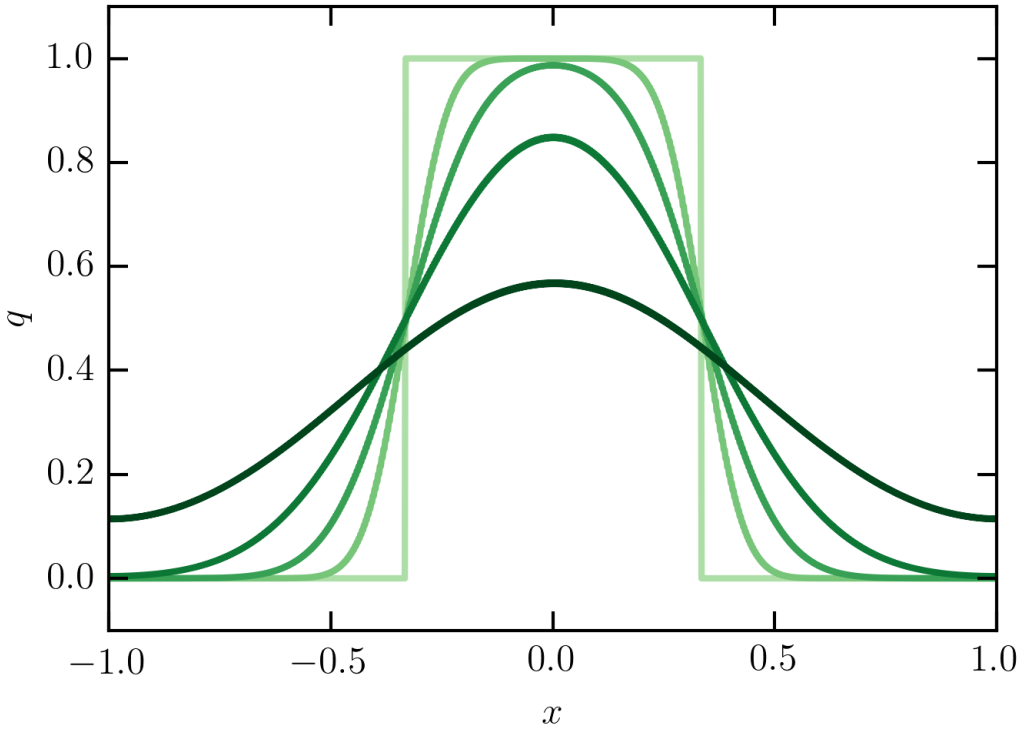
Effects of advection errors on ISM structure in galaxy simulations



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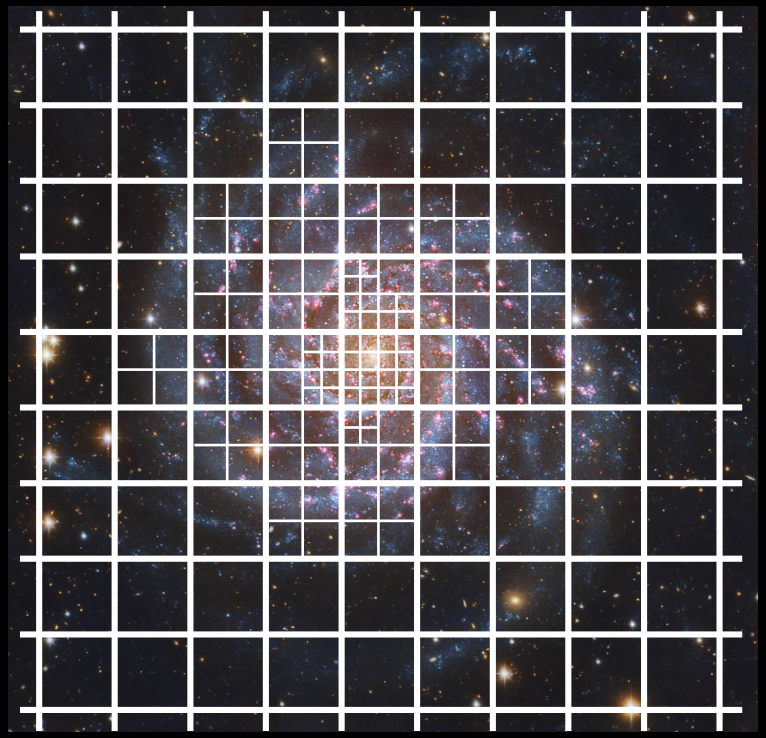
Yike Tang
Andrew MacFadyen
(New York University)

ART

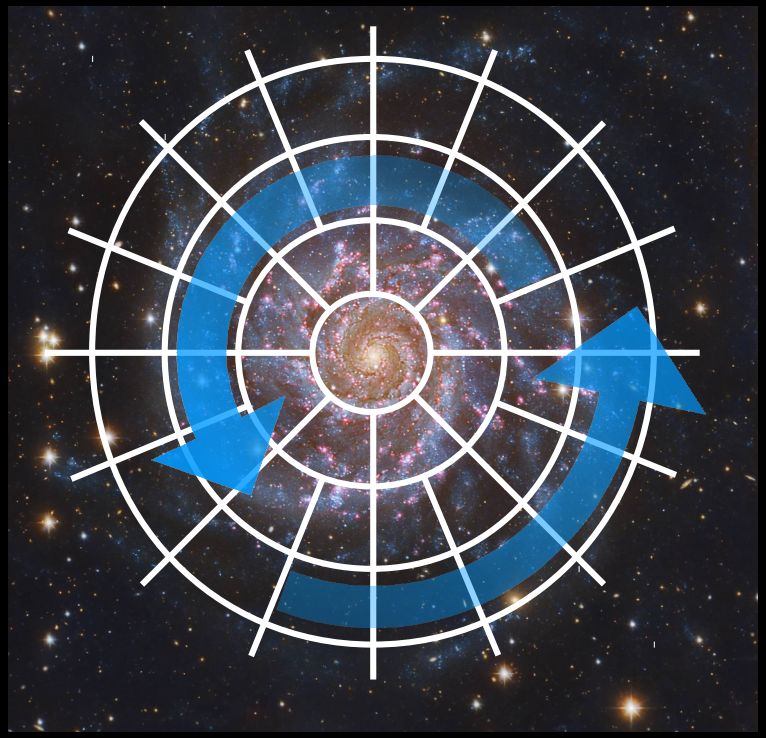
(Kravtsov 1999, Rudd et al 2008, Gnedin & Kravtsov 2011)



