Pop III Supernova Feedback on Formation of the First Galaxies

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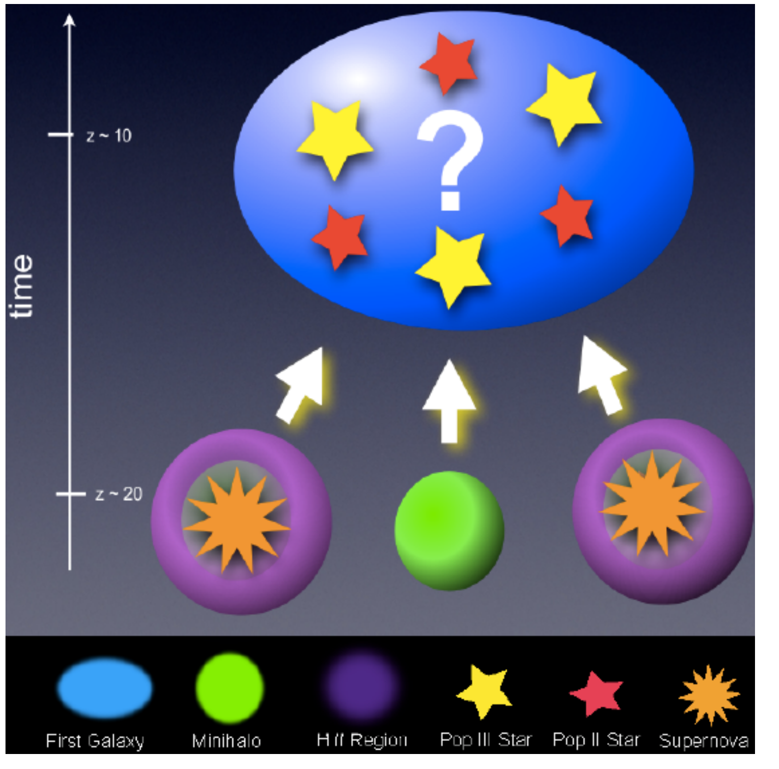
Motivation

- To understand the effect of Pop III supernovae on the star formation history of first galaxies

Numerical Approaches

- AMR code Enzo
- Spherical Collapse
- Dark matter with NFW profile + self-gravity of gas
- Chemical cooling (primordial + metal)
- Star formation with stellar thermal feedback



Credit: Ken Chen

Initial Condition

- Isolated galaxy in a 10 kpc box
- Uniform density for background gas with supernova remnants (SNR) reside in the galaxy
- Velocity turbulence added to the background gas
- Drift velocity added to the supernova remnants
- Dark matter mass ~ 1e9 M_sun with gas mass ~ 1e8 M_sun
- Dark matter halo core 1 kpc

Remnants from 3 types of supernova

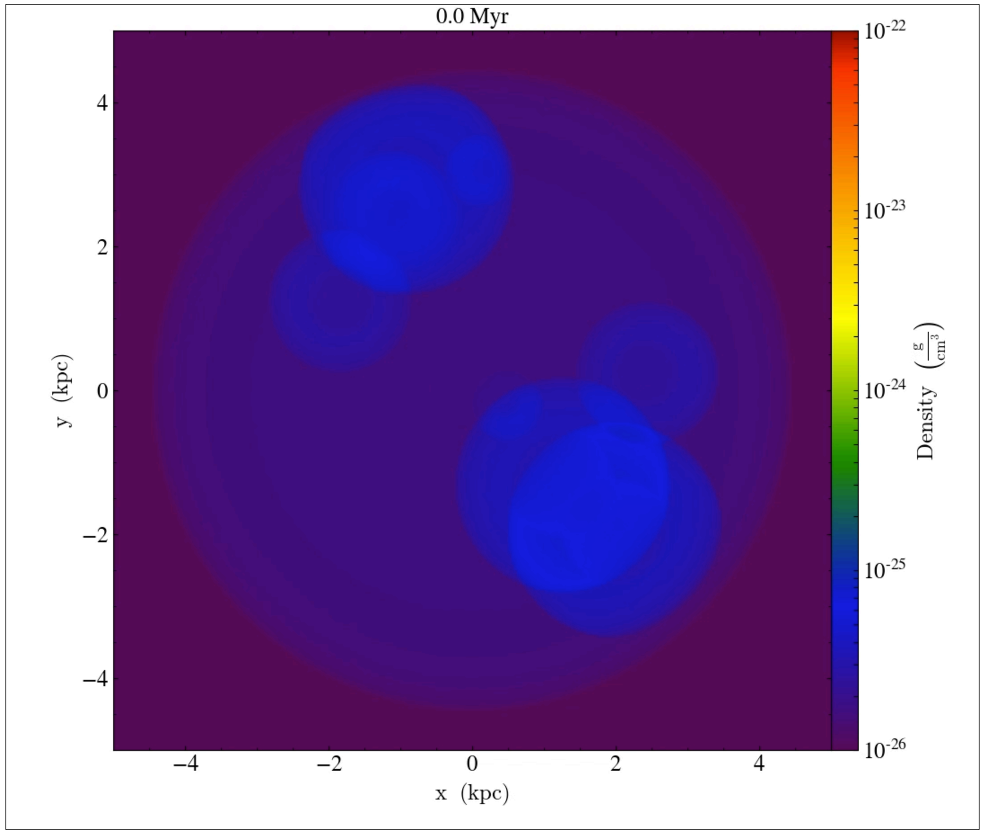
- Core collapse supernovae (ccsne):
  radius of 500 pc, lower metallicity and density
- Hypernovae (hne):
  radius of 1 kpc, medium metallicity and density
- Pair instability supernovae (pisne):
  radius of 1.5 kpc, high metalliciity and density

