DISK-CORONA GAS CYCLE IN SIMULATED MILKY WAY-LIKE GALAXIES

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James Wadsley
Thomas Quinn
Rok Roskar

Life cycle of gas in galaxies, ASTRON, 2015

GAS ACCRETION ONTO HALOS

Cold vs *hot* mode of gas accretion (e.g., Keres+05,09)

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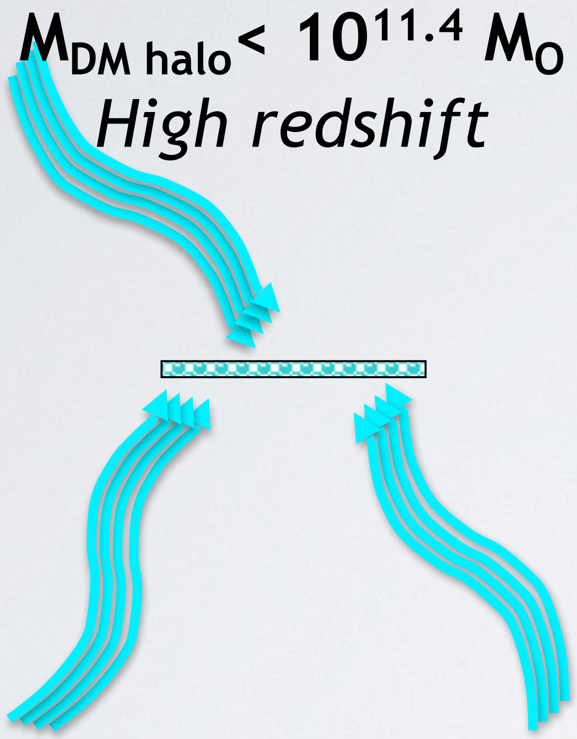

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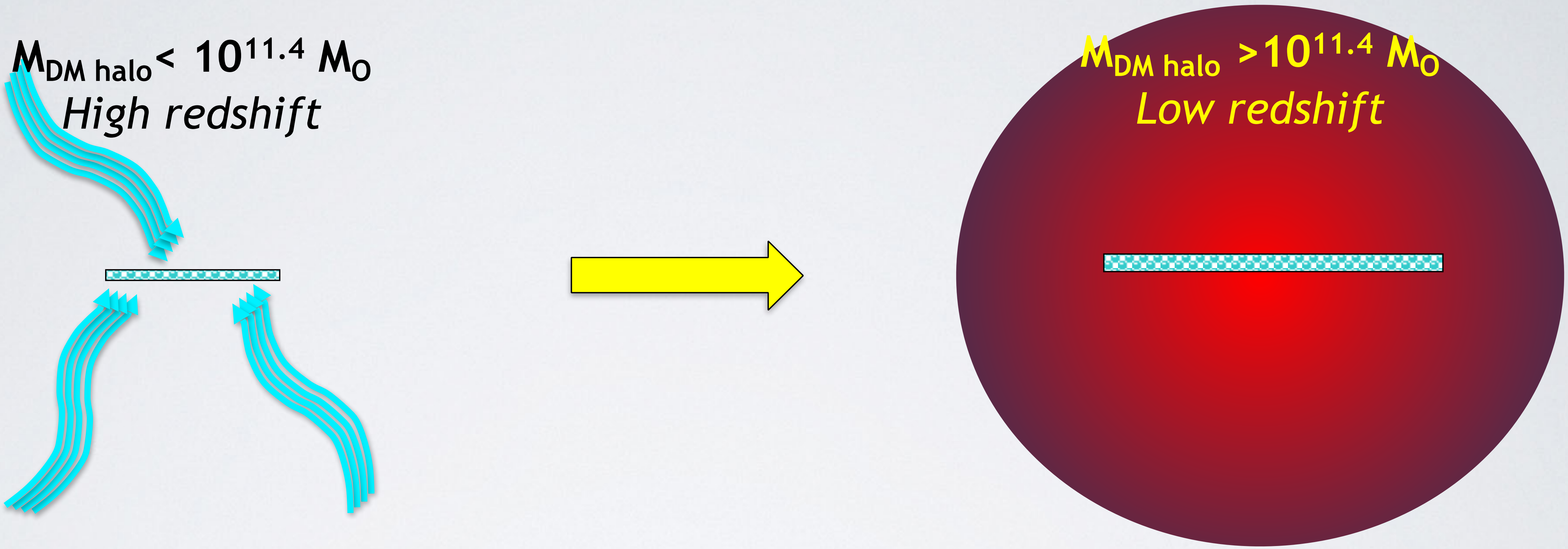

Coronae in MW like galaxies:

- $T \sim T_{vir}$ (few 10^6 K)
- Extended hundreds of kph
- Low metallicity

see Fukugita & Peebles 2006

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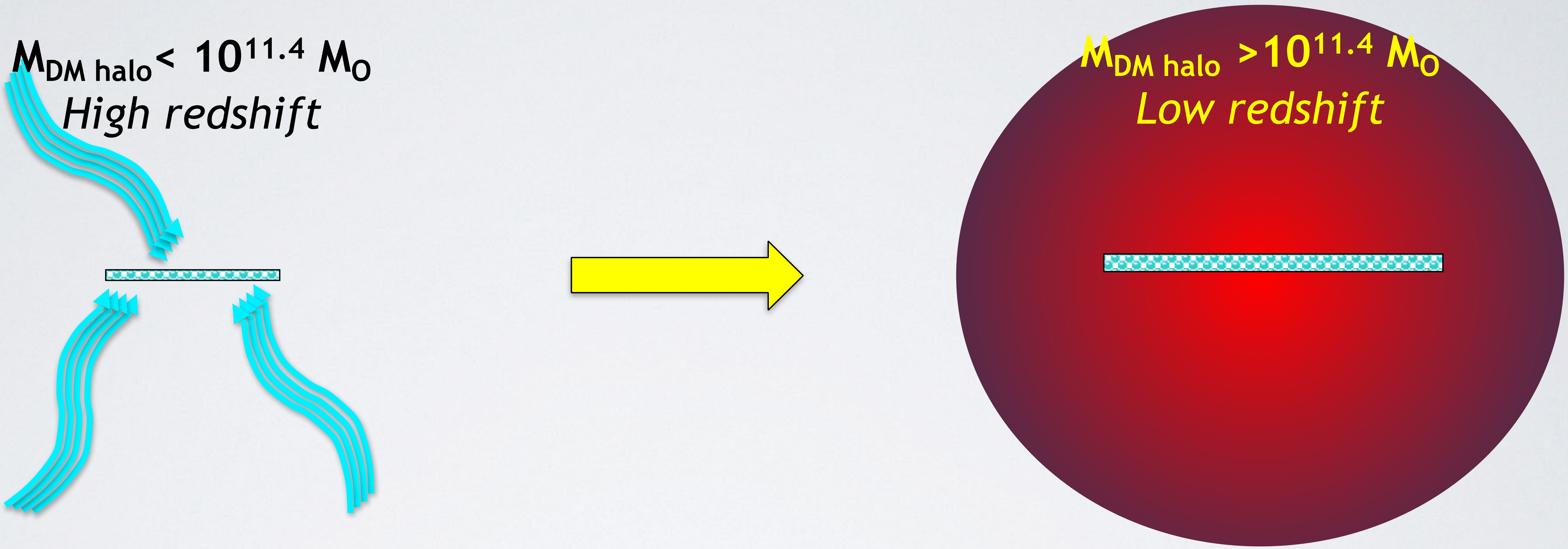

transition at z ~ 2

↓

the MW corona had fed our Galaxy continuously in the last 10 Gyr!

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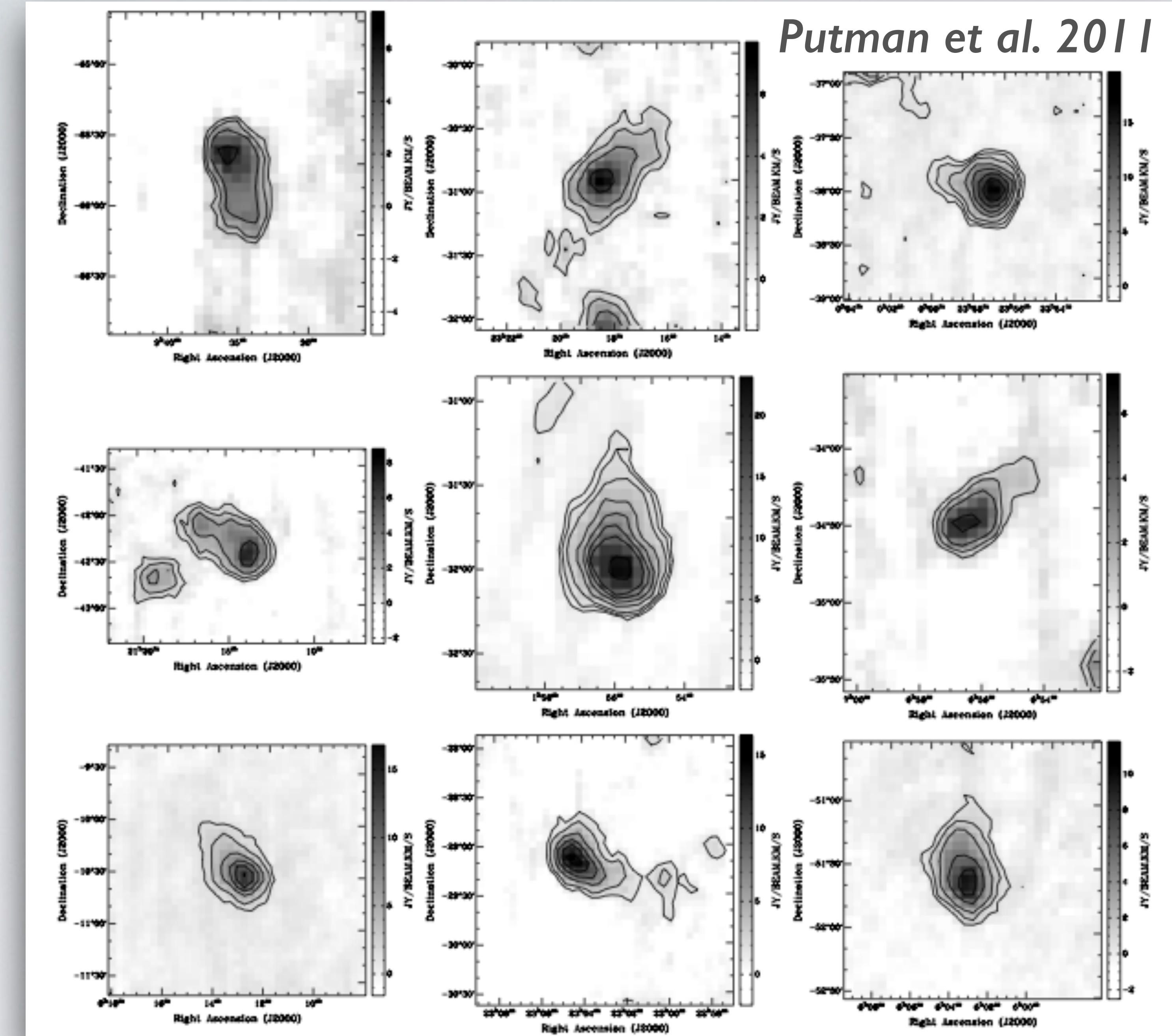