AMR

DISCO

(Duffell 2016)



Moving mesh

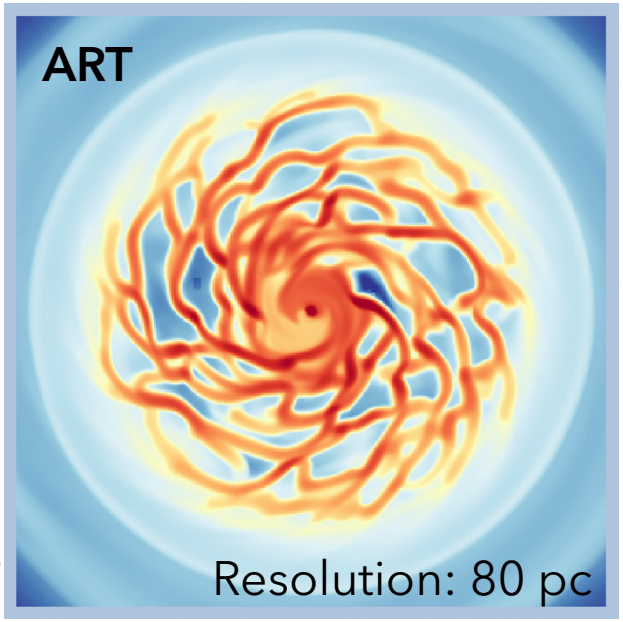
Exponential gaseous disk: $M_{gas} = 10^{10}\ M_{sun}$; $r_d = 3.4$ kpc, $z_d = 0.1 r_d$

Halo, bulge: tabulated **external potential** (AGORA)

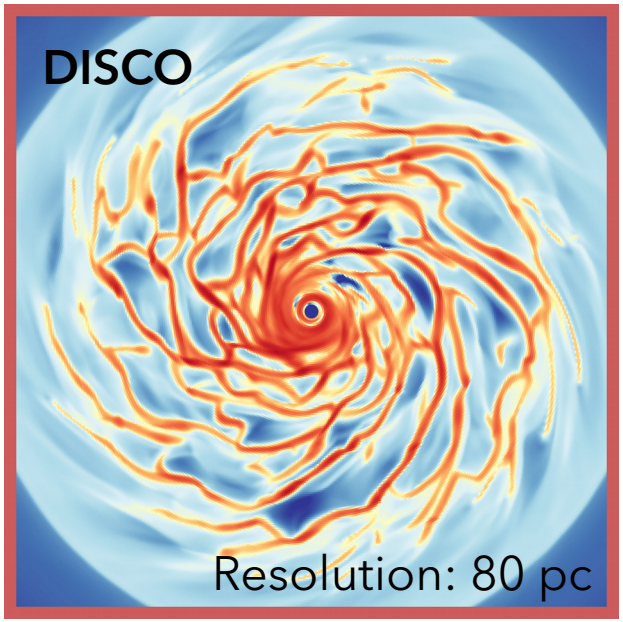
Same **Riemann solver** (HLLC), same **cooling**, varying resolution

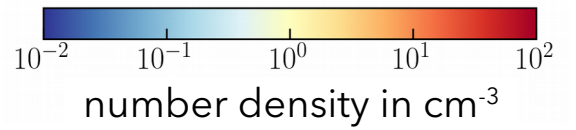
Artificial **pressure floor**: $L_{J,min} = 320$ pc in all runs

