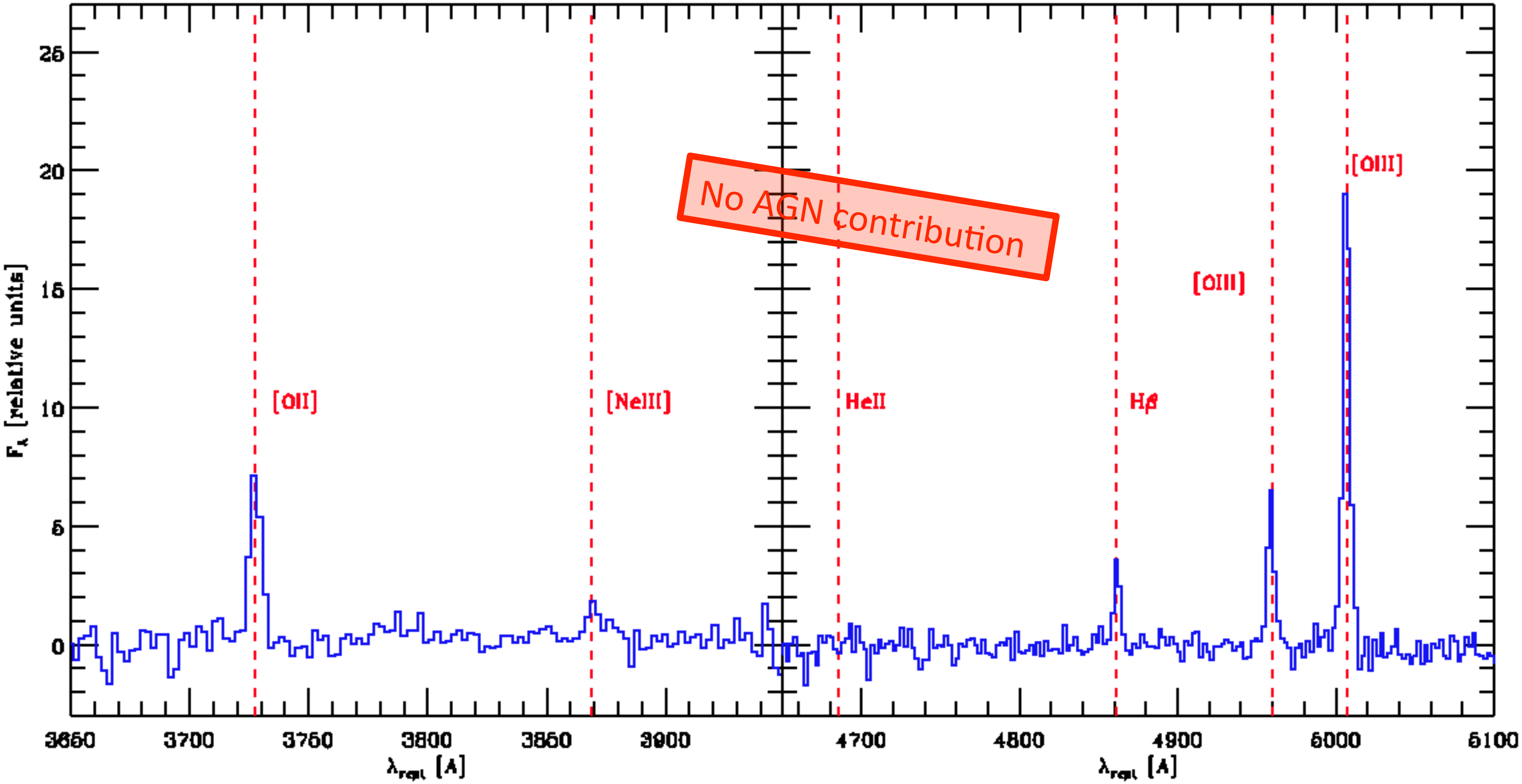


SSA22a–M38
z=3.2940

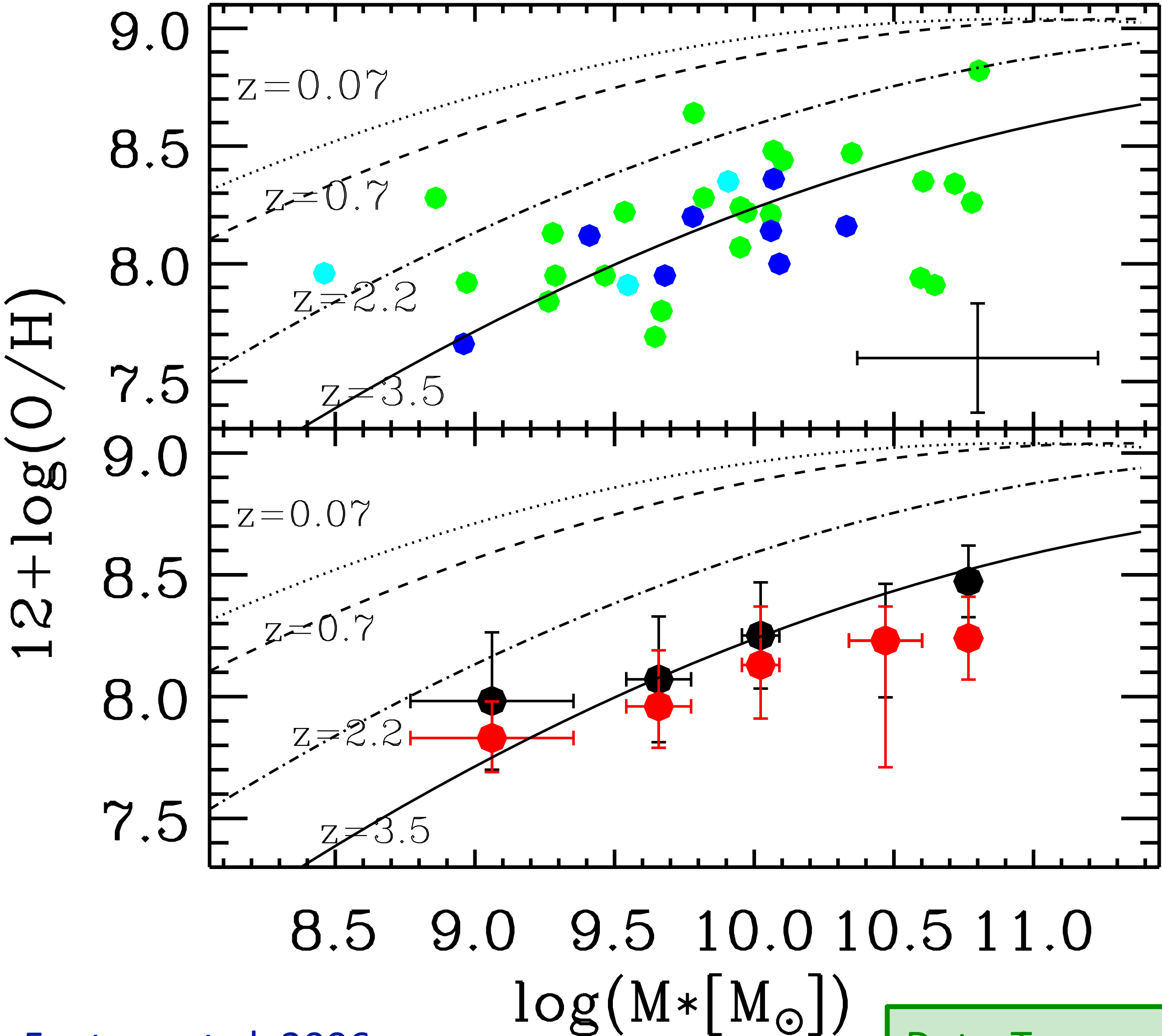




COMPOSITE SPECTRUM



Mass-Metallicity relation



Blue: LSD

Green: AMAZE

Cyan: Lens

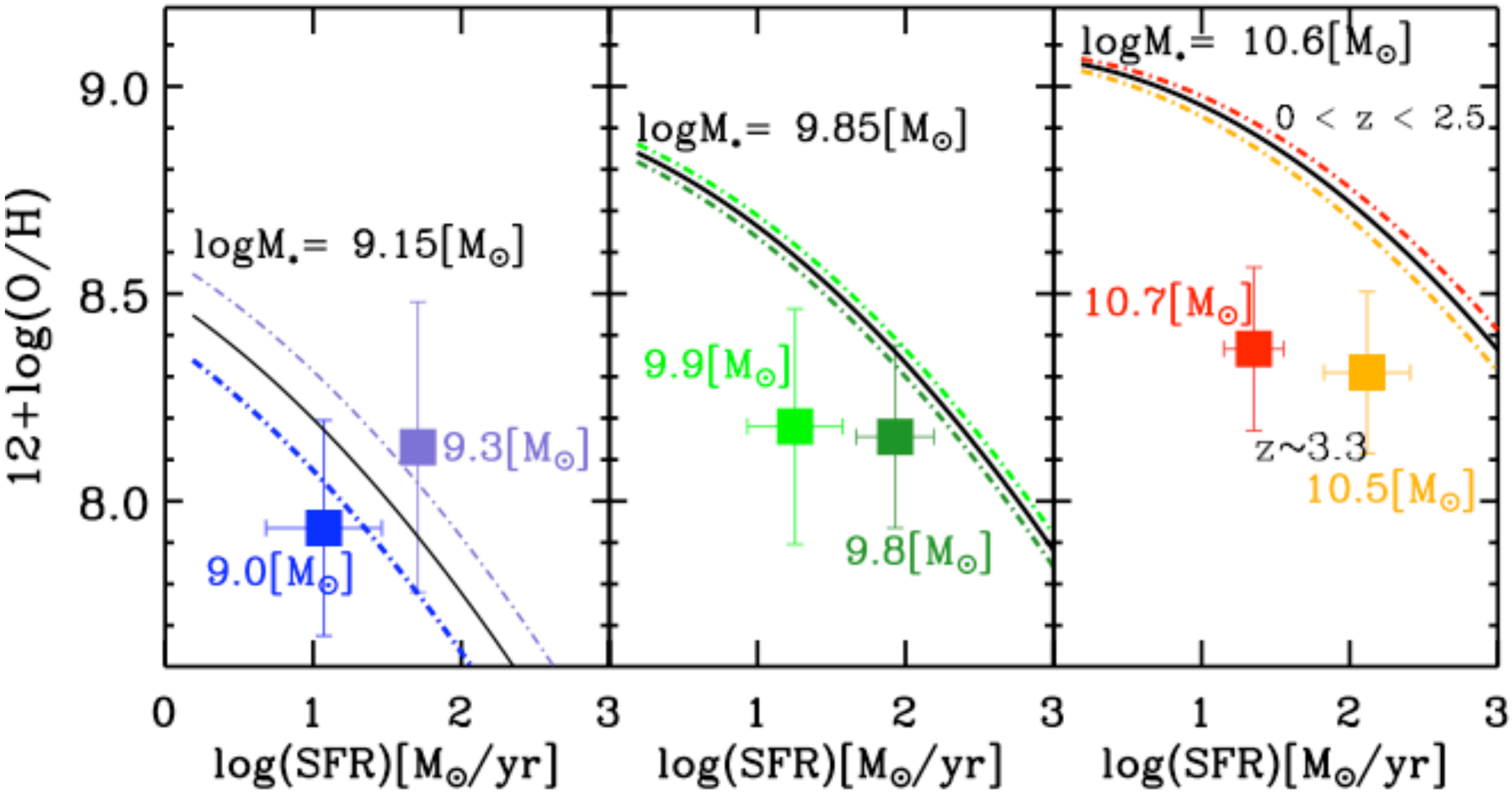
