# Stellar feedback
during the
# reionization
with
# *EMMA*


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# Summary

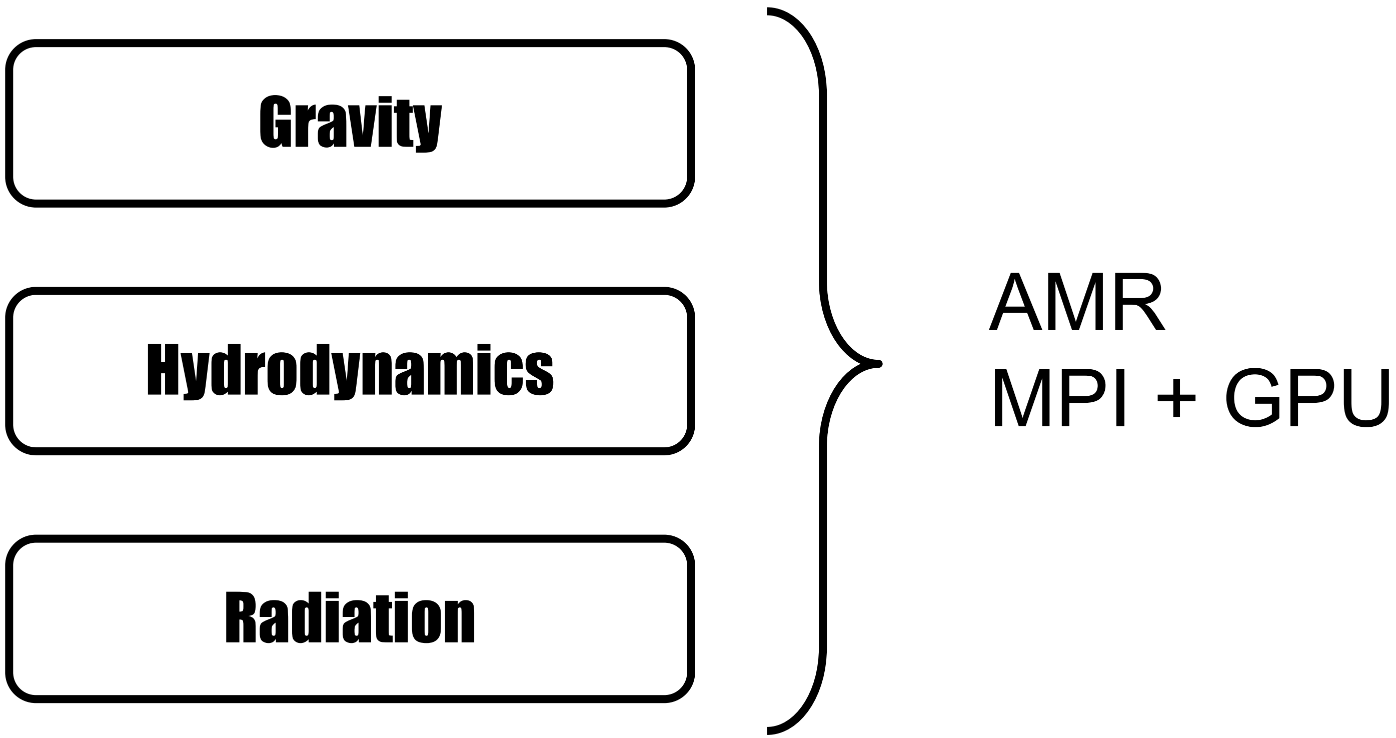
- Introduction
- Stellar model
- Calibration
- Decrease of SFR in low mass halo around z=5

# *EMMA* - Overview

ref : Aubert, Deparis, Ocvirk 2015

## Emma is a code design to study the reionization

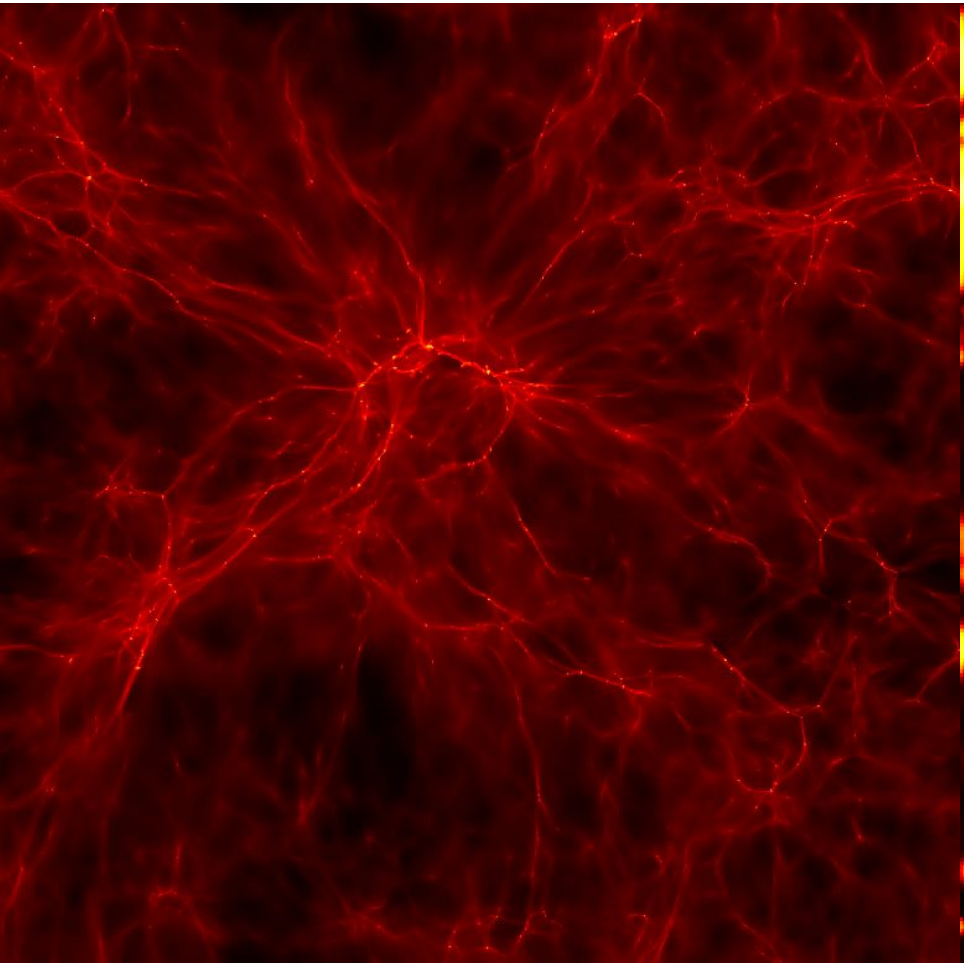
It does hydro and radiation in a fully coupled way



