

The background image is a simulation of an active galactic nucleus (AGN) fueling and feedback in a disk galaxy. It features a bright, glowing central source, likely a supermassive black hole, surrounded by a disk of gas and dust. The simulation shows the complex structure of the accretion disk and the outflows from the central region. The color palette is dominated by warm tones of orange, red, and yellow, with a bright white and yellow core. A small blue spot is visible in the center of the disk, possibly representing the innermost part of the accretion disk or the black hole itself.

Simulations of AGN fueling and feedback in disk galaxies

Jared Gabor
CEA Saclay

w/ Frédéric Bournaud, Orianne Roos, Stéphanie Juneau

THE FATE OF THE GAS IN GALAXIES



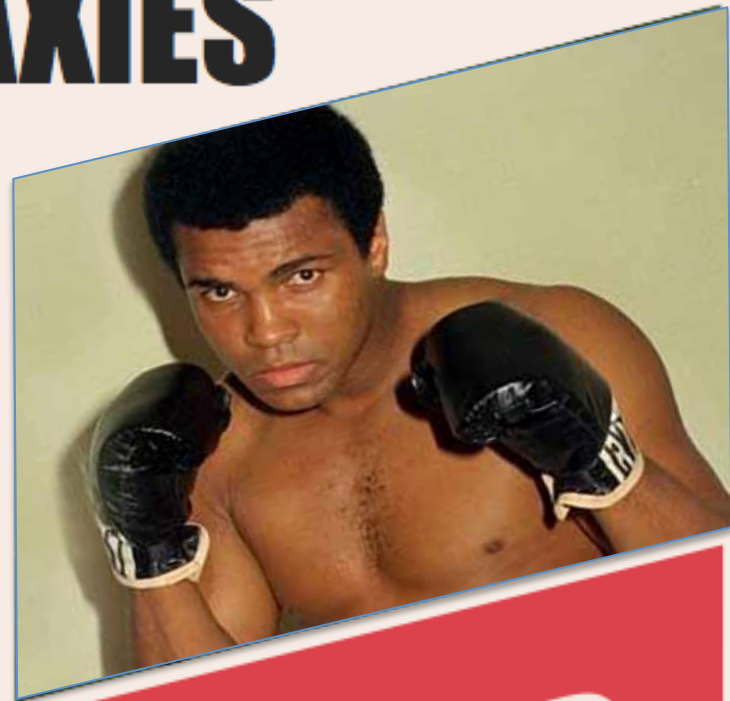
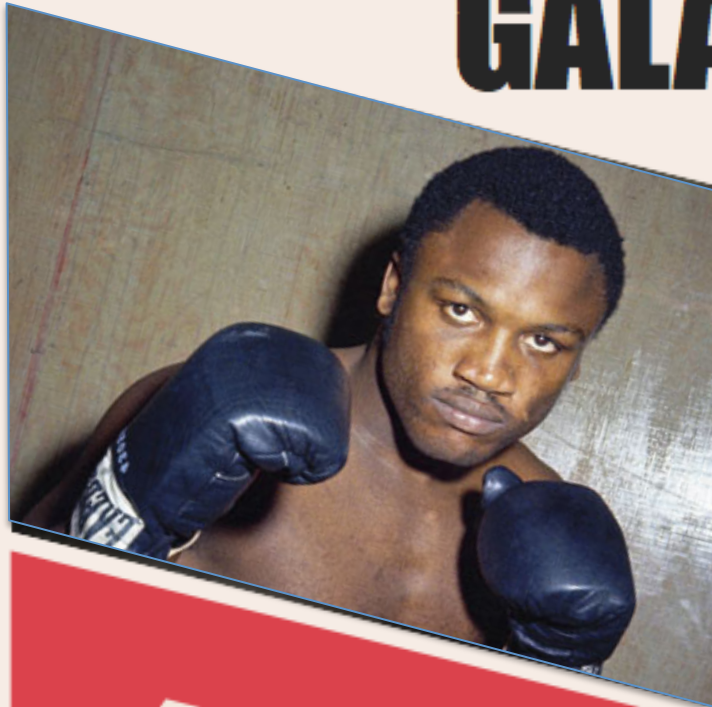
AGN

VS.

**STAR
FORMATION**

**28 JUL
to
1 AUG
2014**

THE FATE OF THE GAS IN GALAXIES



AGN

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THE FATE OF THE GAS IN GALAXIES



AGN

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FORMATION



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Peaceful Coexistence

AGN & SF

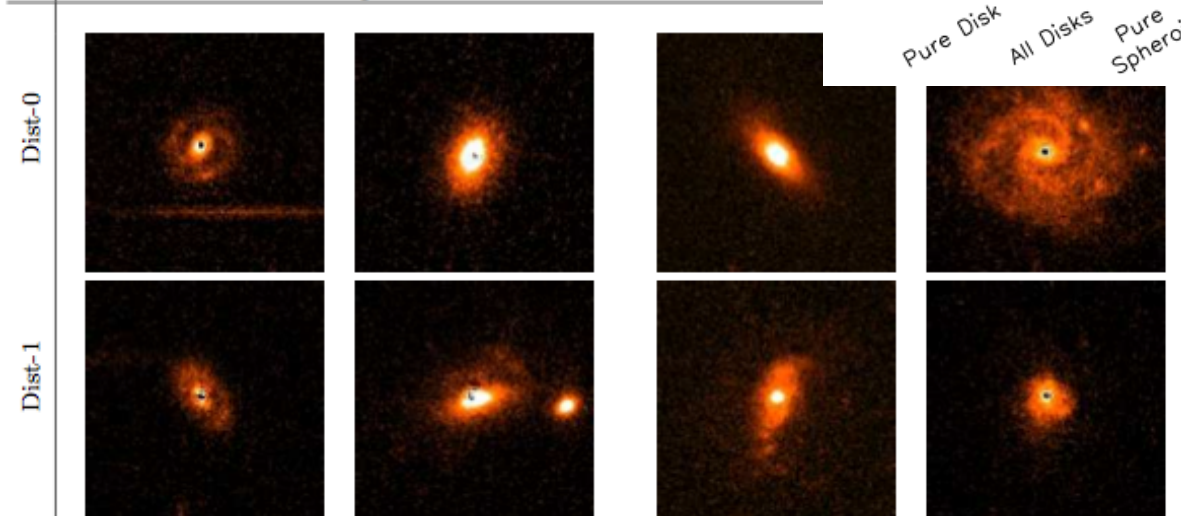
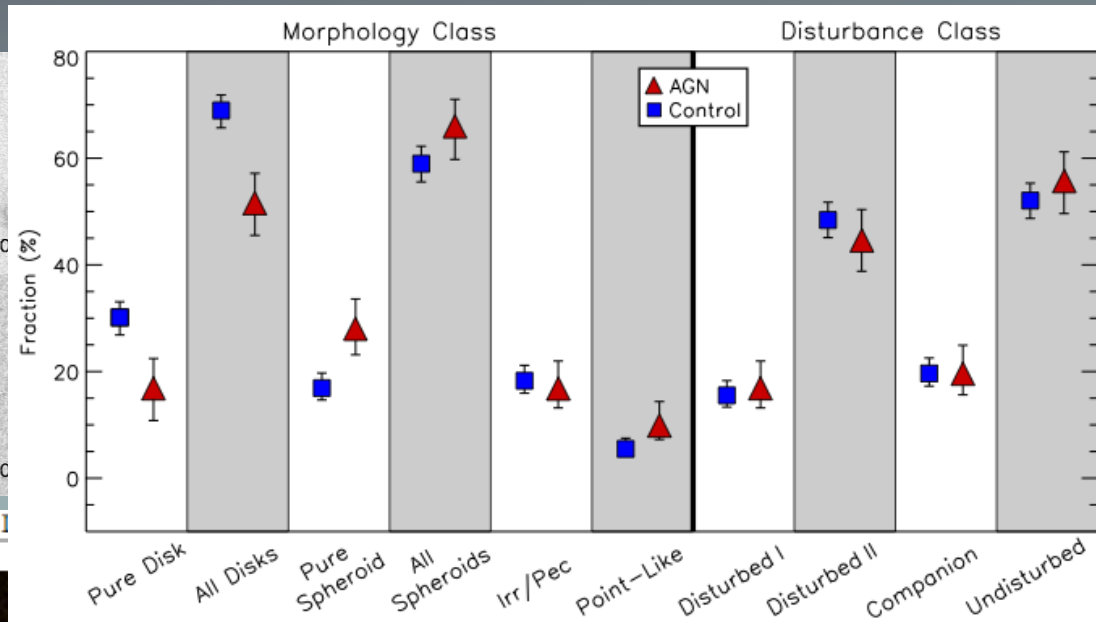
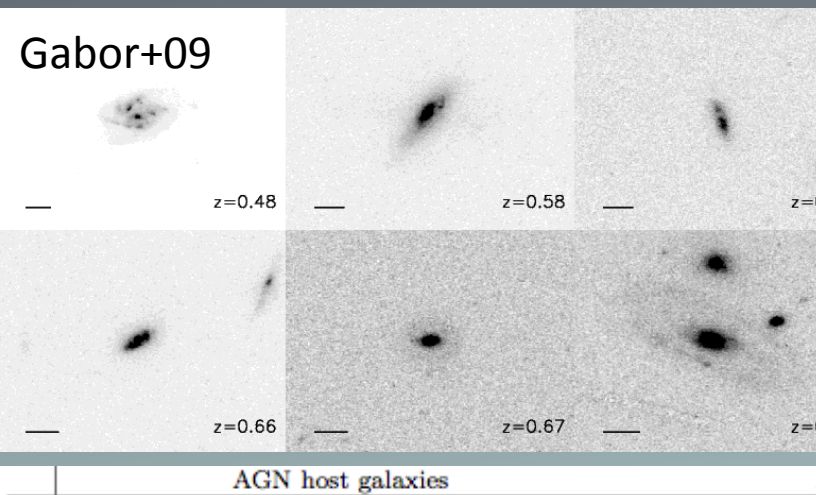
can live together in harmony

