



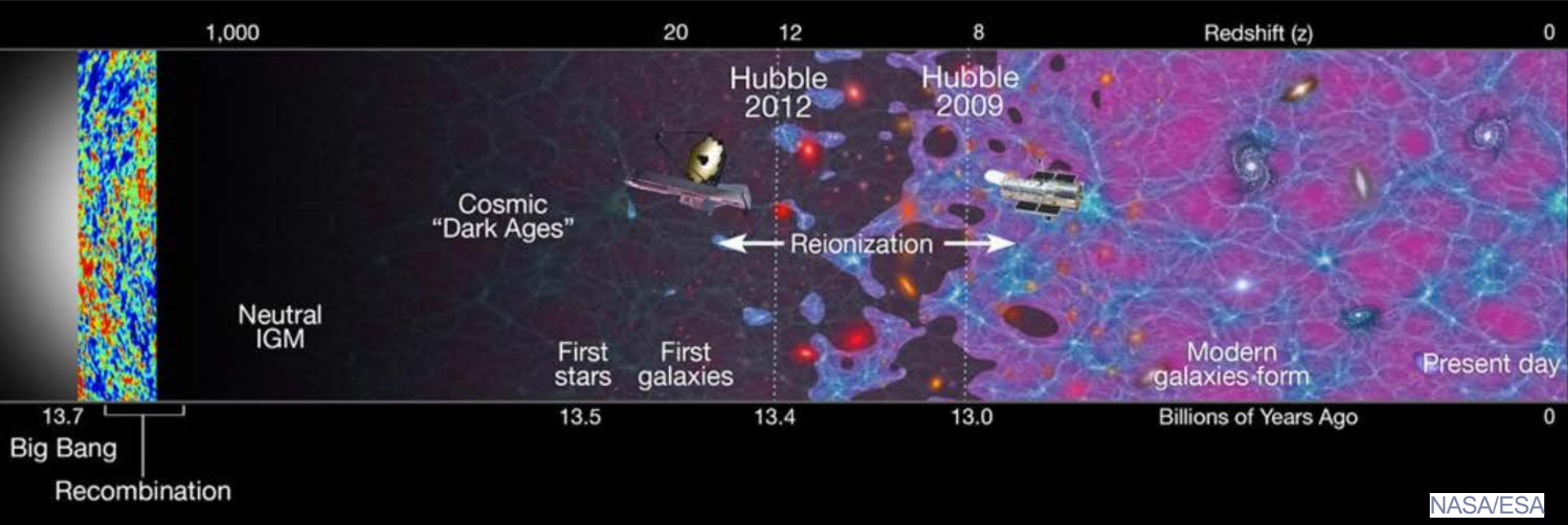
I use Blue Waters to

Model Galaxy Formation in Quasar Proximity Zones during Reionization

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UChicago

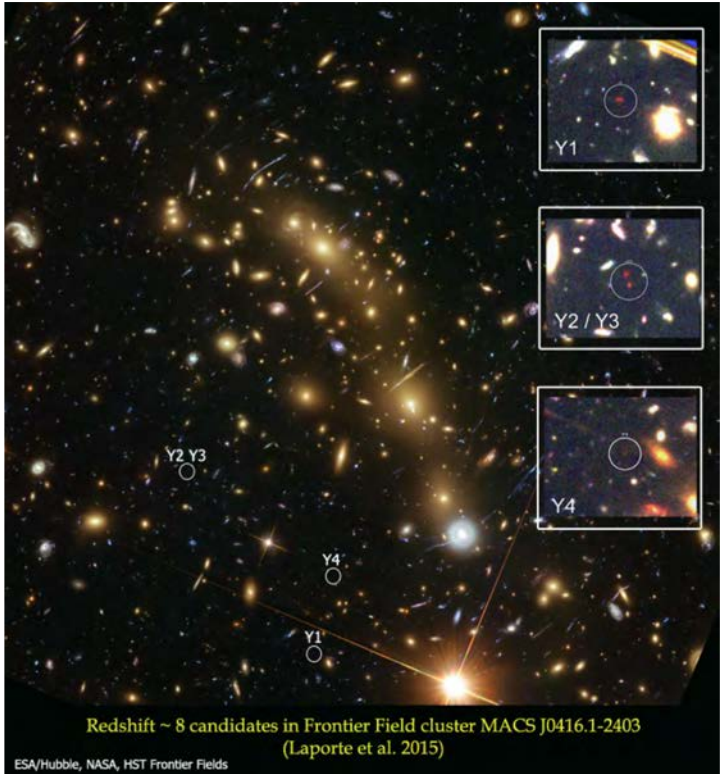
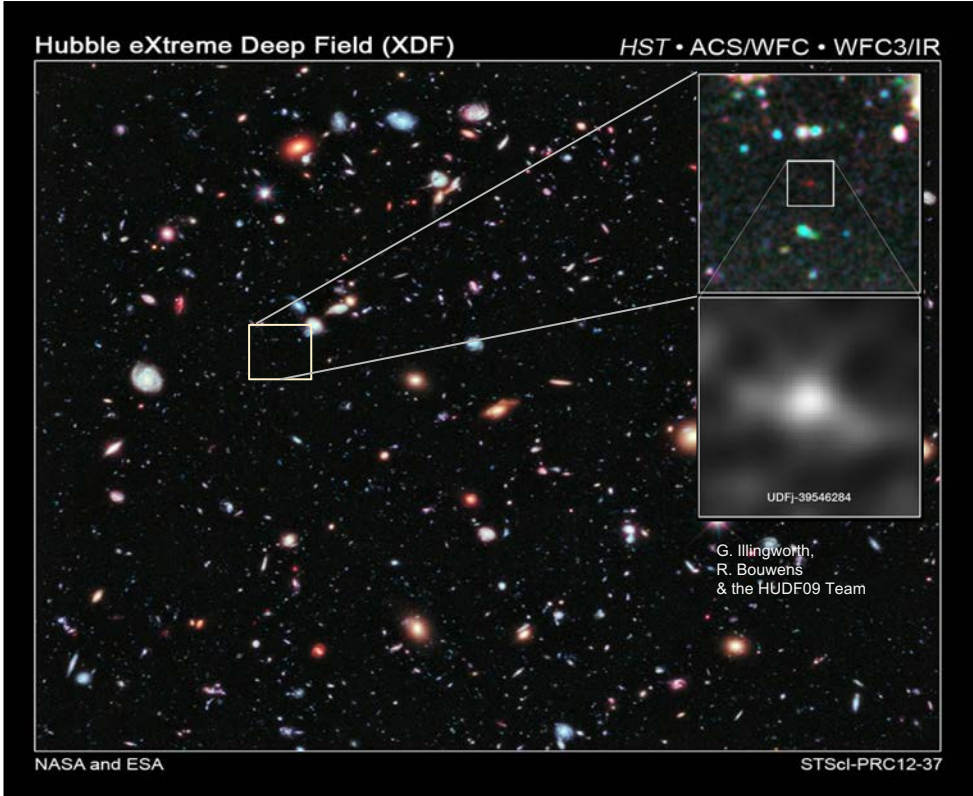
Science Team: Faintest Galaxies in the JWST Era PI: Nick Gnedin

