The impact of the smallest galaxies on the EoR

A brief overview of past, current and future works

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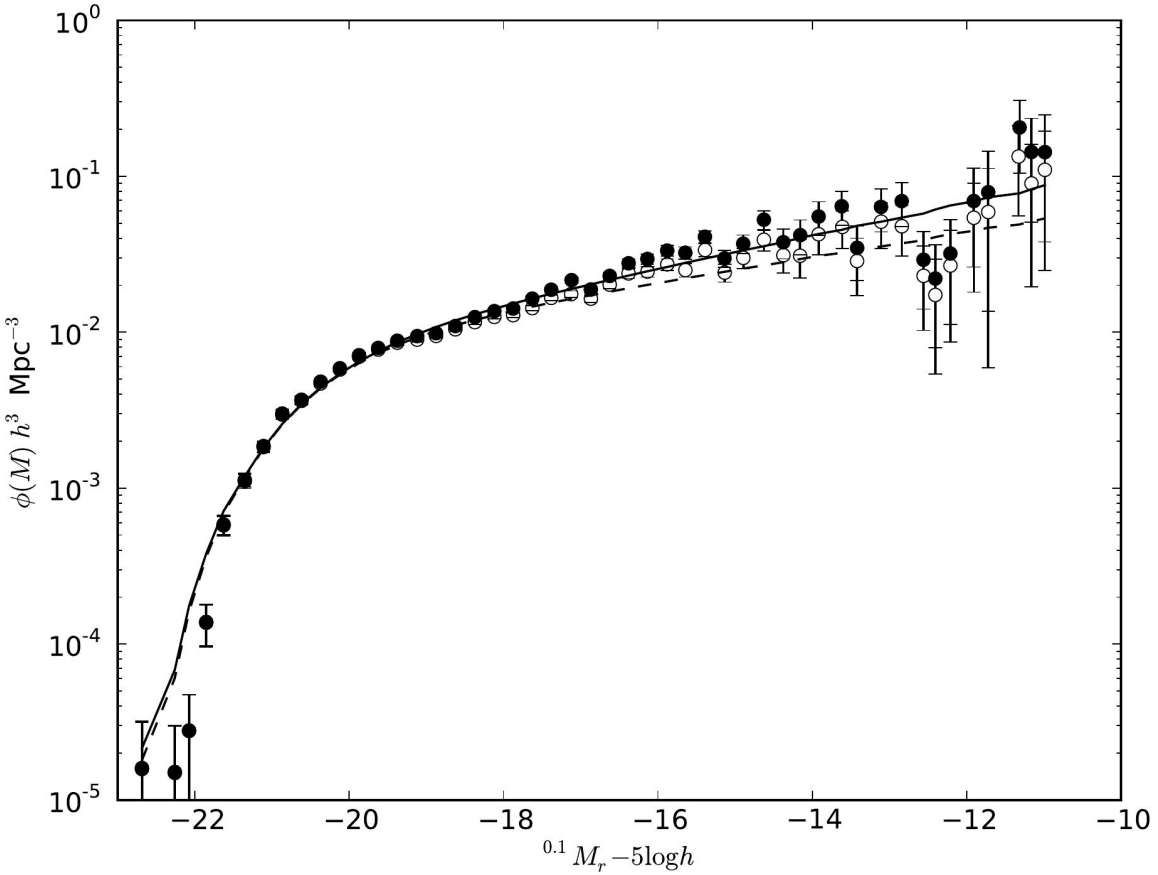
Dwarf galaxies

