

On the [CII]-SFR relation in high redshift galaxies

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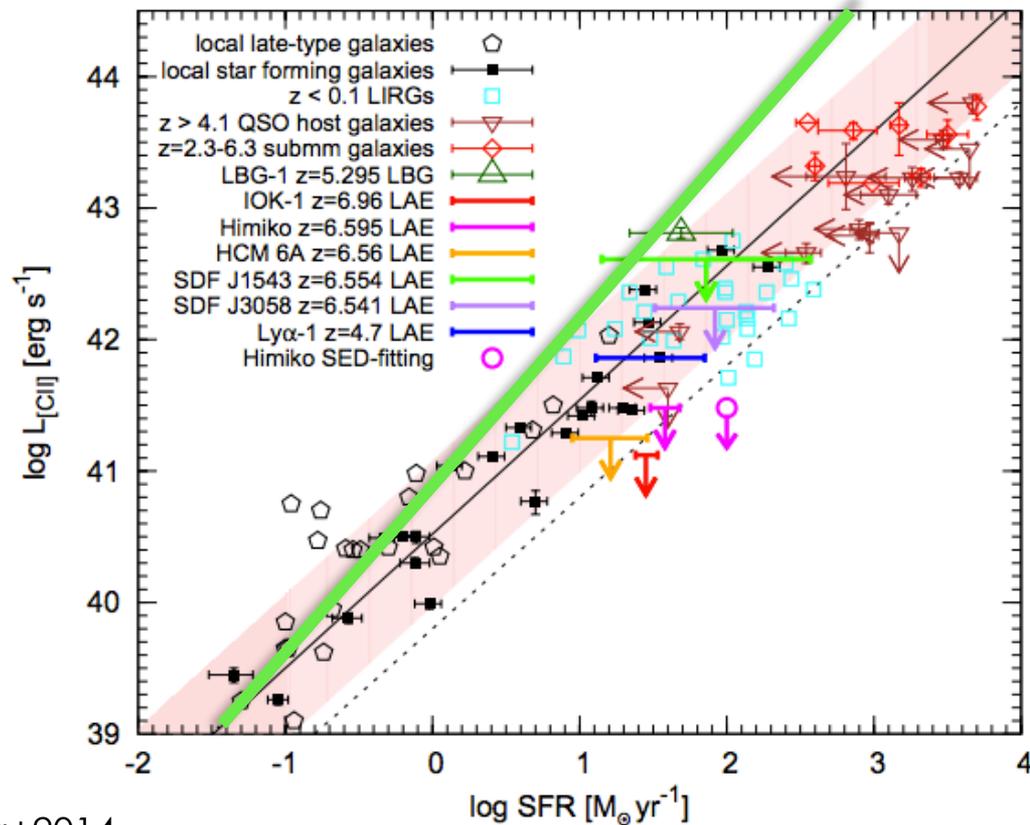
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Motivation

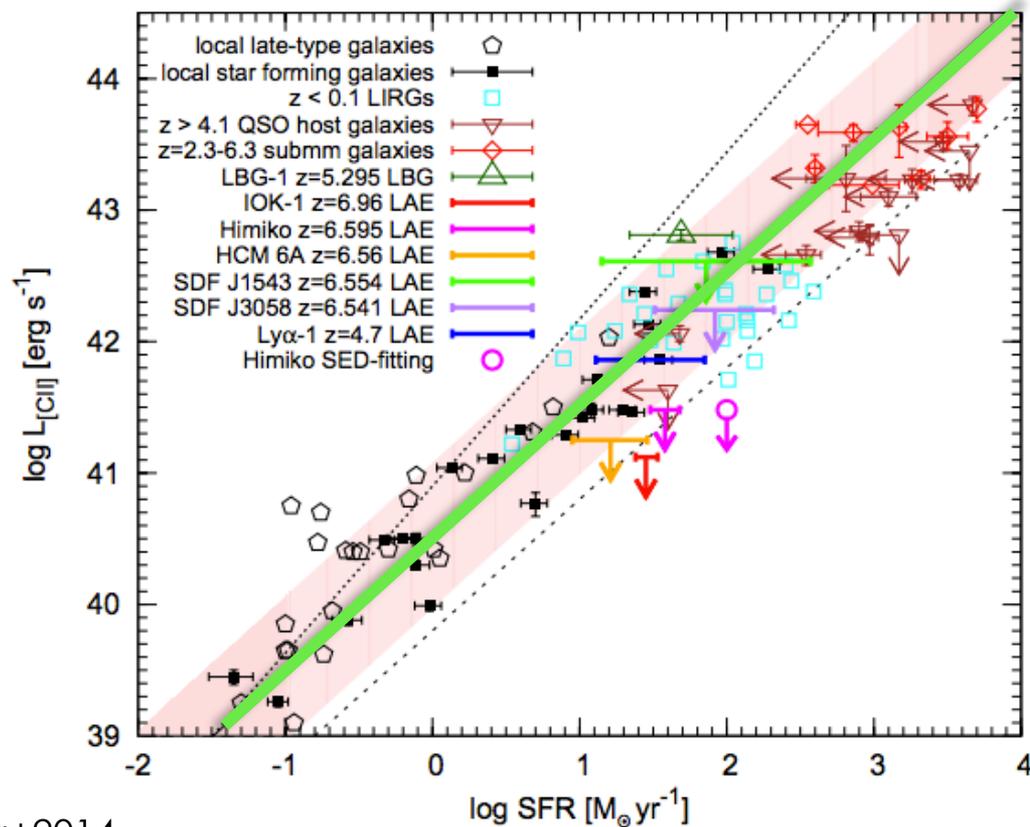
- In local galaxies we observe a correlation between the [CII] luminosity and the SFR (De Looze+2011, De Looze+2014).



