Simulating Heavy Seed Black Hole Formation

Lewis Prole

Maynooth University

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

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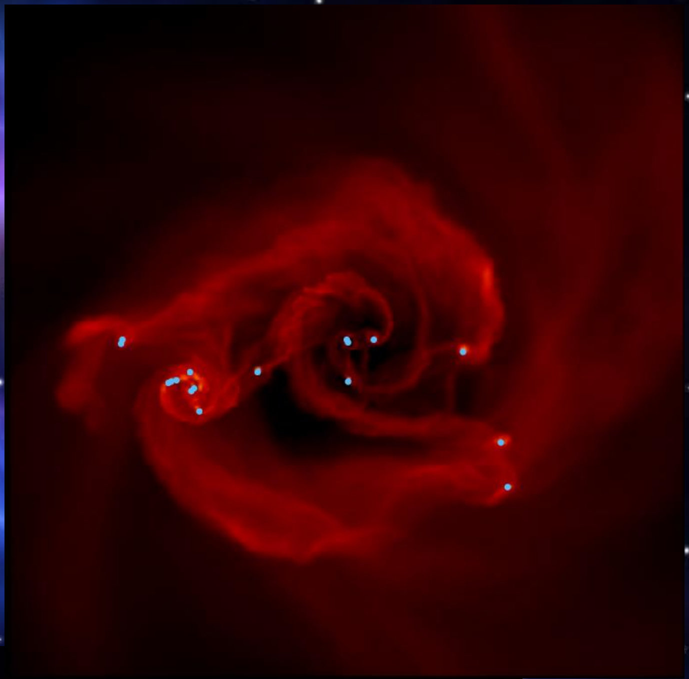
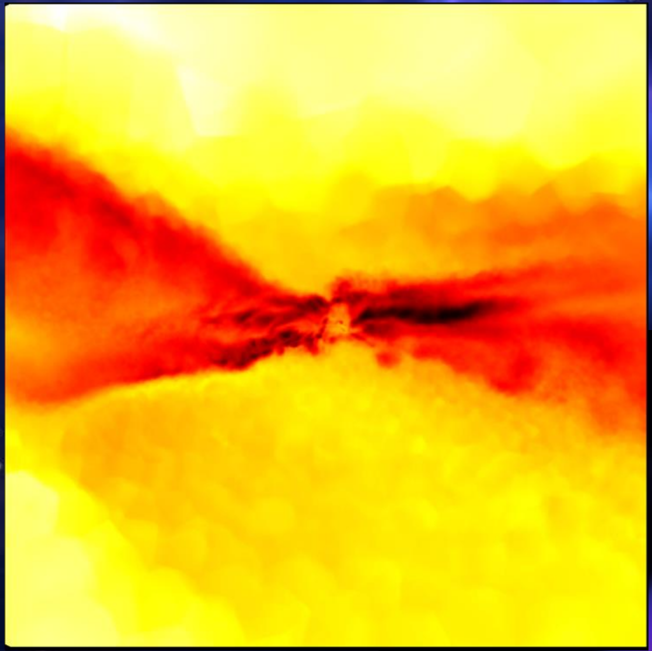
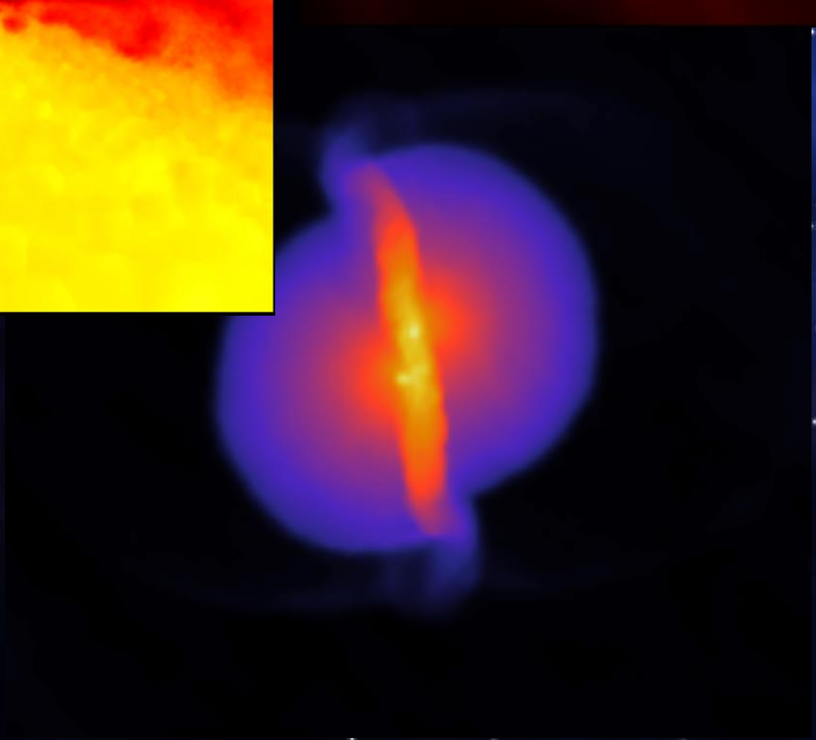
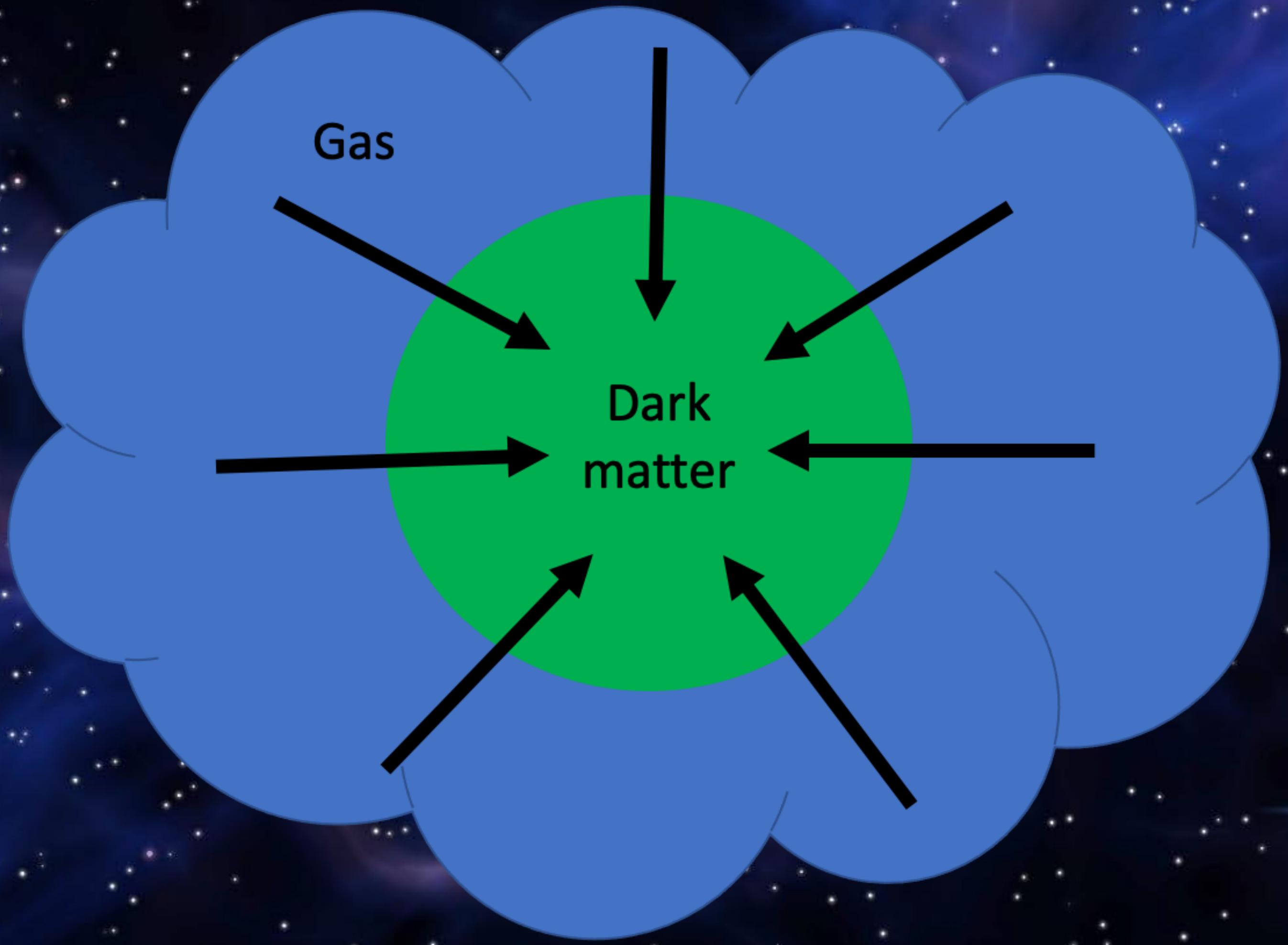
Topics