Reionization



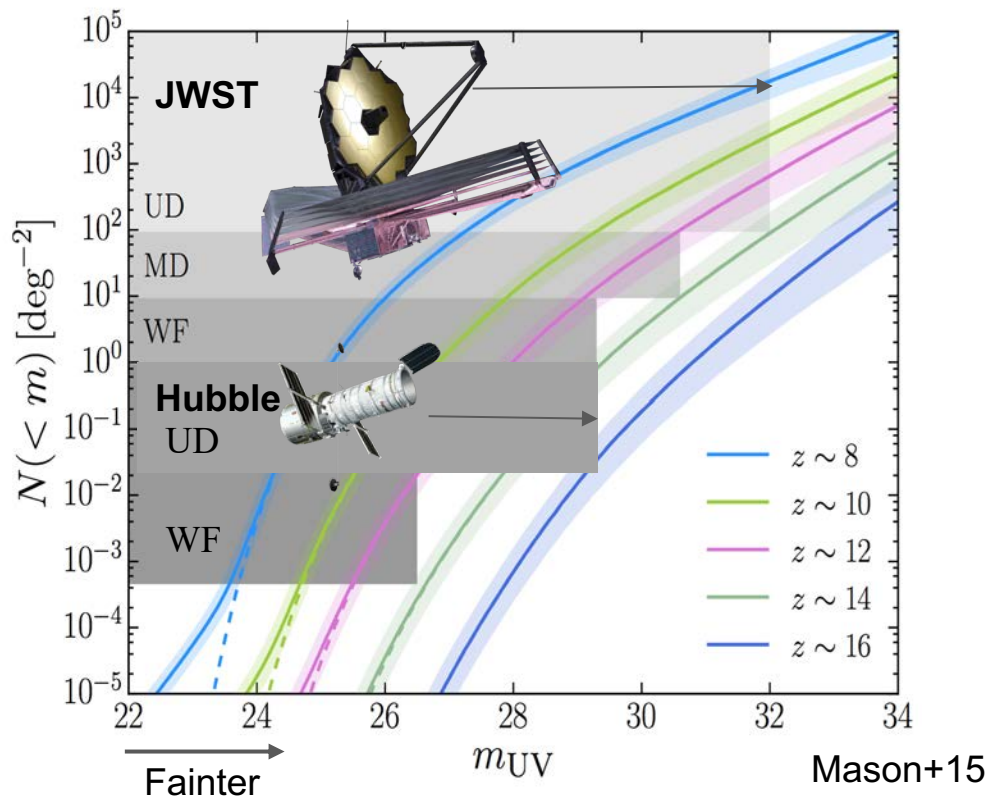
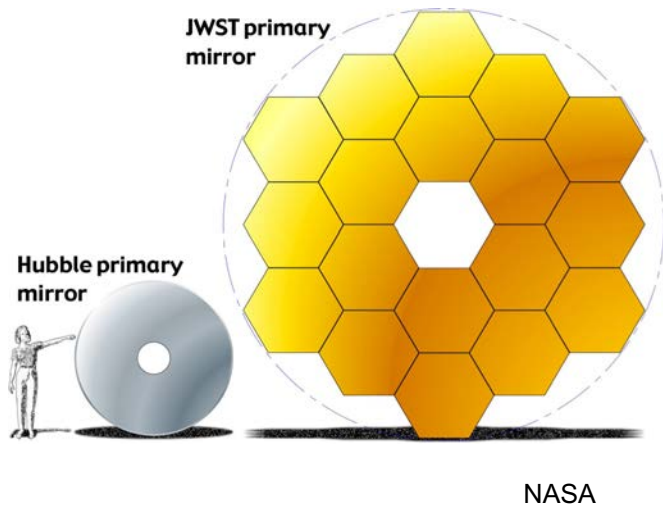
Big Problem: What Drives Reionization?

Galaxies in Reionization



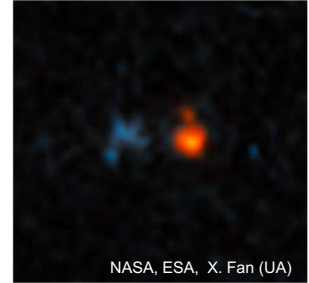
New Flagship JWST: Probing Fainter Galaxies

Studying reionization is the primary science goal of JWST.



Quasars in Cosmic Reionization

Quasars are ultra luminous Active Galactic Nuclei



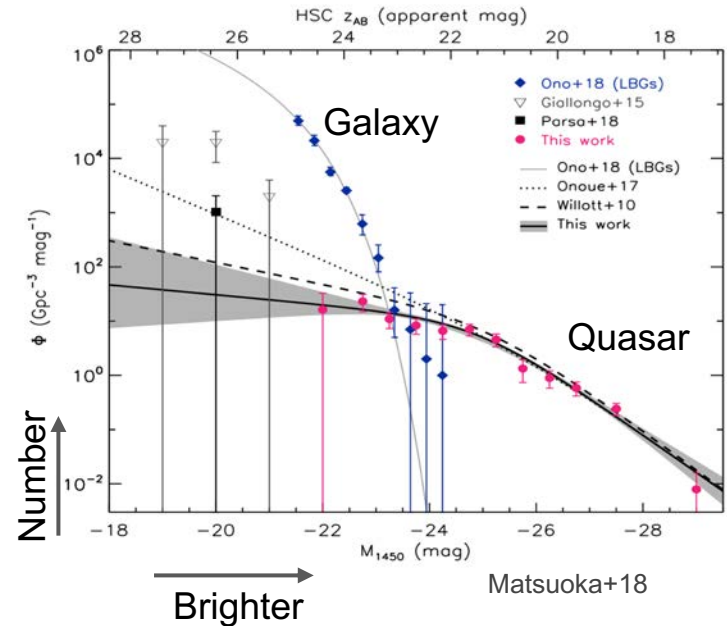
What drives reionization?

