Dynamics of Supermassive Black Holes in Gas-Rich, Star-Forming Galaxies

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With: Romain Teyssier, Andreas Bleuler

Based on: arXiv:1701.05190

Small-scale simulations

- sub-parsec resolution
- mostly studies of BH mergers
- no problems if circumnuclear disk is smooth
- ejections and chaotic orbits if gas disk highly fragmented (see e.g. Fiacconi+13; Roskar+15; Souza Lima+16)

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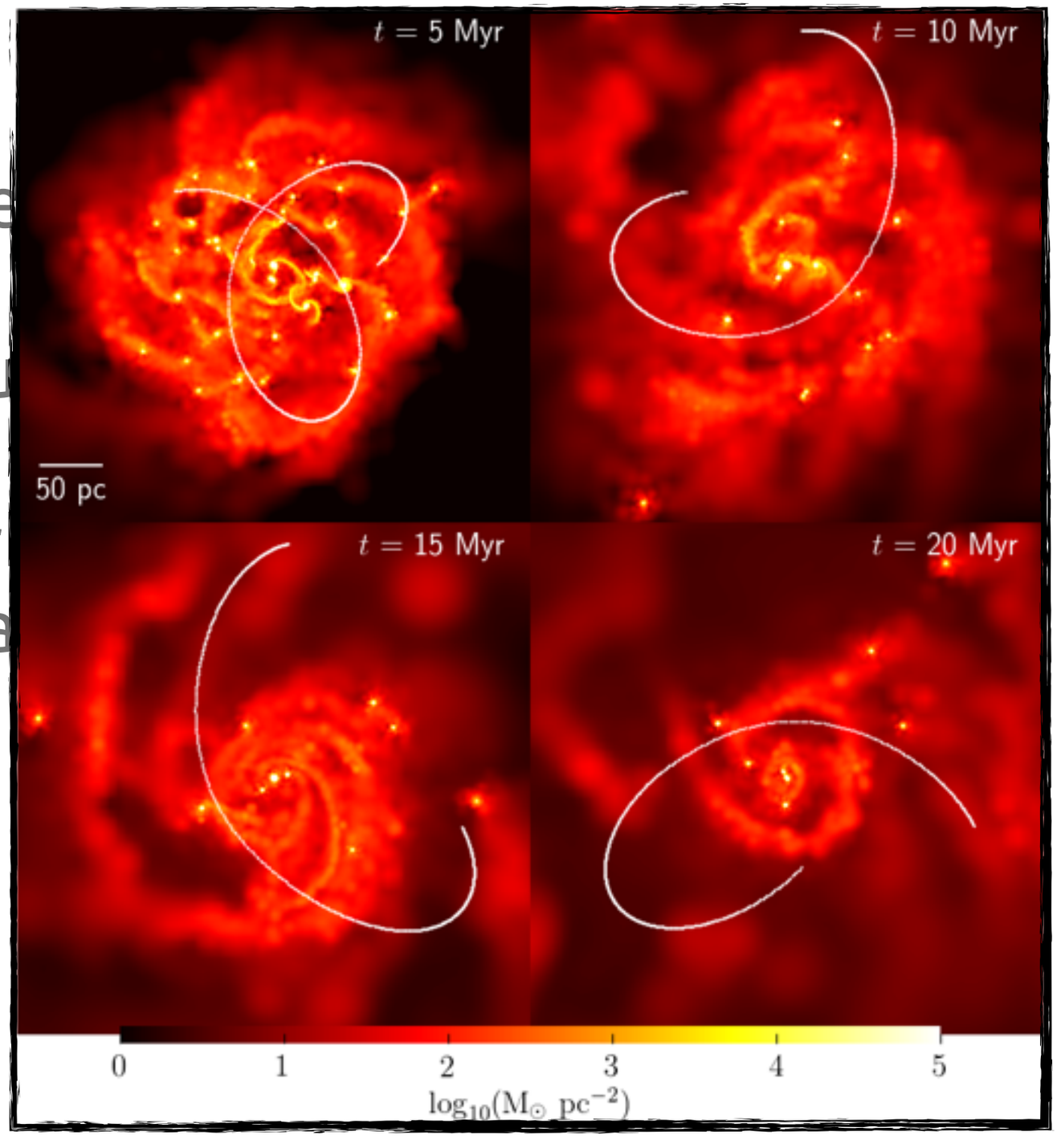

Large-scale simulations - the cheatsheet

- do not evolve the position
- reposition the sink when it moves 'too far'
- push the sink to the minimum of the potential
  - known as 'advection'
  - but how strong?
- fudge the dynamical mass, because of poor resolution
- swipe the problem under the carpet