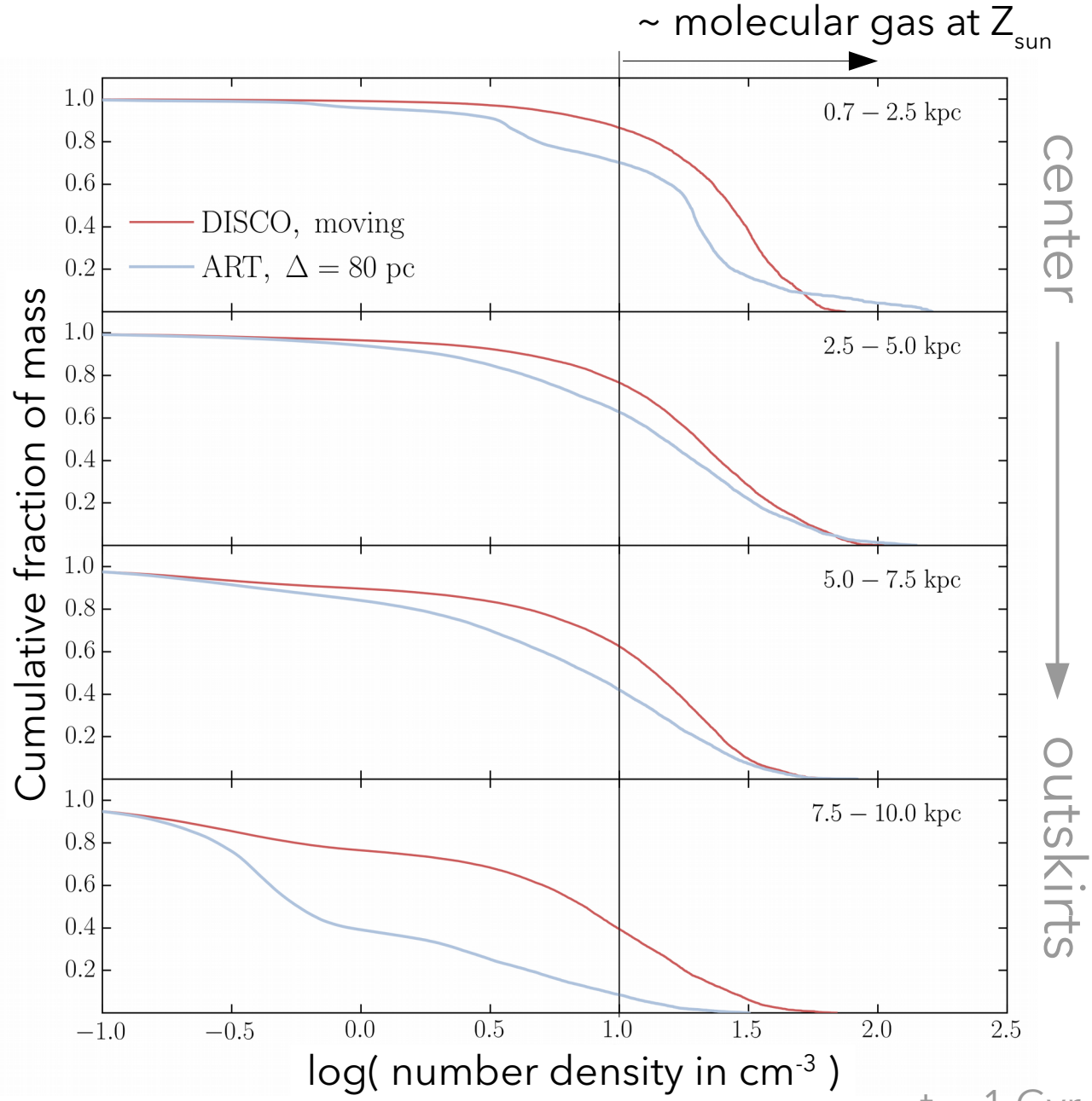
Structure of ISM modeled with AMR and moving mesh