Ota+2014

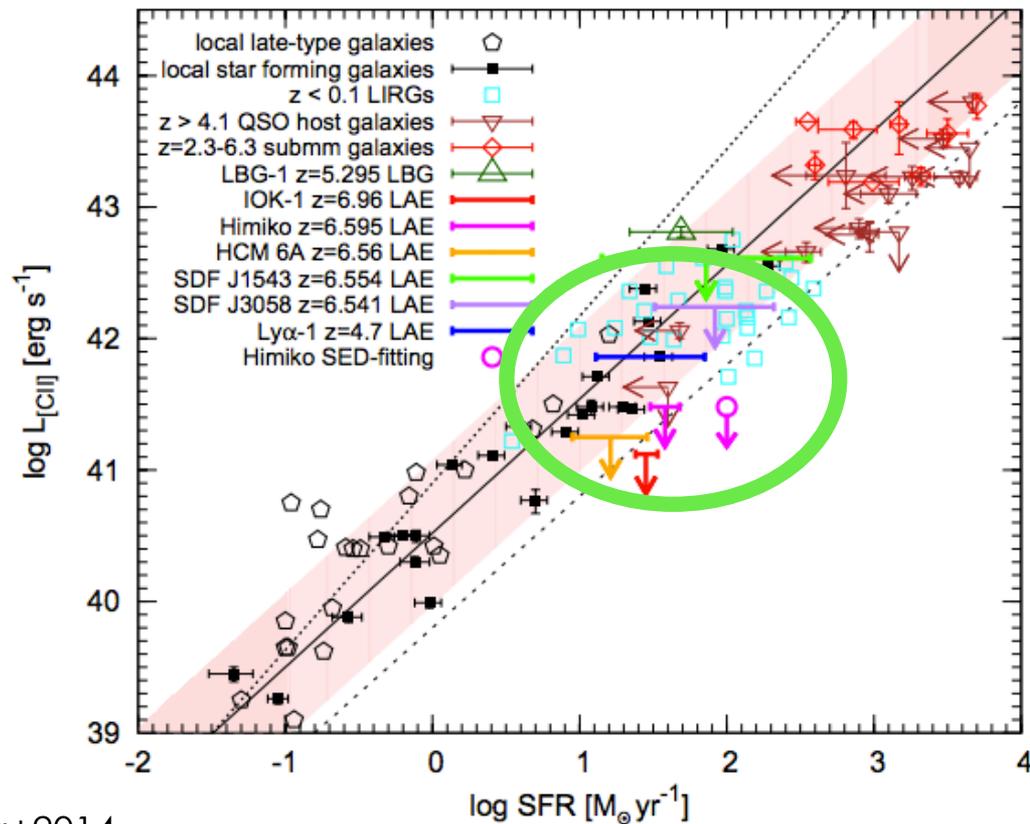
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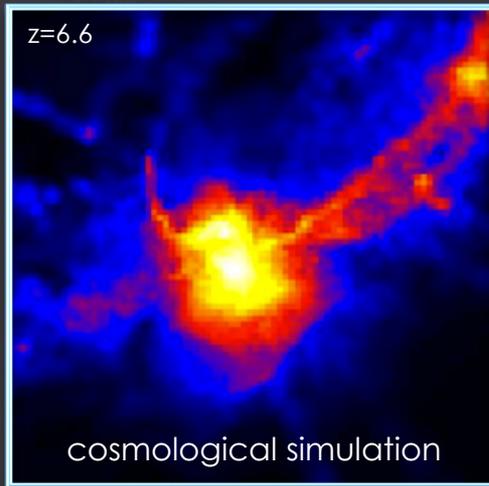
Motivation

- Current observations at $z \sim 7$ have, at a given SFR, a [CII] luminosity lower than that observed most local galaxies

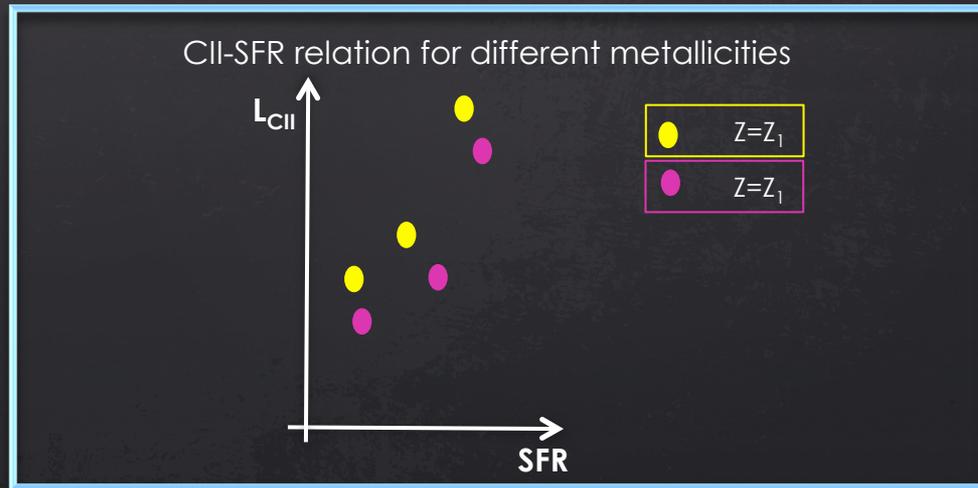
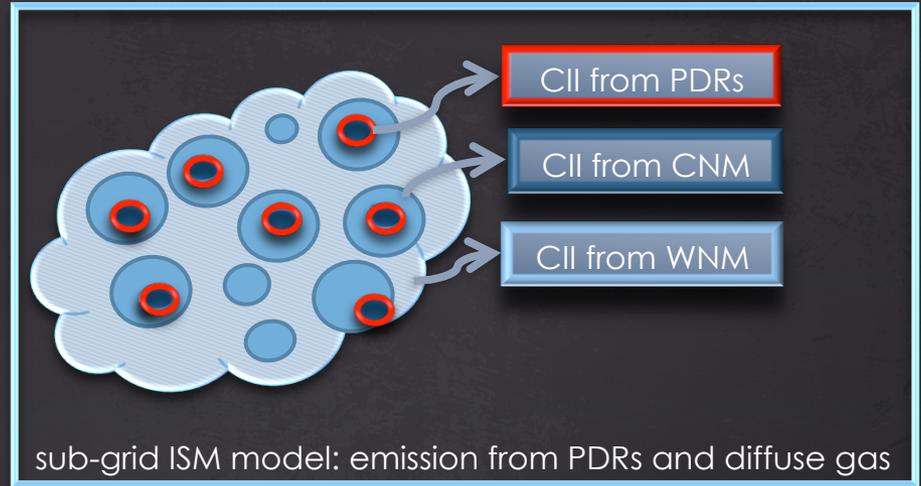


