Chemical evolution and gas flows in star forming galaxies up to z~3.5
"AMAZE+LSD"

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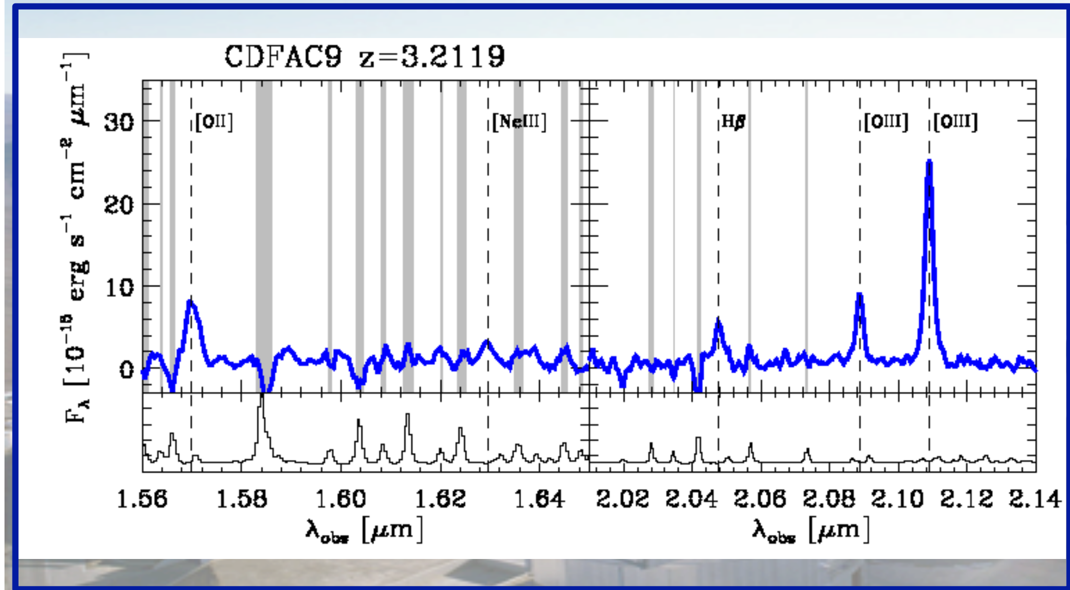
AMAZE Assessing the Mass-Abundance redshift[Z] Evolution

LSD Lyman-break galaxies Stellar populations and Dynamics

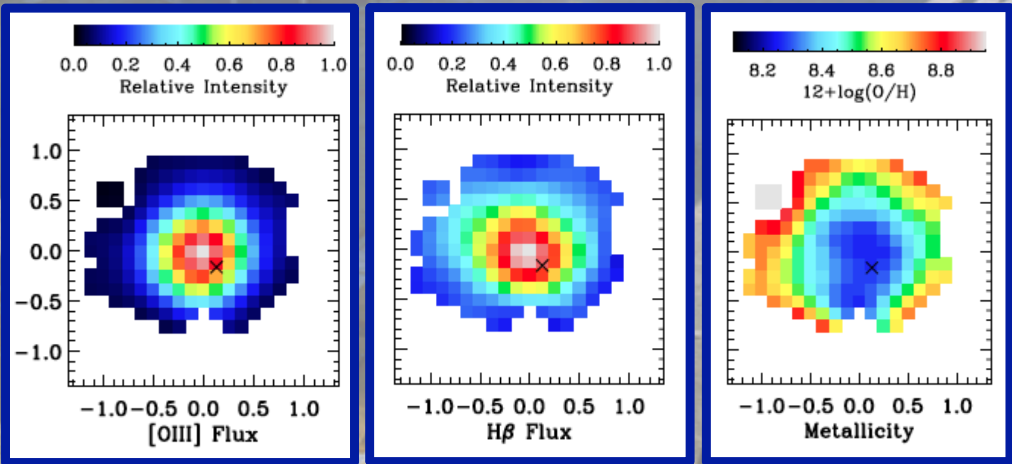


•Sample of 35 LBG's at z~3.3

• M*, SFR, E(B-V)
(UV to Spitzer-MIPS at 24 μm)

• Metallicity measured with [OIII], [OII], Hβ and [NeIII] ratios.