Black: average

Red: stacked

SED fitting: Fontana et al. 2006;
Grazian et al. 2006, 2007.

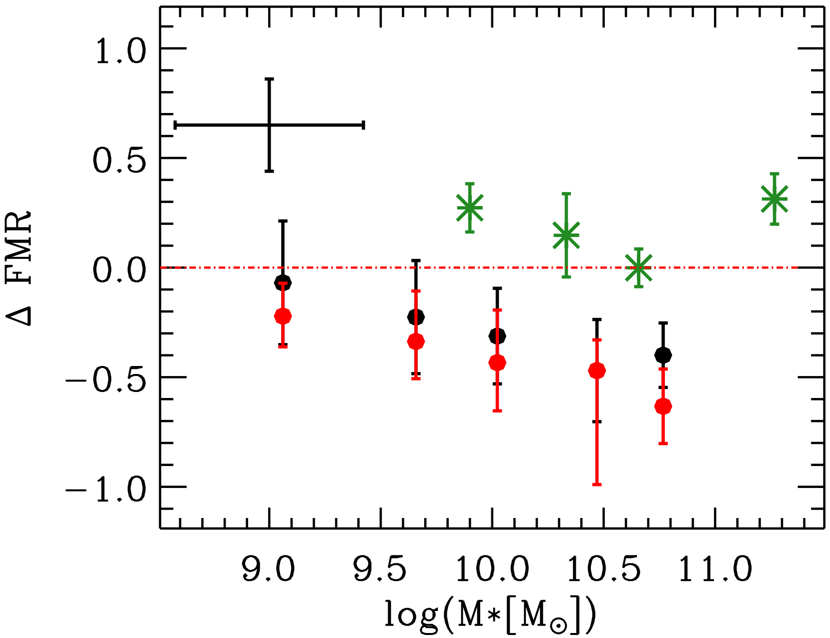
Dots: Troncoso et al. 2011 in prep.
Lines: Maiolino et al. 2008.