Galaxies:	Quasars:
Faint	Bright
Many	Few

Mysteries of the First Quasars:

Life time? ---> photons per quasar

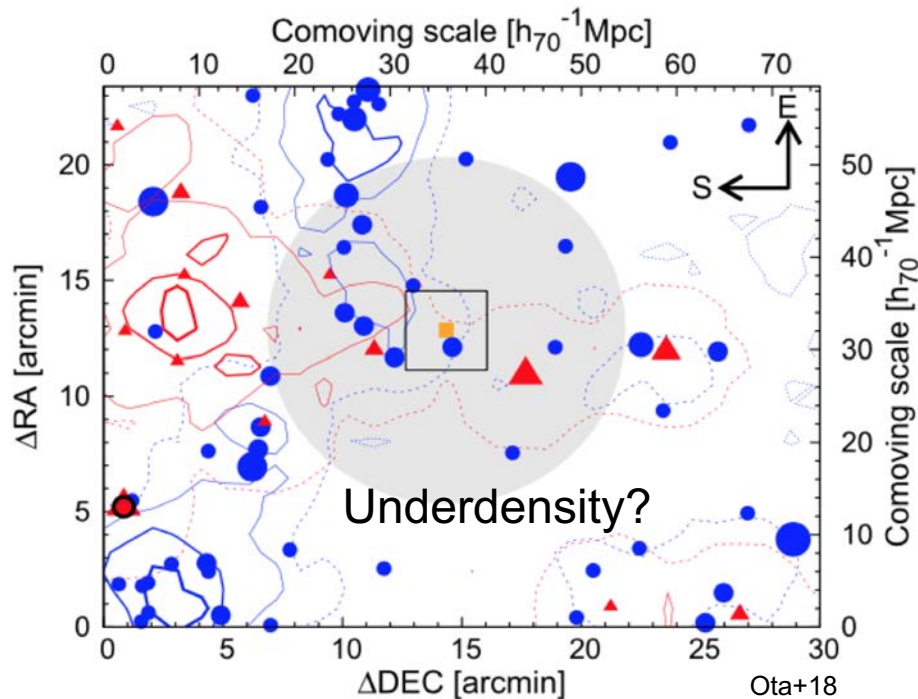
Host halo? ---> total number of quasars



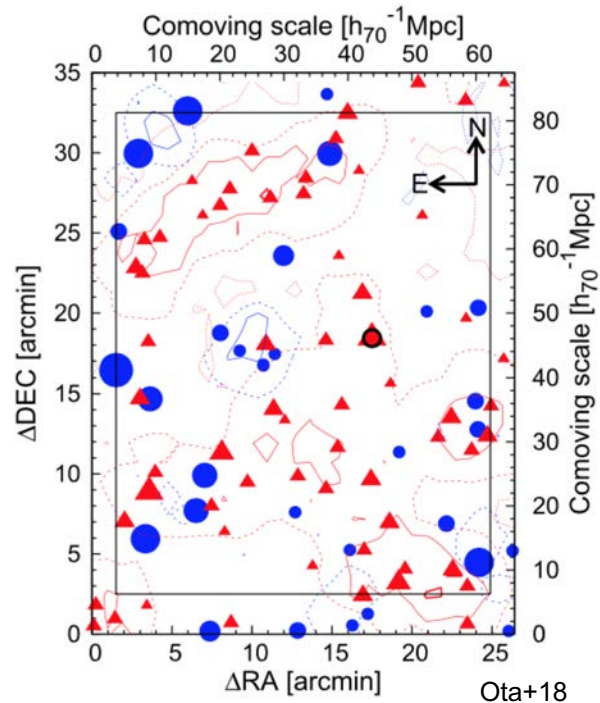
Current Observation

Need to study quasar-galaxy coevolution!

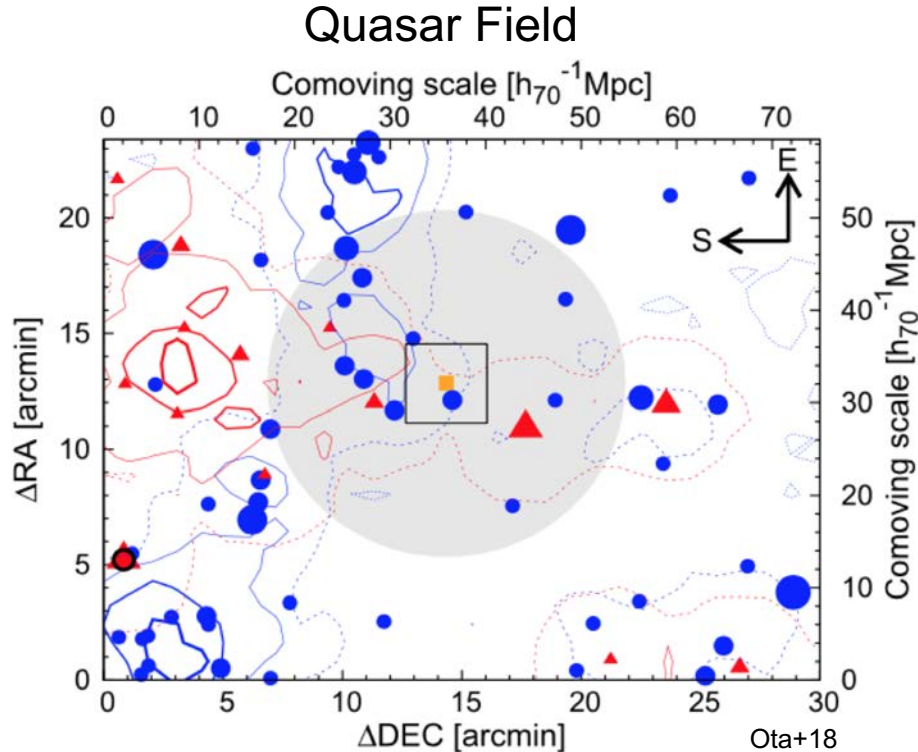
Quasar Field



Random Field



Computational Challenge



Large Dynamical Range:

Quasar proximity zone: ~ 30 Mpc

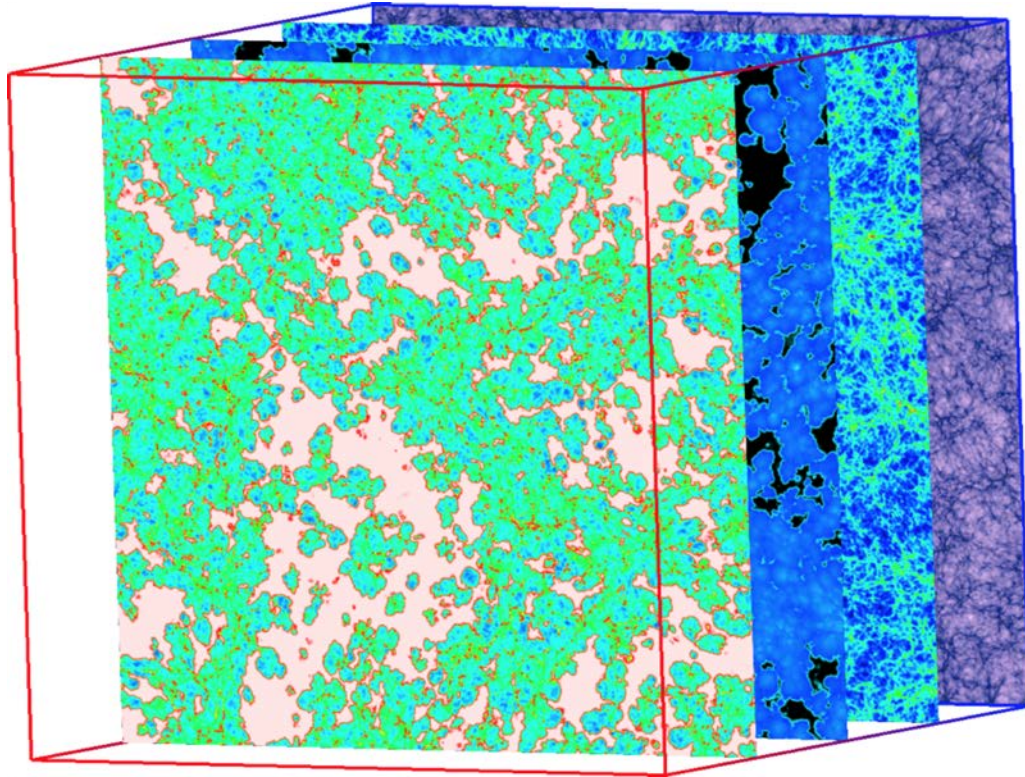
To resolve galaxy: ~ 100 pc

Use ART Code
(Adaptive Refinement Tree)

