# Simulating AGN jet feedback in galaxy clusters


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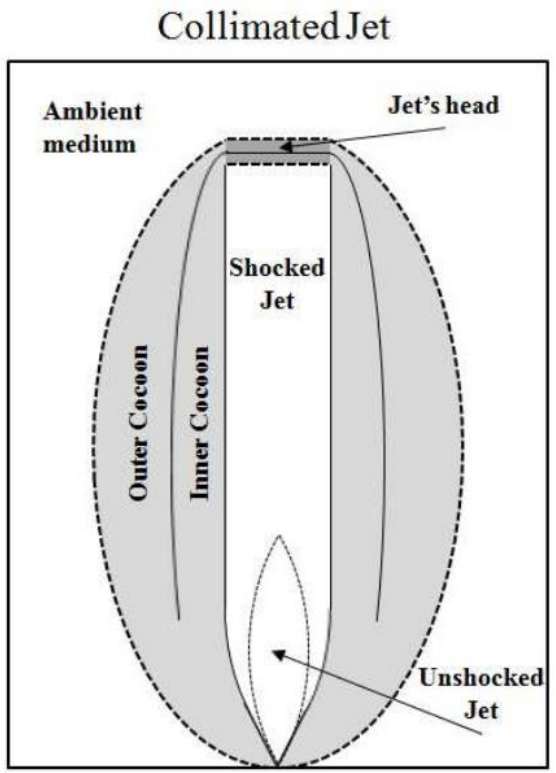
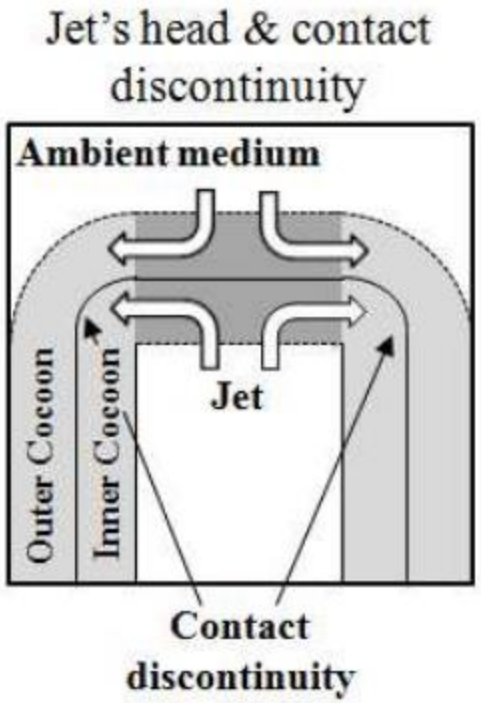
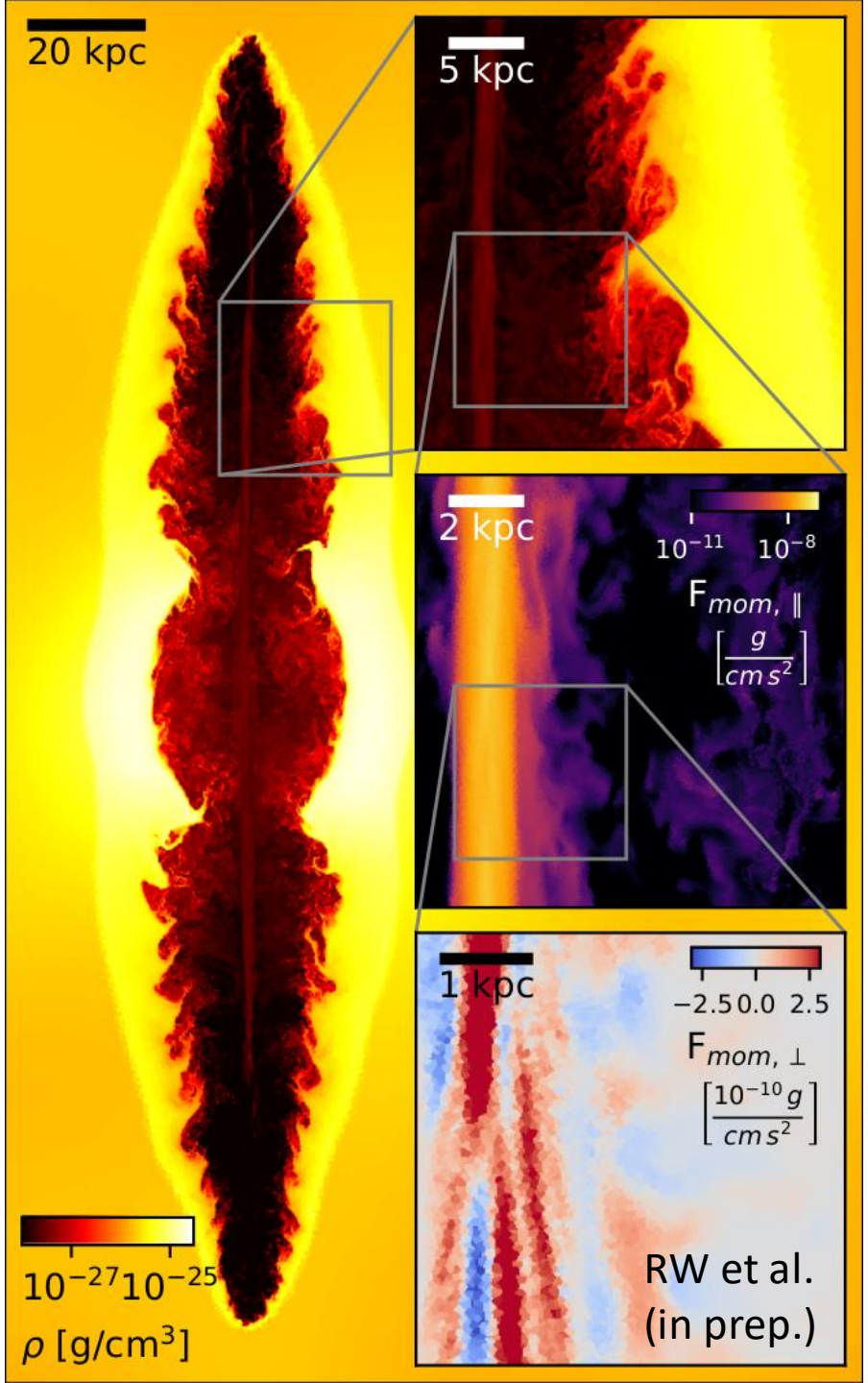
- Jet propagation
- Feedback effects at $t < t_{cool}$
- Self-regulation
- Multi-phase gas

