UNIVERSITY OF CAMBRIDGE

THE VARIABLE SPEED OF LIGHT APPORXIMATION AND H_2 AT HIGH REDSHIFT

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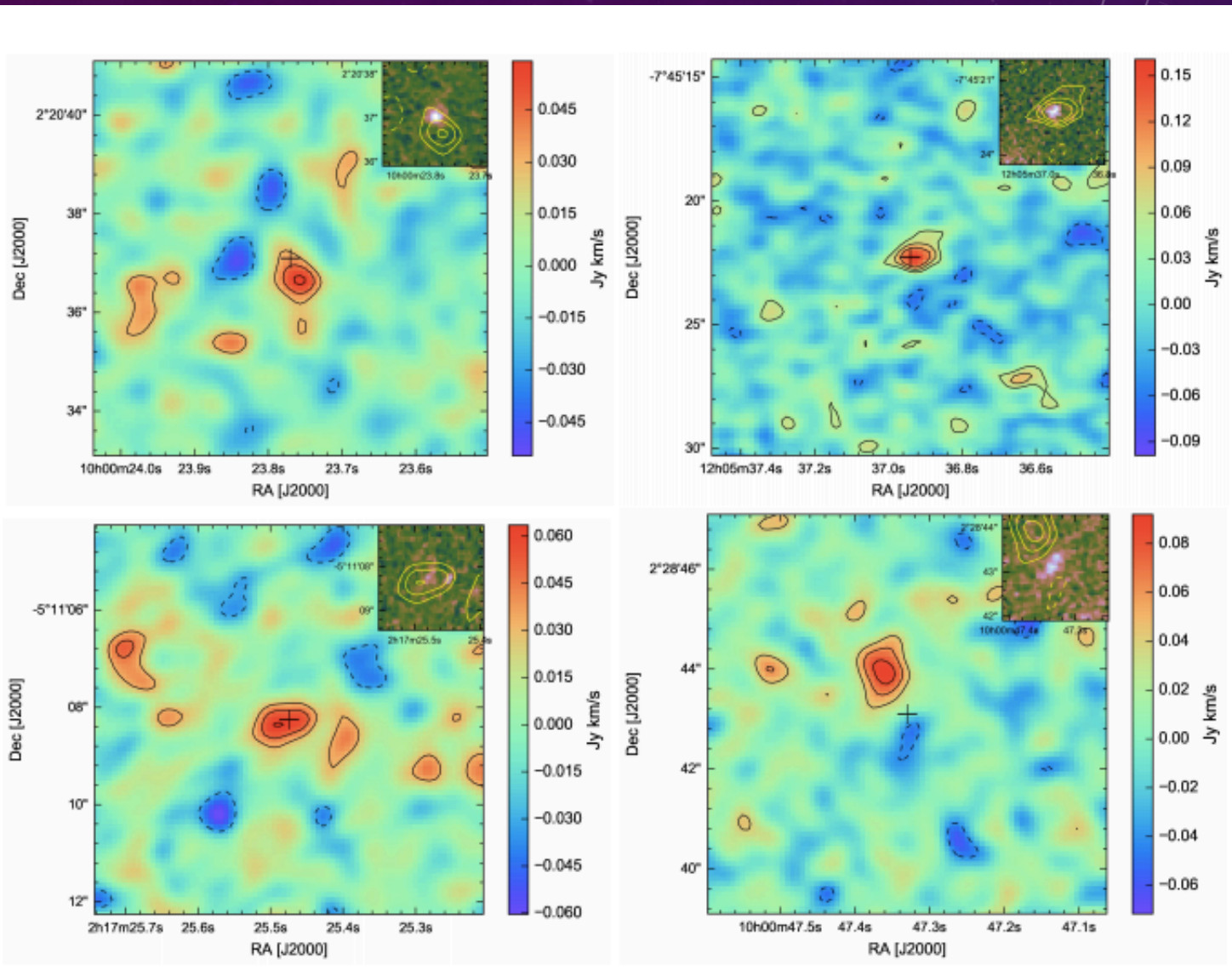
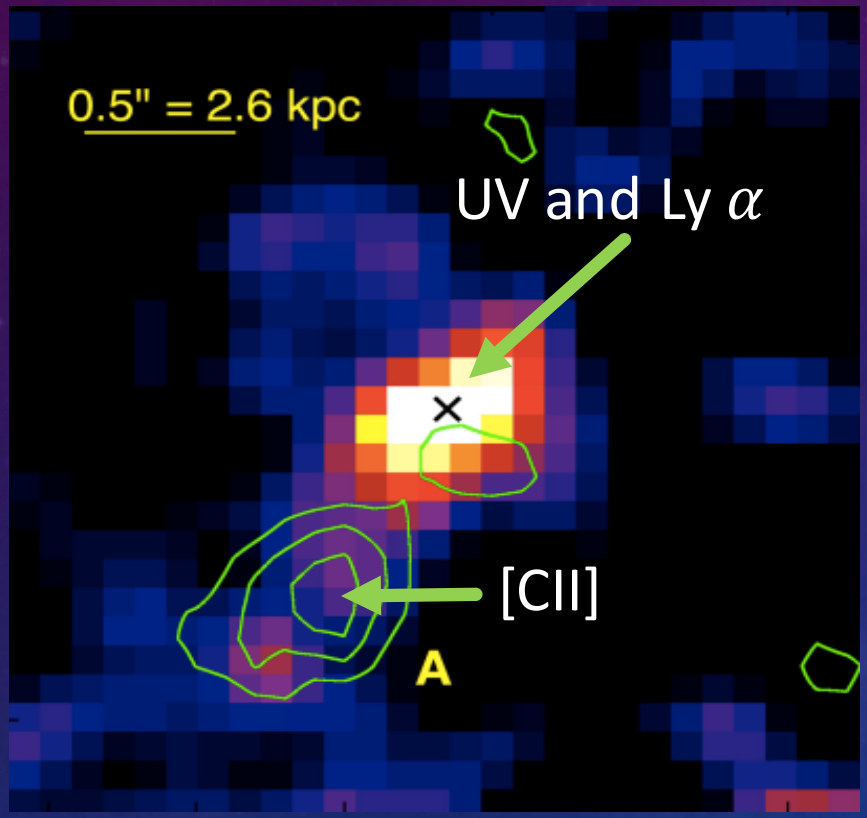


Pentericci et al. 2016

ALMA OBSERVATIONS IN THE EOR

z = 7.1 SFR = 5-15$M_\odot$/yr



Maiolino et al. 2015

Open Questions

[CII]-SFR relation?