Ota+2014

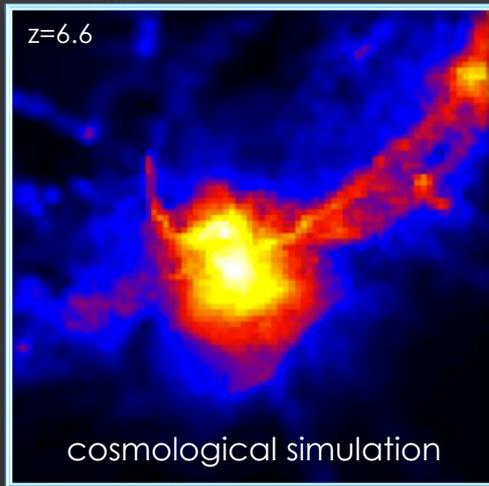
Outline of the work



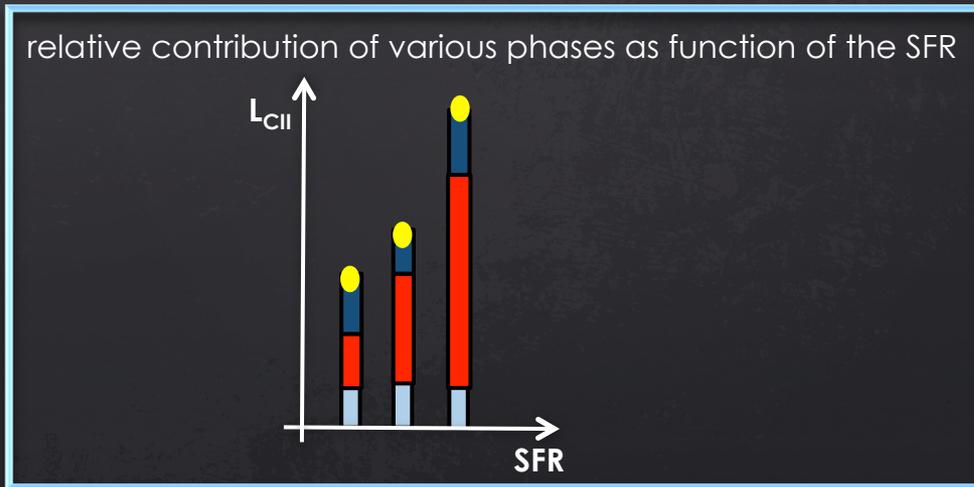
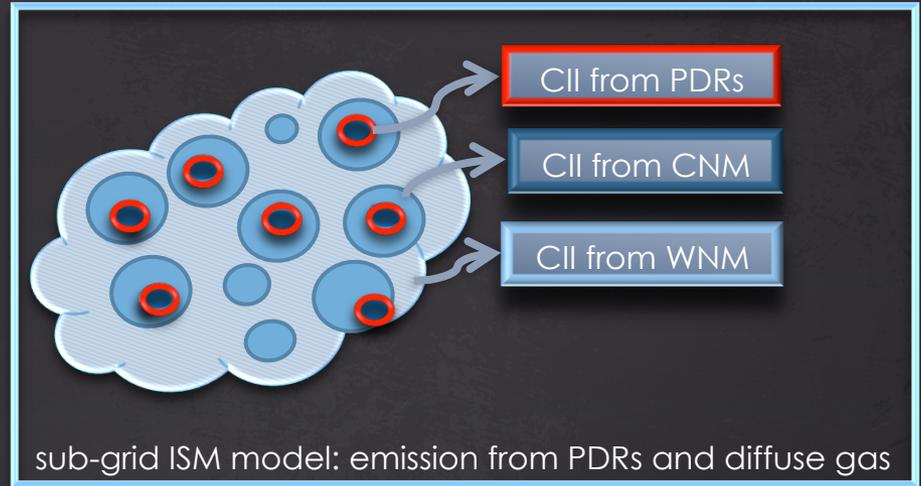
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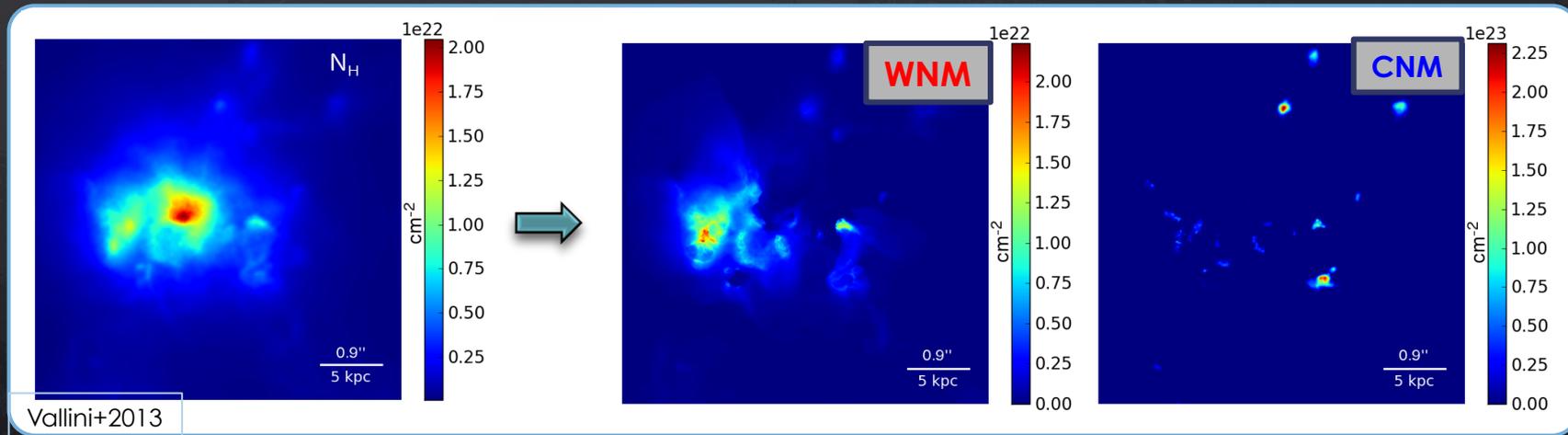