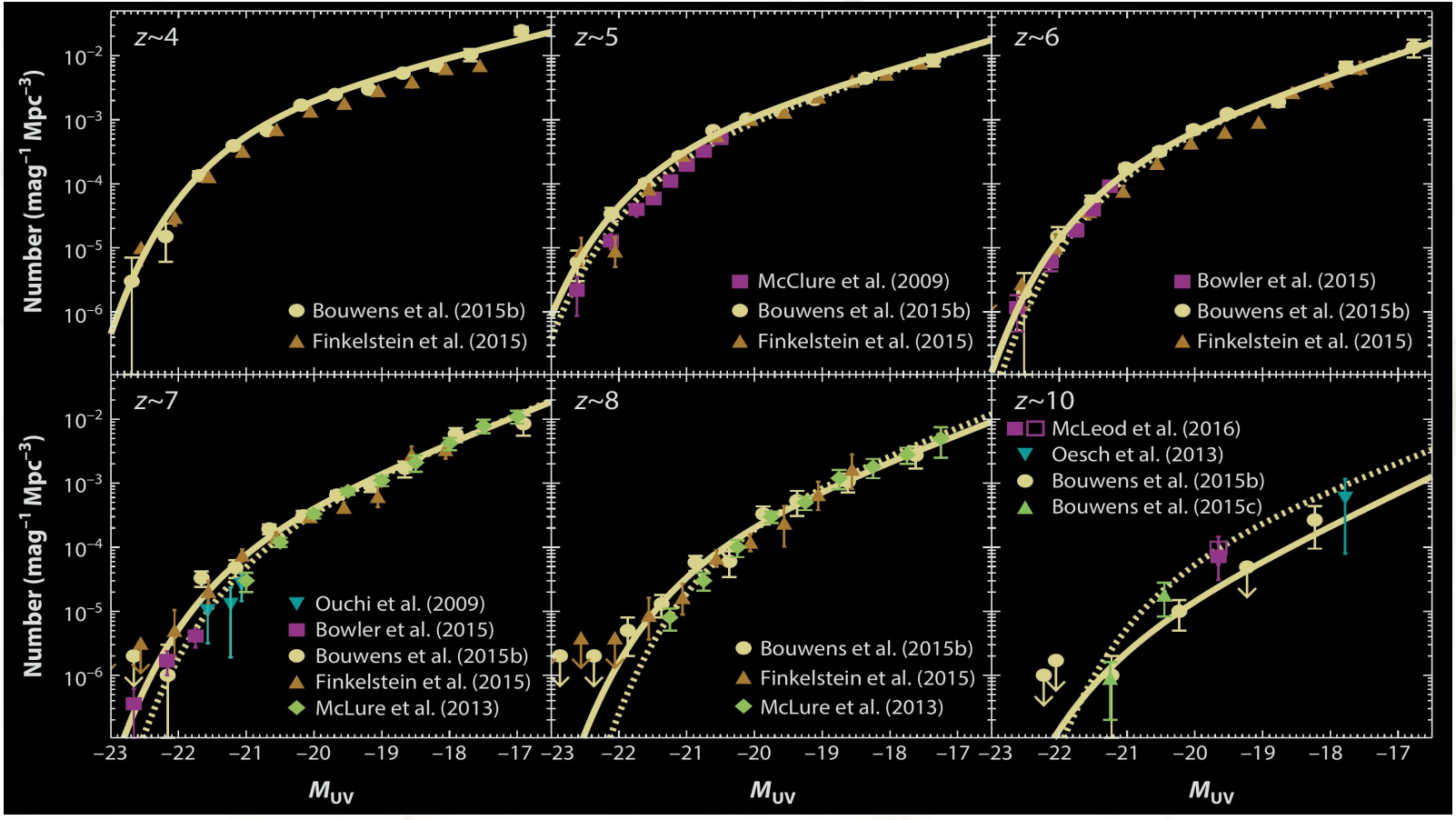
The GAMA Luminosity function (*Loveday+2012*) z<0.1



Dwarf galaxies

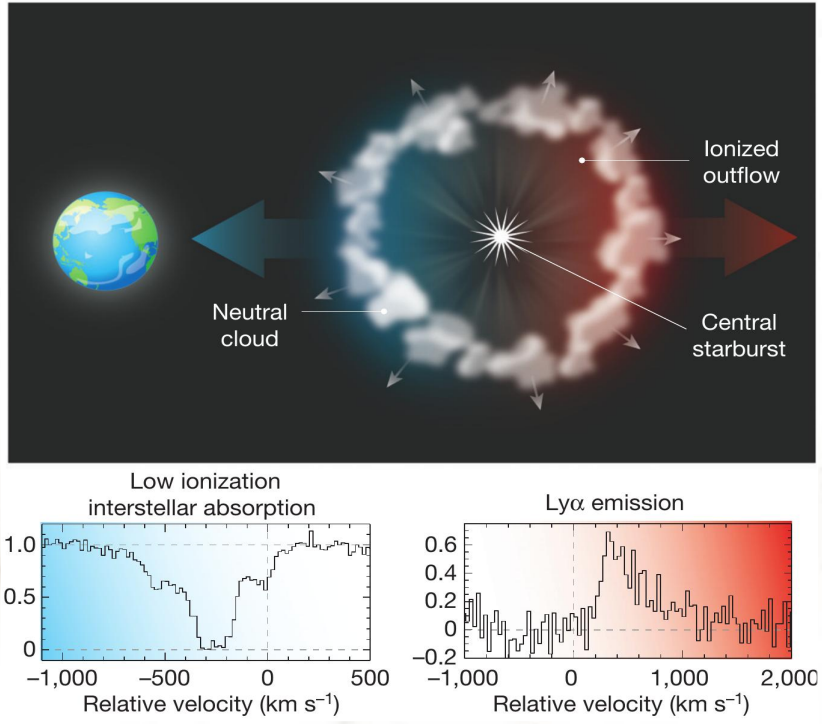
also the most abundant galaxies at high redshift

