Star Cluster Formation: The Effects of Early Forming Massive Stars and Building a Bridge Between Voronoi Mesh and Block-Structured Codes

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January 6, 2023

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- What about *when* massive stars form?

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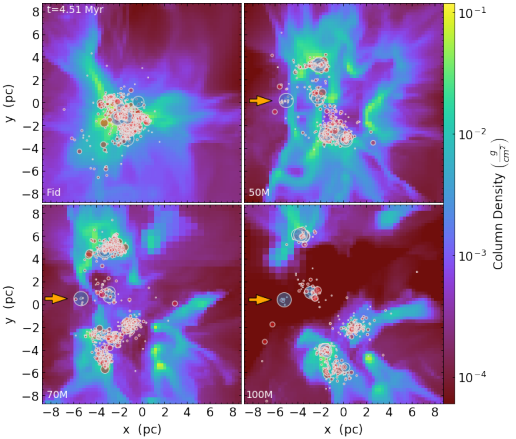
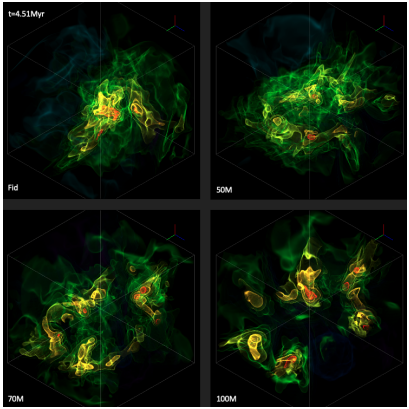
A Controlled Experiment

Using `Torch` computational framework

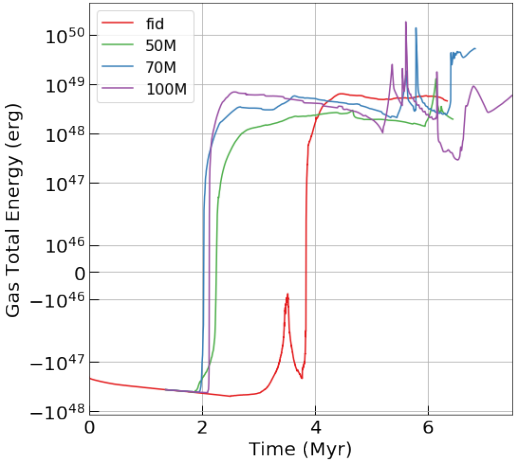


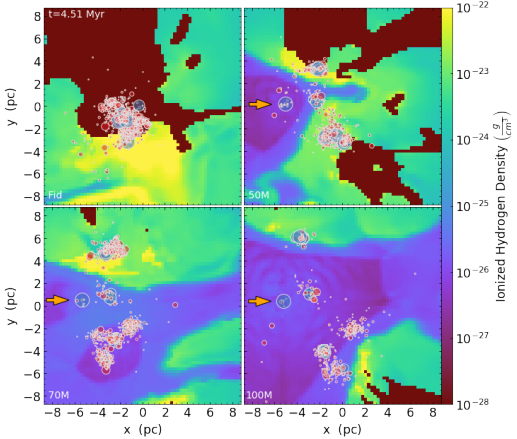
Lewis et al. (2023)



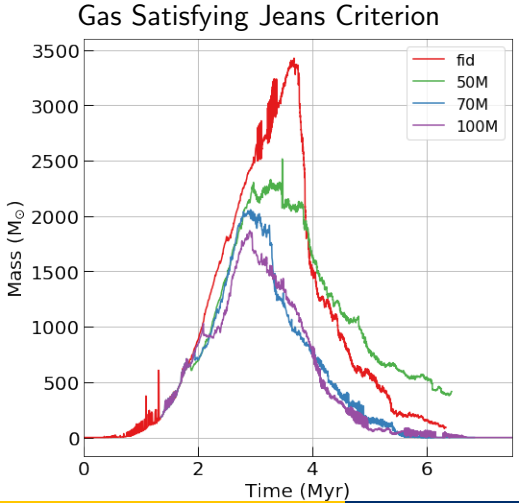
Gas density contours

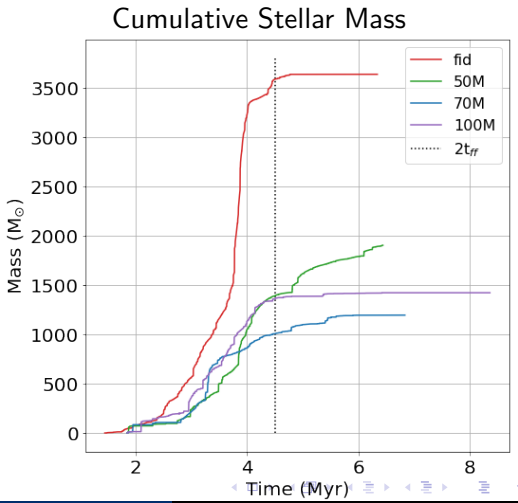
Early Forming Massive Stars Rapidly Unbind GMC