Peaceful Coexistence

Powerful
AGN & **SF**
outflows

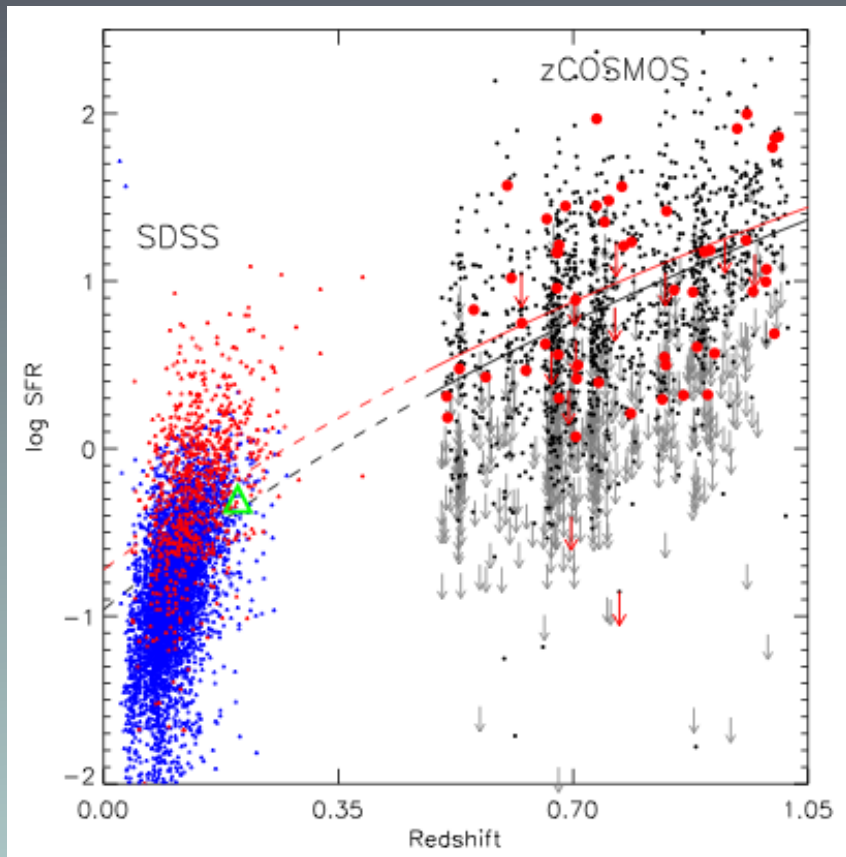
can live together in harmony

AGNs in normal SF galaxies

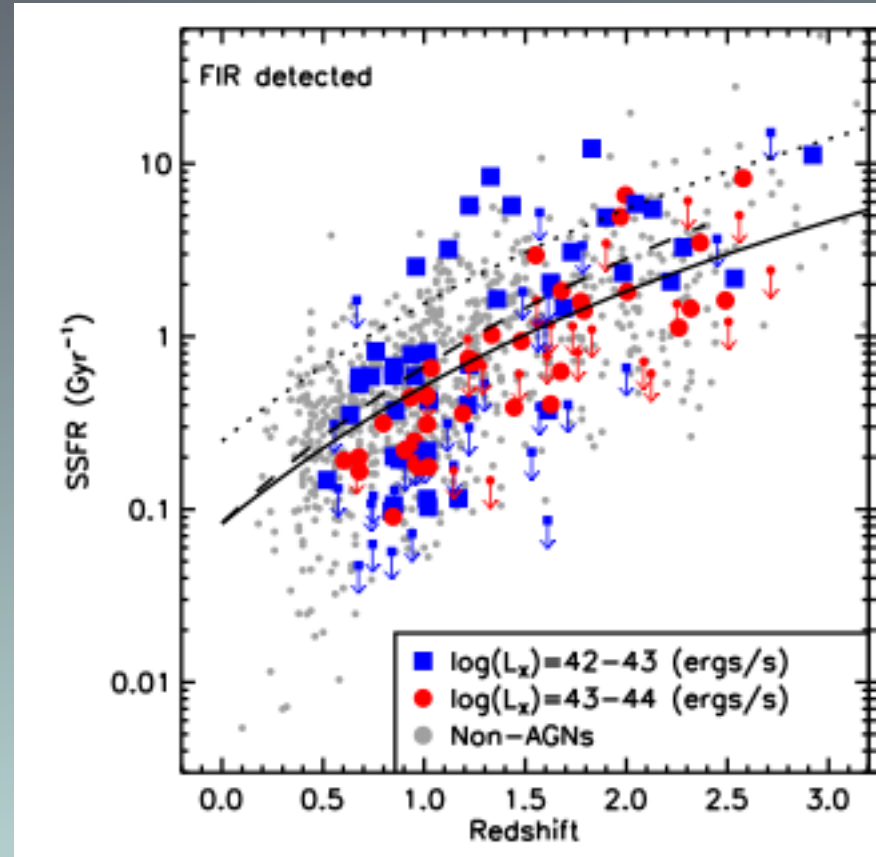


z=2, Kocevski+12

AGNs in normal SF galaxies

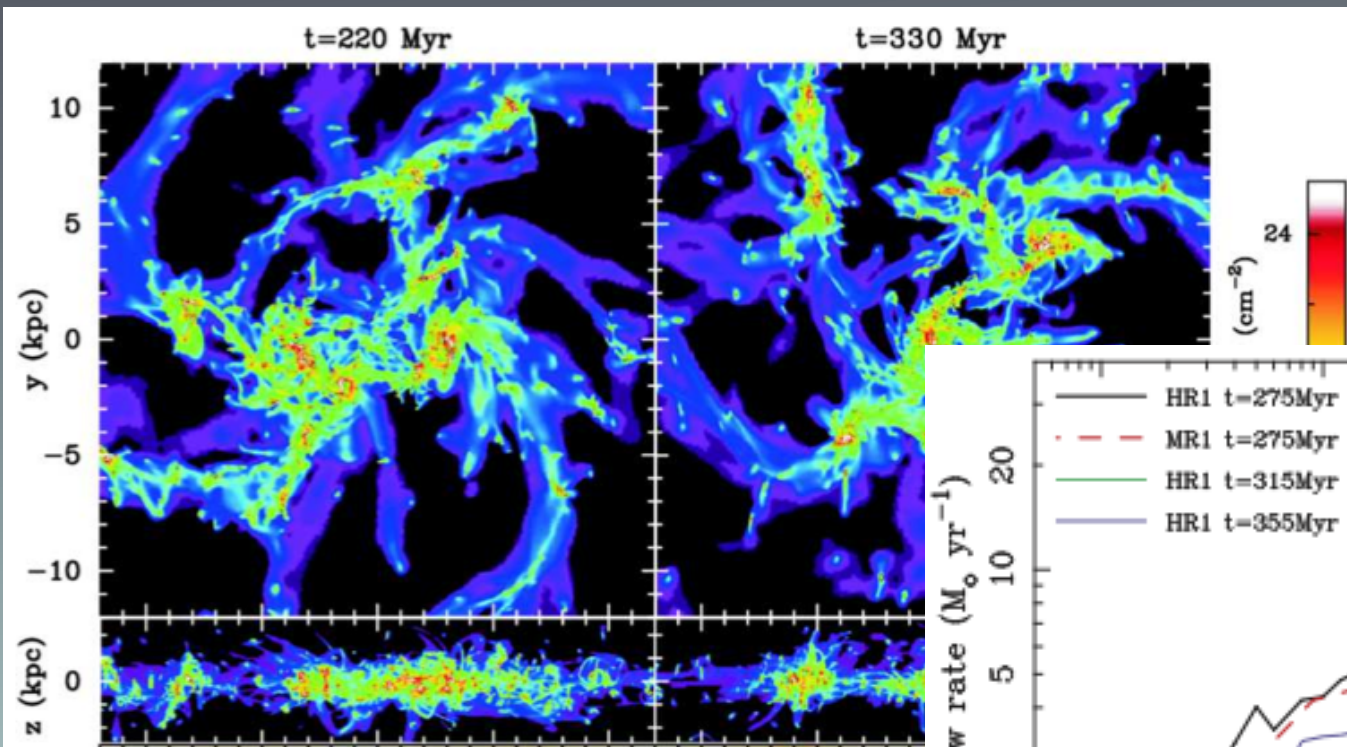


Silverman+09

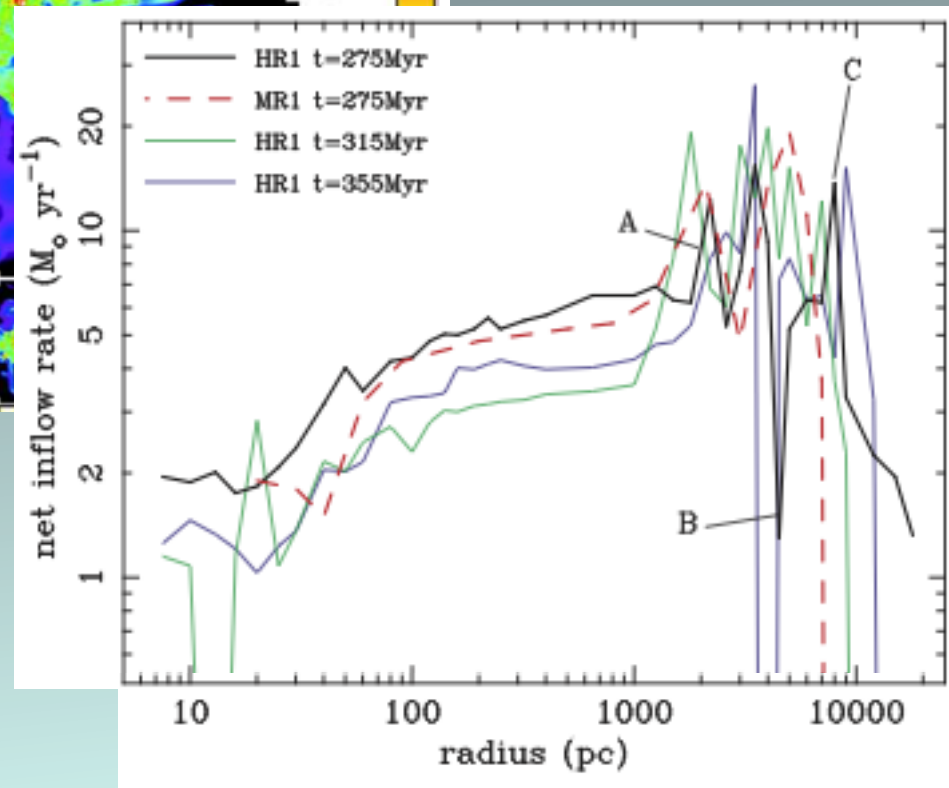


Mullaney+12

Inflow in unstable disks

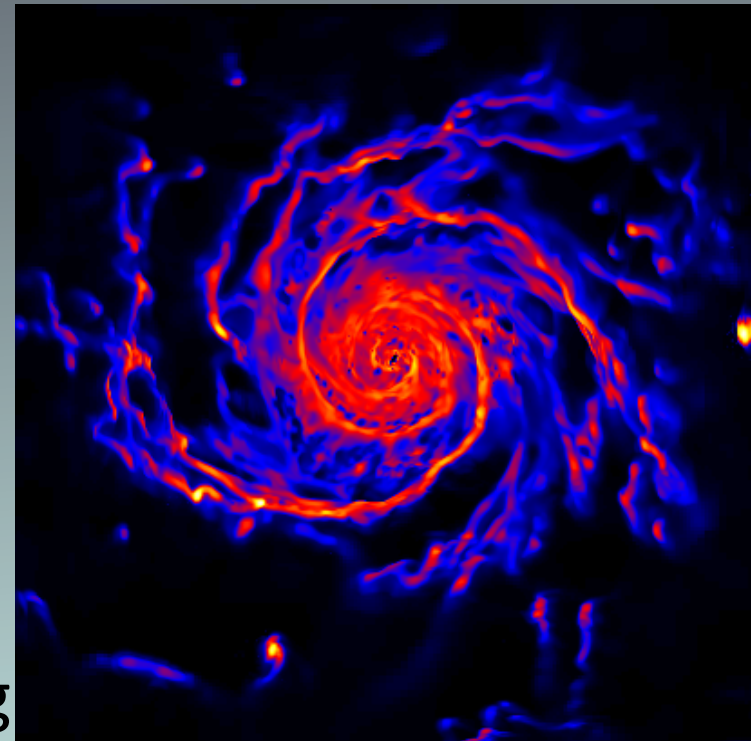


Bournaud+11,
cf. Hopkins & Hernquist 06



Simulations

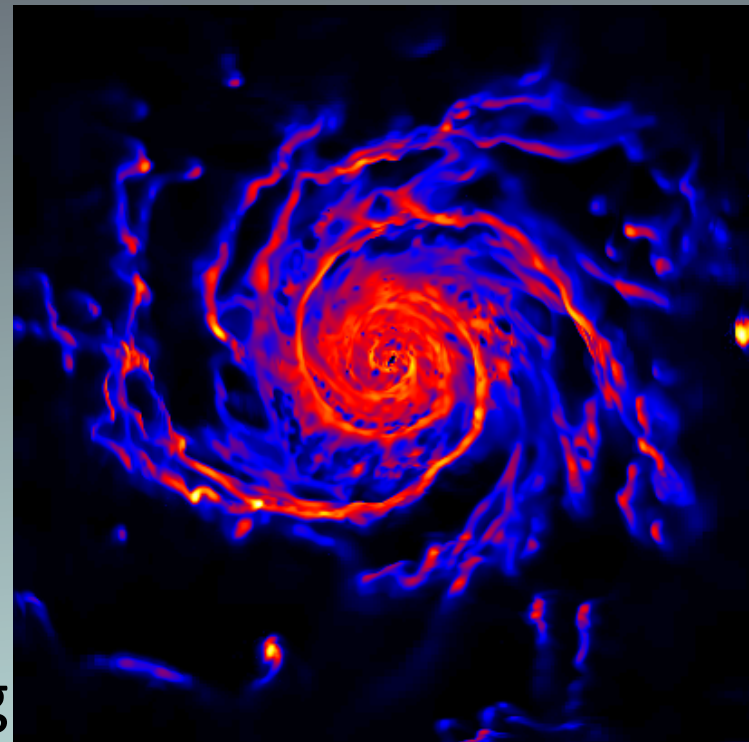
- RAMSES AMR code
- 6-pc max resolution
- Idealized, isolated galaxies
 - exponential stellar+gas disk
 - bulge and dark matter
- Weak stellar feedback
 - supernovae + delayed cooling
- Thermal AGN feedback
 - cf. Dubois et al. 2010,
Booth & Schaye 2009



Simulations

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Deposited *isotropically* on 10 pc scales