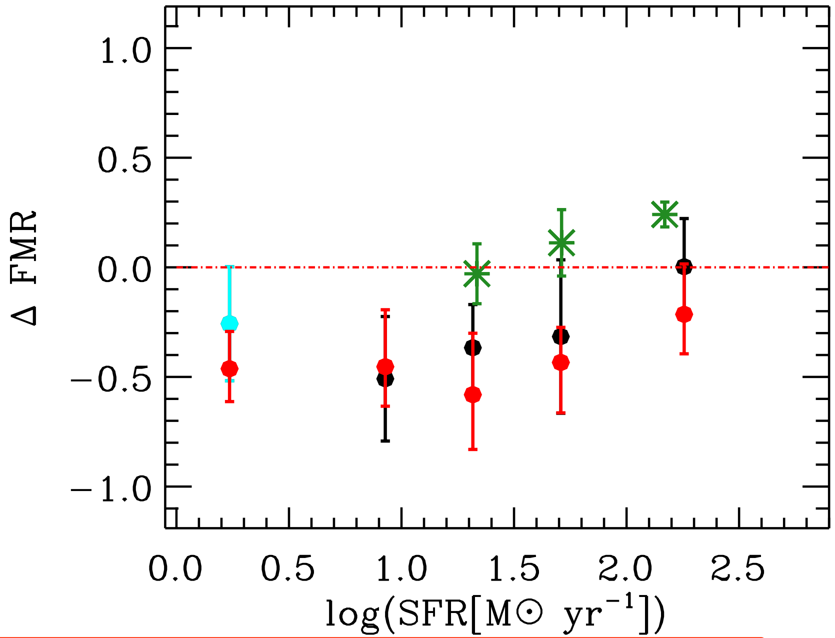
AMAZE- FMR comparison



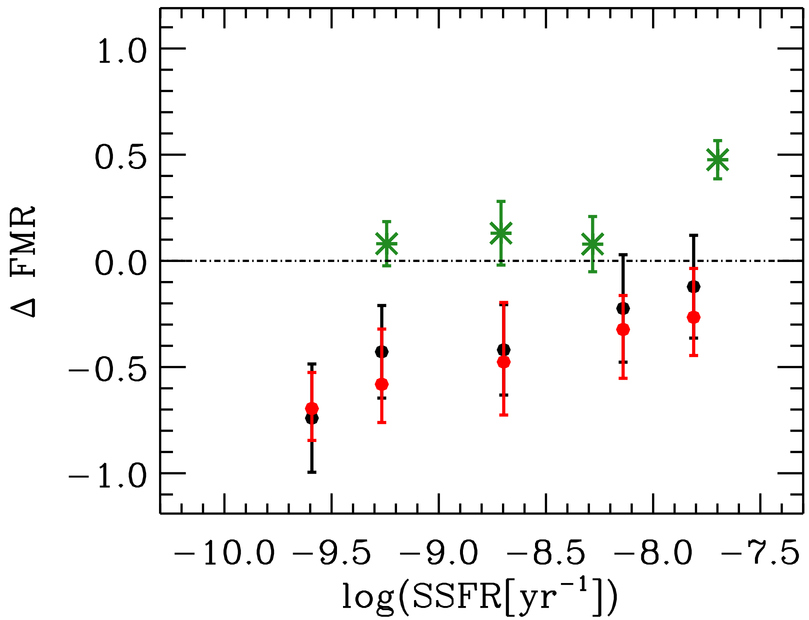
Squares: Data at z~3.5. Troncoso et al. 2011 in prep.
Lines: Fit observations FMR at z<2.5, Mannucci et al. 2010.

AMAZE+LSD- FMR comparison





Massive, low-SFR galaxies present higher deviation respect to FMR.



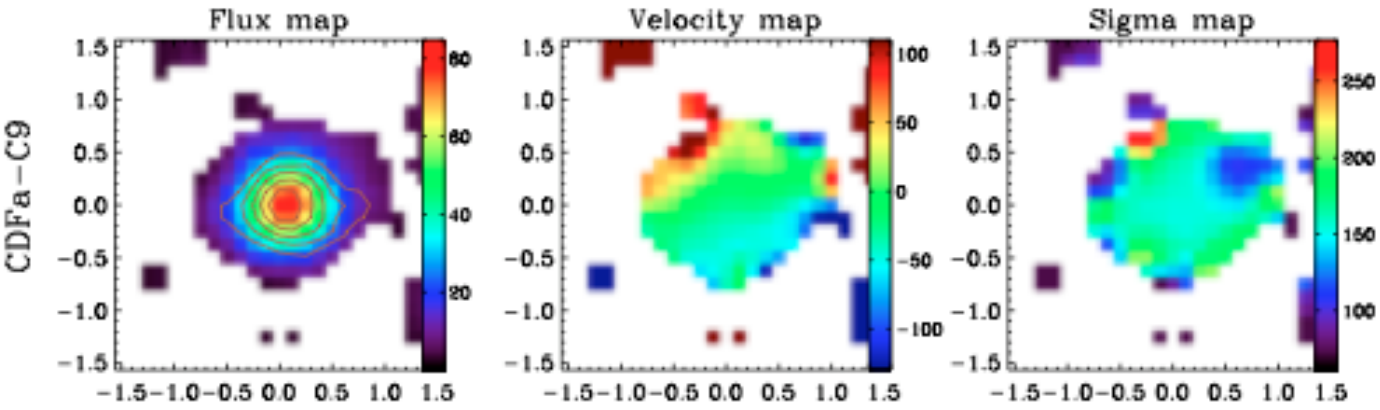
Black: average AMAZE+LSD

Red: stacked AMAZE+LSD

Green: SF at z~2

Cyan: Lens

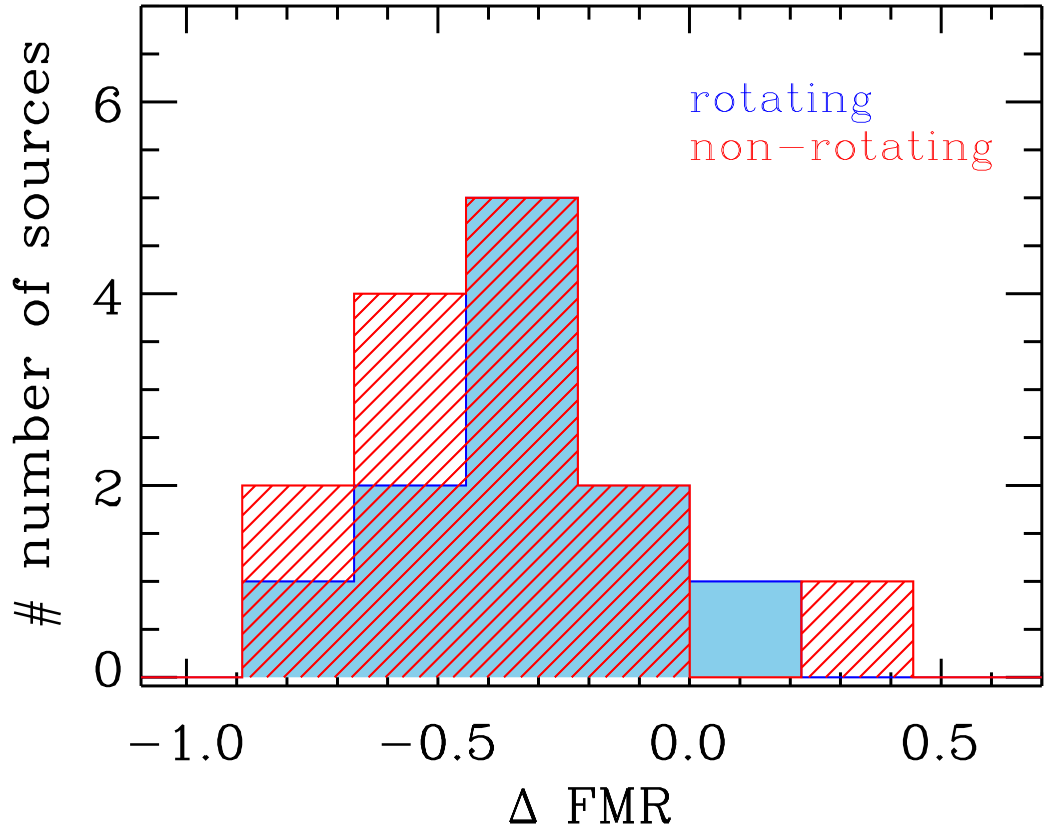
Enhanced mergers??