# Jet

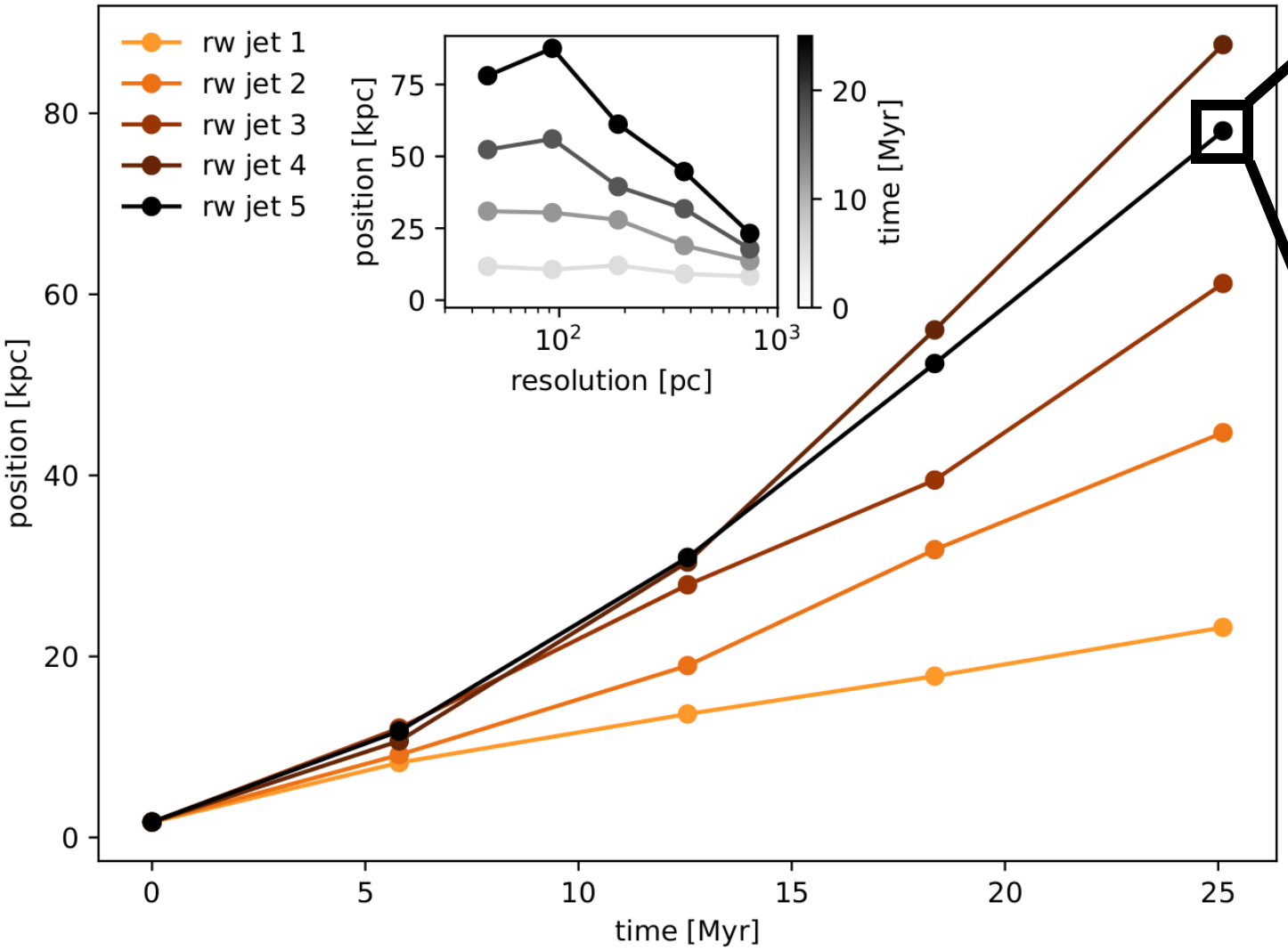


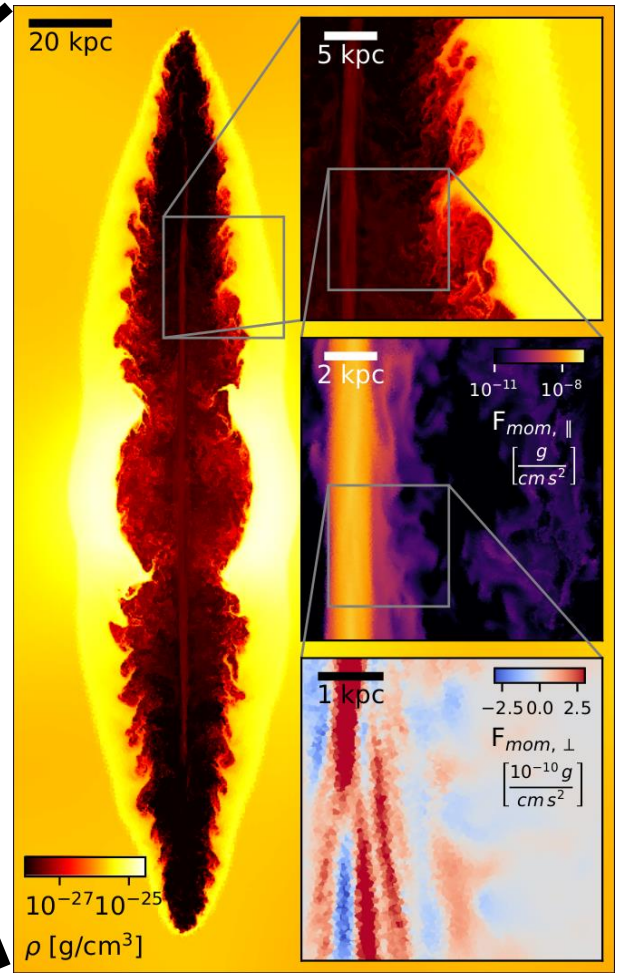




Bromberg et al. (2011)



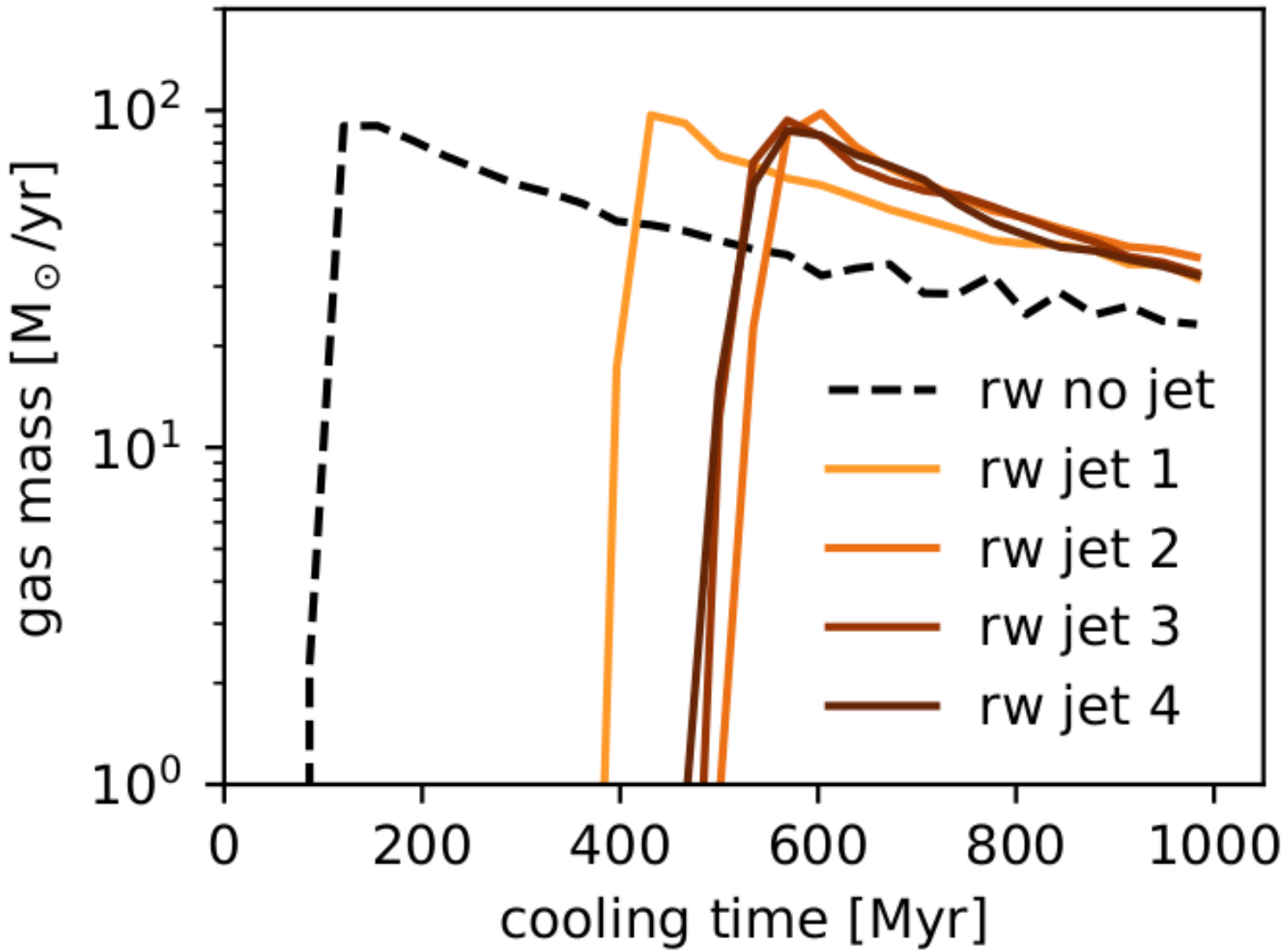
# Jet propagation

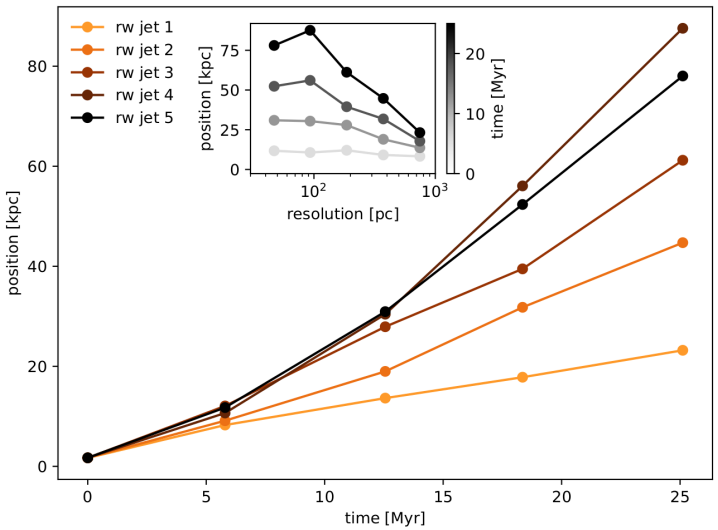



RW et al. (in prep.)