Models

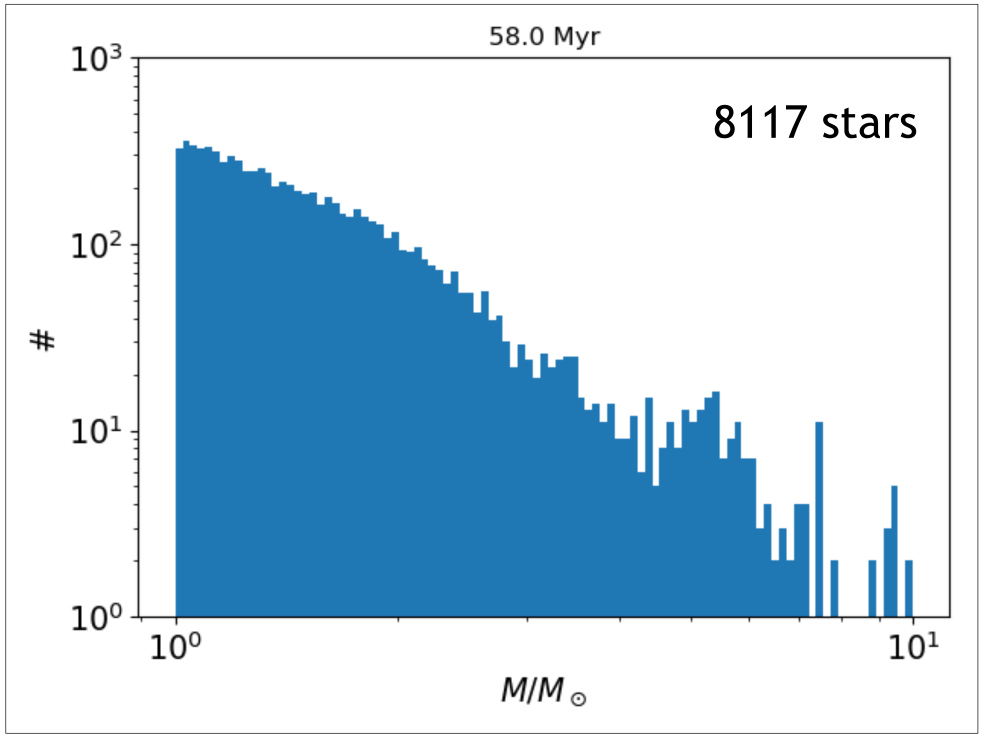
- A1: equal portion of 3 types of SNR (Flat PopIII IMF)
- A2: mostly from ccsne, only 2 from hne (Salpeter's IMF)
- A3: mostly from pisne, only 2 from ccsne (Cosmological simulation by Shingo Hirano et al. 2015)

Simulation A1 (flat IMF)