(see. Ouchi+2009,Oesch+2013,McClure+2009,2013,Bouwens+2015,Finkelstein+2015,Bowler+2015, Atek+2015)

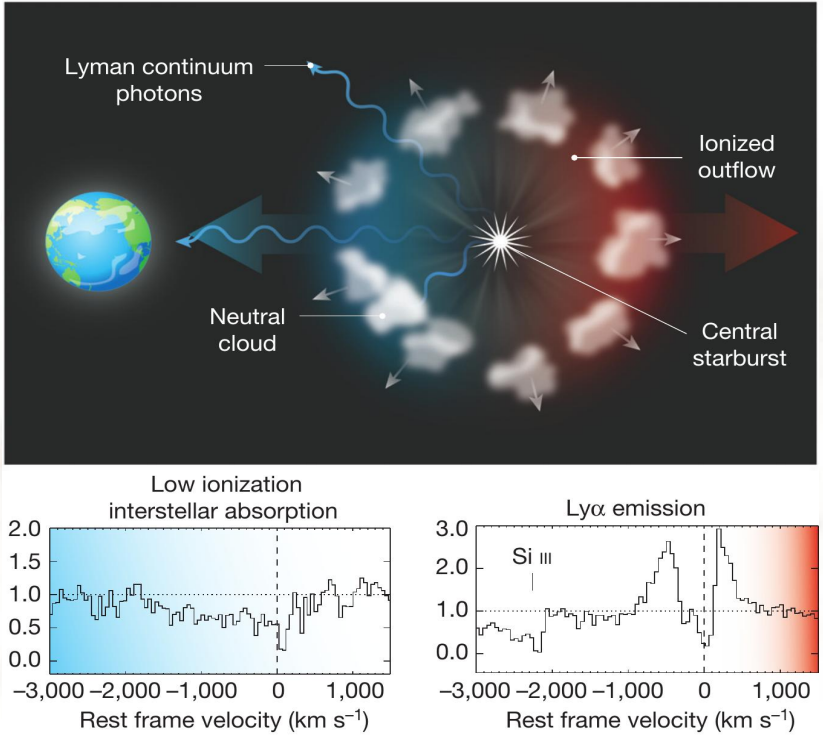


The ionizing escape fraction of Dwarf galaxies

Nearly complete covering fraction of the neutral hydrogen



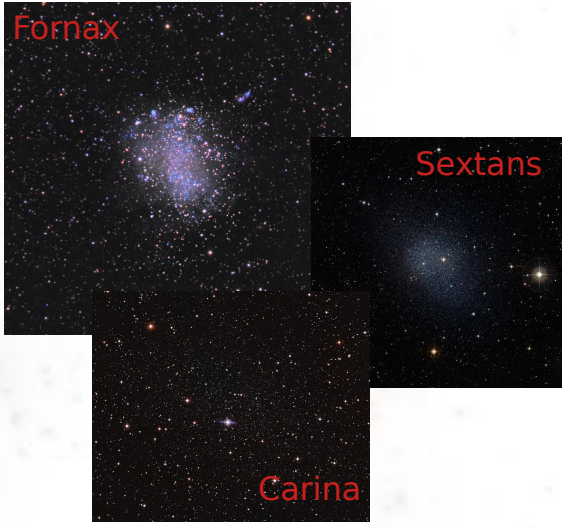
Incomplete covering fraction of the neutral hydrogen



Erb+2015

Our approach:

- Study dwarf galaxies through a full Hubble time via numerical simulations and check if their properties reproduce in detail available observations
  - Observations of dwarf galaxies in the Local Group
    - Line-of-sight velocities
    - Deep colour magnitude diagrams
    - High resolution spectroscopy of individual stars