SINFONI - VLT
NIR - IFU

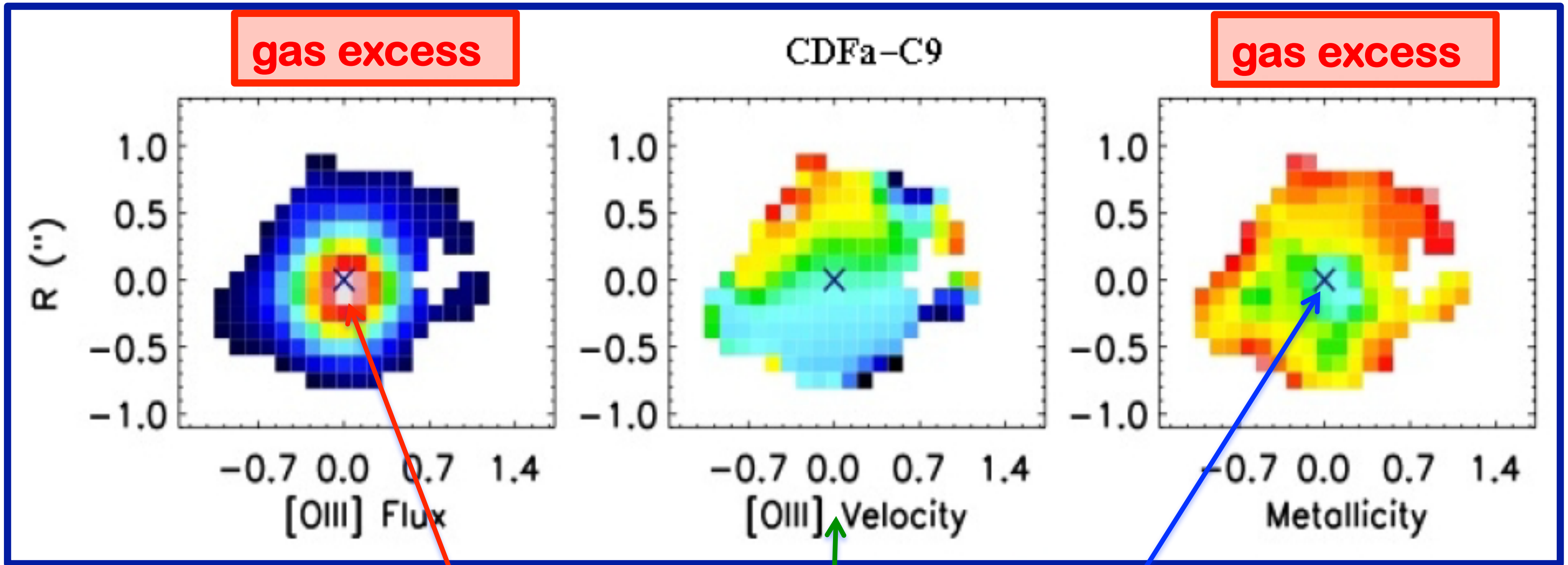


P. Troncoso – CNR- Bologna, April 2-3.

What do we learn from the metallicity distribution?

AMAZE+LSD at z~3.3

Correlation between the peak of the star formation and the part of the galaxy with lowest metallicity



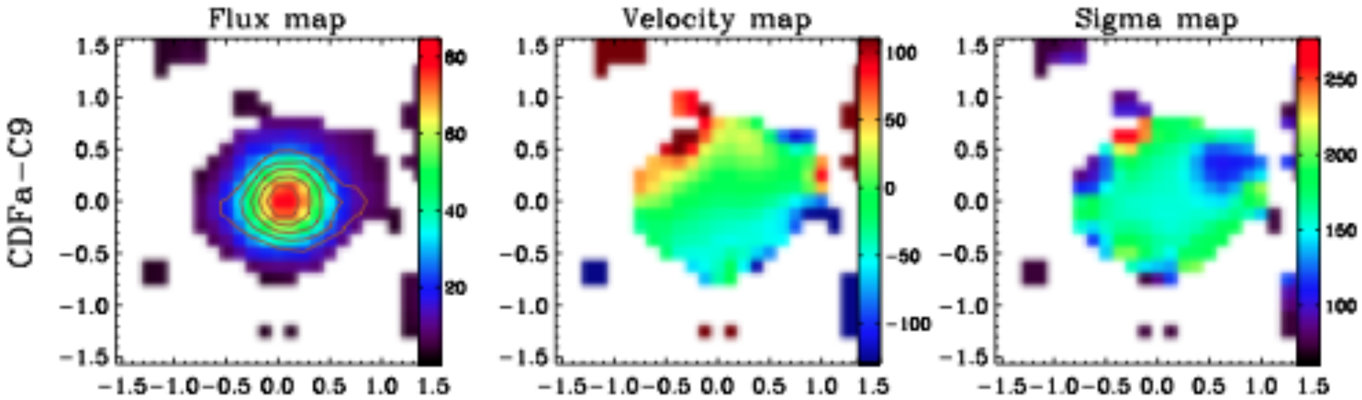
Gas excess likely due to prominent *inflows of pristine* gas that boosts the star formation but also dilutes the metals. **Cresci+10**

Troncoso in prep.

Massive turbulent rotating disk

Has the gas excess been driven through merger events?