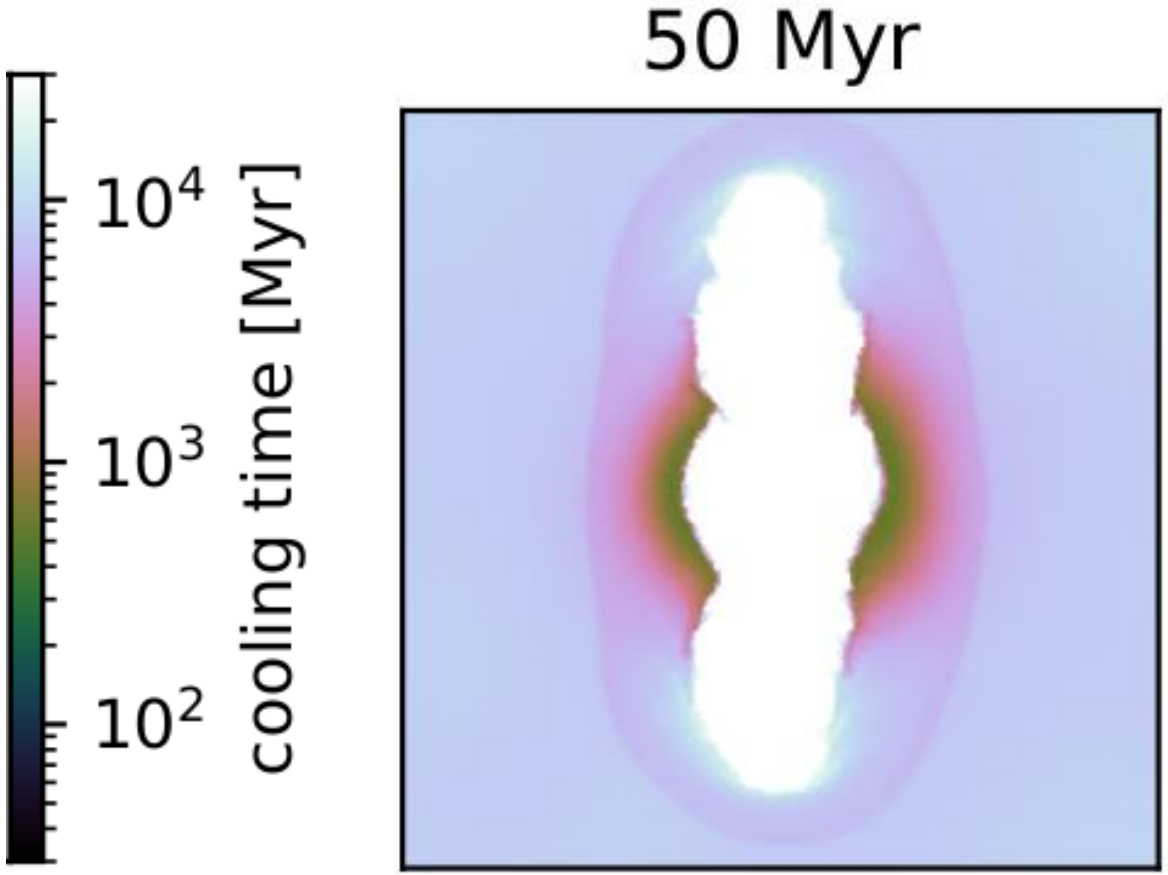
# Feedback convergence

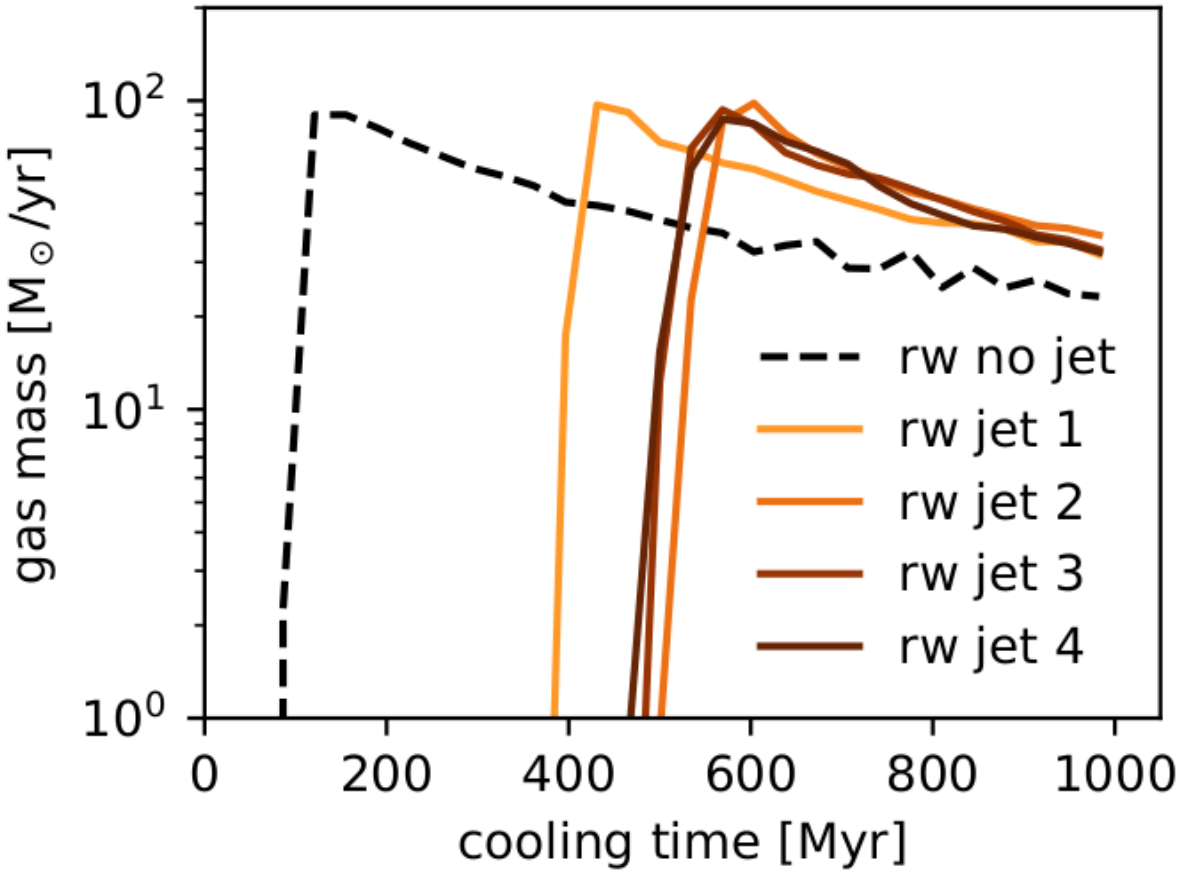



RW et al. (in prep.)

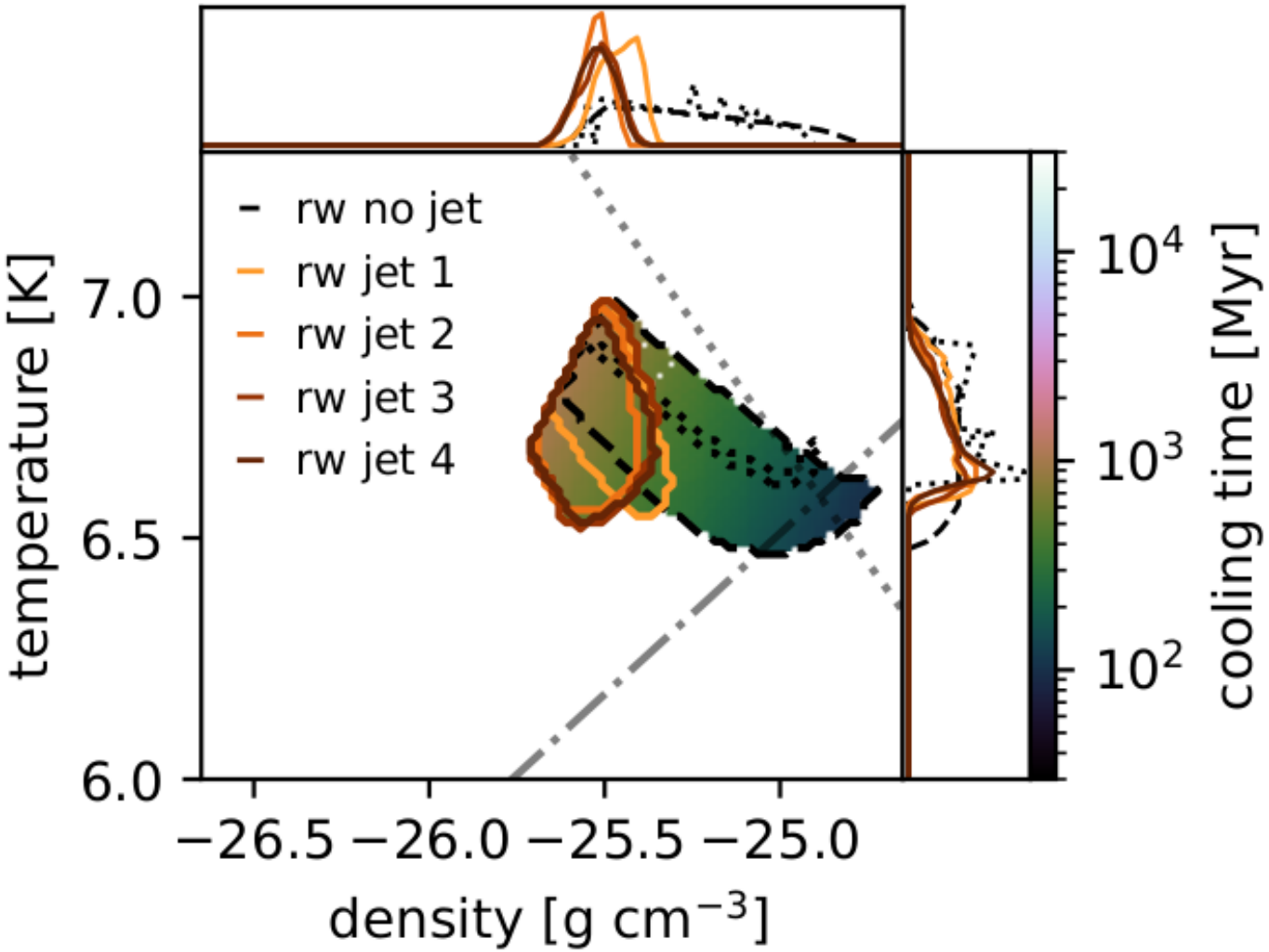
# Feedback mechanism

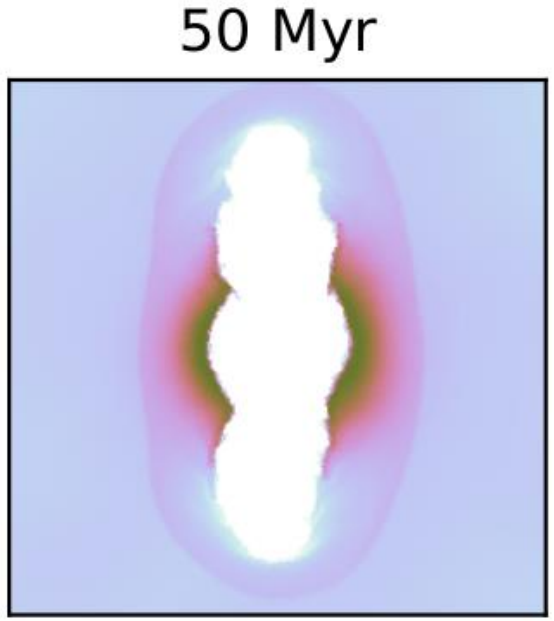



RW et al. (in prep.)