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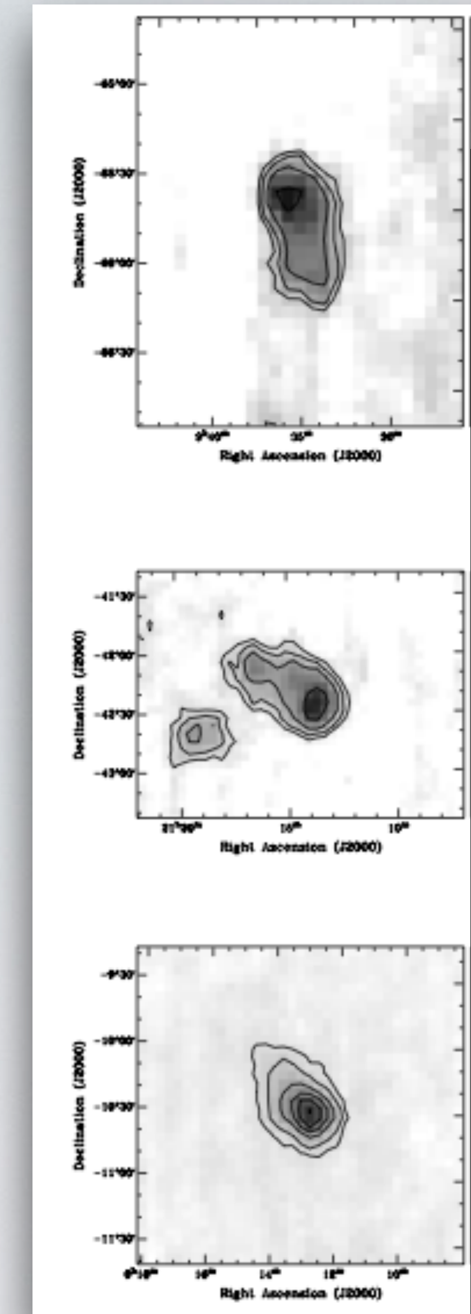
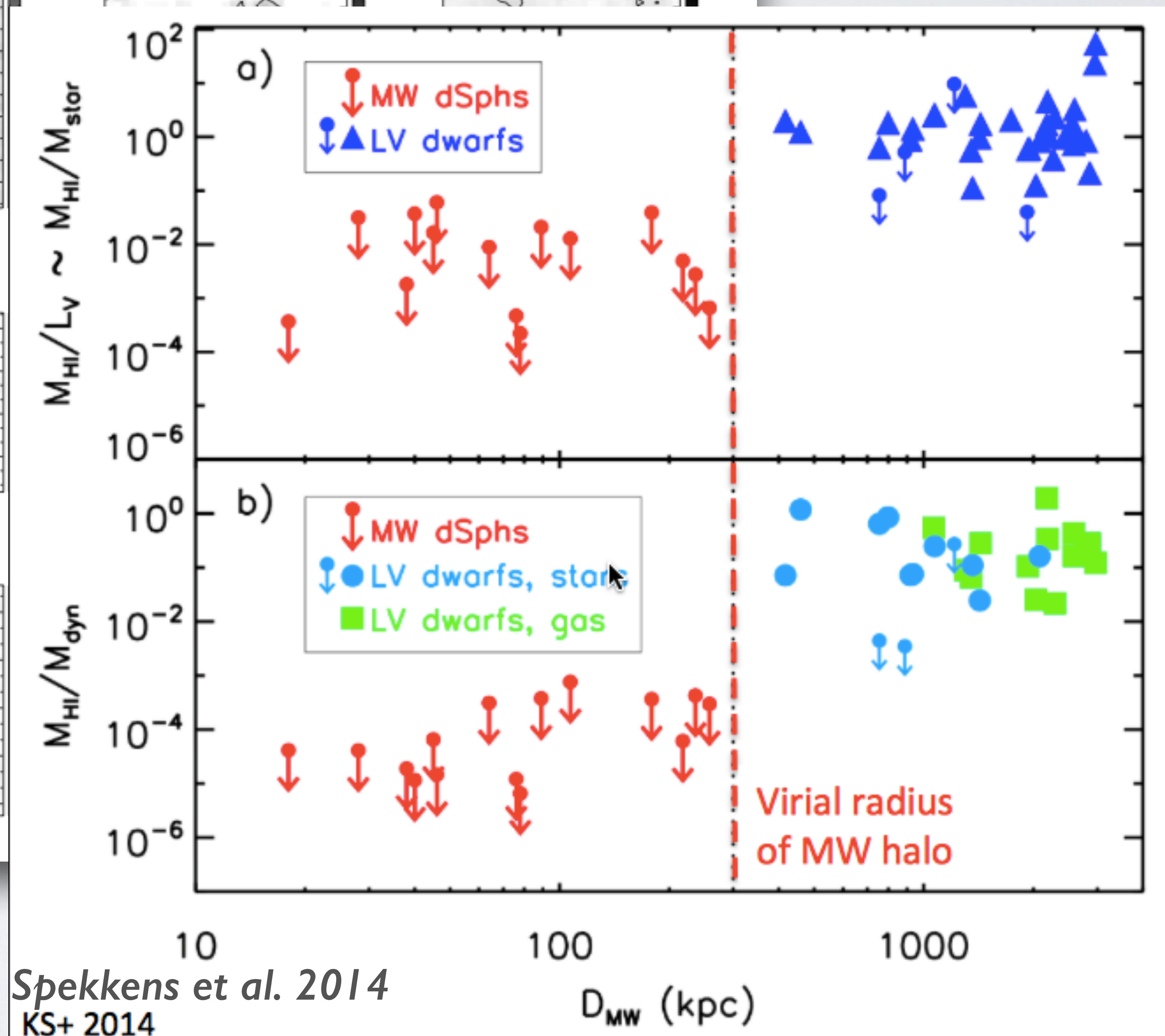


Putman et al. 2011



Spekkens et al. 2014

KS+ 2014

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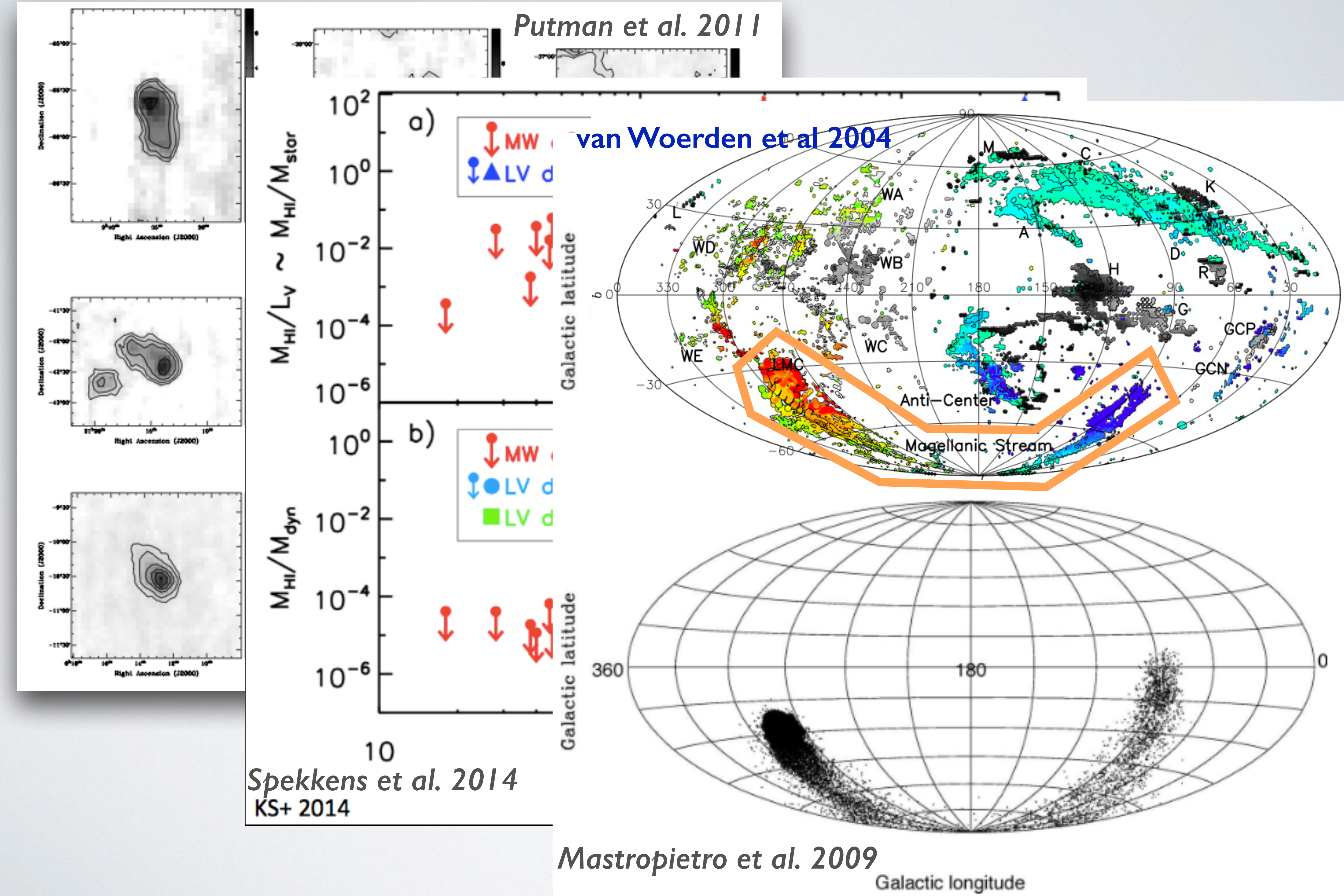

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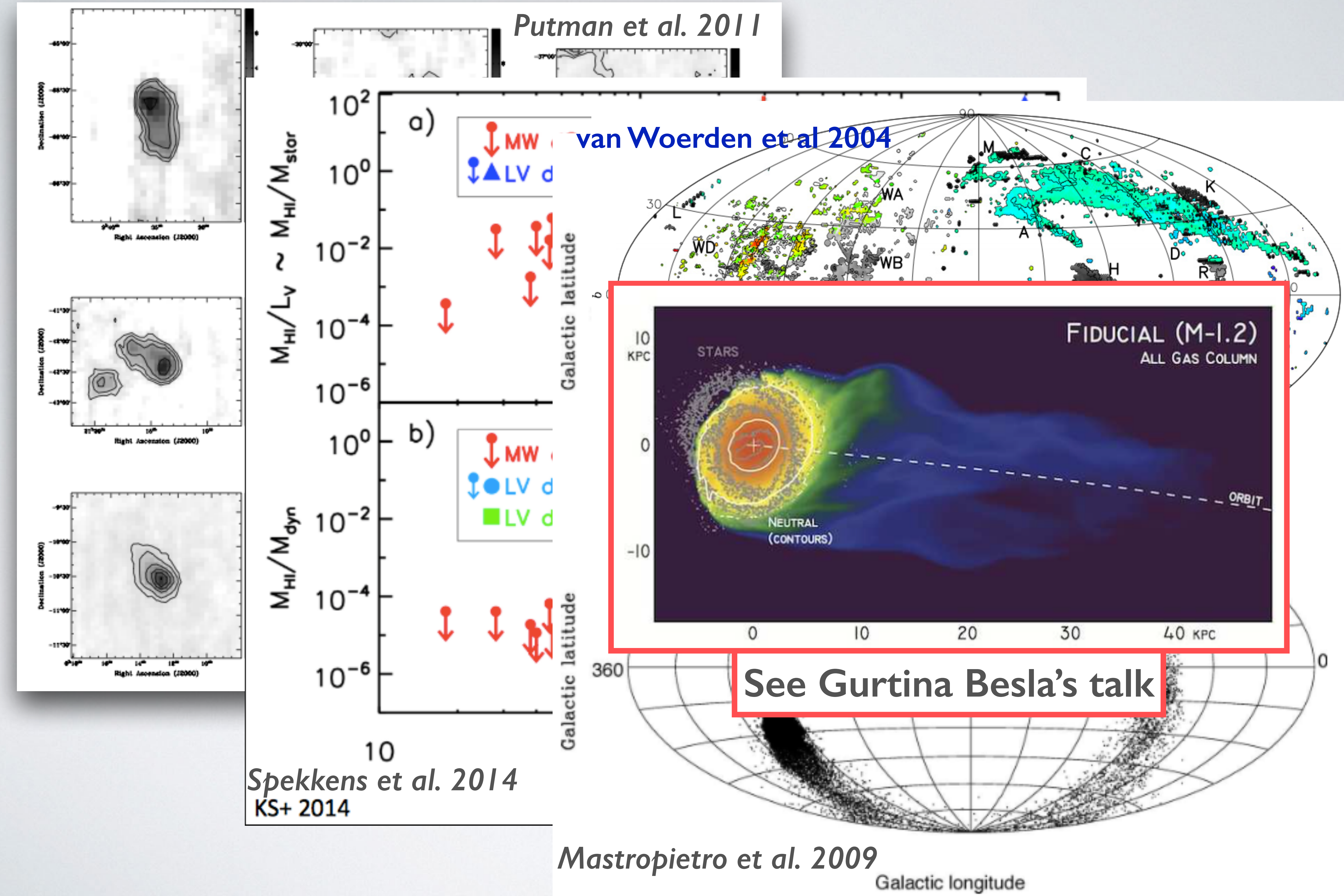

