Motivating f_{esc} During Reionzation Using Semi-Analytic Models

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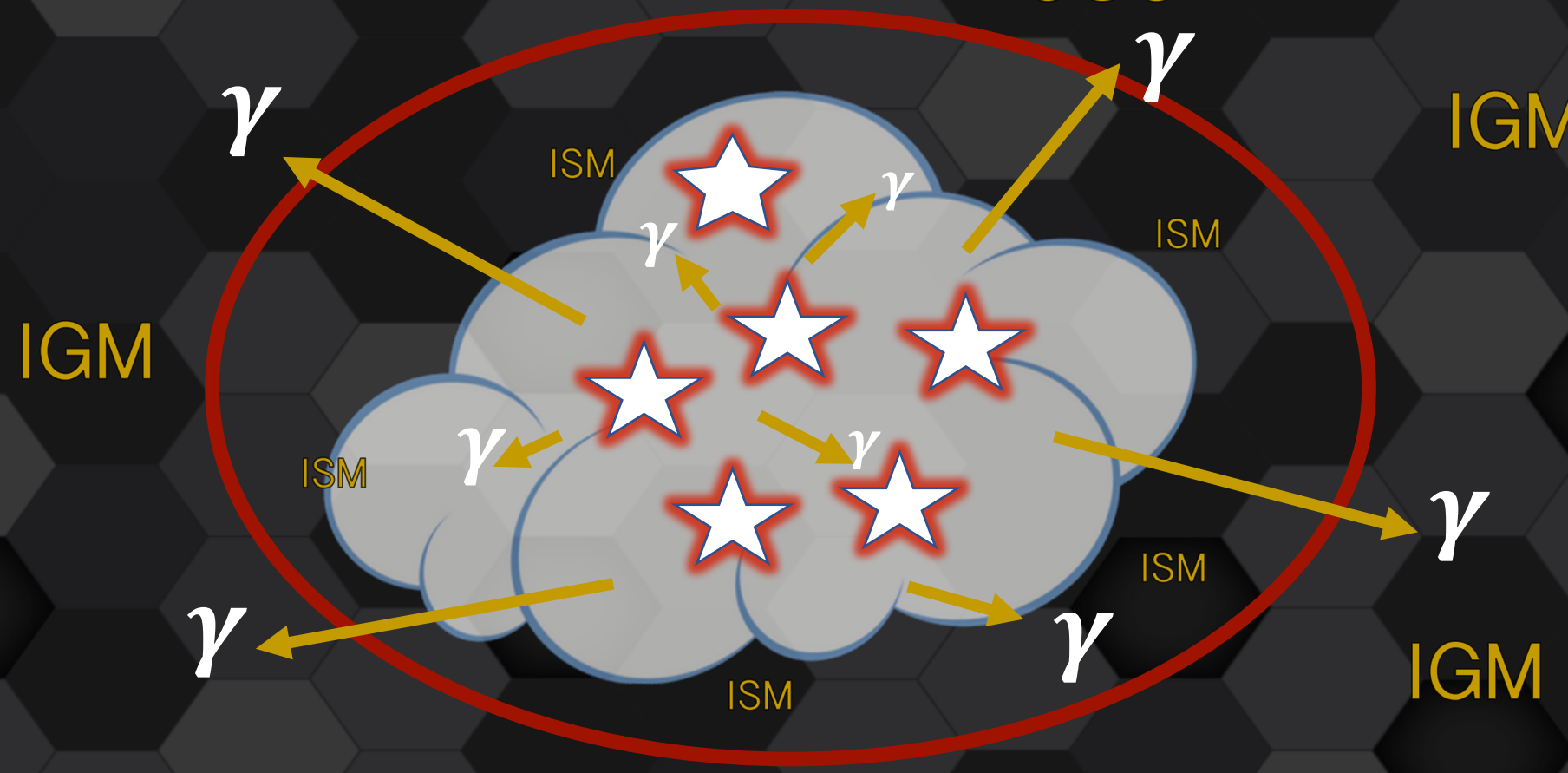
What is f_{esc}?



f_{esc} = Number of HI Ionizing Photons Produced / Number of Photons that Escape Into IGM

Uncertainty in f_{esc}

- Observational limits place f_{esc} at 0-5% for z < 1.5 (Cowie+ 2009, Grimes+ 2009), and < 10-20% at z ~ 3 (Guaita+ 2016, Grazian+ 2017). But also measurements of f_{esc} > 20%! (Vanzella+ 2016, Bian+ in prep)

- As a first step often assume f_{esc} is a constant.