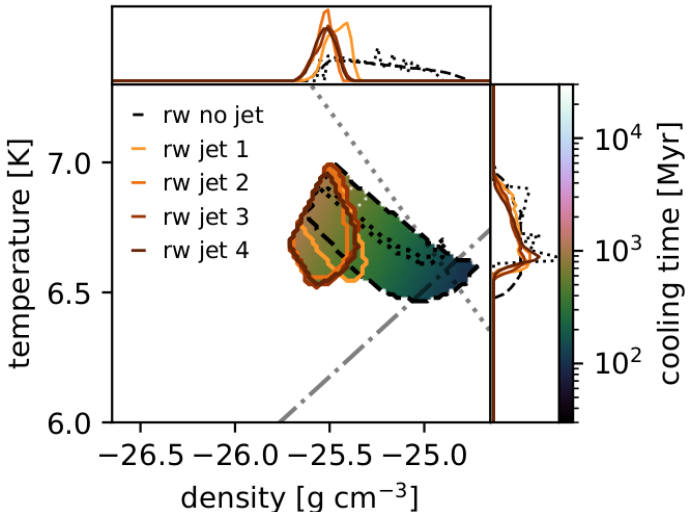
# Feedback mechanism

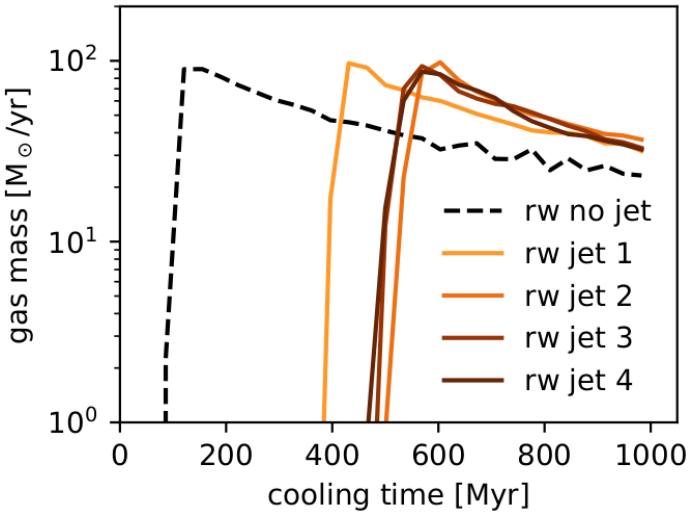


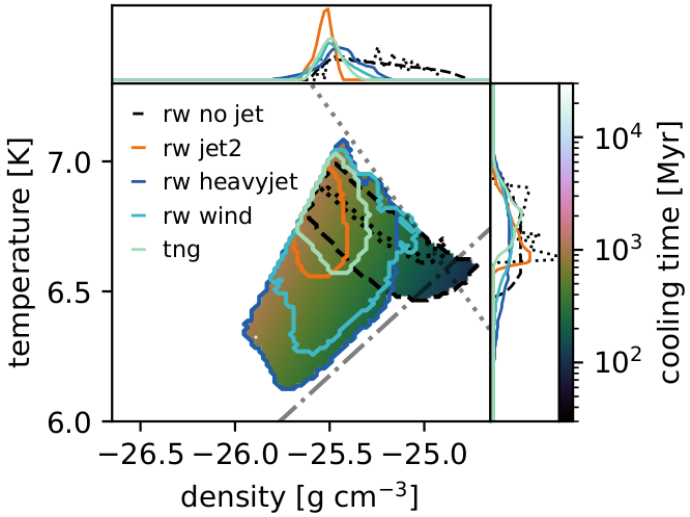



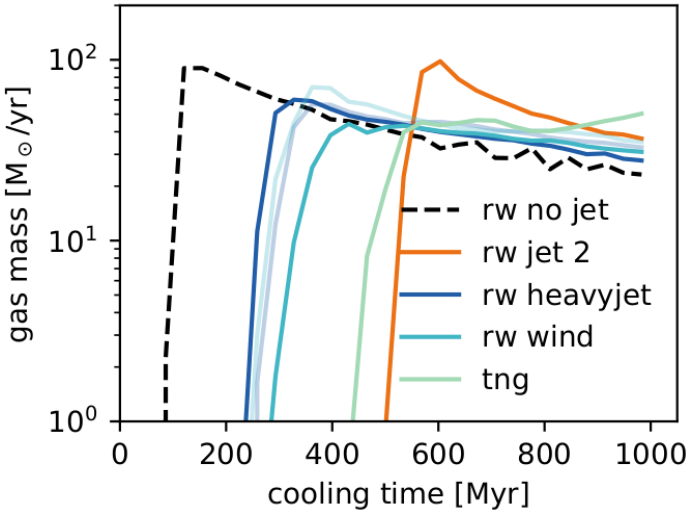

RW et al. (in prep.)

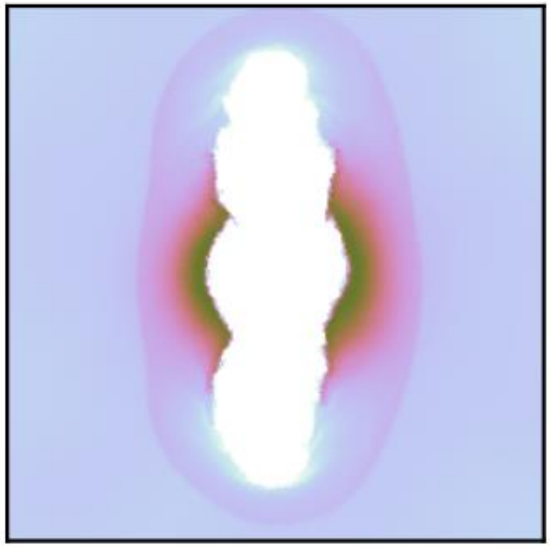
# Model dependence



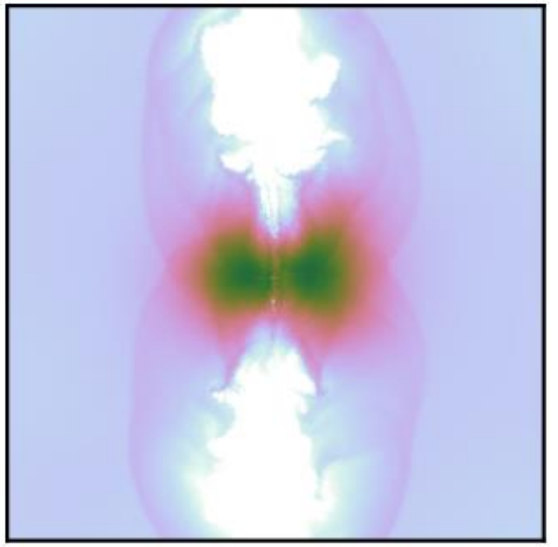



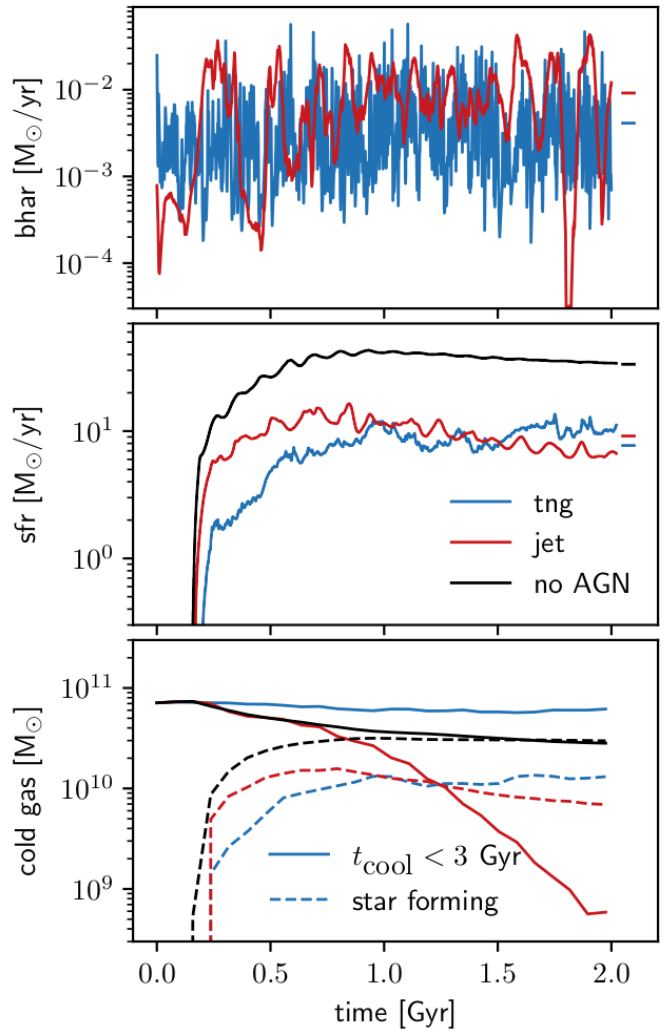

rw jet 2

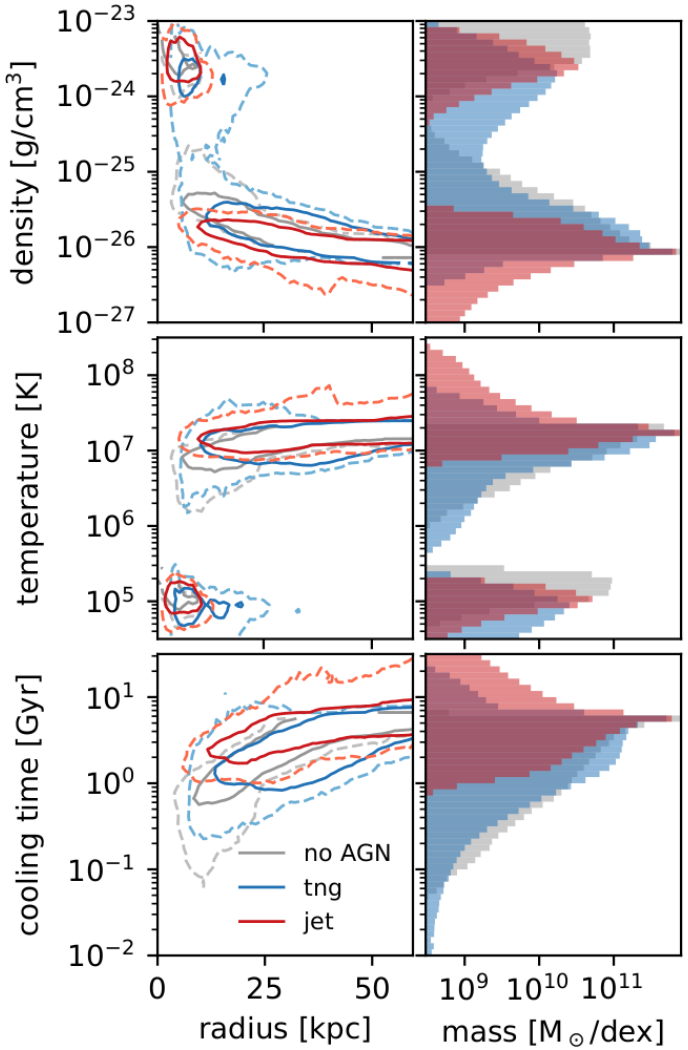


rw heavyjet

RW et al. (in prep.)