See Gurtina Besla's talk

SIMULATION SETUP

Code: *GASOLINE* (SPH; Wadsley+04)

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- NFW
- r_{200} = 200 kpc
- $M_{vir} = 10^{12}$ Mo
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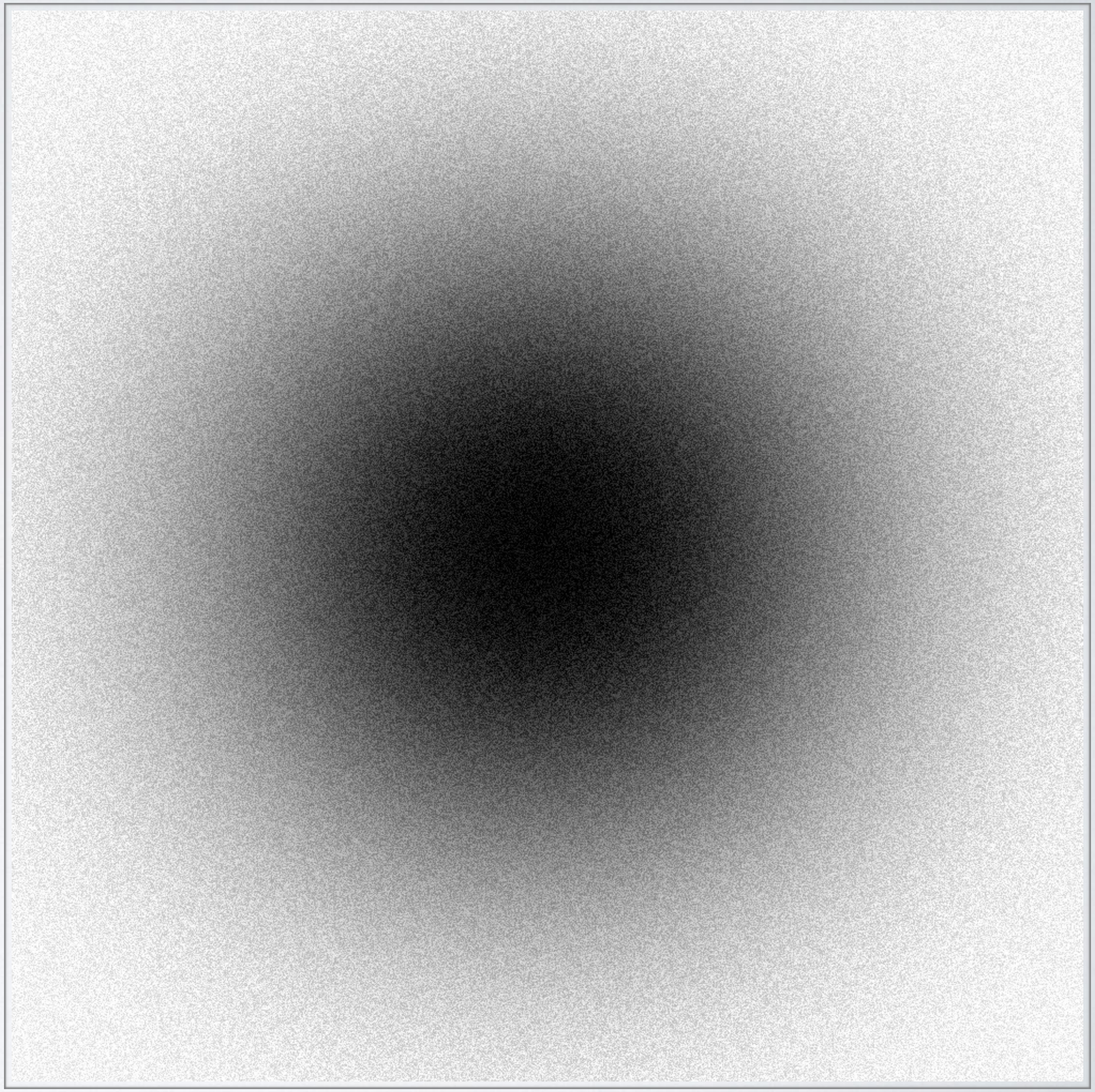

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- 10% of Mtot
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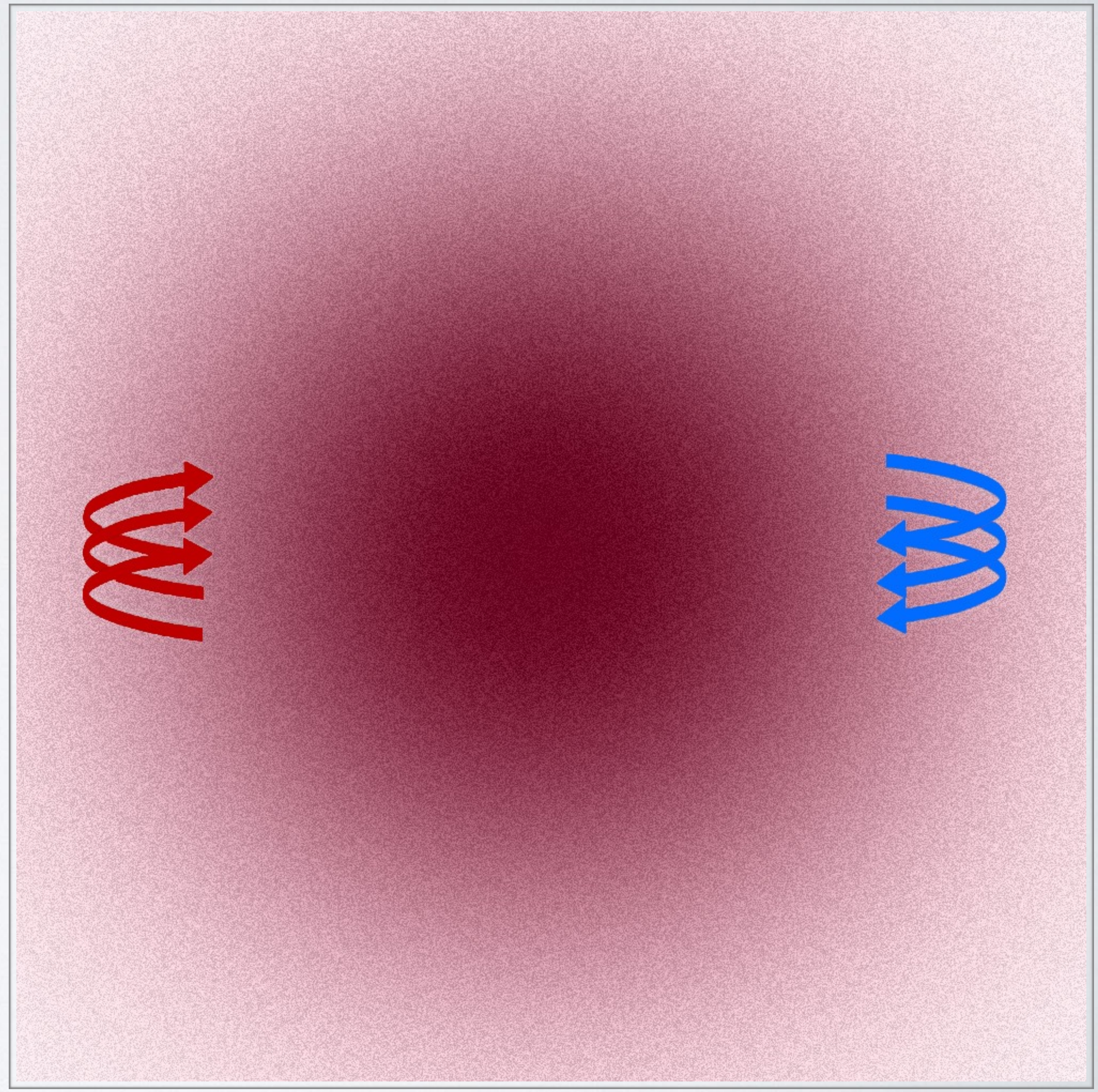
- hydro equilibrium
- $\lambda = 0.065$
- $m_{gas} = 1.4 \times 10^{5}$ Mo



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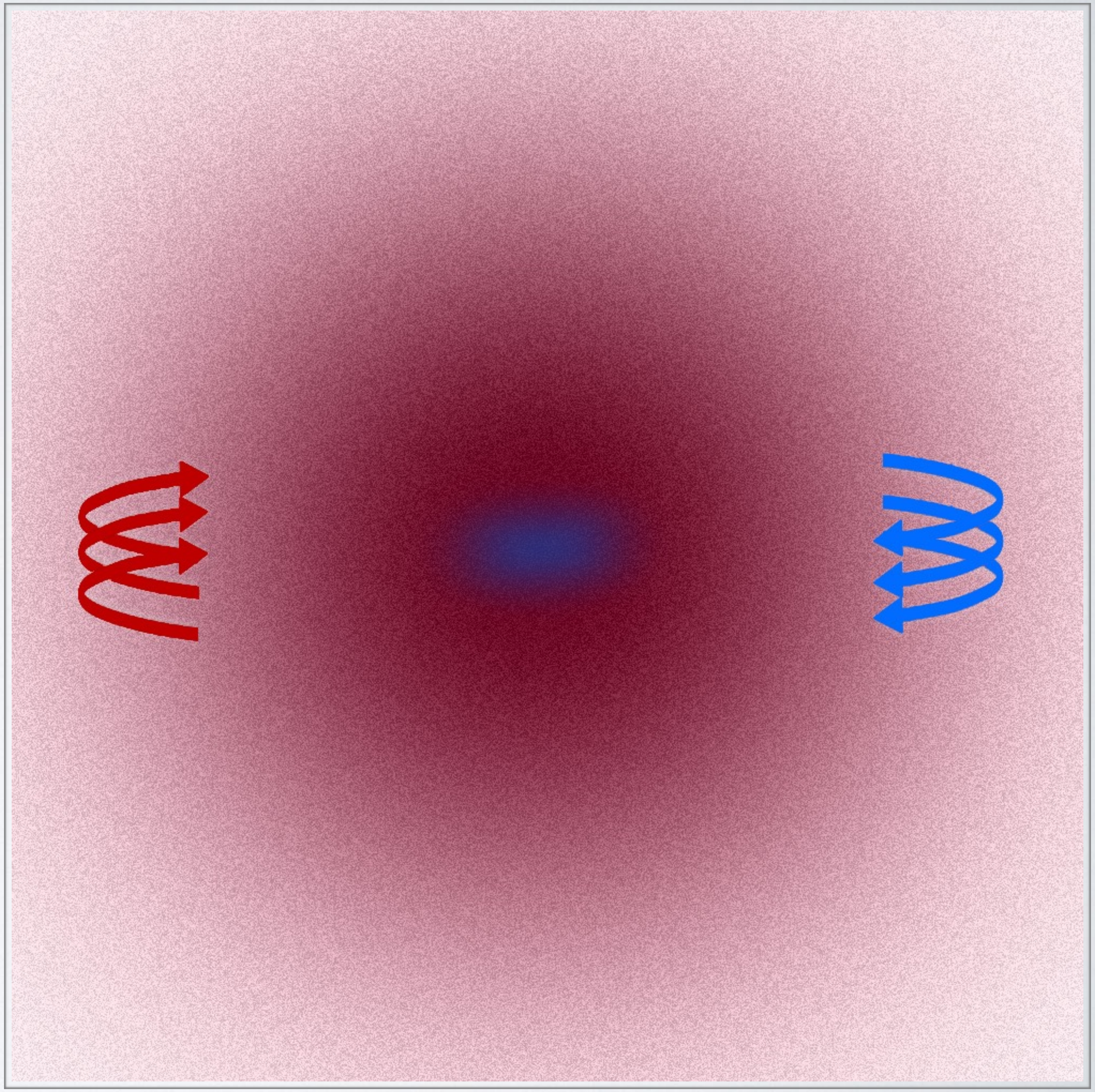
- rho,T and Z dependent