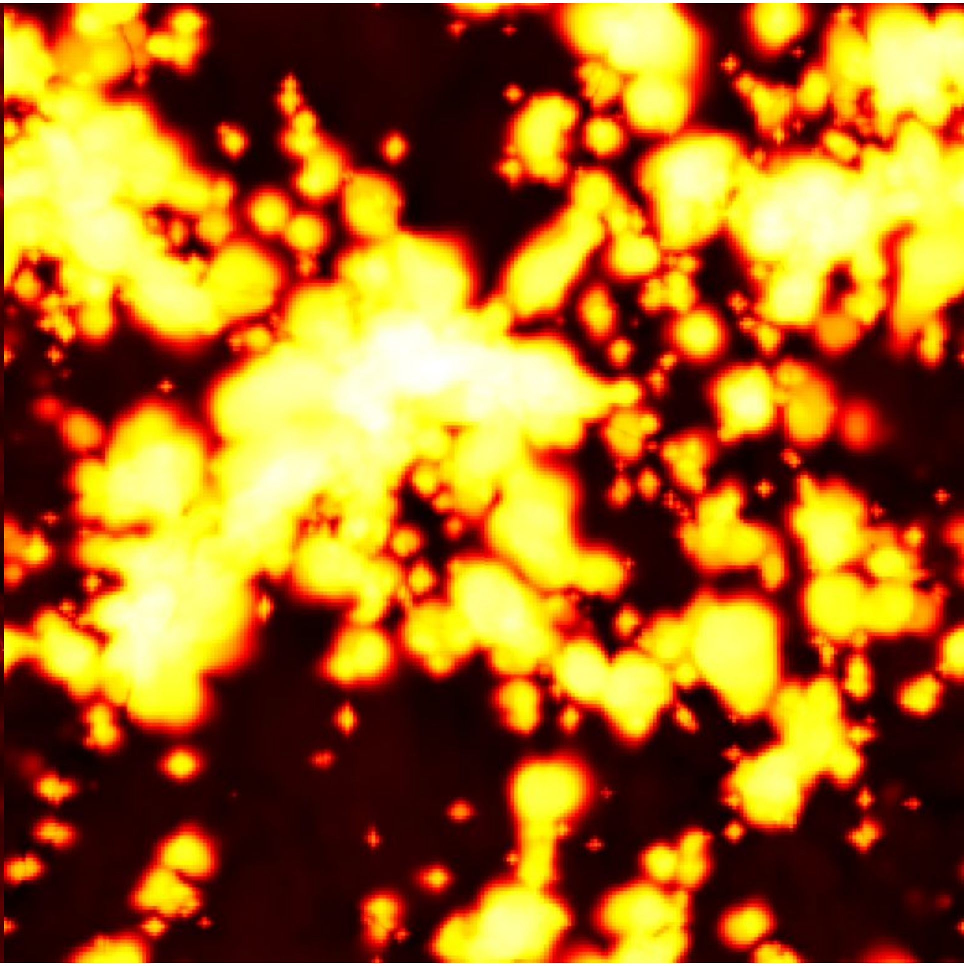
# *EMMA* - Outputs

ref : Aubert, Deparis, Ocvirk 2015

8Mpc/h - $256^3$



Gas density



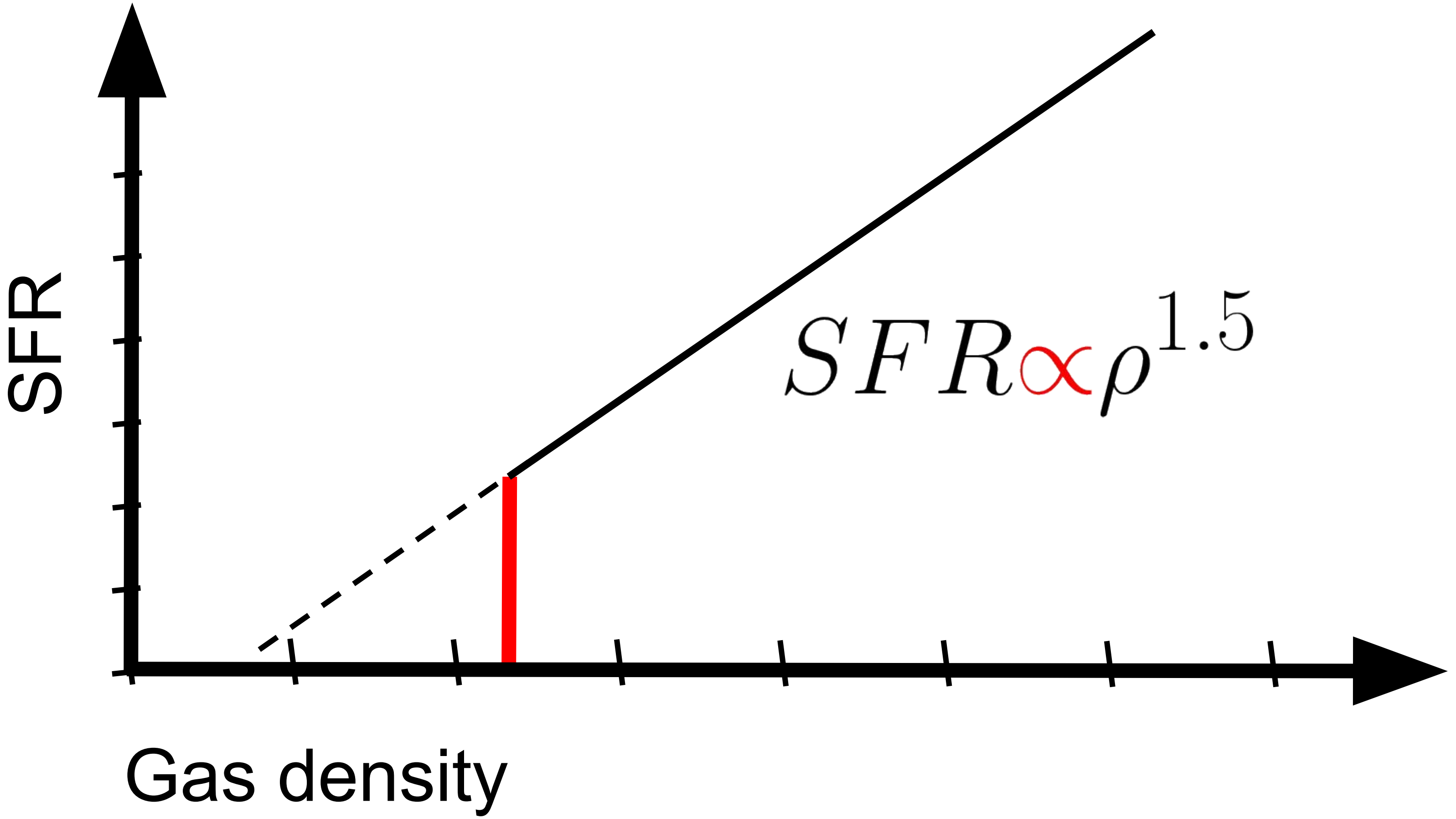
Ionization fraction

# Stellar model

# Star formation

ref : Kennicutt 1998

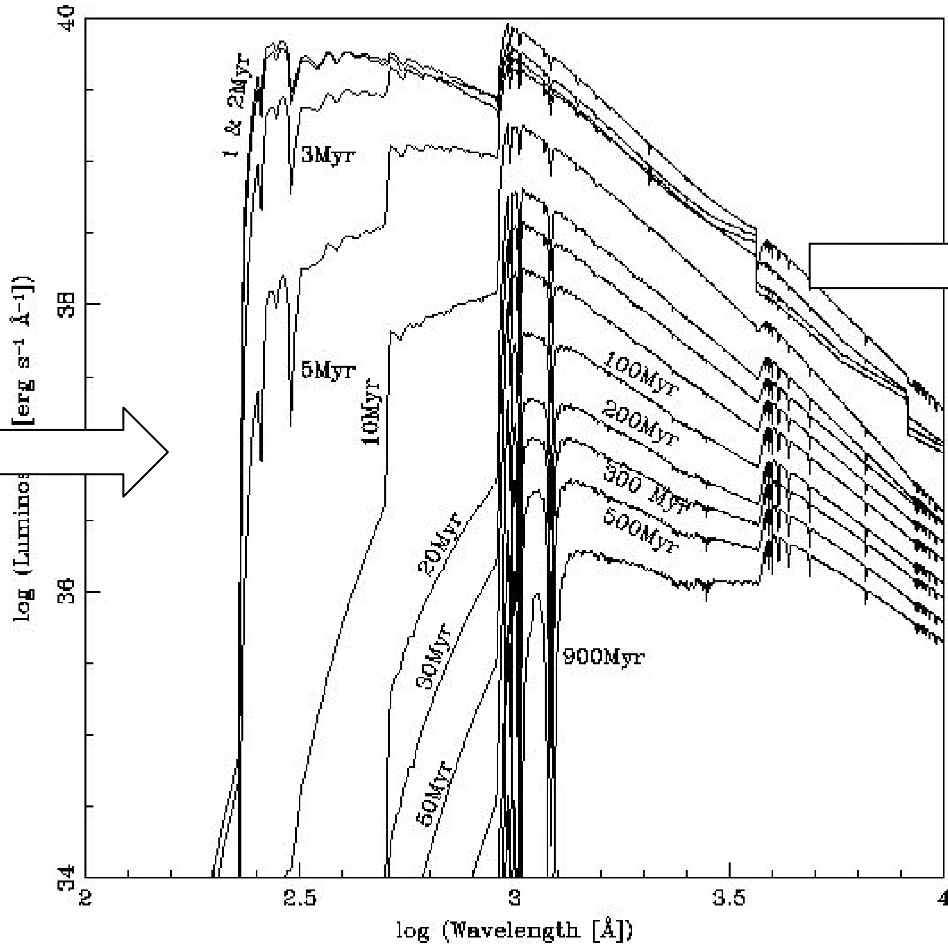
*** Free parameters**



# Radiative lifetime

ref : Starburst99 - Leitherer et al. 1999

**IMF**
($Z=10^{-3}$)




E photon

Emissivity (t)

\+

E(t) SN

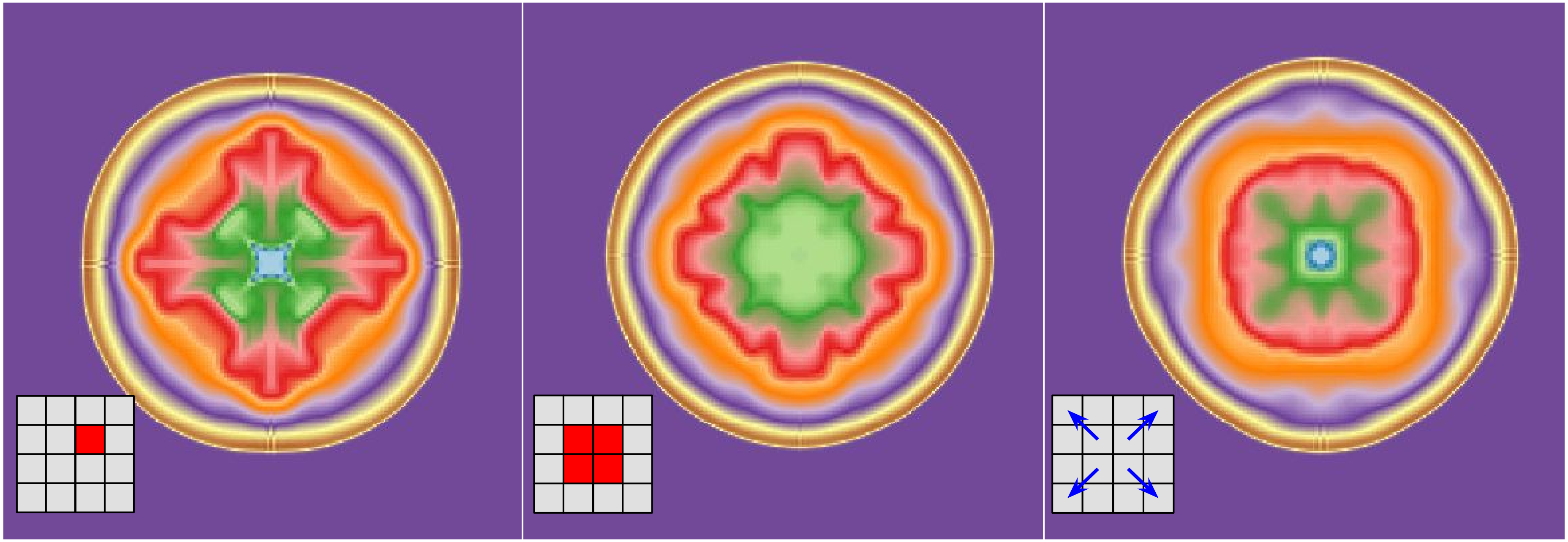
M(t) SN

# Supernovae

ref : Sedov 1959

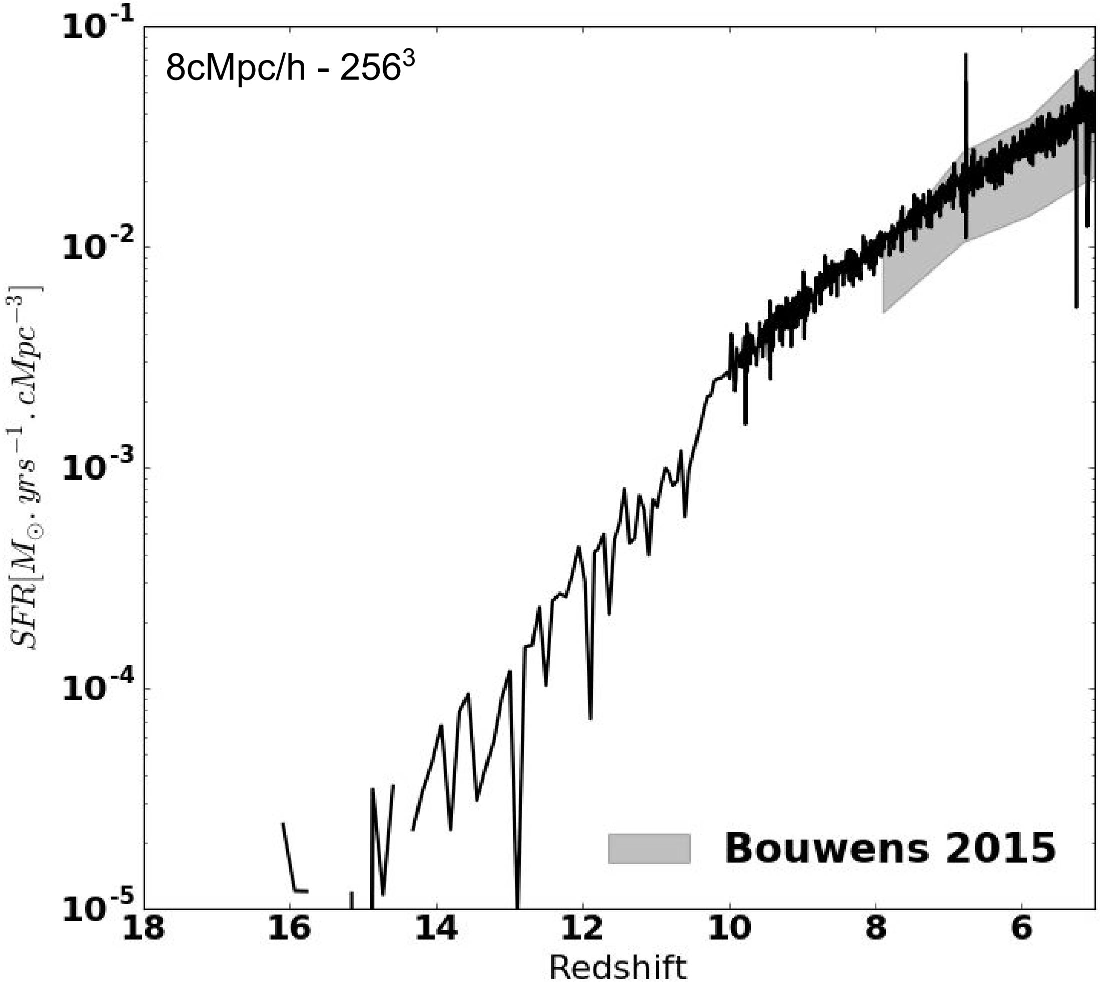
There are different ways to deal with energy injection
We use a pure kinetic form of feedback