	Model	Description	f_{esc}	α_{SF}	Relative av. bubble size	Max. frac. diff. in dim. power
—	F (Fiducial)	Feedback from a UV background incorporated as per Section 2.3.2. Supernova feedback incorporated as per Section 2.2.	0.2	0.03	-	-
-·-	NoSNeFB	Recalibrated fiducial model without feedback from supernovæ.	0.239	0.00106	19% ↓	17%
– –	NoFB	Recalibrated fiducial model without feedback from reionization or supernovæ.	0.2328	0.00106	18% ↓	15%
—	CSHR	Constant stellar-to-halo mass ratio set as $M_*/M_{vir}^{FoF} = 0.055$.	0.01547	0.03	22% ↓	18%
·····	CSHR.Mcut.9	Constant stellar-to-halo mass ratio model only including galaxies with $M_{vir}^{FoF} \geqslant 10^9$ $M_\odot$.	0.031	0.03	17% ↓	15%
-·-·	CSHR.Mcut.10	Constant stellar-to-halo mass ratio model only including galaxies with $M_{vir}^{FoF} \geqslant 10^{10}$ $M_\odot$.	0.1302	0.03	19% ↑	69%

(Geil et al., 2016)

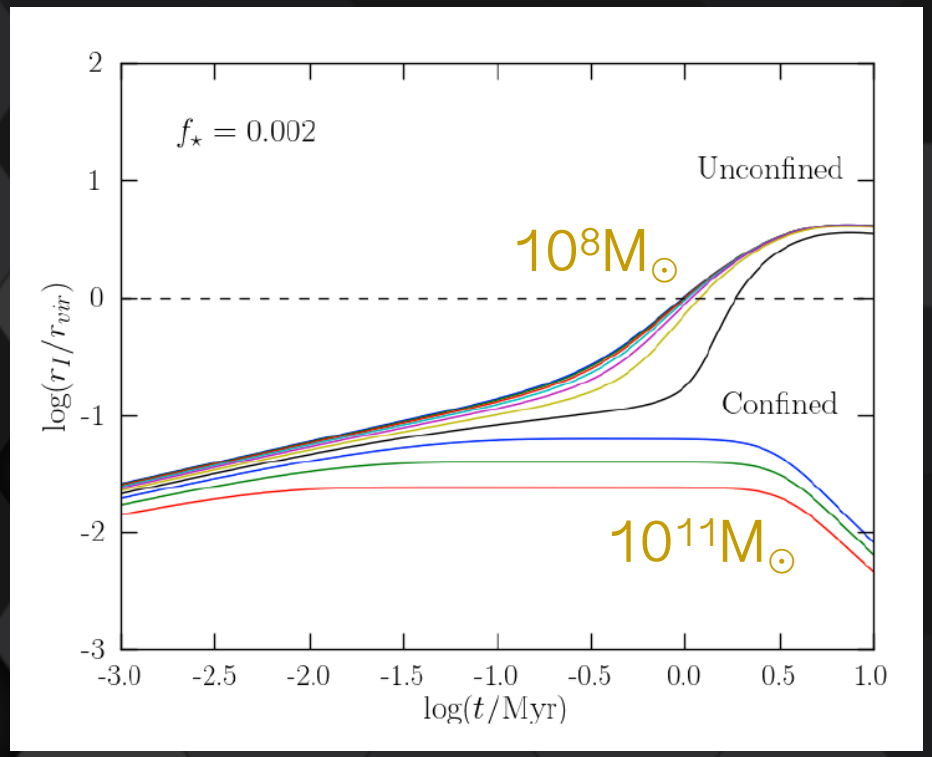
See Also: Kuhlen & Faucher-Giguere (2012)

Sobacchi & Mesinger (2014)

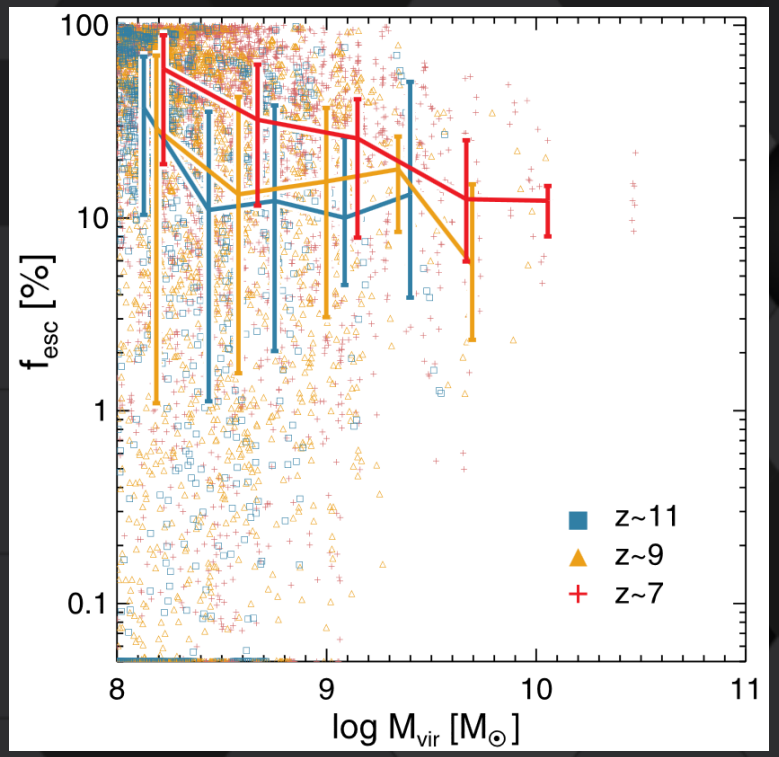
Yajima et al. (2017)

Is f_{esc} A Function of Halo Mass?

- As halo mass decreases gas becomes less dense.
  - ➢ Lower recombination rate so higher escape fraction?