1024 root grids

7 levels of refinement

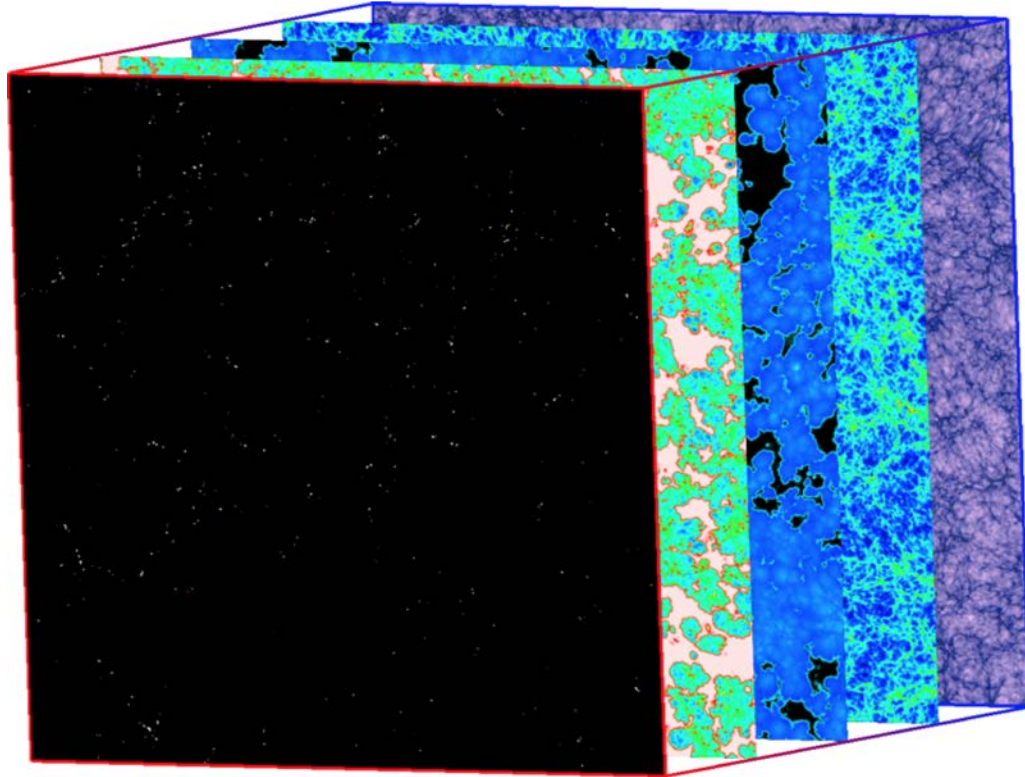
Computational Challenge



Different Physical Processes:

- Dark matter
- Gas dynamics
- Atomic processes
- Radiative transfer

Computational Challenge



Different Physical Processes:

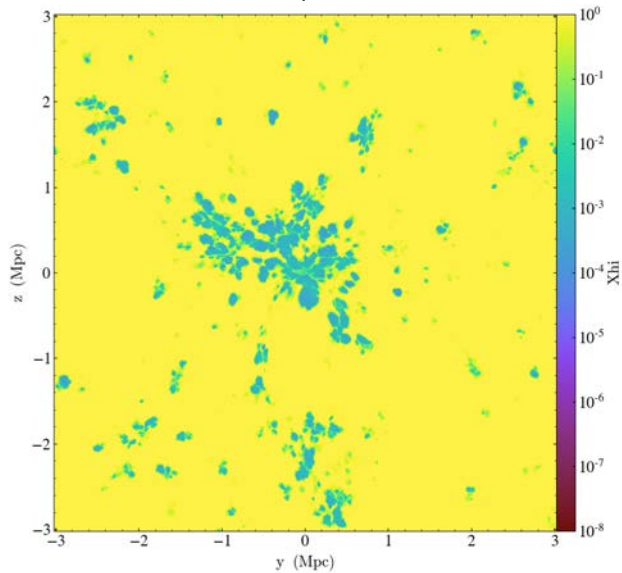
- Dark matter
- Gas dynamics
- Atomic processes
- Radiative transfer
- Star formation & stellar feedback

>20,000 node-hours per simulation
~ 1TB per snapshot

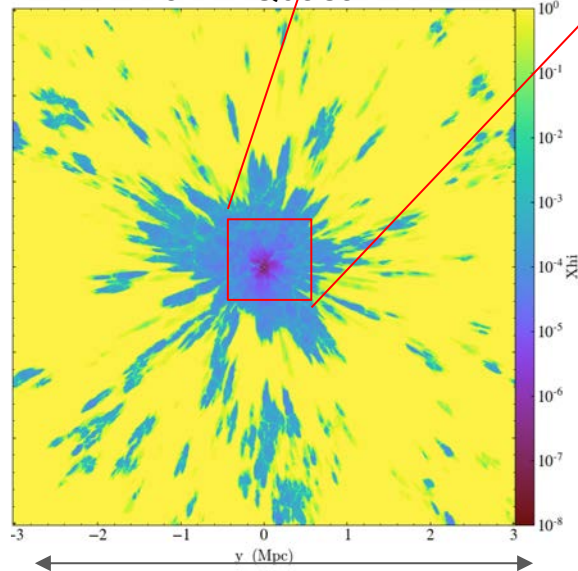
We Need Bluewaters!