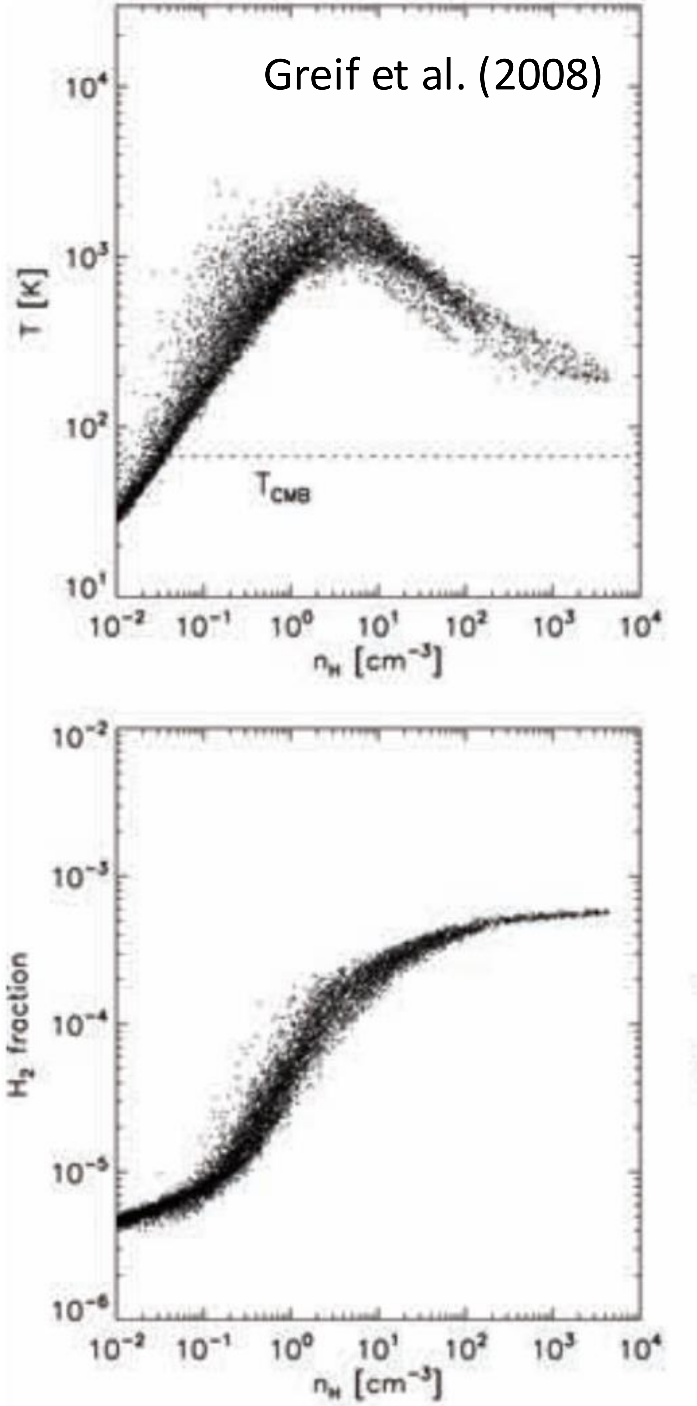
1. First collapsing objects
2. Delayed halo collapse?
3. Halo mergers/collisions