**Density slices for Sedov tests**



# Calibration of a 8 cMpc/h - $256^3$ box on observables

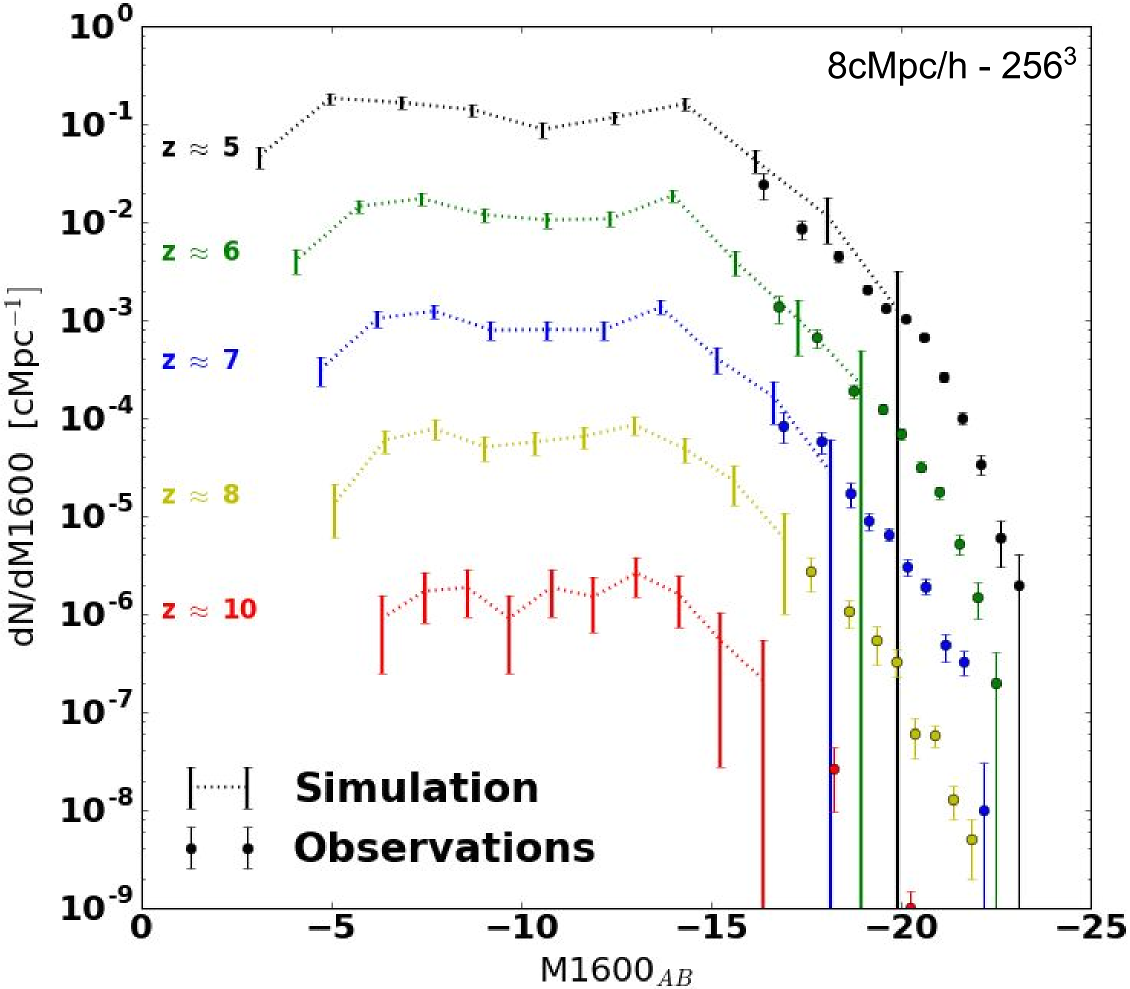
# Star formation history




A Schmidt law with an efficiency parameter is enough to get a good global SFH

Threshold=50.$rho_c$
Efficiency=0.02

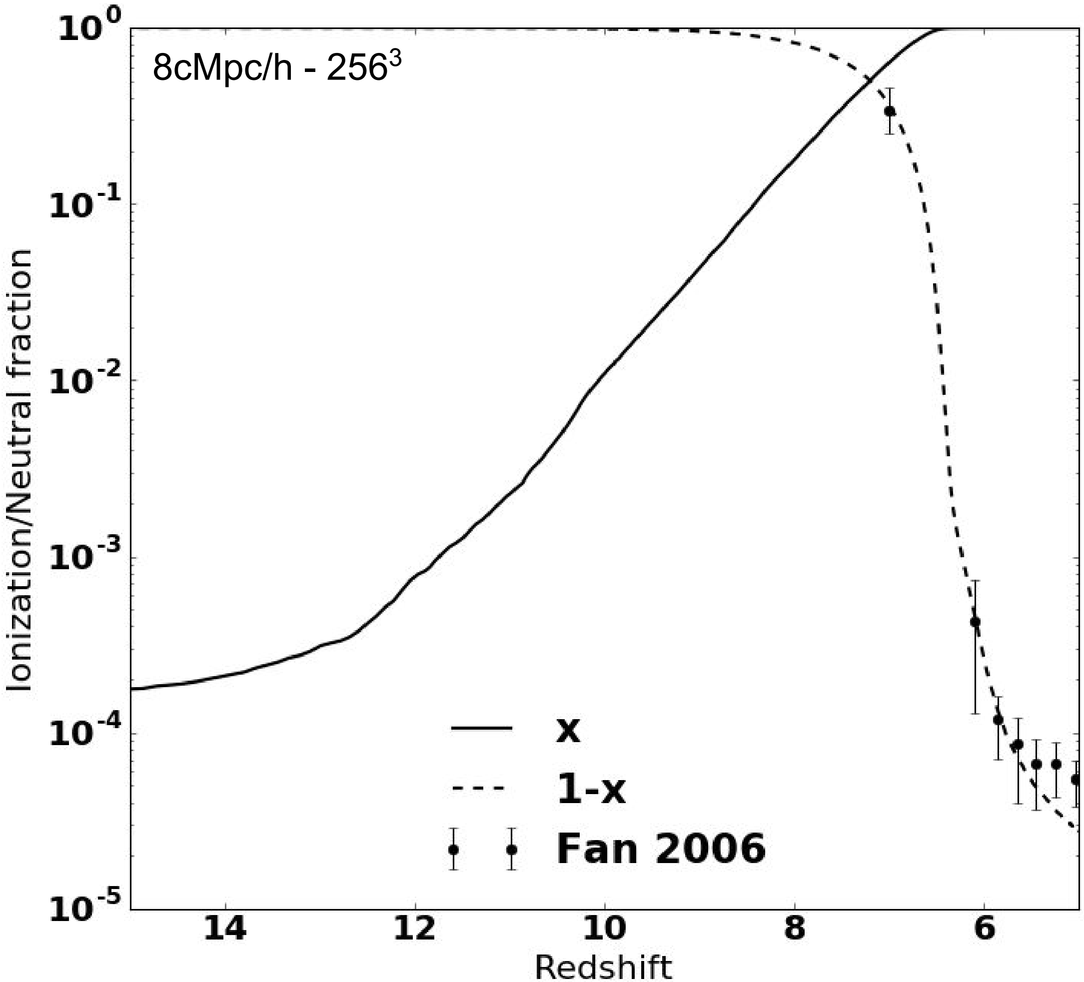
# Luminosity functions




We use the **same spectrum** to compute **UV** and **M1600** luminosity

Luminosity functions are in accordance with observations from redshift 10 to 5

# Ionization history




We fits ionization history by using a **TopHeavy IMF**

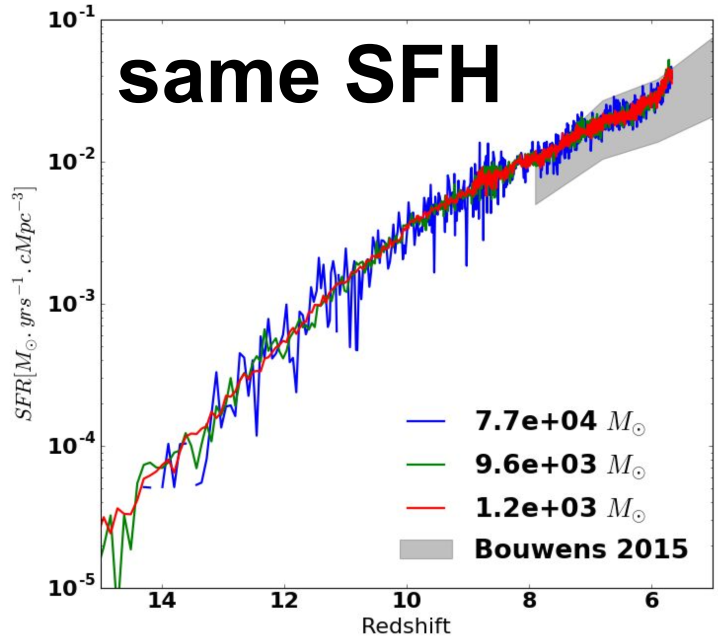
(Salpeter doesn't give enough UV)