Gabor+Bournaud 13

M16f50
Mb=16·10¹⁰, fg=50%

1 kpc

M4f50
Mb=4·10¹⁰, fg=50%

1 kpc

M1f50
Mb=1·10¹⁰, fg=50%

1 kpc

M16f10
Mb=16·10¹⁰, fg=10%

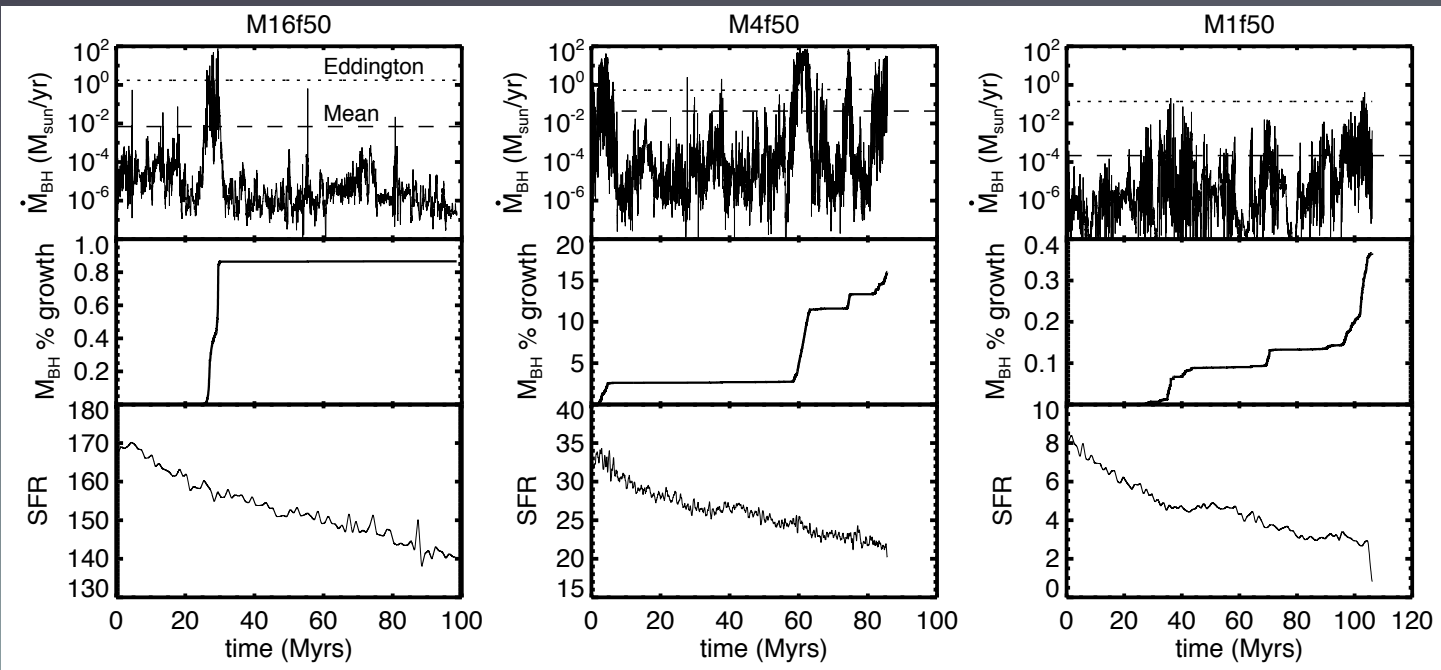
1 kpc

M4f10
Mb=4·10¹⁰, fg=10%

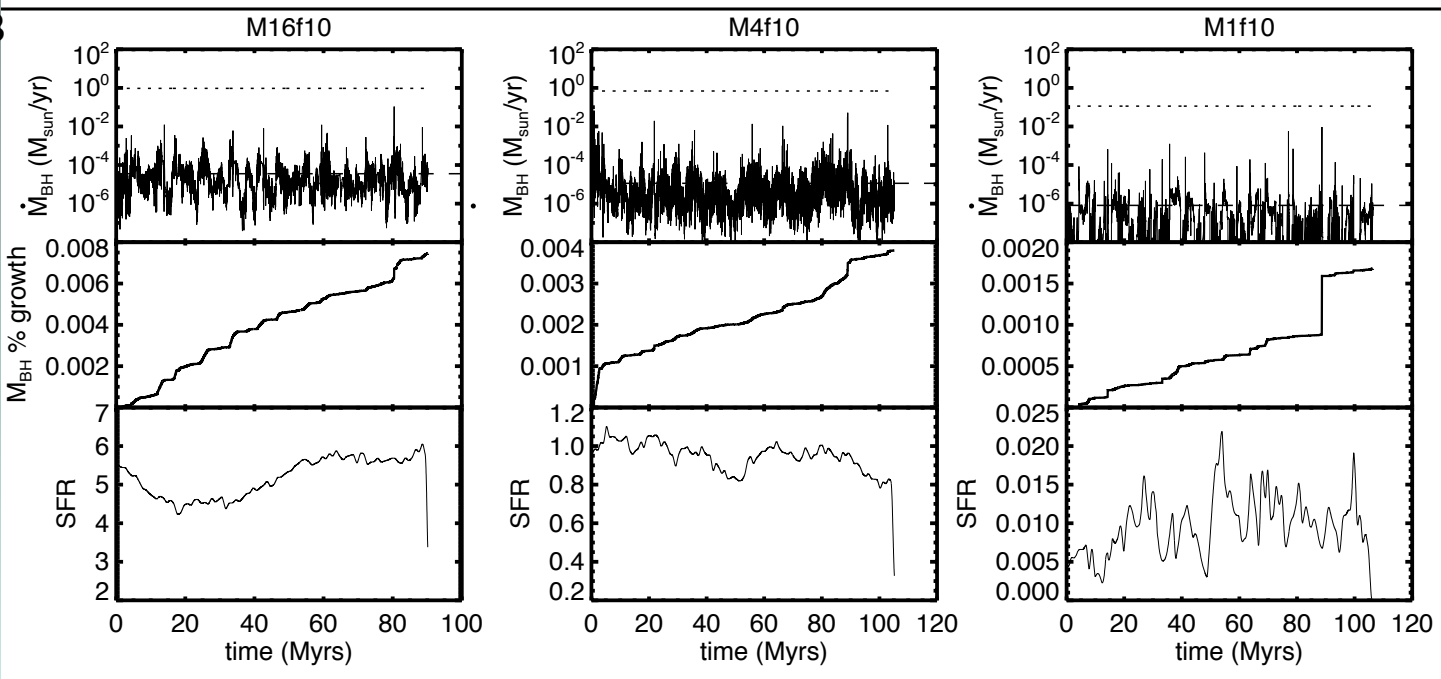
1 kpc

M1f10
Mb=1·10¹⁰, fg=10%

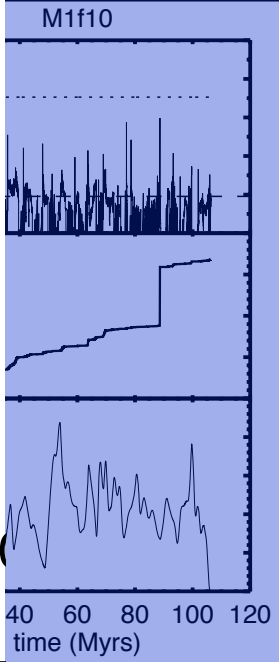
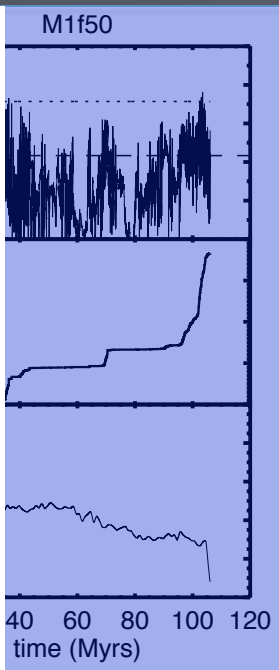
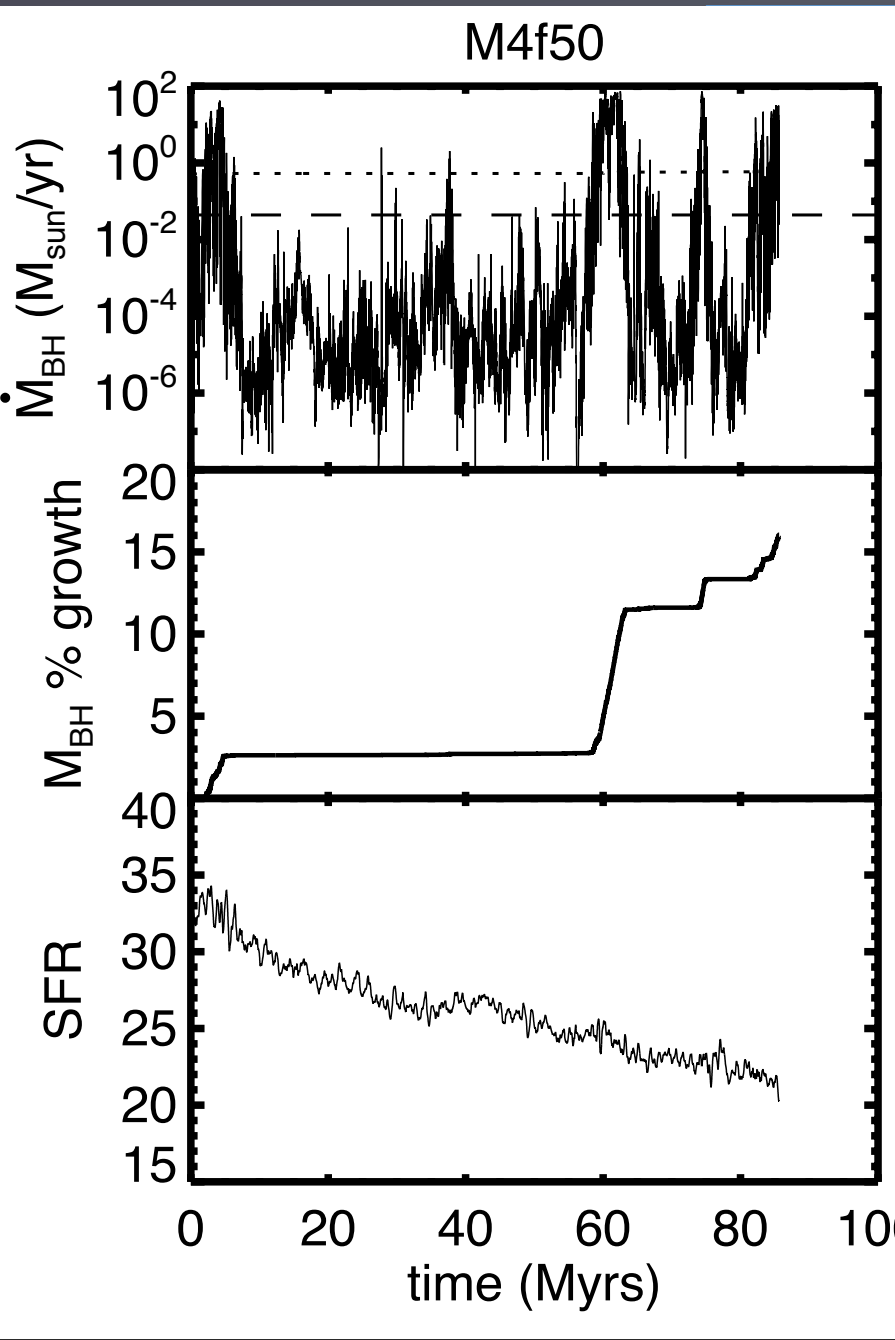
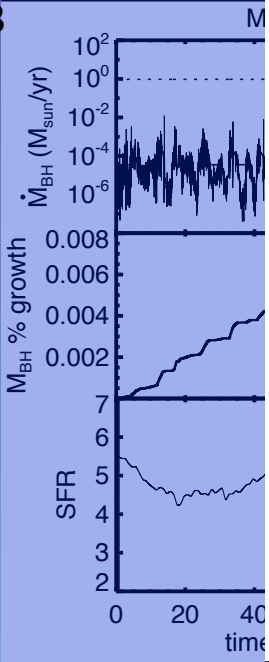
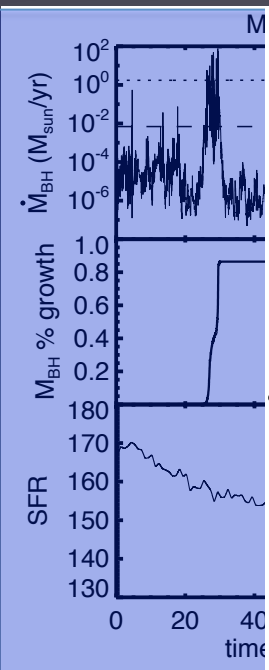
1 kpc