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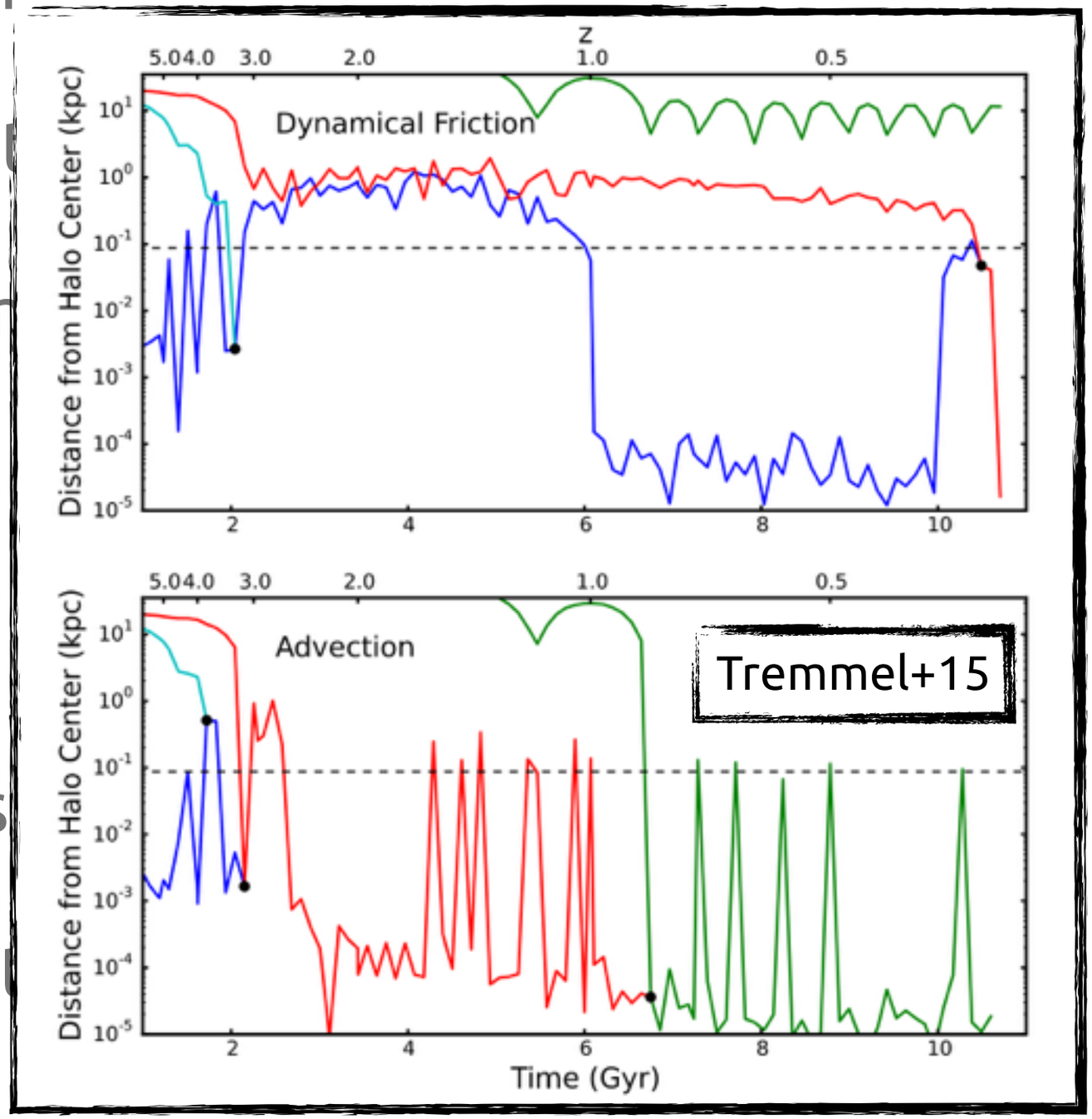


Bridging the gap - isolated cooling halo

- RAMSES AMR
- gas-rich, slowly-rotating halo - Toomre mass of 3×10^8 M_{sun}
- dark matter halo of 2×10^{12} M_{sun} - probed with one million particles
- spatial resolution of 80 pc

- dynamical fraction timescale: 2.7 Gyr (10^8 M_{sun}/M_{BH})

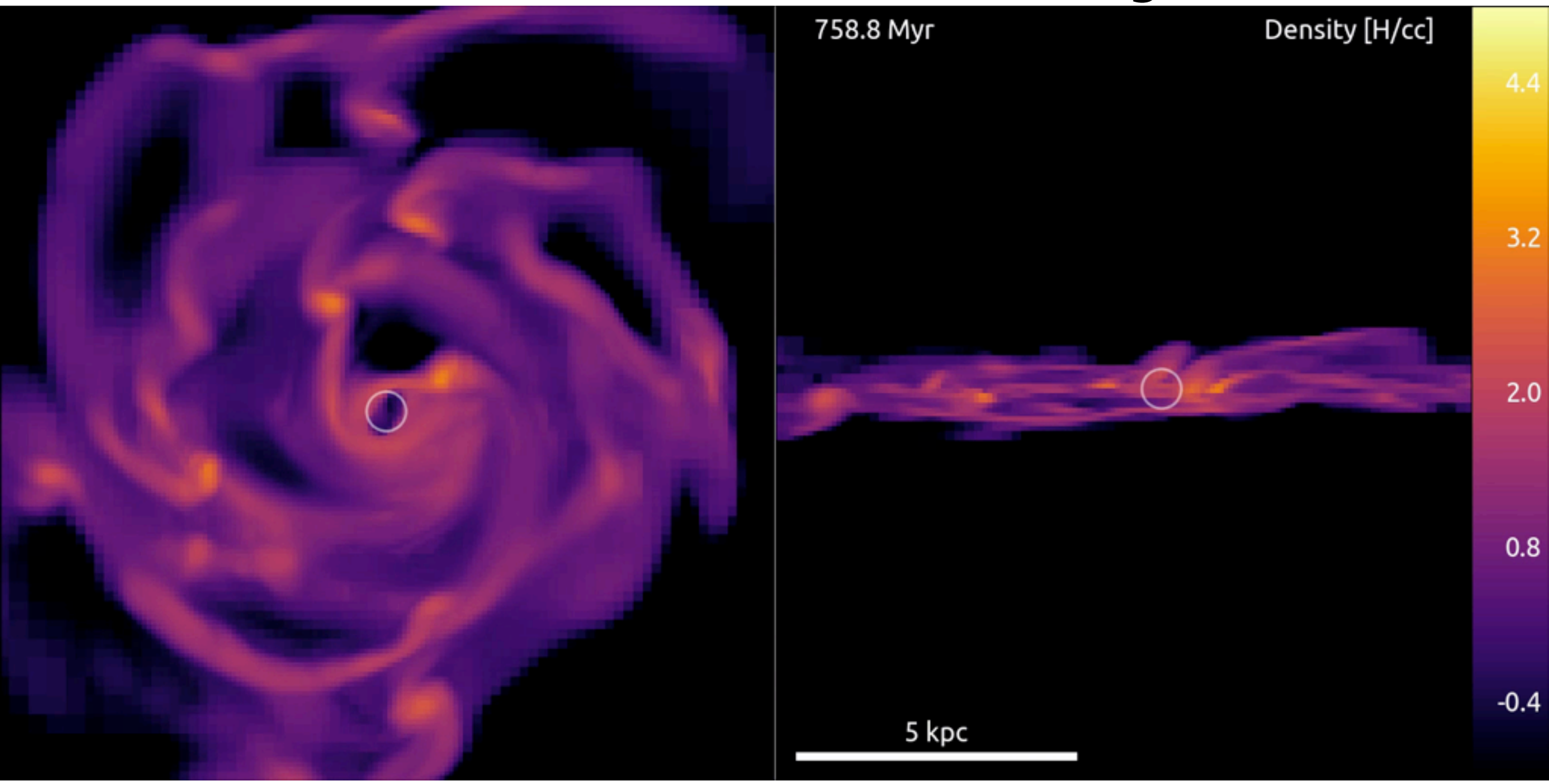
- supernova feedback
  - thermal blast, 10% efficiency and yield of 0.1
  - delayed cooling on the scale of 10 Myr
  - exploding in GMCs of 10^8 M_{sun} (Teyssier+13)