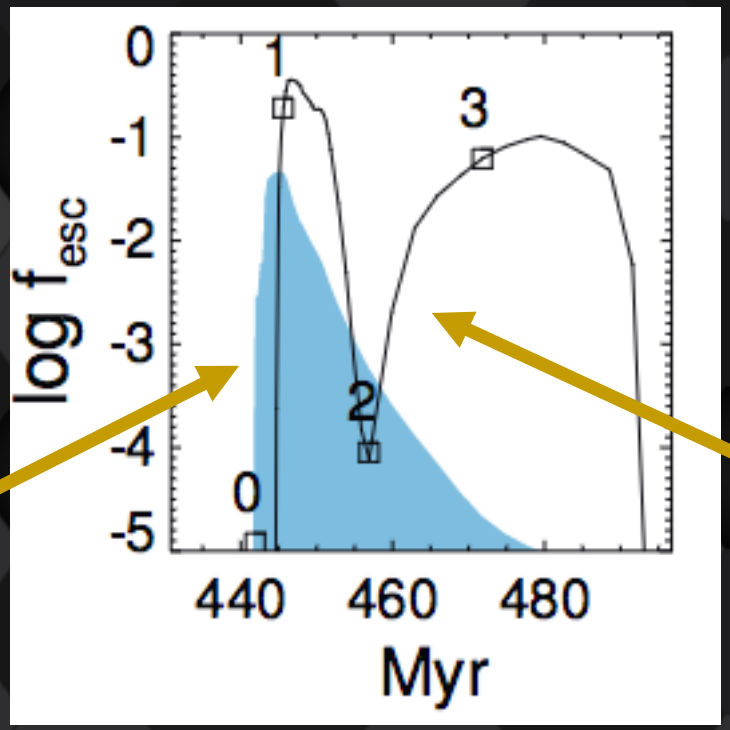
(Ferarra & Loeb, 2013)



(Kimm & Cen, 2014)

Is f_{esc} A Function of the Individual Galaxy?

- Stellar feedback + Supernovae blowouts move gas to outskirts.
  - ➢ Photons can more easily escape into the IGM?