3D Simulation

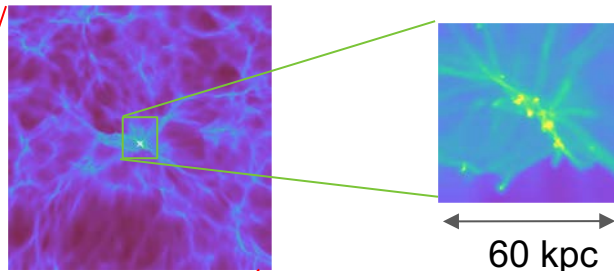
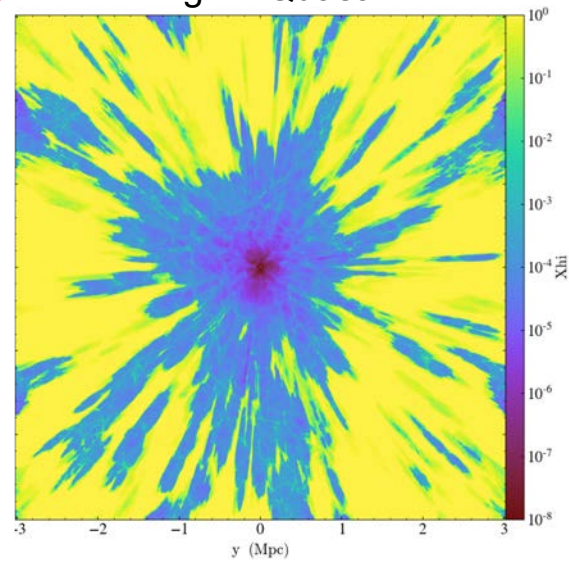
No Quasar



Low L Quasar

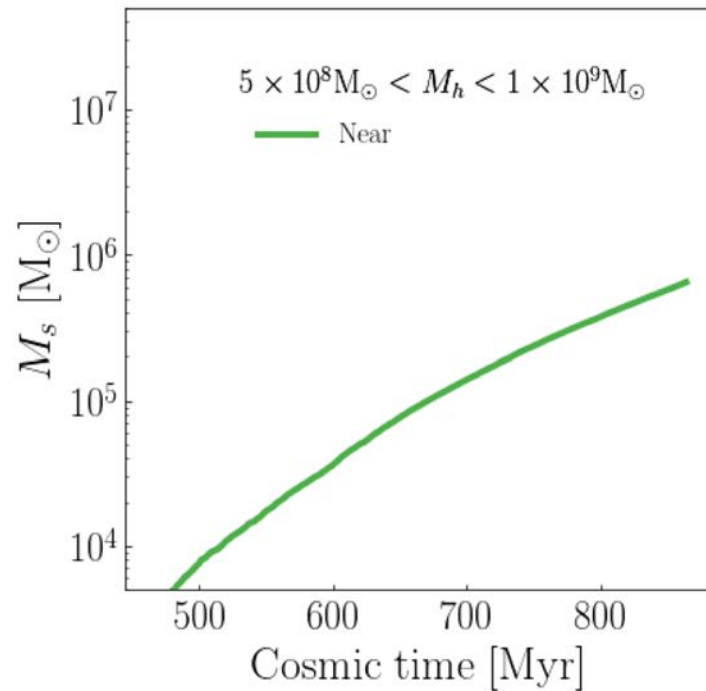
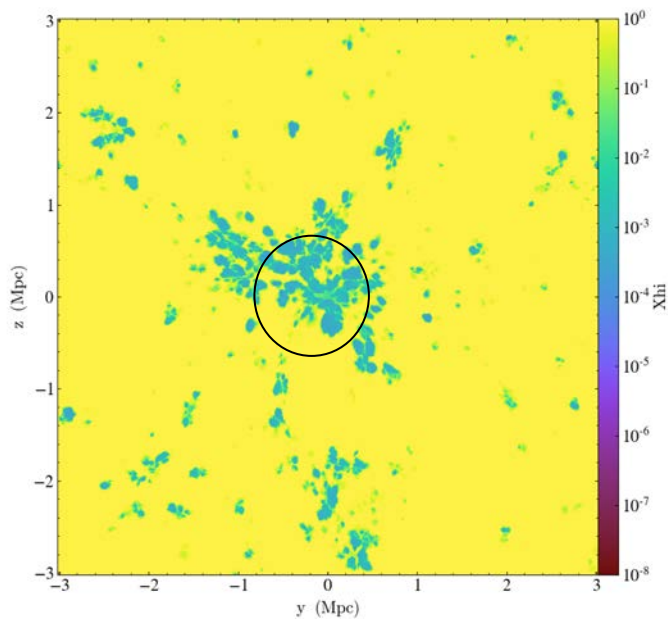


High L Quasar

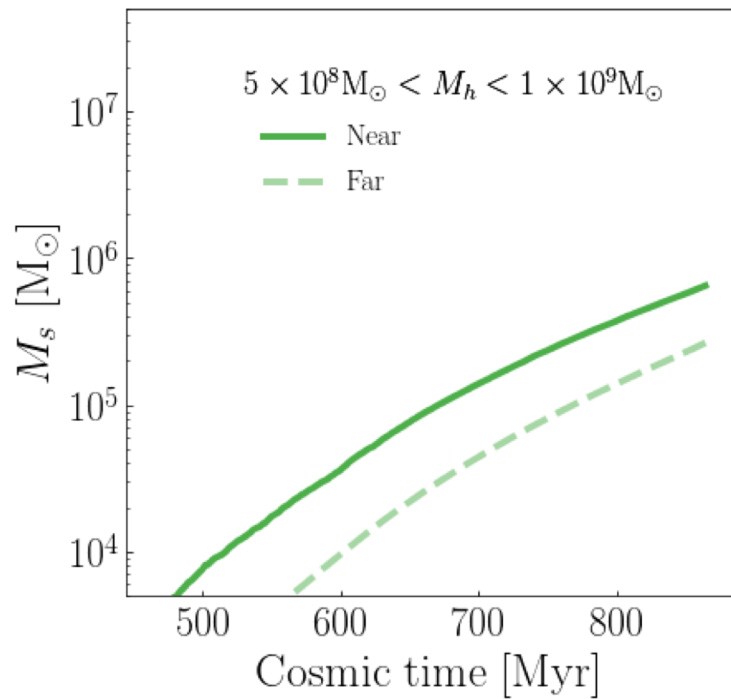
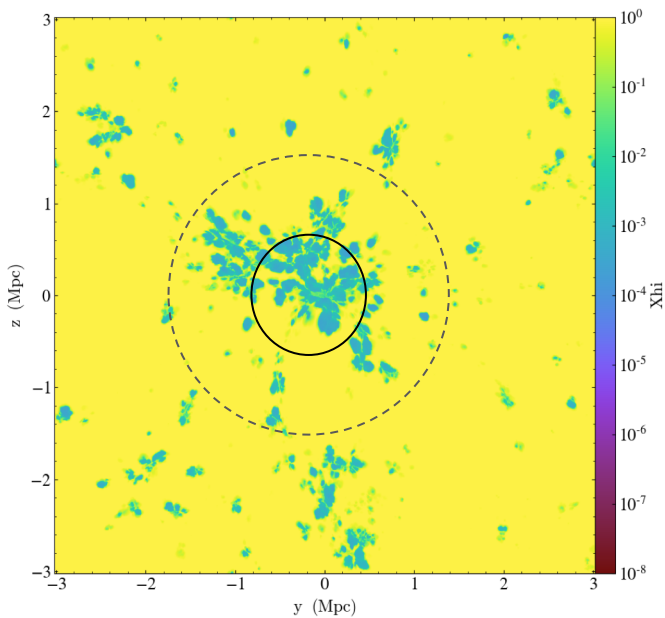