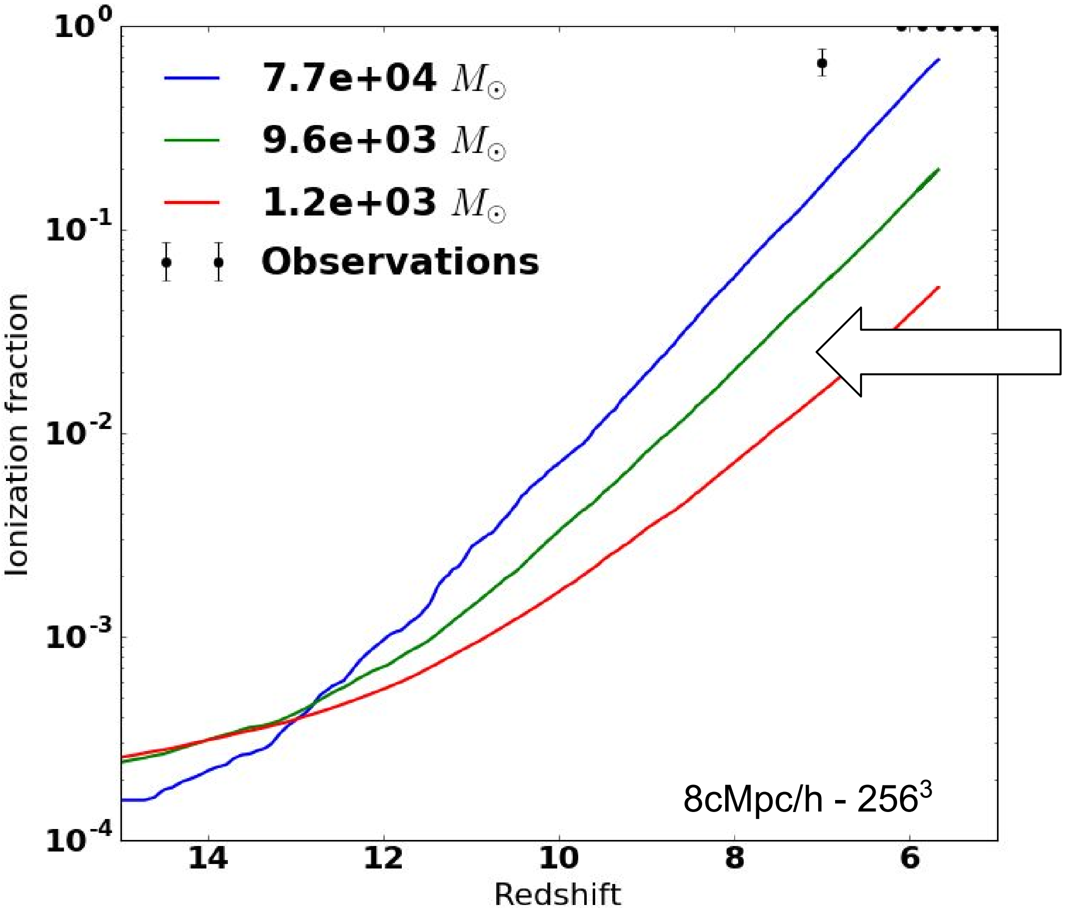
IMF = TopHeavy
Escape fraction = 0.35

**Mstar = 7,7.10$^4$Mo**

# The stellar mass problem

3 runs without SN



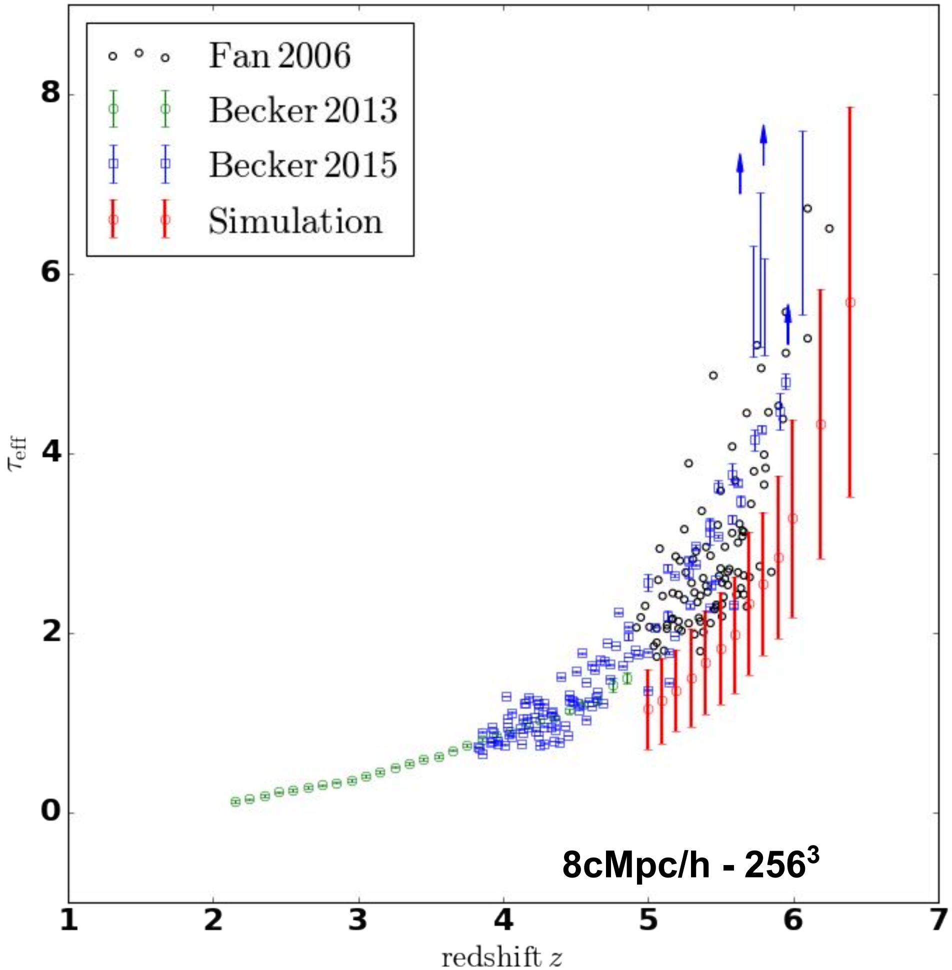




**The bigger the stellar particle, the faster the reionization**

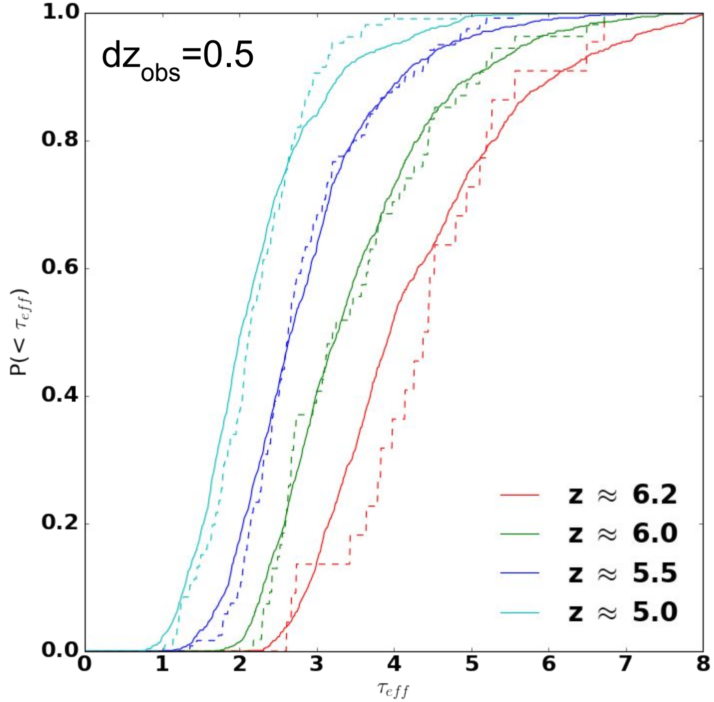
For small masses the radiation is trapped in the cell due to the recombinaison

# Ly-Alpha forest constraints

## 1000 lines of sight




Mean values are shift

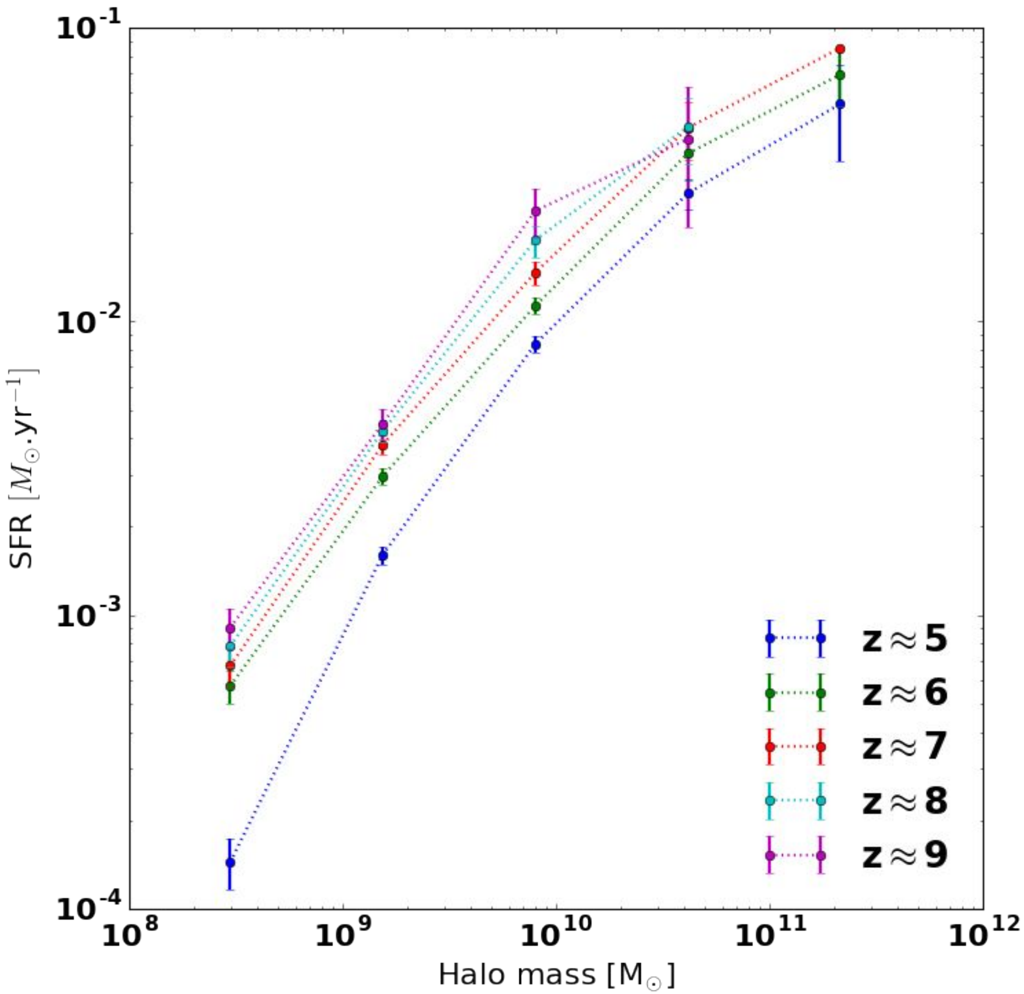


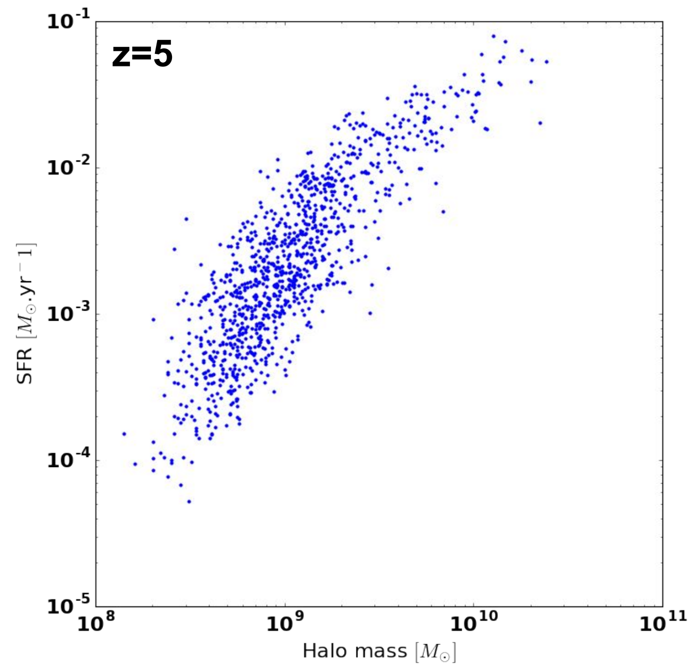

Optical depth are too low : **the simulated volume is too small**

But their distribution are well reproduce

So now,
we have a
“good” simulation,
let’s analyse it !