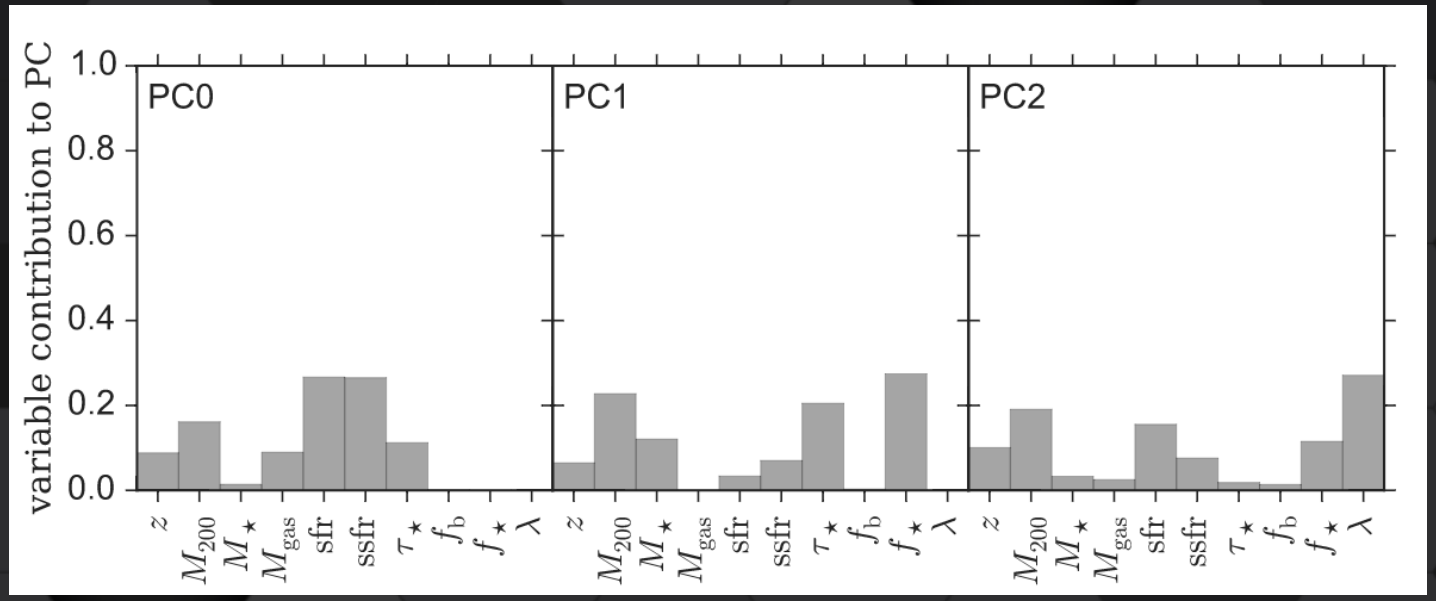
Radiation Feedback

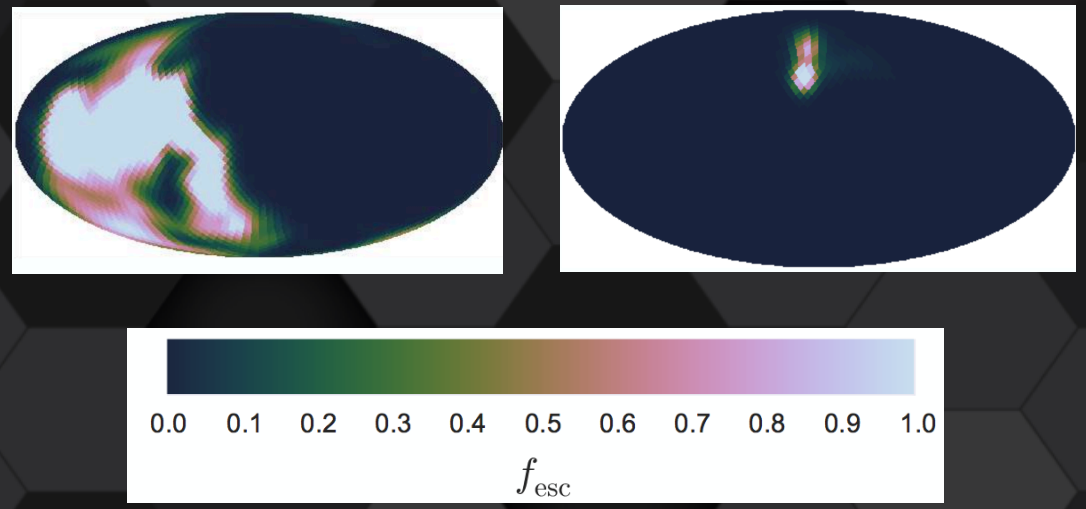
SN Blowout

(Kimm et al., 2016)

f_{esc} Is Complex

- f_{esc} is a complex combination of many parameters. Choosing a constant fraction is a result of this complexity.

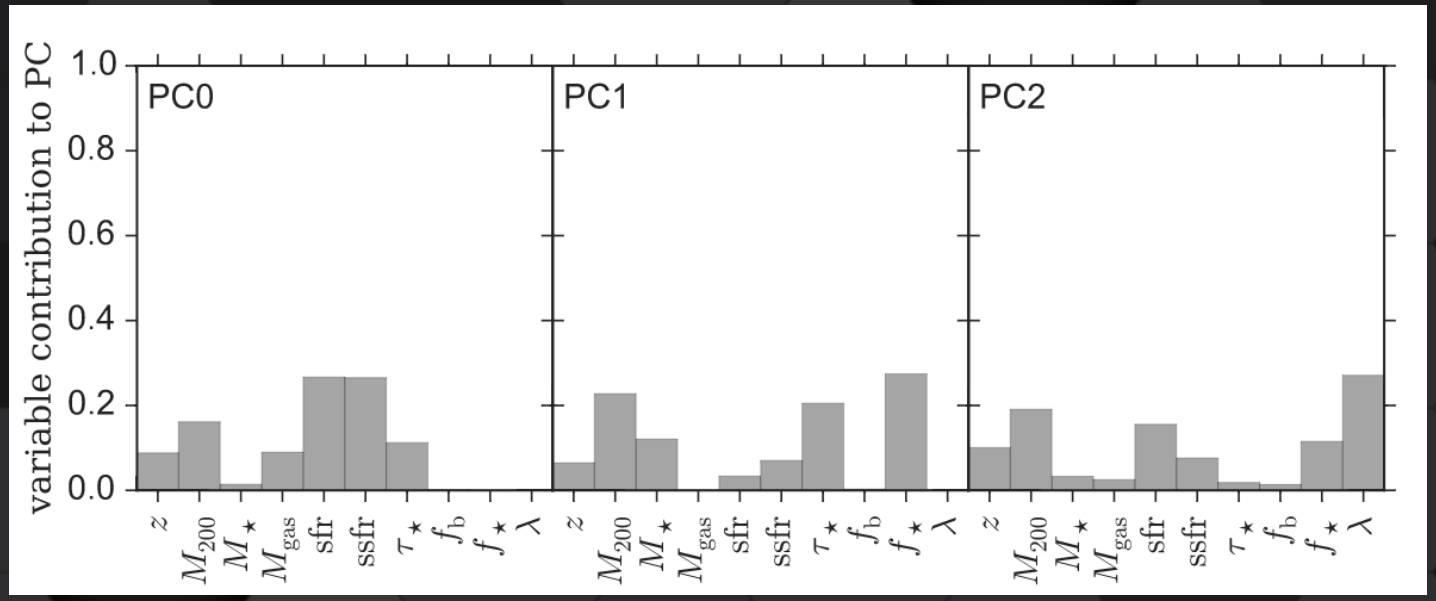


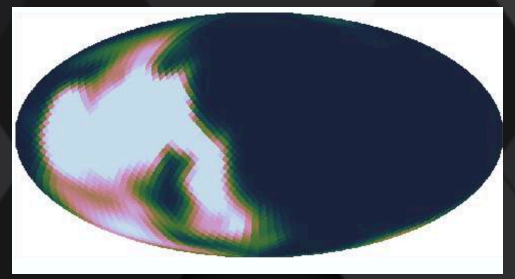


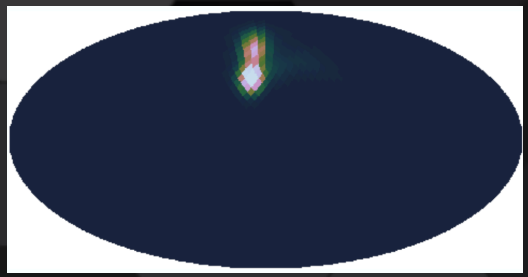
(Paardekooper 2015)