25 kpc

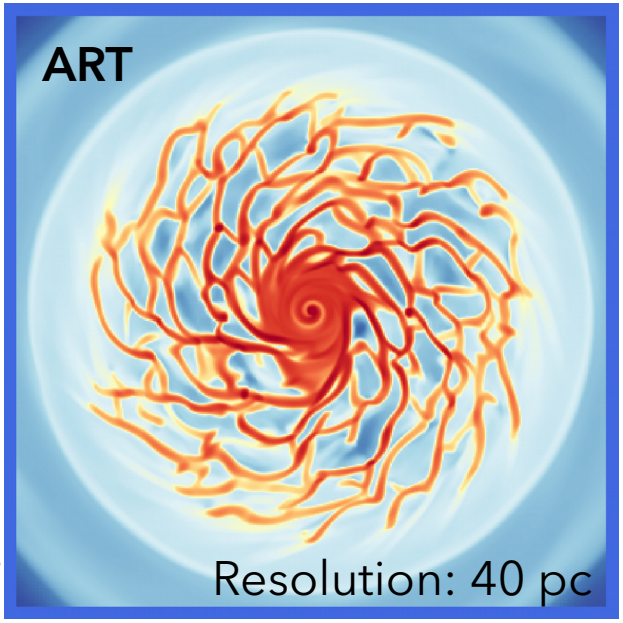




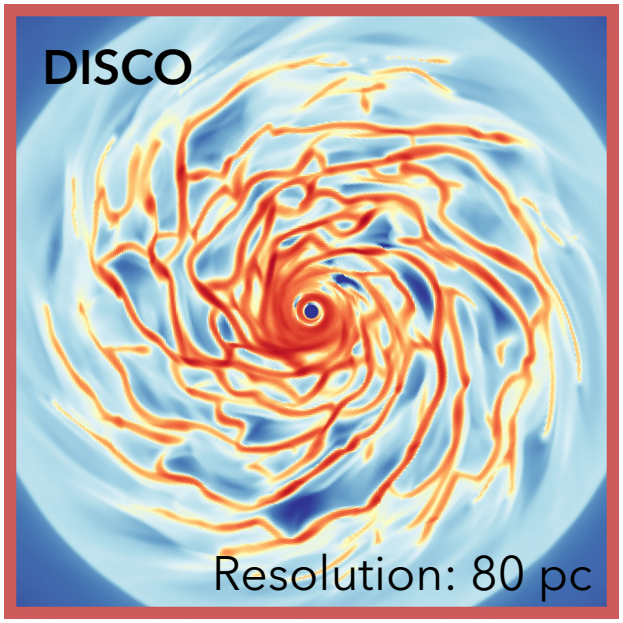


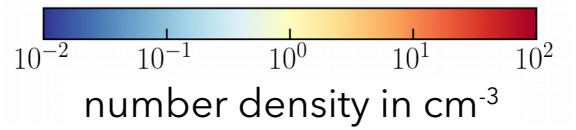
t = 1 Gyr

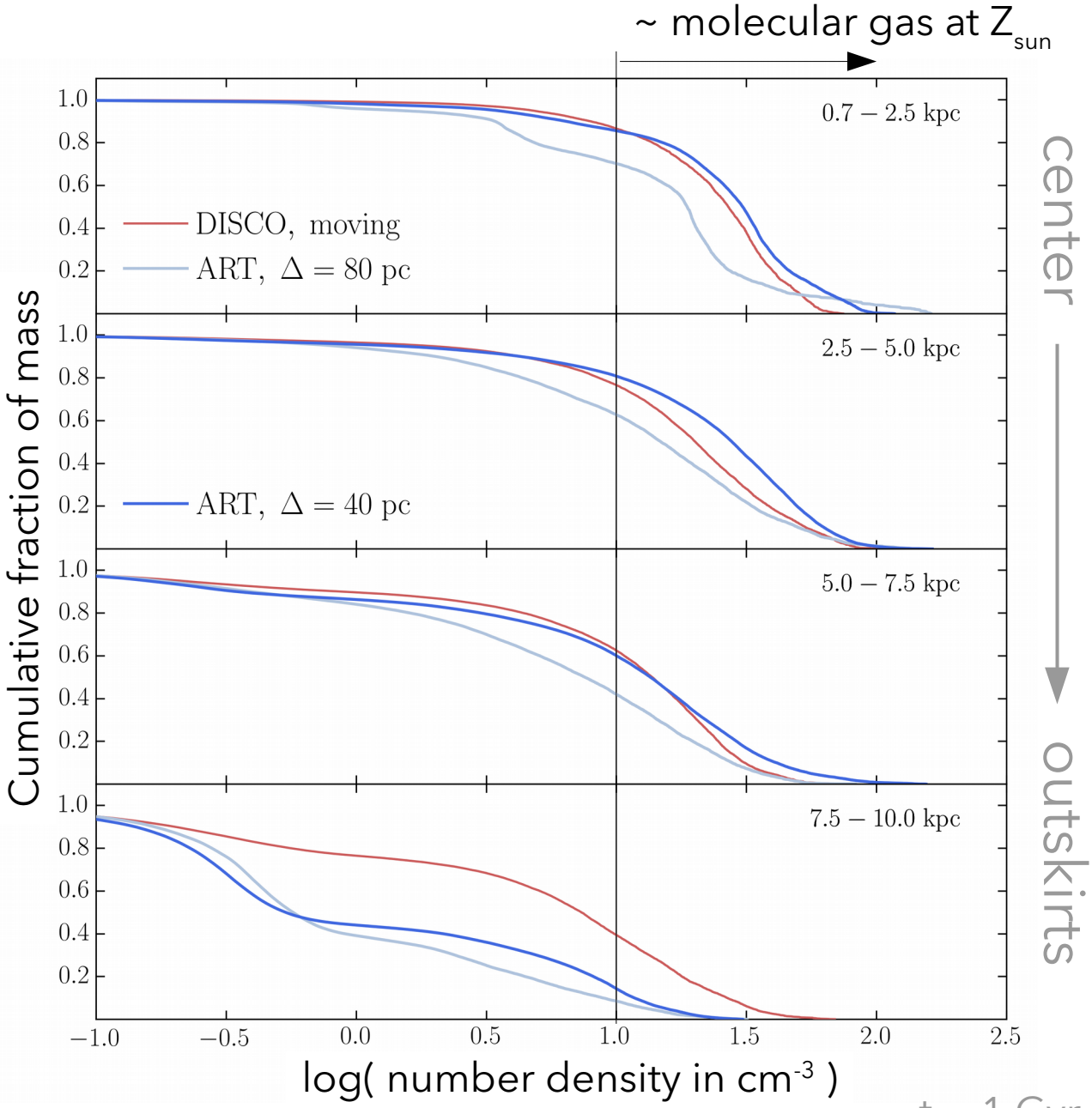
Structure of ISM modeled with AMR and moving mesh