- AGN feedback - thermal dump ε_c=0.15 (Teyssier+11, Dubois+12, Martizzi+14) with boosted Bondi accretion

- two sets - AGN-only and SN+AGN

Face-on

Edge-on



No SN: AGN-only

Circle - sink's accretion/ feedback zone

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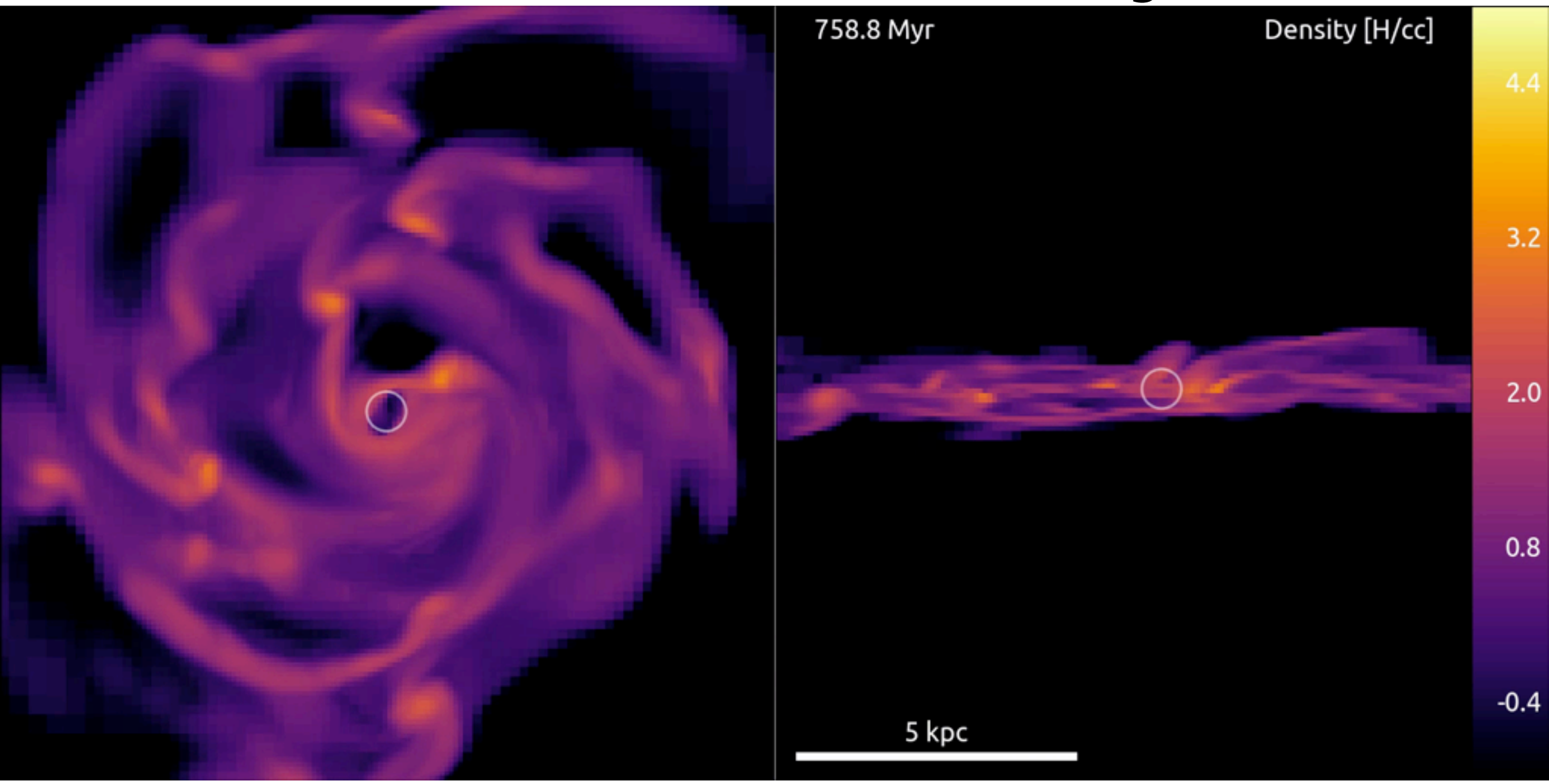