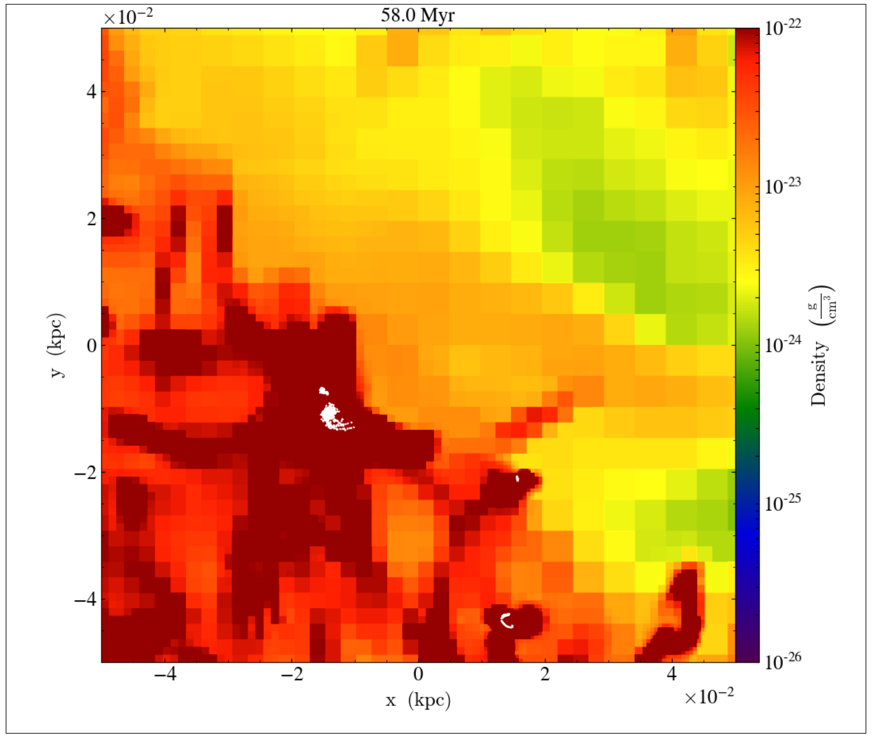
Density



Stellar Mass Distribution

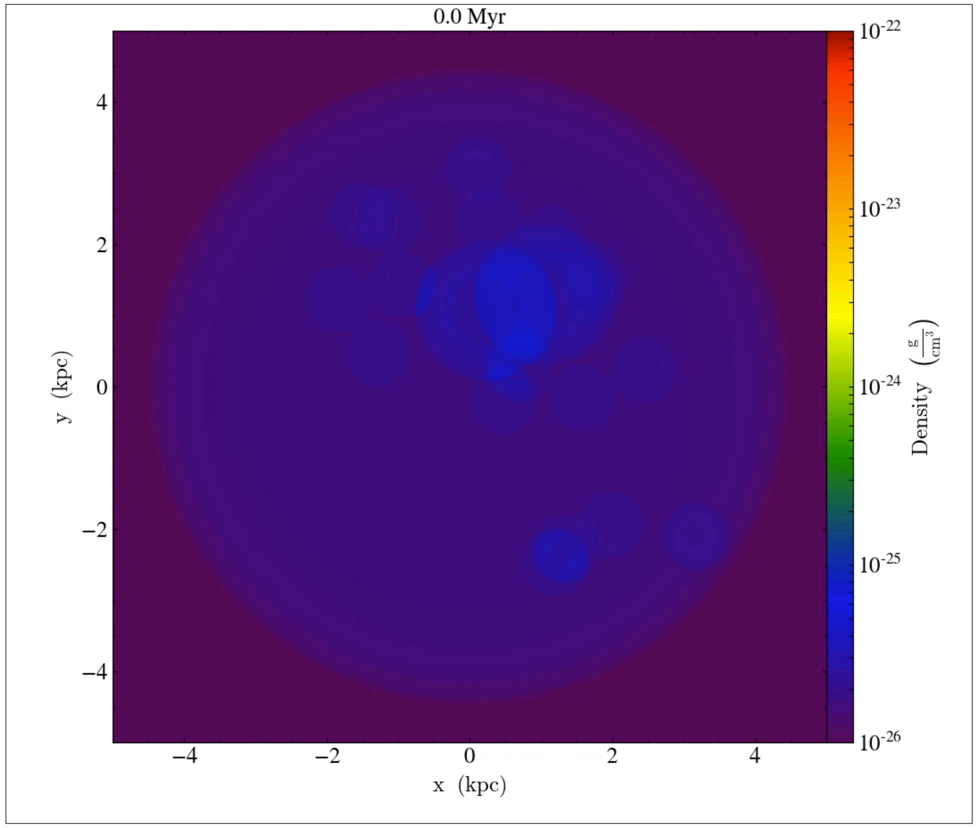


Star forming cites

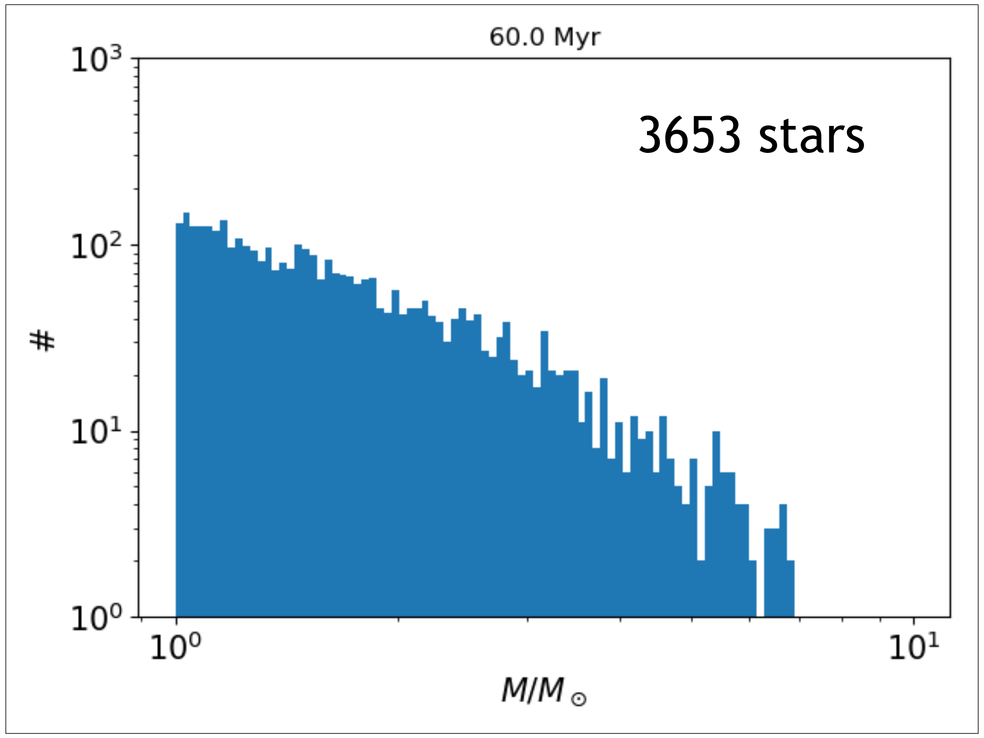


Simulation A2
(PopIII SNR composition based on Salpeter IMF)