Supernova Feedback?

Origin of [CII] emission?

1) Cold, neutral HI clouds
2) Ionized ISM
3) Surfaces of dense molecular clouds (PDRs)

TOWARDS MODELLING THE ISM AND THE EARLY UNIVERSE

Multfrequency RT at E > 5.6 eV (+ optical & IR)

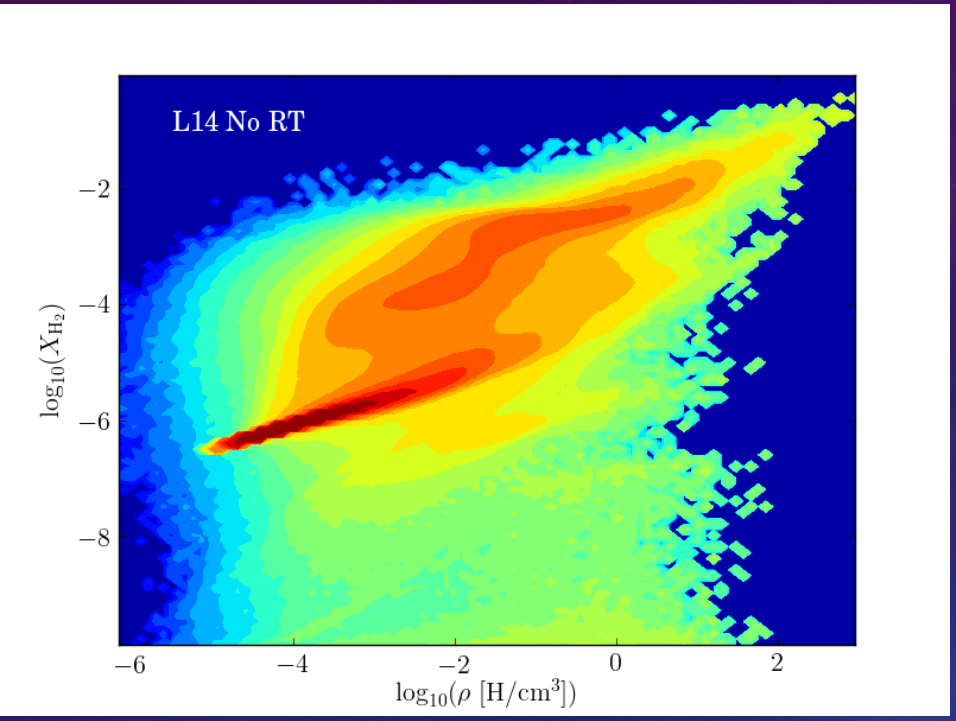
H_2 coupled to radiation (cooling, molecular clouds/PDRs, Lyman Werner, UV pumping)

Correct propogation of I-fronts in all bands (Variable speed of light approximation)

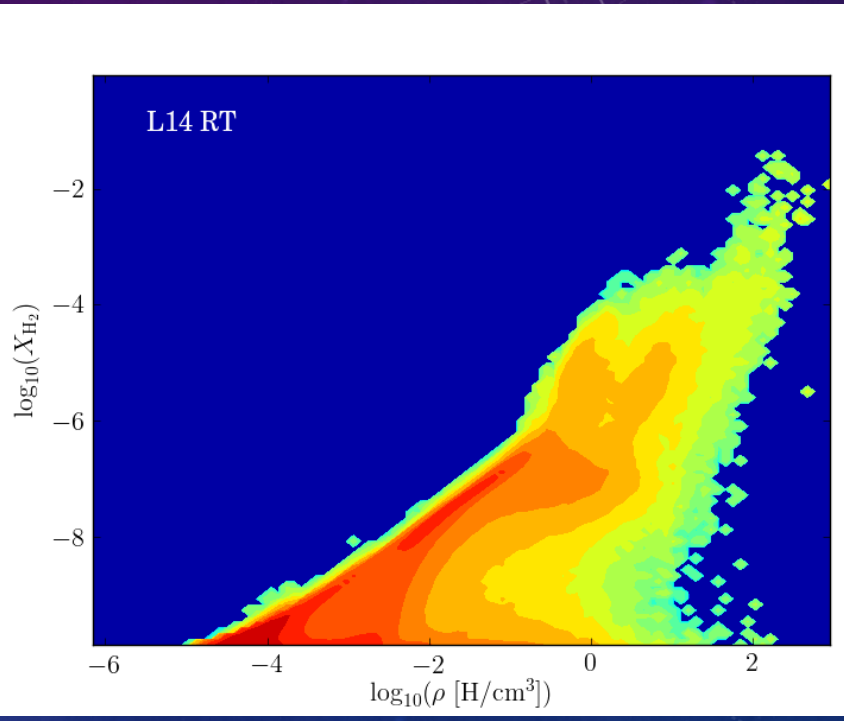
Photoelectic heating on dust

Ionization from multiple sources (stars, quasars, PopIII)