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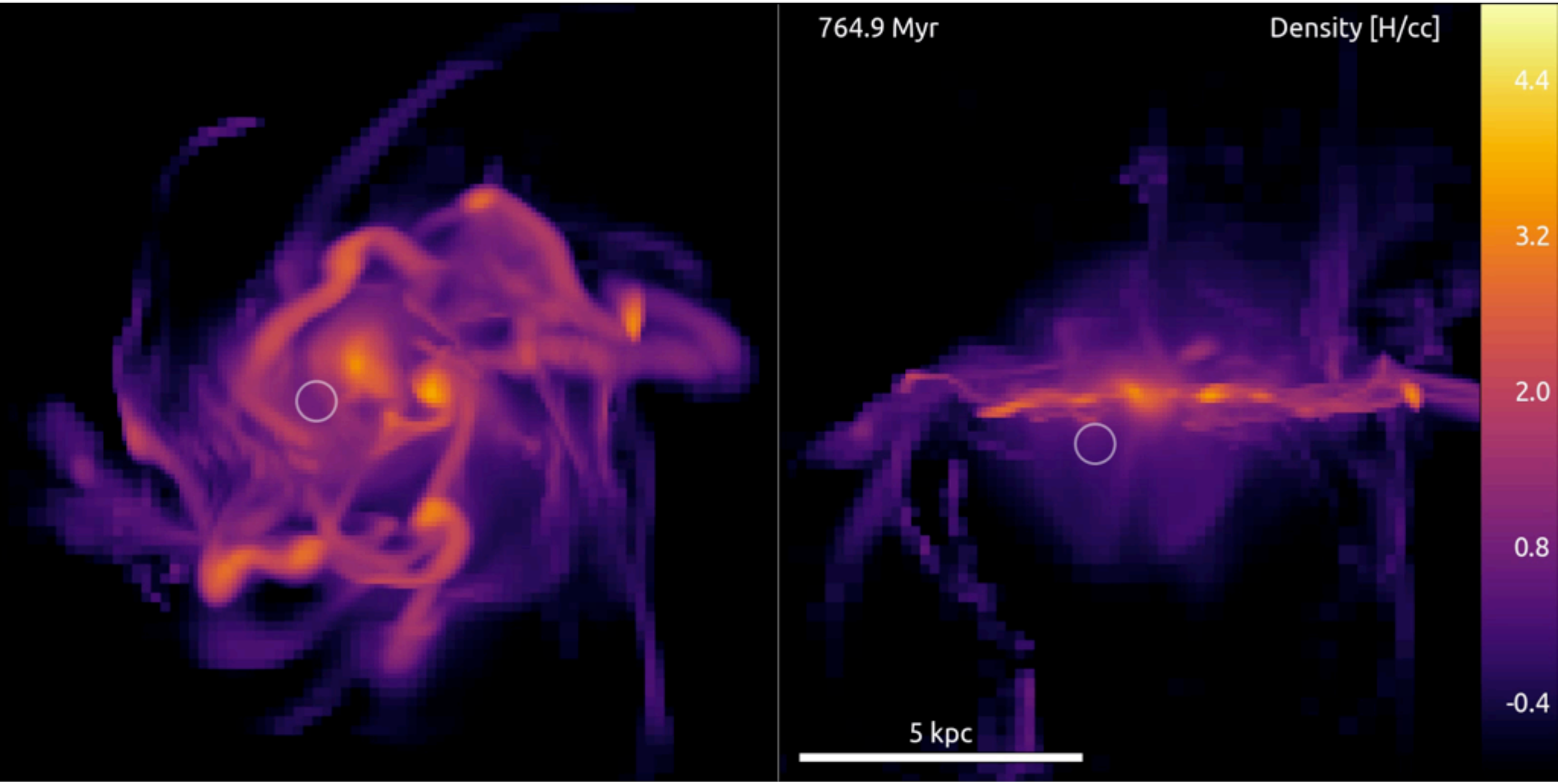

SN and AGN feedbacks

Here is where problems start

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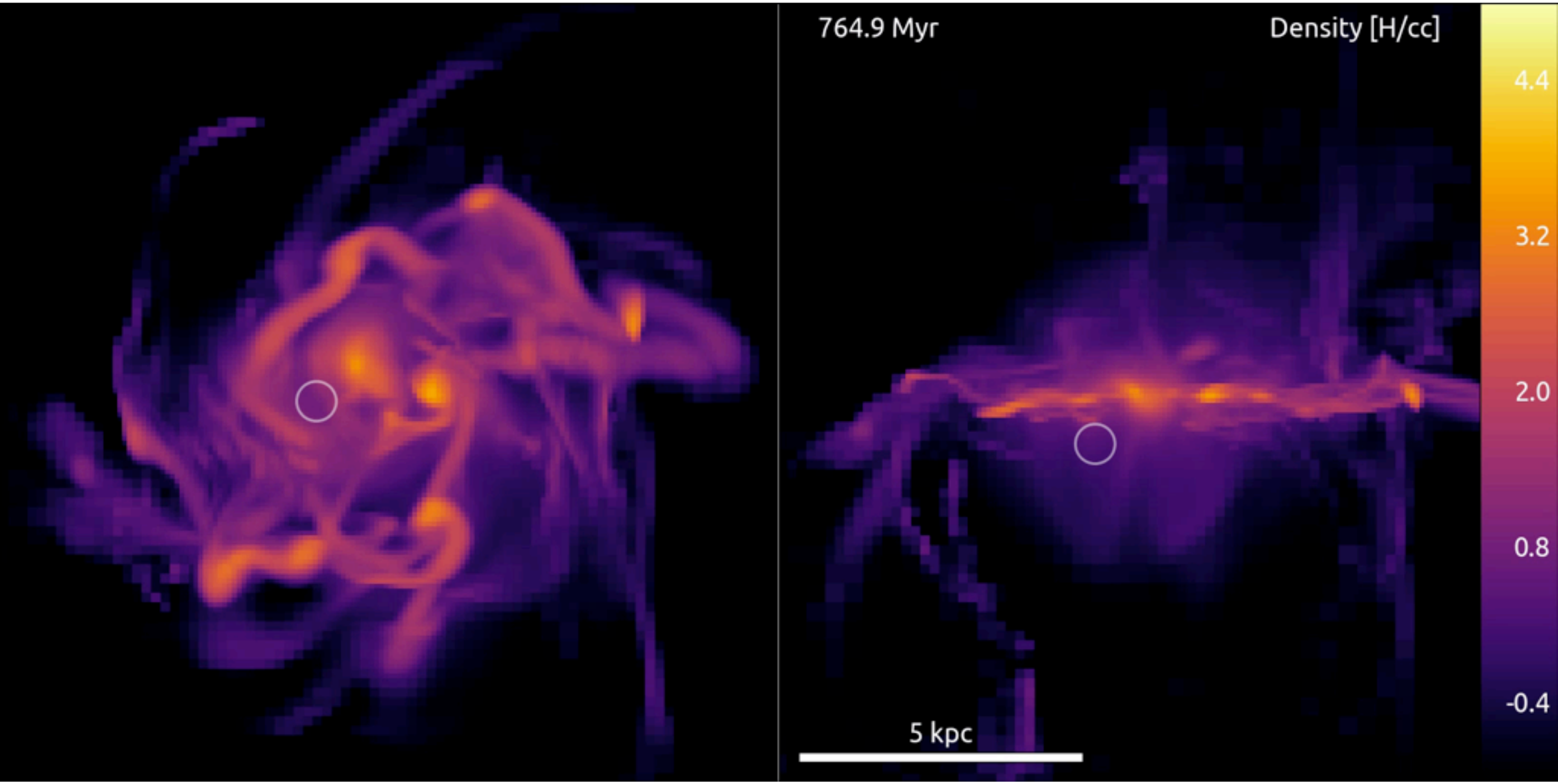