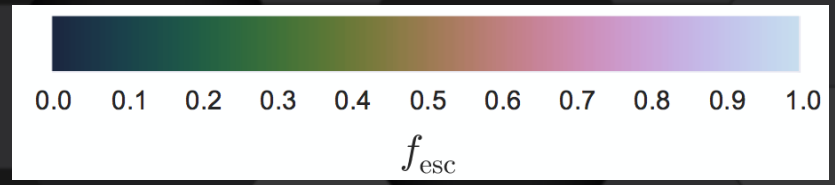
“Couldn’t we just choose any escape fraction?”

- f_{esc} is a complex combination of many parameters. Choosing a constant fraction is a result of this complexity.







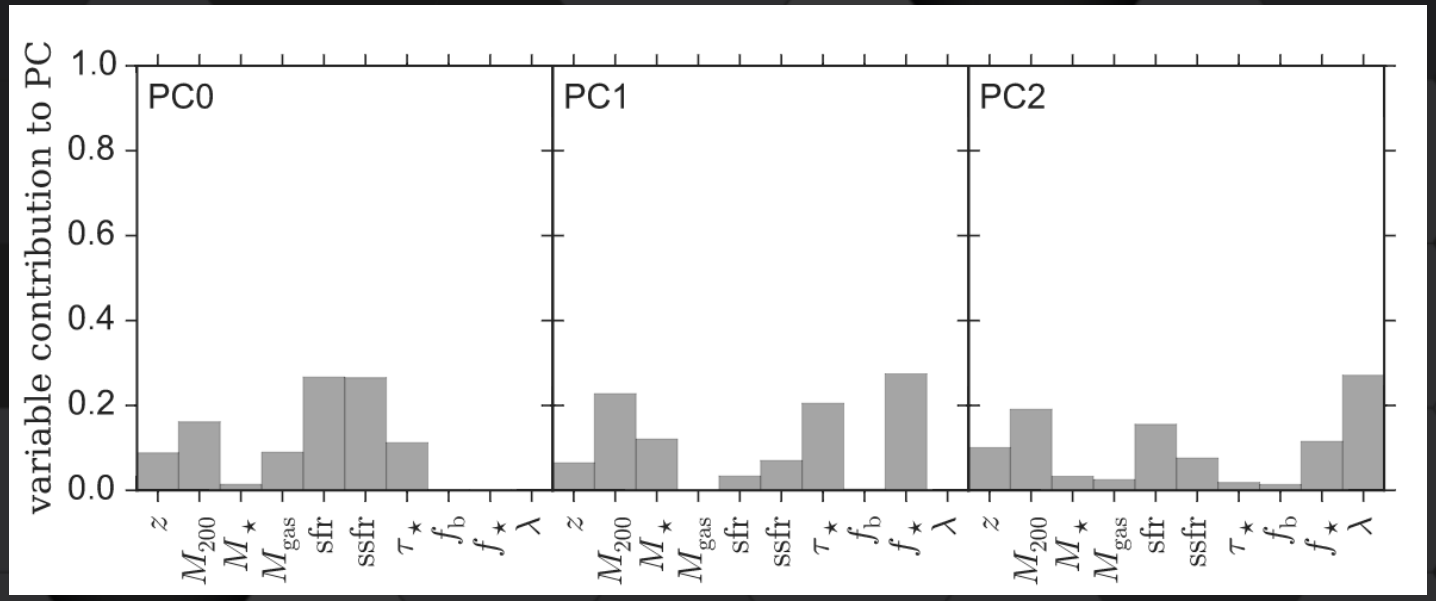


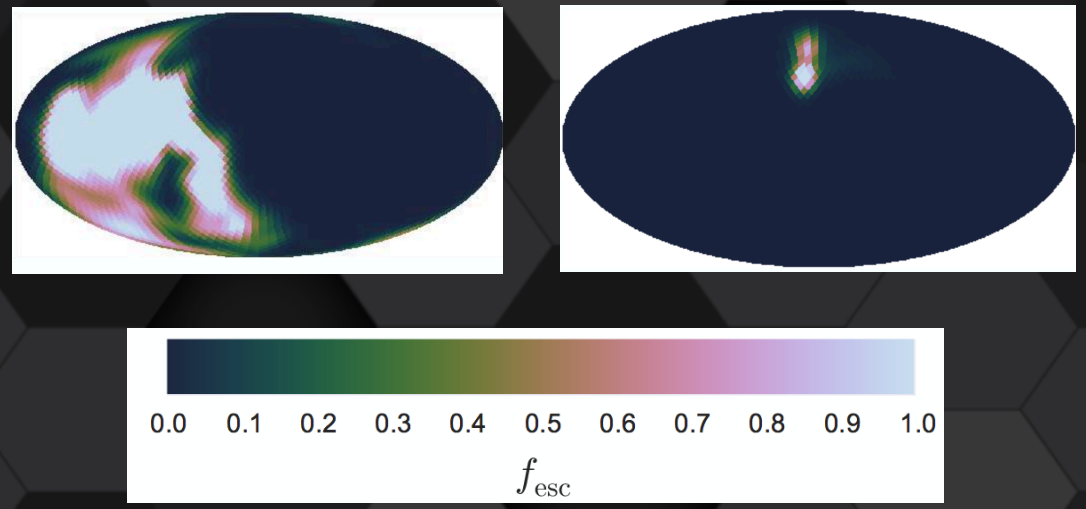
(Paardekooper 2015)