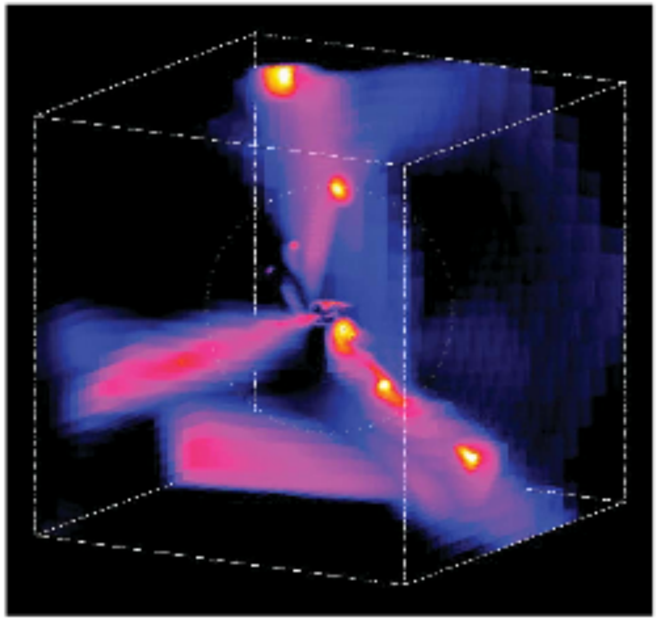
Dynamics: AMAZE+LSD at z~3.3



Gnerucci et al. 2010

In some cases (65%) galaxies show evidence of being merger products (not rotating or not dynamically classified). How about the other 35% classified as rotating objects?

Dekel+10, Dave+11a, Dave+11b



Metallicity gradients as fingerprints of galaxy evolution!

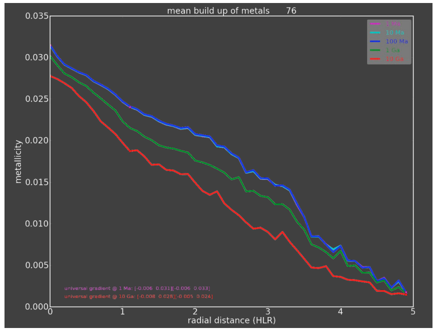
Gas role?

TIME

Gas fraction

z ~ 0

Negative gradients, some exceptions, Werk+10, Florido+12.



Inside-out formation

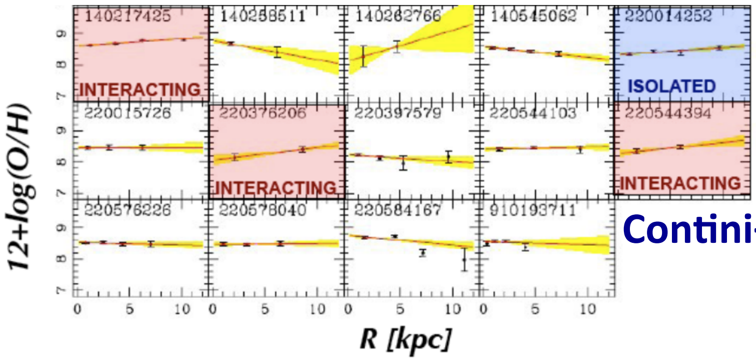
$\mu \sim 0.06$

E. Pérez-CALIFA team

z ~ 1

z ~ 2

Negative, positive and flat gradients.
Positive gradients pref. in interacting systems.



Gas inflows driven by tidal forces? (Rupke+11)

$\mu \sim 0.3$

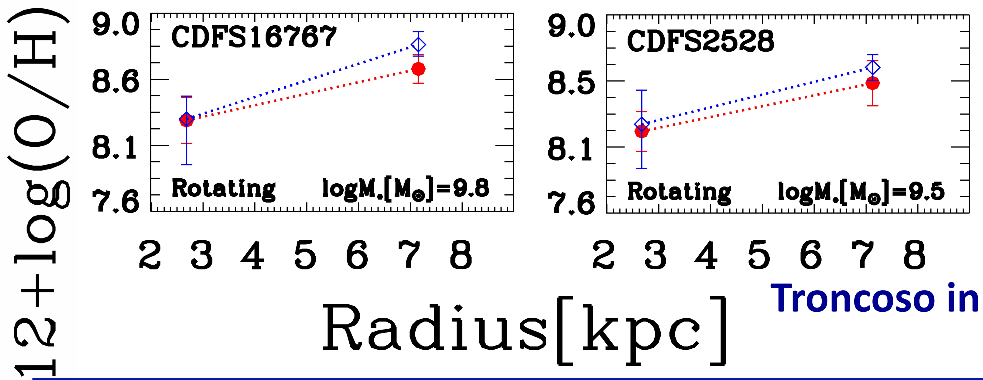
Contini+11

$\mu \sim 0.4$

Massive accretion cosmic cold gas?

z ~ 3

Positive, flat gradients, no preference about interacting/isolated (Cresci+10, Troncoso+12).



Troncoso in prep.