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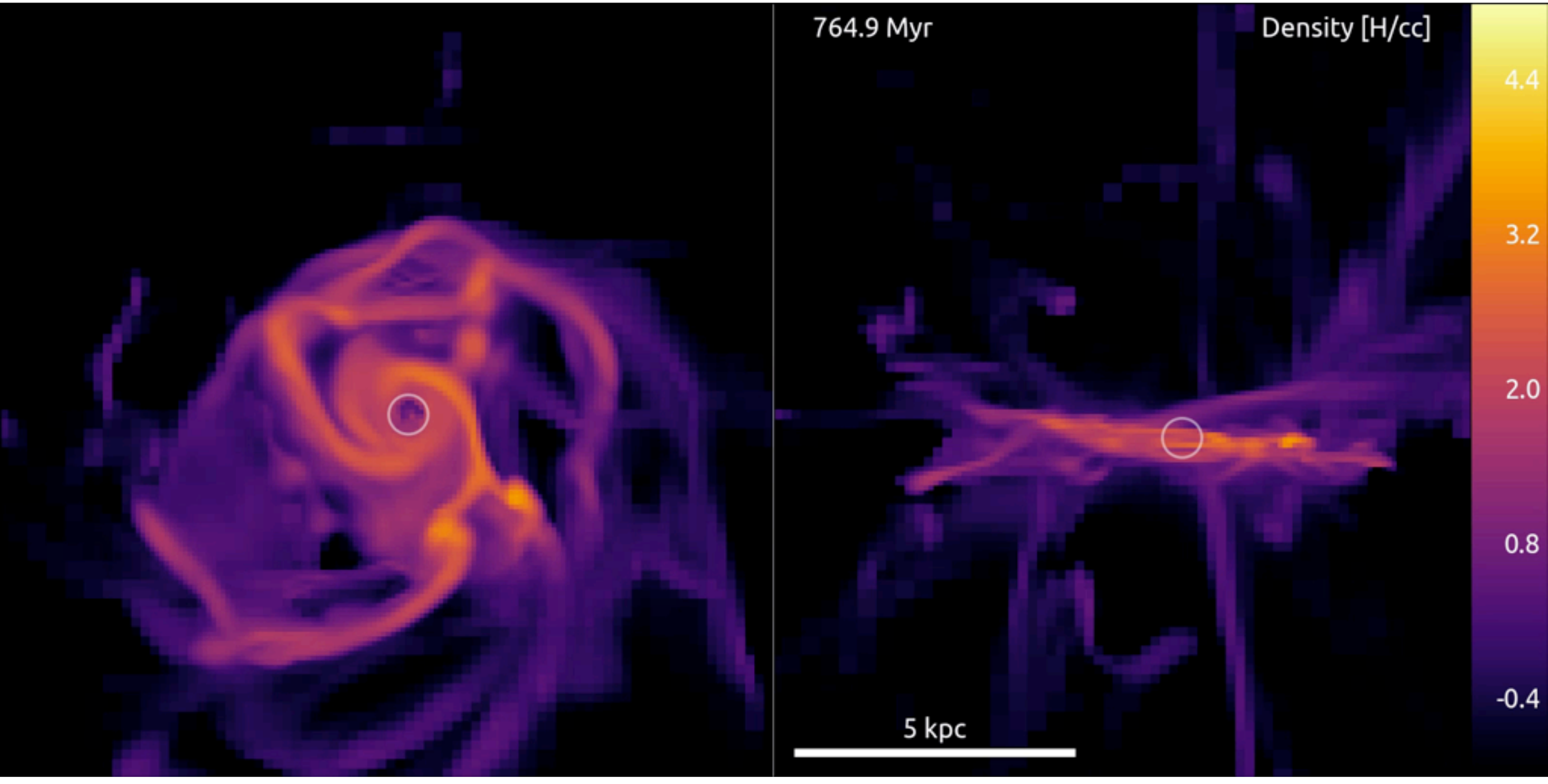

Nuclear Star Cluster comes to rescue!