# SFR function of halo mass

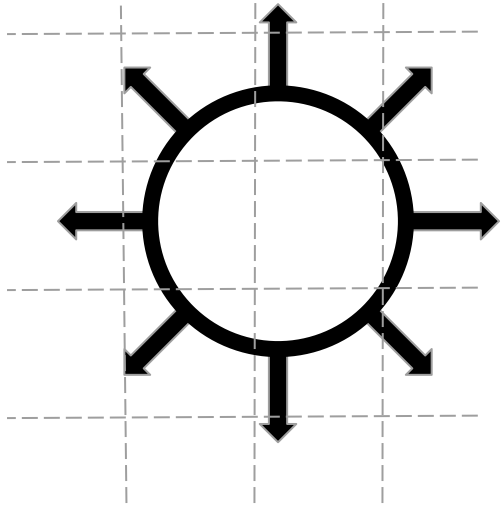


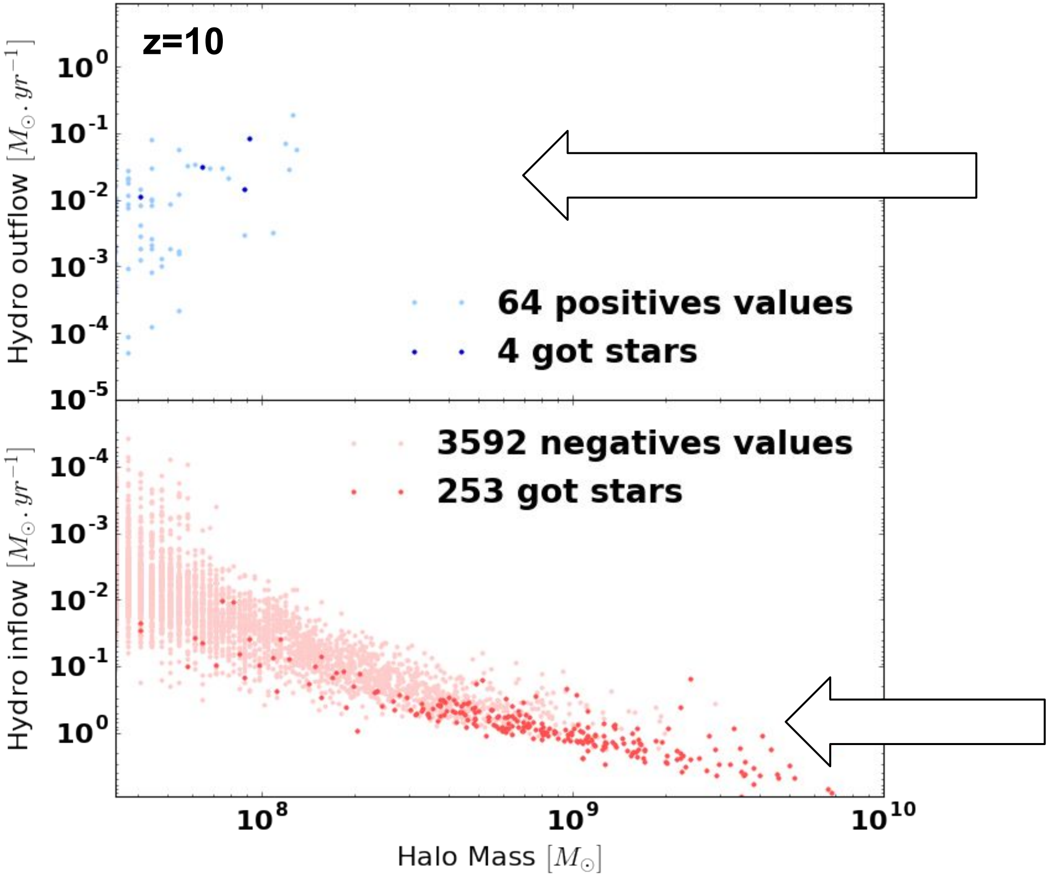




We observe a decrease in the SFR of low mass halo at z=5

# Hydrodynamical flow

At R200





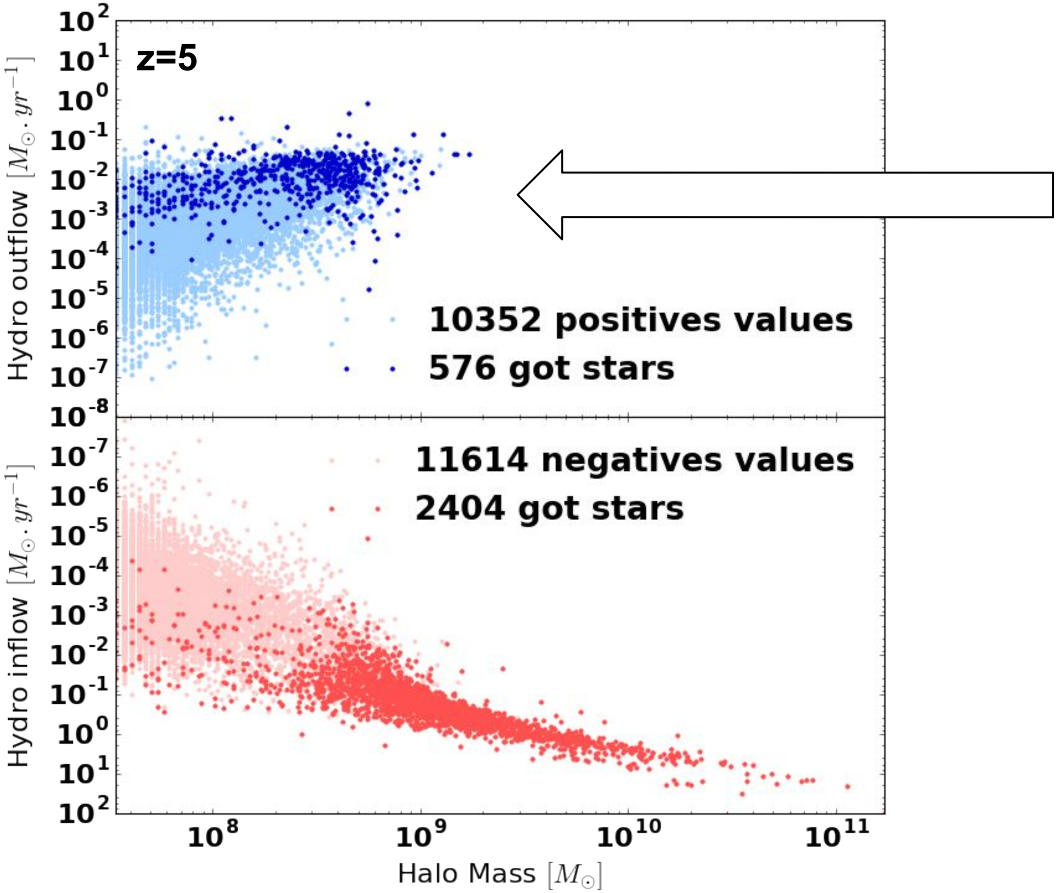

At z=10 there is almost no halo with outflow

The more massive, the more inflow

# Hydrodynamical flow

At R200

It's difficult for small halos to hold their baryon back



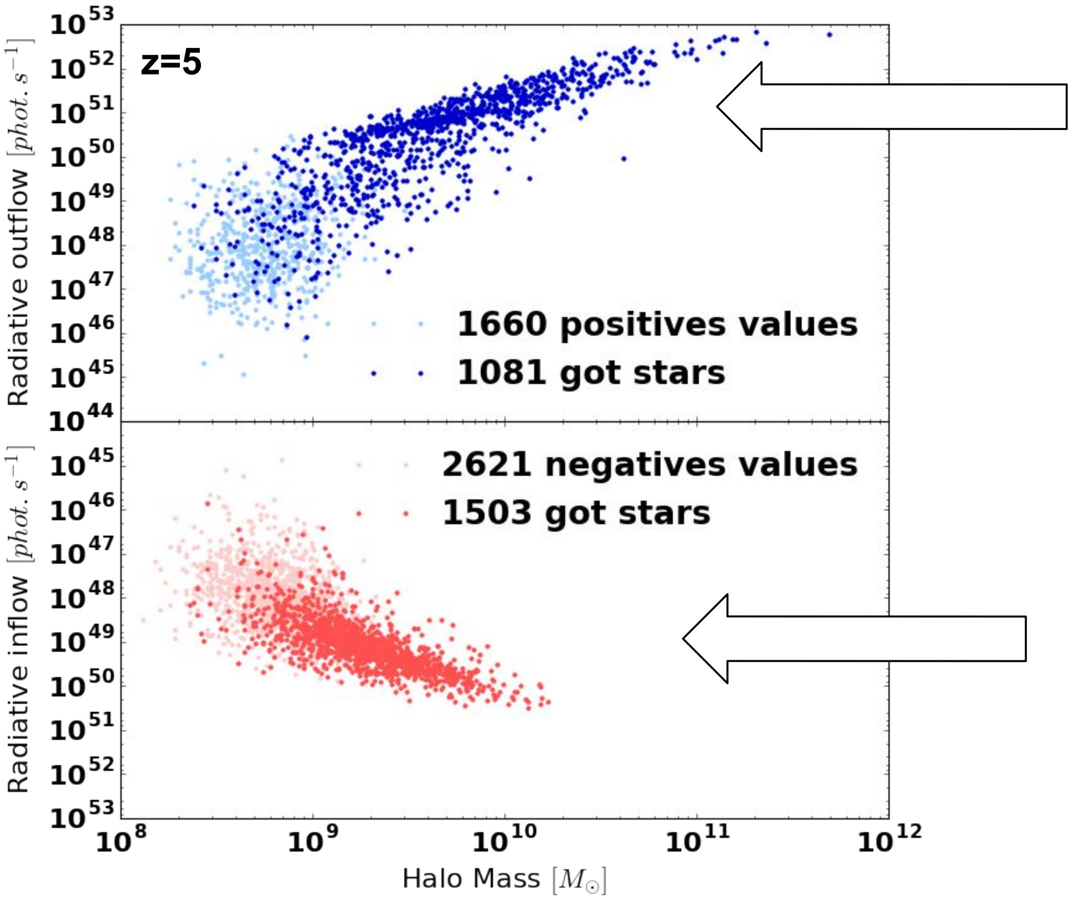

There is a lot more outflow at z=5 than at z=10

There is halos without stars with outflow : not only due to SN

Radiative heating?
Dynamic (Bullet cluster)?