“Couldn’t we just choose any escape fraction?”

- f_{esc} is a complex c… hoosing a constant fraction i…

Well, yeah.





(Paardekooper 2015)

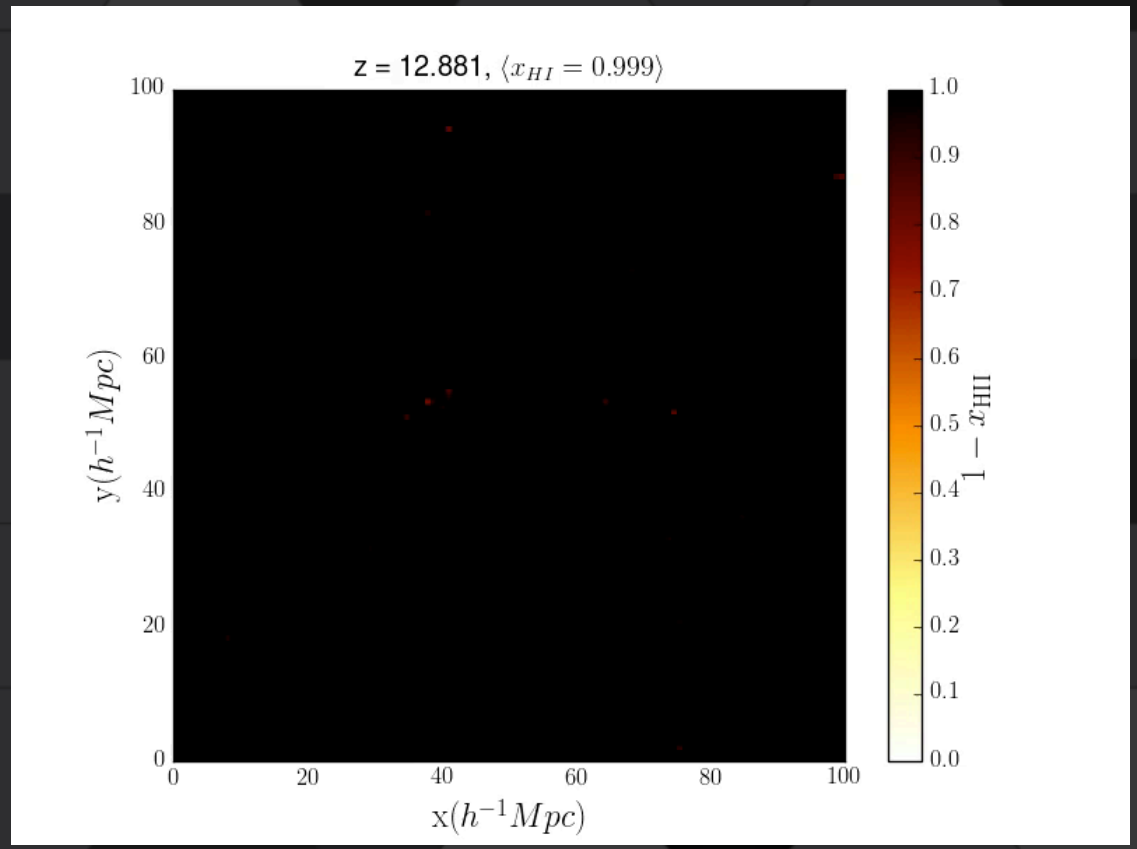
Our Aim

Is it possible to model the Epoch of Reionization using a more physically motivated escape fraction parameterization?