Without RT

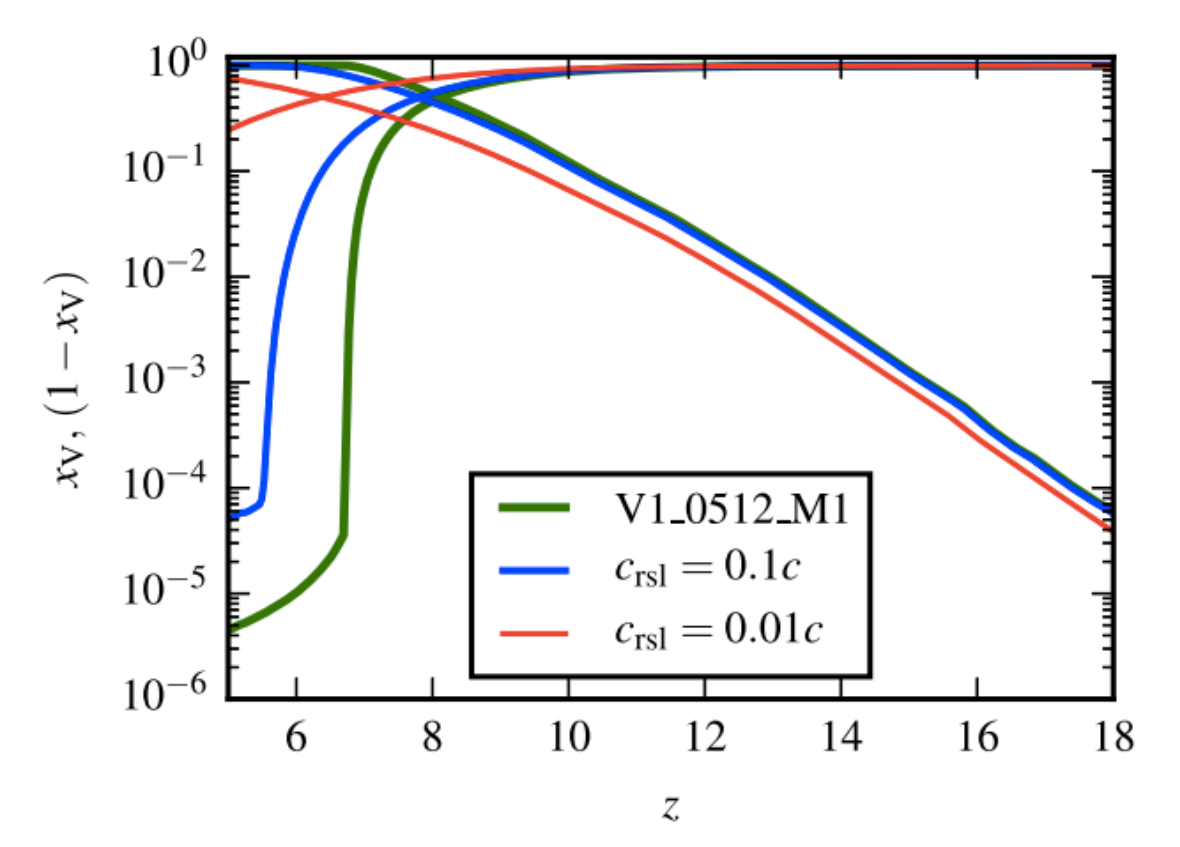


With RT



REDUCED SPEED OF LIGHT APPROXIMATION

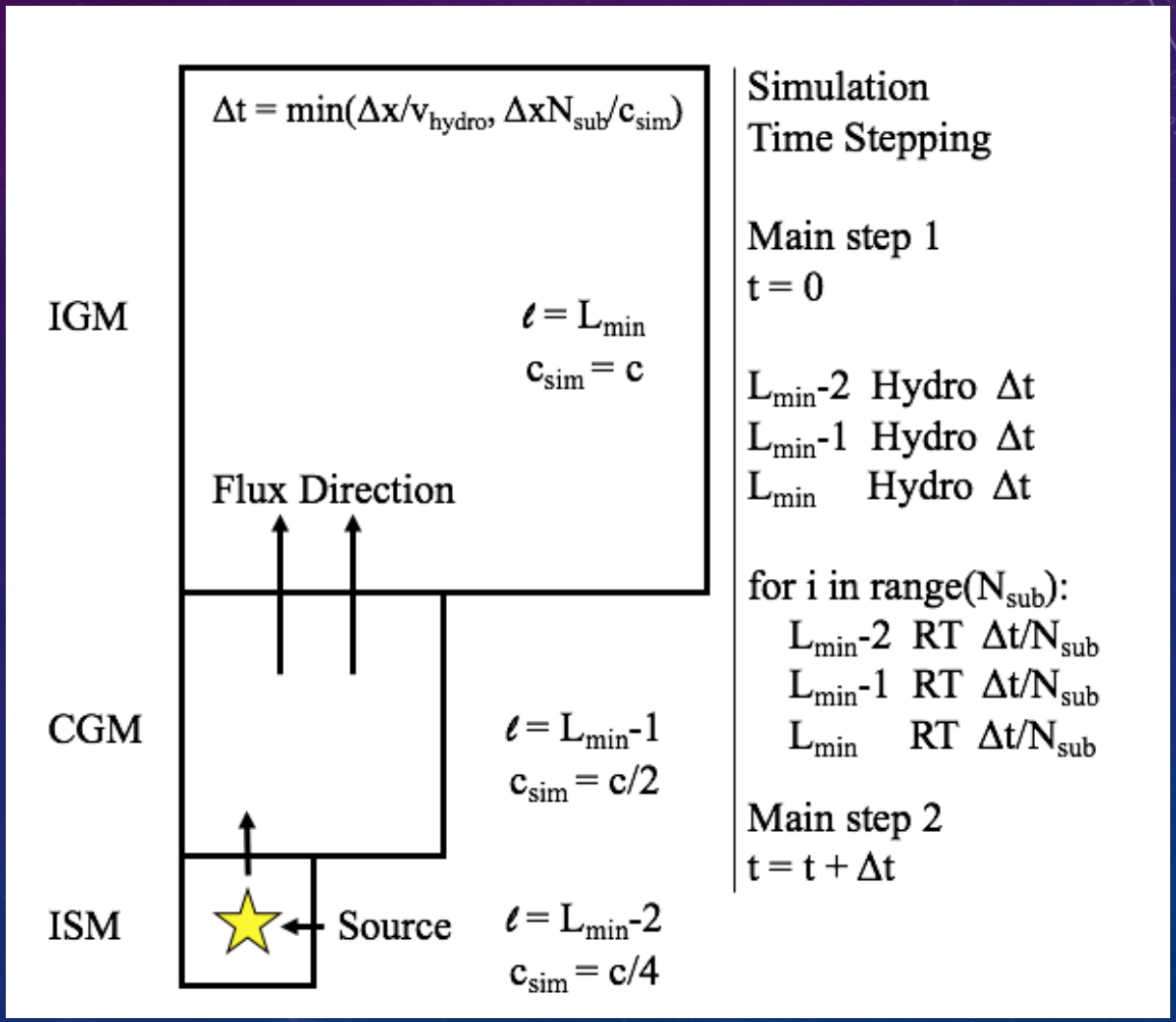
Courant Condition: $\Delta t \leq \frac{\Delta x}{3c}$