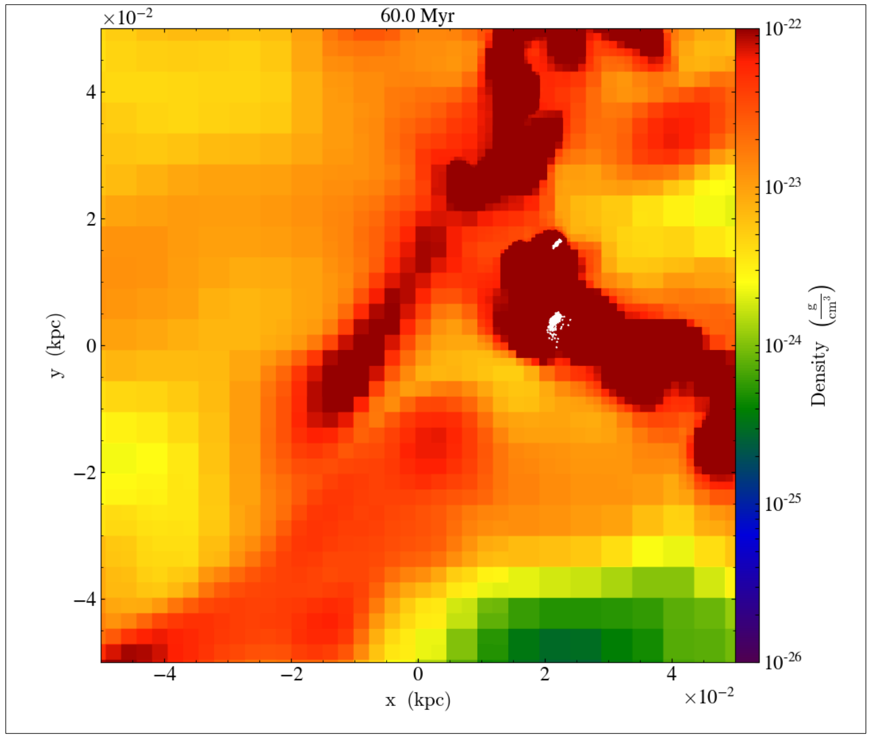
Density



Stellar Mass Distribution

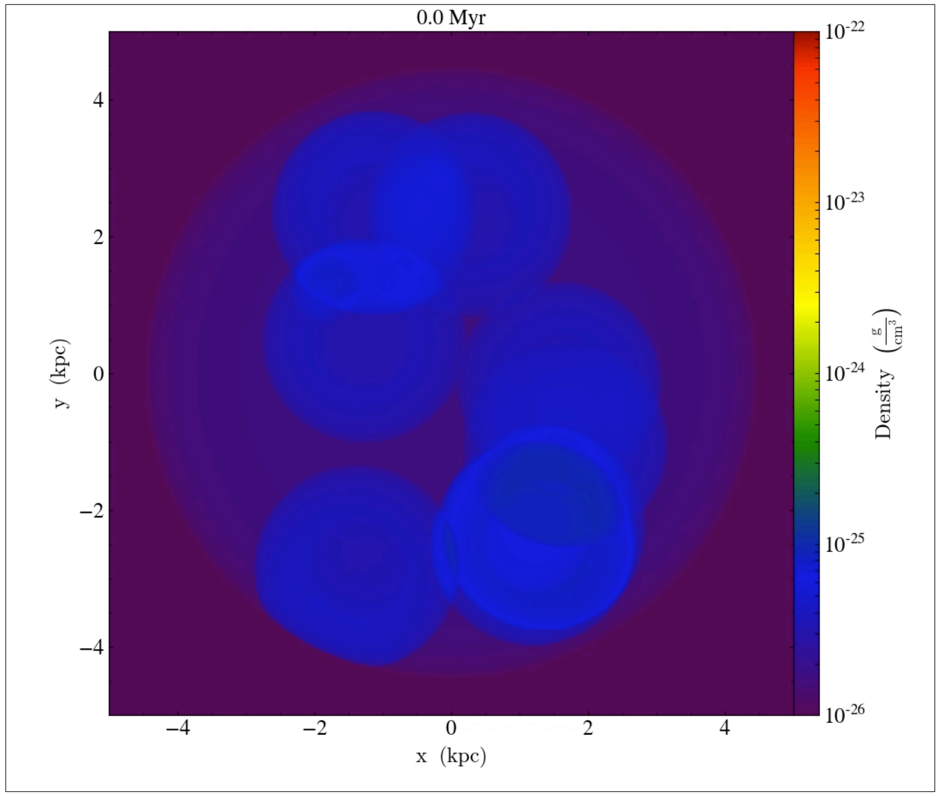


Star forming cites

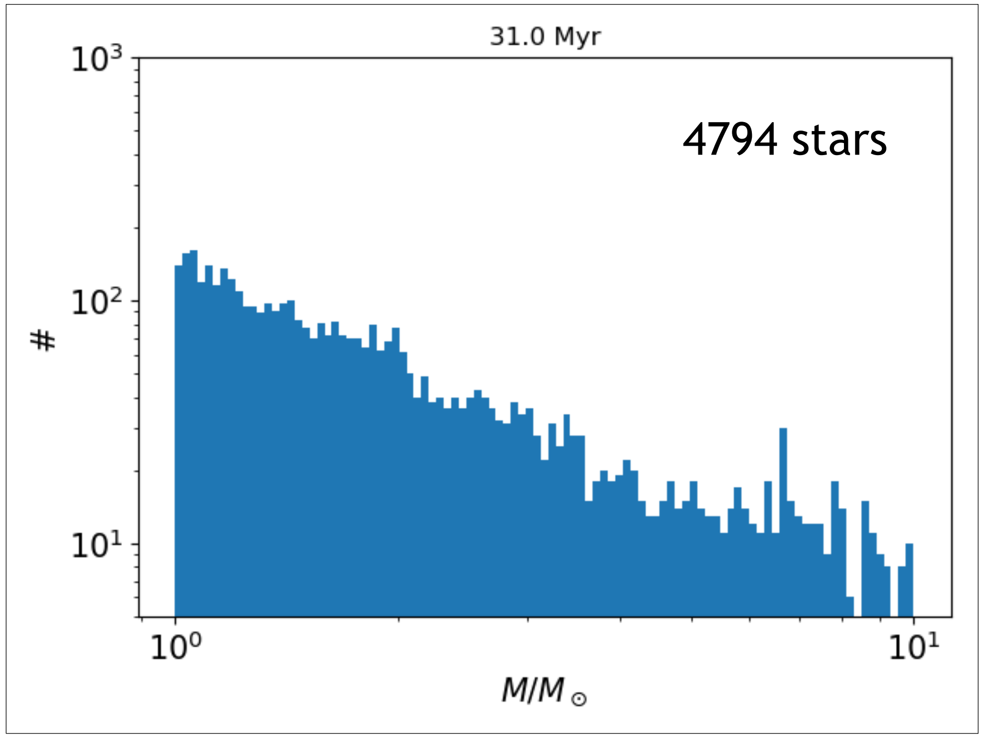


Simulation A3 (PopIII SNR composition based on cosmological simulation in Hirano et al. 2015)