Gnerucci et al. 2010

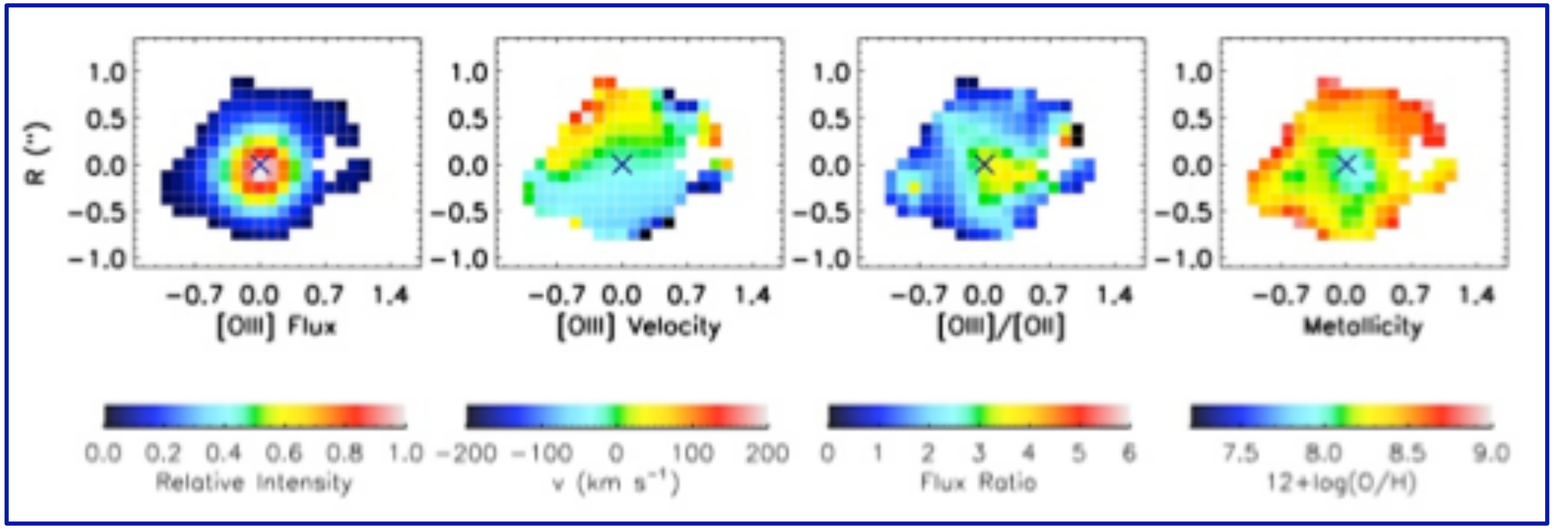
There is no correlation between the dynamical state of these galaxies and the differences respect to the FMR.

Enhanced merging at z>3.3 cannot be the only reason for the deviations from the FMR at z>3.