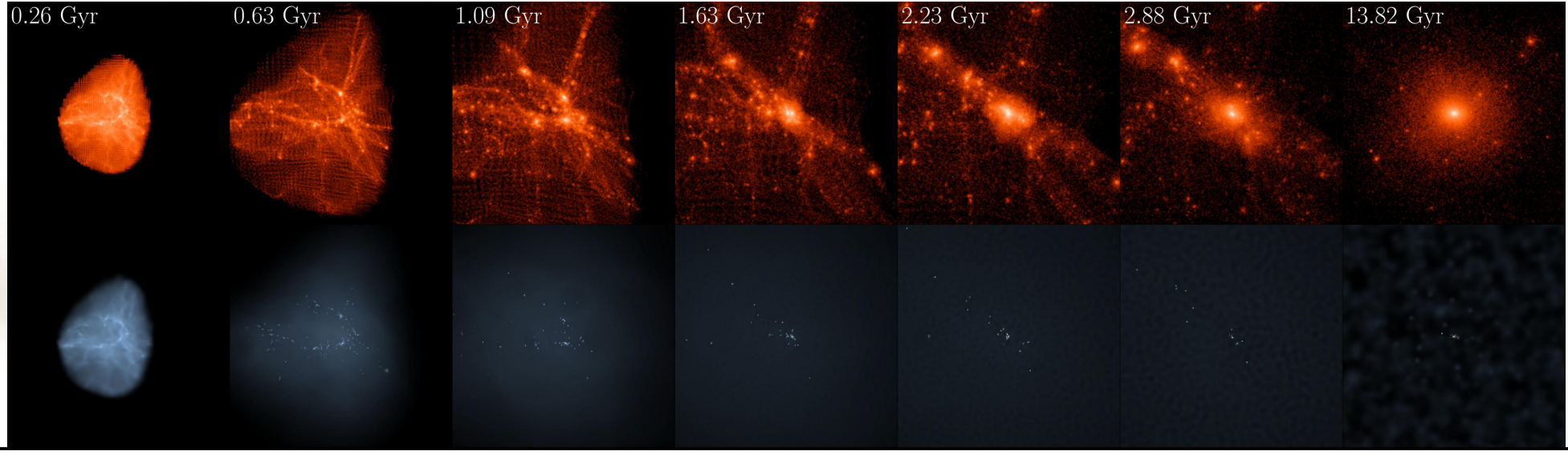


- Obtain constraints on stellar feedback that impacts the photon escape fraction at high-z, determinant for the role of dwarf galaxies during the EoR