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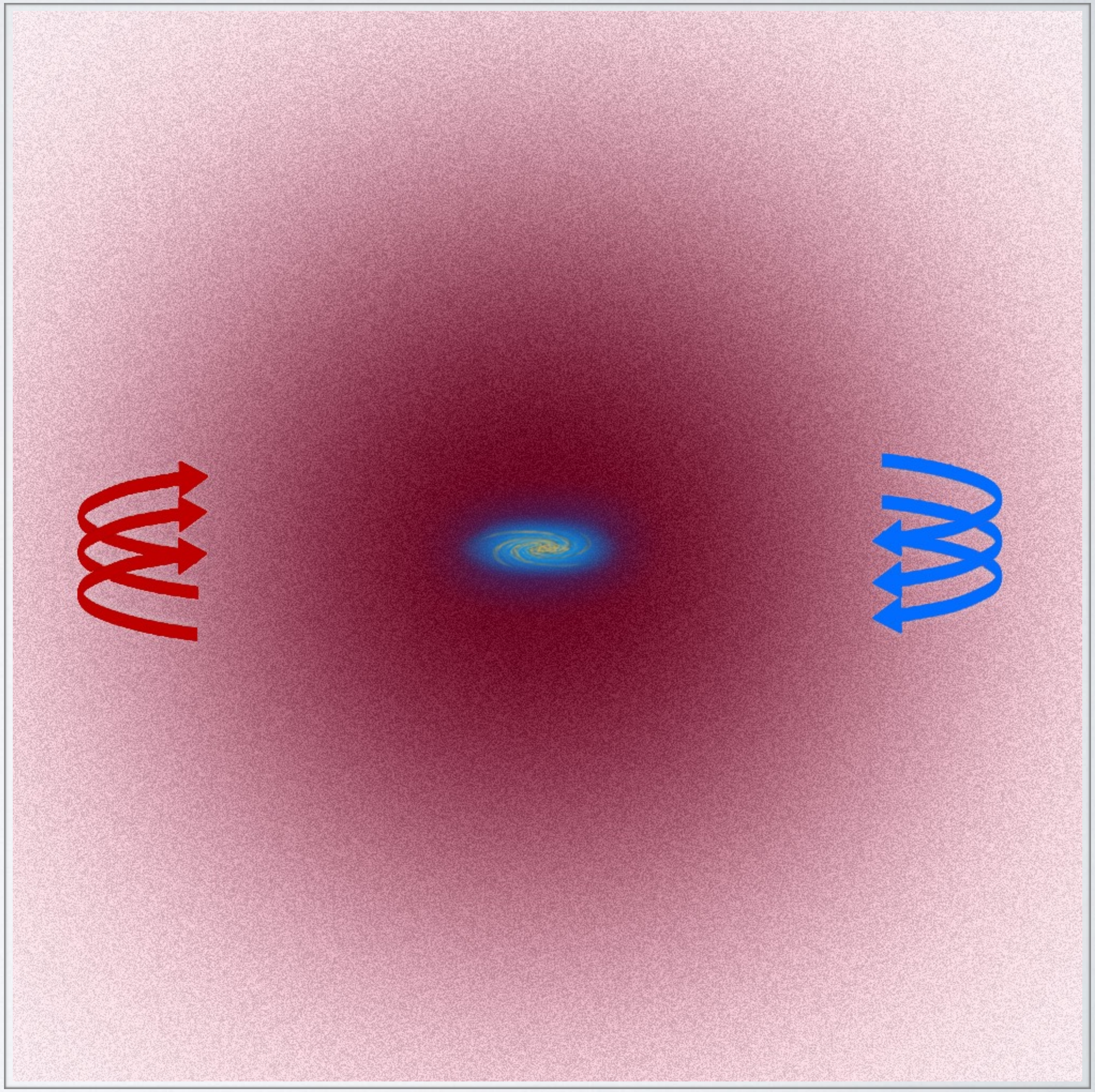

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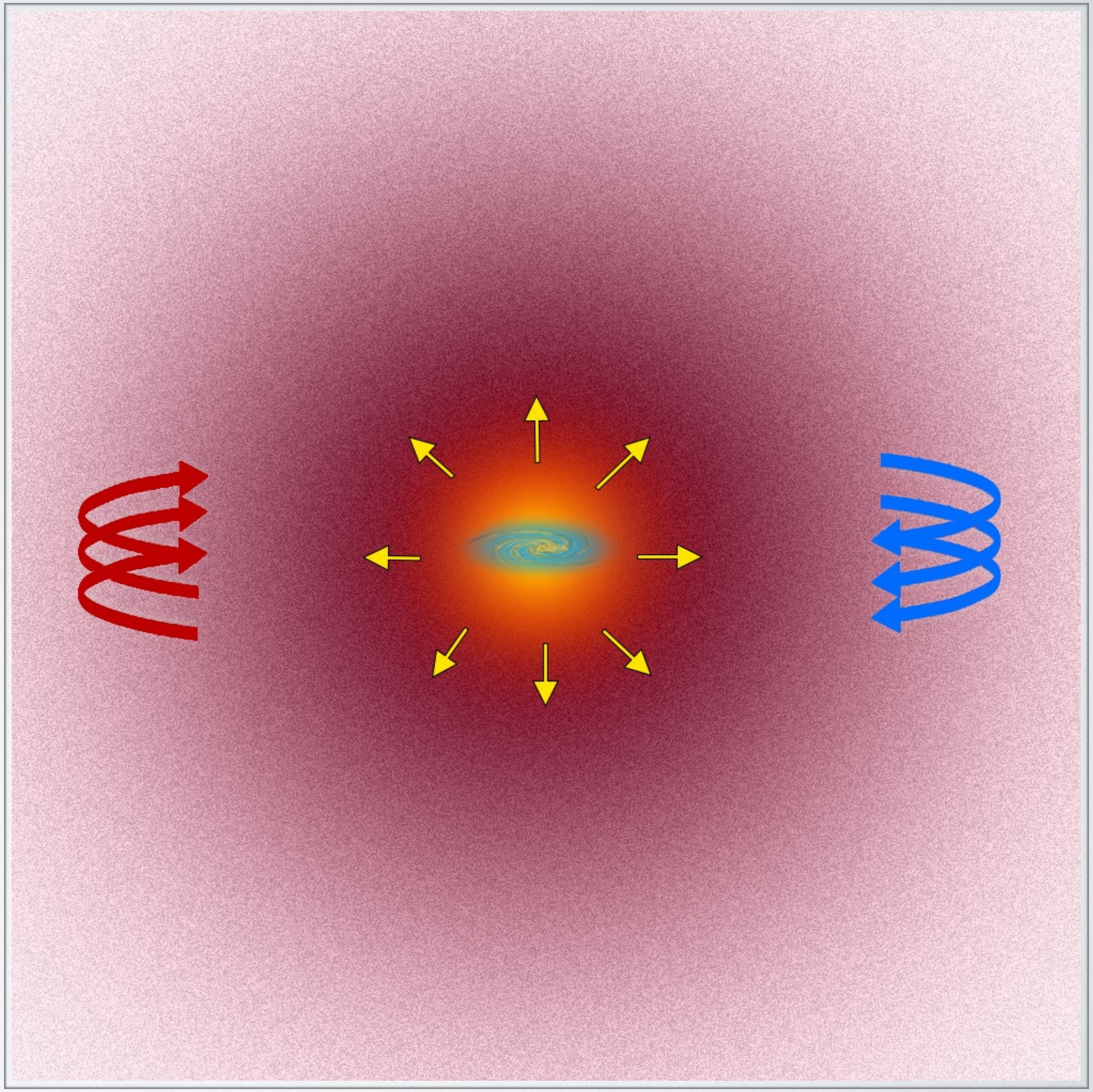
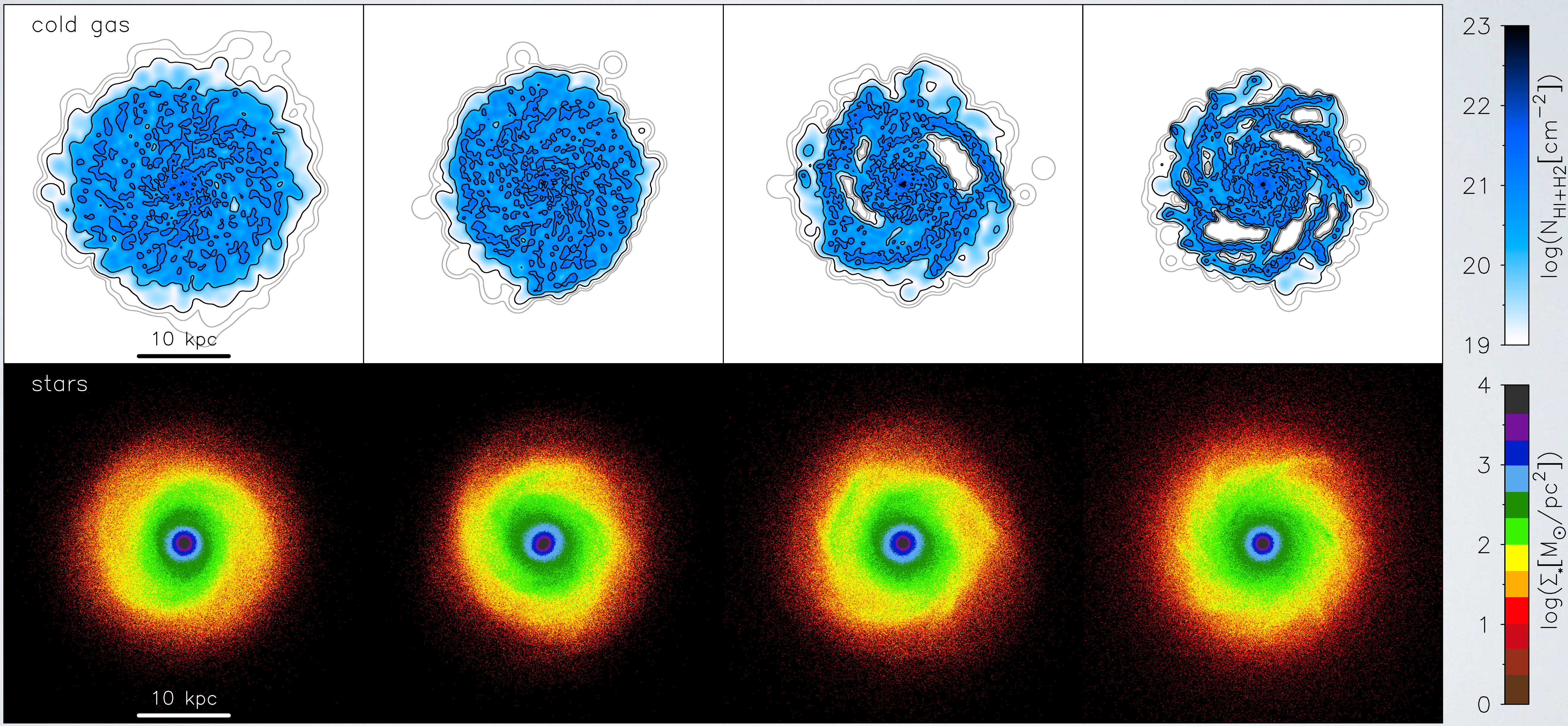
Stellar feedback (Stinson+06)
- SN feedback (thermal, blast-wave)
- **E_{SN} as a free parameter**
- stellar winds (~25%)