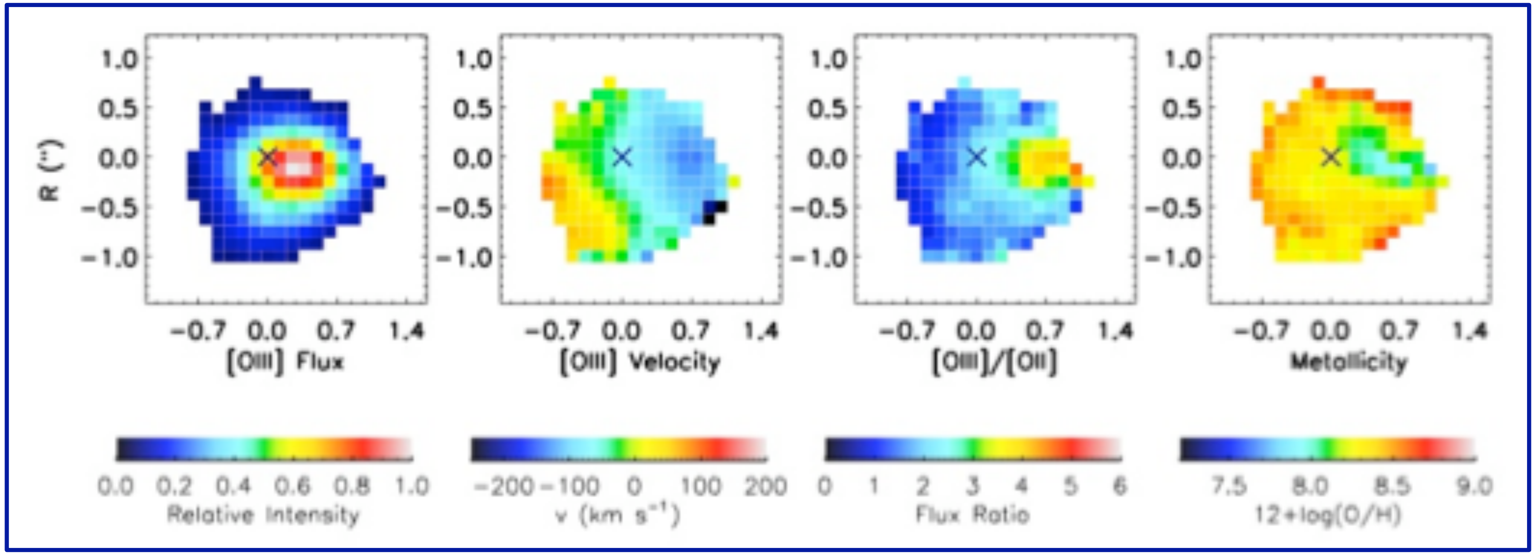


AMAZE @ z~3

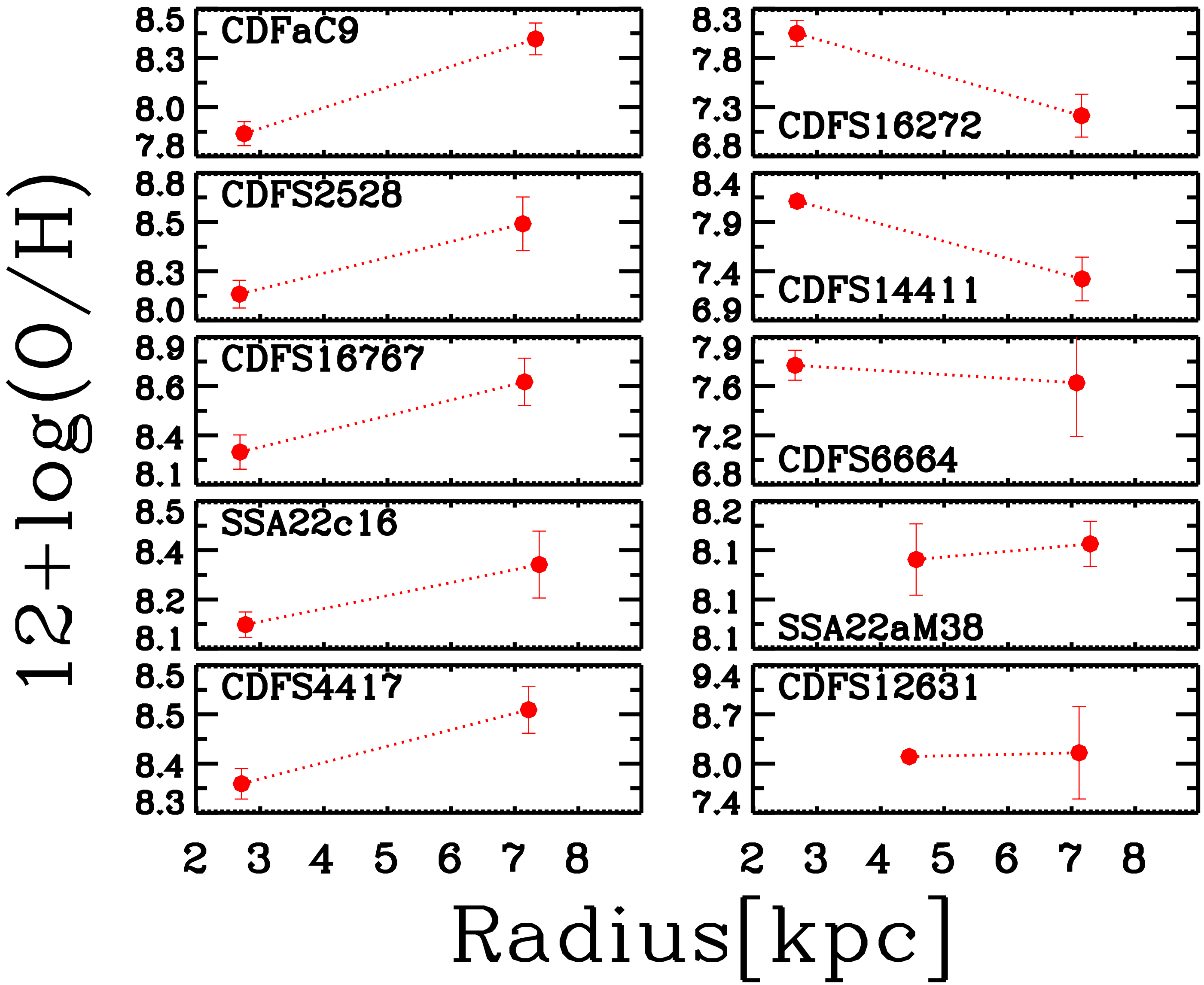
CDFa-c9
z = 3.219

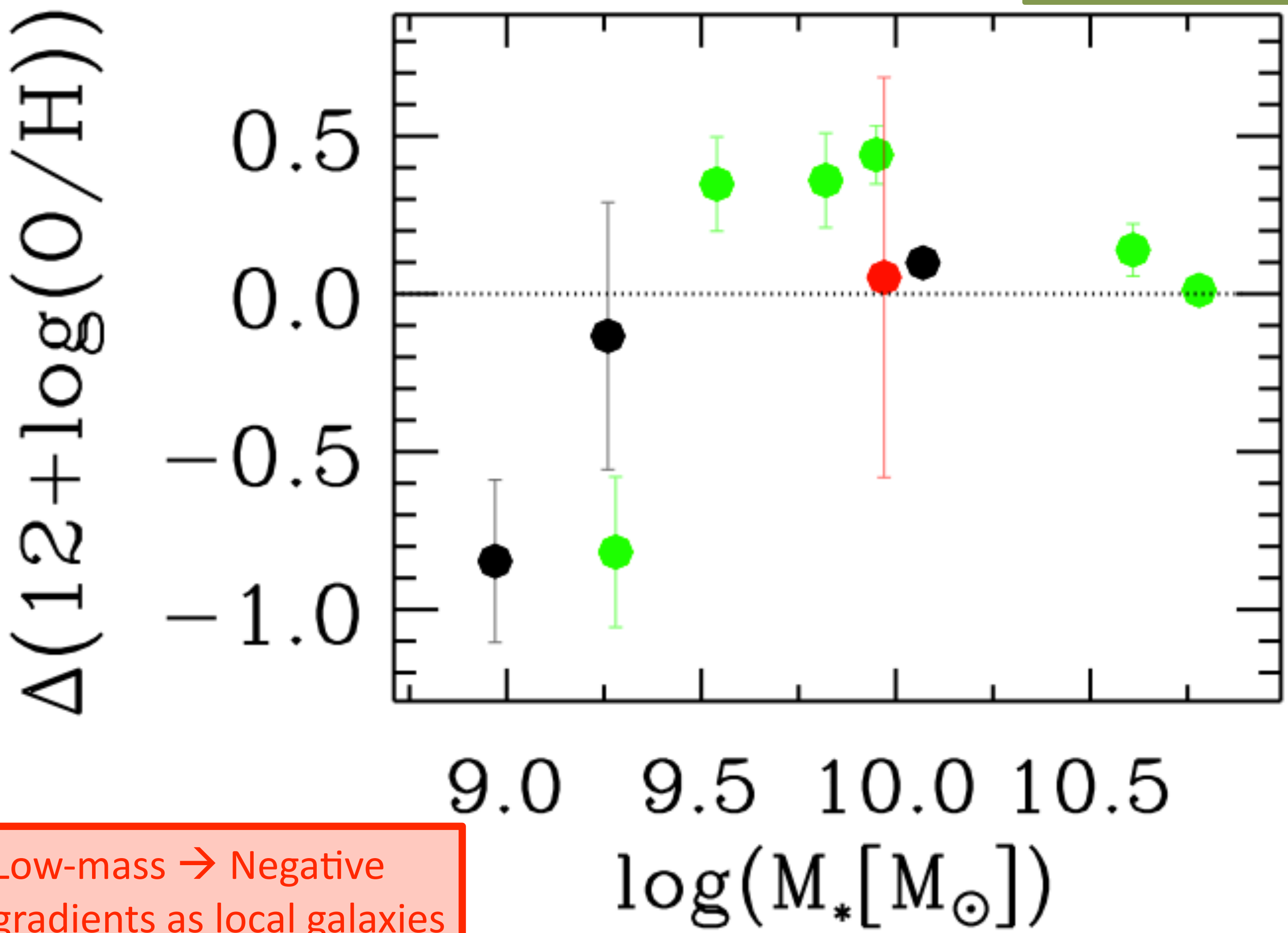


SSA22a-C16
z = 3.065



Metallicity gradients @ z~3





High-mass → Positive or inverted gradients.
4/5 rotationally supported.
Colds flows scenario?