Early Forming Massive Stars Suppress Gas Accretion and Star Formation





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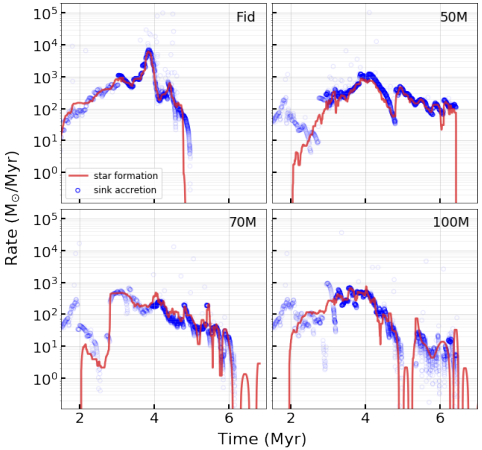

Early forming massive stars reduces sink accretion and star formation rates.

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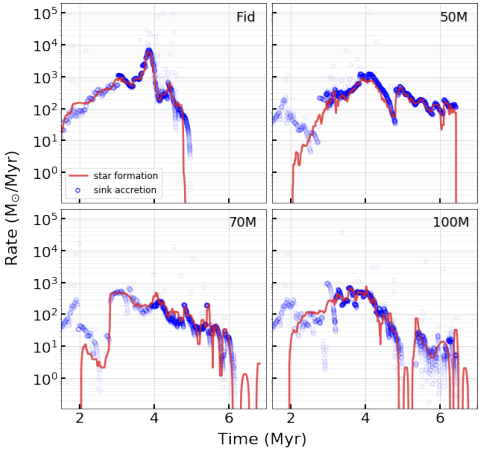

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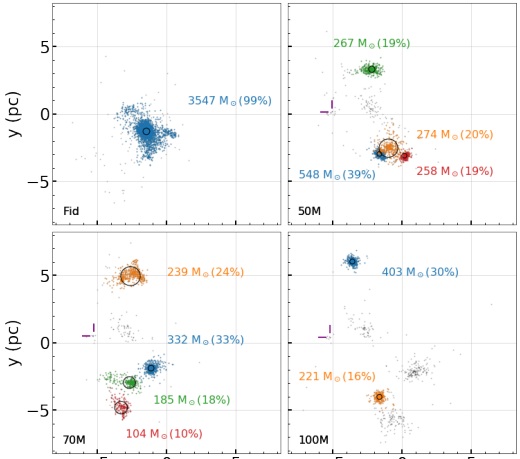
Run	$\langle \epsilon_{ff} \rangle$
Fid	0.23
50M	0.08
70M	0.03
100M	0.04

Early Forming Massive Stars Promote Formation of Fragmented, Low Mass, Loosely Bound Clusters



Run	Mass in Clusters $10^3\ M_\odot$	Frac Mass M_c / M_{tot}	r_h MMC pc	E_{bind} MMC 10^{46} erg
Fid	3.6	0.99	0.25	-140
50M	1.4	0.97	0.17	-12
70M	0.86	0.85	0.21	-4.2
100M	0.62	0.46	0.18	-3.8

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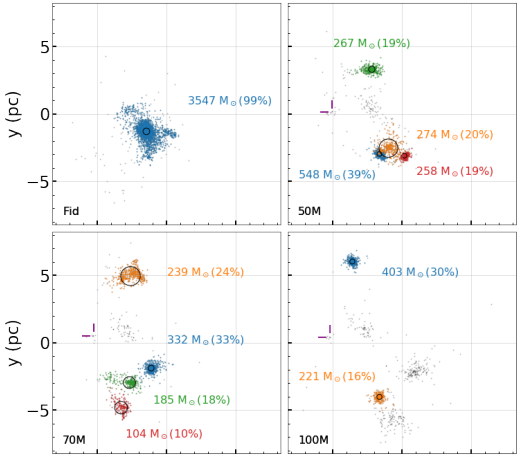

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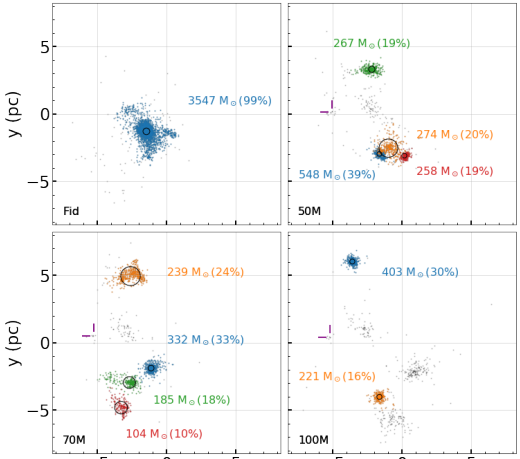

- Low mass and spatially distinct clusters.
- Loosely bound; more unassociated stars.