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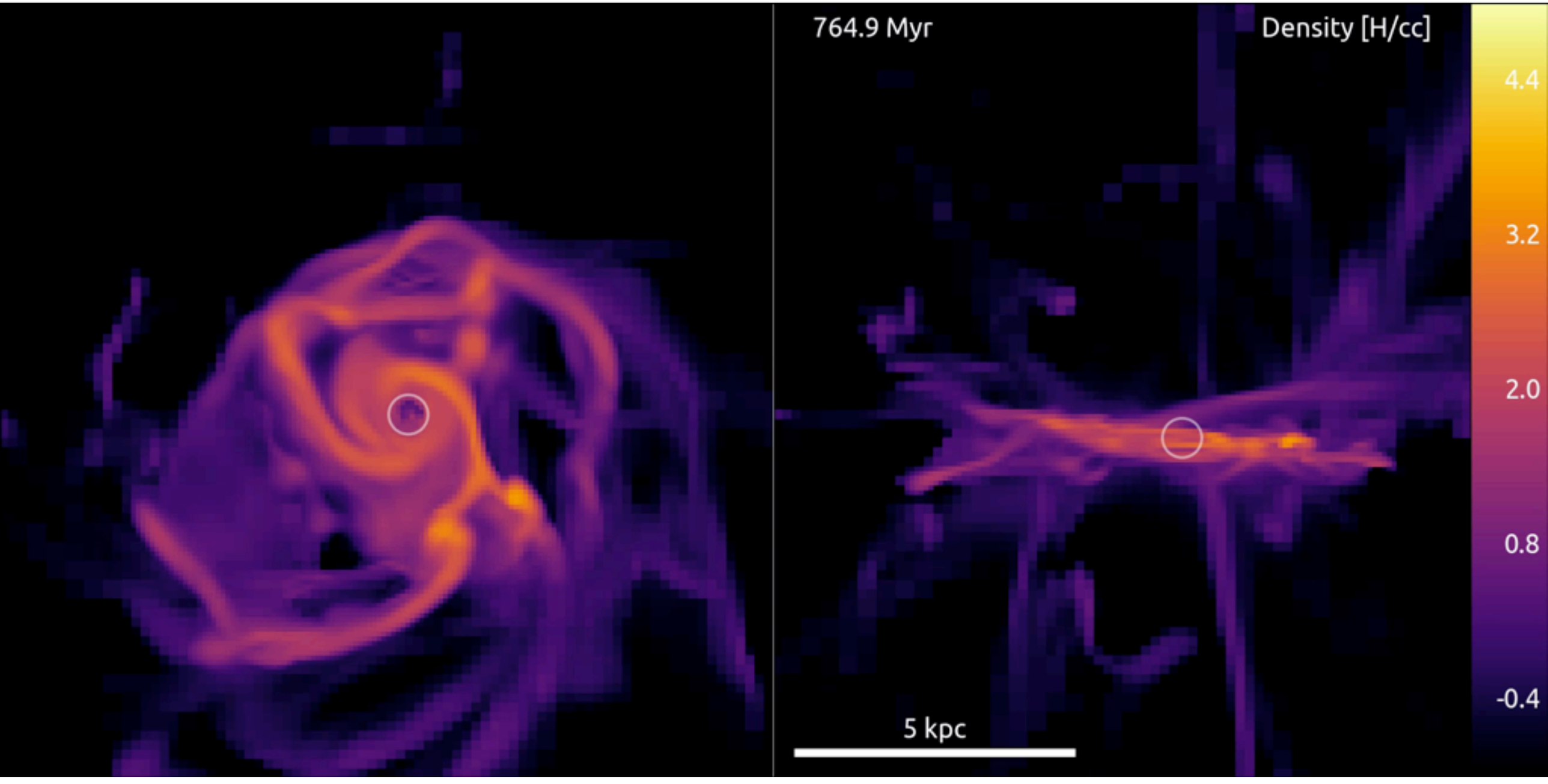