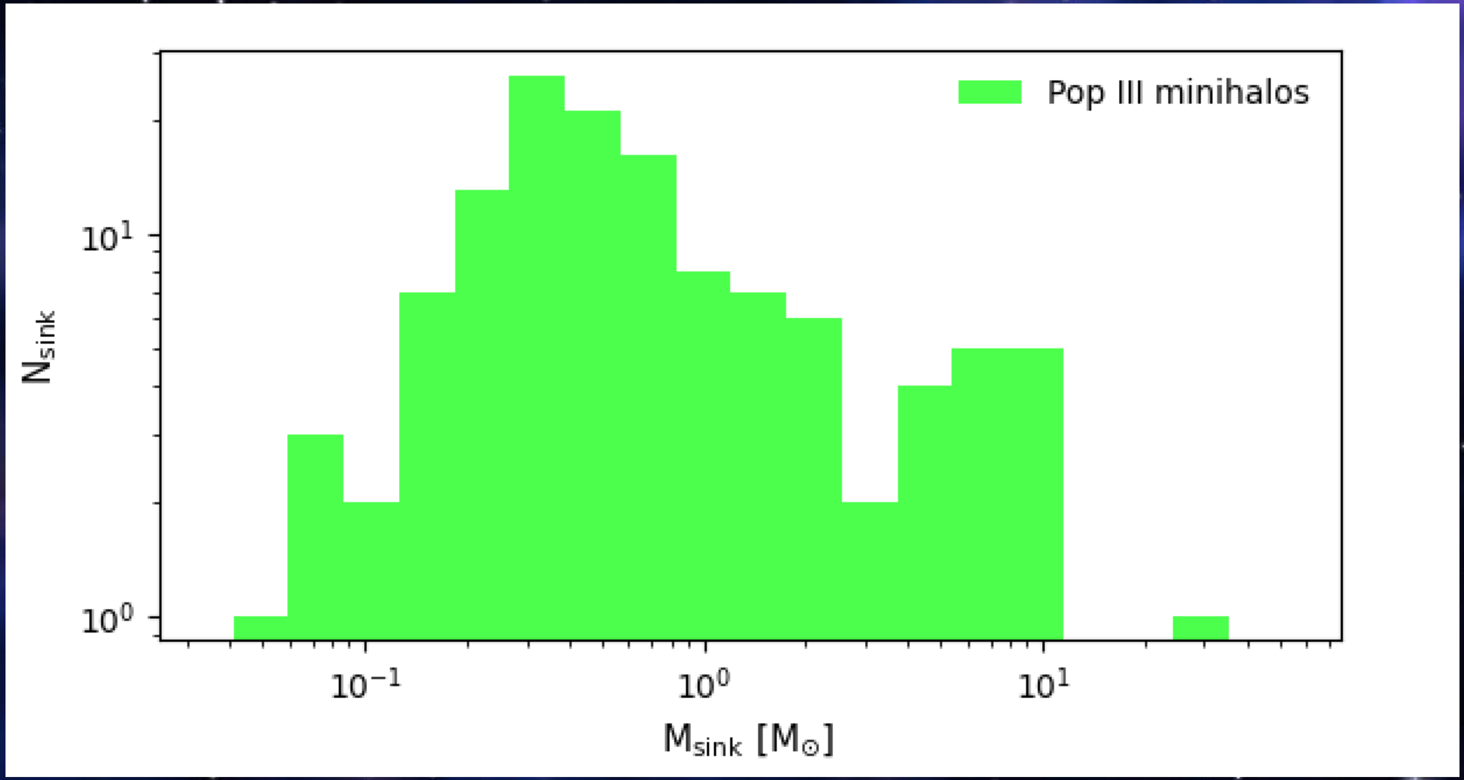
Halos as Formation sites



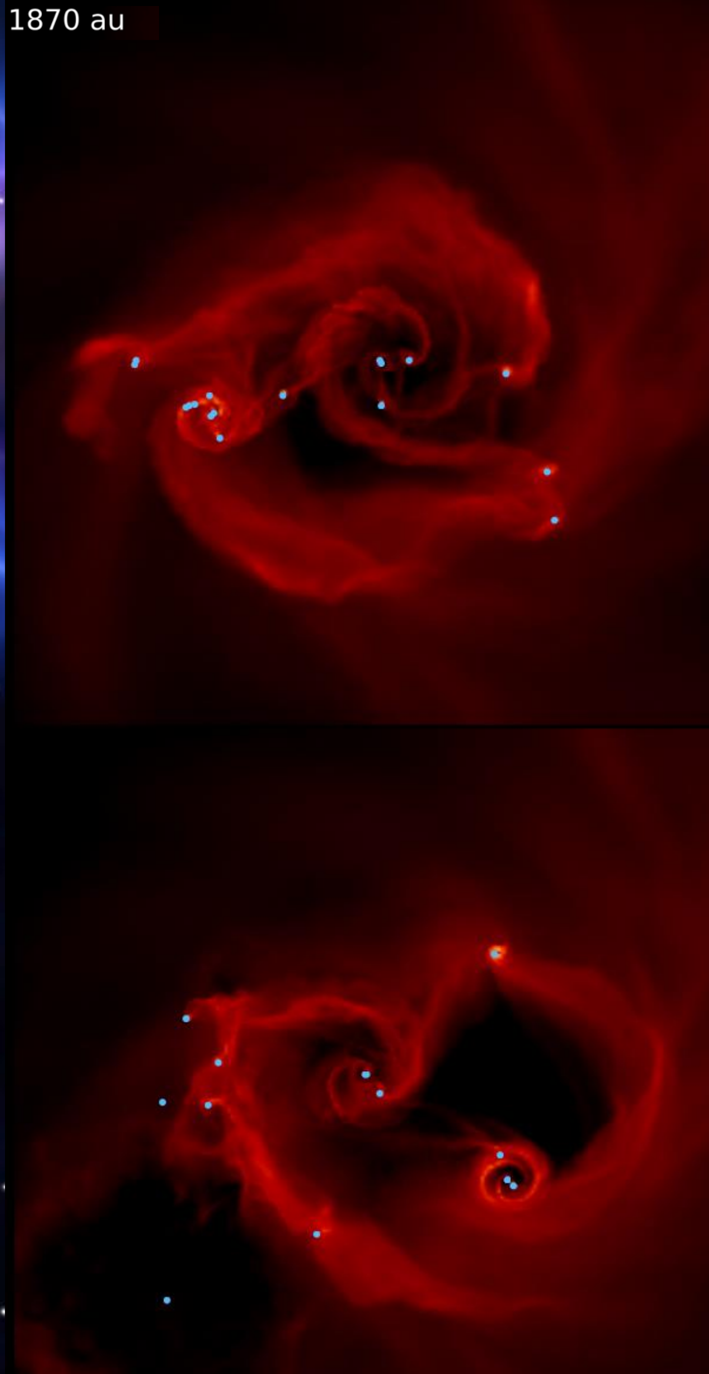
Greif et al. (2008)