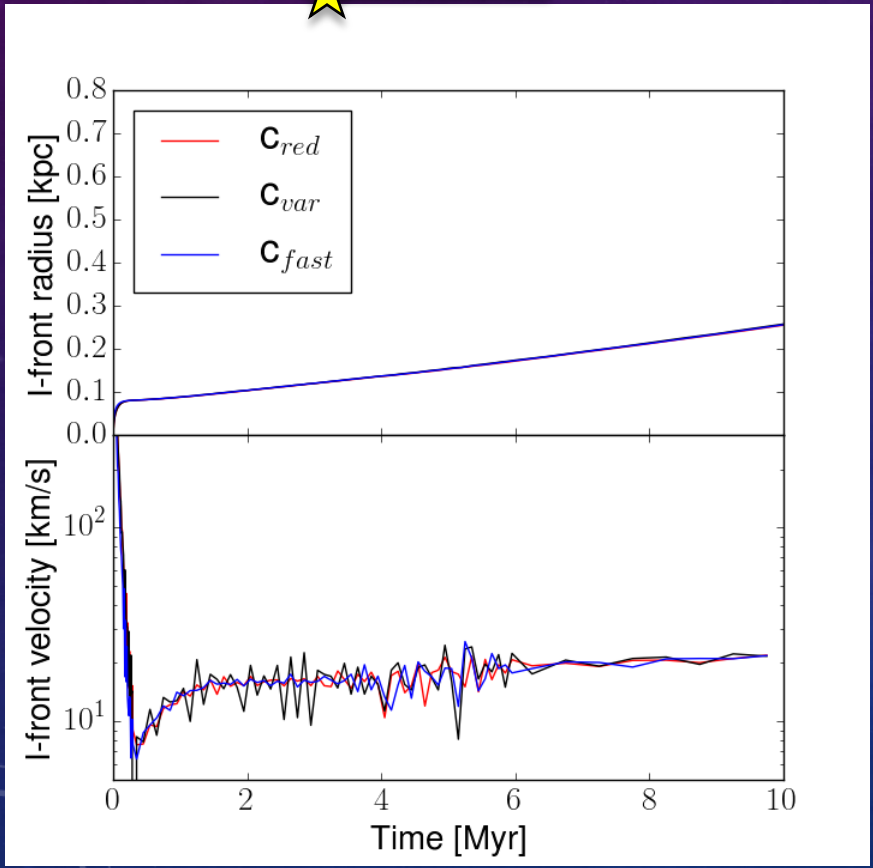
Bauer et al. 2015

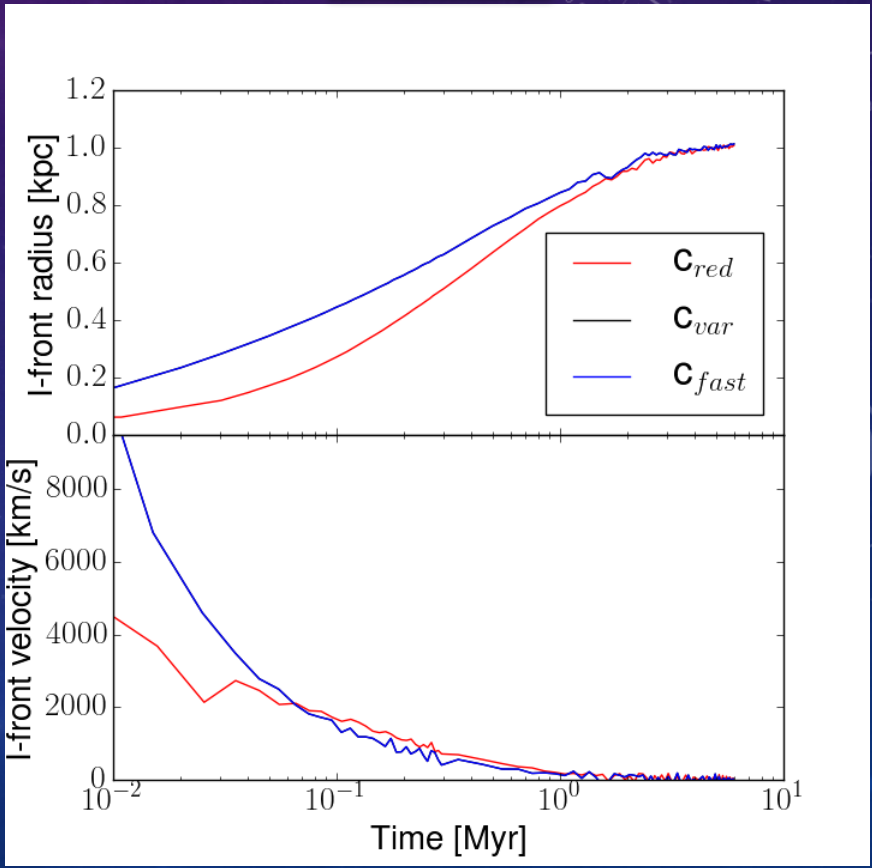
VARIABLE SPEED OF LIGHT APPROXIMATION

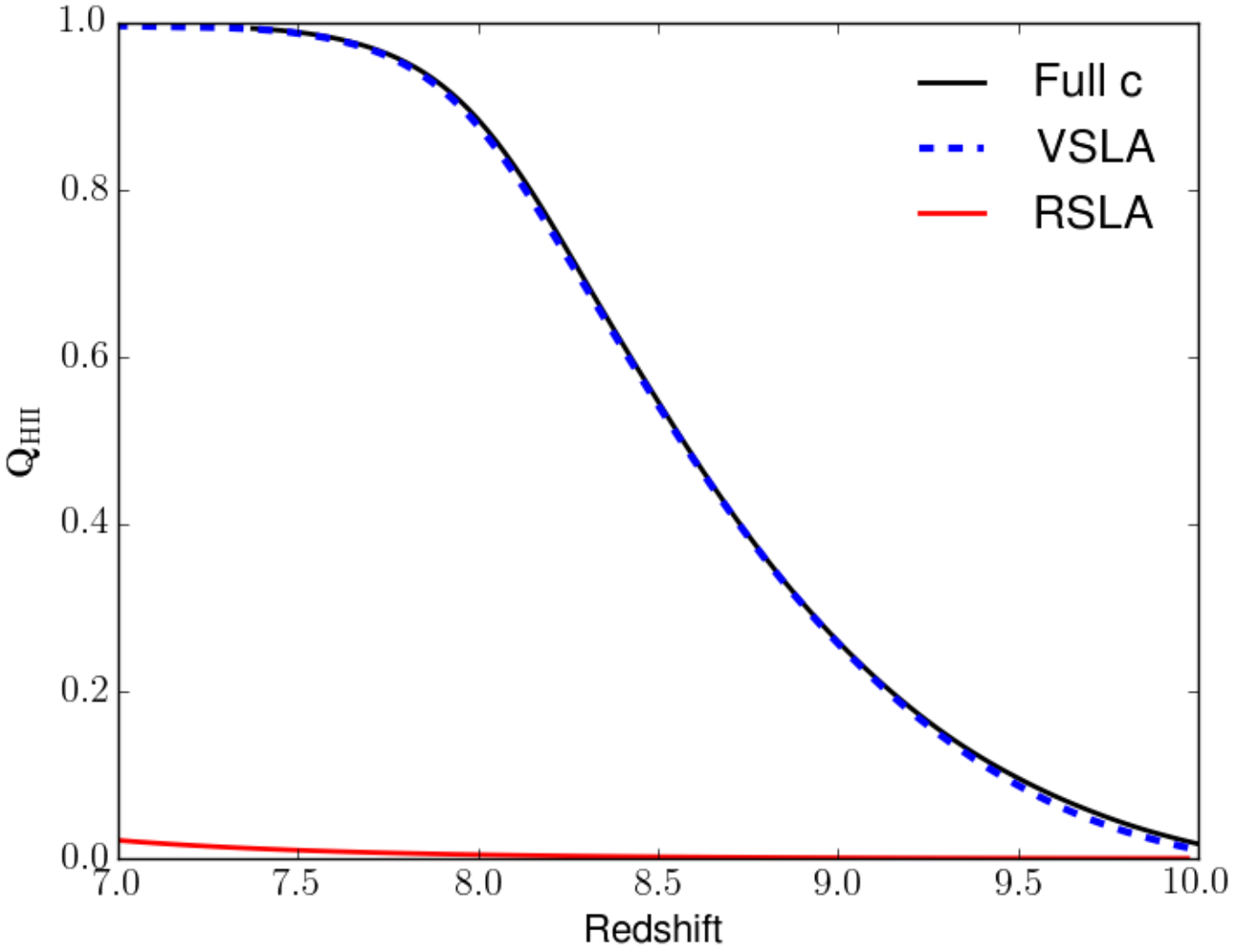
$$\Delta t(level) \propto \Delta x(level)/c_{\mathrm{sim}}(level)$$