60 cMpc

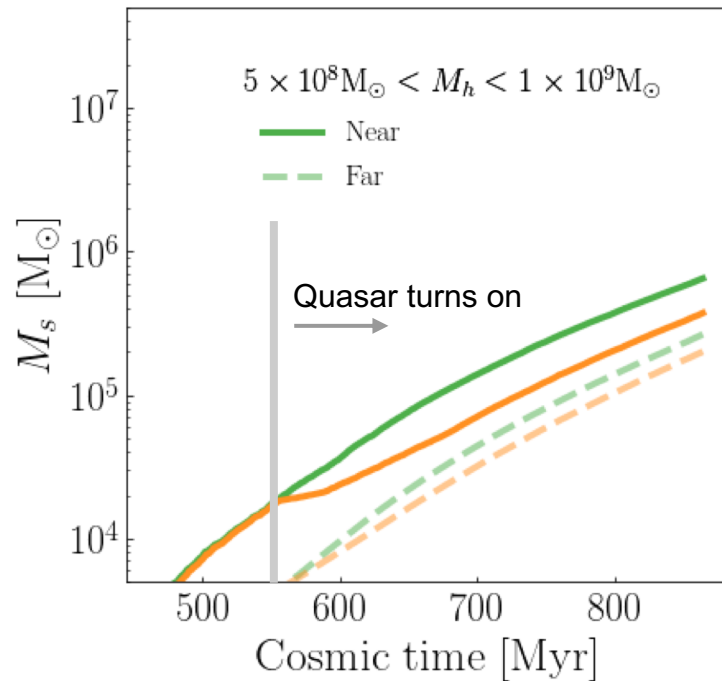
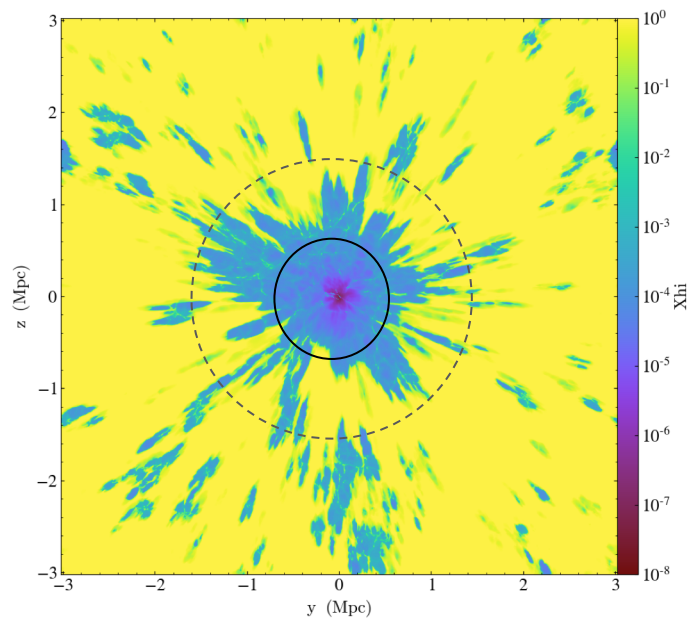
Star Formation History without Quasar



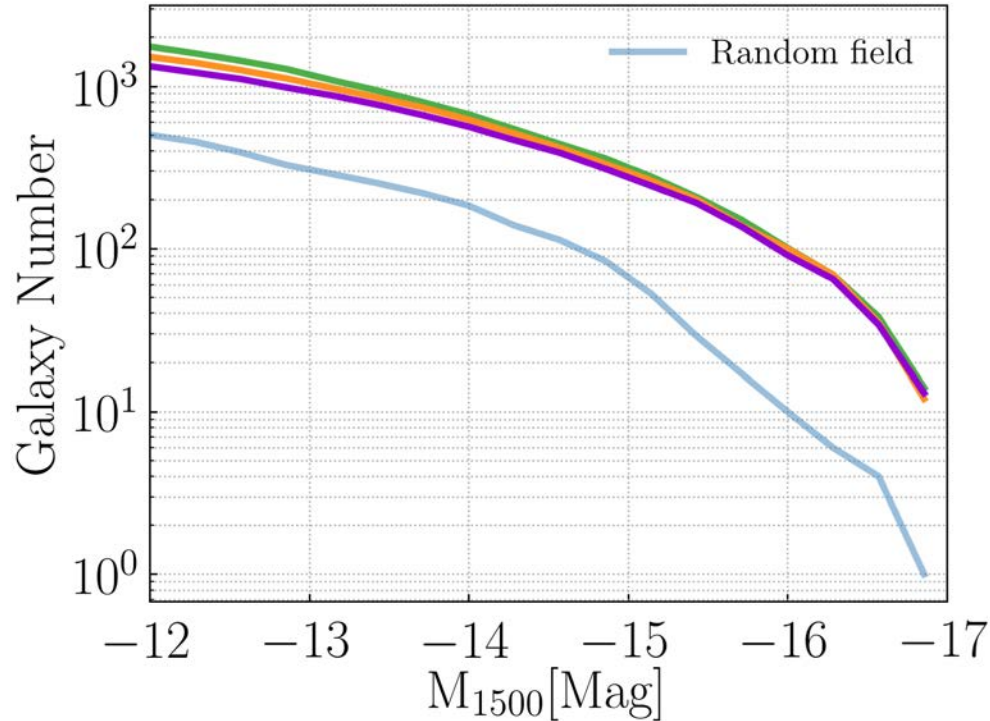
Stars Form Earlier in Overdense Region



Quasar Radiation Suppresses Star Formation



Imprints on Luminosity Function



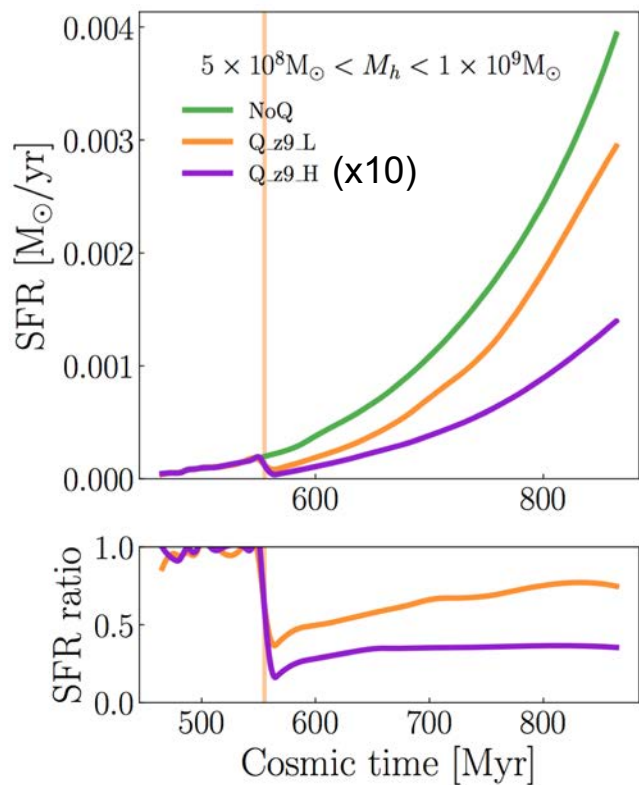
Quasar radiation does not affect the bright end