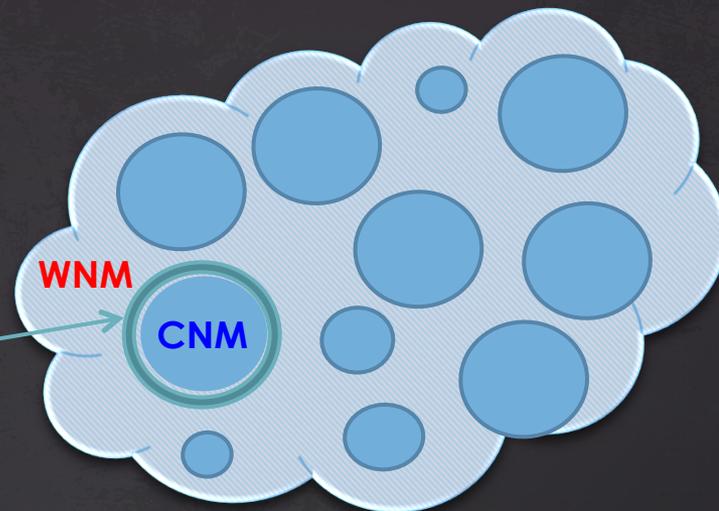
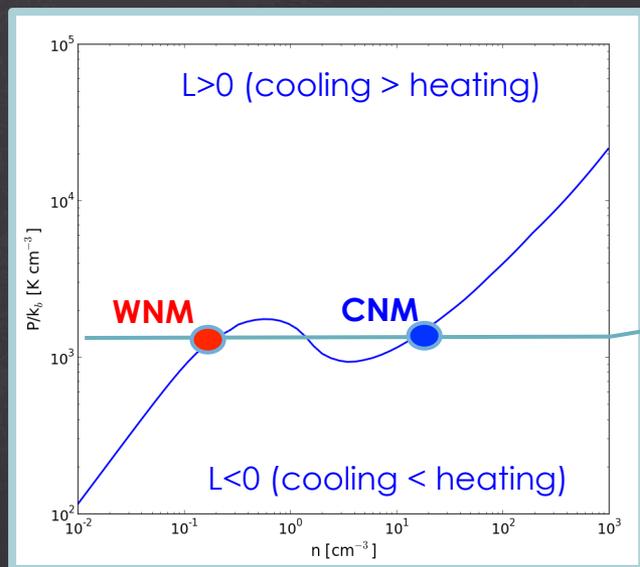
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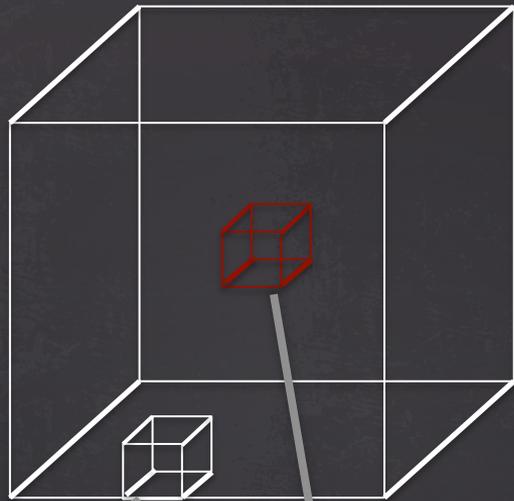
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The sub-grid model: the diffuse gas