ILIEV TEST 6: r^{-2} DENSITY PROFILE

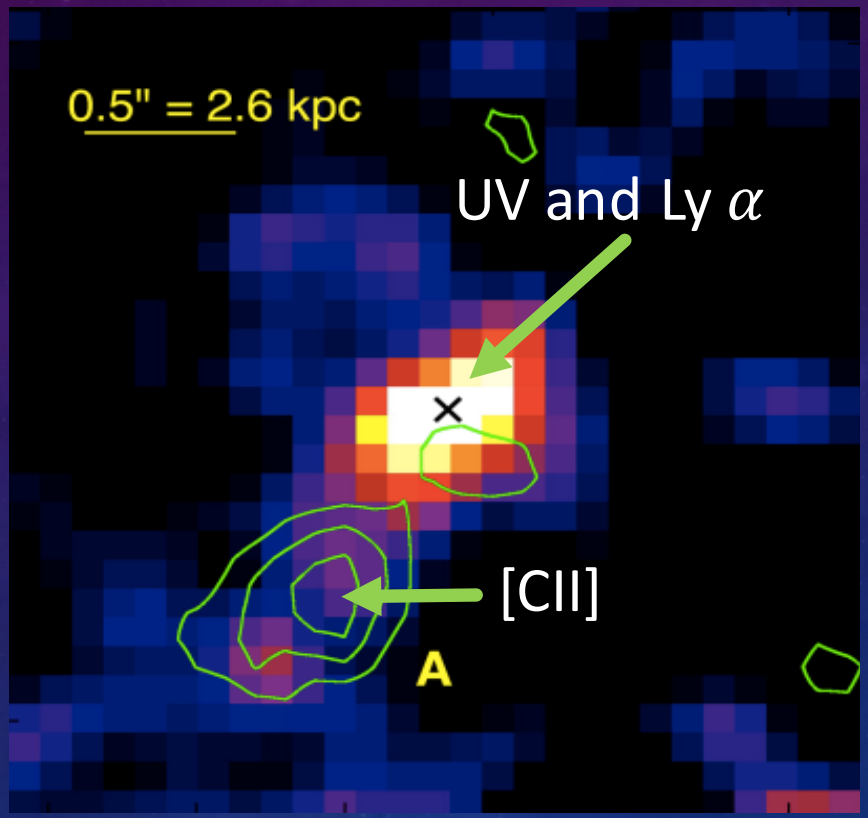





1.0
0.8
0.6
0.4
0.2
0.0
Q_{HII}
7.0
7.5
8.0
8.5
9.0
9.5
10.0
Redshift
Full c
VSLA
RSLA