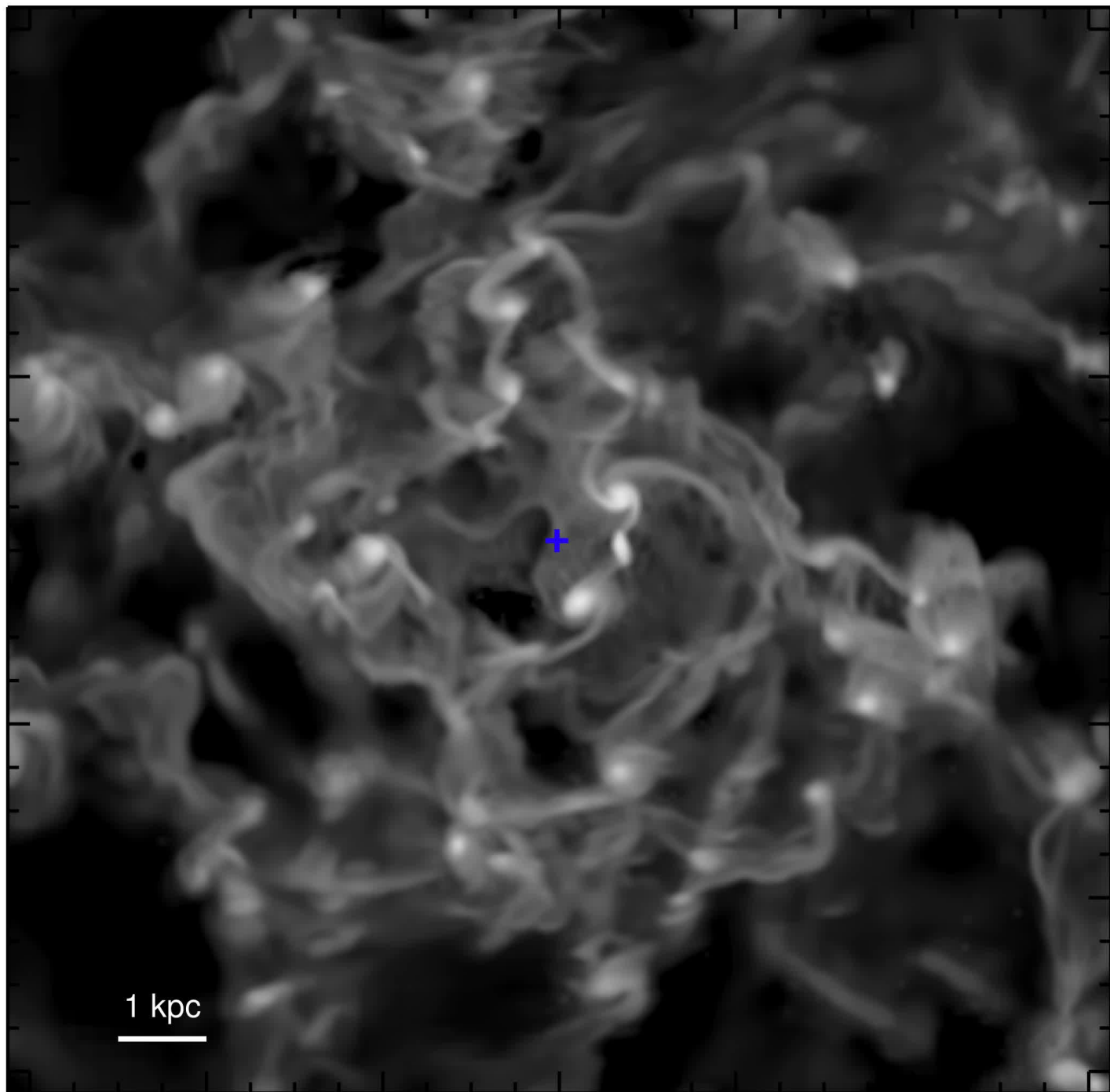
Gabor
+Bournaud 13

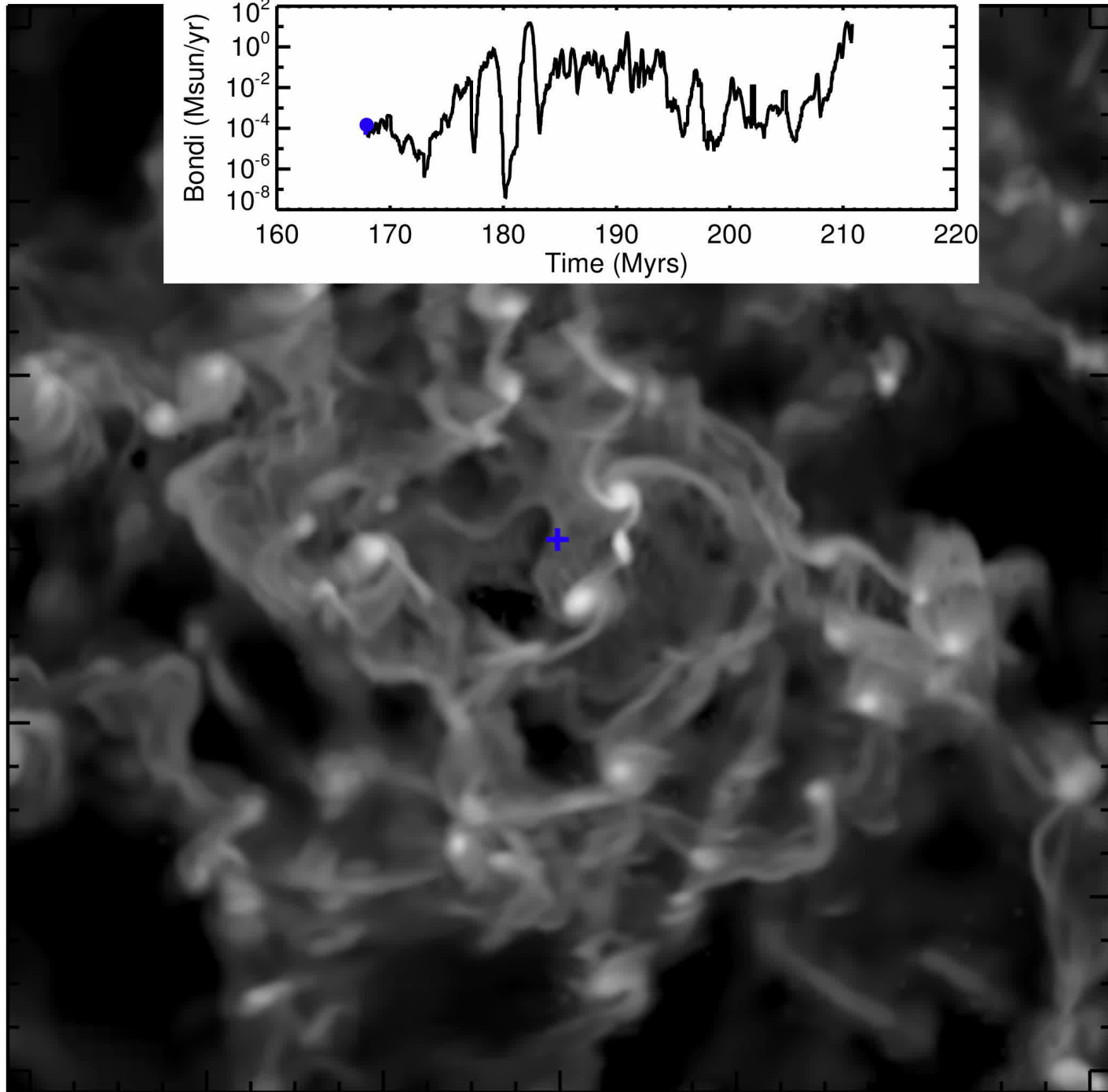
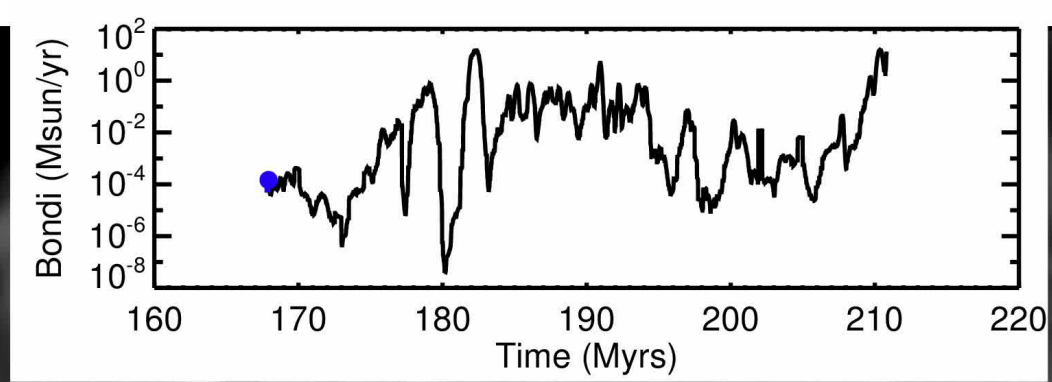


Gabor
+Bournaud 13

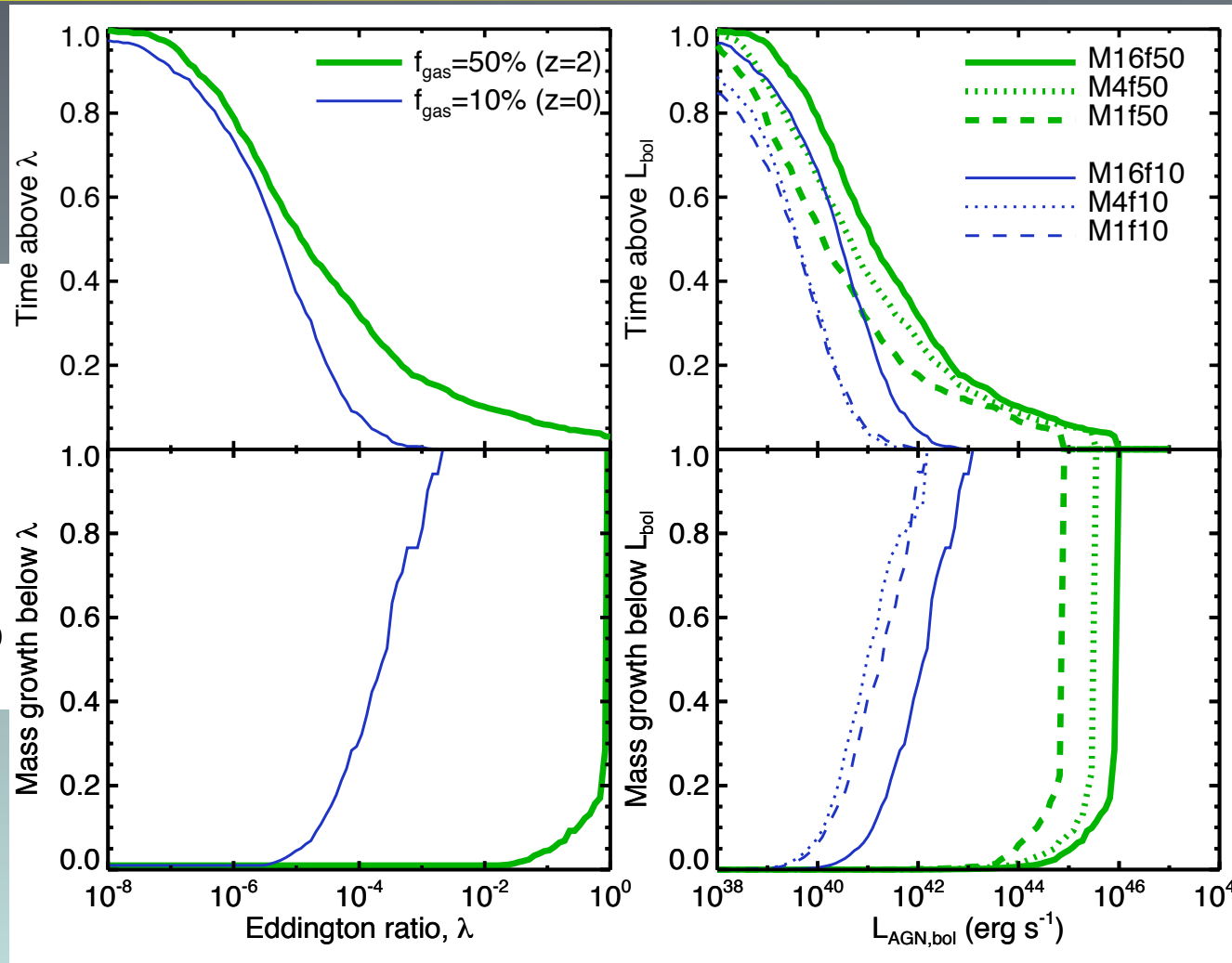
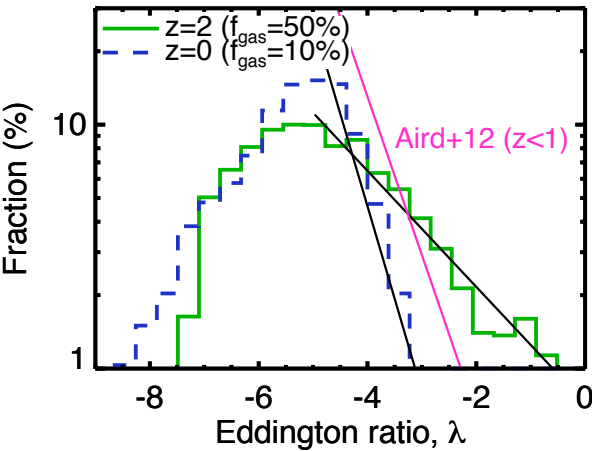