# Radiative flow

At R200

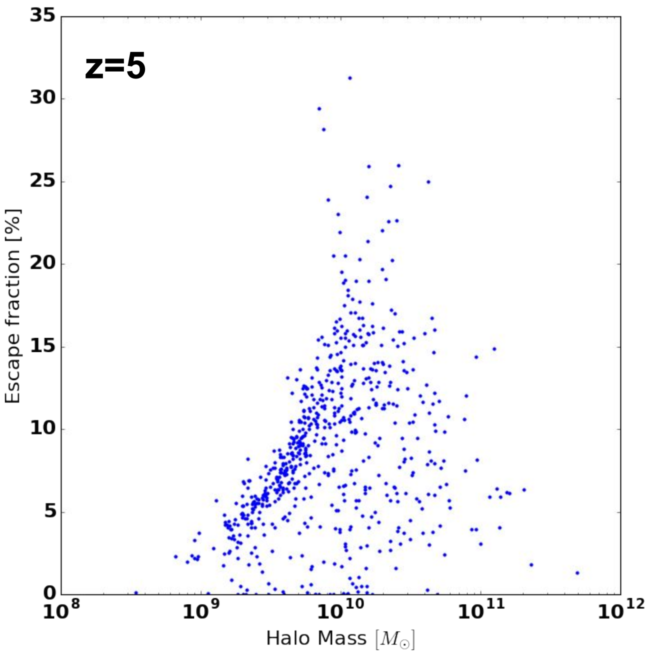


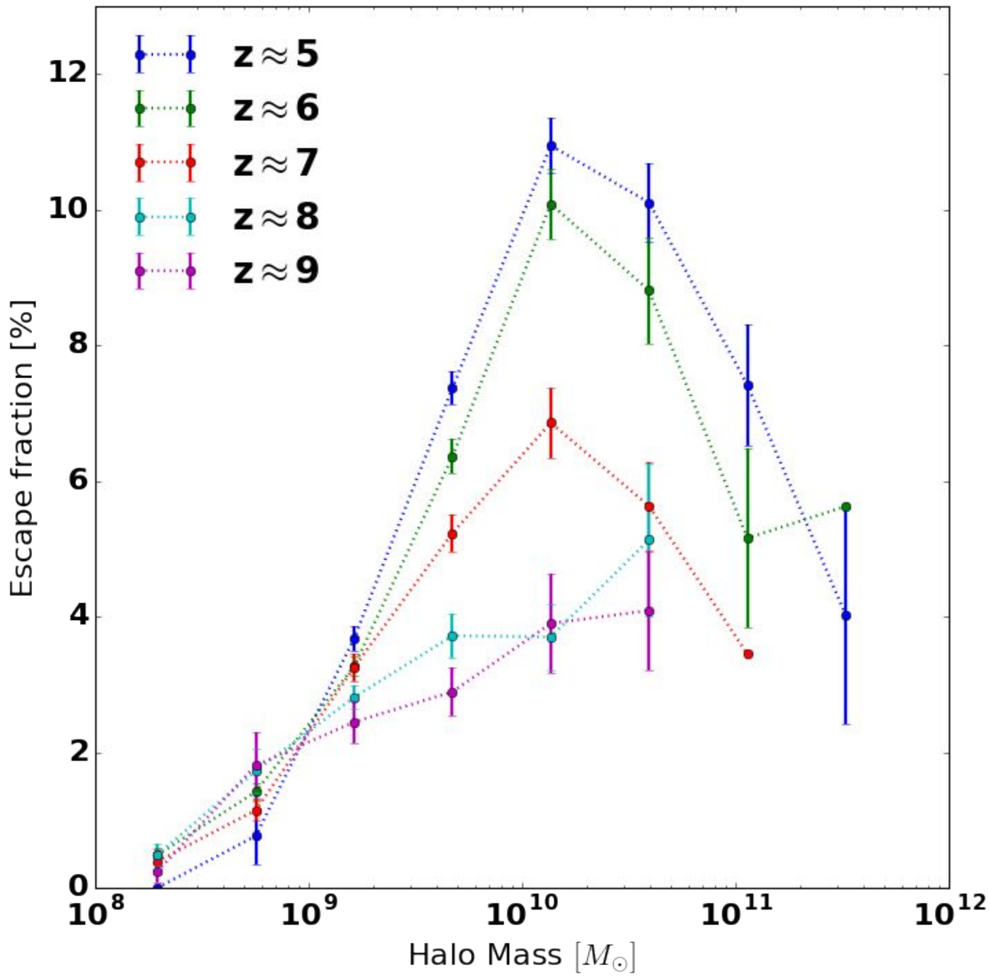

The more massive, the more outflow

Halos without stars get outflow ?

A lot of halos (even with stars) get inflow

# Escape fraction
## R200/stellar

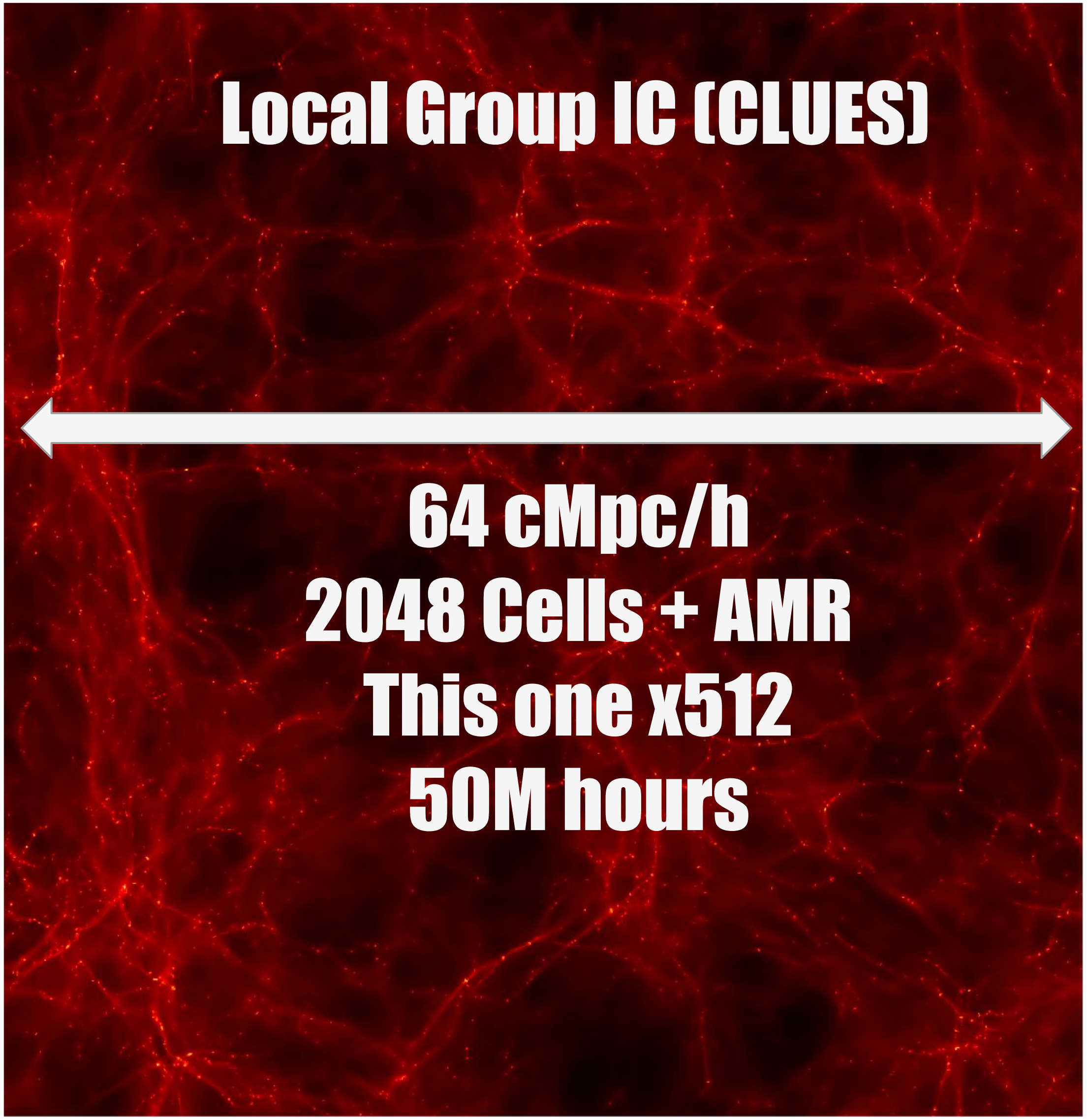



We use a fluid representation of light, escape fraction estimations are often made by ray tracing