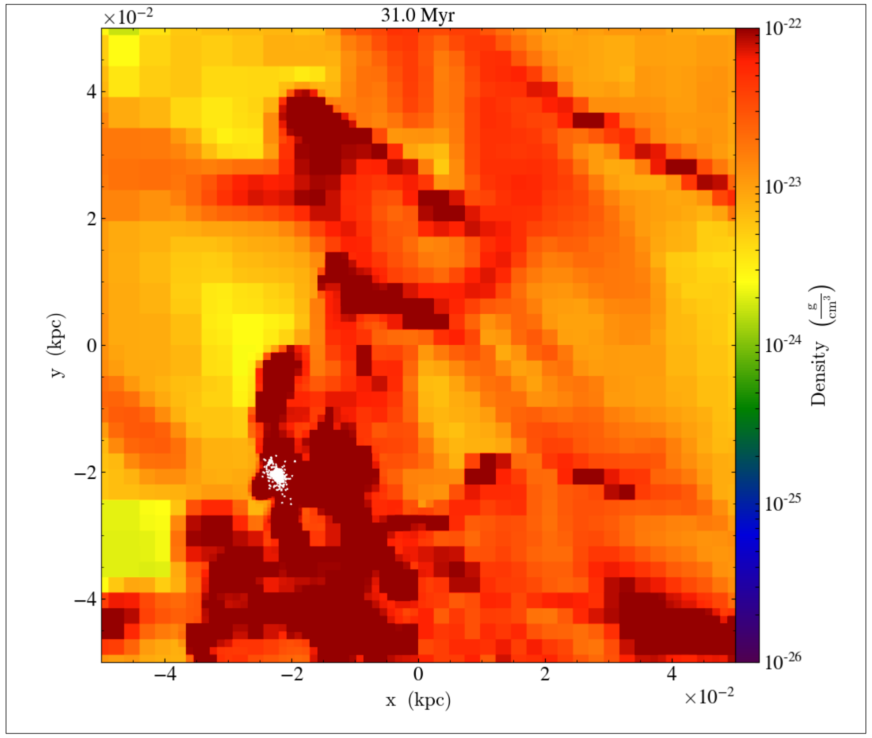
Density



Stellar Mass Distribution



Star forming cites



Conclusion

- The star formation history is dependent on the initial conditions determined by the composition of the Pop III supernova remnants.
- We find a flatter IMF for the next generation of stars when the the composition of supernova remnants comes from the cosmological simulation than the ones from Salpeter IMF or Flat IMF for the first stars.

Future Work

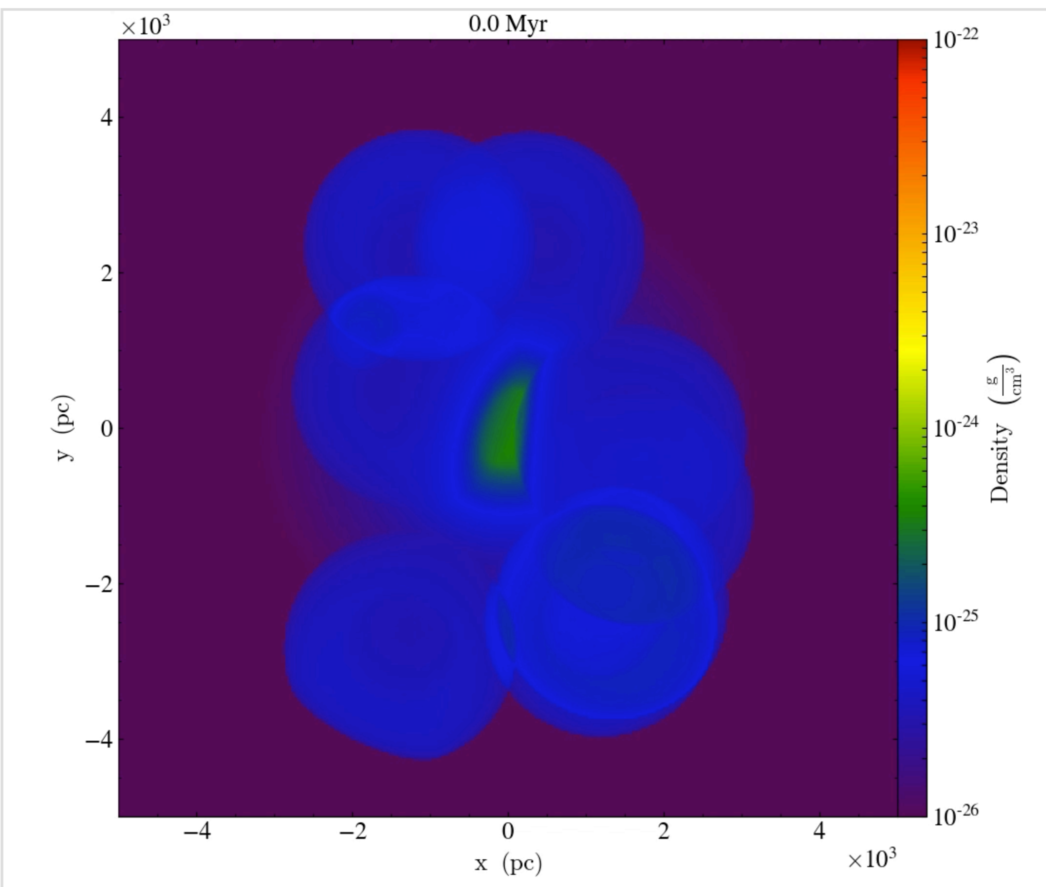
- Continue to work with RT and post-process previous results to obtain observables such as luminosity.
- Use initial condition which comes from zoom-in simulations of first stars and first supernovae.

Thank you for your attention!