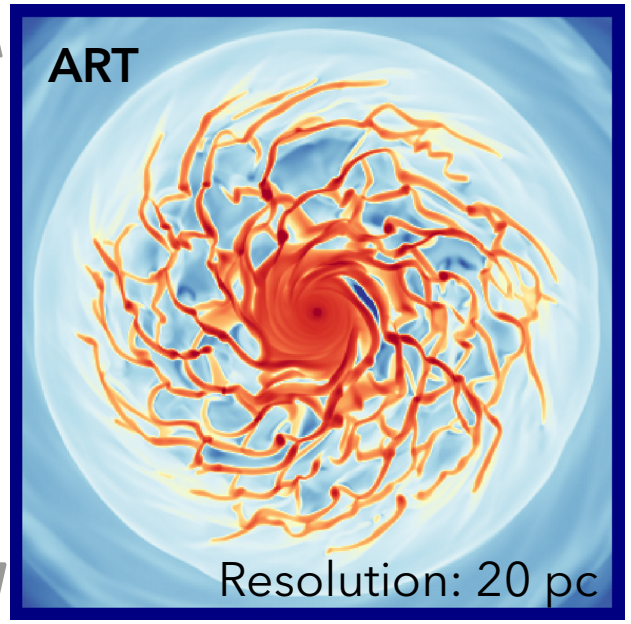
25 kpc



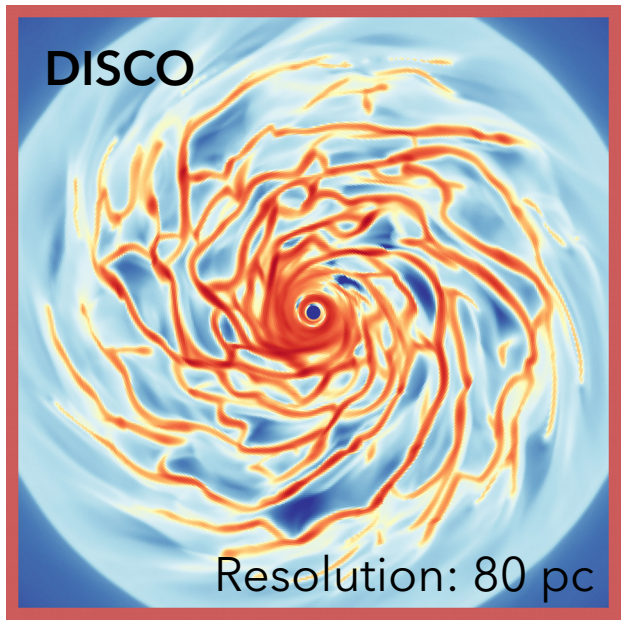


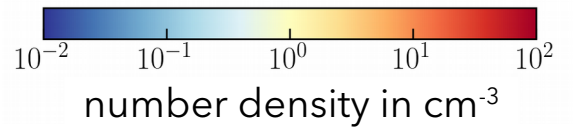


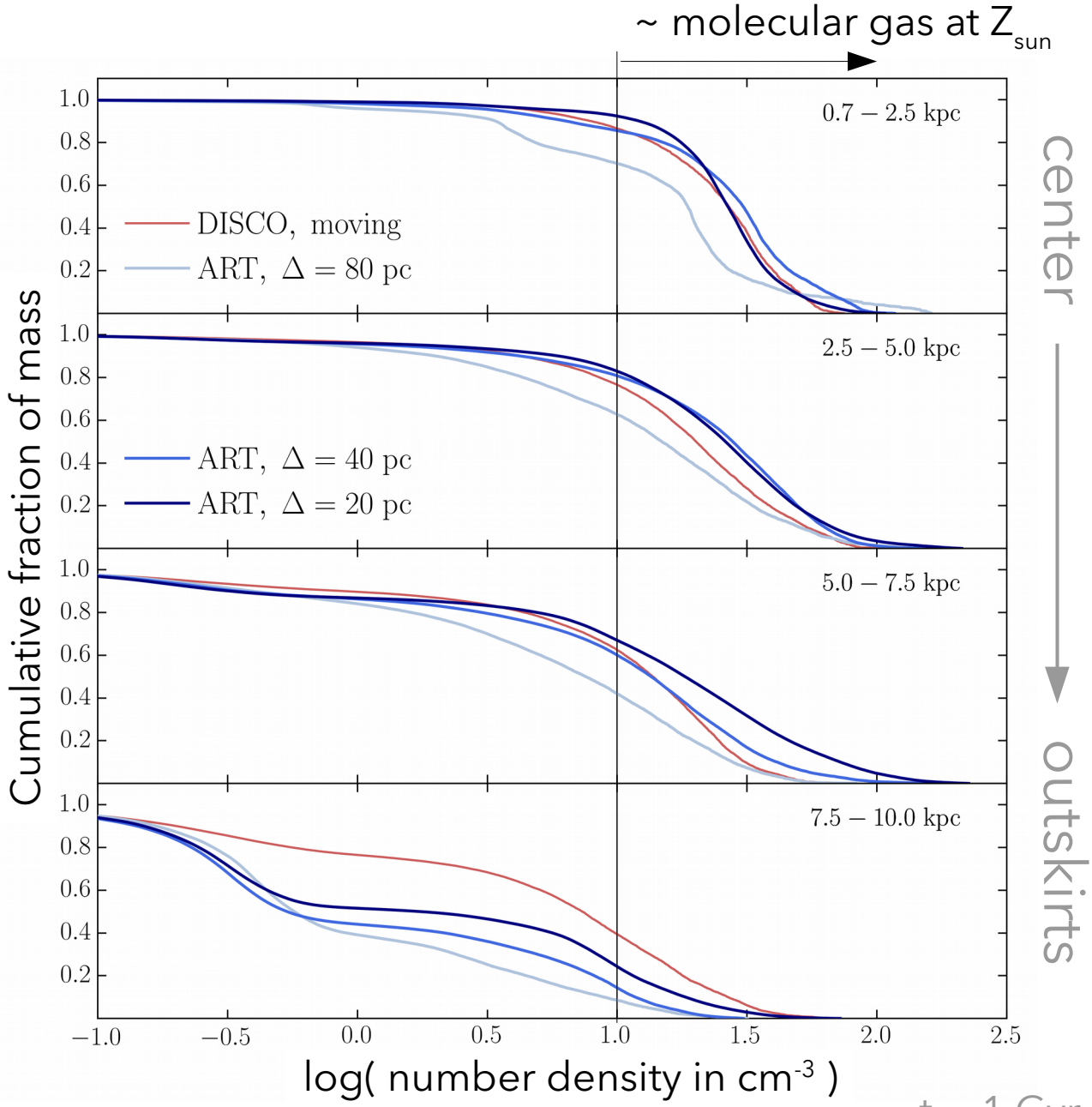
Structure of ISM modeled with AMR and moving mesh