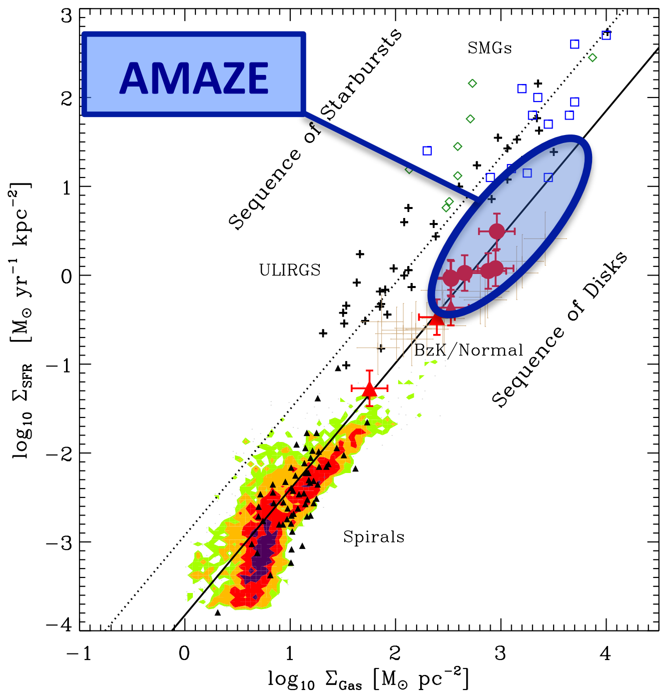
$\mu \sim ?$

Gas content at high-z by inverting SK law

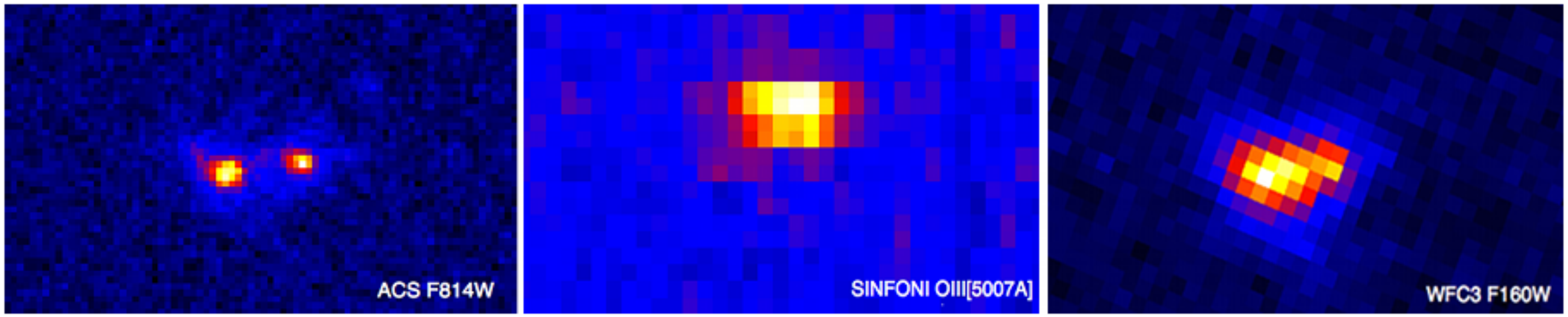
I) Exploiting SINFONI's IFU*

* improved method to determine M_{GAS}

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