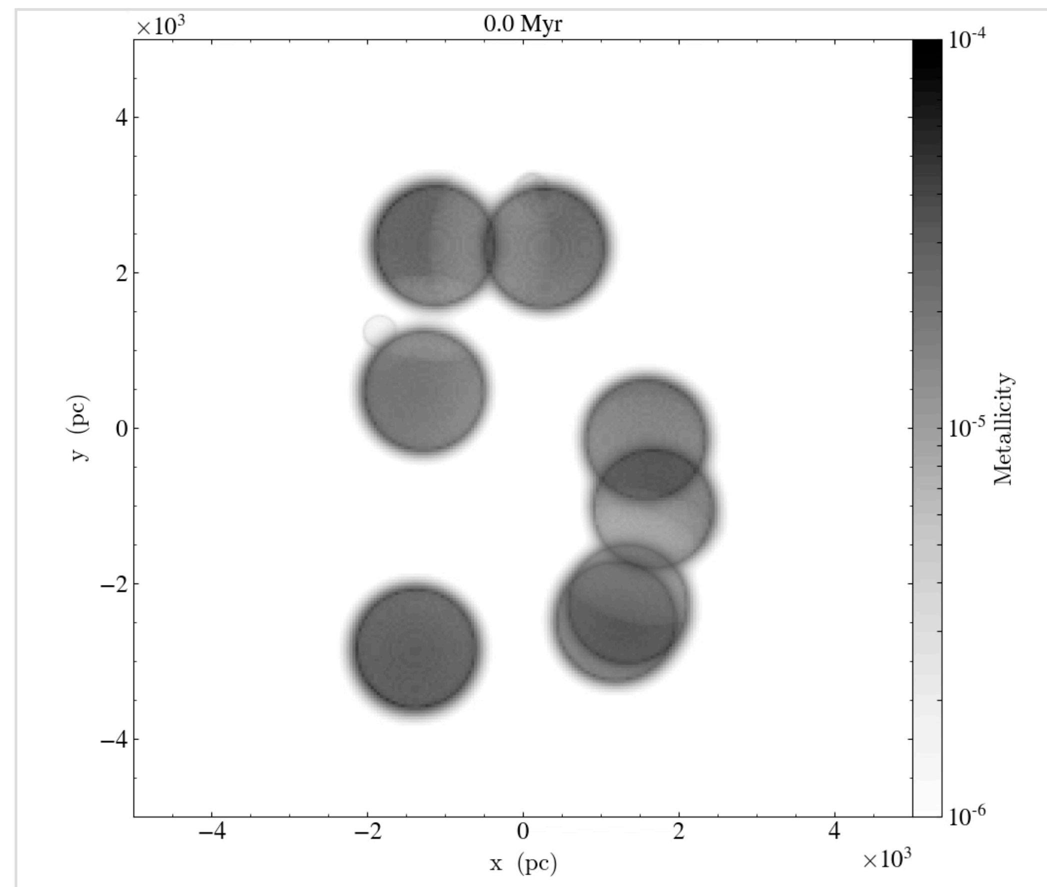
Ongoing work:

- **Gradient density profile (background gas)**
- **PopIII and PopII star formations**
- **Radiative Transfer**