Low-mass → Negative gradients as local galaxies

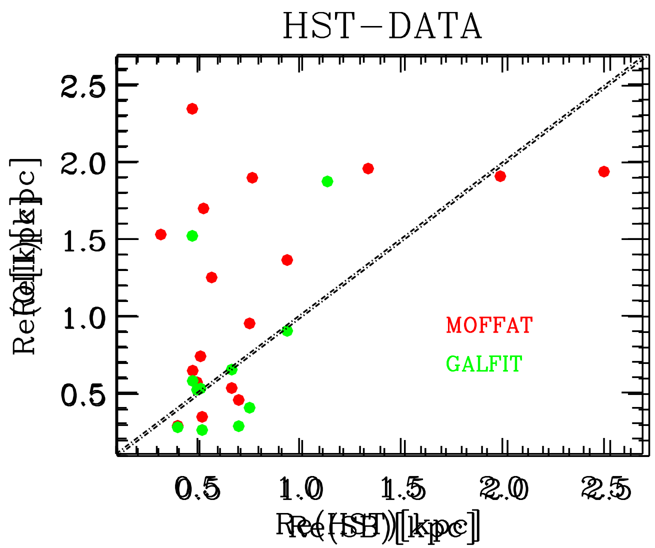
Gas content SK law at high-z ?

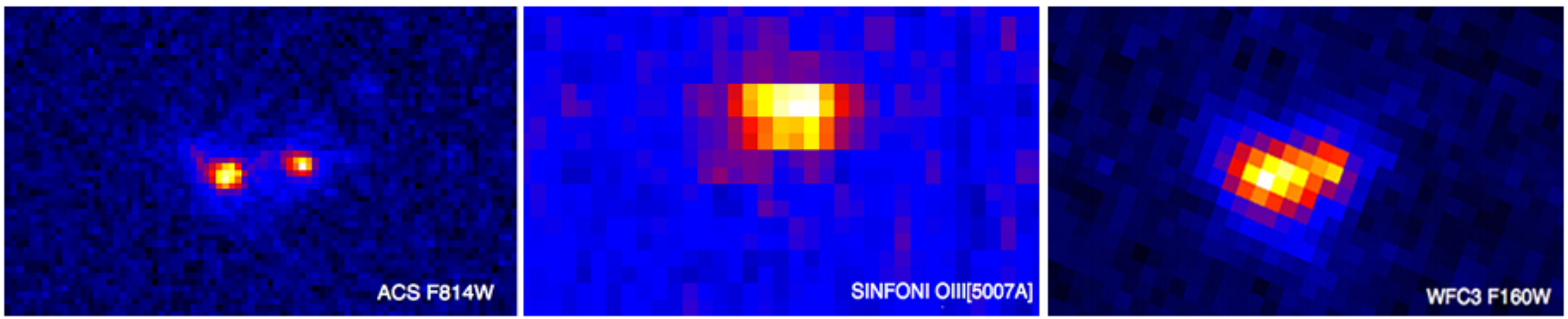
$$\Sigma\ \mathrm{SFR} \sim (\Sigma_{GAS})^n$$

$$M_{gas}(M_\odot) = 757 \times 10^6 \left(\frac{\mathrm{SFR}}{\mathrm{M_\odot/yr}}\right)^{0.71} \left(\frac{r}{\mathrm{kpc}}\right)^{0.58}$$

Galaxy size

- 2 methods: SB & Moffat.
- Images: OIII seeing limited, OIII AO & continuum HST.

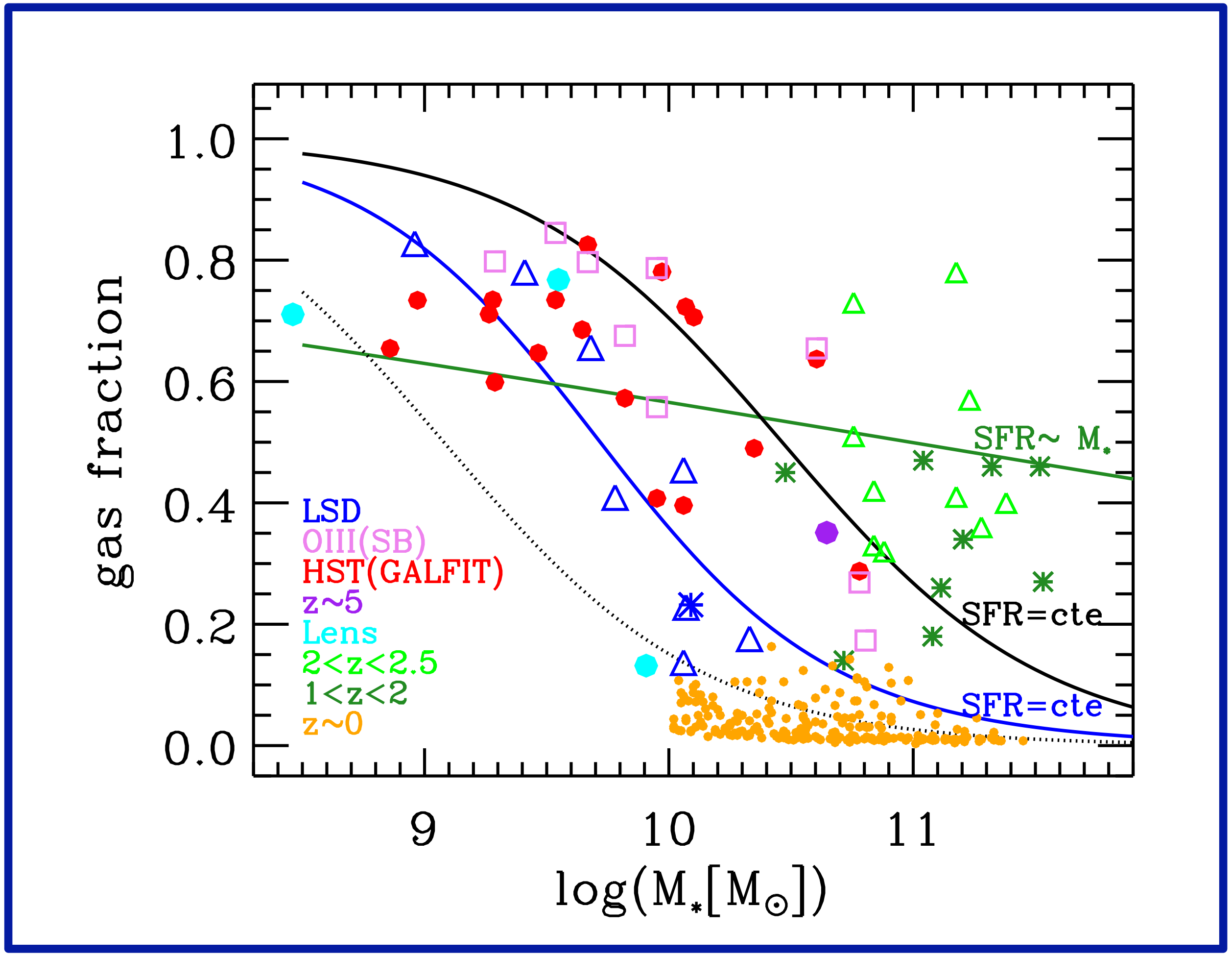




LSD, SFR = 7-18 [Mo/yr]

AMAZE, <SFR> = 80 [Mo/yr]

SFR_min ~ 2 [Mo/yr]