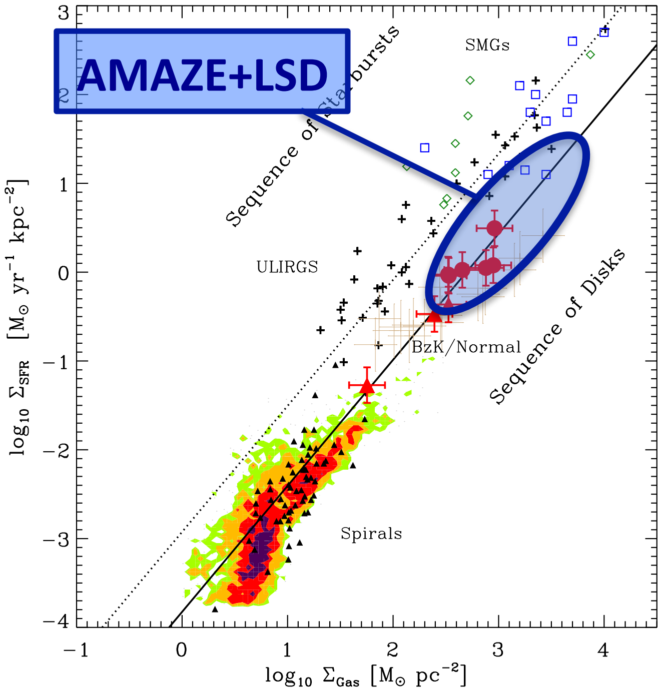
II) ALMA's prospects

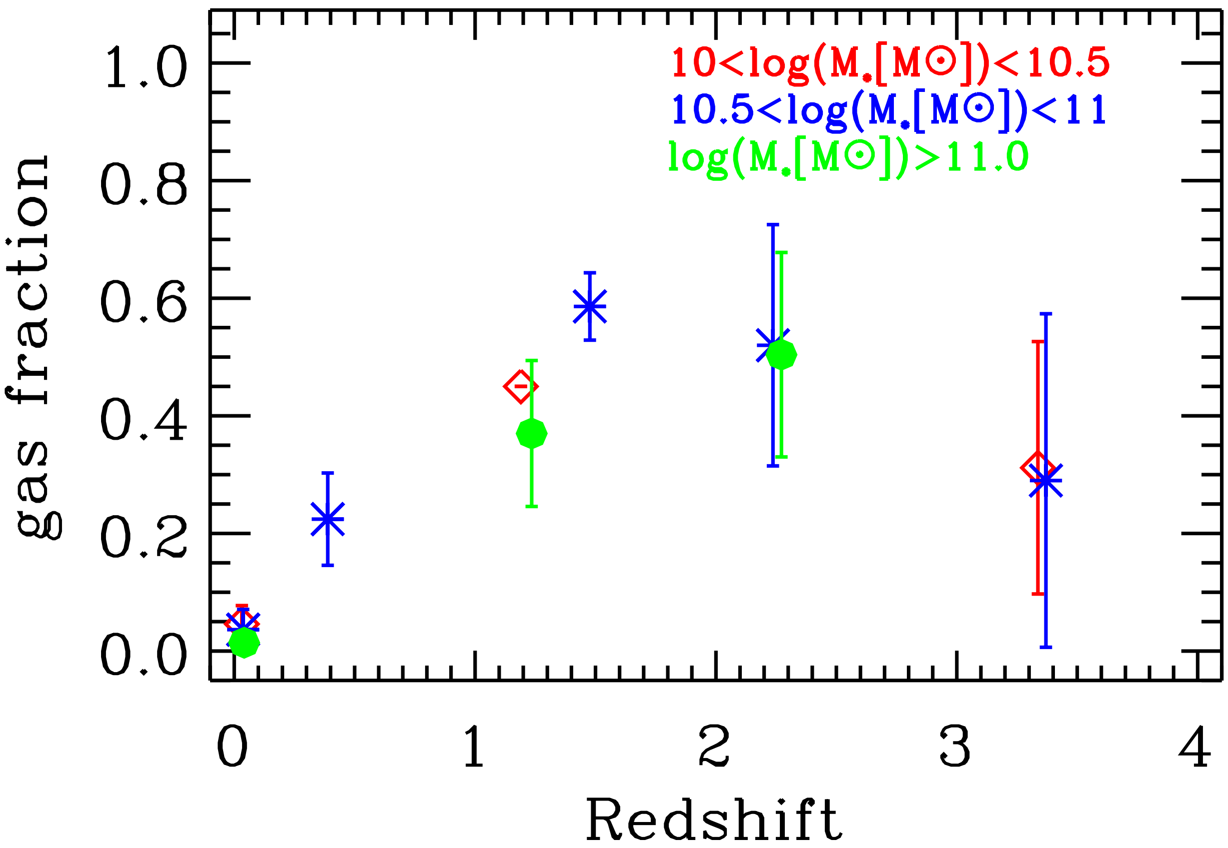


Gas content estimation: AMAZE+LSD at z~3.3

Cosmic evolution of the gas fraction

By inverting the SK law, and using Σ_{SFR} information from IFU data we can determine the mass of gas.