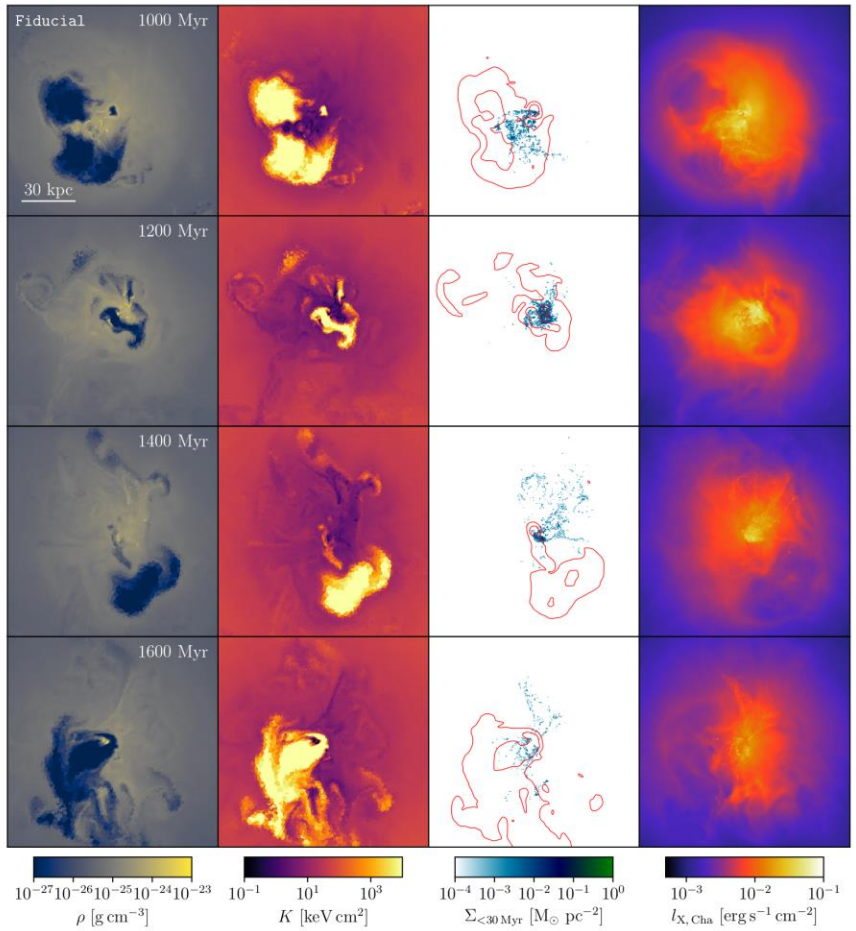
# Self-regulated heating & cooling



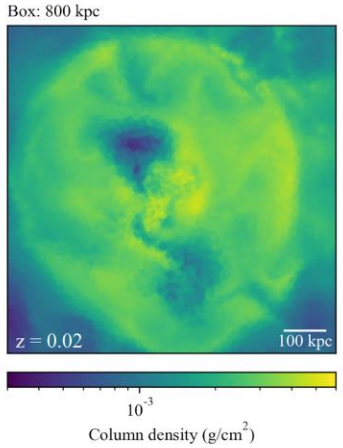



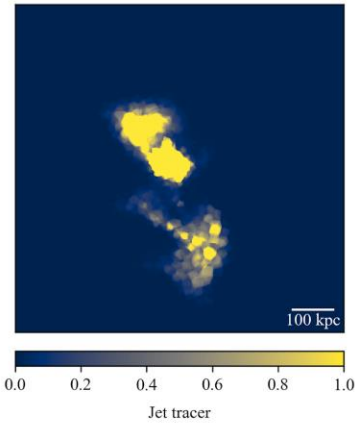

RW et al. (in prep.)

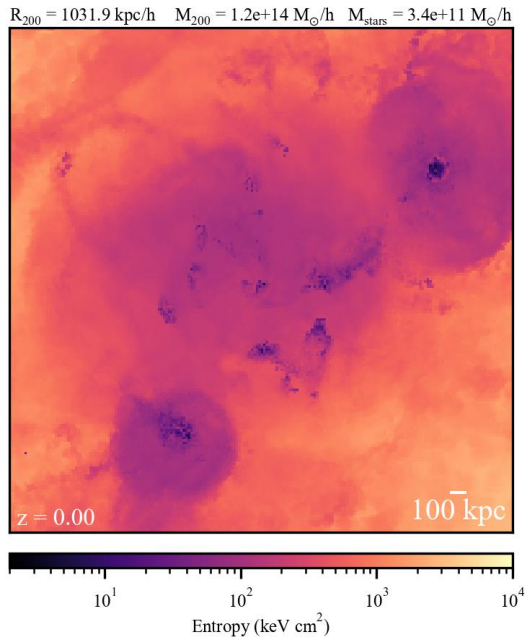
# Simulations of galaxy clusters




Ehlert et al. (arXiv:2204.01765)

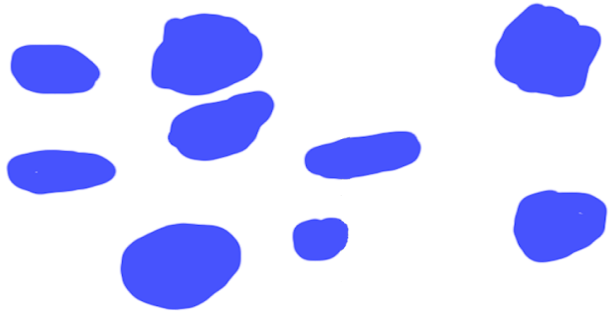


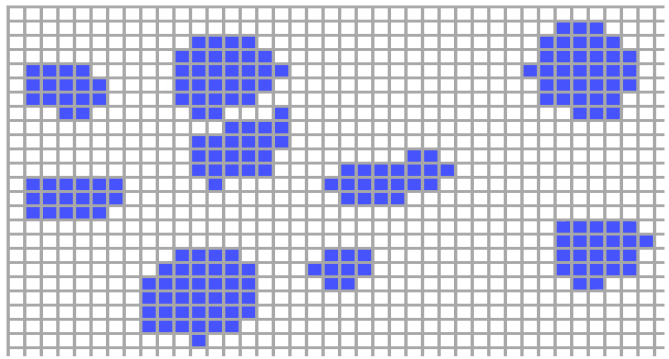



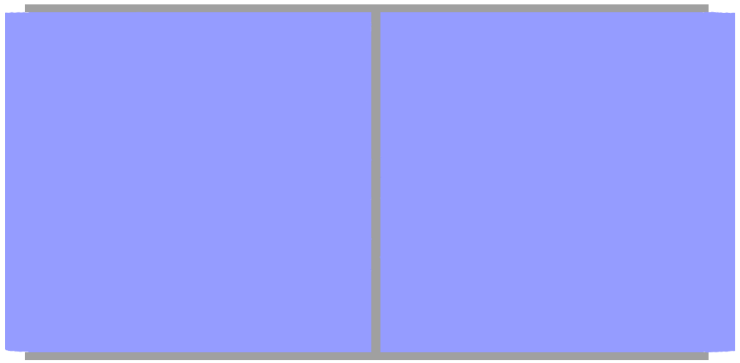



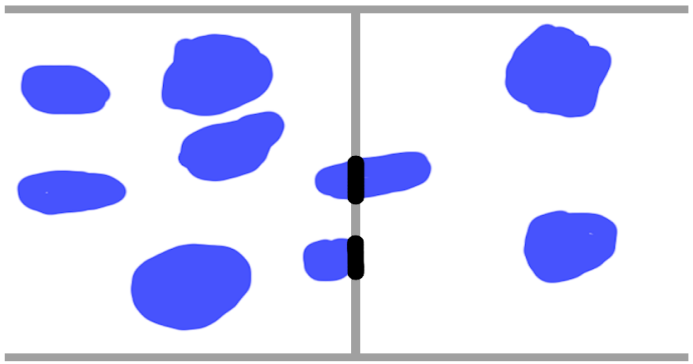

Jlassi et al. (in prep.)

# Multi-phase medium







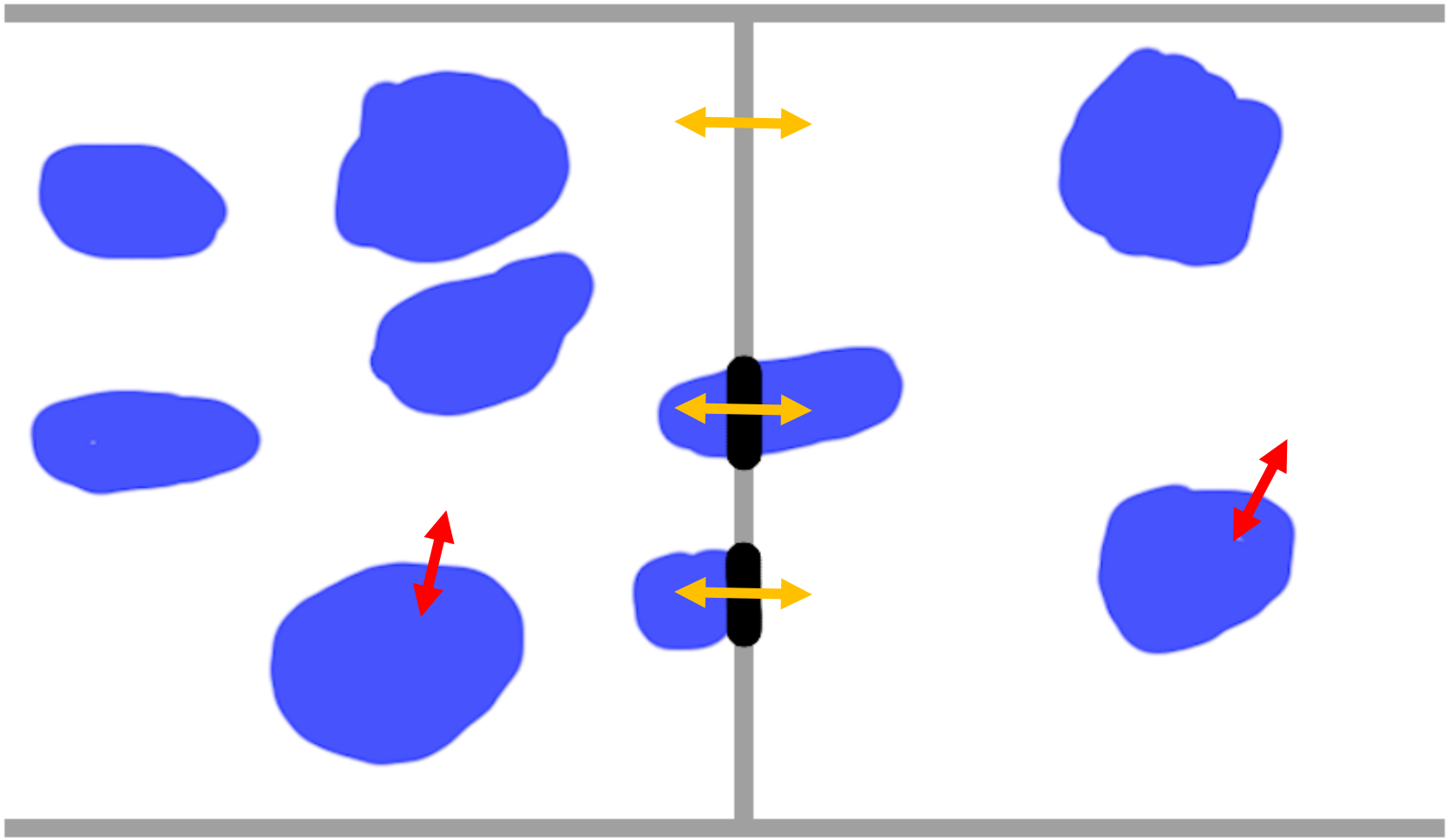


RW & Hernquist (arXiv:2204.05316)