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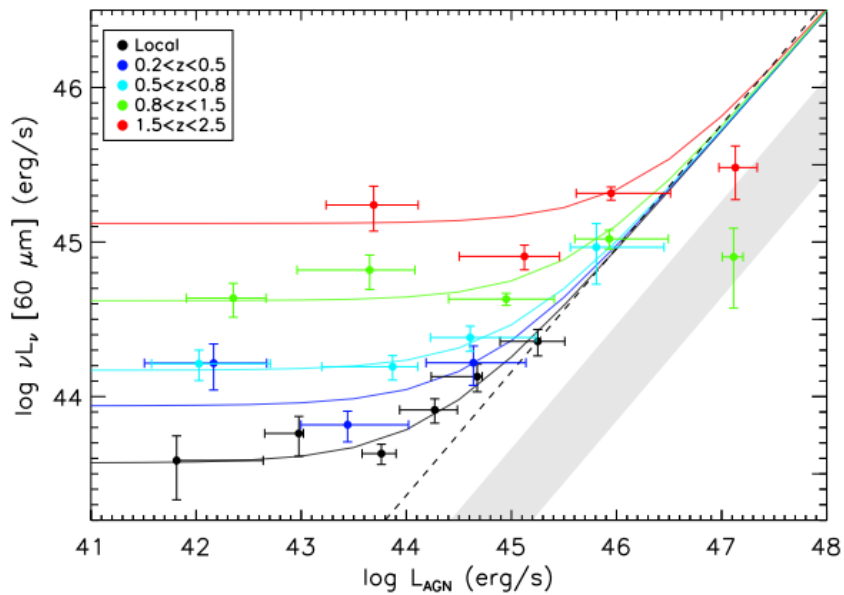
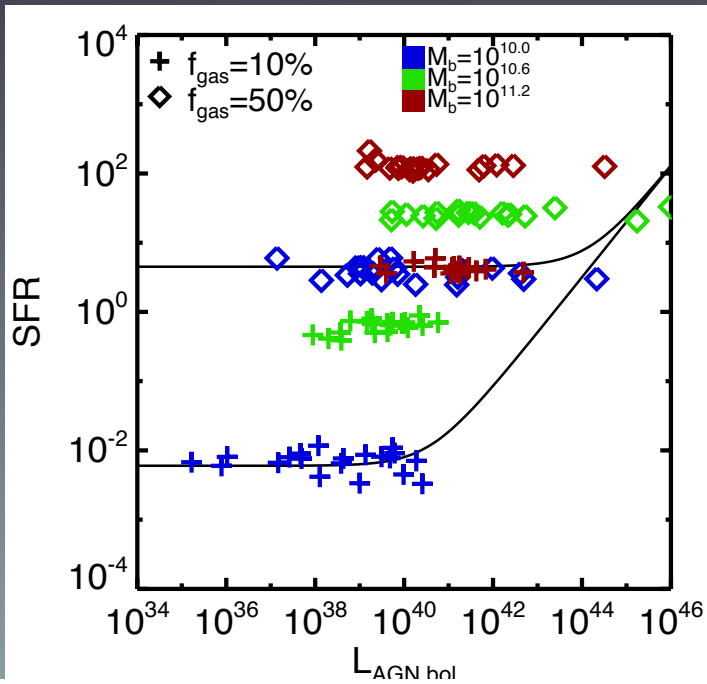


Eddington ratios and duty cycle

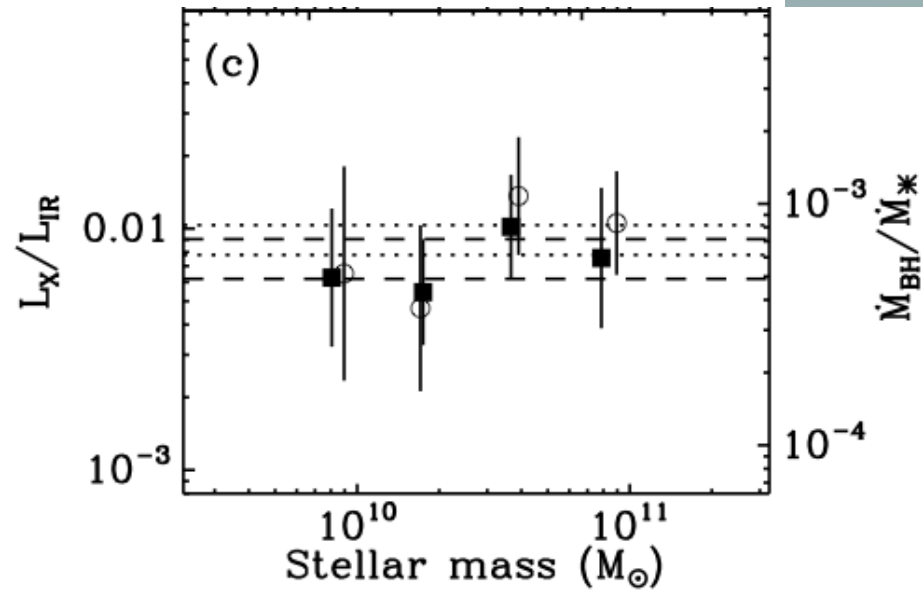
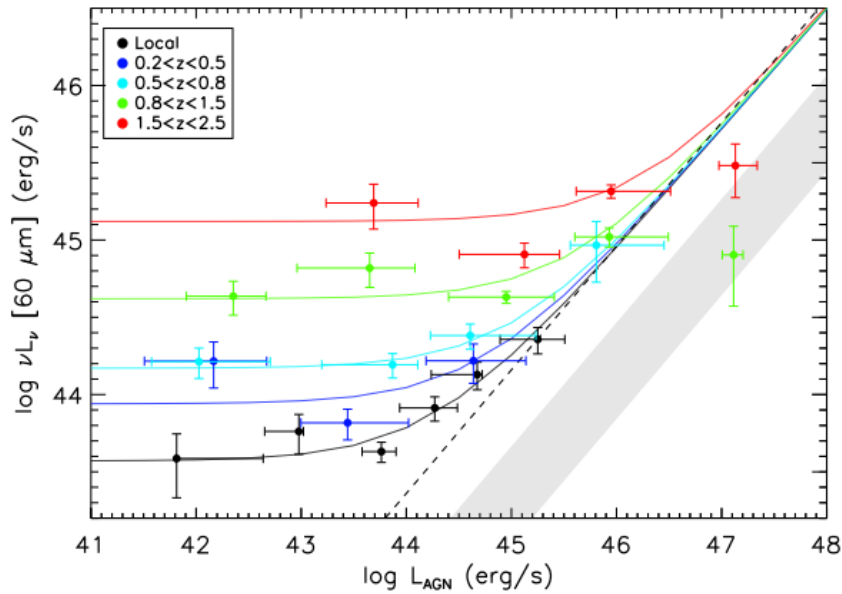
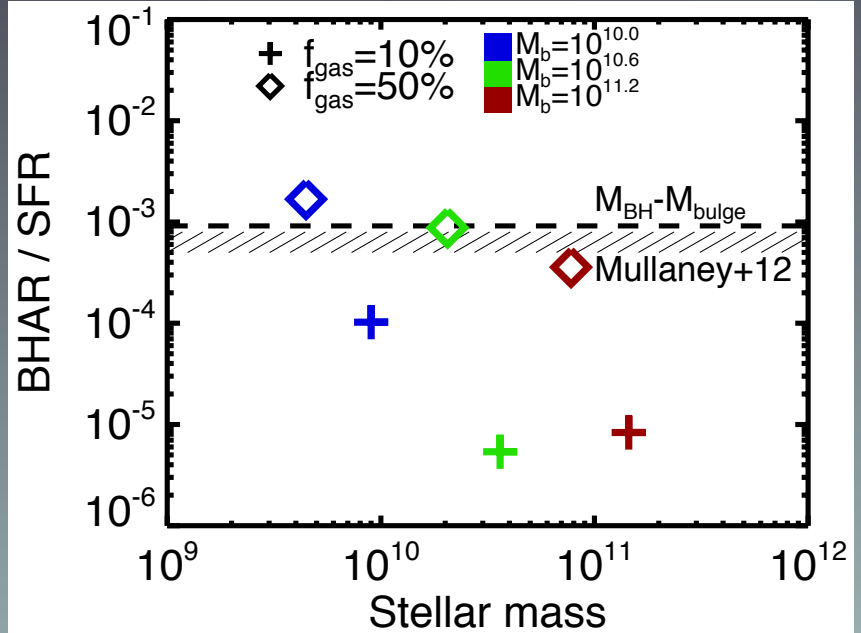
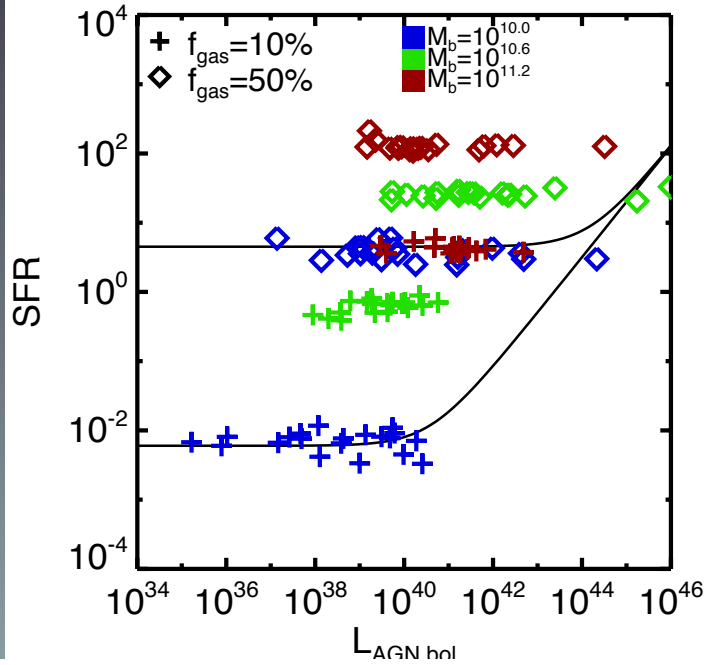