Minihalos

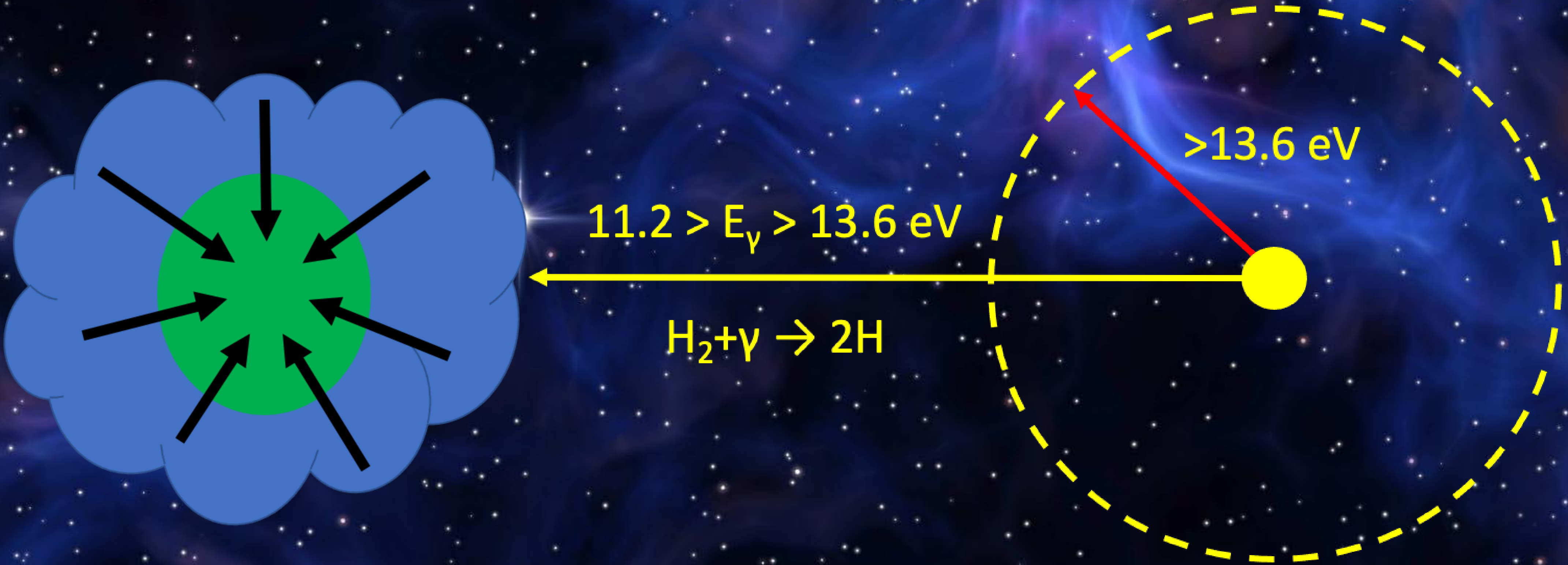


Prole et al. (2023)



Prole et al. (2022b)