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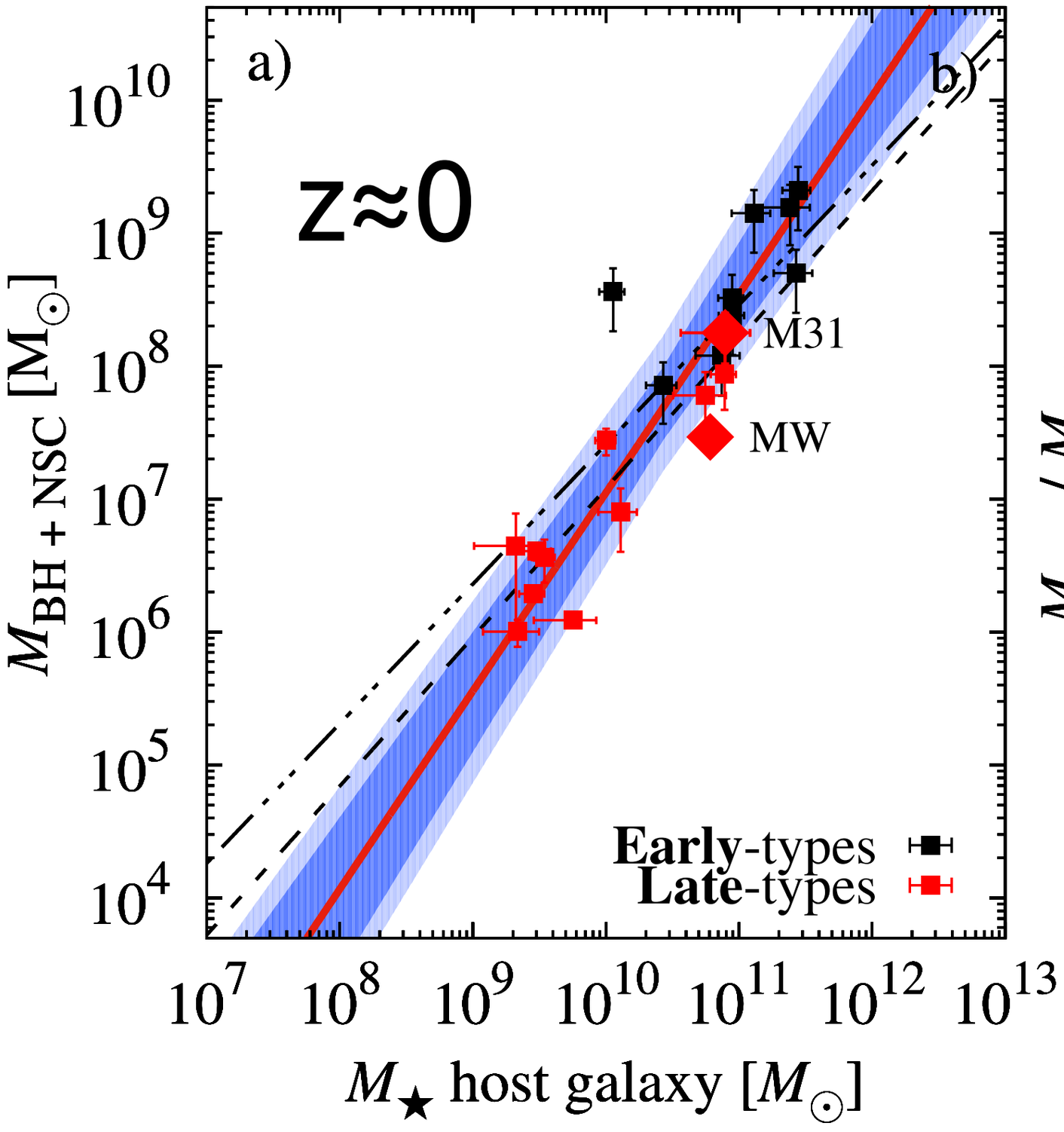
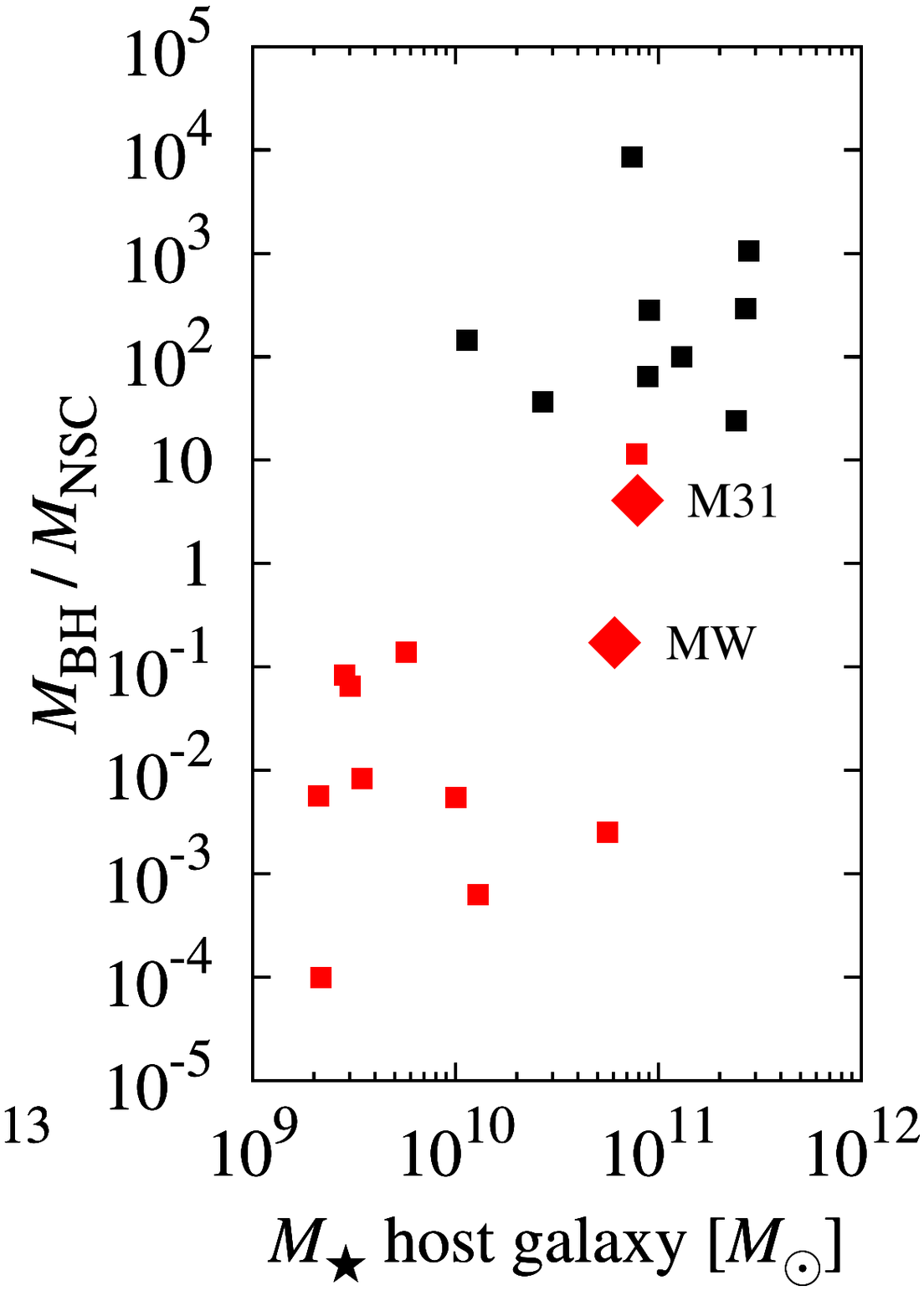
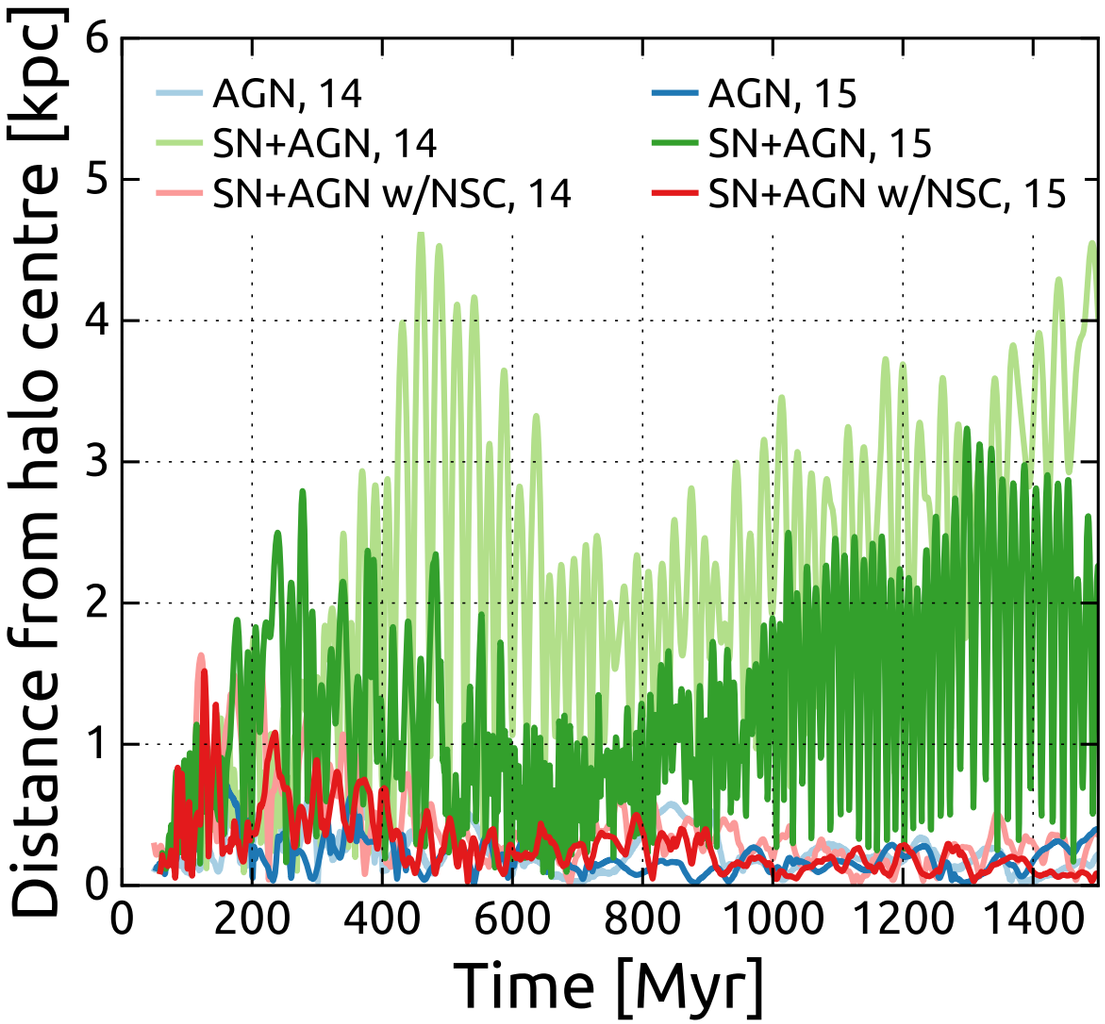