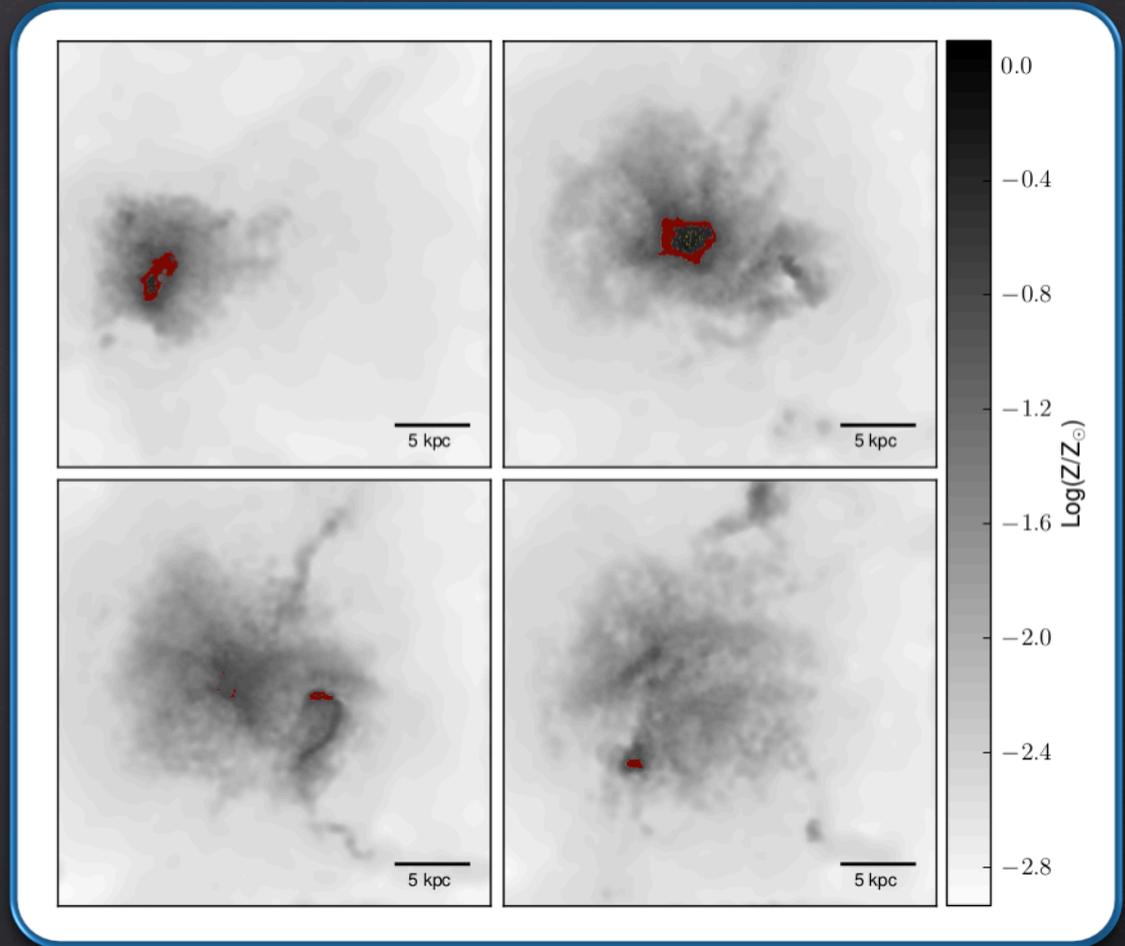


The sub-grid model: the GMCs



$$M_{\text{gas}} < M_{\text{Jeans}}$$

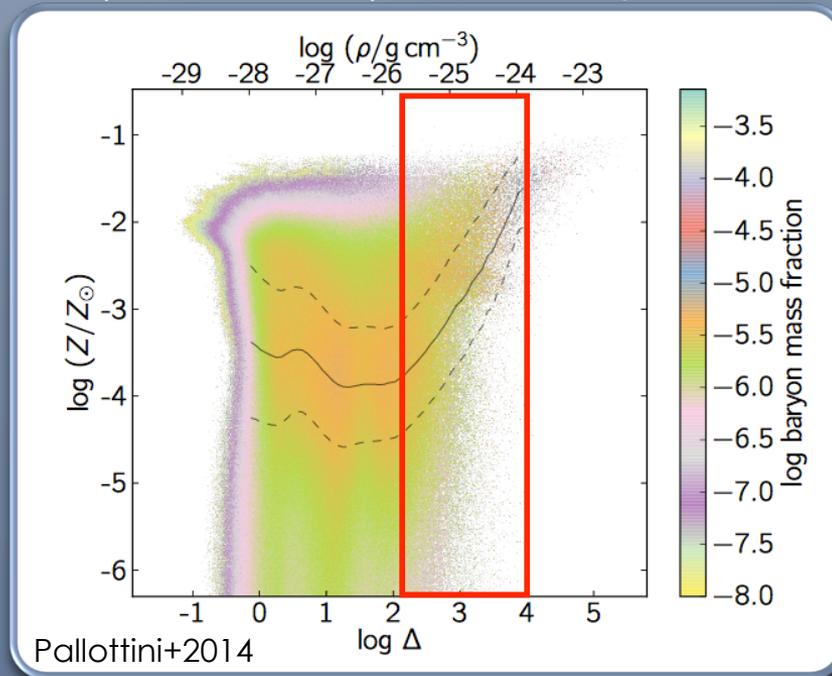
$$M_{\text{gas}} > M_{\text{Jeans}}$$



Emission from PDRs



- n from the log-normal distribution resulting from the turbulent fragmentation of the GMCs
- G_0 scales with the SFR
- Z following the Z - Δ relation (Pallottini+2014), or constant profile.