Lyman-Werner Stellar Feedback



Atomic halos

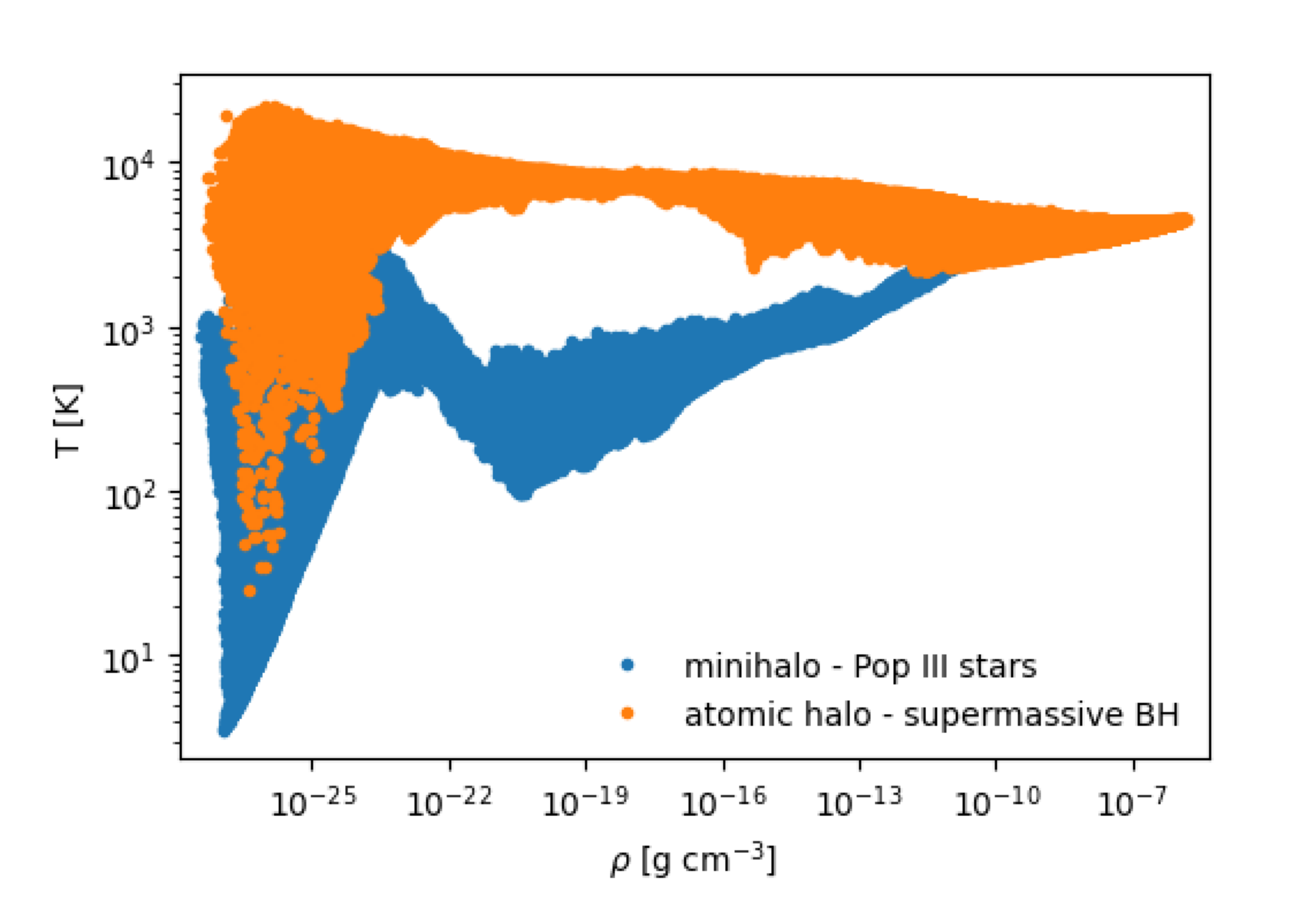
10^9 M_o BH observed at z=7

Light BH seeds <10^3 M_o

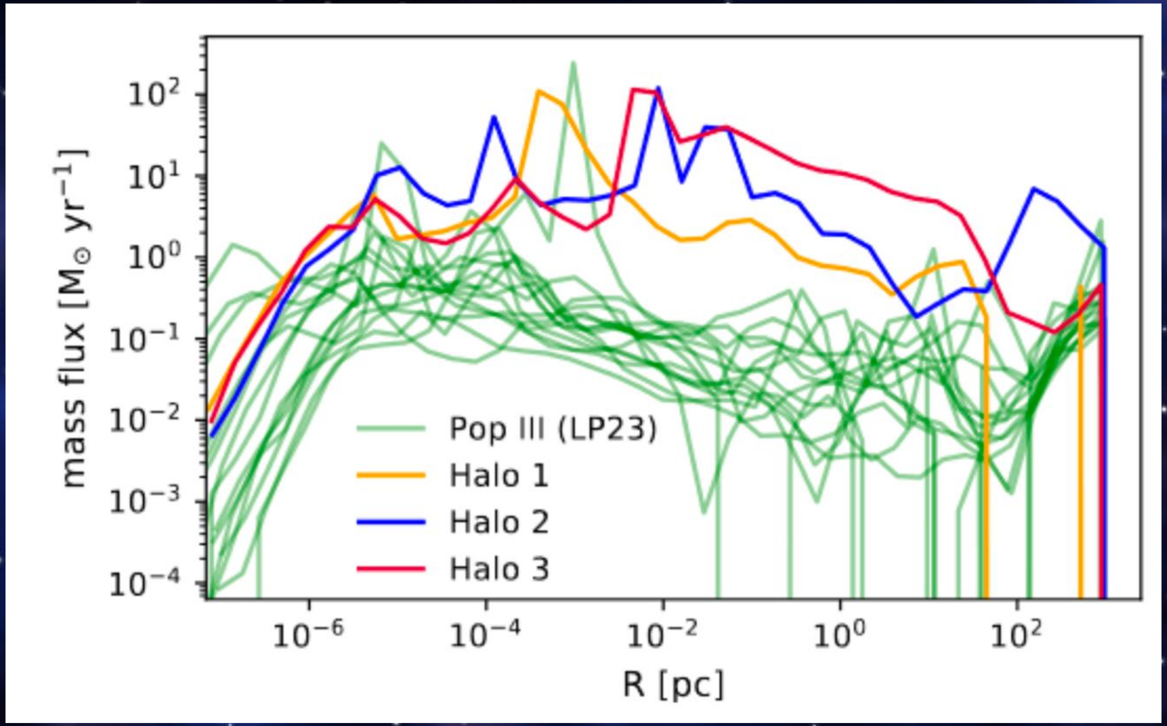
-> Eddington accretion required
-> Feedback limited

