Effect of feedback on the escape of ionizing radiation from high-z galaxies

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Introduction

Small galaxies ($M_{vir} \lesssim 10^9 M_\odot$) are responsible for most of the ionizing budget for the Reionization.

- How do these galaxies form their stars?
- How much of the UV radiation escapes the galaxies?

Very hard to constrain with current observations, but major science case for JWST.

$\Rightarrow$ Need for high resolution simulations of high-z, low mass galaxies with radiative hydrodynamics.

Methods: Ramses-RT

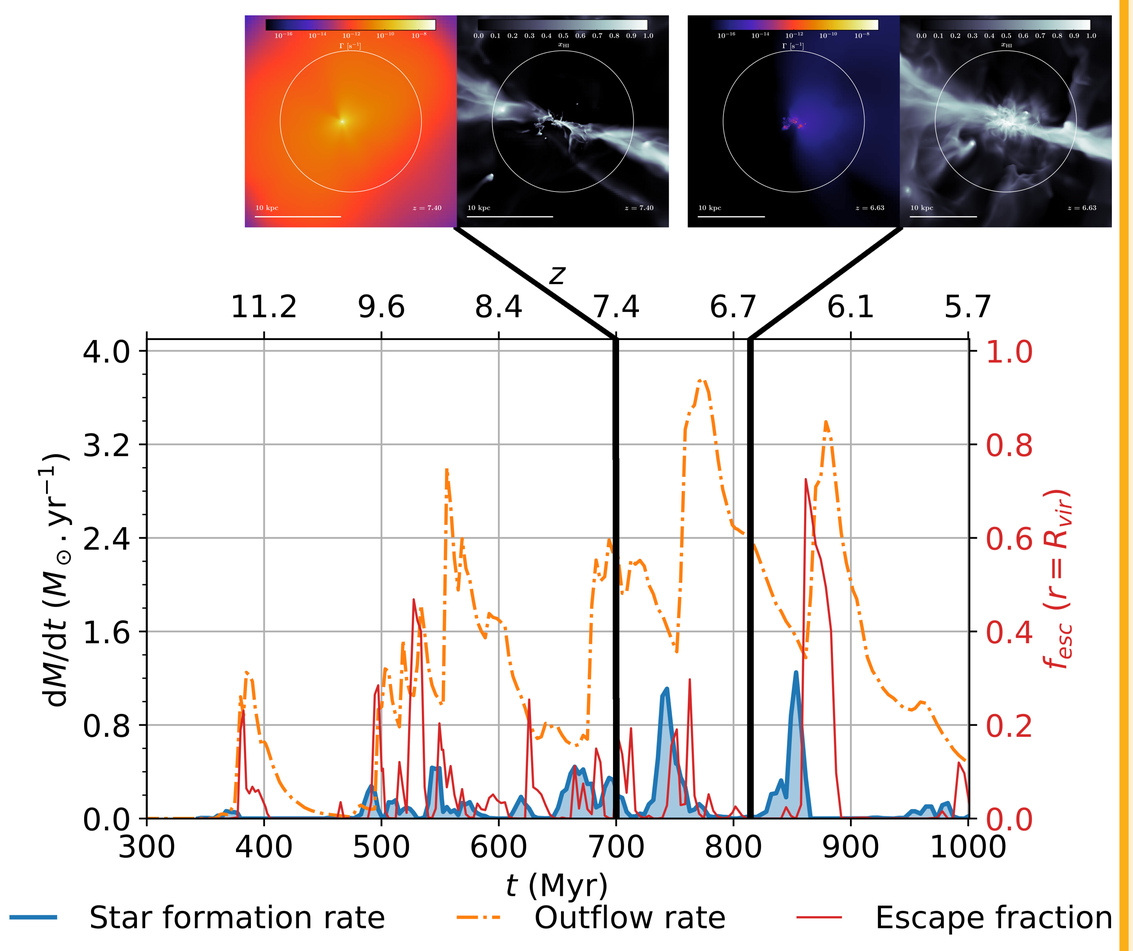
We use the RHD version of the Ramses AMR code (Rosdahl et al, 2013).

- High resolution
  - Dark matter: $m_{DM} \simeq 10^3\ M_\odot$
  - Gas: $\Delta x \simeq 10$ pc
  - Stars: $m_\star \simeq 120\ M_\odot$
- Recent subgrid models
  - Gravoturbulent star formation (Devriendt+, in prep.)
  - Resolved mechanical feedback (Kimm & Cen, 2014)
- Ionizing radiation propagated in 3 bins (HI, HeI, HeII)
- H + He thermochemistry