# 2-fluid hydrodynamics

**Interface fluxes**

**Source term**

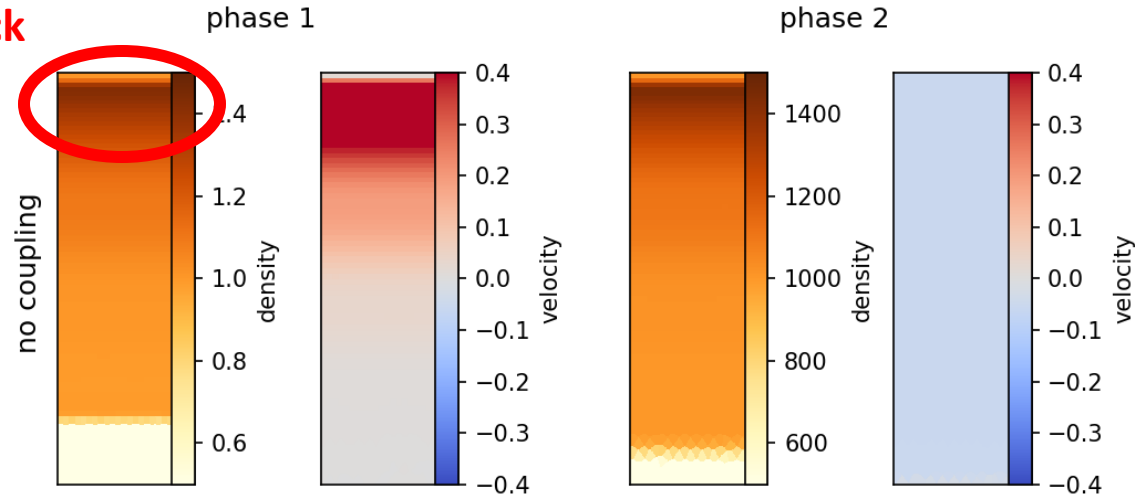


RW & Hernquist (arXiv:2204.05316)

# Multi-phase outflows

**No interaction between phases**

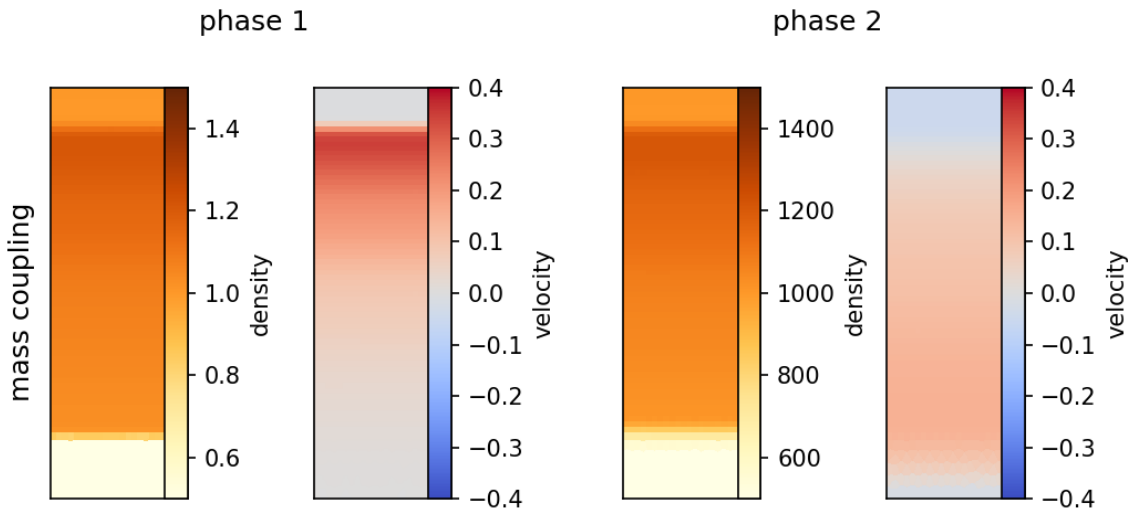
**no Source term**




**gravity**

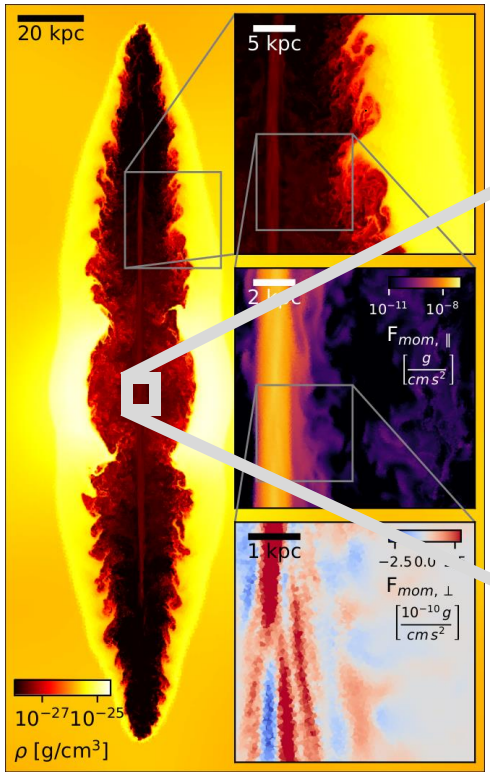
**Mass exchange between phases**

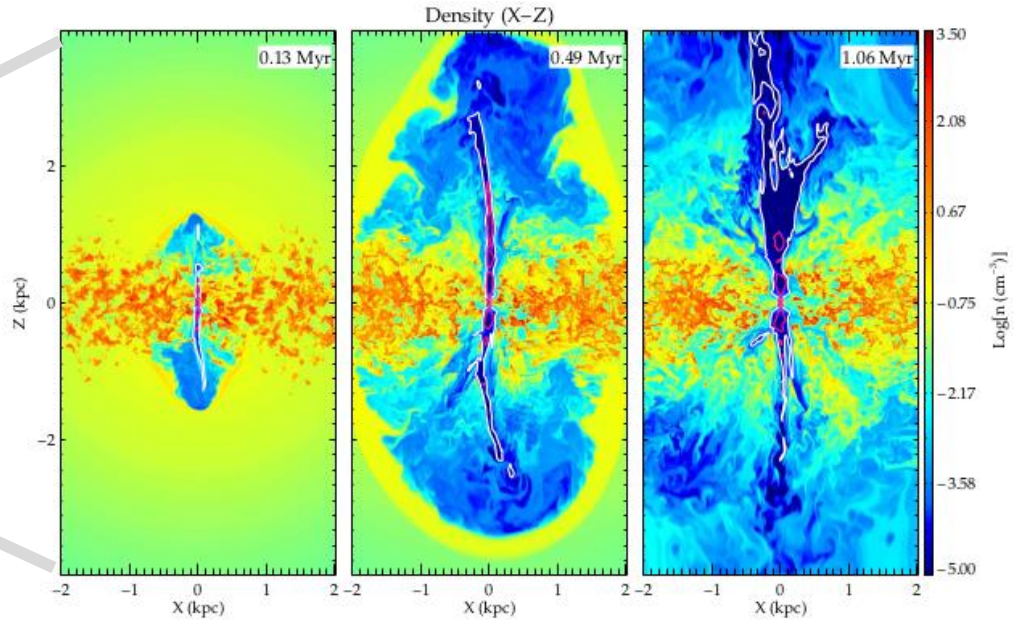
**Source term**




RW & Hernquist (arXiv:2204.05316)

# Jet propagation in the interstellar medium



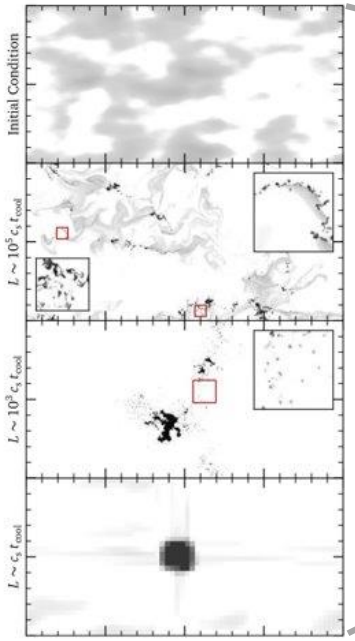




Mukherjee et al. (2018)