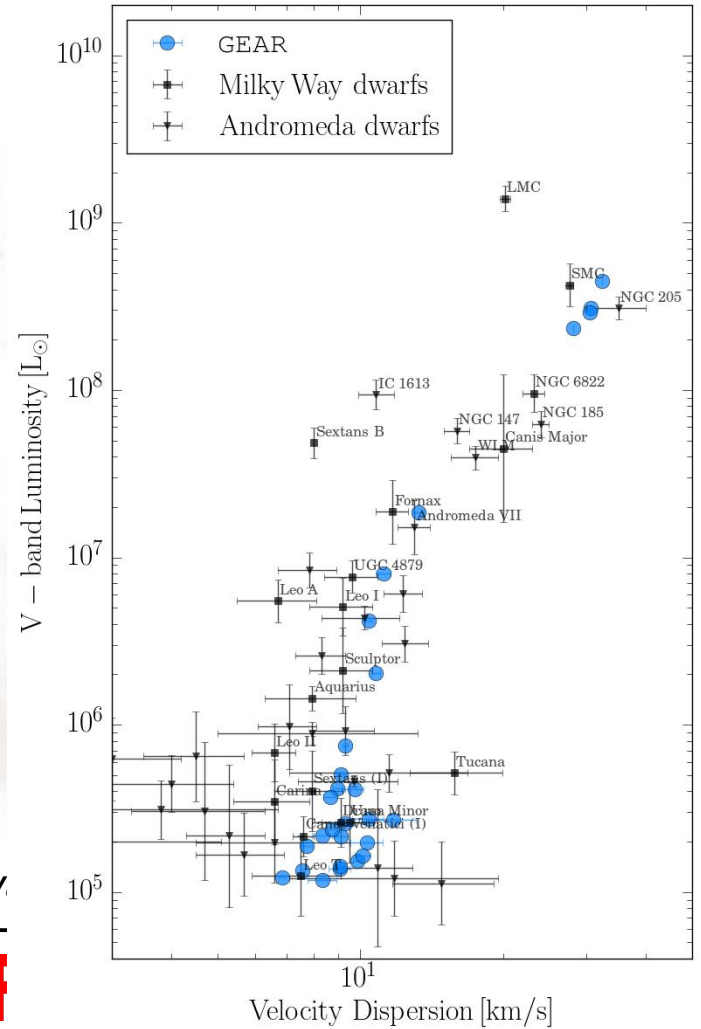
Numerical methods: GEAR

Cosmological zoom-in simulations of dwarf galaxies and UFDs

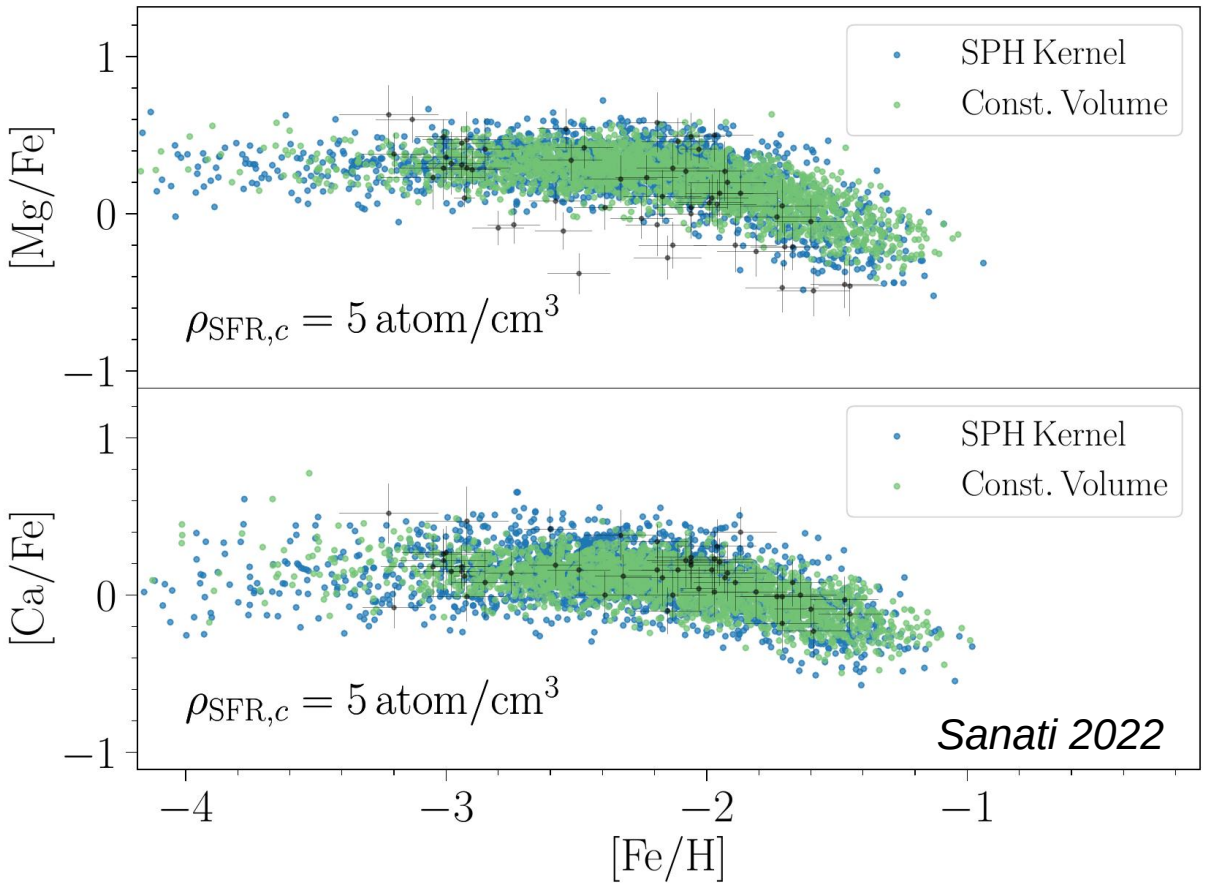
- Boxsize : 5 Mpc
- Stellar mass resolution : down to 380 $M_\odot$
- Luminosities : from 10^8 to $3x10^3$ $L_\odot$