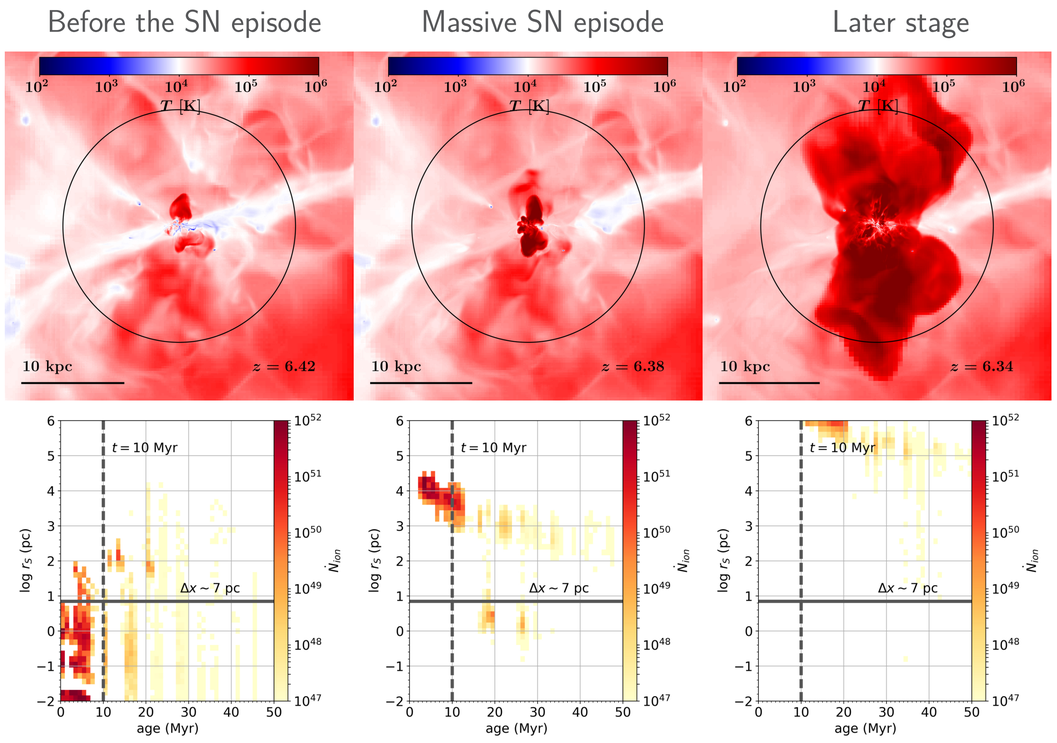
We focus on a halo with $M_{vir} = 2.5 \times 10^9 M_\odot$ at $z \simeq 5.7$.

Bursty assembly of galaxies

- Low mass galaxies undergo a succession of episodes of star formation and SN feedback.
- SN feedback removes gas from the ISM and heats the gas in the halo.
- The escape of ionizing radiation happens after the stellar birth cloud has been cleared by SN.
- Galaxies alternate between "burst" phases and "quiet" phases.



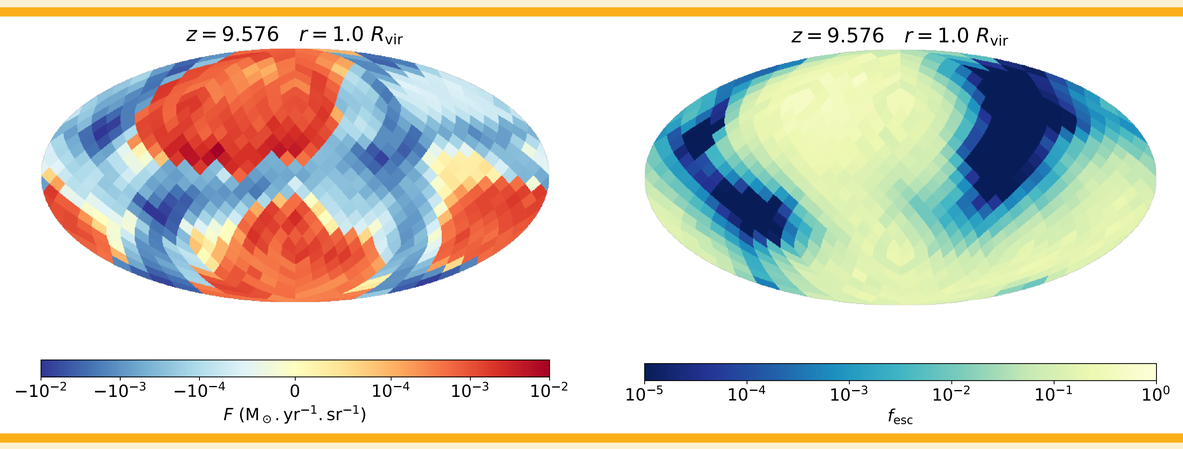
Feedback is needed for radiation to escape



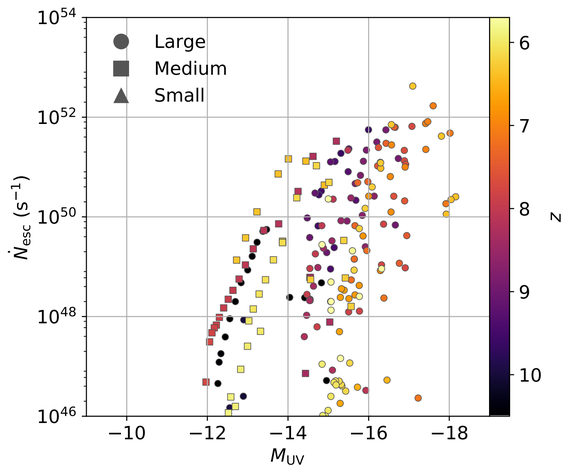
- The galaxy undergœs a succession of episodes of star formation and SN feedback that launch powerful winds.
- Before feedback events, the ISM is optically thick to ionizing radiation
- For each episode, SN clear the path for ionizing photons to escape

Anisotropic escape

- Ionizing radiation escapes preferentially through direction cleared by outflows
- Along these directions, the escape fraction f_{esc} can be very high



Observational consequences



- At fixed UV luminosity, large scatter in the number of ionizing photons released in the IGM
- At fixed $\dot{N}_{esc}$, large scatter in the UV magnitude

Perspectives

- Other channels of feedback could boost the escape of radiation
  - Small SMBH in small galaxies are expected at high redshift
  - Work in progress: quantifying the impact of their feedback on f_{esc}
- Highlights the need for a more detailed description of the ISM of high-z galaxies

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Animations