$\Lambda = (\text{actual accretion rate}) / (\text{Eddington limit})$

Gabor+Bournaud 13



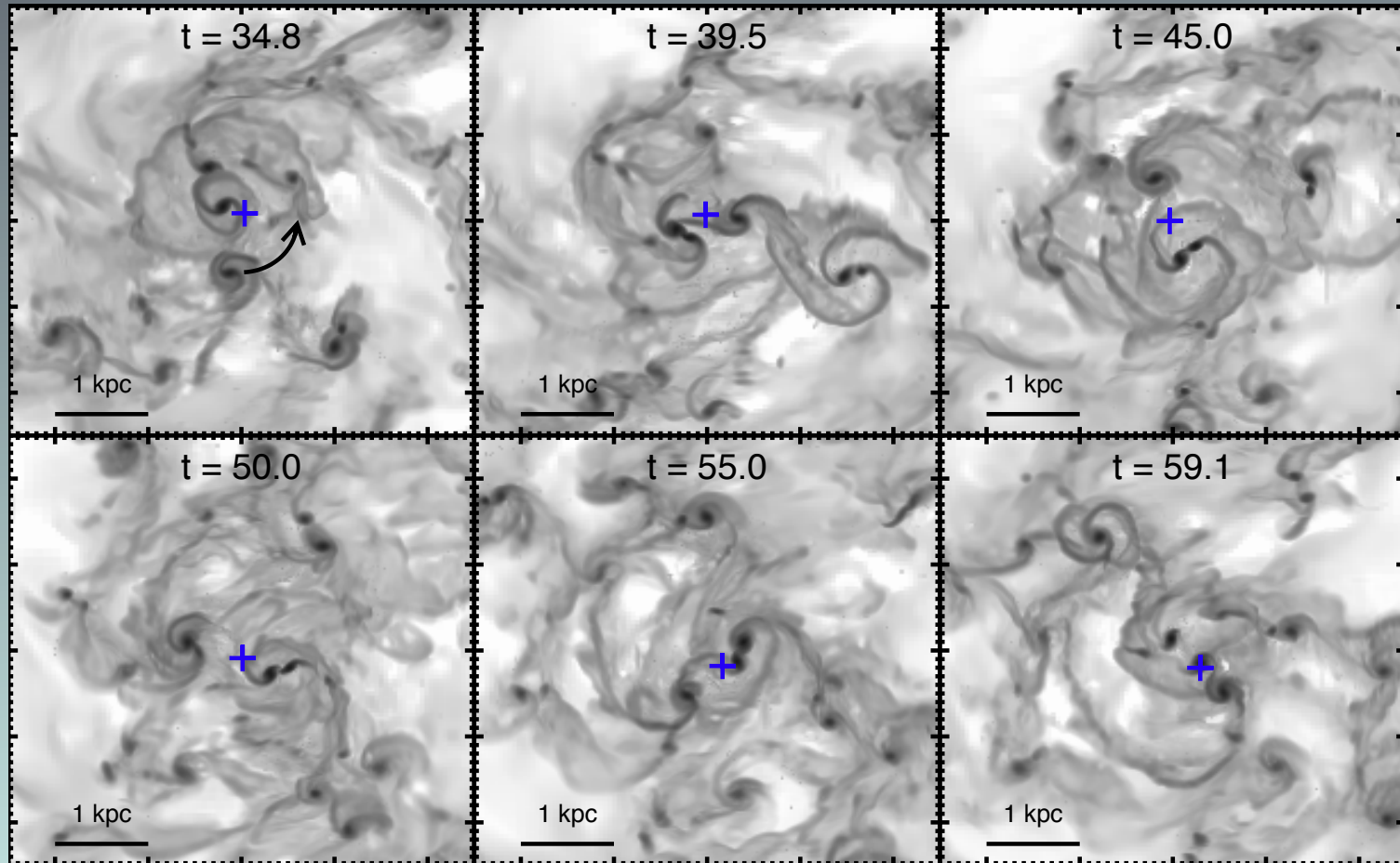
Rosario+12

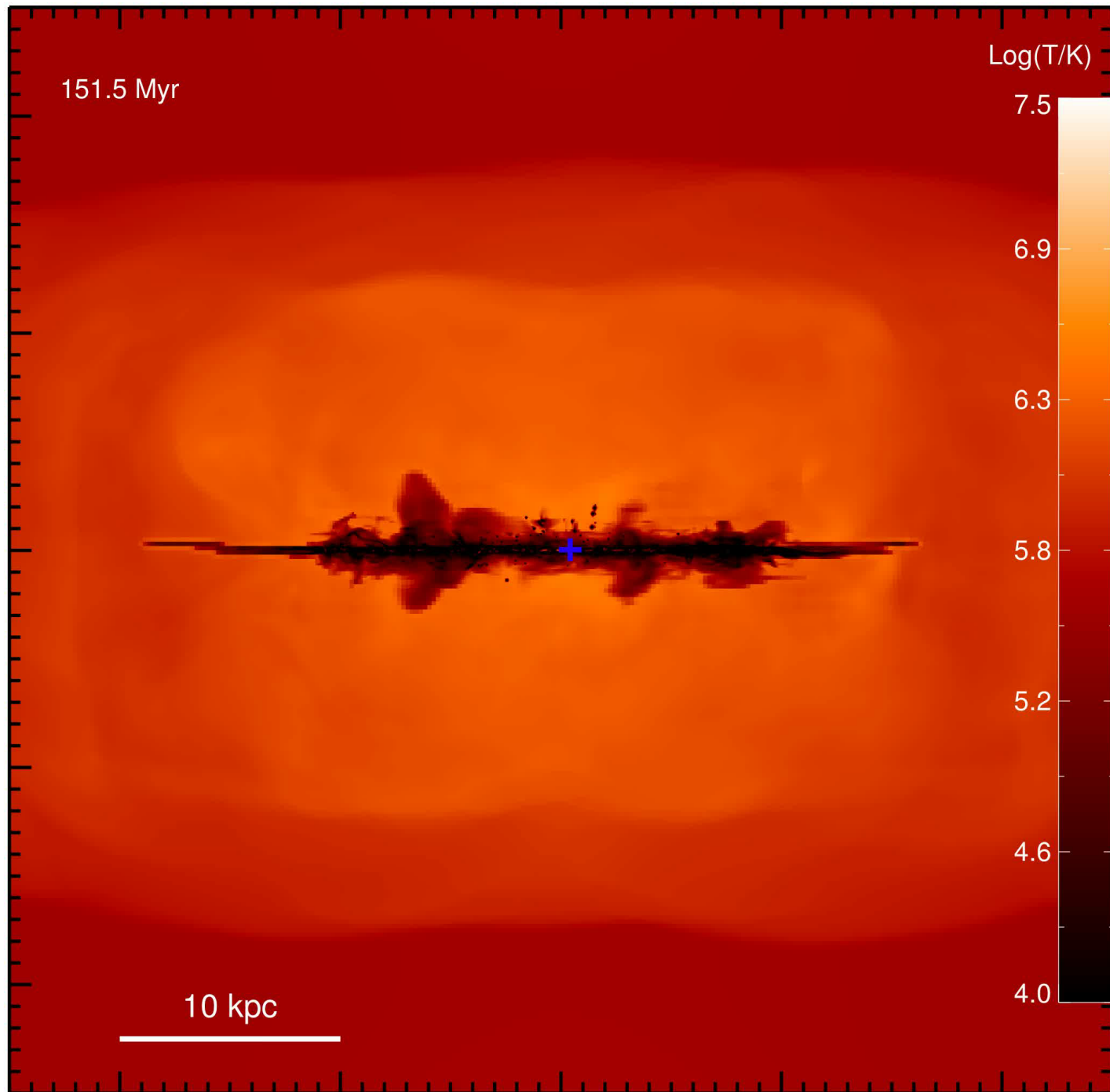


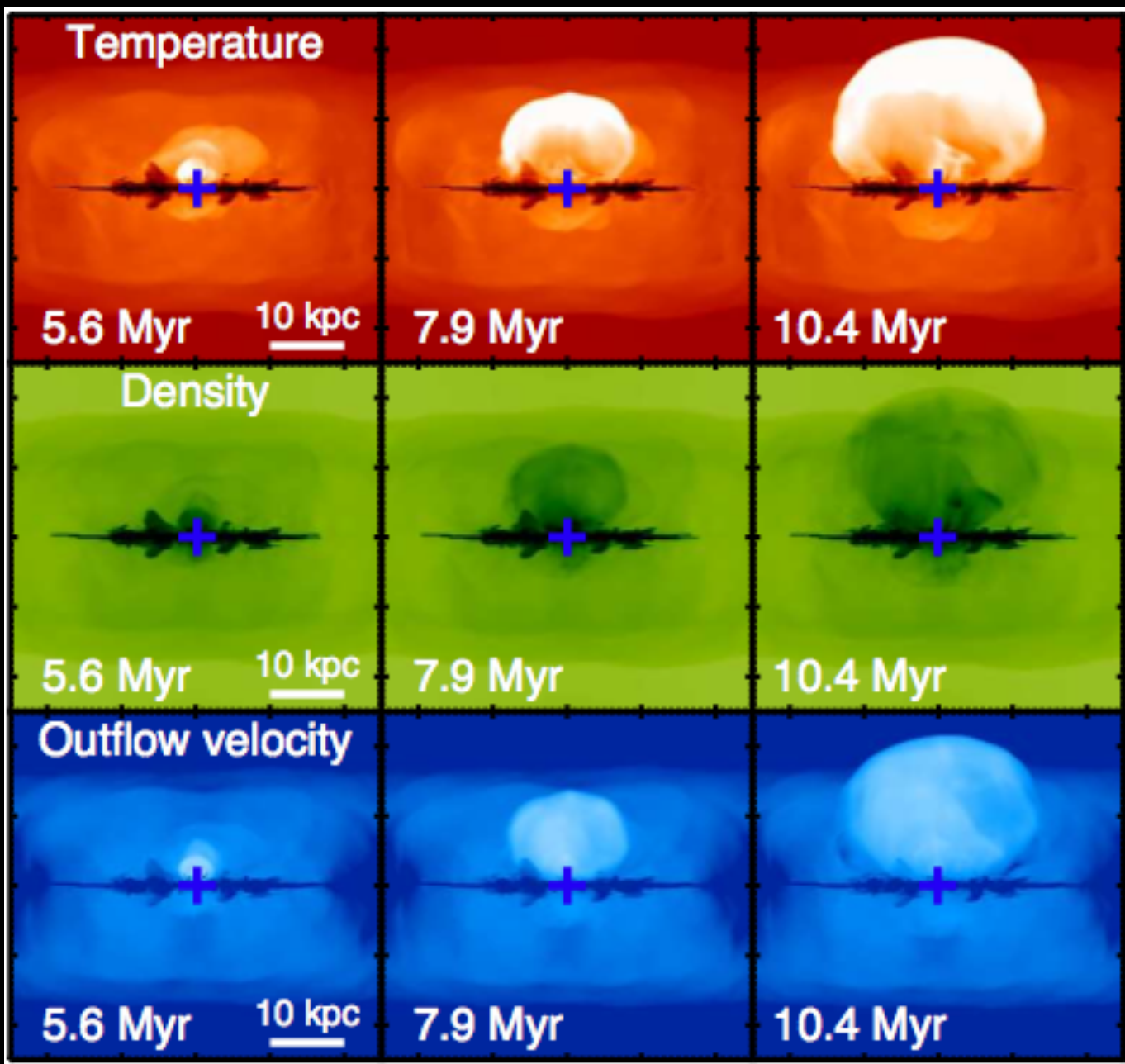
Rosario+12

Mullaney+12b
Jared Gabor

Impact of the AGN

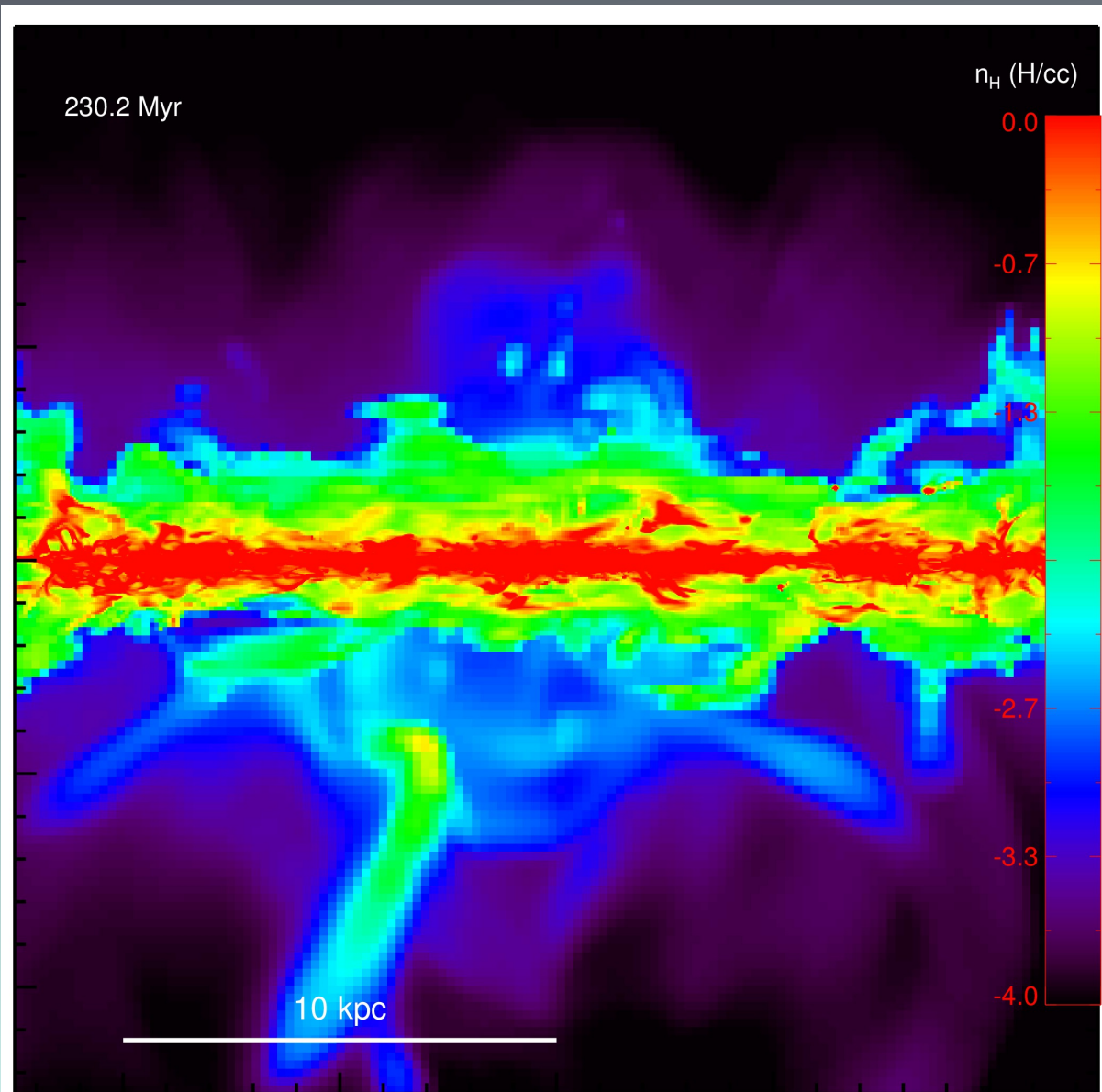




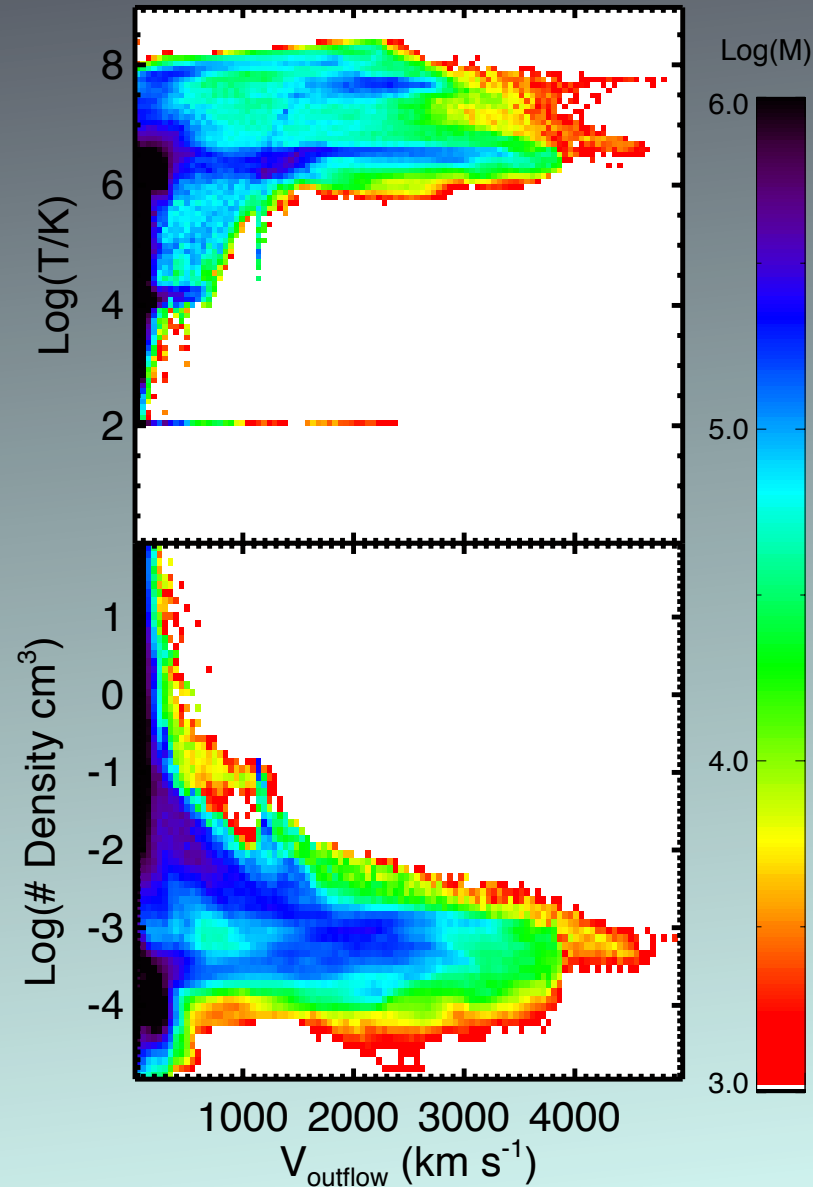


Gabor &
Bournaud
2014

Cold, dense clouds in hot outflow



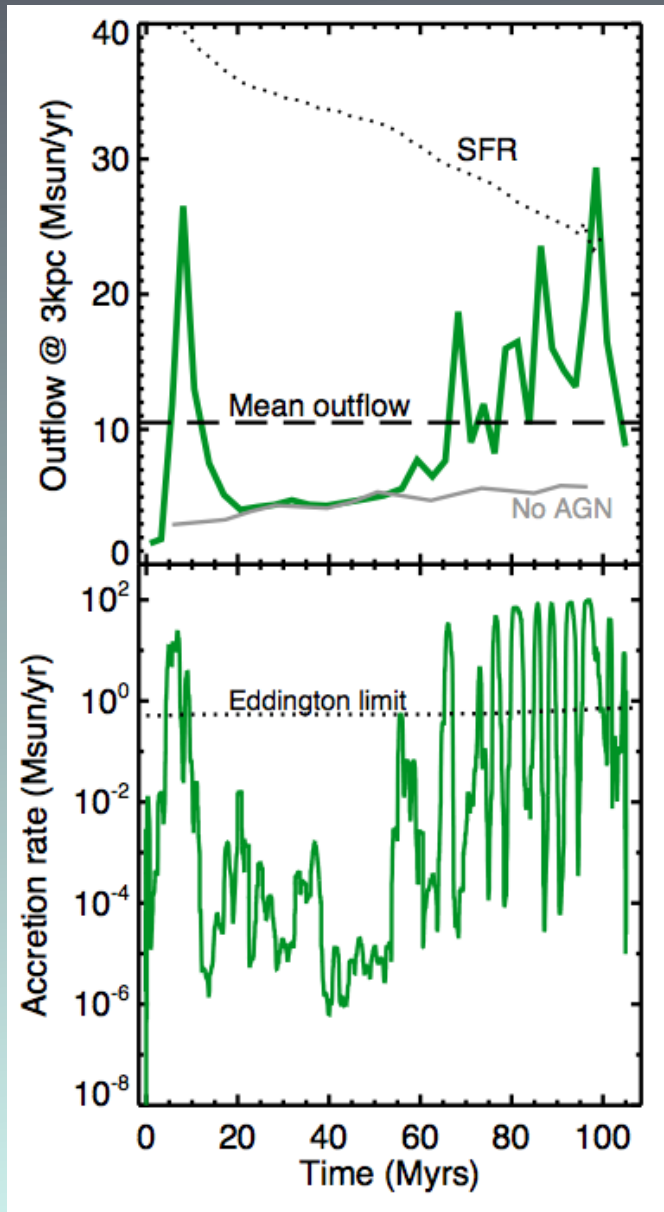
Outflow phase structure