Gas content estimation: AMAZE+LSD at z~3.3

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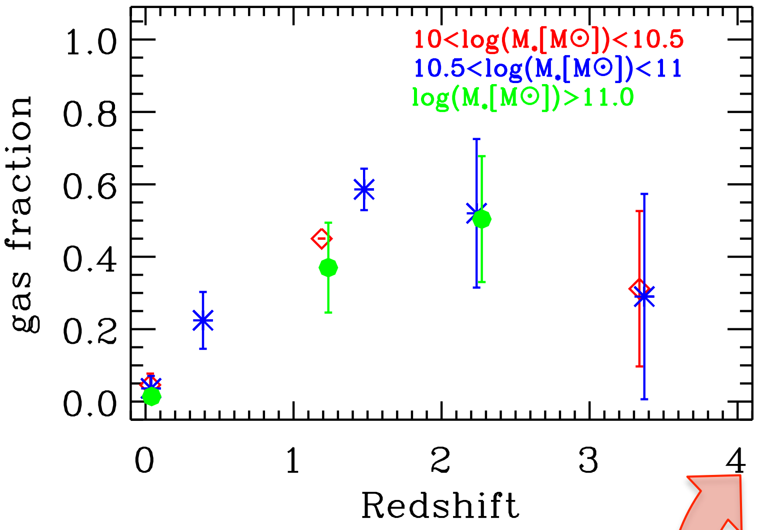
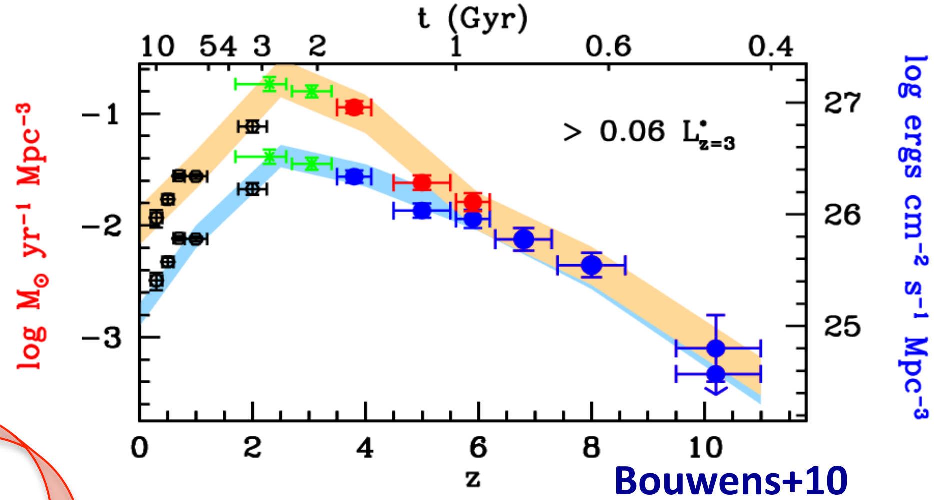
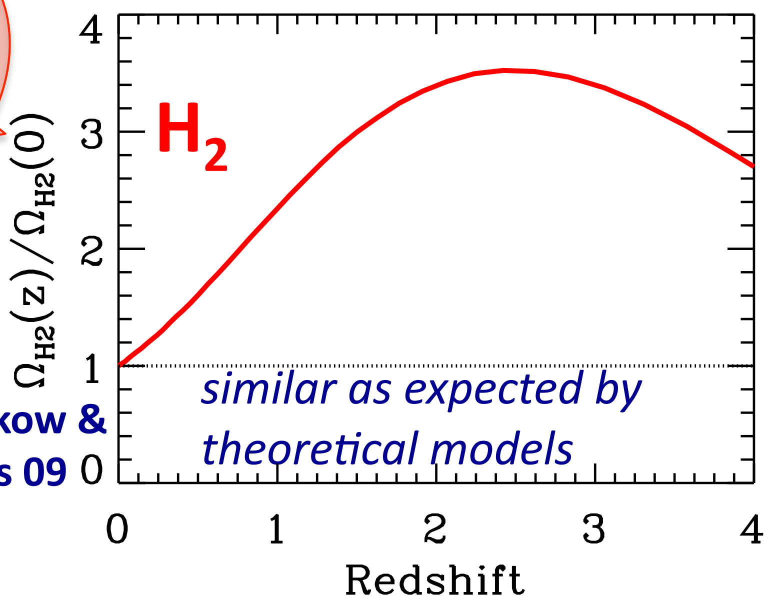


z~0 COLD GASS, z~0.6 Geach+09
z~1 Taconni+10, Daddi+10
z~2 Taconni+10,
z~3 Troncoso in prep.



Bouwens+10



Obreschkow & Rawlings 09

Galaxy evolution is driven by the amount of gas & how it was acquired or lost at different cosmic epochs.

Depletion times: AMAZE+LSD at z~3.3

LSD, SFR = 7-18 [$M_\odot$/yr]

AMAZE, <SFR> = 80 [$M_\odot$/yr]

Tacconi+11: massive galaxies at z~2.2.

Tacconi+11: massive galaxies at z~1.2.

Saintonge+11 IRAM at z~0.

2[Gyr] μ~0.6 135$M_\odot$/yr

τ_{gas}~ 0.2[Gyr]