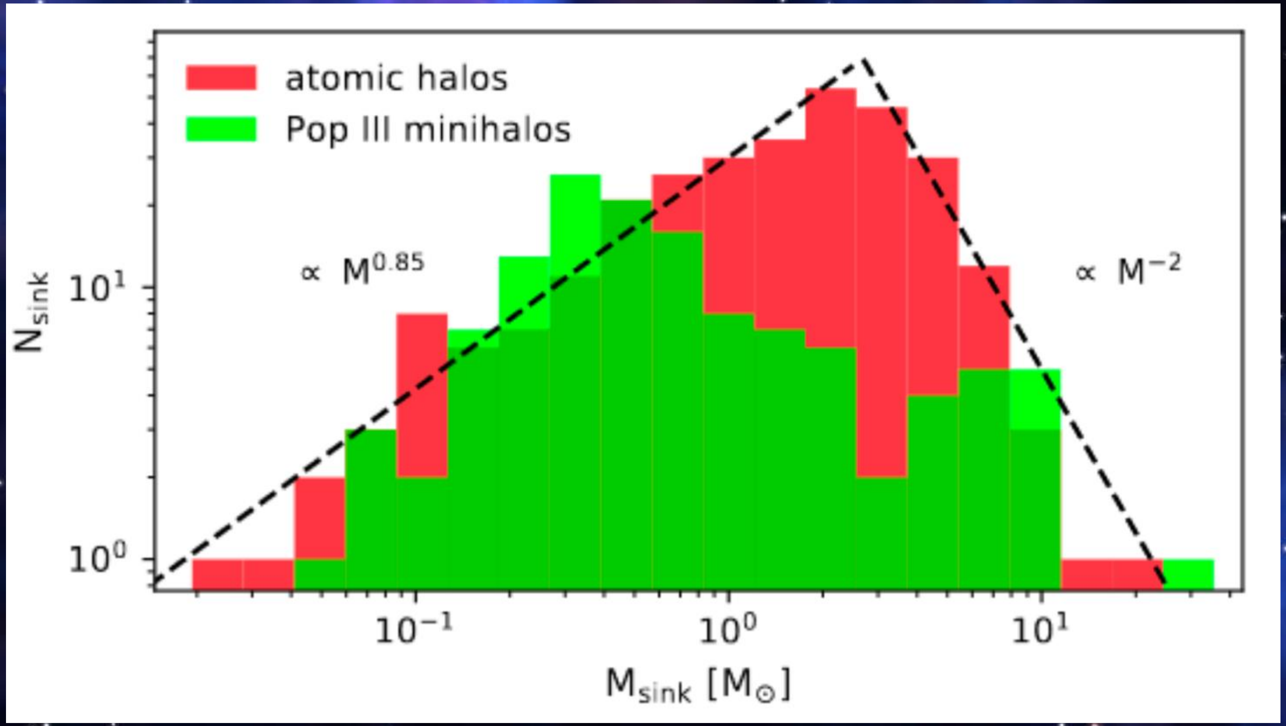
Heavy BH seeds >10^3 M_o

-> Atomic halo required?
-> Rare



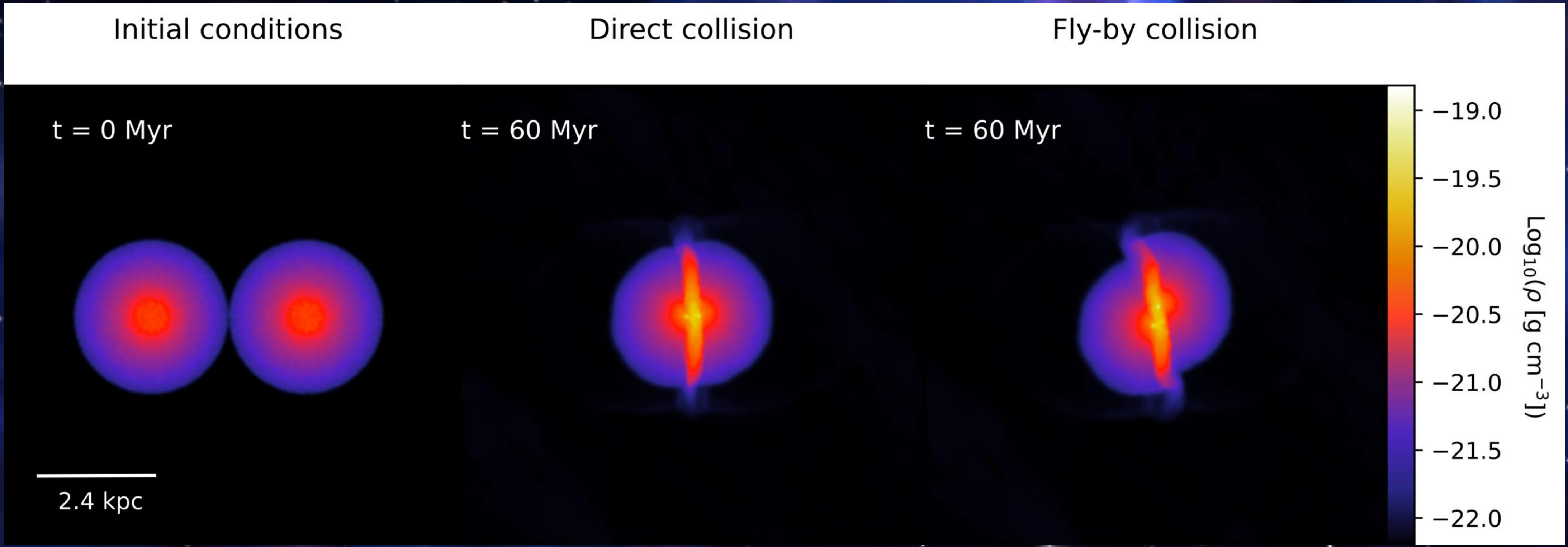
Atomic halos





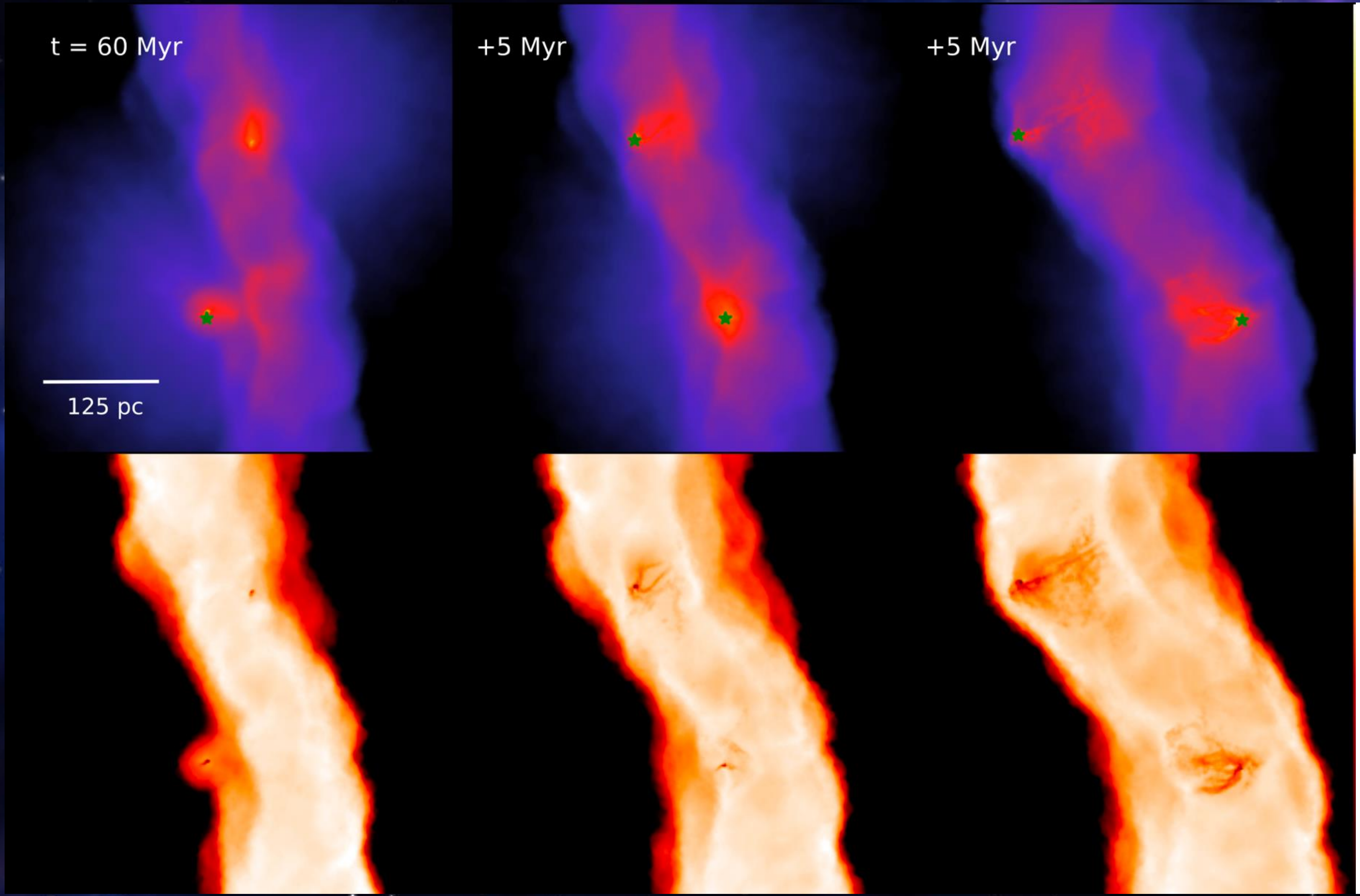
Prole et al. (2024)