Numerical methods: GEAR



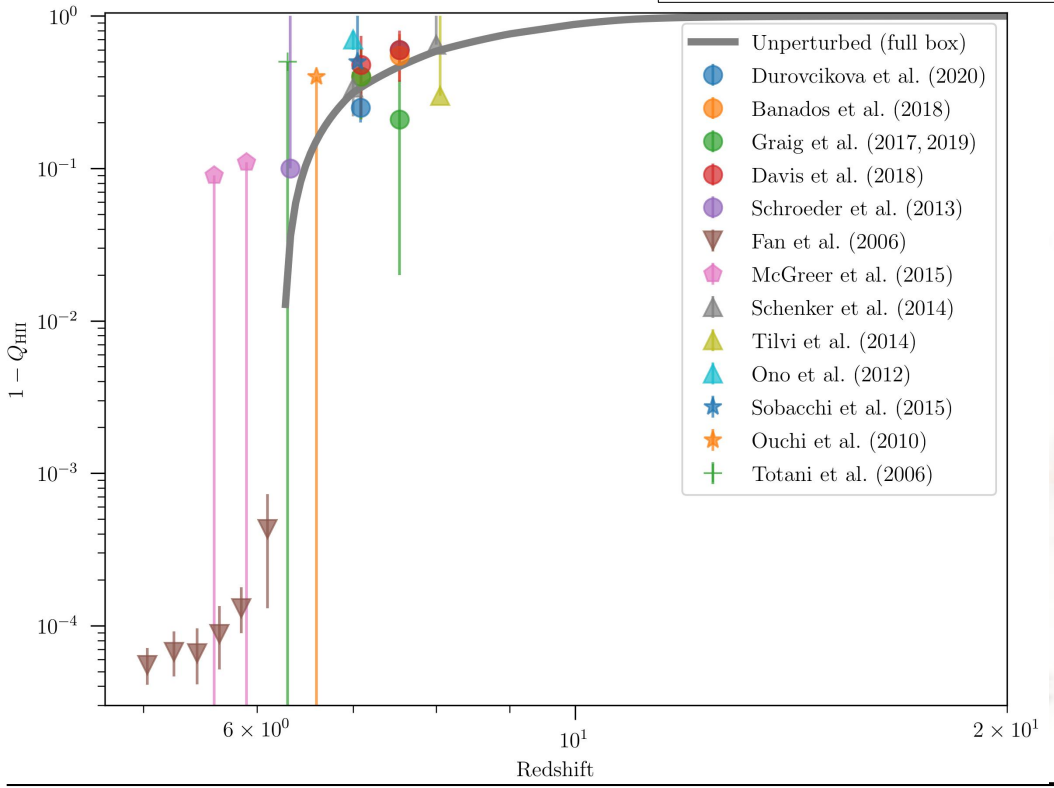
Reproducing the abundances of Sextans

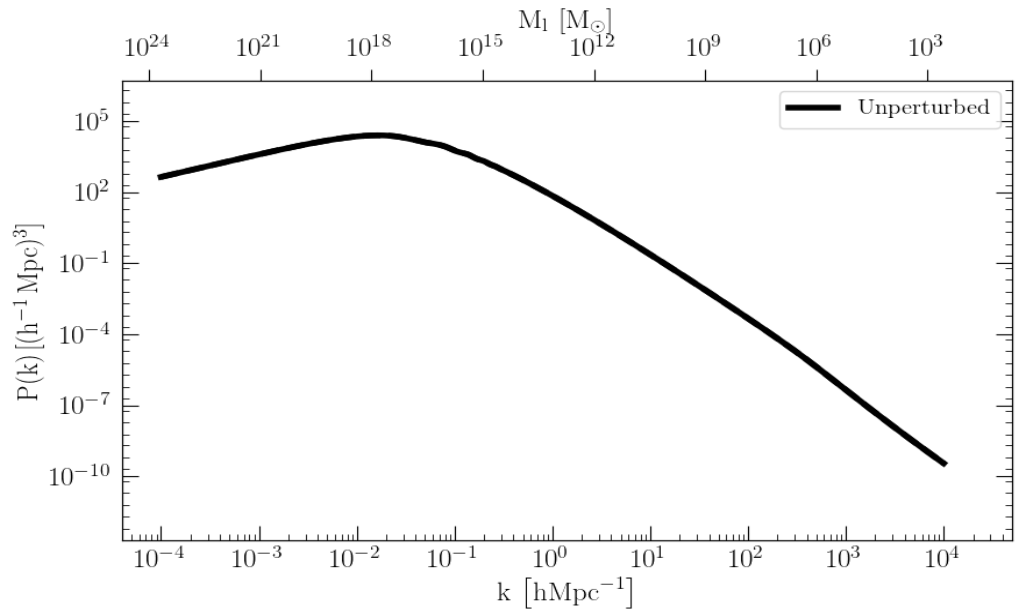


The impact on the neutral gas fraction

Sanati 2020

$$\dot{Q}_{\rm HII} = \frac{\dot{n}_{\rm ion}}{\bar{n}_{\rm H}} - \frac{Q_{\rm HII}}{t_{\rm rec}}$$