Quasar radiation suppresses the faint end by $\lesssim 50\%$,
Much smaller than the field-to-field variation

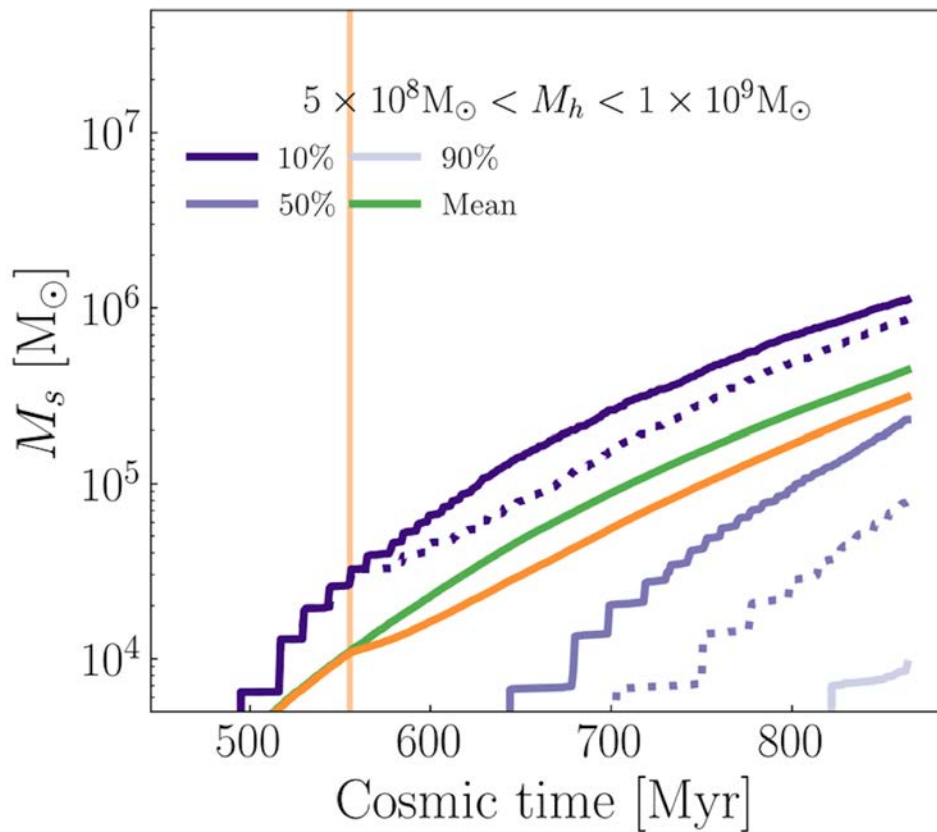
Summary

- Future flagship JWST will be observing fainter galaxies in reionization
- Mysteries of first galaxies, first quasars and their coevolution are waiting to be solved
- 3D cosmological simulations help us understand galaxy formation in quasar proximity zones
 - Star formation history varies with distance to quasar
 - Quasar radiation suppresses star formation in low mass halos
 - Quasar radiation leaves a small imprint on the galaxy luminosity function
- Lots of fun ahead

Non-linear Luminosity Dependence

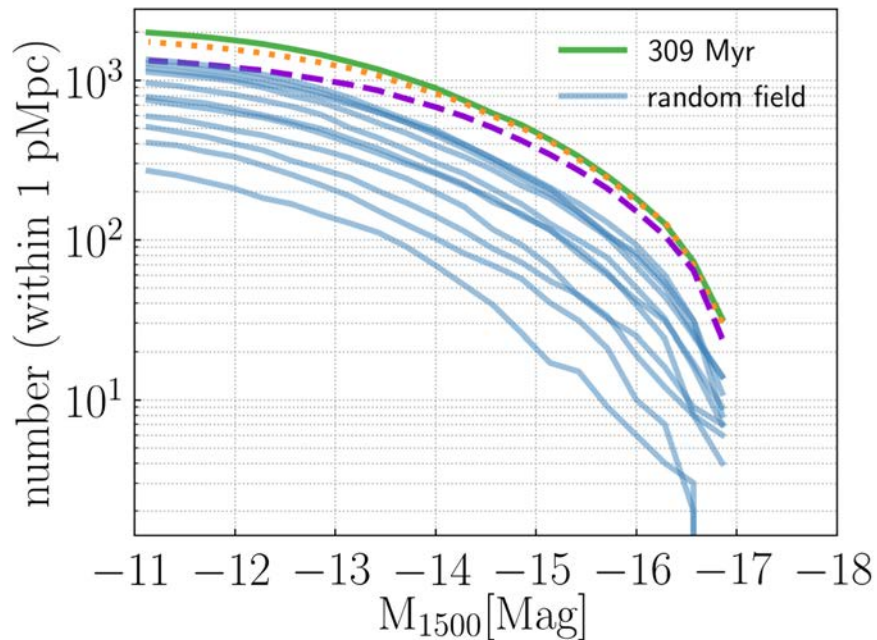
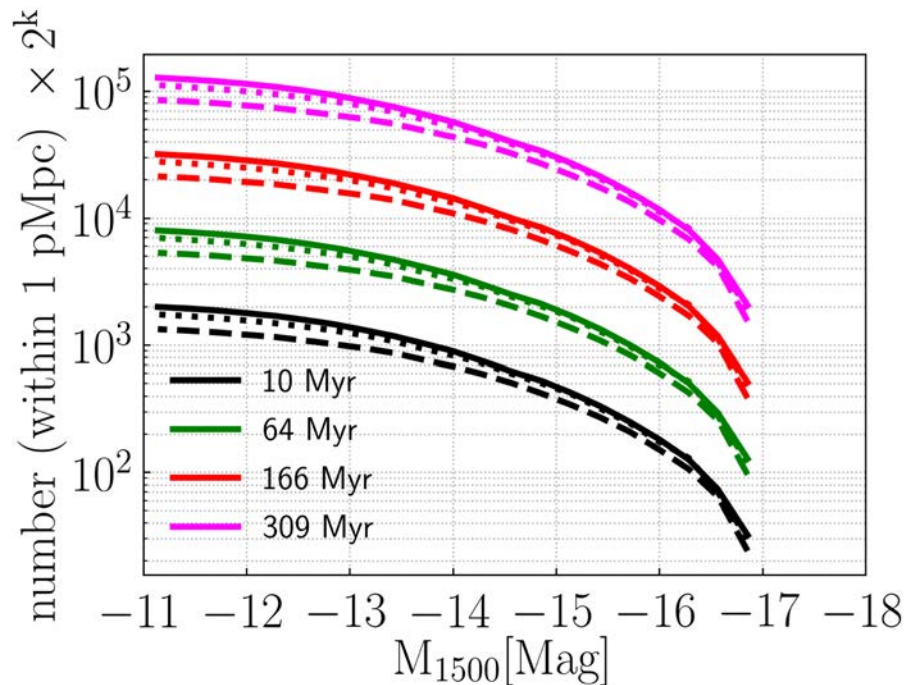