Effect of the CMB on the line emission

The T_{CMB} increases as $(1+z)$ hence at high redshift it becomes a stronger background against which we observe the [CII] line.

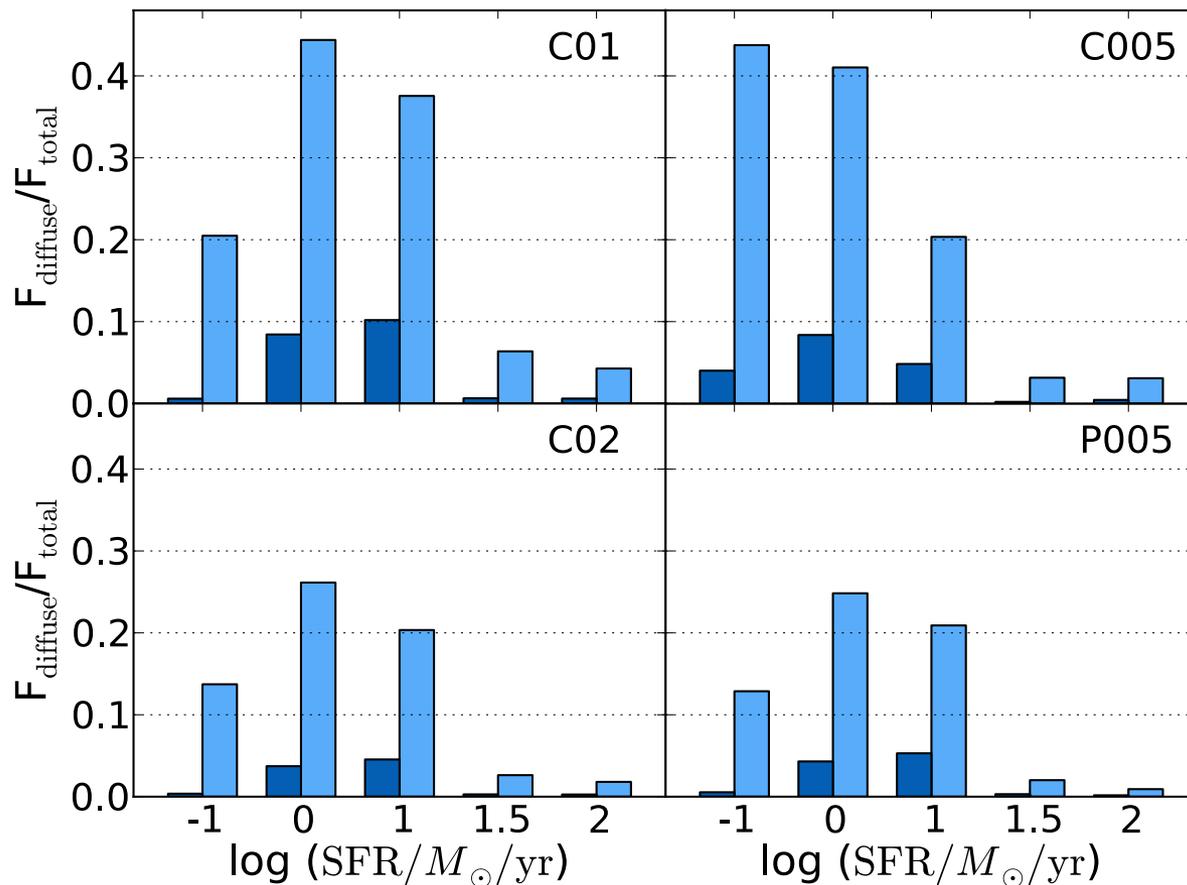
If: $T_{\text{ex}}([\text{CII}]) \rightarrow T_{\text{CMB}}$ the fraction of the of the intrinsic line flux observed against the CMB radiation approaches to zero.

$$\zeta \equiv \frac{F_{\nu}^{\text{ag}}}{F_{\nu}^{\text{int}}} = \frac{[B_{\nu}(T_s) - B_{\nu}(T_{\text{CMB}})] \tau_{\nu}}{B_{\nu}(T_s) \tau_{\nu}} = 1 - \frac{B_{\nu}(T_{\text{CMB}})}{B_{\nu}(T_s)}$$