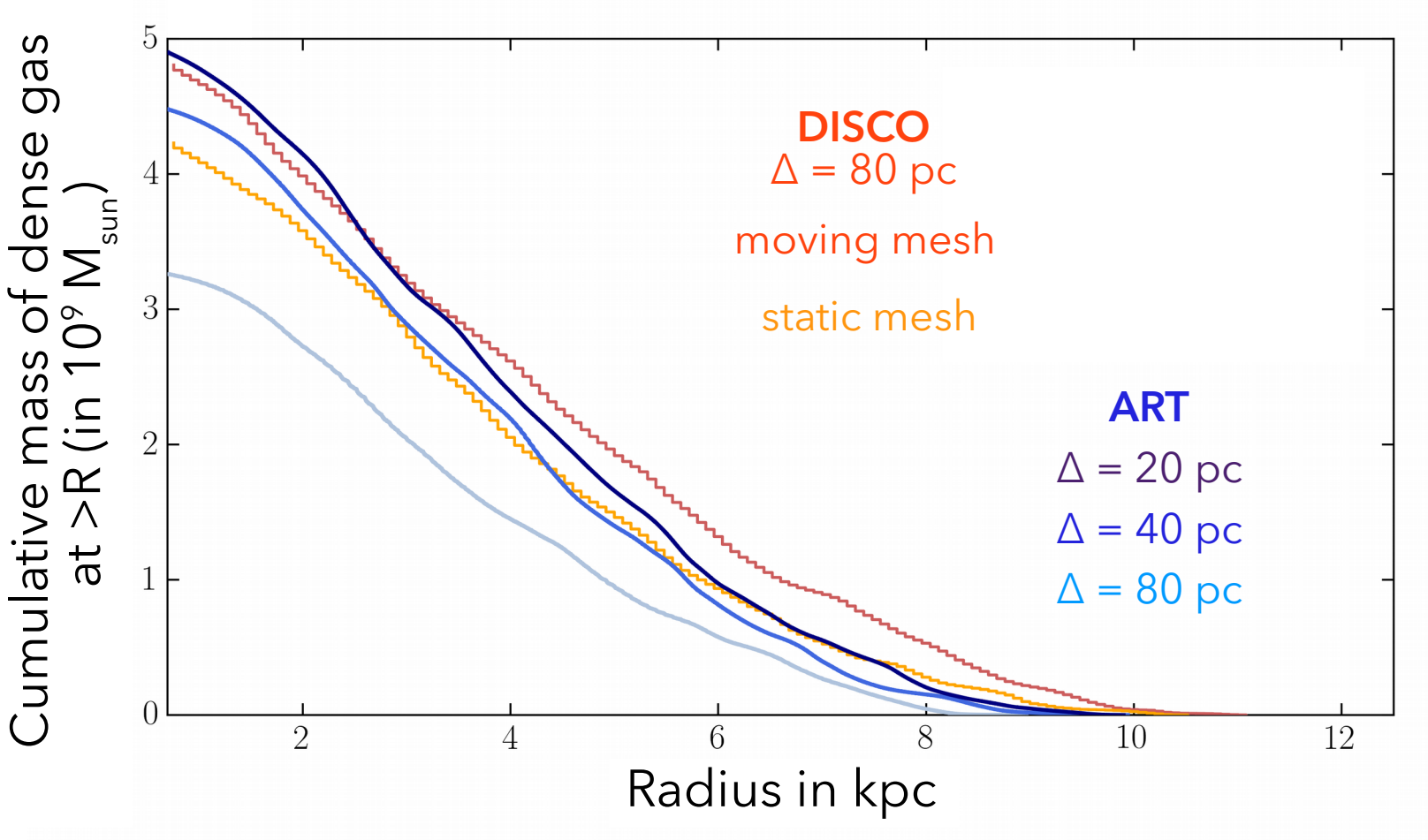
25 kpc





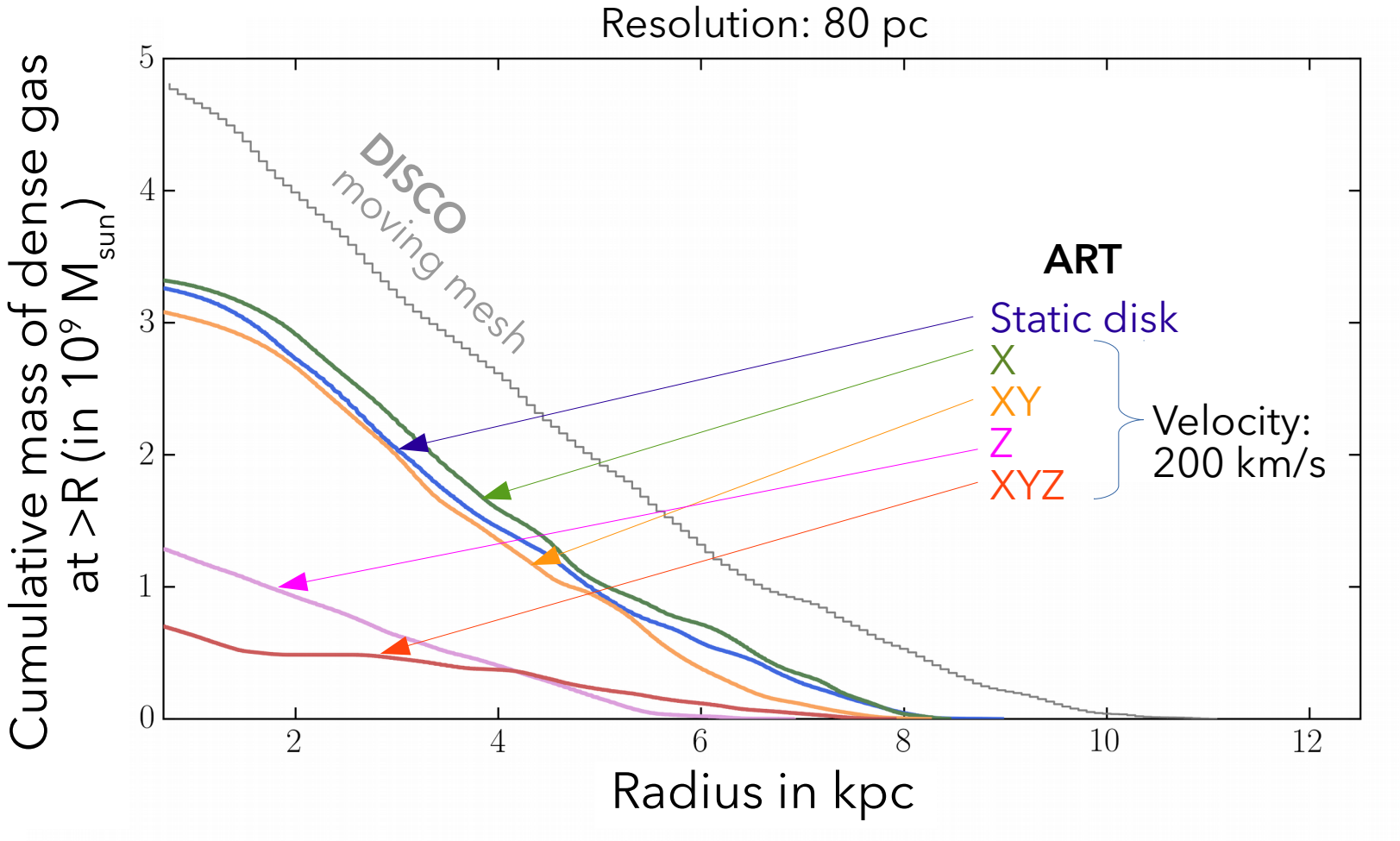


Effect of advection on total mass of dense gas



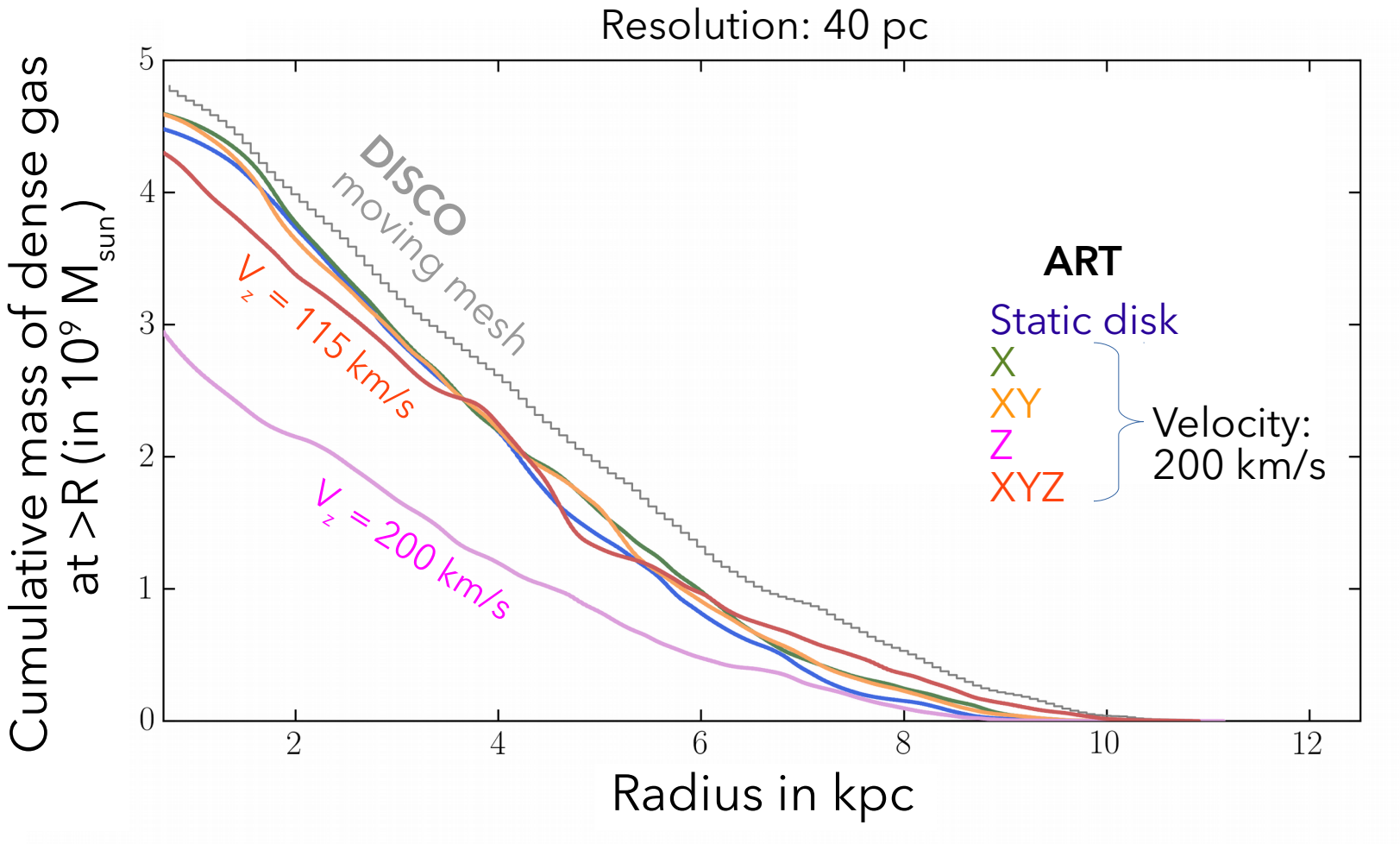
- Effect of advection decreases with increasing resolution
- Transient nature of dense features + compressive restoring forces → effect of advection is small
- Effect of advection is smaller when gas flows perpendicular to cell interfaces