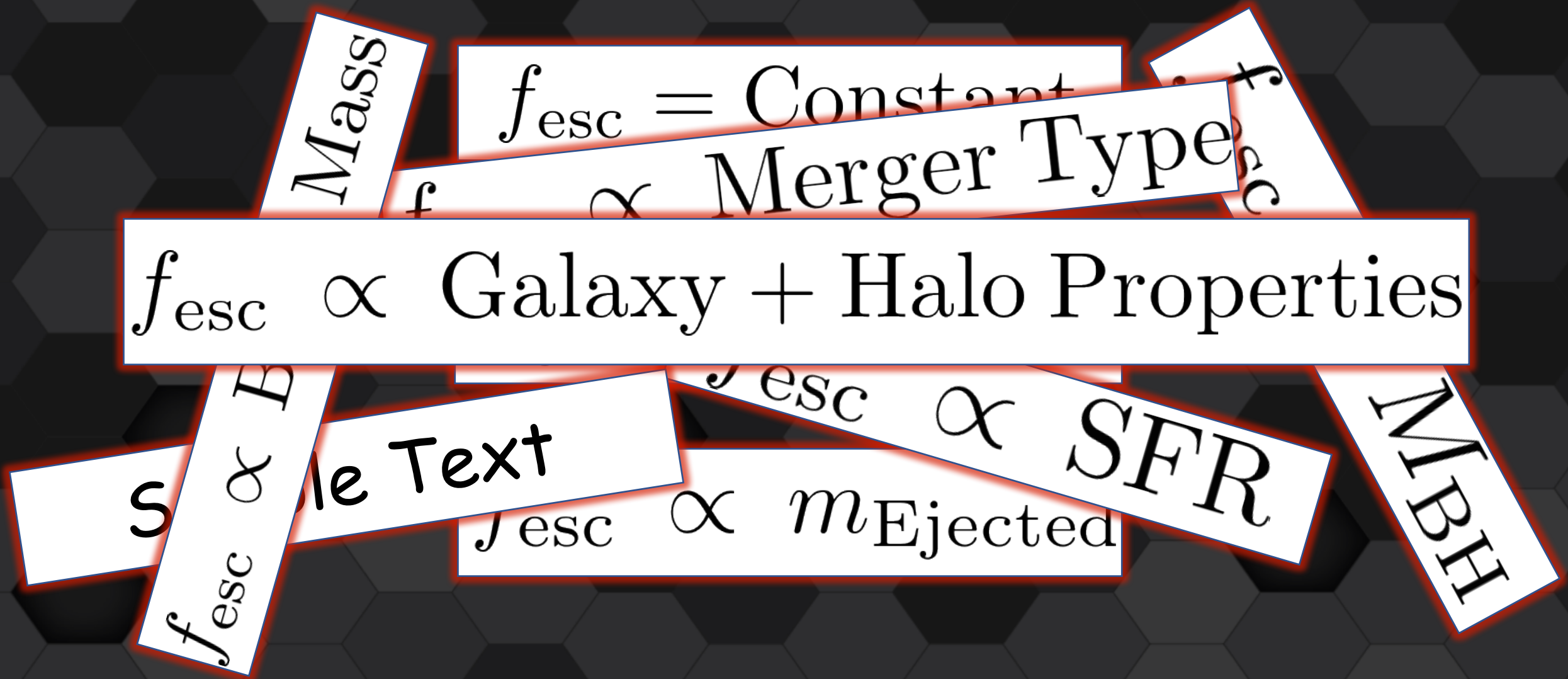
- What are the ‘key’ observations/measurements/results that we have to match?

Galaxy Properties + Photons

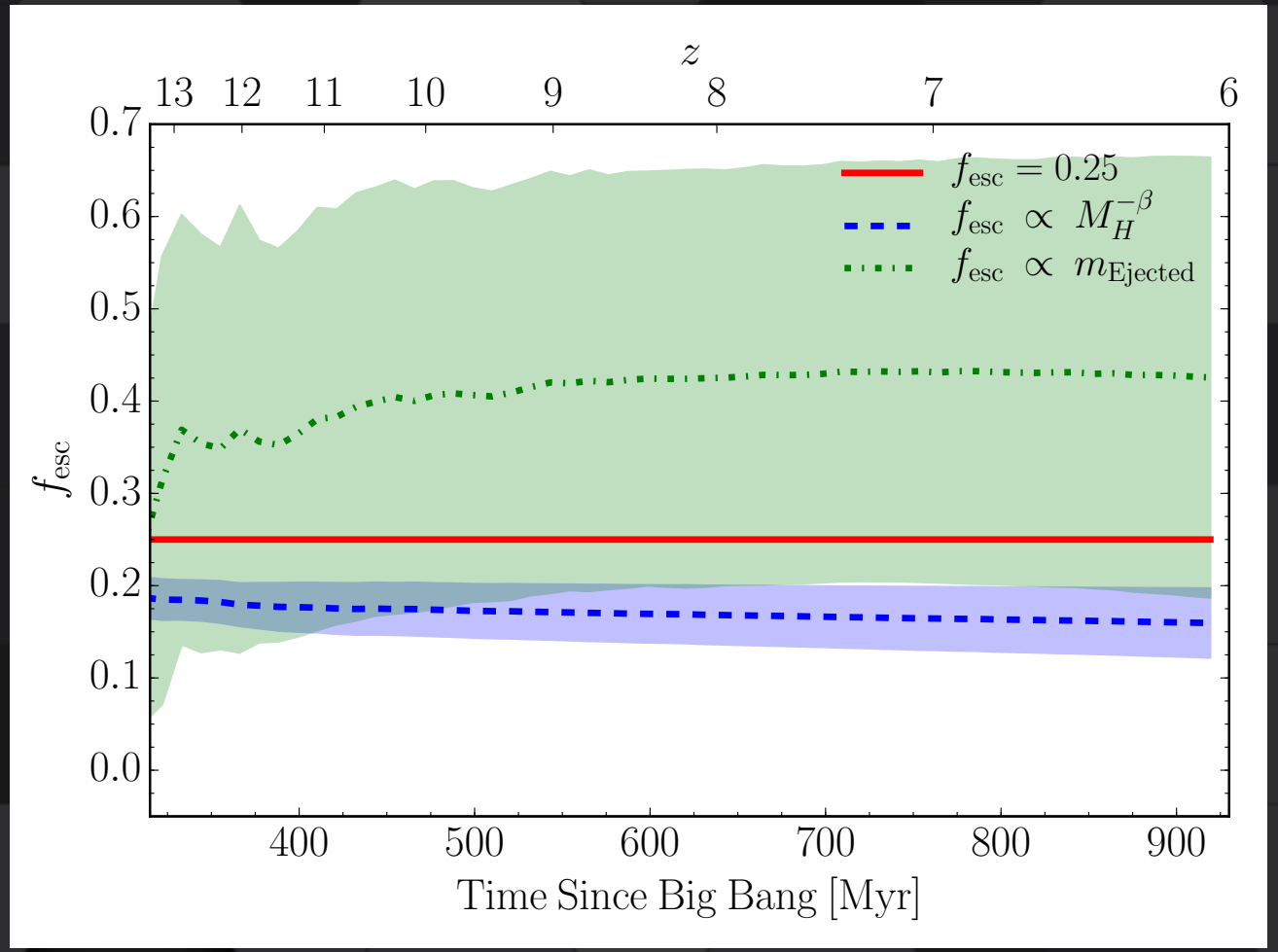
- Use Semi-Analytic Galaxy Evolution model to generate galaxy properties.
- Model reionization in a post-processing step.
- Use SFR to calculate number of ionizing photons.
- Draw spheres and count the number of ionizing photons + neutral H + recombinations.