We only use positive flux, and halo with young stars

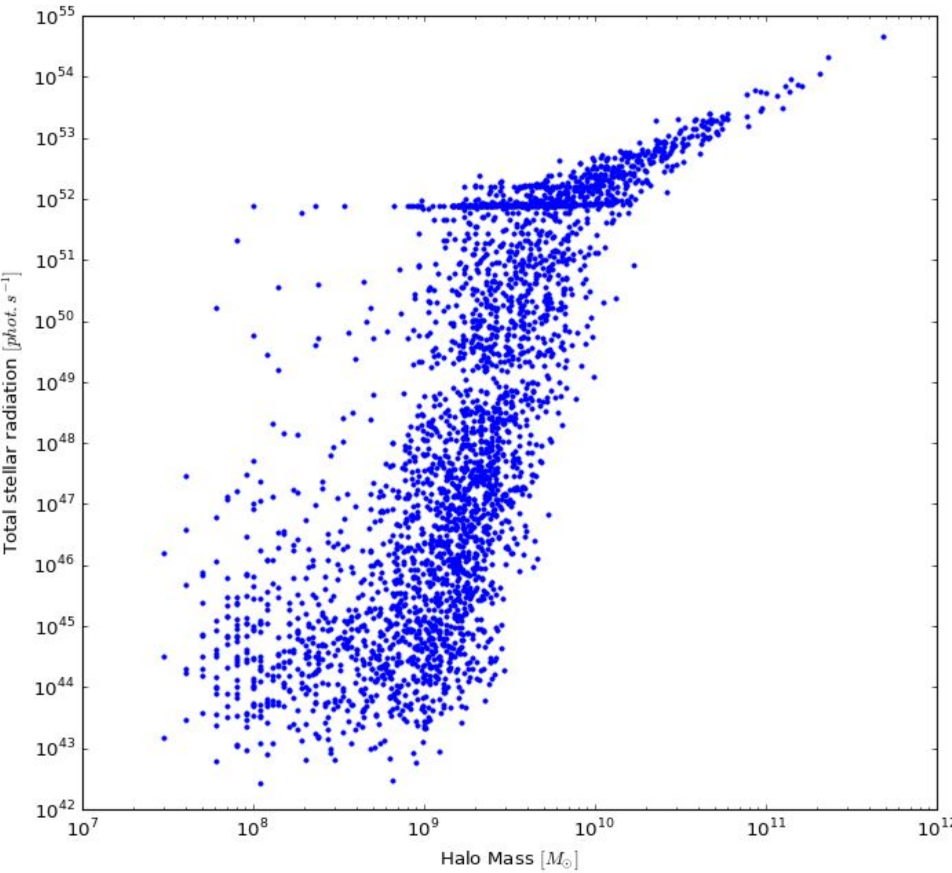
# Prospect - CODA II



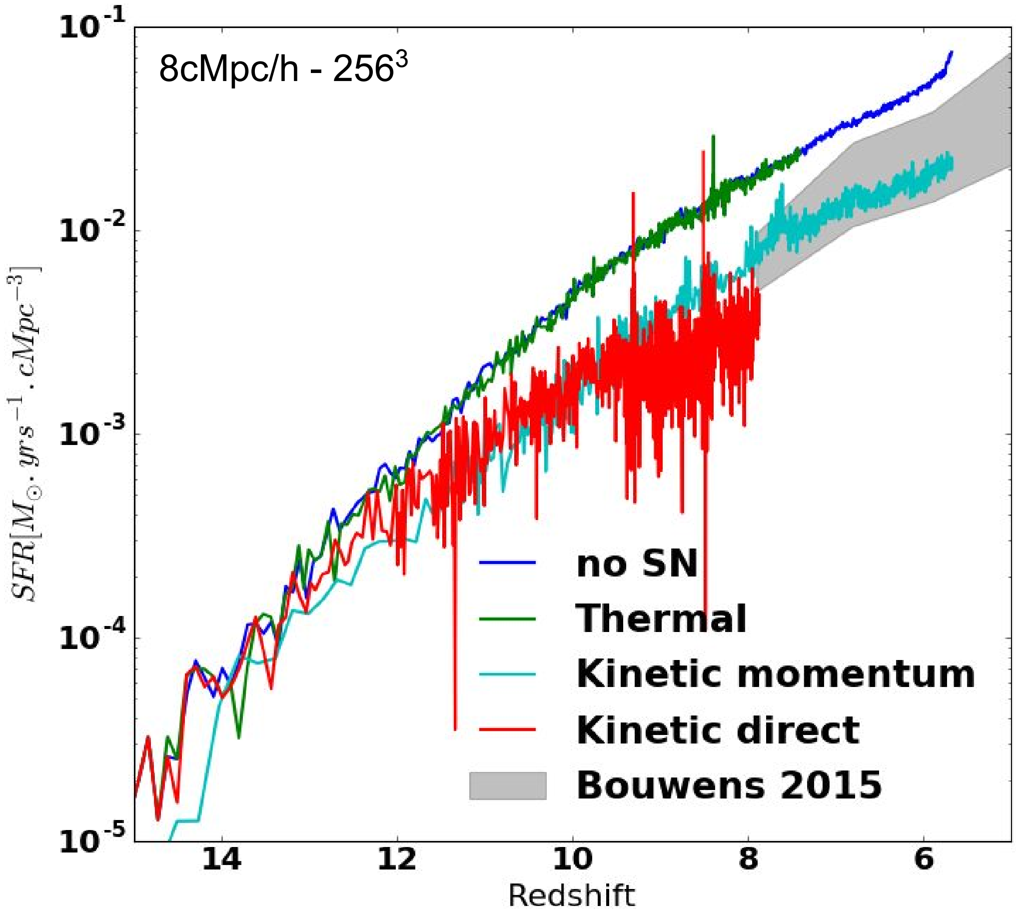
# Thanks

# Stellar emissivity

**z=5**



# Supernovae - Feedback




**In Full Physics:**

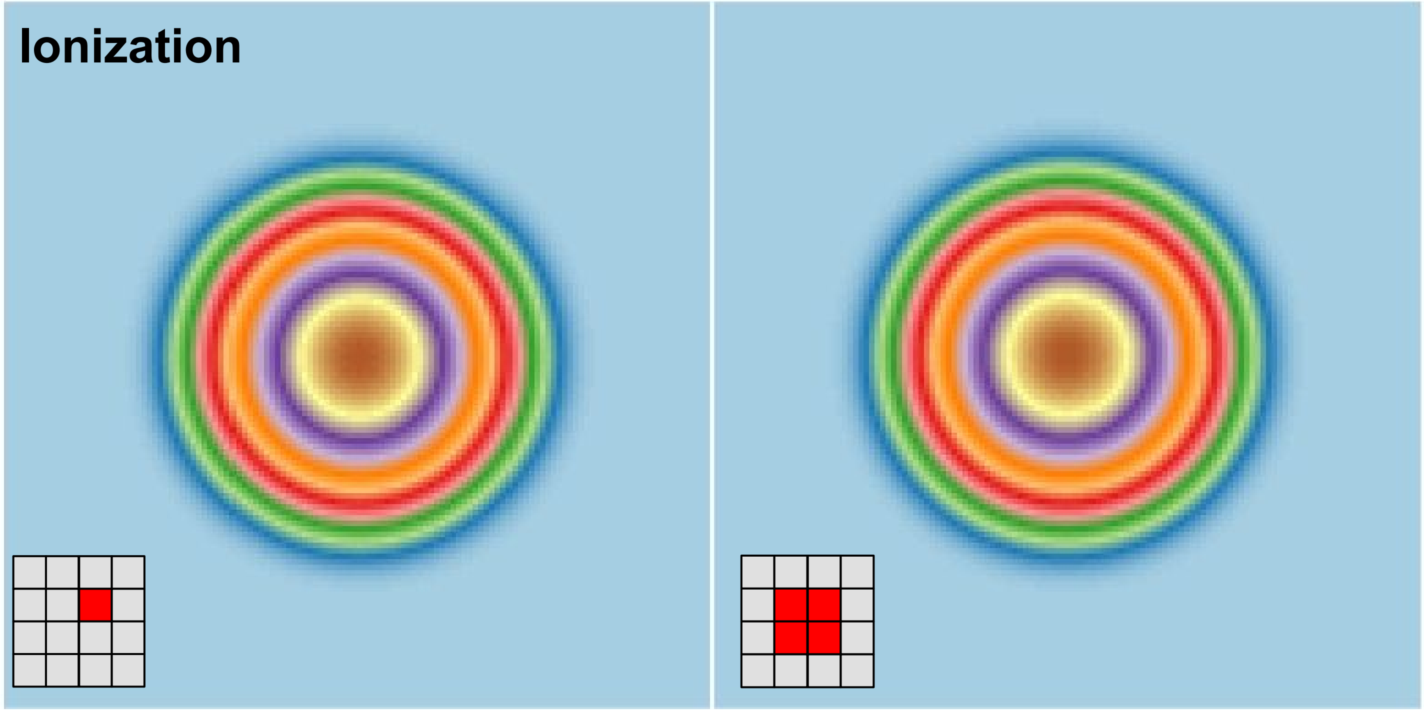
For a **given energy** injected the **method** of injection is **predominant**.