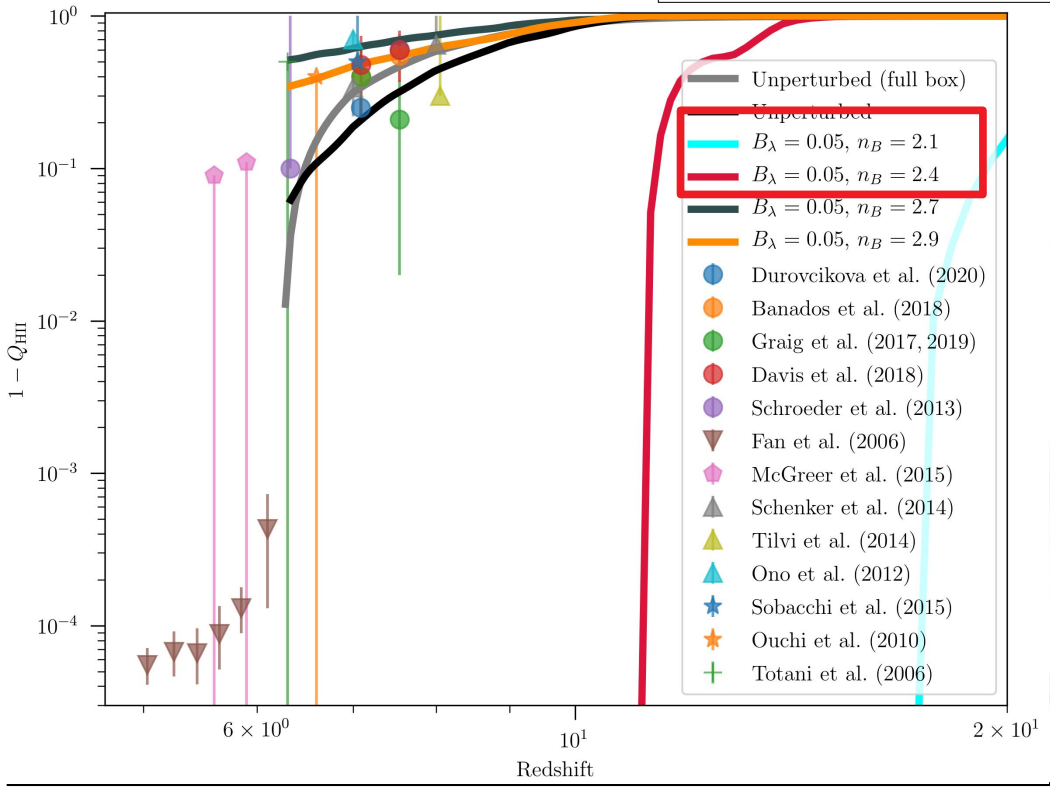


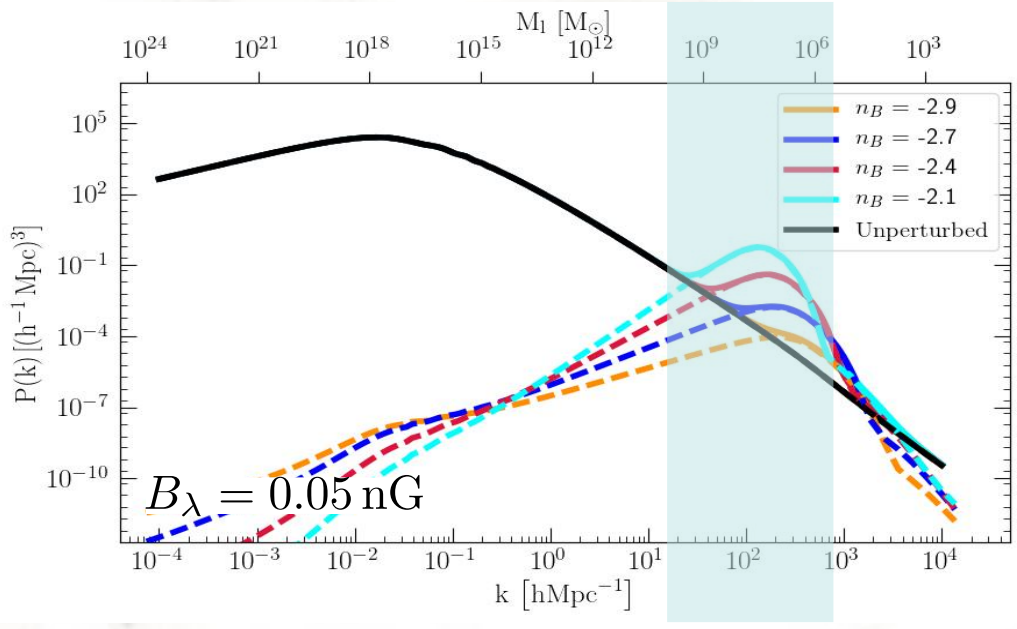


Effects of Primordial Magnetic Fields

Sanati 2020

$$\dot{Q}_{\rm HII} = \frac{\dot{n}_{\rm ion}}{\bar{n}_{\rm H}} - \frac{Q_{\rm HII}}{t_{\rm rec}}$$





Radiative transfer : the SWIFT code

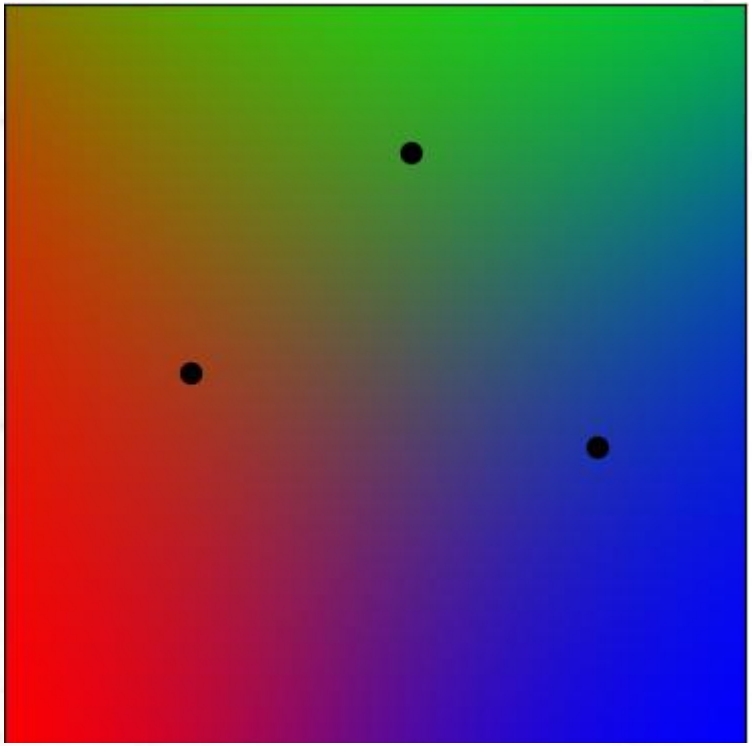
Ivkovic 2022, in prep.