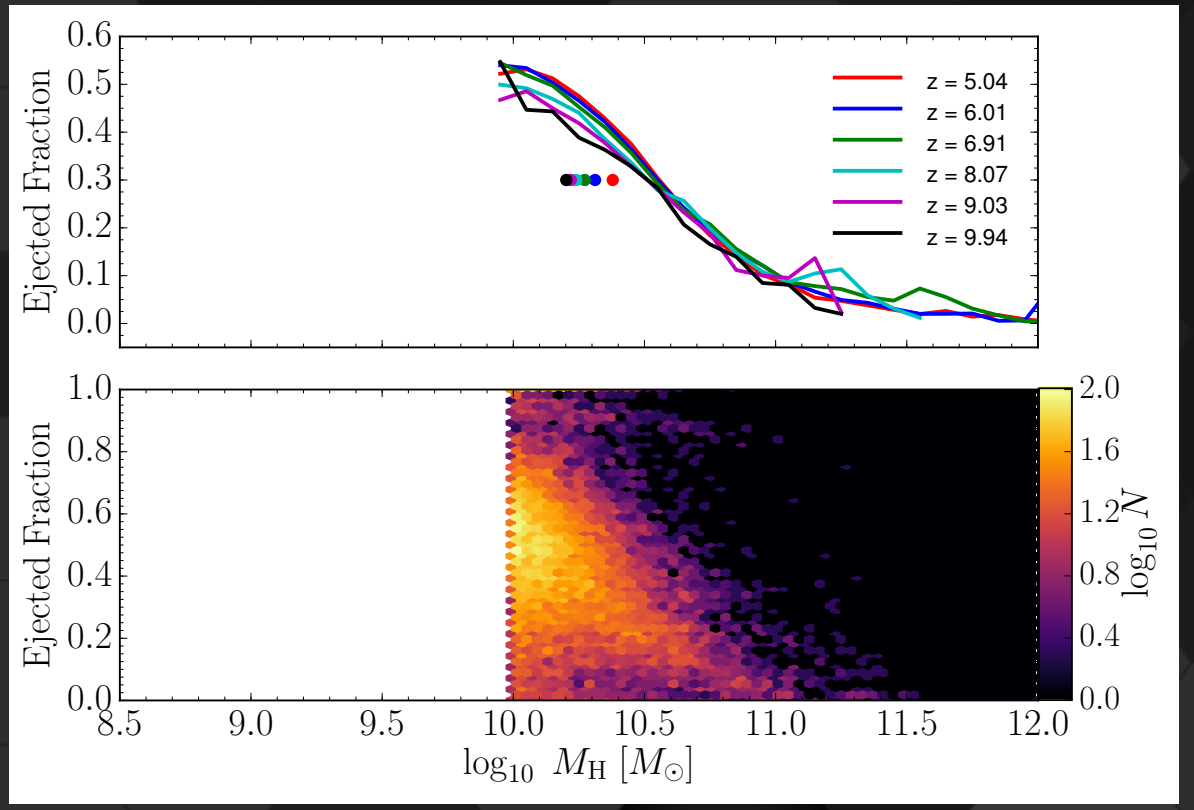


Escape Fraction Parameterization



Preliminary Results





Summary

- f_{esc} is not a constant but is a complex combination of parameters.

- Using galaxies evolved from a Semi-Analytic Model, we attempt to implement a more physical prescription for f_{esc}.

- Our key assumption is that f_{esc} depends strongly on the density of the galaxy gas.
  - Attempt to capture this by using halo mass and ejected fraction.

- Important consequence is that since these parameters evolve, the escape fraction will evolve as well.