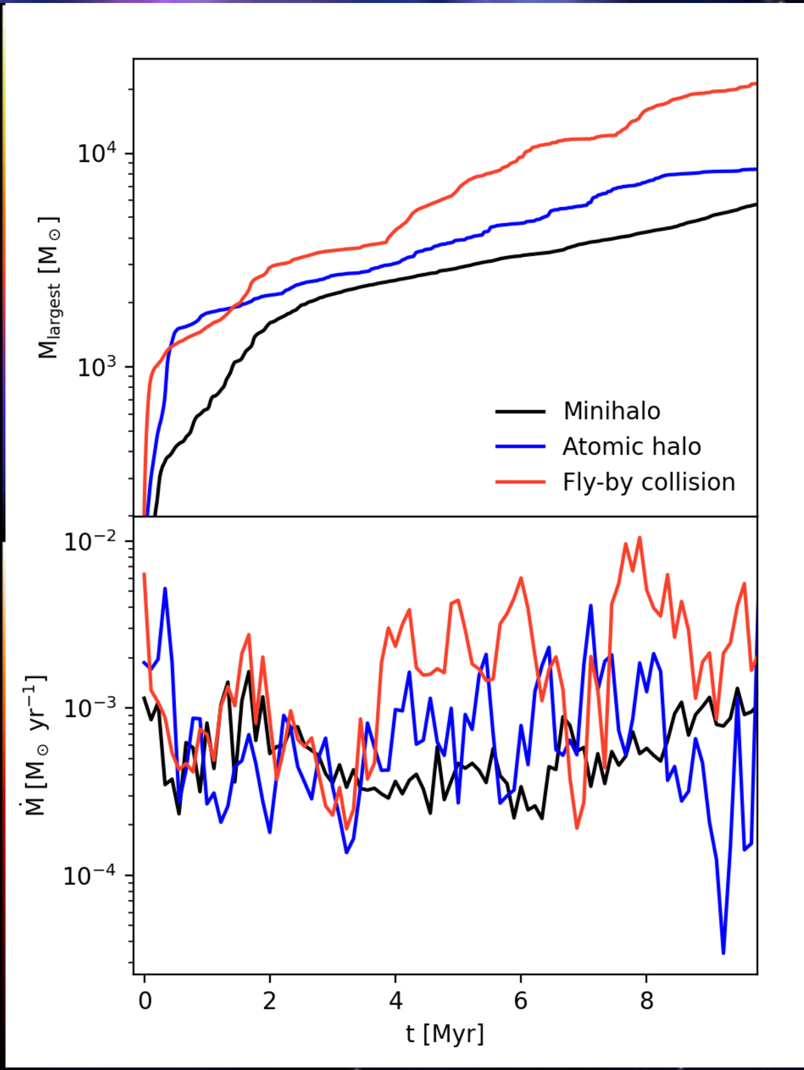
Halo collisions



Prole et al. 2024b (submitted)