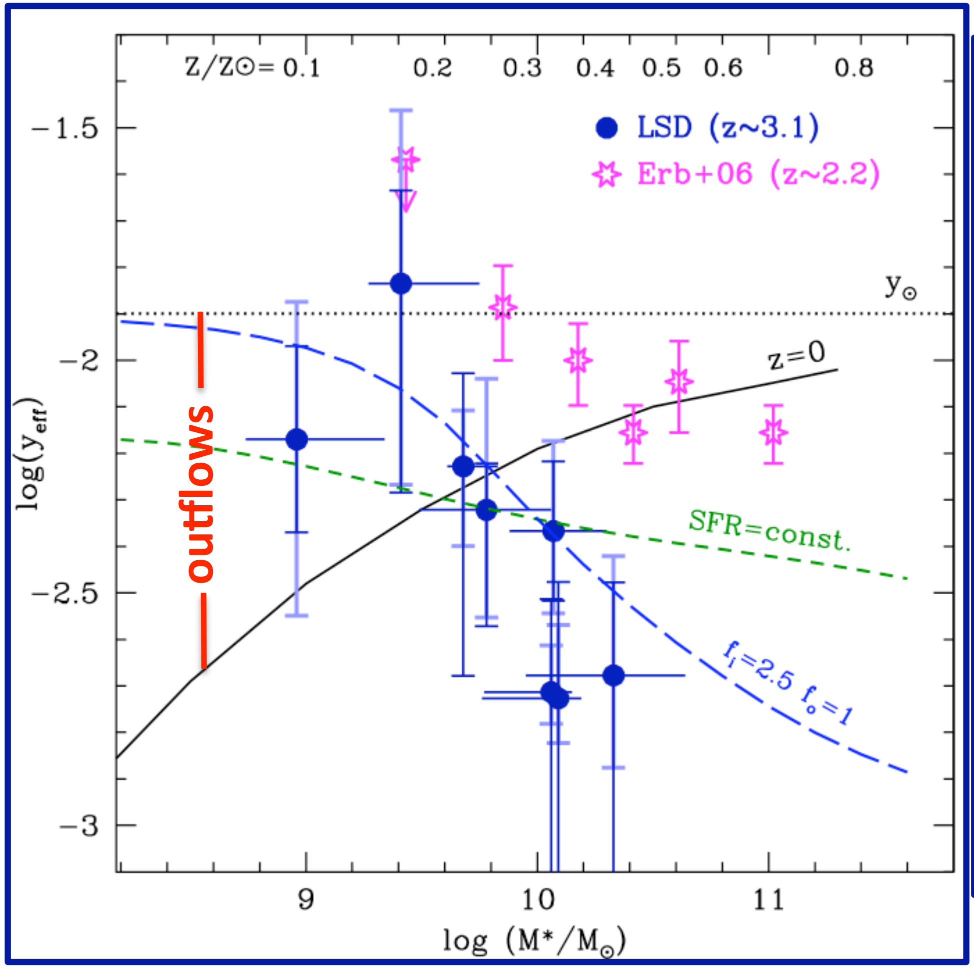
Tacconi et al. 2011: massive galaxies at z~1.2, 2.2. SFR ~ M*

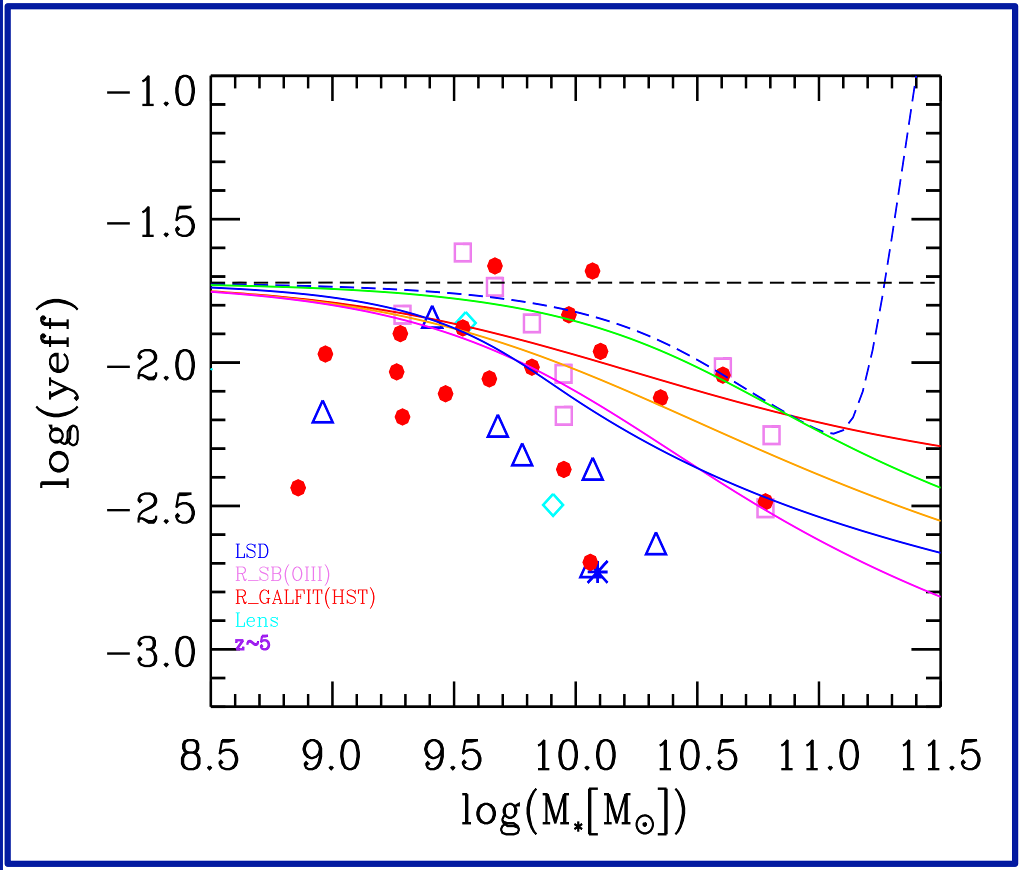
IRAM at z~0
Saintonge 2011.

Y_{eff}=metals produced and retained in the ISM.

Pure outflows, f_i=0, f_o=6

Outflows + Inflows, f_i=2.5, f_o=1



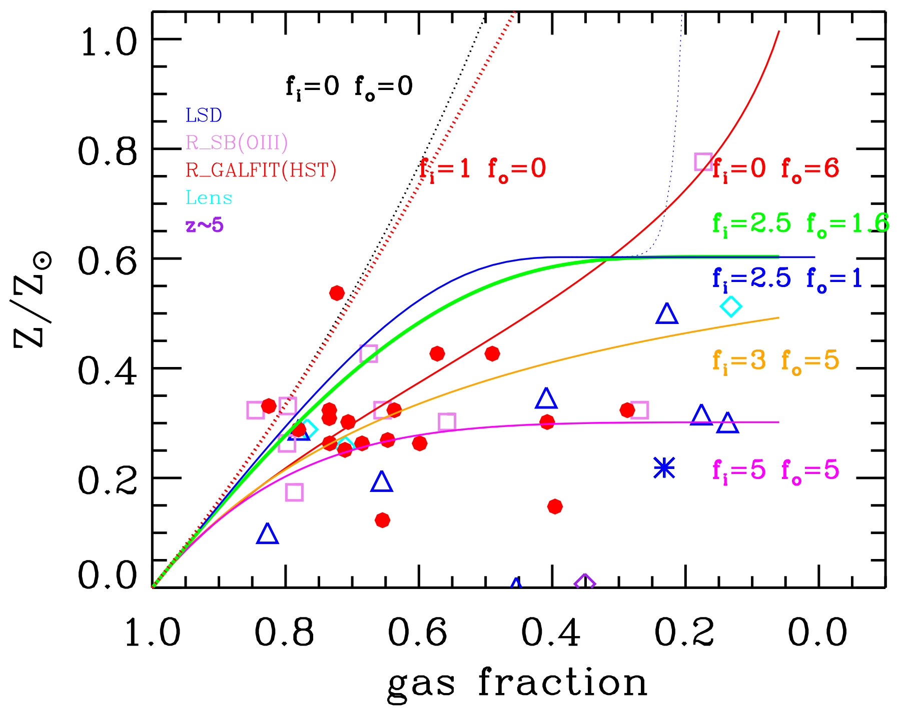


<u>Model:</u> Erb 2006

Stars: Erb 2008 z~2.2.