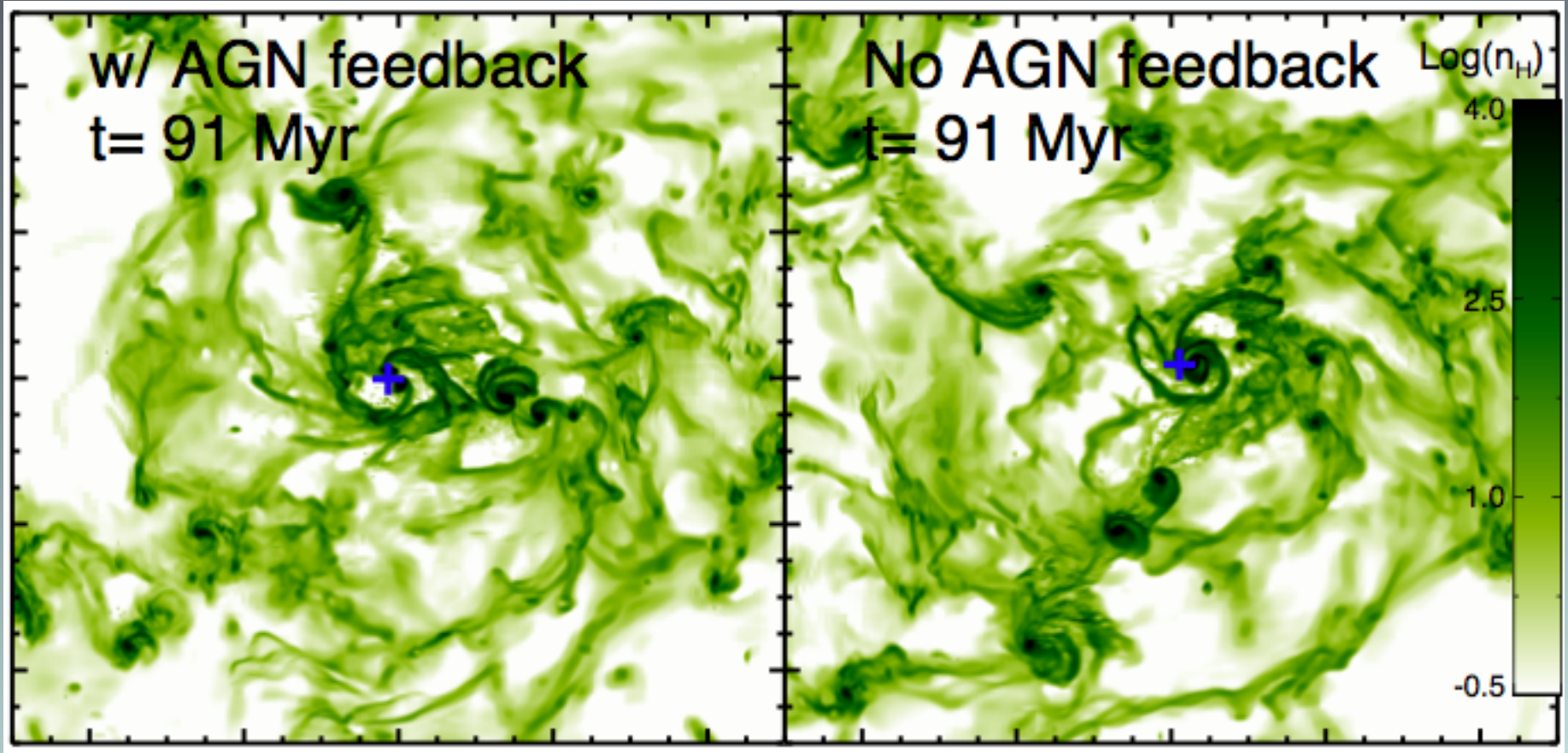
Outflow rates

$$L_{\text{AGN}}/c \sim 10^{34} \text{ g cm/s}^2$$

$$\text{outflow } dp/dt \sim 10^{35}$$

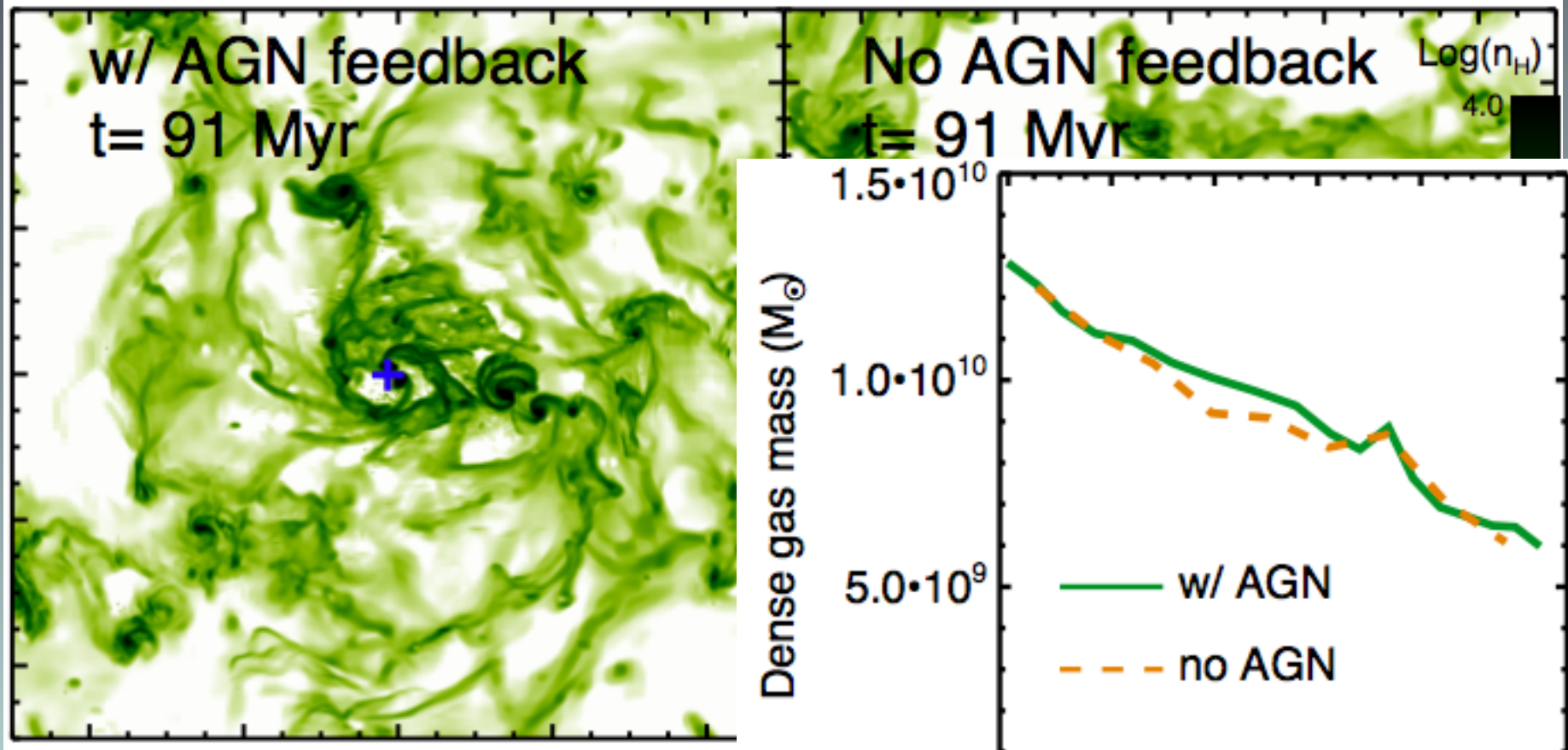


Effect on the host galaxy



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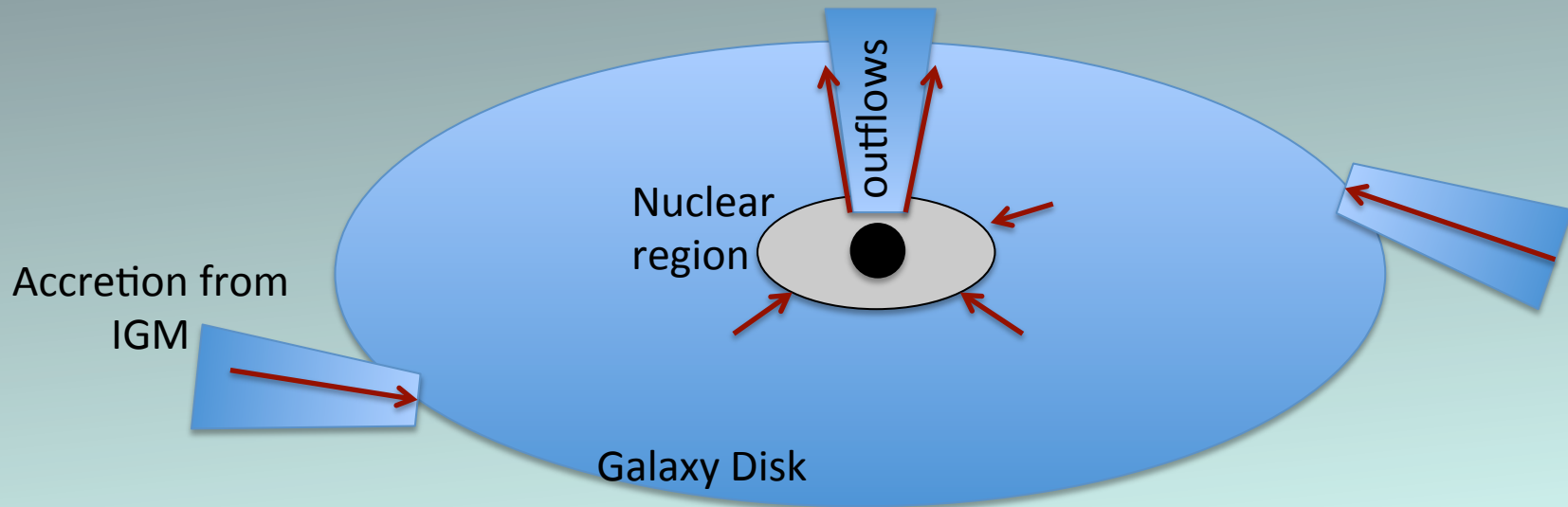
Effect on the host galaxy



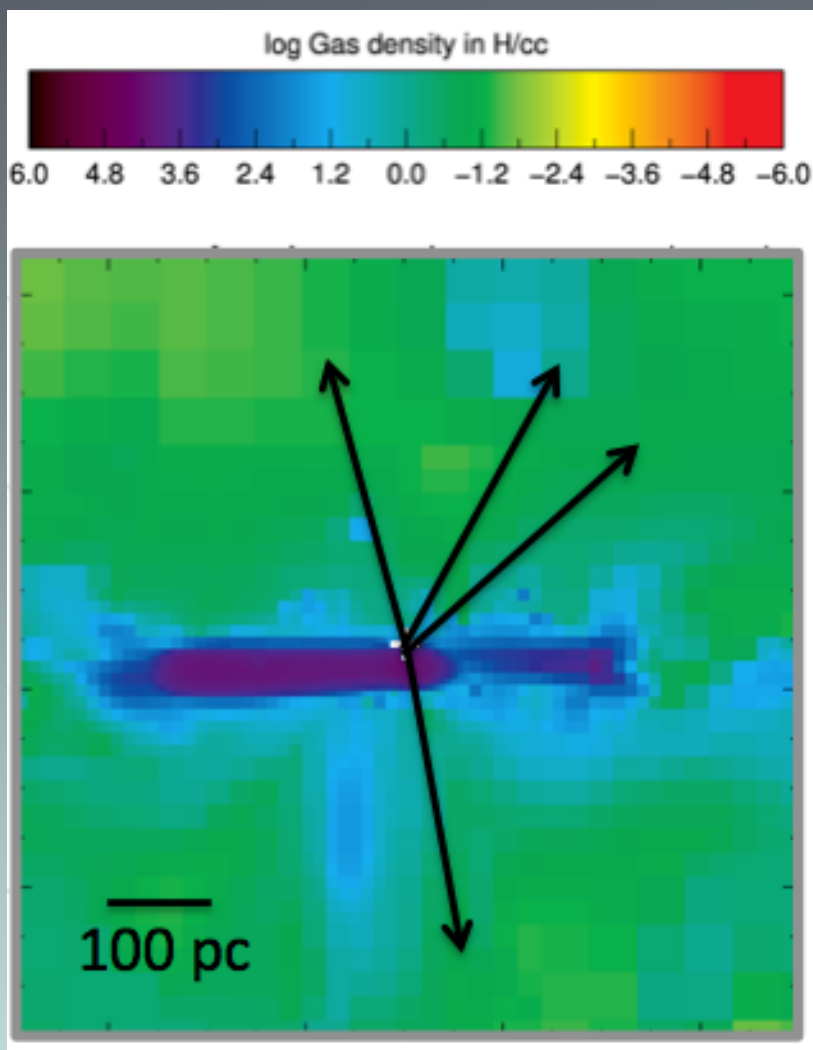
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AGN outflows *without* quenching

- Nuclear region nearly decoupled