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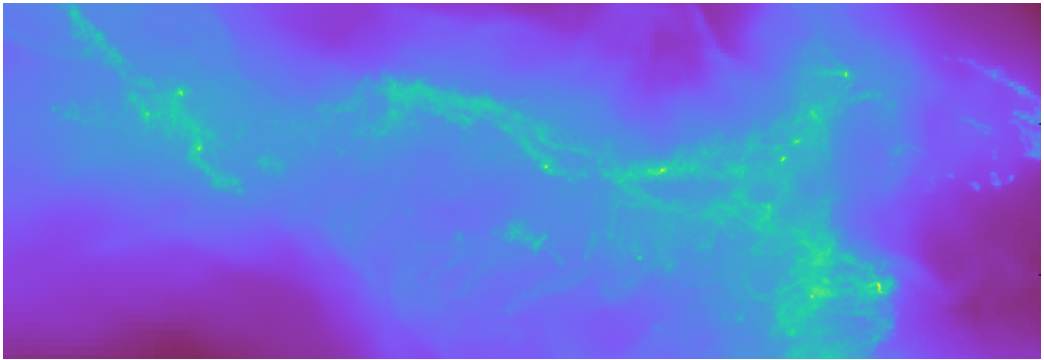
- The star formation rate per free-fall time is suppressed by up to a factor of seven, reducing the total mass of stars formed.
- Stifle the hierarchical assembly process of massive star clusters, instead promoting the formation of spatially separate and more loosely bound subclusters.

In the Pursuit of a Self-Consistent Star Formation Simulation



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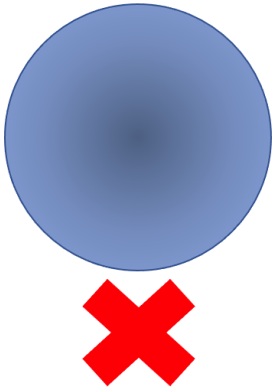
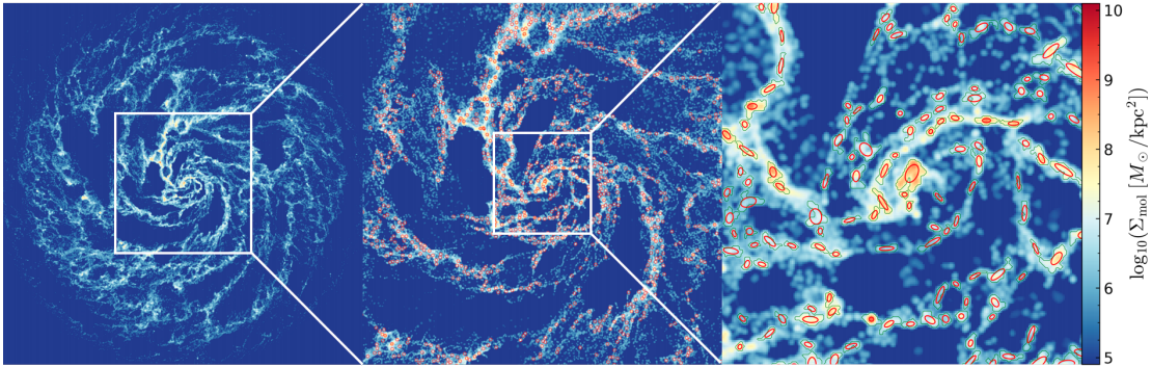