Migration towards SWIFT, a brand new tasked based cosmo-hydro code

- Implementation of the «mesh-less» scheme
  Lanson & Vila 2008, Gaburov & Nitadori 2011
- Solve the moments of the RT equations
  Aubert 2009, Rosdhl 2013

$$\frac{\partial E_\nu}{\partial t} + \vec{\nabla}\vec{F}_\nu = -\kappa_\nu\, c\, E_\nu + S_\nu$$

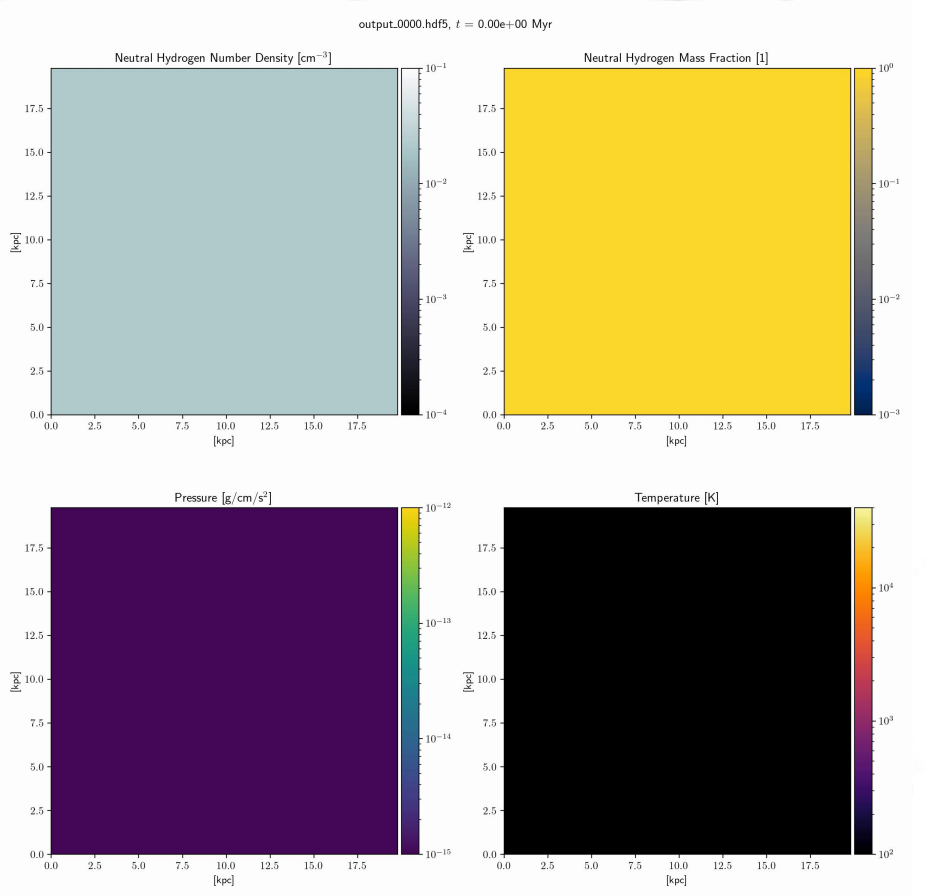
$$\frac{\partial \vec{F}_\nu}{\partial t} + c^2\, \vec{\nabla} \cdot P_\nu = -\kappa_\nu\, c\, \vec{F}_\nu$$



Radiative transfer : the SWIFT code

Ivkovic 2022, in prep

HII region expansion test:
The Stromgren Sphere (*Iliev 2009)*



Future Plans

- Zoom-in simulation with a mass resolution between 10-50 $M_{\odot}$
- New «sink particle» technique : simulate individual massive stars
- On the fly radiative transfert
- Primordial chemical network : H, H^-, H^+, He, He^+, He^{++}, H_2, H_2^+

The End