Circles: Mannucci+09 at z~3.5.

Massive galaxies at z~3.5 experience pronounced smooth infall of pristine gas fi=2.5*fo.

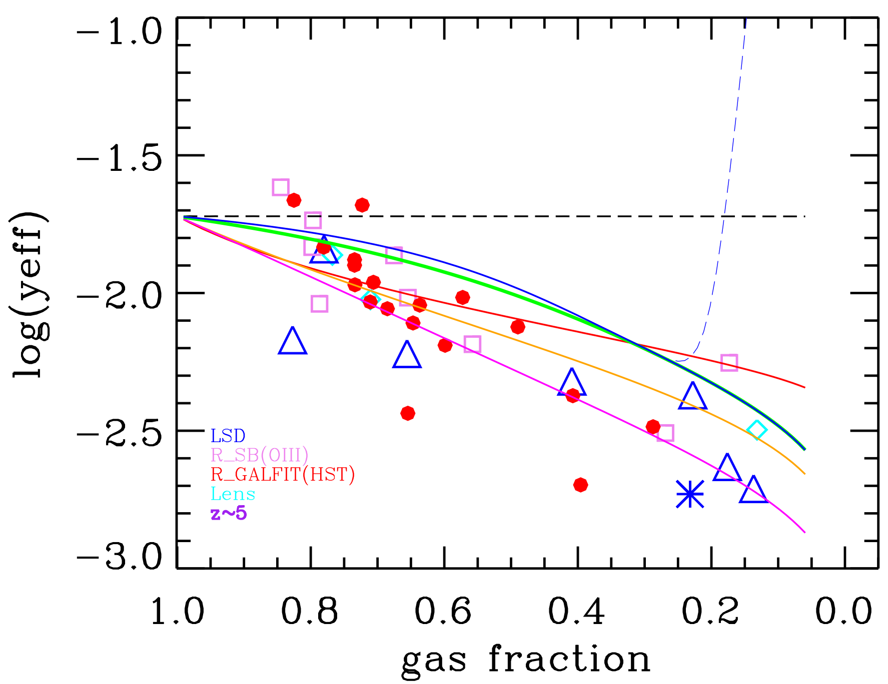


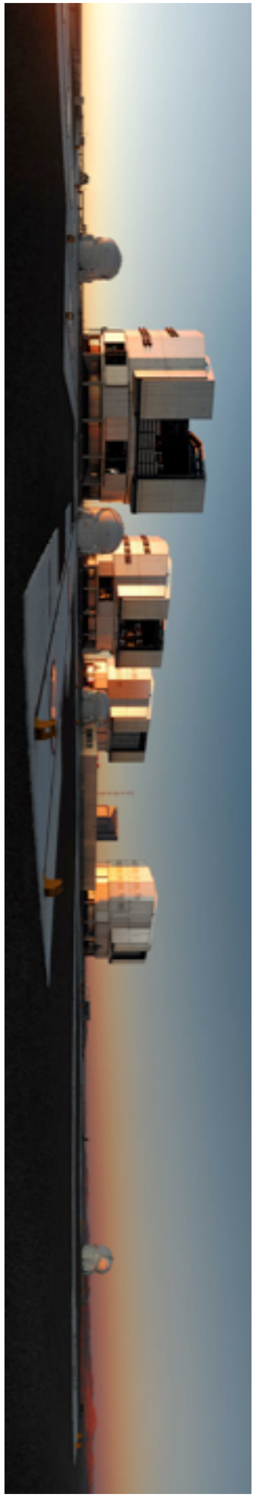
Models: Erb 2006.

Circles: AMAZE, r(HST).

Squares: AMAZE, r(OIII).

Triangles: LSD, OIII size.





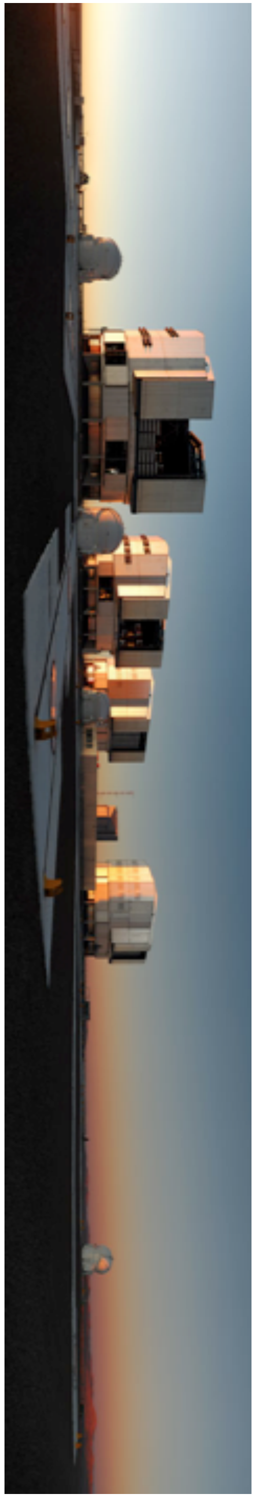
Summary

I Multi wavelength observations of star forming galaxies at z~3.3 suggest a change on the mode of star formation from z<2.5 up to z~3.3.

II Dynamical studies: These differences are equal for rotating and not rotating. Therefore, enhanced merging at z>3.4 cannot be the only reason for the deviations from the FMR at z>3.

III Inverted galactic gradients supports the cold flows scenario.

III **HST** images, **JWST** and **ALMA** follow-up are required to sample the early stages of galaxy evolution.



Study the chemio-dynamical evolution of star forming galaxies through the cosmic epochs.

•Derive metallicities from SINFONI NIR IFS data on star forming- galaxies at z~3.3.

• Connect with the information inferred from gas dynamics and galaxy SED.

• Compare with data at lower redshift in order to study the evolution.

AMAZE II. Chemical evolution constraint at redshift 3.3.
Troncoso et al. 2011b in preparation.

• Metallicity gradients, relative role of various processes: inflows, outflows, star formation.

AMAZE III. Metallicity gradients, gas fraction at z ~ 3.3.
Troncoso et al. 2011a in preparation.

• Constrains models of galaxy formation & evolution with these observations.
Troncoso et al. 2012?

•JWST-NIRSpec data simulation.
ELIXIR consortium 2012?