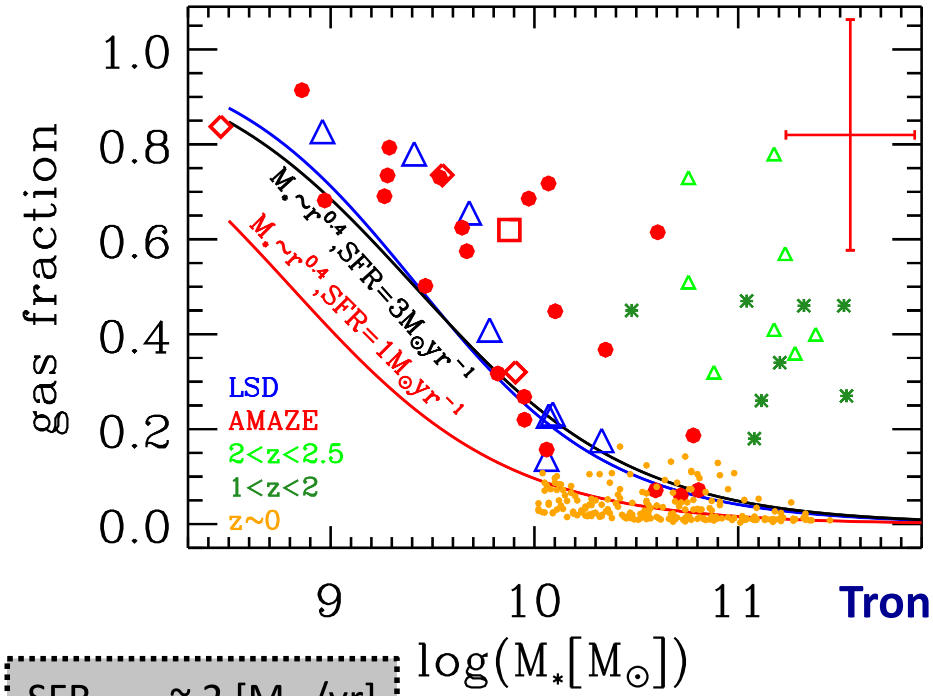
3[Gyr] μ~0.5 150$M_\odot$/yr

τ_{gas}~ 1.1[Gyr]

5[Gyr] μ~0.4 100$M_\odot$/yr

τ_{gas}~0.8[Gyr]

13.5[Gyr] μ~0.06 few $M_\odot$/yr



SFR_min ~ 2 [$M_\odot$/yr]

Troncoso in prep.

"High gas fractions at z~3.3,2-1" – Replenishment of fresh gas to young galaxies.

M_{gas}=M_{gas}(SFR,Radius)

Radius=R(M_*)
Mosleh et al. 2010

IV) ALMA prospects: AMAZE+LSD at z~3.3

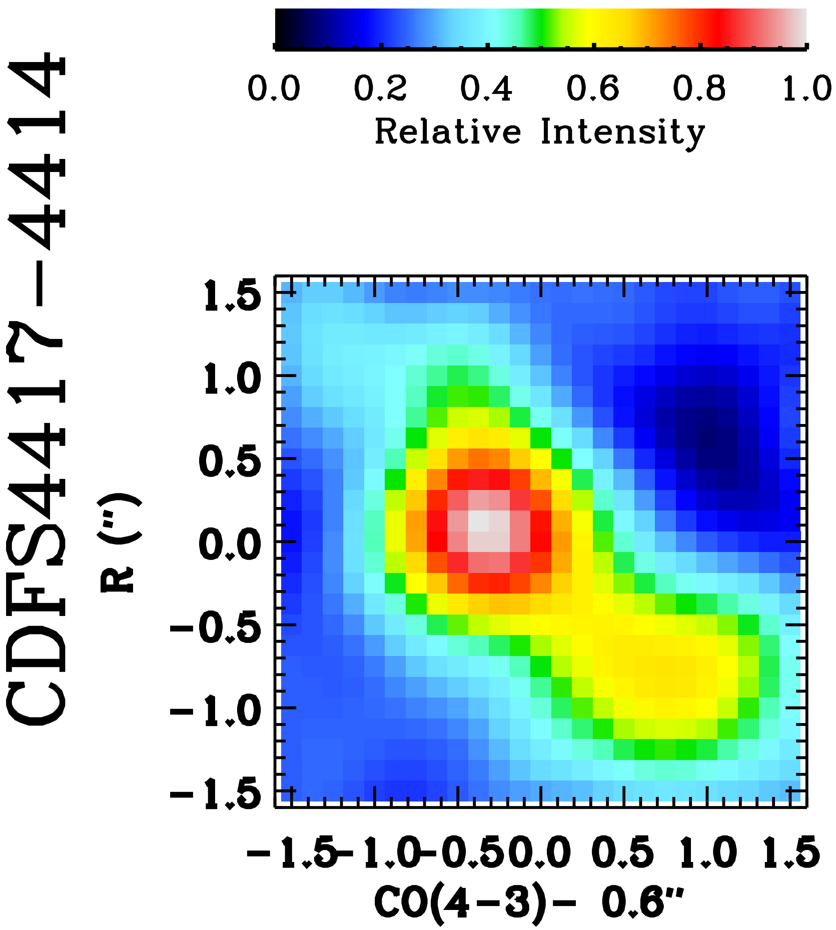
- Allows studies of the gas content and the dynamics of typical star forming galaxies at z~3.3, where physical processes regulating the chemical evolution (SFR, gas inflows and outflows) differs from nearby galaxies (0<z<2.5).
- Prove SK-law at z~3 for typical star forming galaxies.
- Determination of the dynamical mass of gas through CO observations allows to constrain α_{CO} from independent methods, Mgas=Mdyn-M*-Mdark.
- Non detection of CO flux from rotational numbers higher than CO(J 4-> 3) would confirm the similarity between the excitation conditions of these galaxies and nearby disks.
- Constrains for galaxy formation models

a) evolution of the cosmic molecular gas fraction (Lagos et al. 2011a,b, Obreschkow+09).

b) α_{CO} has been shown to be dependent on metallicity (AMAZE+LSD unique sample at z~3 with metallicity determined).

c) gas replenishment mechanism at this early epochs.