# Radiation - Stromgren sphere

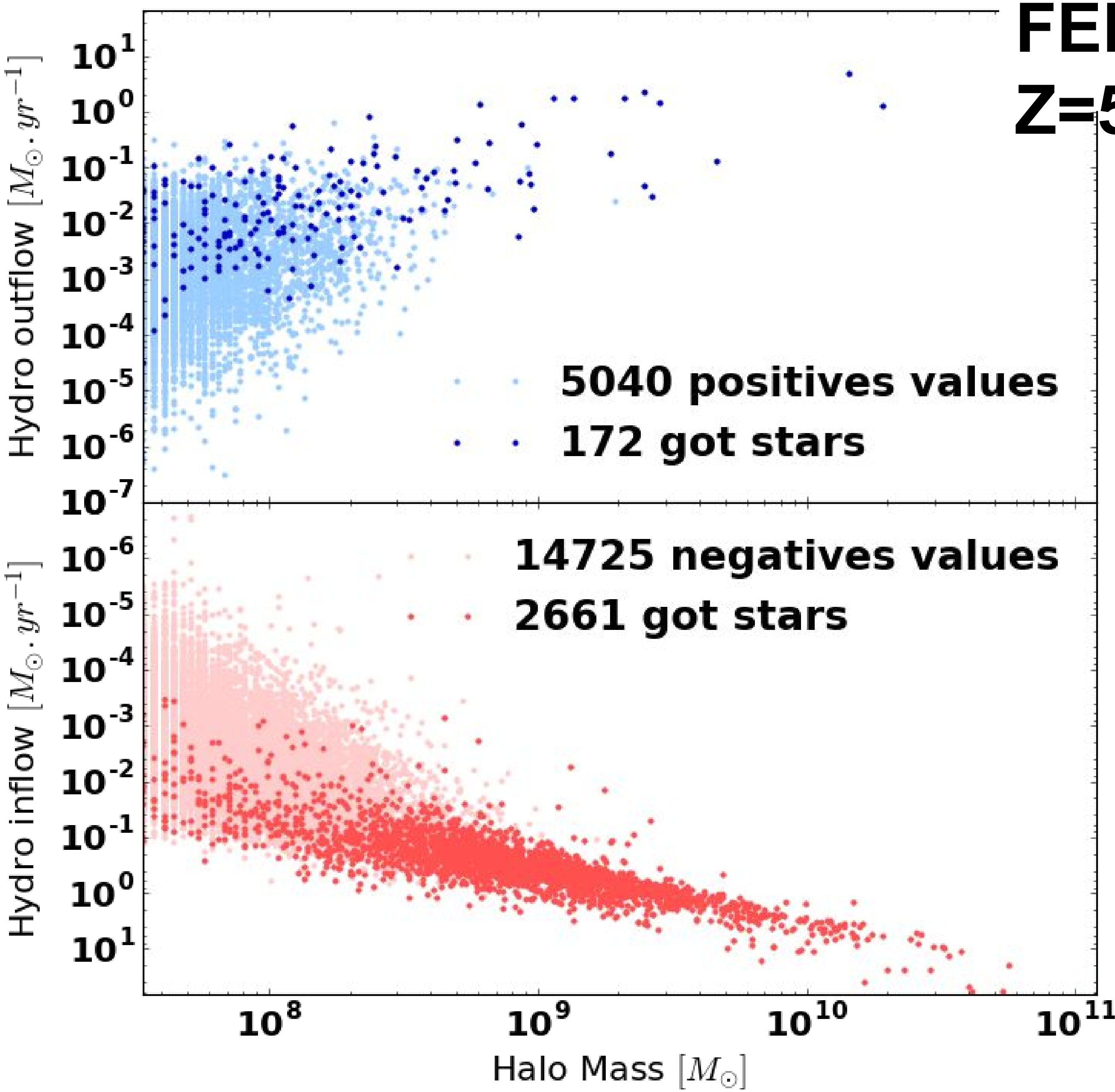
ref : Strömgren 1939

**In Unit Test:**

Ionization pattern doesn't depend of the injection scheme

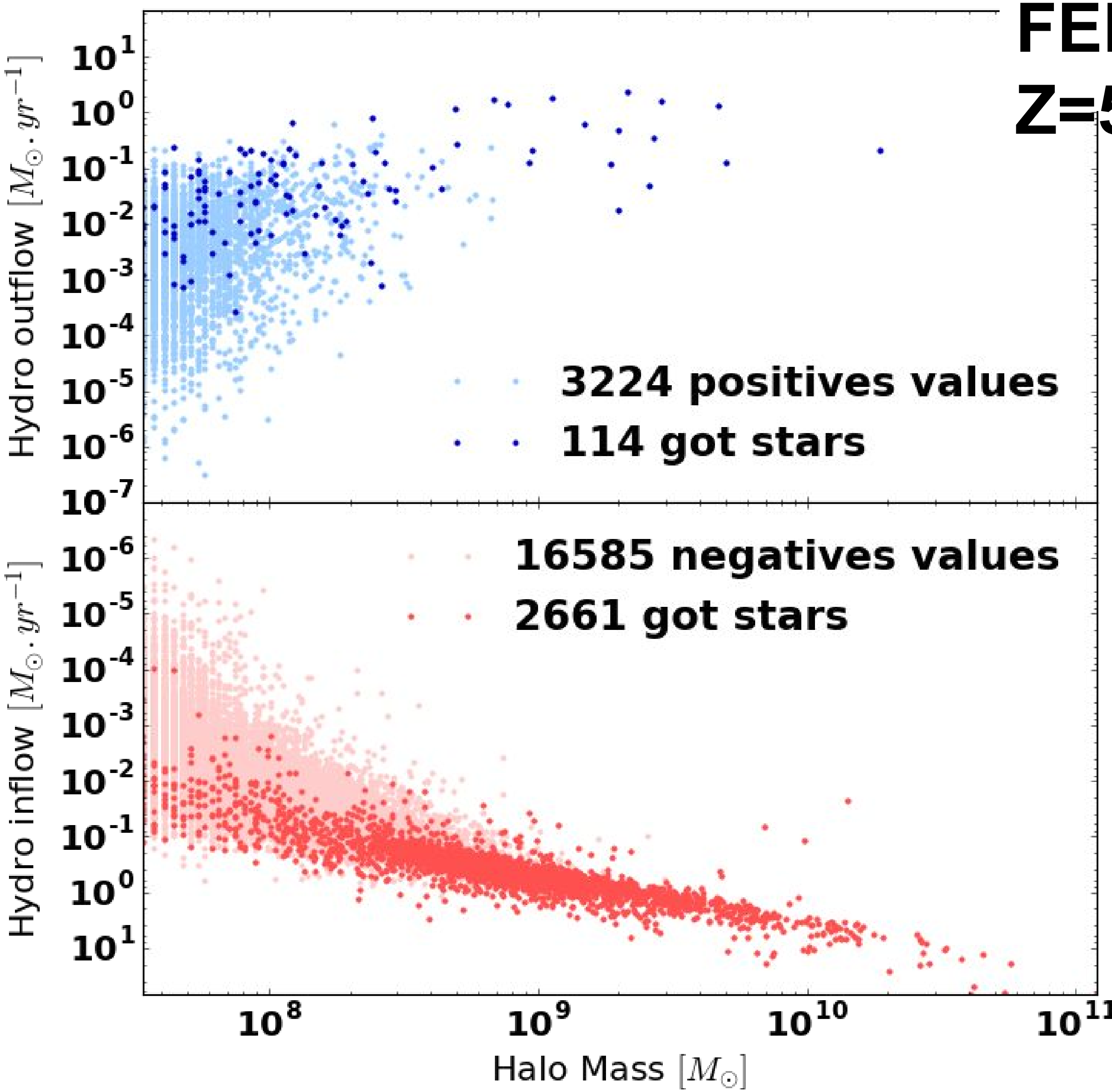


FEED ON
Z=5.7



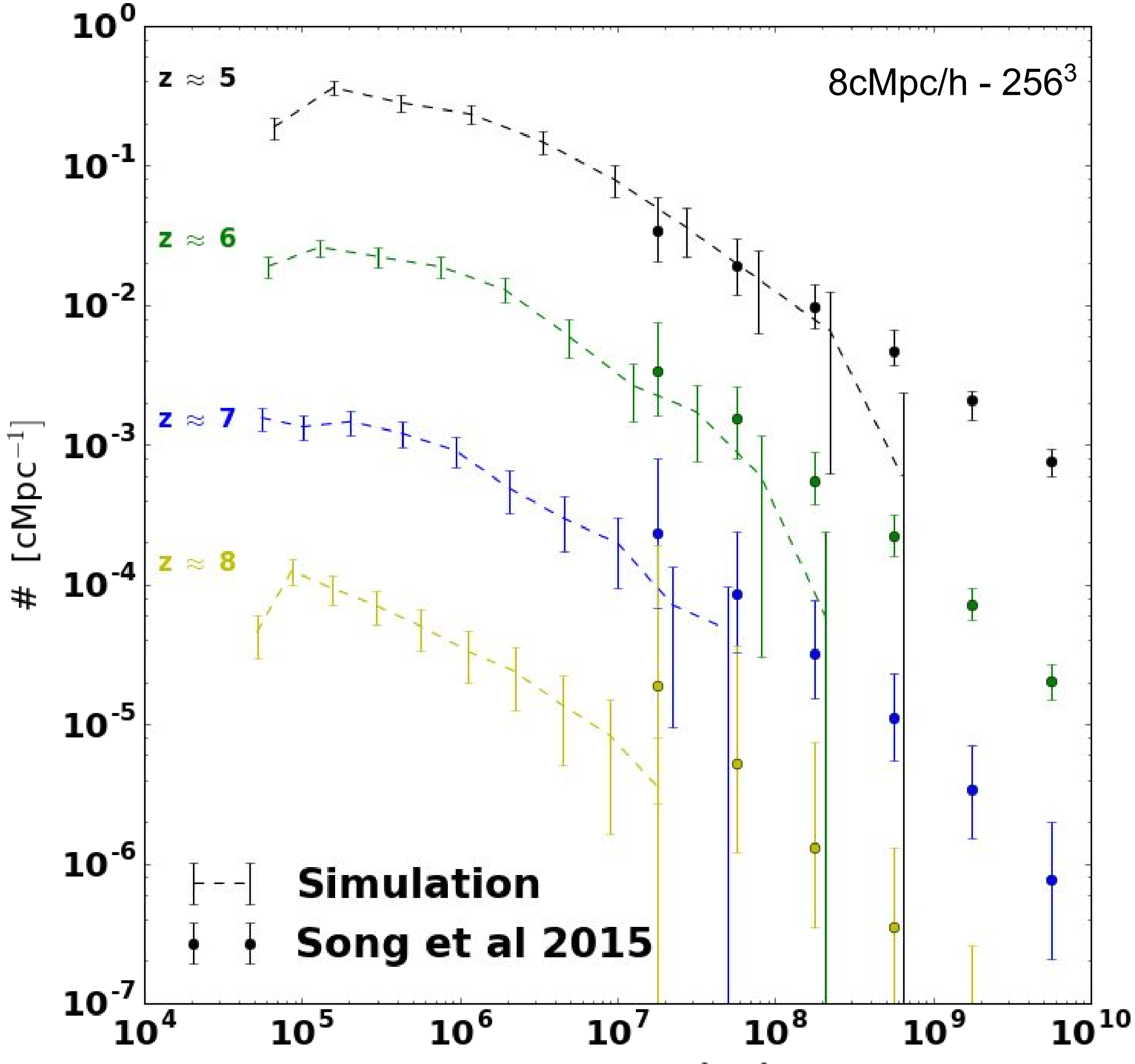
Hydro outflow $[M_\odot \cdot yr^{-1}]$
Hydro inflow $[M_\odot \cdot yr^{-1}]$
Halo Mass $[M_\odot]$
5040 positives values
172 got stars
14725 negatives values
2661 got stars

# FEED OFF
# Z=5.7



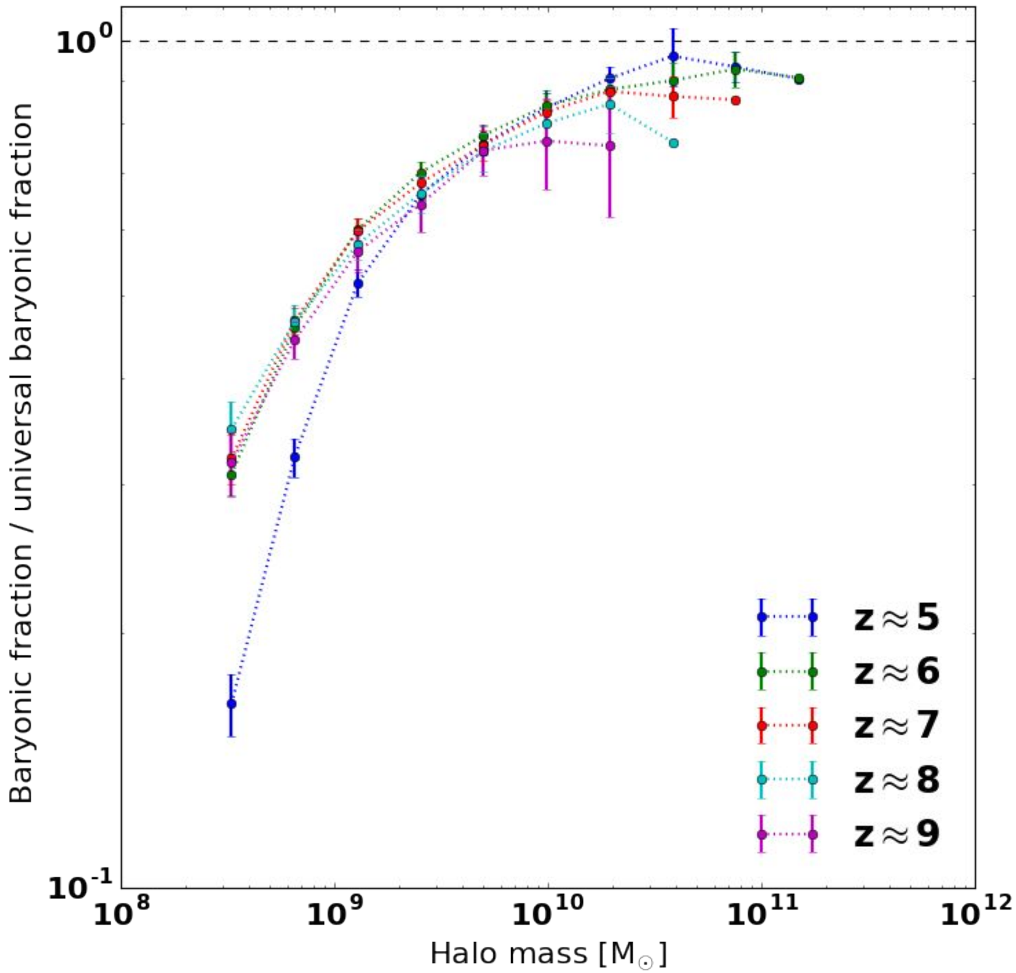
3224 positives values
114 got stars
16585 negatives values
2661 got stars
Hydro outflow $[M_\odot \cdot yr^{-1}]$
Hydro inflow $[M_\odot \cdot yr^{-1}]$
Halo Mass $[M_\odot]$

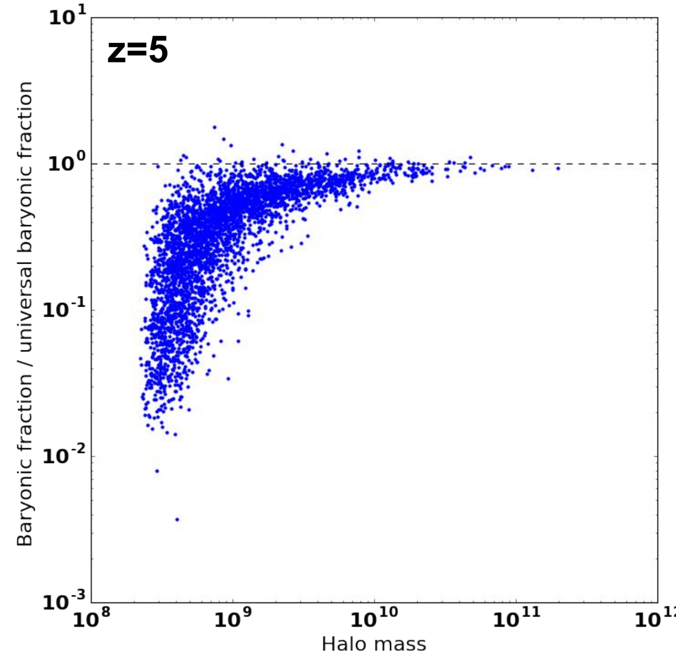
# Stellar mass functions




Stellar mass functions are in accordance with observations from redshift 8 to 5

# Baryonic fraction




We also see this decrease in the baryonic fraction

Baryon are going out from halo of low mass