 - instability-driven inflows $\rightarrow \approx 10 \text{ M}_{\text{sun}}/\text{yr}$
- AGN outflows escape the galaxy
- Galaxy disk fed by inter-galactic accretion



AGN photoionization



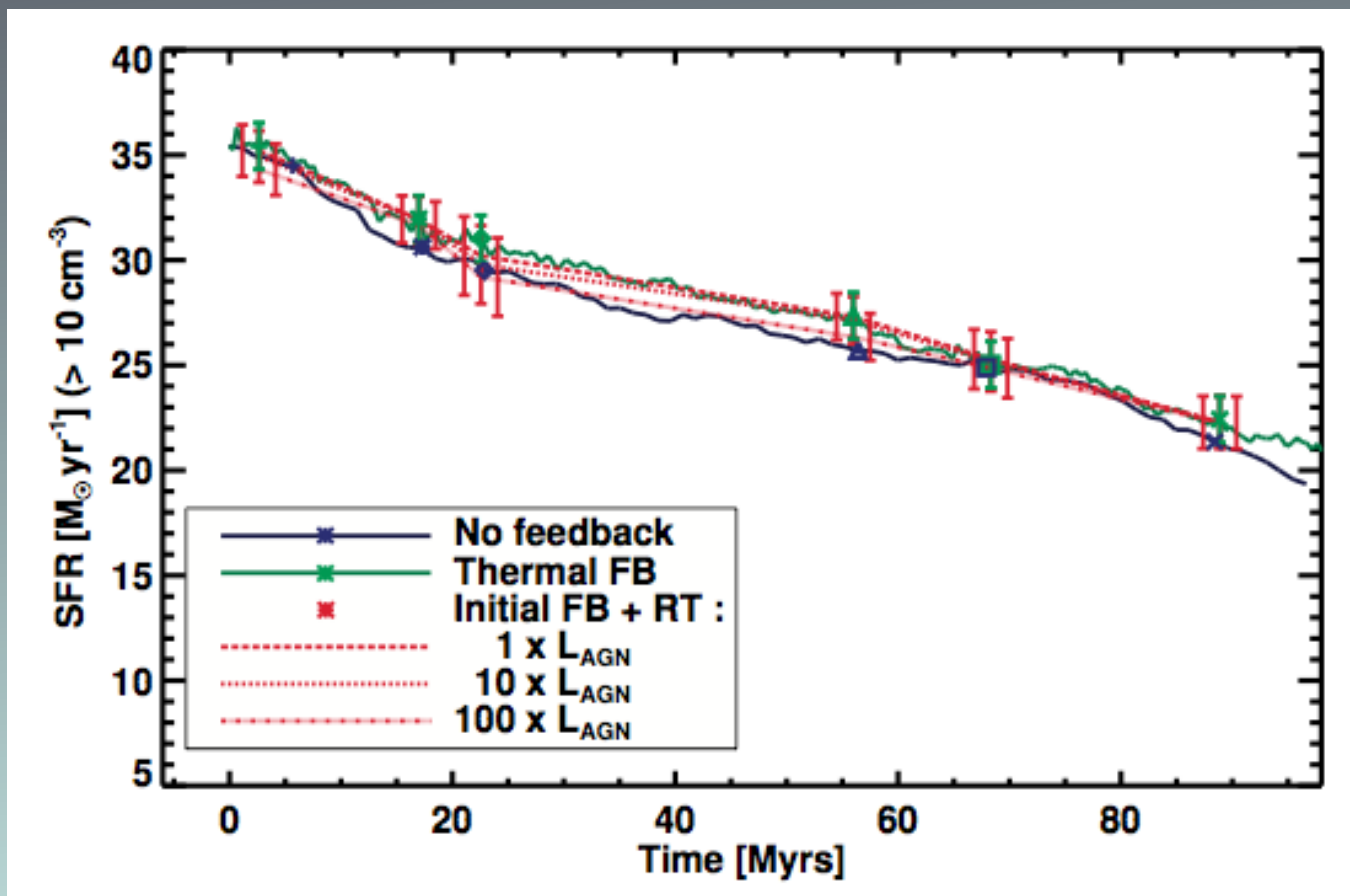
See poster by Orianne Roos

- Post-processed lines-of-sight
- Radiative transfer w/ CLOUDY
- Minimal impact on SFR

cf. Roos et al. -- arXiv:1405.7971

AGN photoionization

See poster by Orienne Roos



Roos et al. -- arXiv:1405.7971

Summary

Powerful AGNs can drive fast outflows
without quenching star formation

The End