BACK TO SCIENCE

z = 7.1 SFR = 5-15$M_{\odot}$/yr



Maiolino et al. 2015

FULL BOX REIONIZATION SIMULATIONS

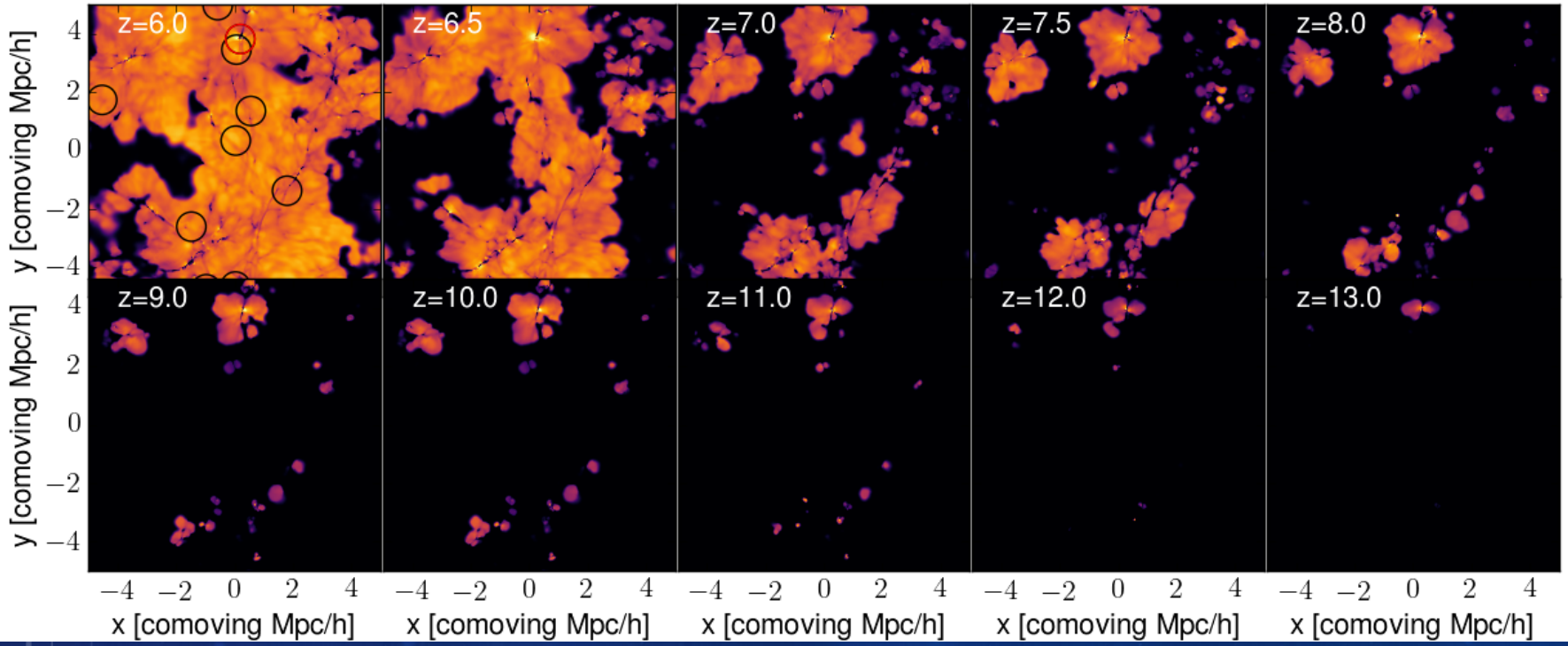
10 Mpc/h box

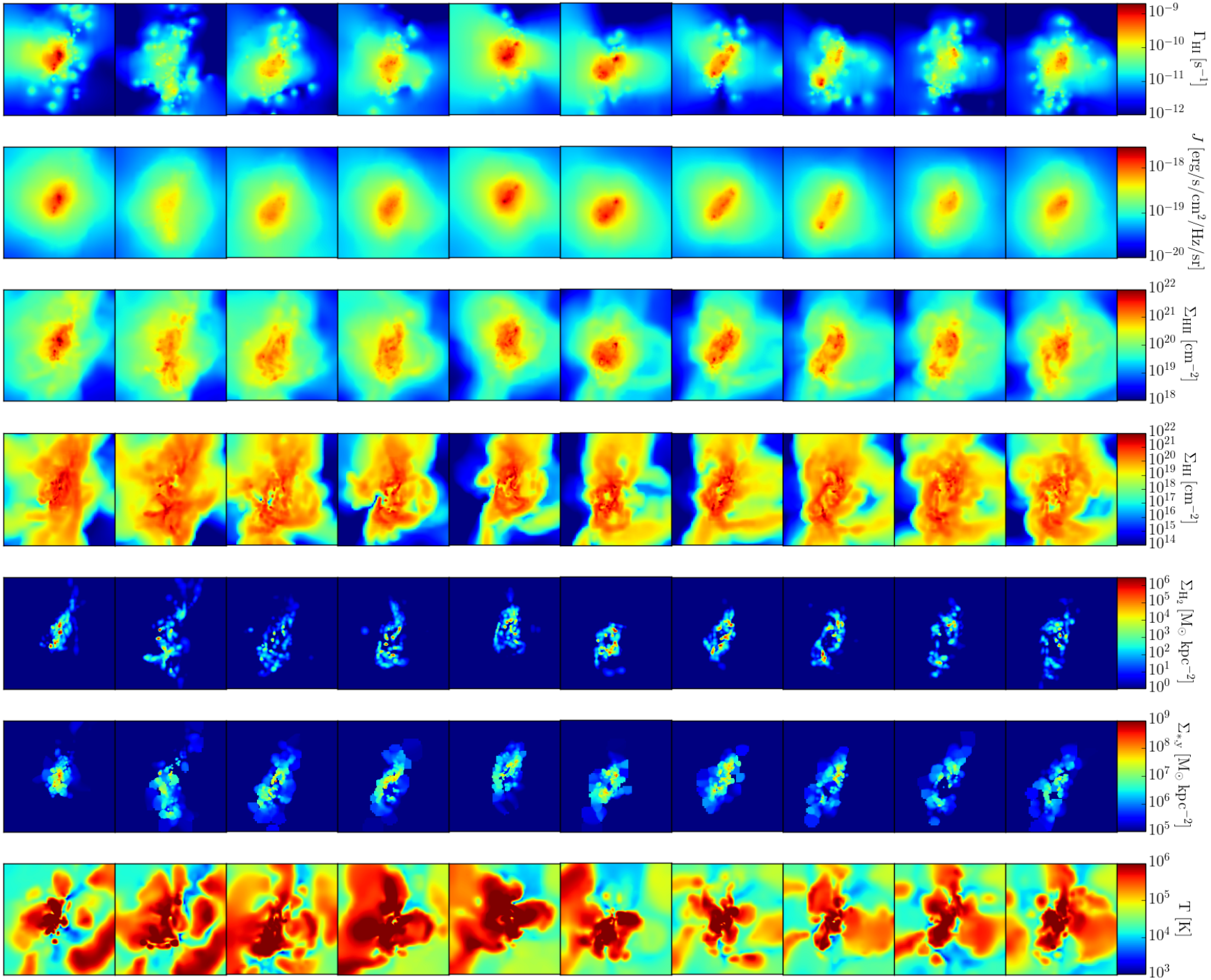