$\zeta = 0.1 - 0.2$
diffuse gas

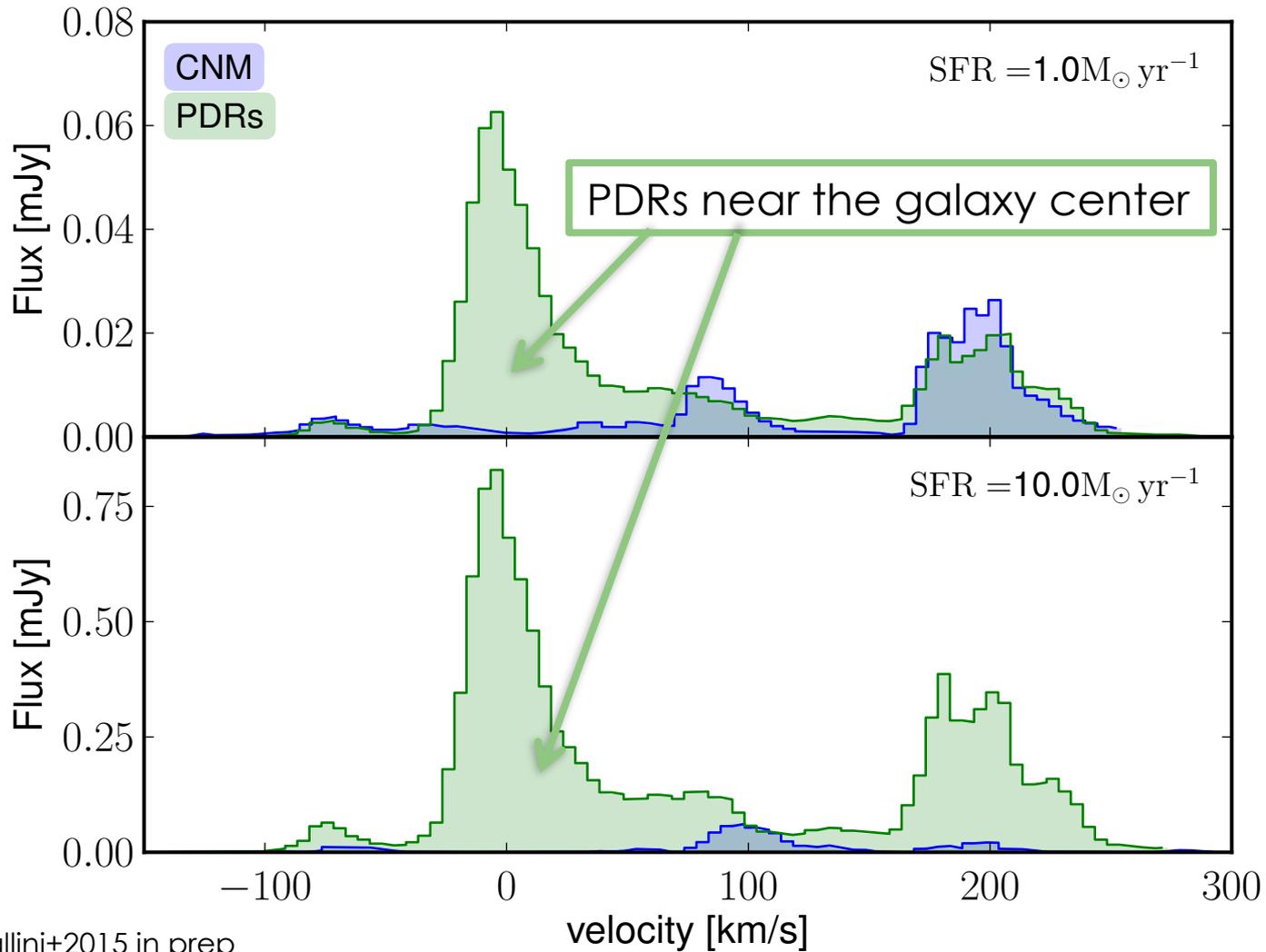
$\zeta = 0.8 - 1.0$
PDRs

Results: contribution of the various gas phases to the [CII]