Effect of disk translation



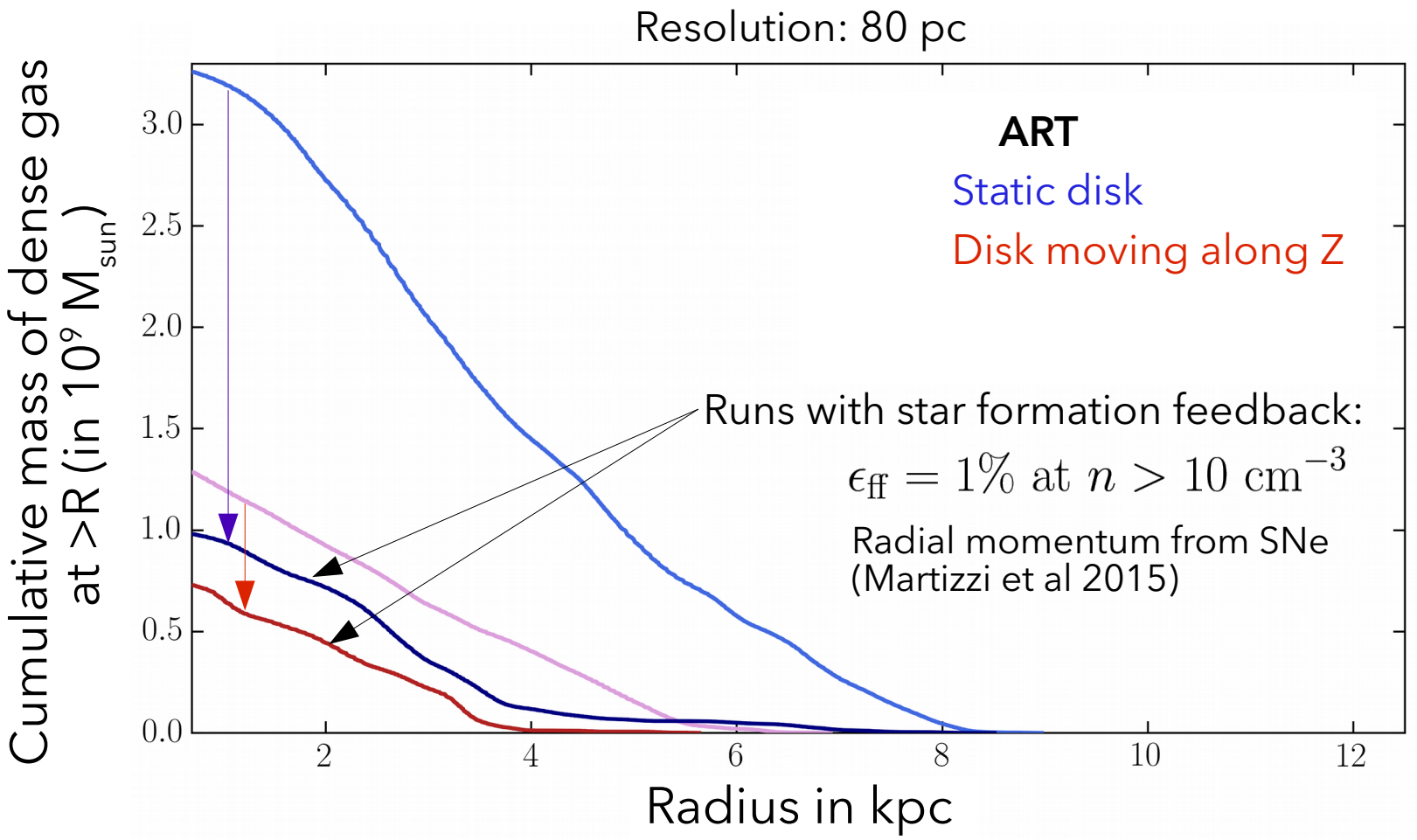
- Effect of disk translation is the strongest when disk is moving vertically
- Zoom-in AMR simulations may benefit from subtraction of bulk velocity; moving patch codes do this automatically

Effect of disk translation



- Effect of disk translation is the strongest when disk is moving vertically
- Zoom-in AMR simulations may benefit from subtraction of bulk velocity; moving patch codes do this automatically
- Effect of translation decreases with increasing resolution

Effect of star formation feedback



- Effect of feedback is stronger than the effect of advection
- Feedback shortens lifetimes of dense structures and thereby decreases effects of advection

Conclusions

Due to the transient nature of dense structures and existence of restoring forces the amount of star-forming gas is only weakly affected by advection errors

The strongest effect comes from vertical bulk motion of the disk

Advection errors are mitigated by increasing resolution and subtraction of the bulk translational motions

In the presence of stellar feedback the effect of advection errors is significantly reduced because feedback shortens lifetimes of dense star-forming regions