256^3 DM particles $(6.5\times10^6 M_\odot)$

$M_* = 7.7\times10^4 M_\odot$

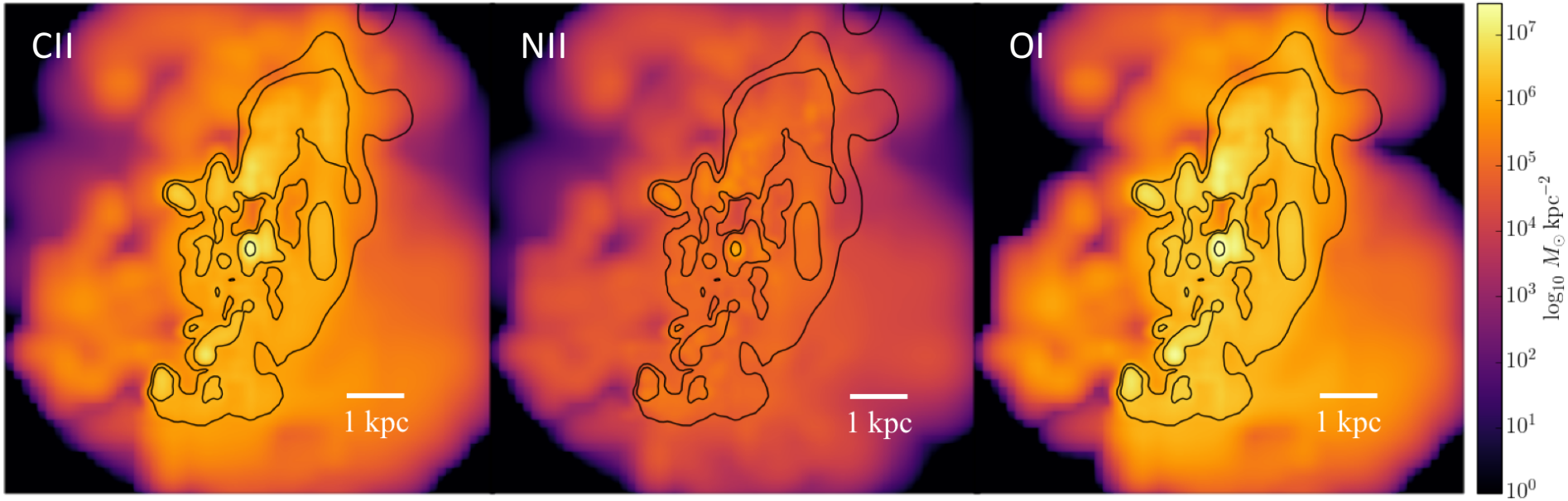
Δx = 125 pc

Bin	E_{min}	E_{min}
1	5.60	11.20
2	11.20	13.60
3	13.60	15.20
4	15.20	24.59
5	24.59	54.42
6	54.42	∞