Density

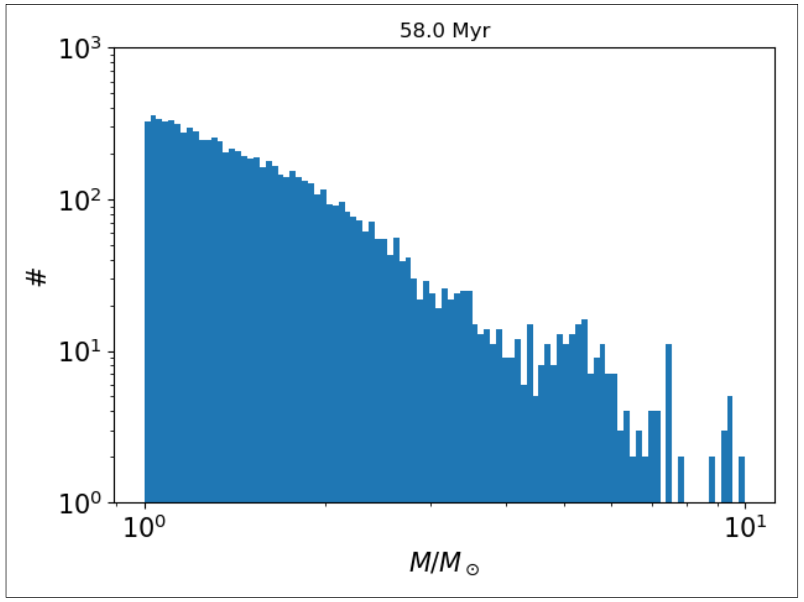


Temperature

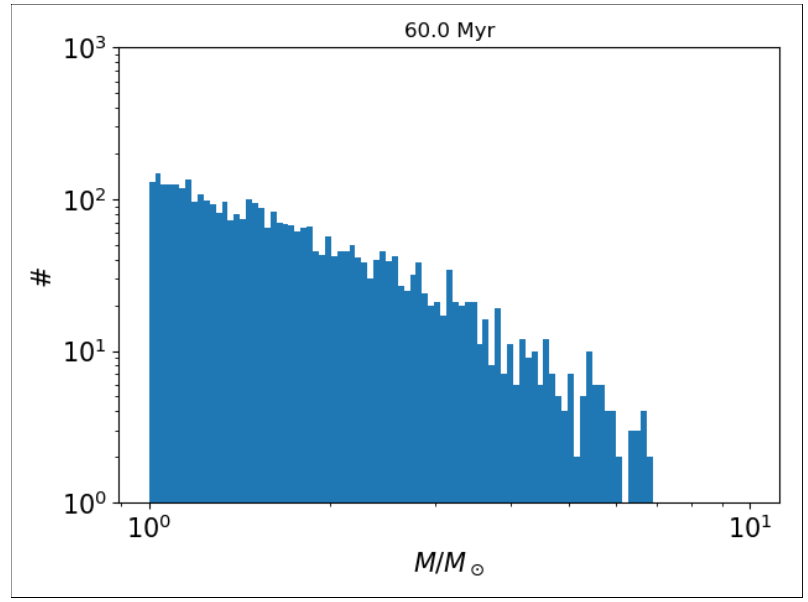


10^9 Halo

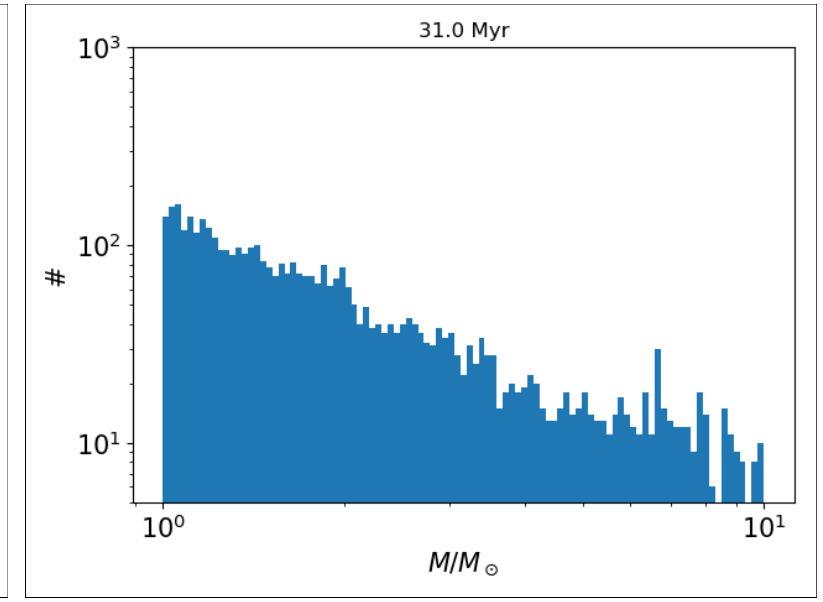
Simulation A1(flat IMF)



Simulation A2(Salpeter IMF)

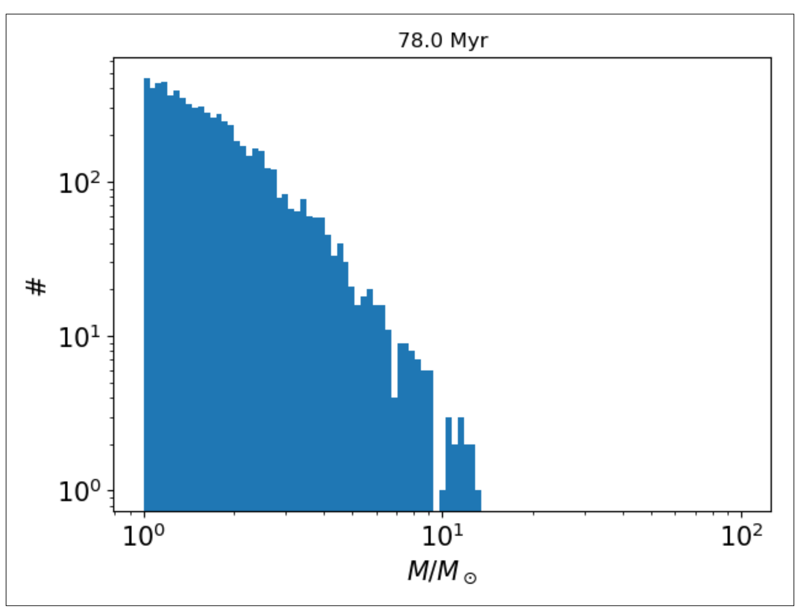


Simulation A3(Hirano IMF)