CDFS4417-4414 as a case study



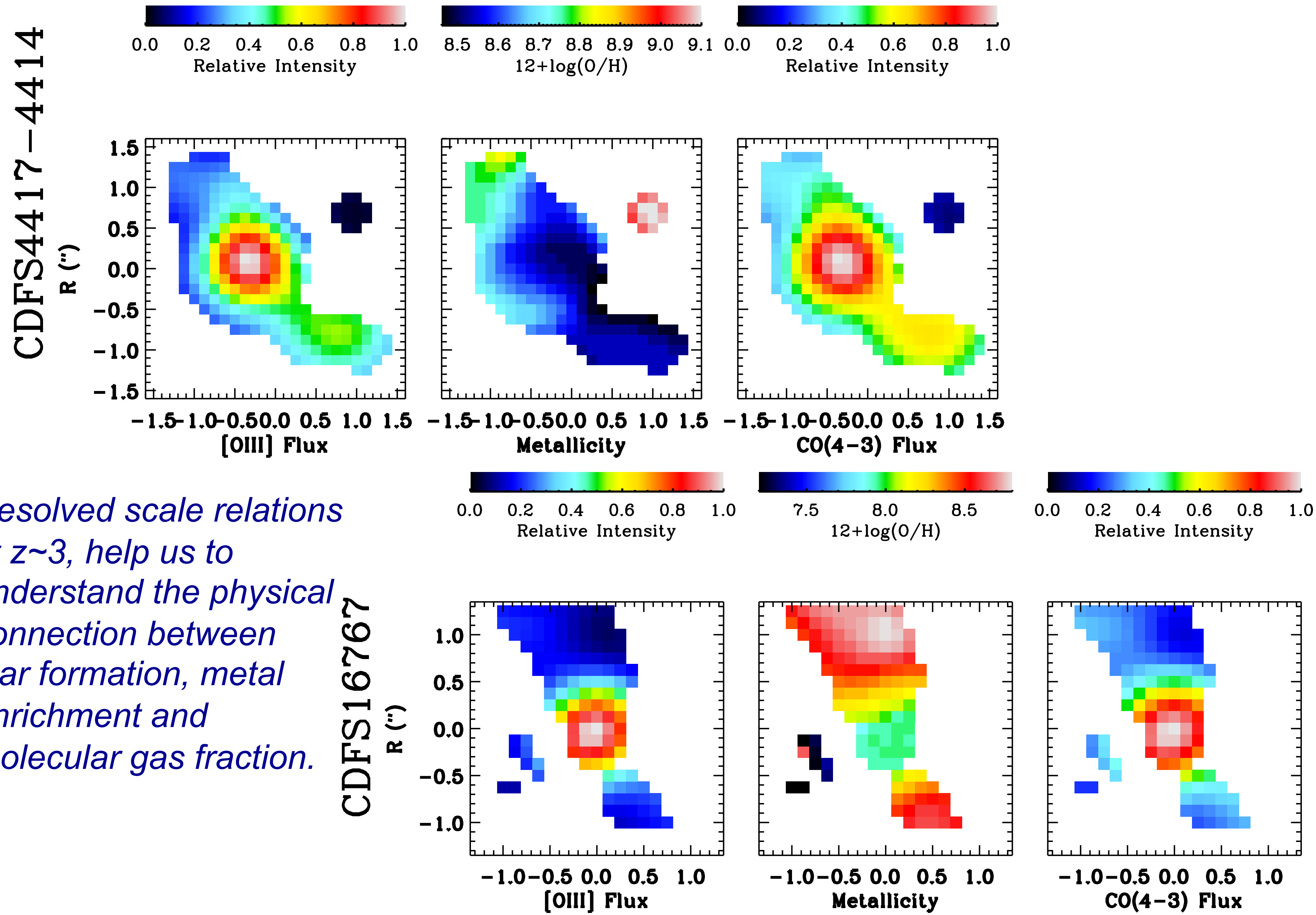
z~3.3, M_{GAS}~10^{11}, F_{CO}=0.2[Jy km s^{-1}] & Peak > 1[mJy]

✓ Early science

- 1hr, σ_{CO} =0.45mJy => 2-3σ detection
- 10 hr, σ_{CO} =0.15mJy => 10σ detection

✓ Full array

- 1 hr, σ_{CO} =0.14mJy => 10σ detection



Resolved scale relations at z~3, help us to understand the physical connection between star formation, metal enrichment and molecular gas fraction.