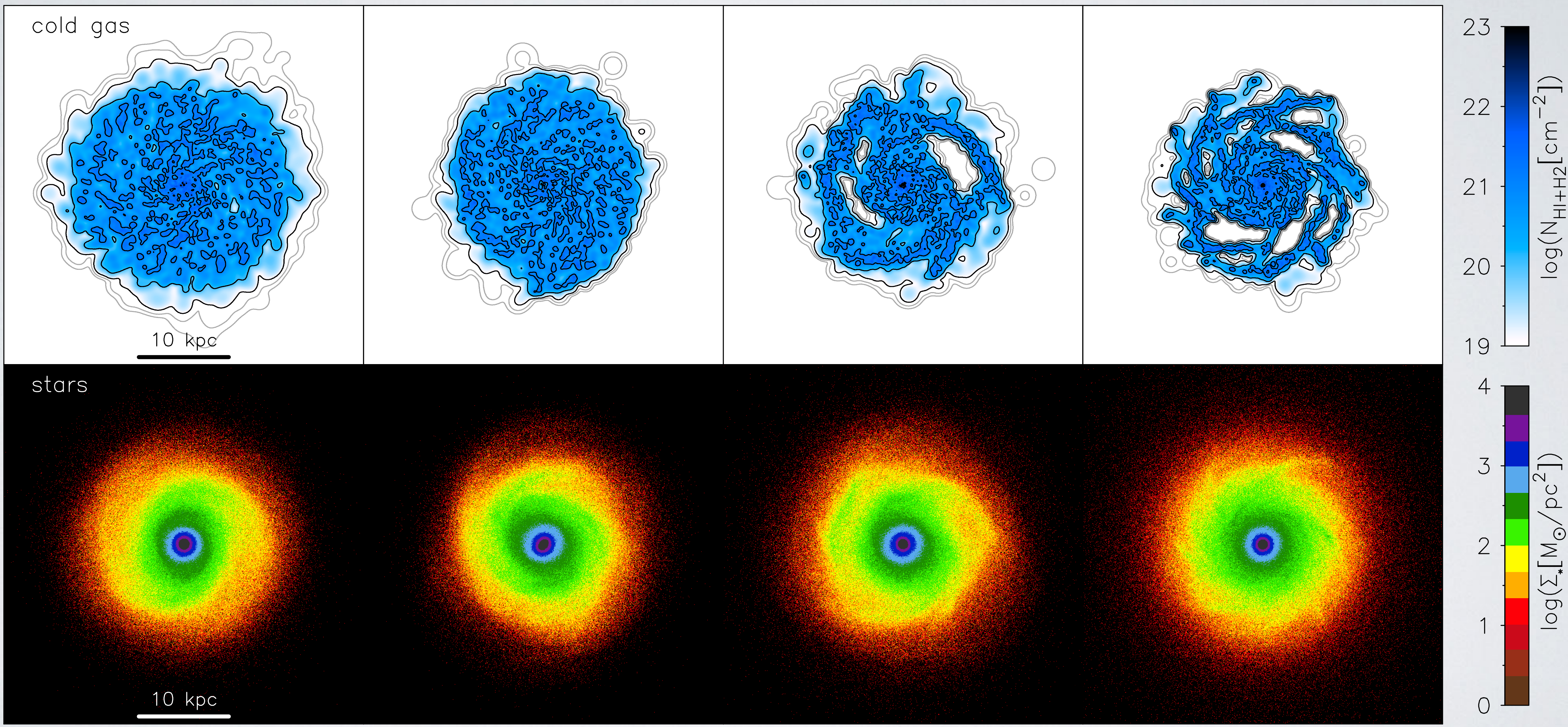
FACE-ON MAPS

F80	F40	F10	F2.5



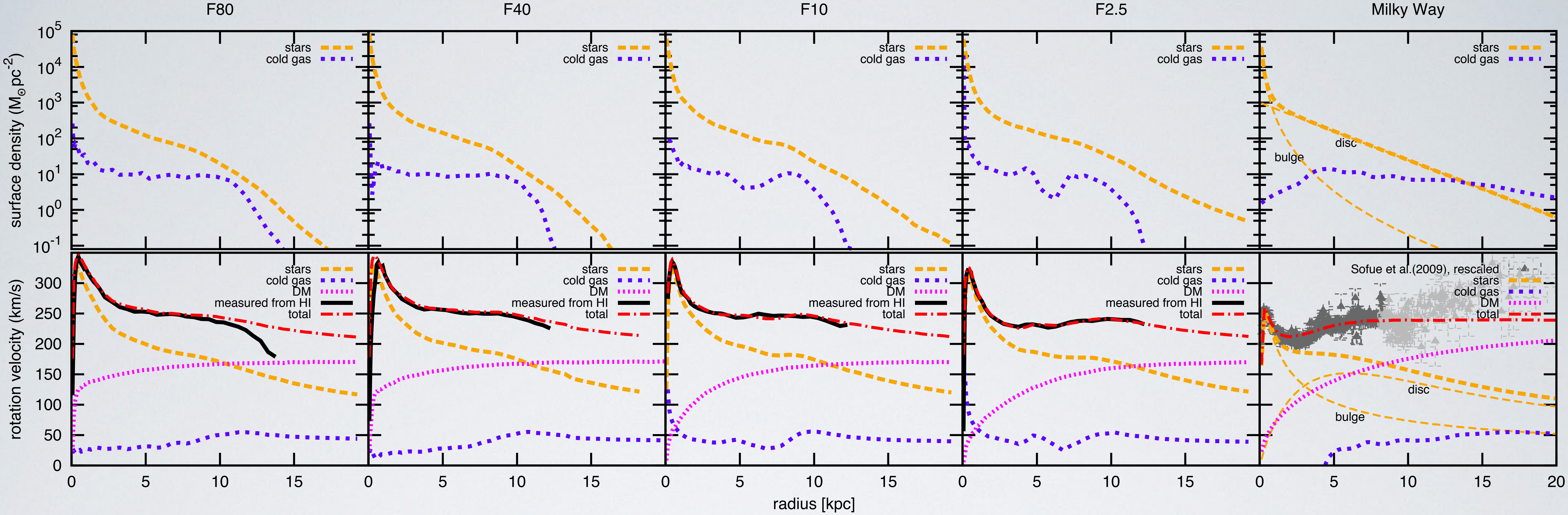
FACE-ON MAPS

F80	**F40**	**F10**	**F2.5**
2.9x10^{9} Mo	2.5x10^{9} Mo	2.4x10^{9} Mo	2.5x10^{9} Mo



5.8x10^{10} Mo	5.9x10^{10} Mo	6.1x10^{10} Mo	6.2x10^{10} Mo

MASS DISTRIBUTION AND KINEMATICS



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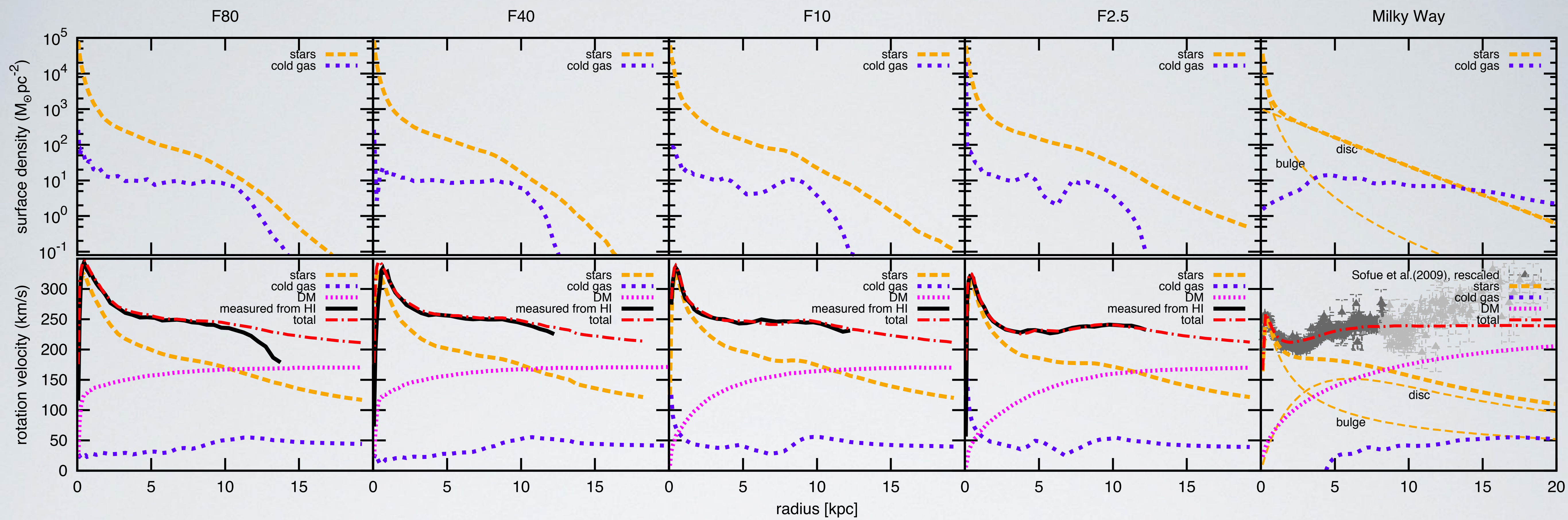
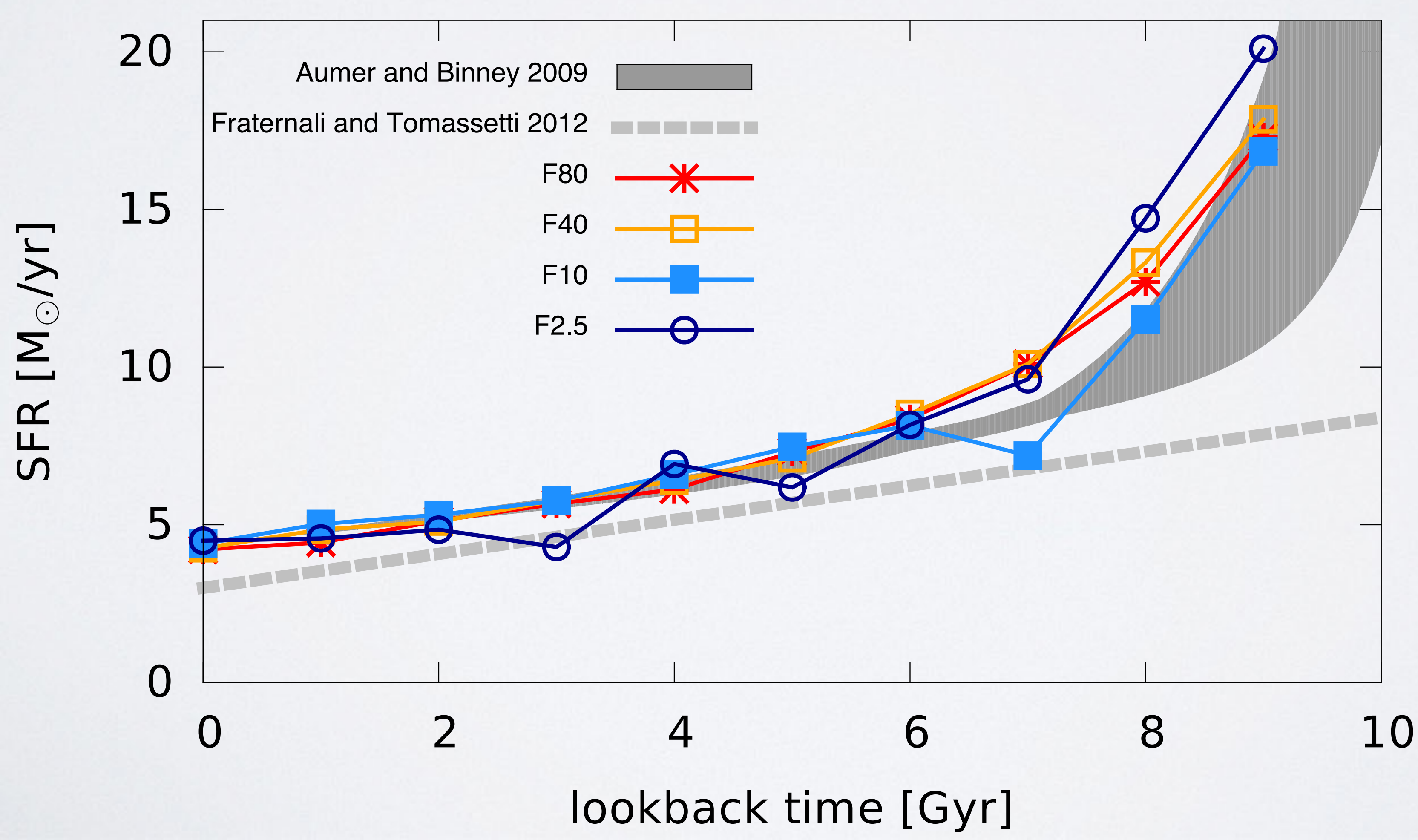