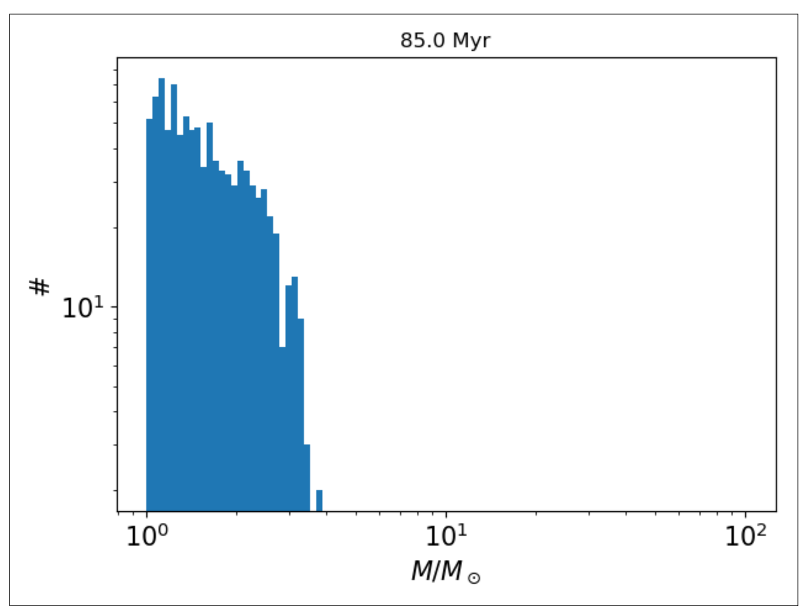


10^8 Halo

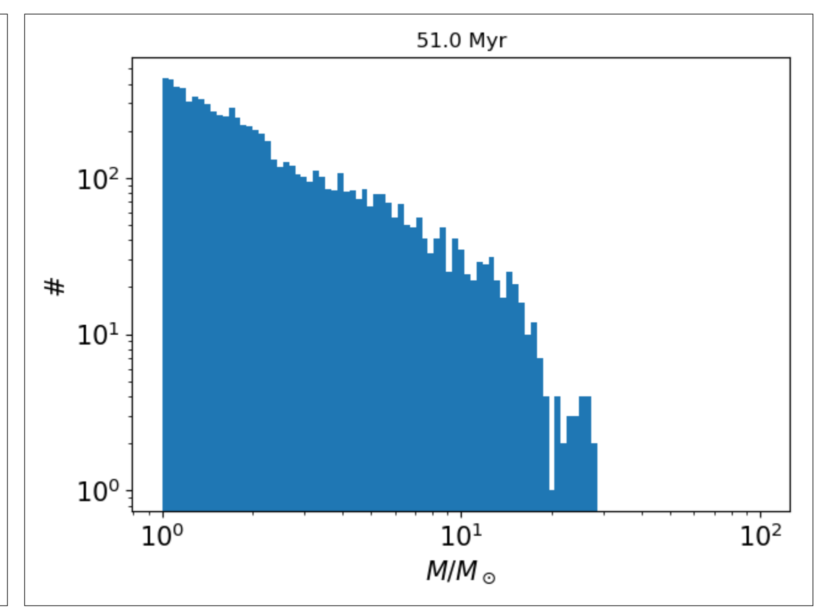
Simulation B1(flat IMF)



Simulation B2(Salpeter IMF)



Simulation B3(Hirano IMF)



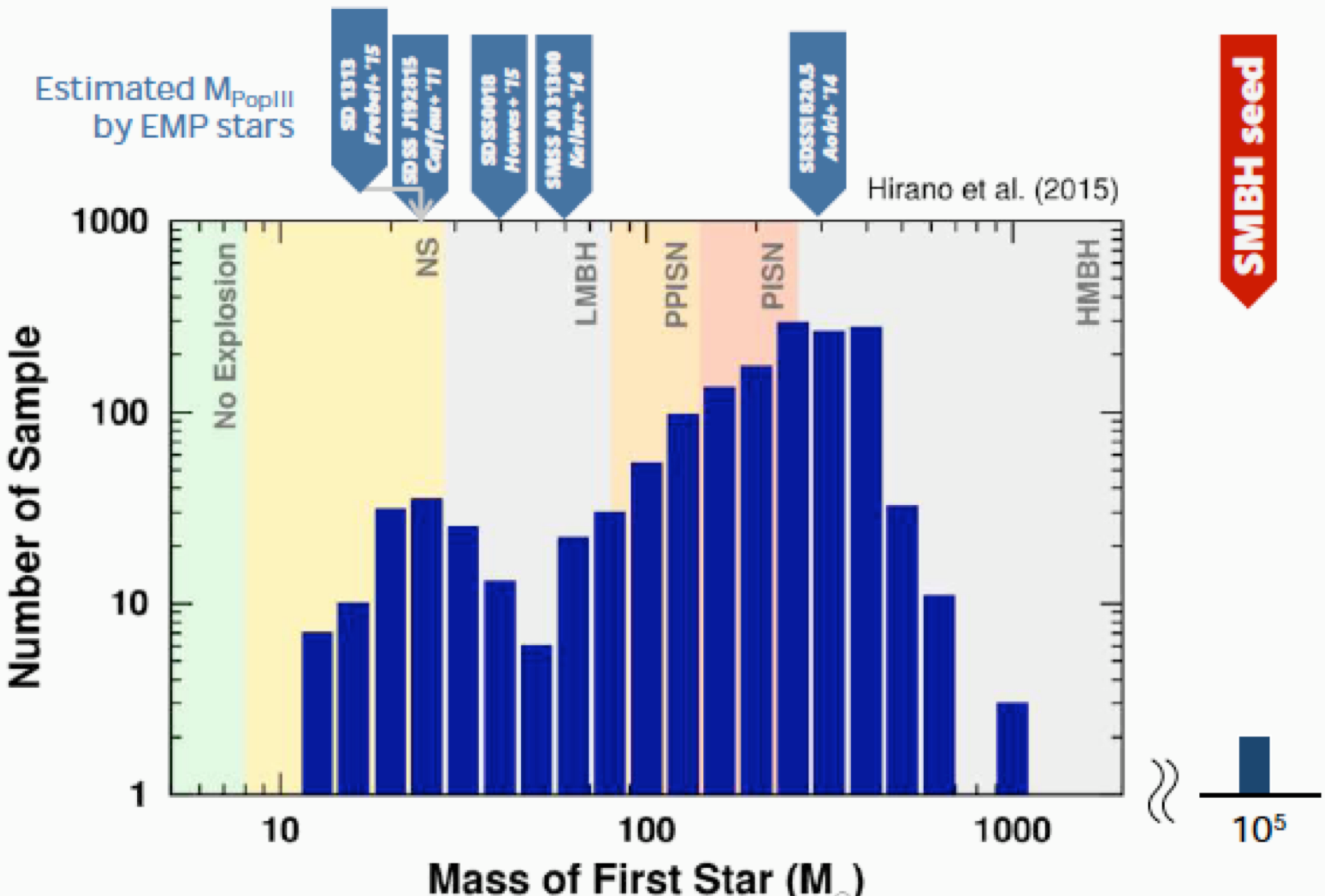
12 Models

1e9 M_sun halo			
	Flat	Salpeter	Hirano
1 kpc	58 Myr, 8117 *	60 Myr, 3653 *	31 Myr, 4794 *
0.5 kpc	42 Myr, 1139 *	64 Myr, 9156 *	21 Myr, 1914 *

1e8 M_sun halo			
	Flat	Salpeter	Hirano
1 kpc	78 Myr, 7001 *	85 Myr, 953 *	51 Myr, 12633 *
0.5 kpc	58 Myr, 2574 *	47 Myr, 1518 *	29 Myr, 12915 *

How massive are First Stars?

ver.2015.12.09



Courtesy of Shingo Hirano