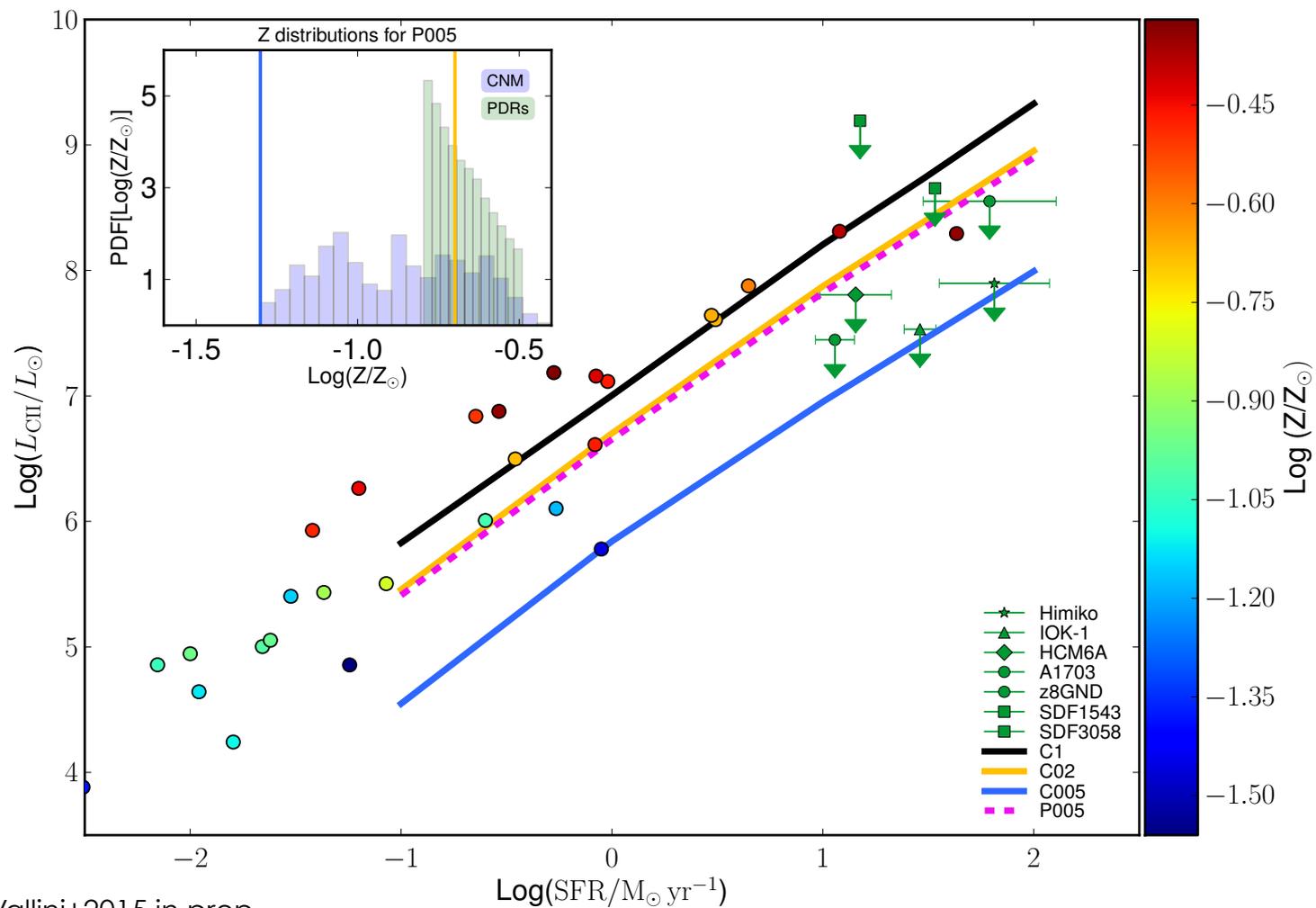


Vallini+2015 in prep

Results: [CII] spectrum from PDRs and CNM for $\langle Z \rangle = 0.05 Z_{\odot}$



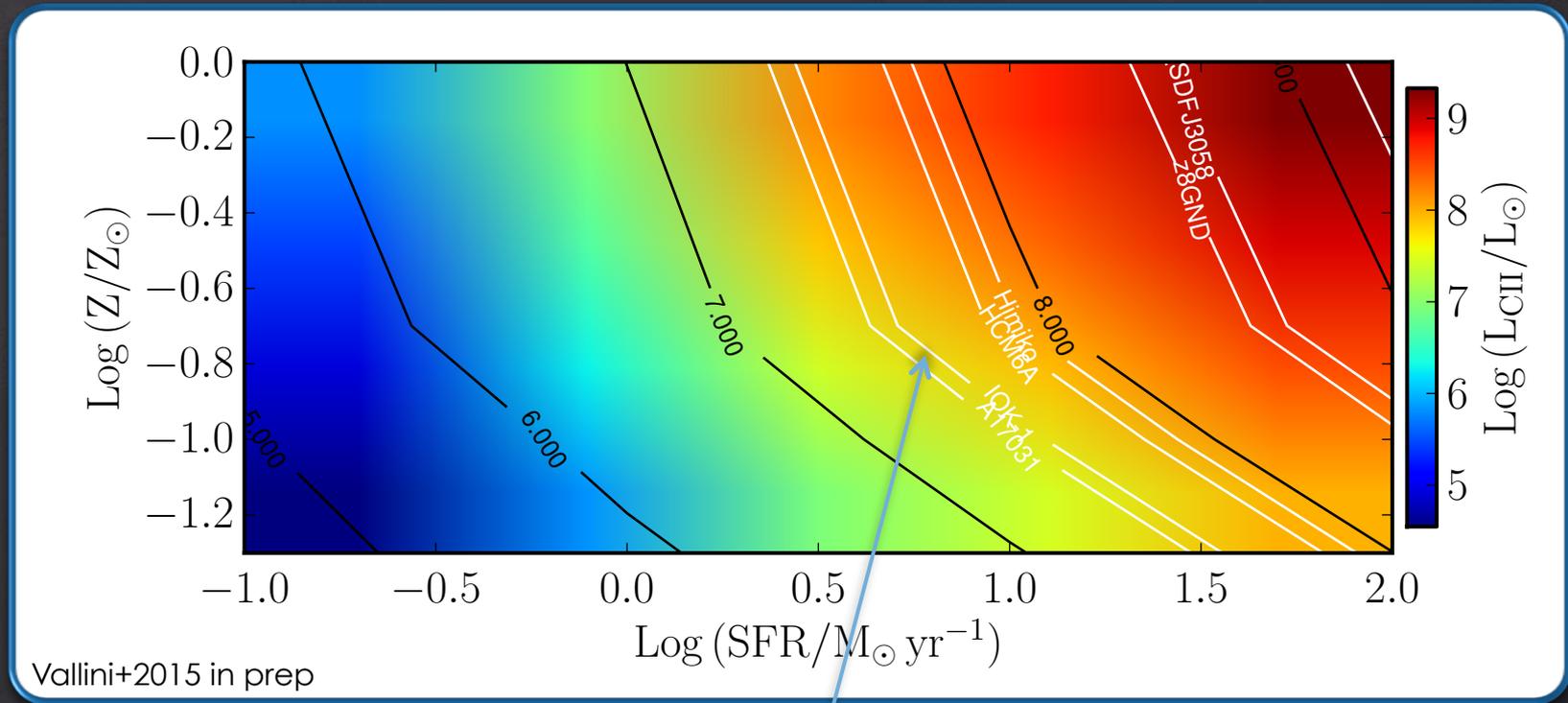
Results: theoretical [CII]-SFR relation



Conclusions

- The fraction [CII] of the emission arising the diffuse medium is $< 10\%$ if we take into account of the effect of the CMB background. Intrinsically it can account up to 40% of the emission.
- The emission from PDRs arises from the central region but we expect also other peaks from the overdense regions at the periphery of the galaxies
- The [CII]-SFR holds at high-z and eventual displacements can be due to
 - (i) extremely low metallicities or
 - (ii) $\Sigma_{\text{SFR}} - \Sigma_{\text{H}_2}$ relation different with respect to local galaxies

Results: [CII] luminosity as a function of Z and SFR



in white the current upper limits on high-z LAEs and LBGs