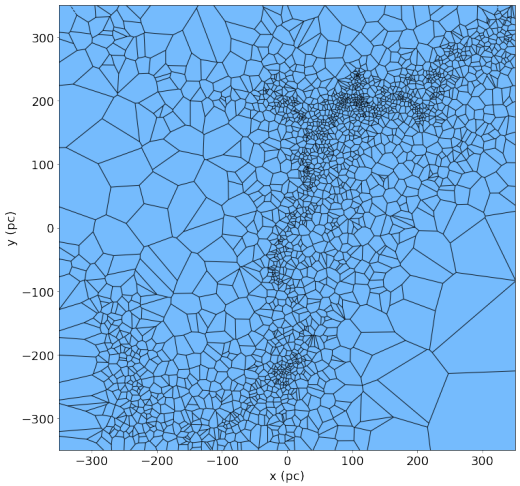
Clouds from Galactic Simulations

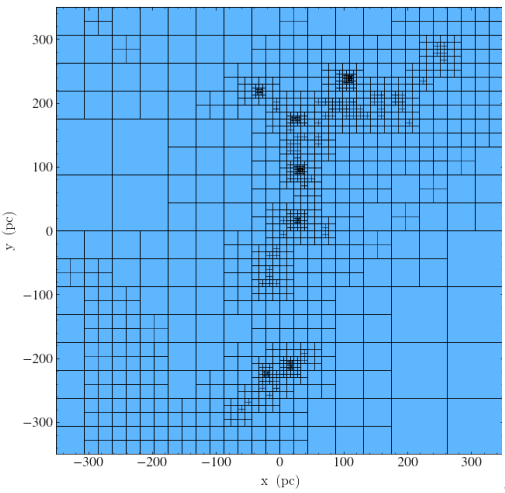


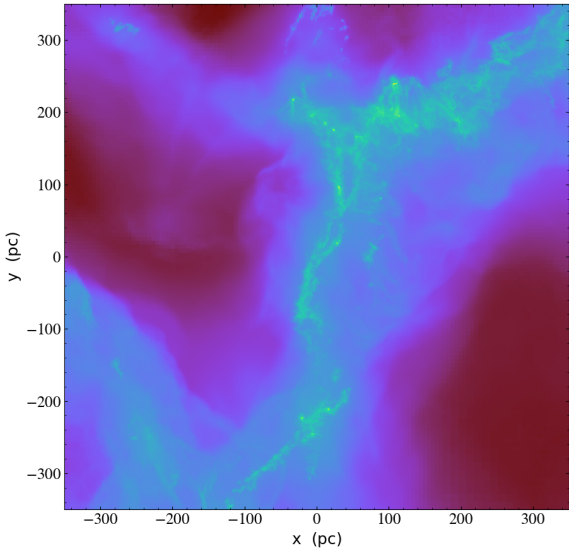
GMC identification[3]

[3] Li, H. et al. (2020)

Voronoi Mesh to AMR Grid






300
200
100
0
−100
−200
−300
y (pc)
−300
−200
−100
0
100
200
300
x (pc)

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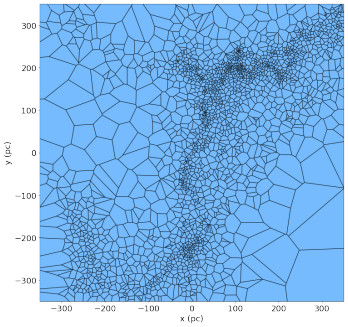
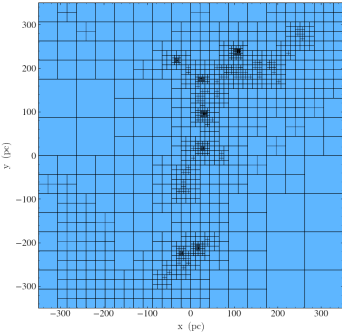
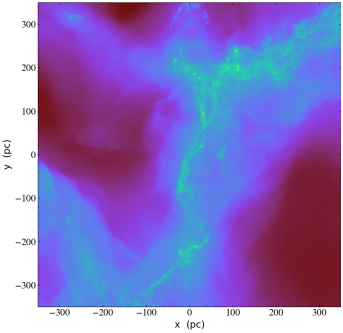
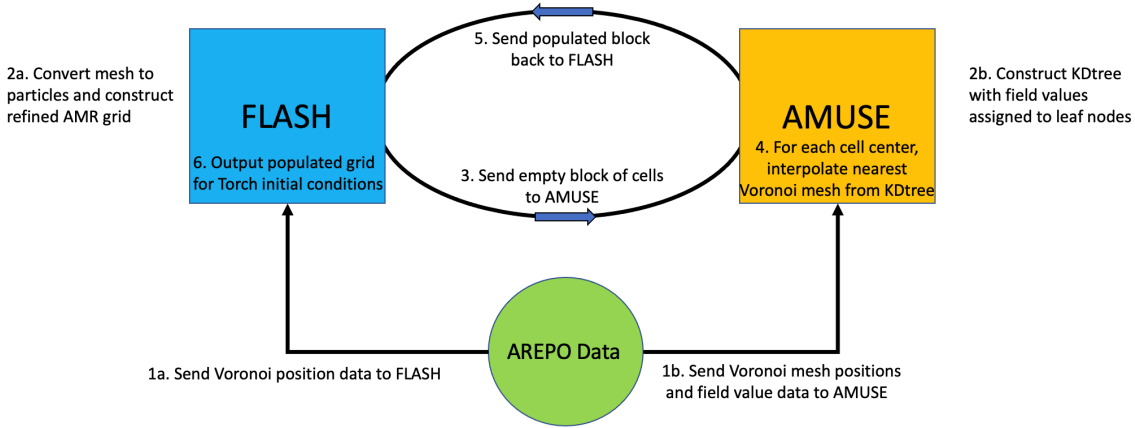






VorAMR: Logic path



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