STAR FORMATION HISTORY



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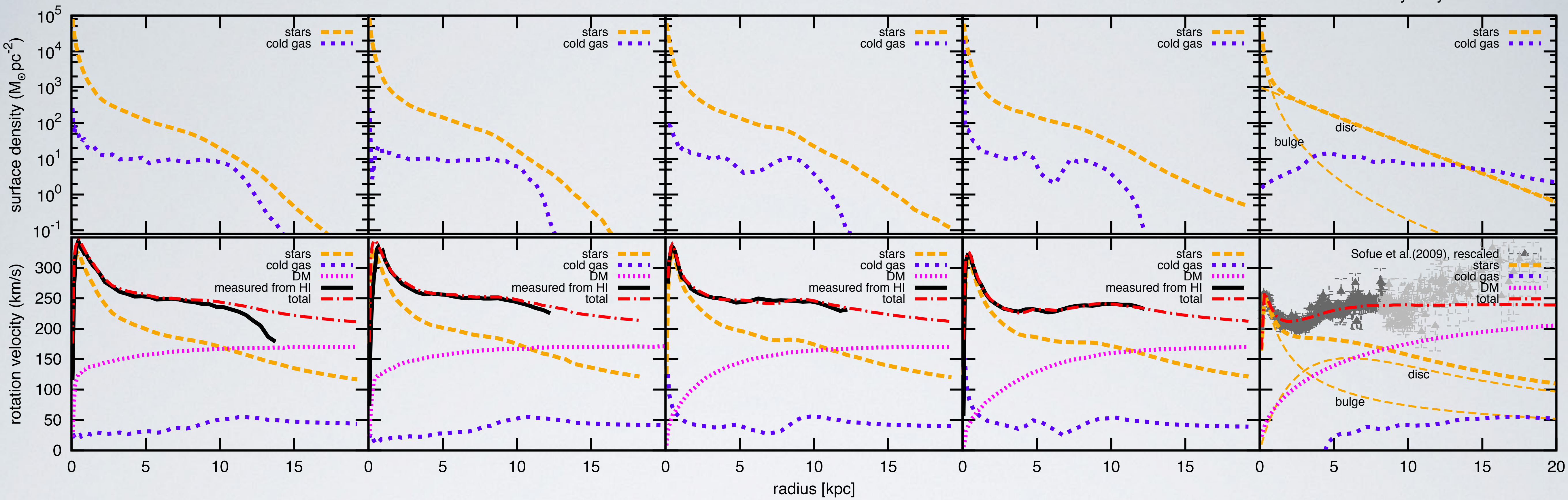

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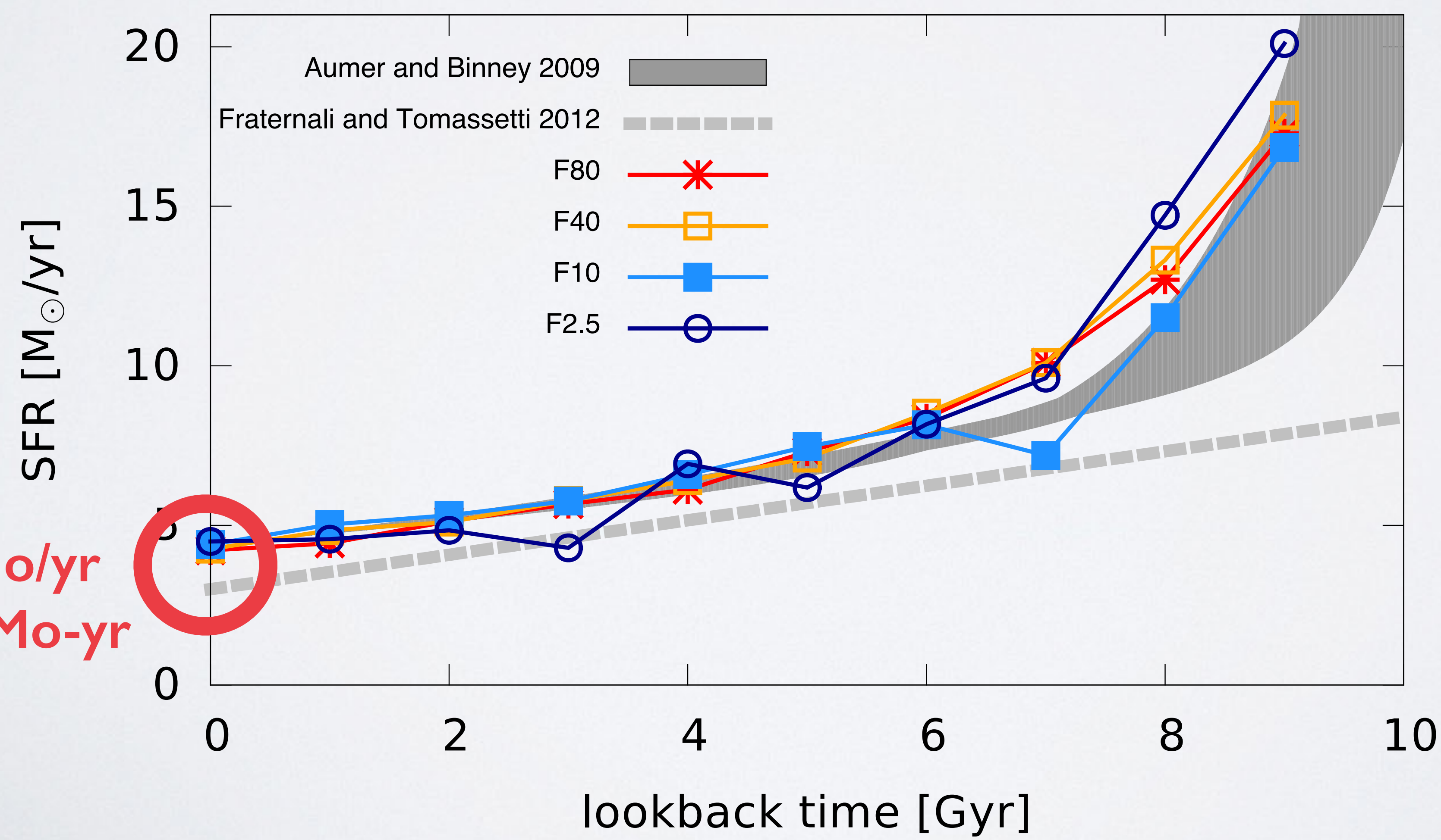

SFR_{SIM} ~ 4 Mo/yr
SFR_{MW} ~ 2-3 Mo-yr

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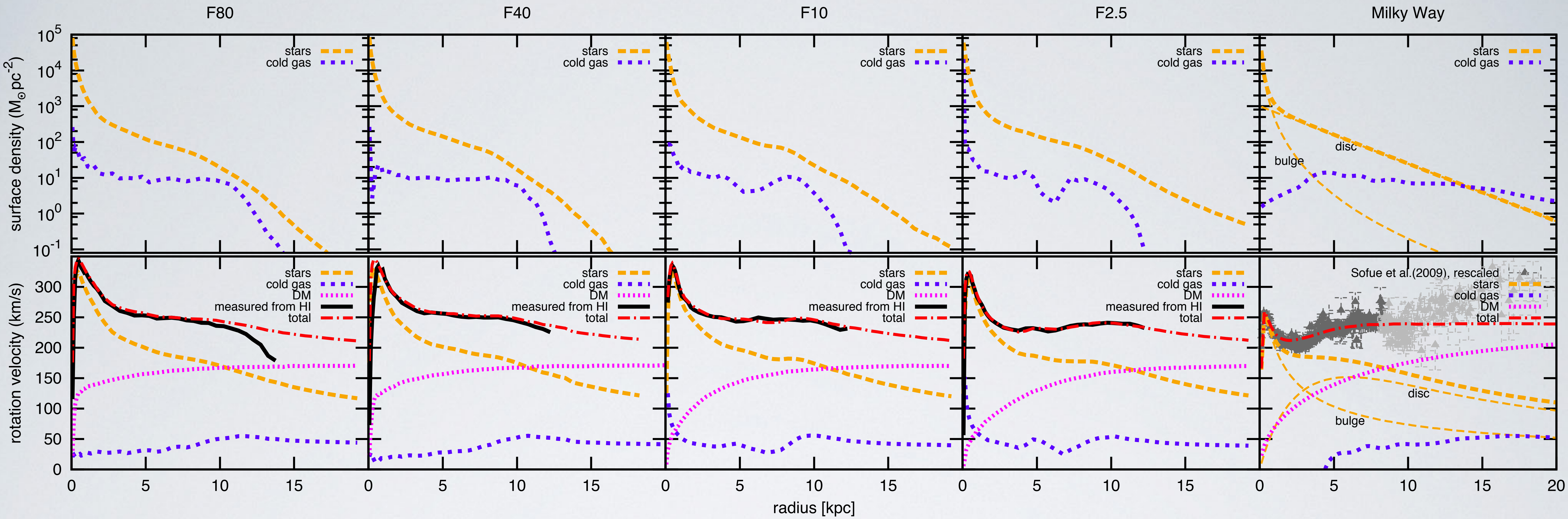

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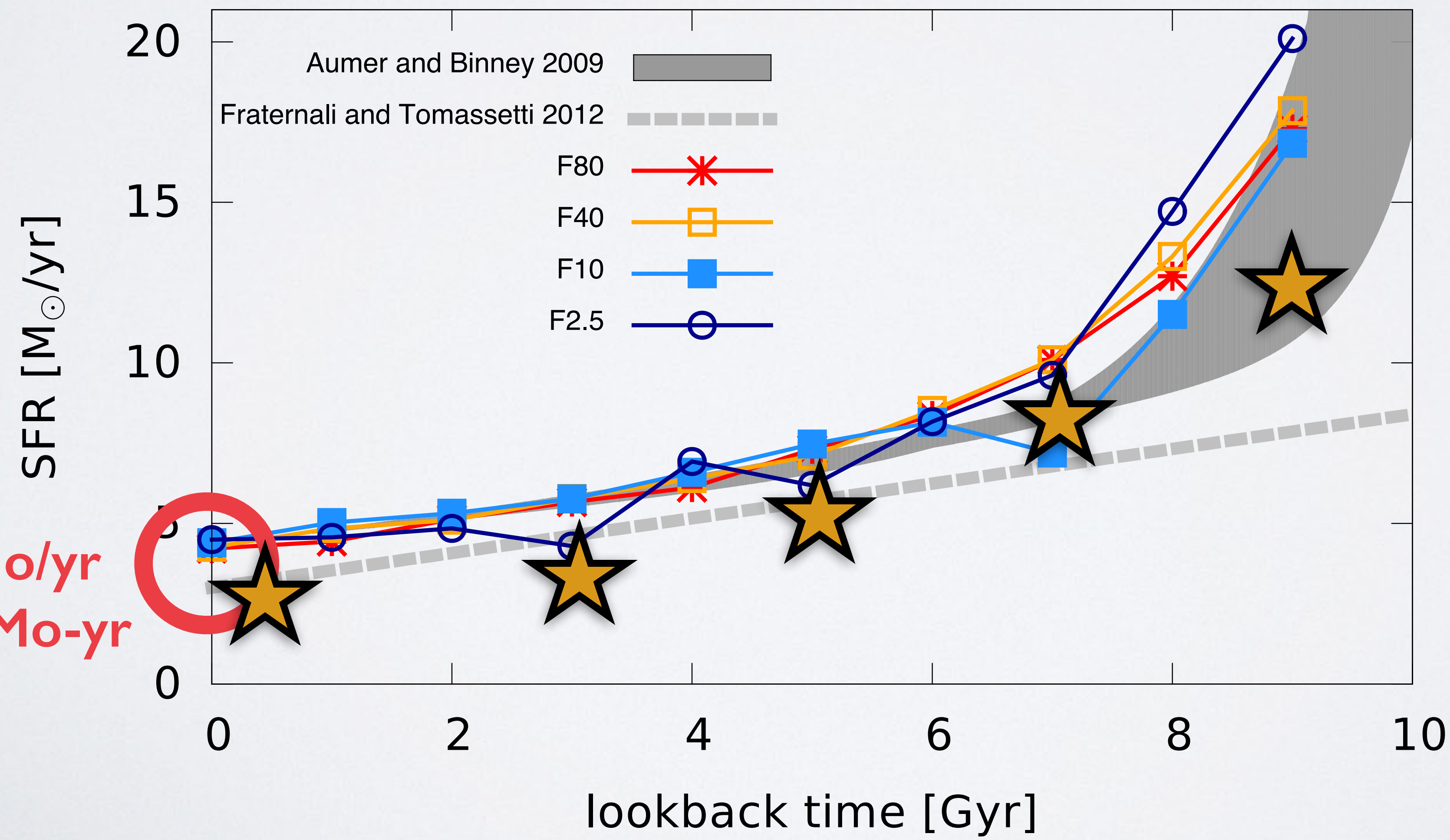