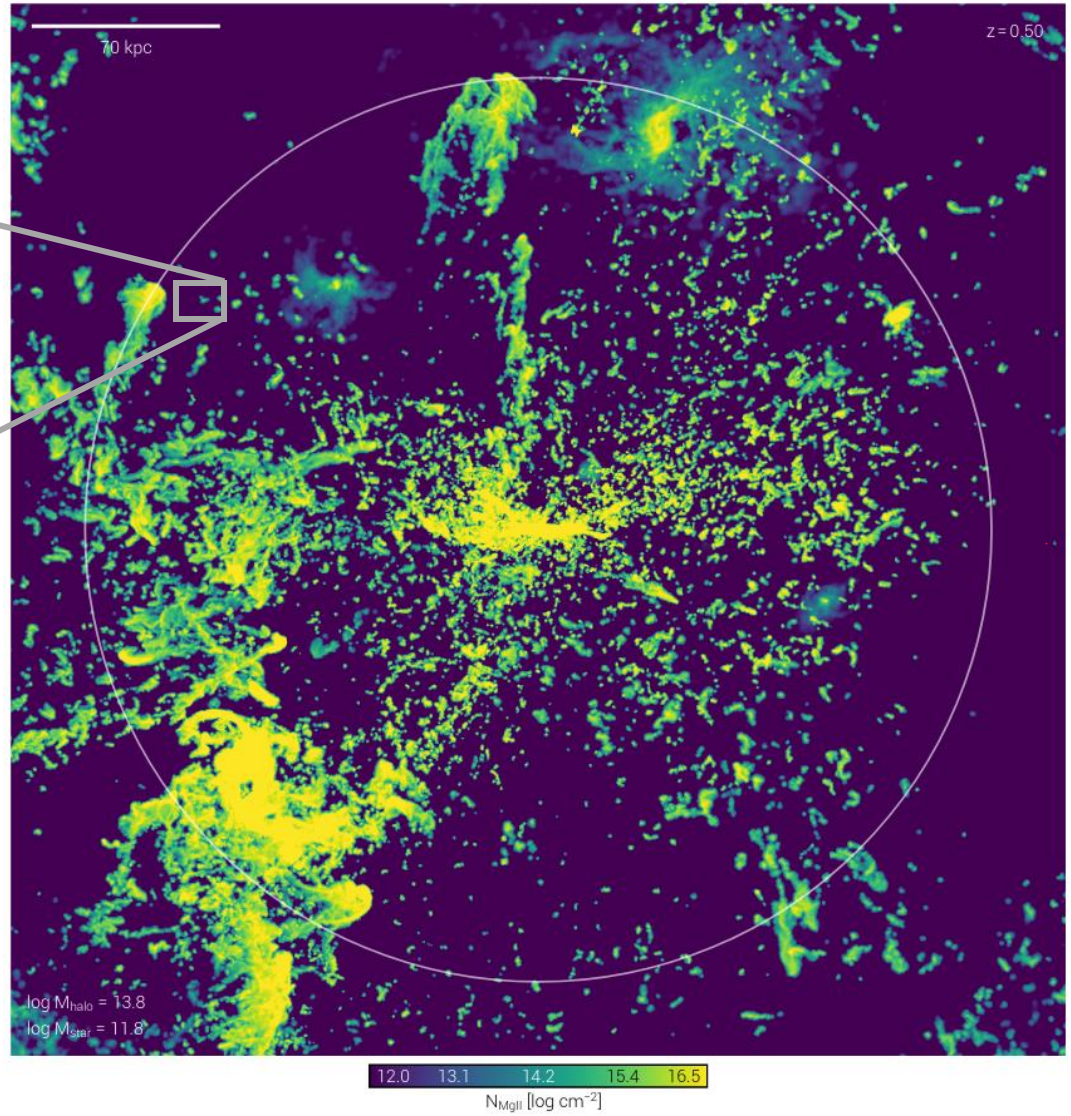
- Flux in hot phase
- Evaporation rate
- Flux in cold phase

RW et al. (in prep.)

# Multi-phase intra-cluster medium

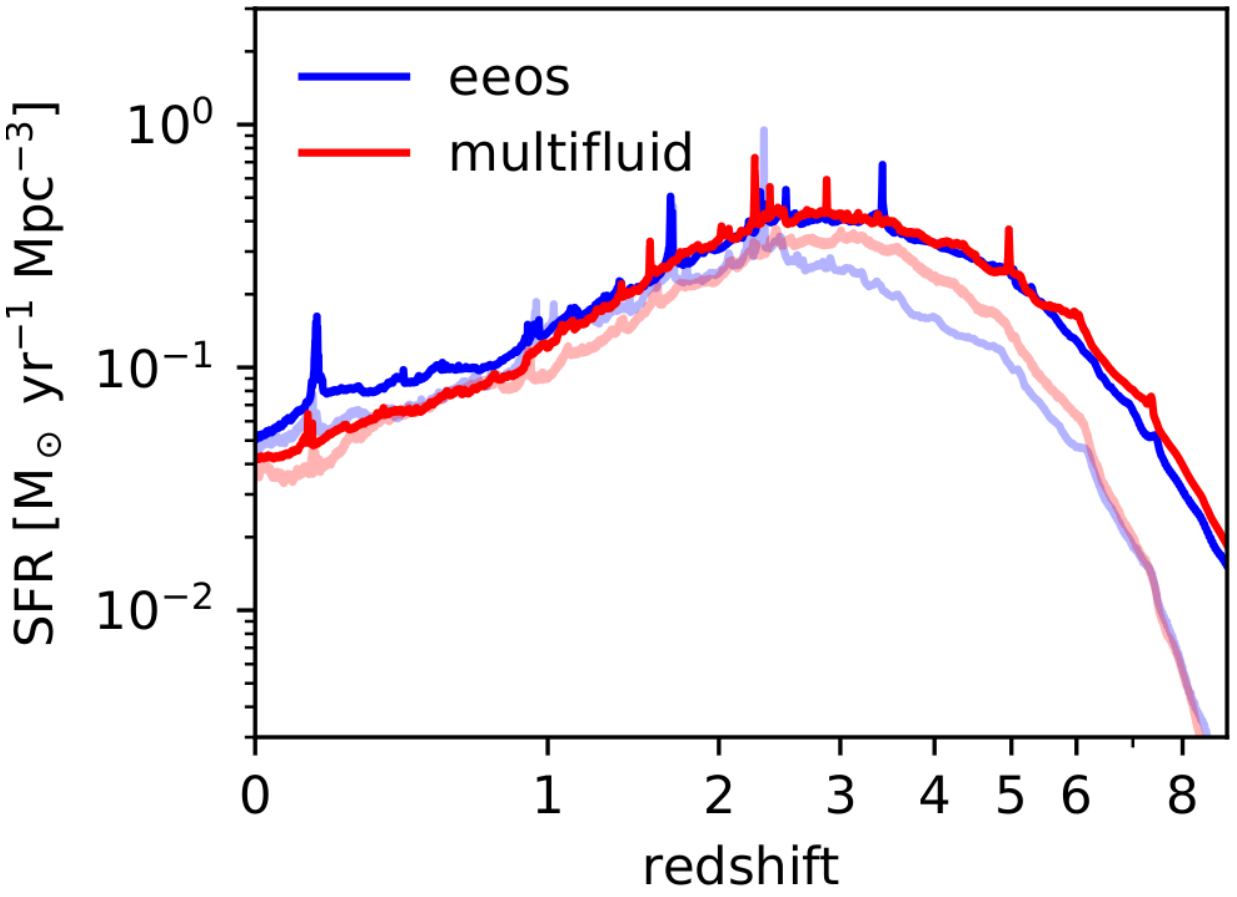


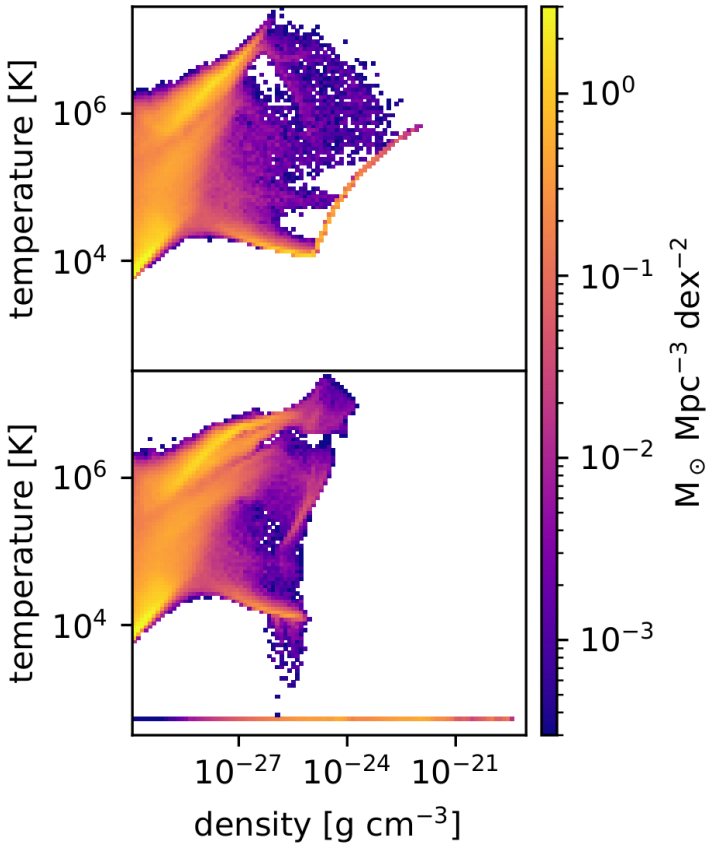

McCourt
et al. (2016)




Nelson
et al. (2020)

# Cosmological simulations




RW & Hernquist (arXiv:2204.05316)

# Summary

Jets in isolation: immediate feedback effect via central cocoon

- Light vs. heavy jet: momentum flux matters for feedback effects

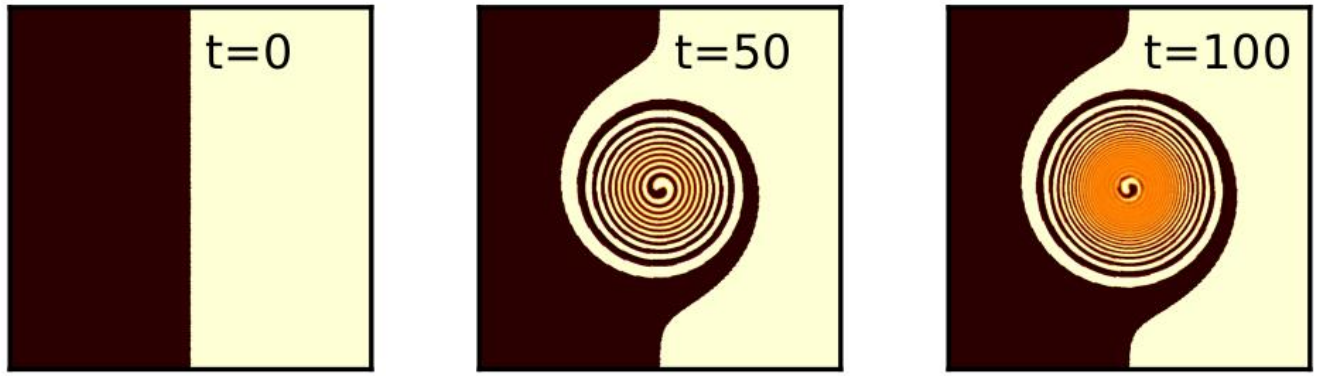
Self-regulated jet simulations: non-uniqueness of AGN feedback