Quasar Impact



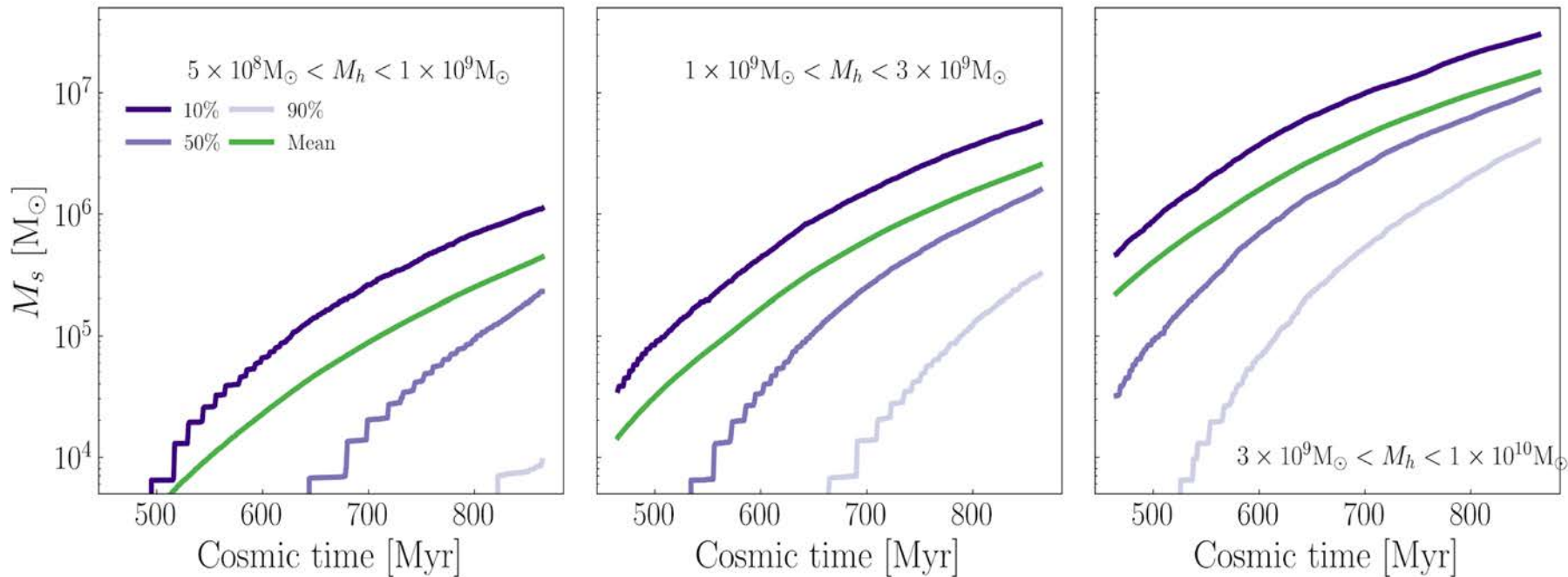
Immediate Suppression
in Low Stellar Mass
Halos

Synthetic Observable: Luminosity Function

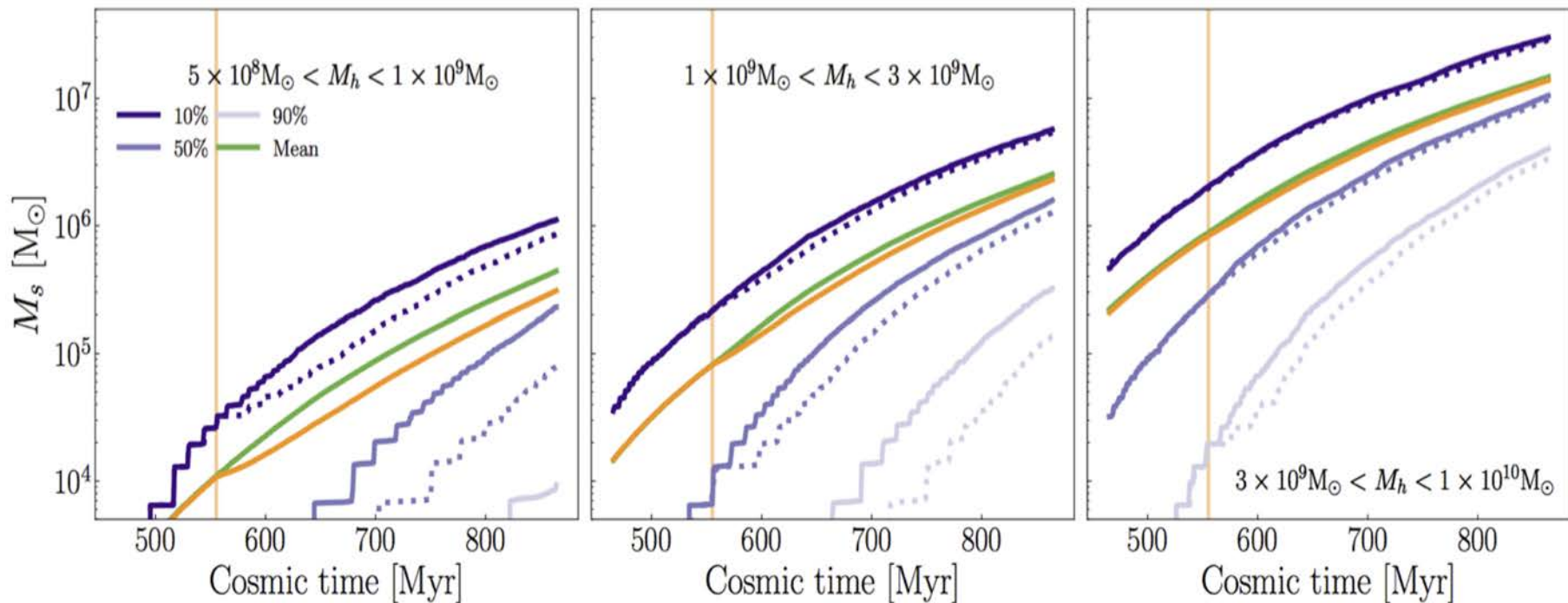


<80% suppression on the fainter end, smaller than the field-to-field variation

Intrinsic Variation in Star Formation Histories



Immediate Suppression in Low Ms Halos



Non-linear Luminosity Dependence