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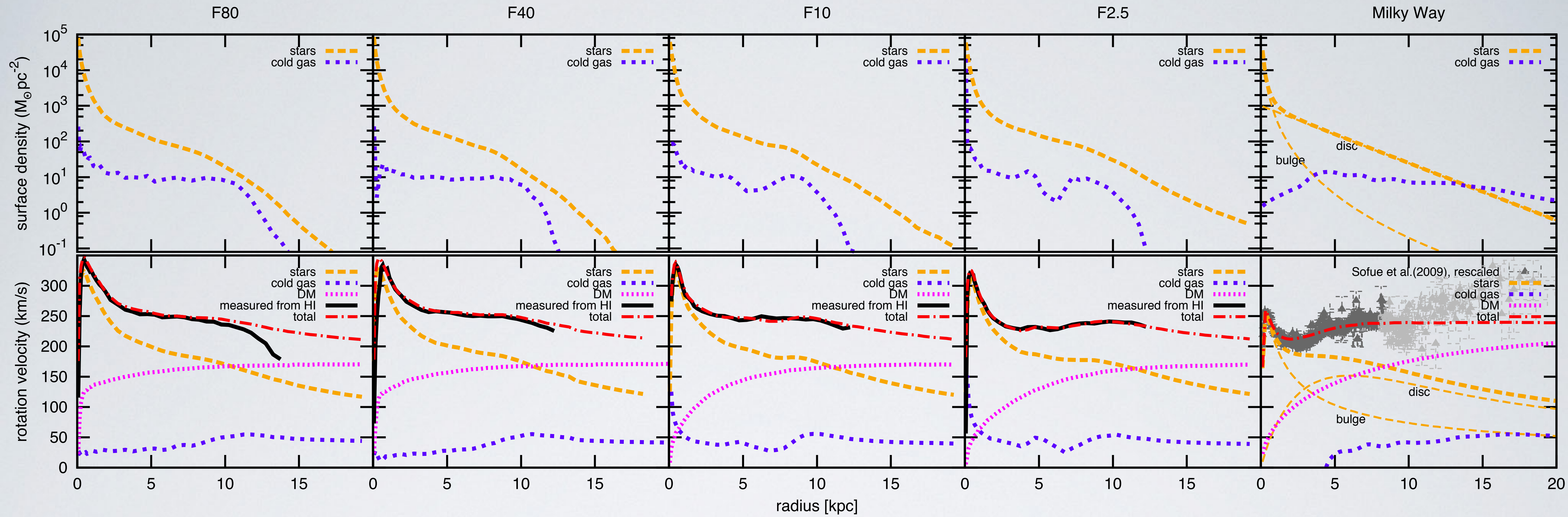

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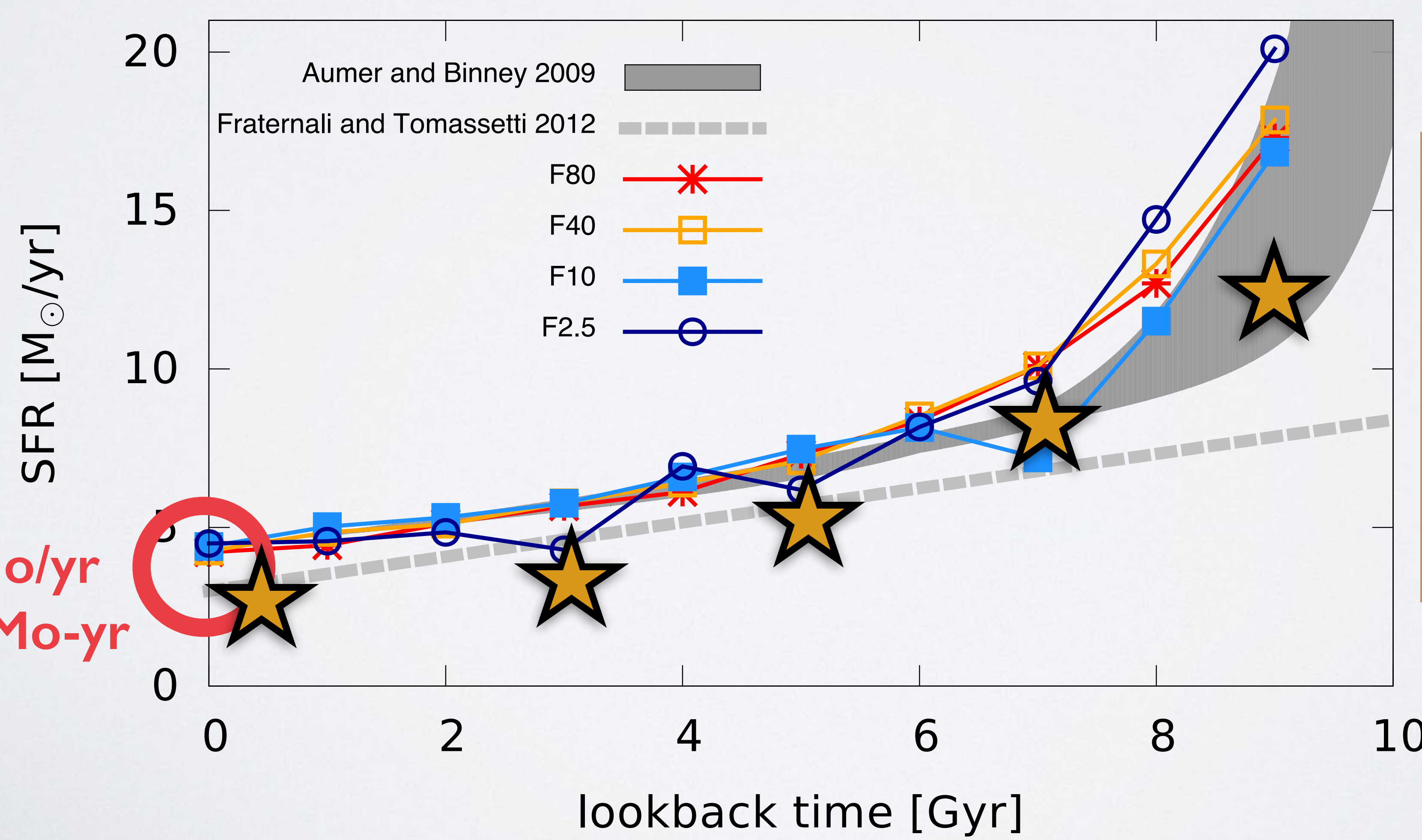

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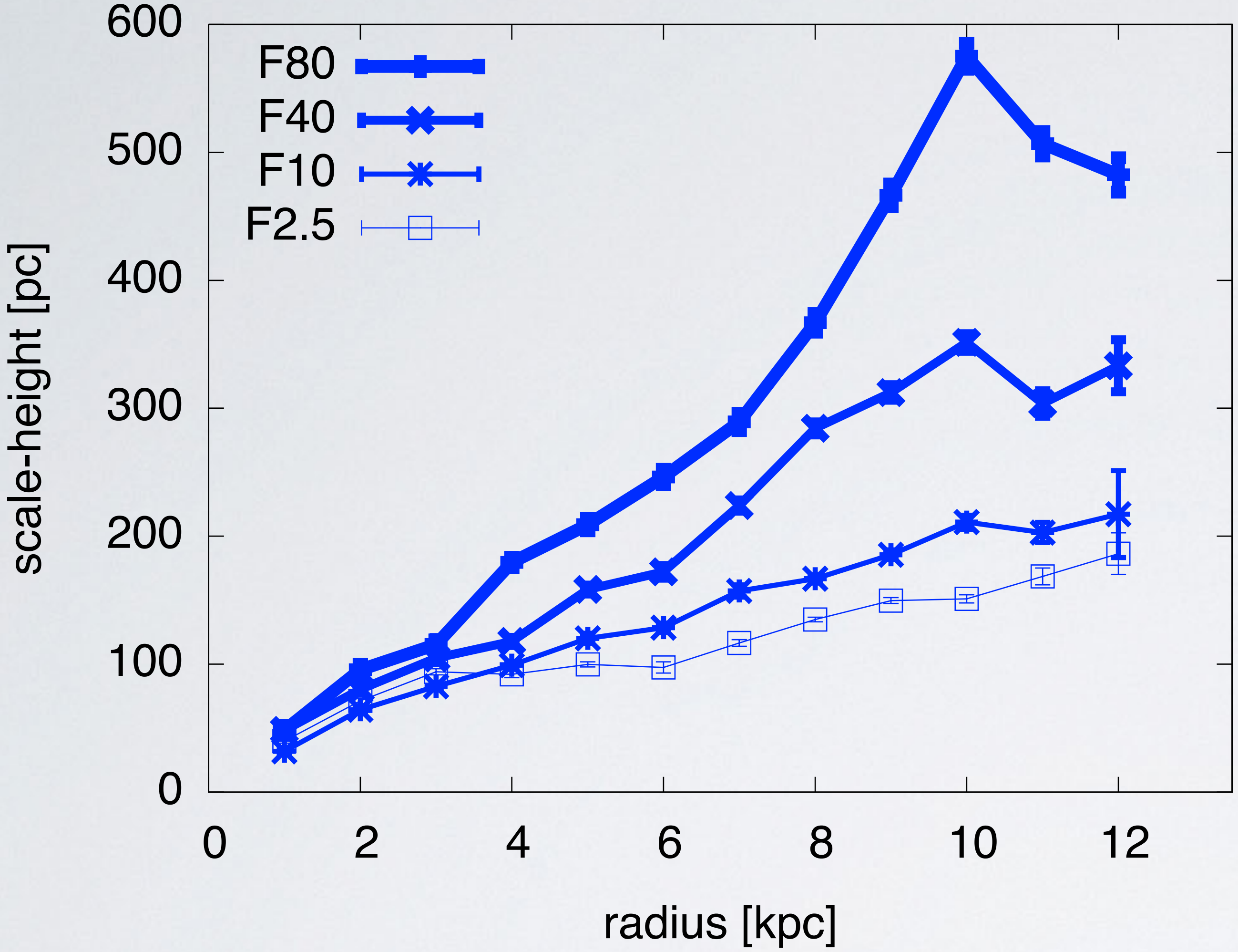
Accretion rates in good agreement with cosmological simulations (e.g. Brook+14)