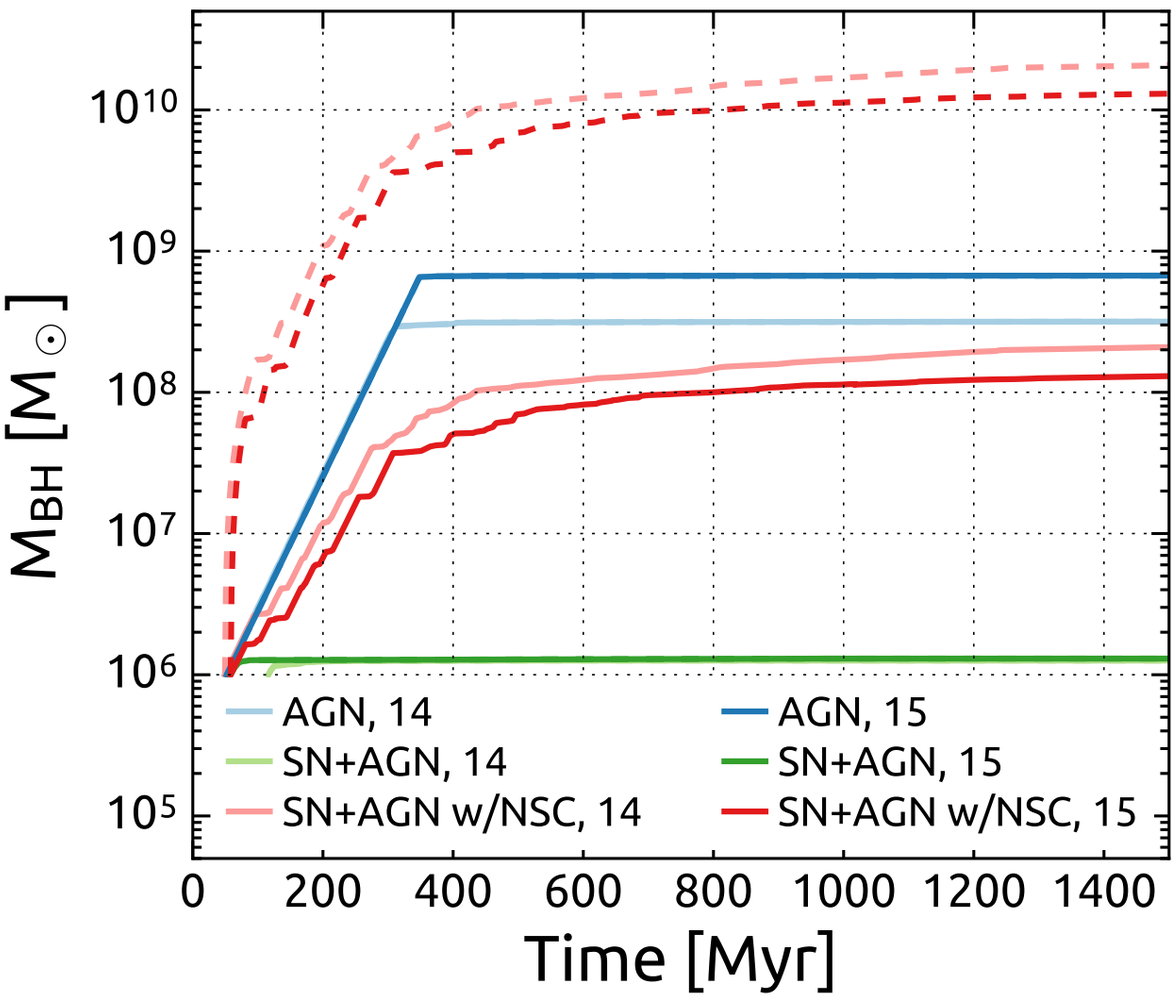


SMBH is not alone

Georgiev et al. 2016

SMBH distance from centre of halo and mass





Take home message

SMBH dynamics in a clumpy galaxy points towards the need for NSC and SMBH coevolution (or bulge) in order to foster quick growth of SMBH

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Preview (Biernacki et al., in prep.)

AGN feedback provides necessary energy to push/unbind the gas residing in the galactic halo and produce dense outflows (come talk to me about it!)