10^{-9}
10^{-10}
10^{-11}
10^{-12}
$\Gamma_{\rm HI}$ [s^{-1}]
10^{-18}
10^{-19}
10^{-20}
J [erg/s/cm^2/Hz/sr]
10^{22}
10^{21}
10^{20}
10^{19}
10^{18}
$\Sigma_{\rm HII}$ [cm^{-2}]
10^{22}
10^{21}
10^{20}
10^{19}
10^{18}
10^{17}
10^{16}
10^{15}
10^{14}
$\Sigma_{\rm HI}$ [cm^{-2}]
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
$\Sigma_{\rm H_2}$ [M$_\odot$ kpc^{-2}]
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
$\Sigma_{*,y}$ [M$_\odot$ kpc^{-2}]
10^{6}
10^{5}
10^{4}
10^{3}
T [K]

IR EMISSION FOR ALMA



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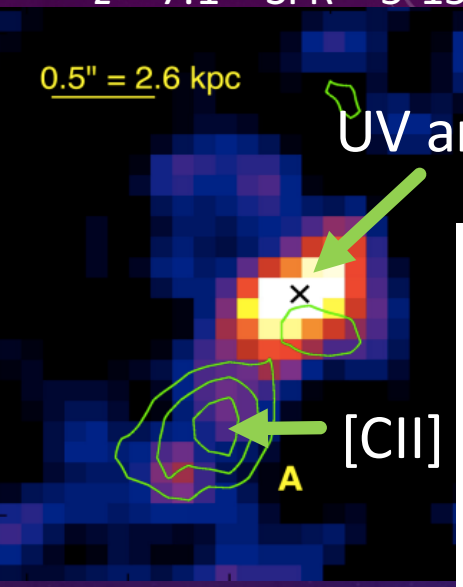
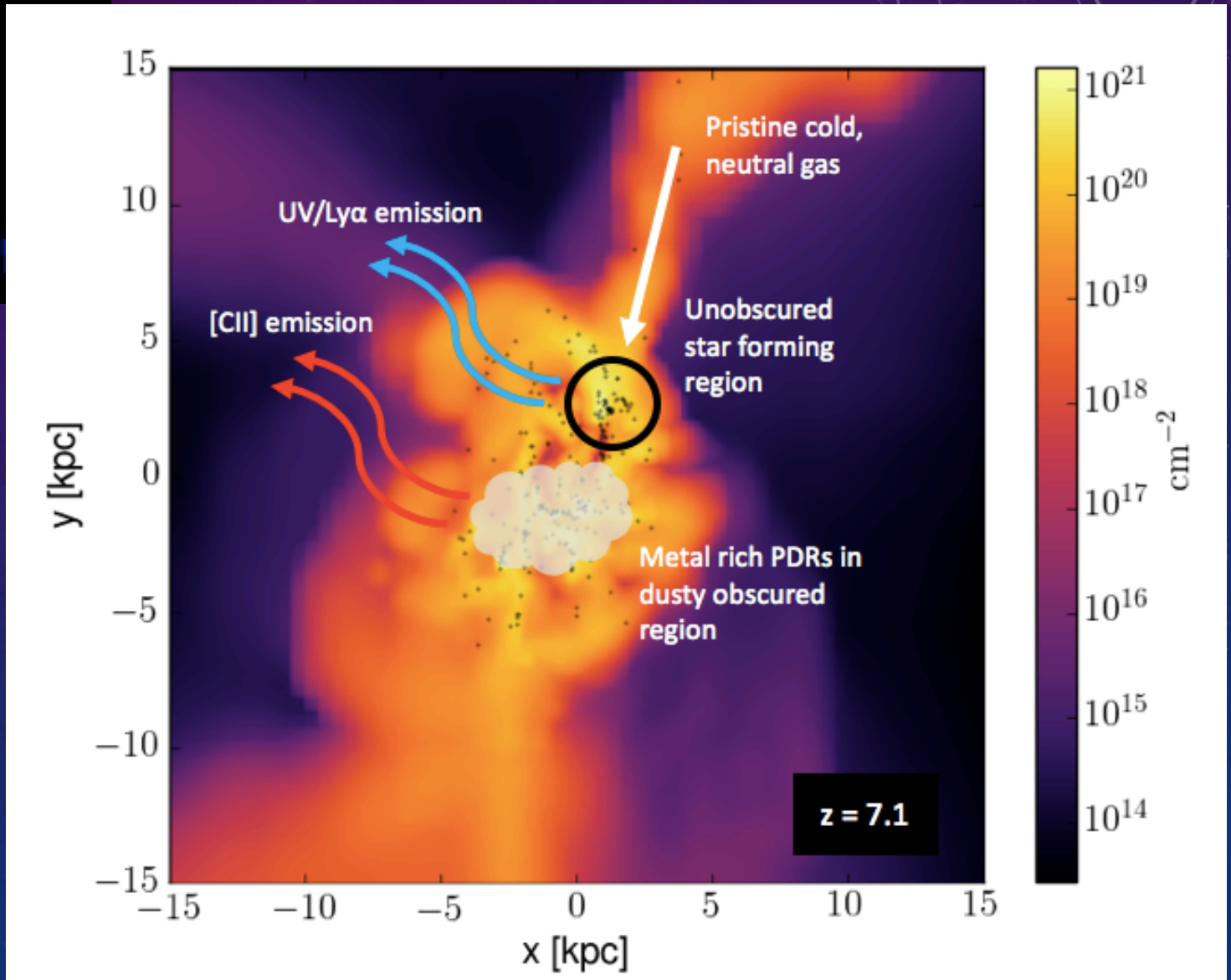


Maiolino et al. 2015



THANK YOU!!!