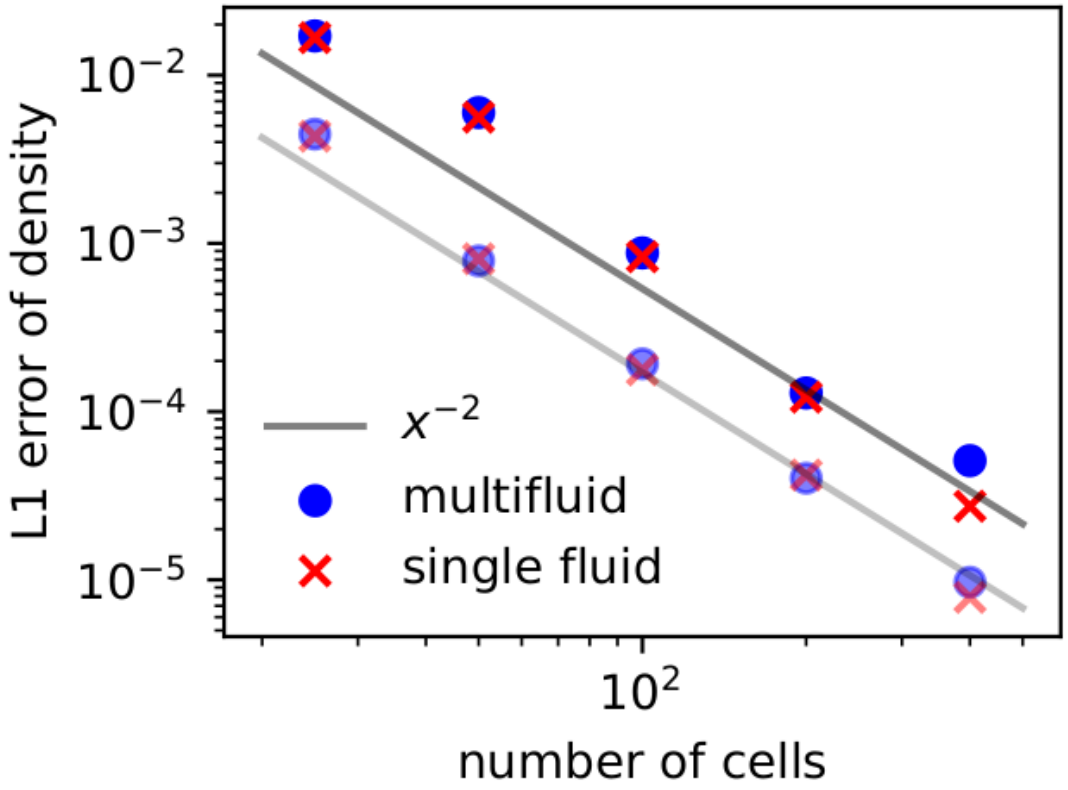
- Correct star formation rate does not imply correct effects on gas structure

Multi-phase medium: 2-fluid modeling for unresolved structure

- Connect cosmological simulations to small-scale studies

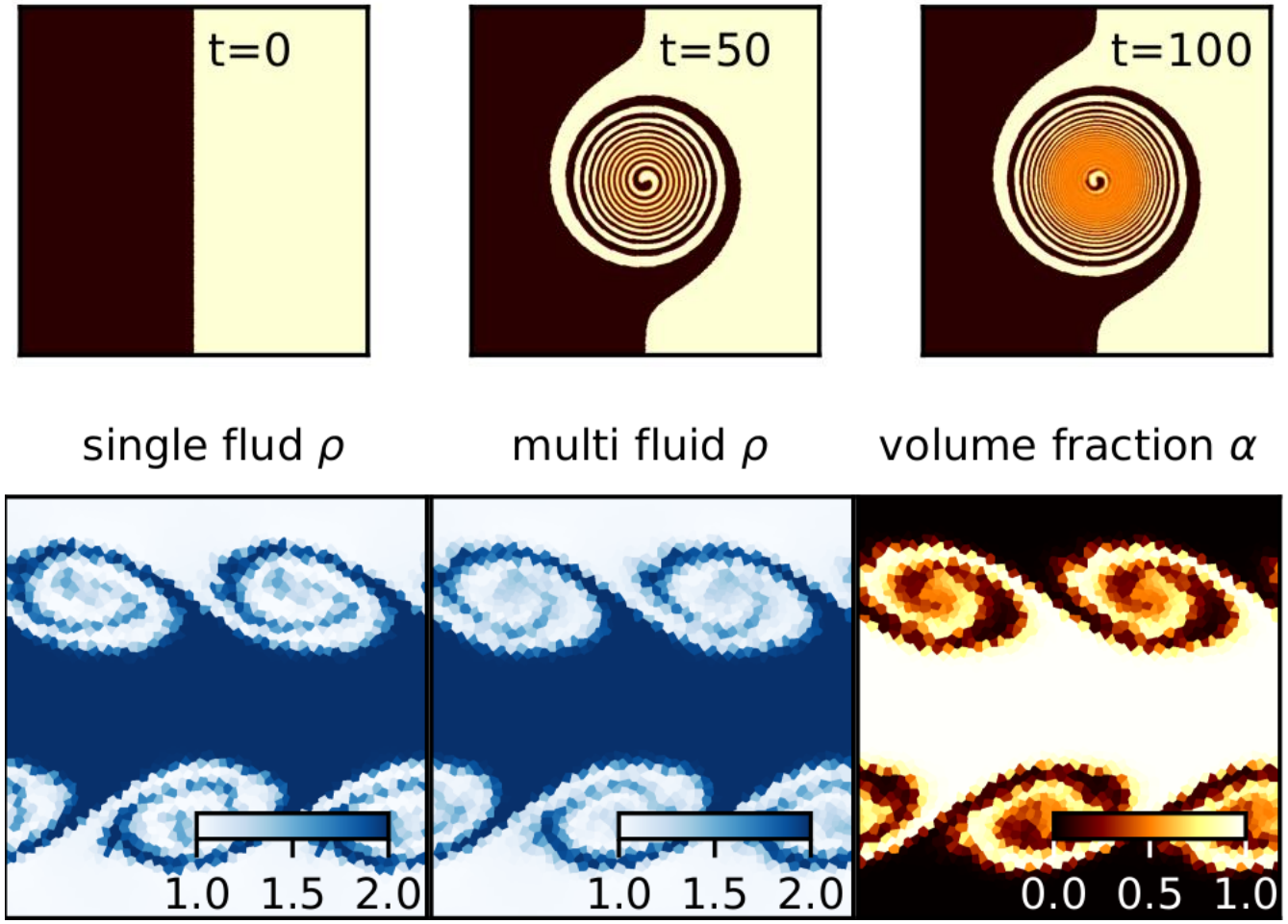
# Modeling of resolved multi-fluid flows

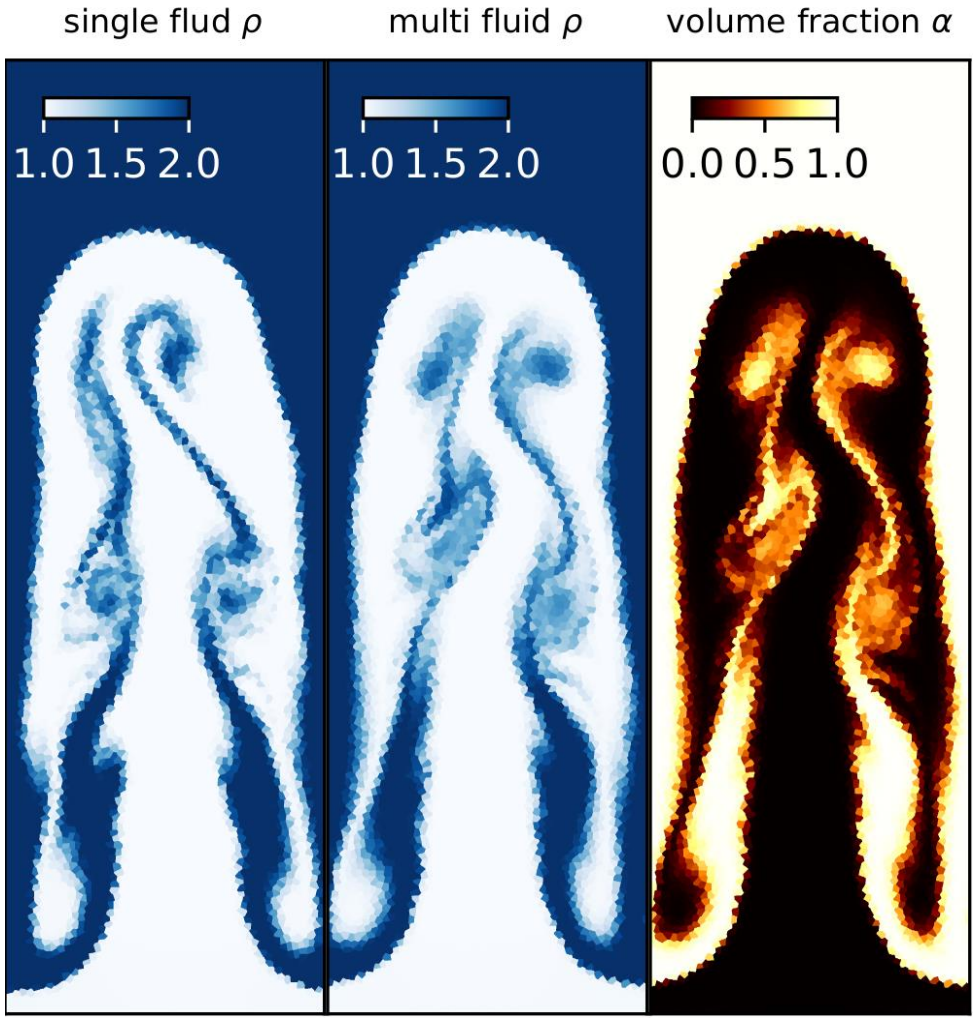



RW & Hernquist (arXiv:2204.05316)

# Modeling of resolved multi-fluid flows




RW & Hernquist (arXiv:2204.05316)