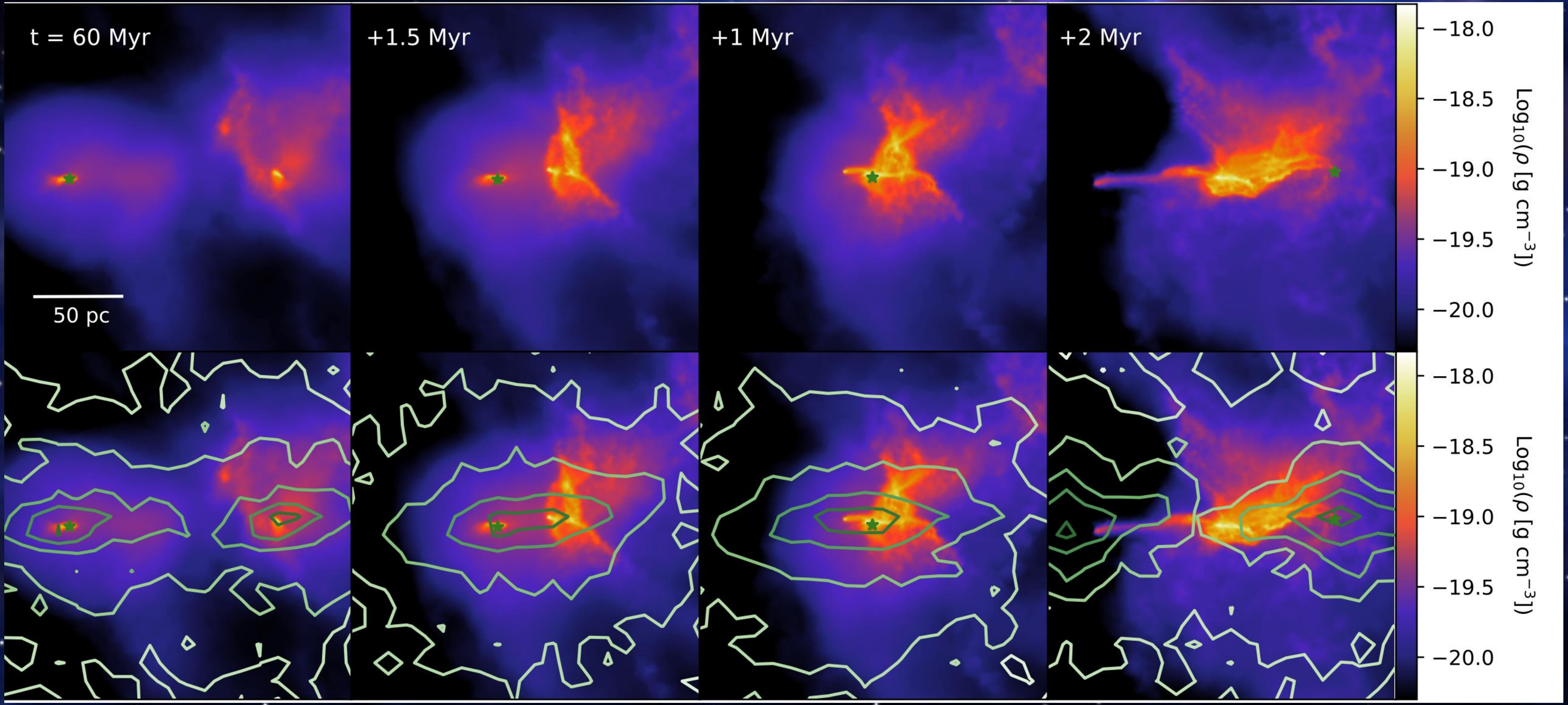
Halo collisions – indirect collision





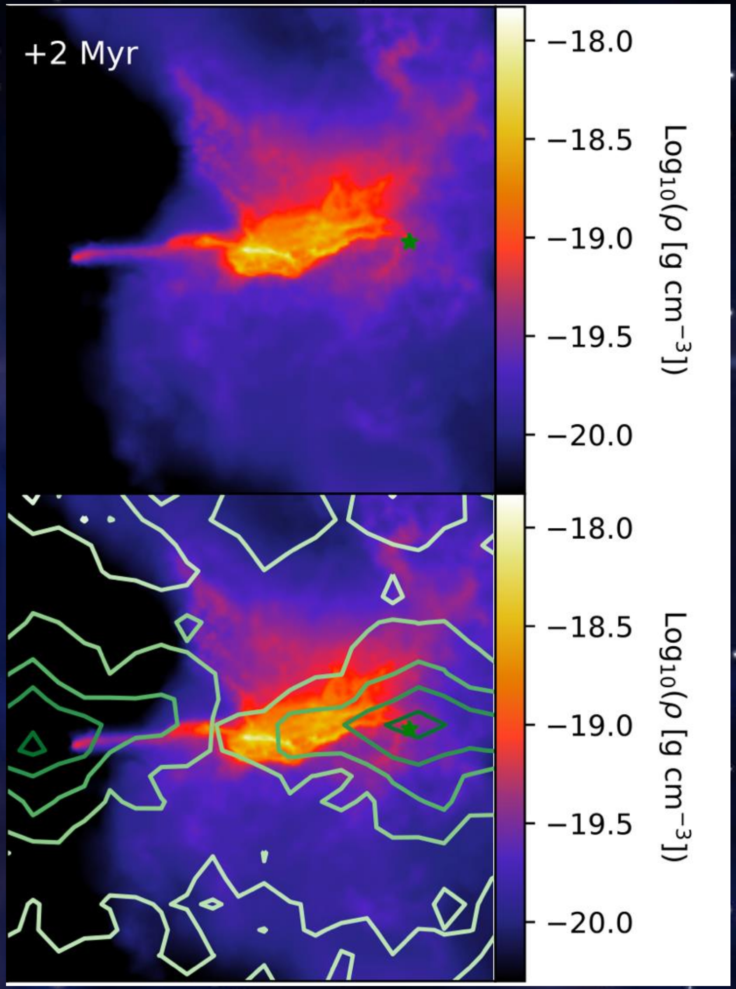
Prole et al. 2024b (submitted)

Halo collisions– direct collisions



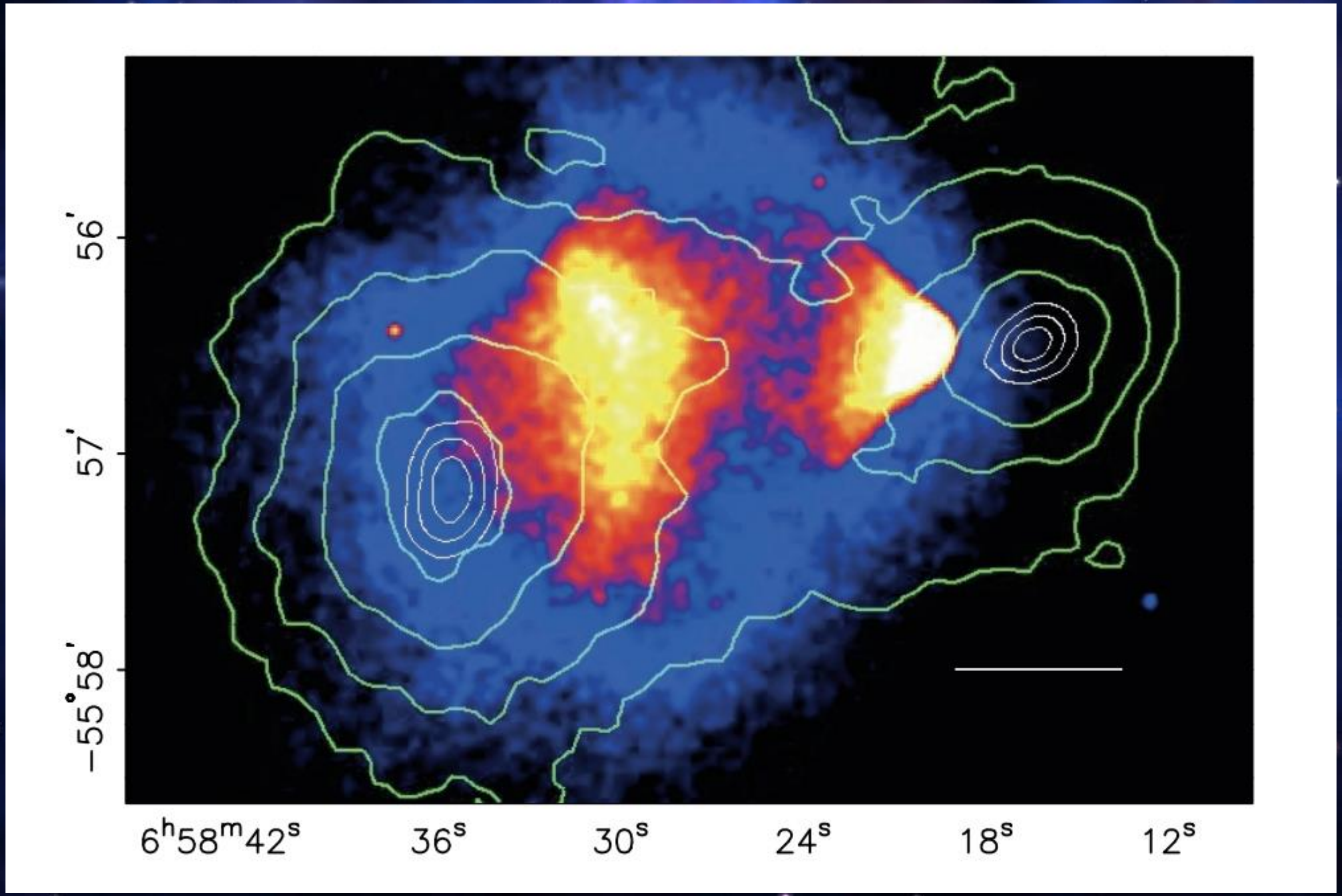
Prole et al. 2024b (submitted)

Halo collisions– direct collisions



Prole et al. 2024b (submitted)

Merging galaxies - “Bullet Cluster”



Clowe et al. (2006)

Summary

Pop III minihalos

Fragmentation leads to low mass stars

Light seeds don't grow fast enough to form SMBHs

LW atomic halos

Delayed and isothermal collapse

Higher accretion rates give higher mass stars

Requires unrealistically intense radiation field

Halo mergers

x2 BH mass enhancement compared to isolated halos

Overcomes accretion limit set by atomic cooling

Requires indirect collision

Forming massive objects

Good	Bad
High initial infall rates onto single object	Prior star formation and feedback
Sustained long-term accretion	Metal pollution from SNe
	Gas fragmentation