THE EFFECT OF FEEDBACK



The cold gas scale-height increases with feedback

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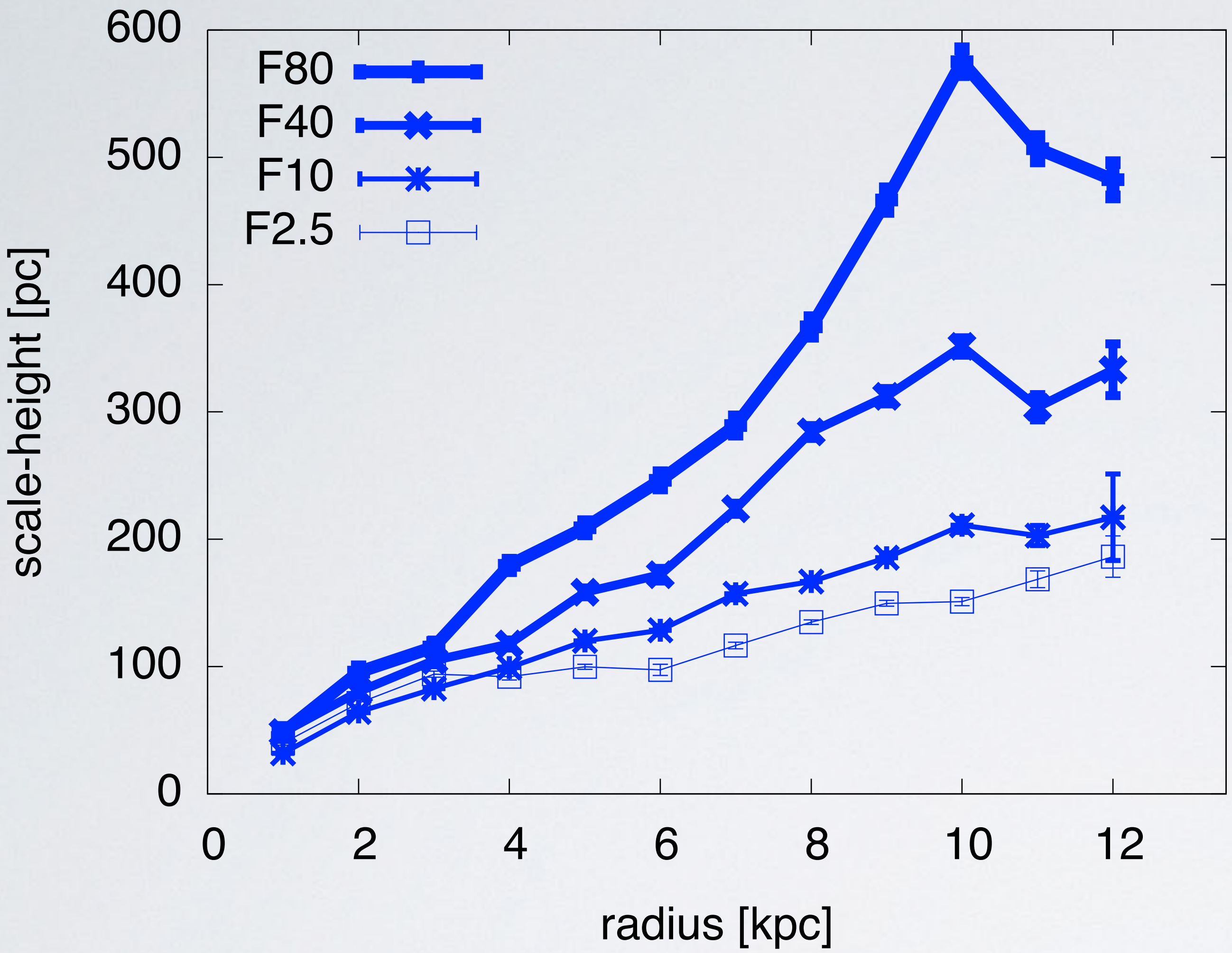

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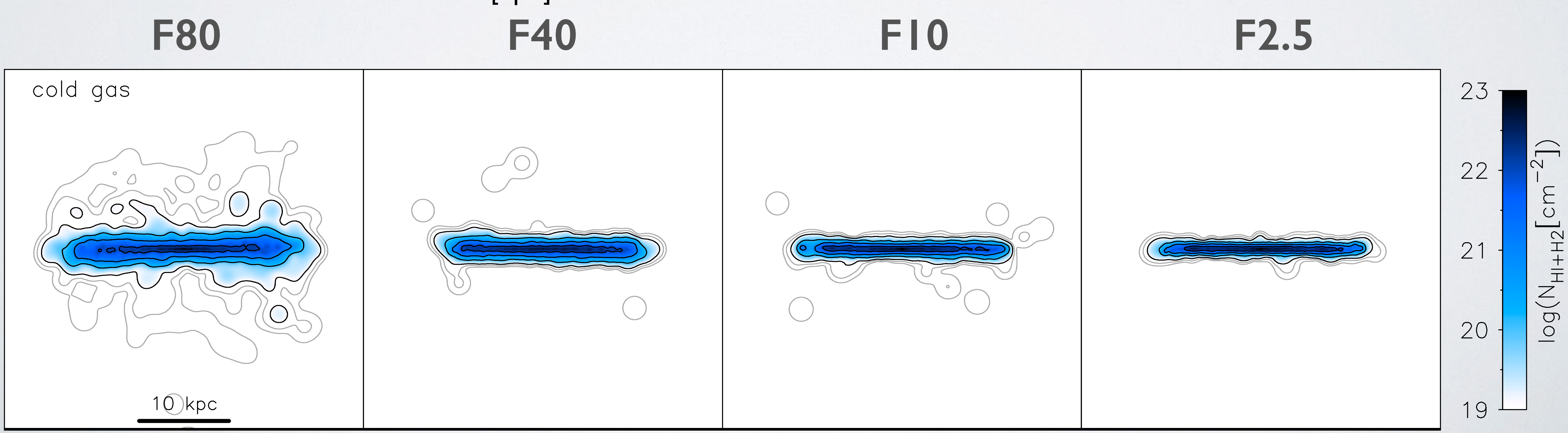

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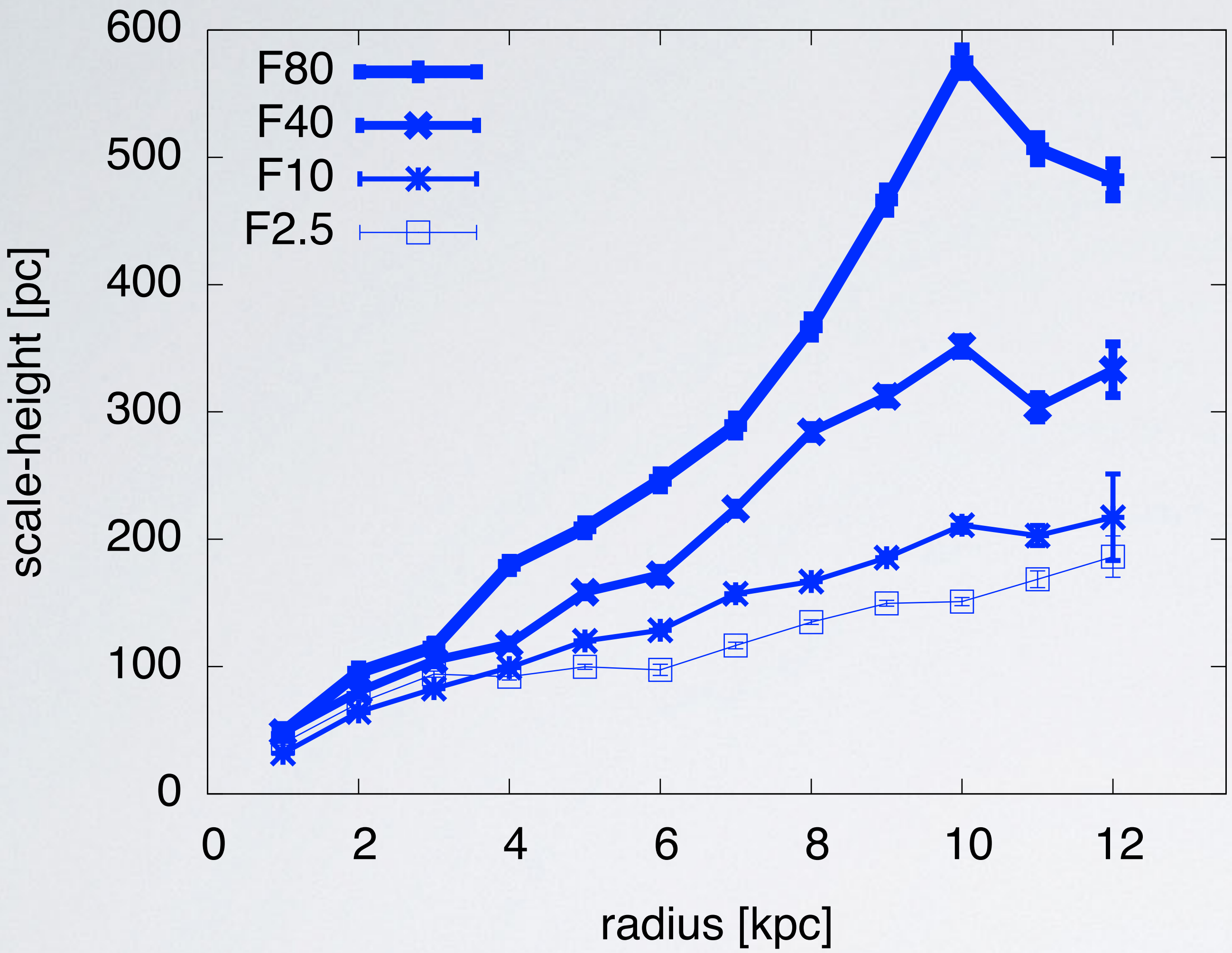

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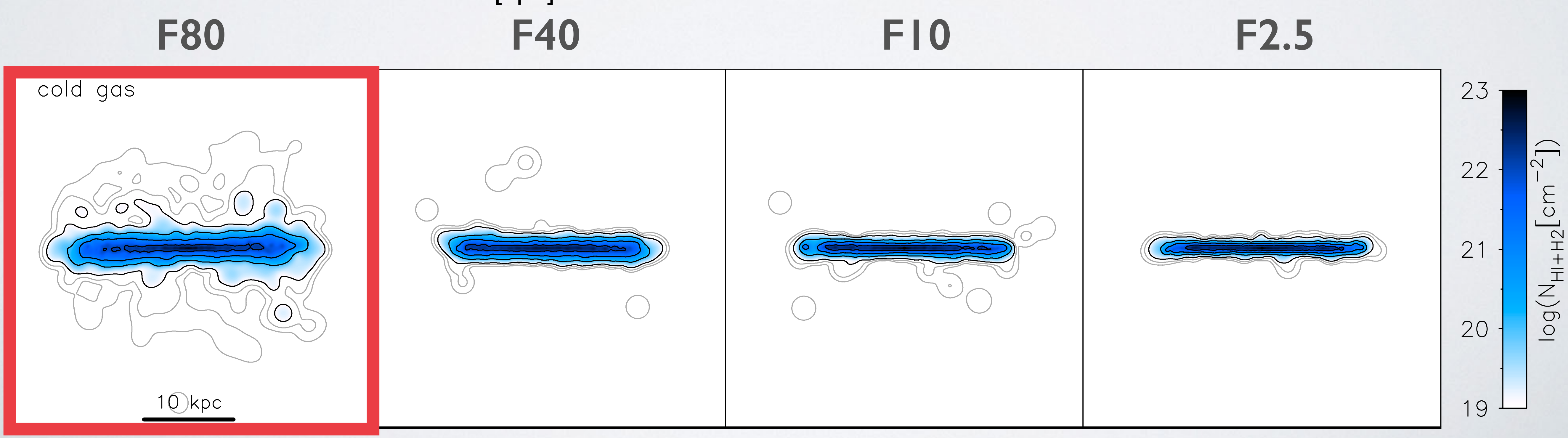
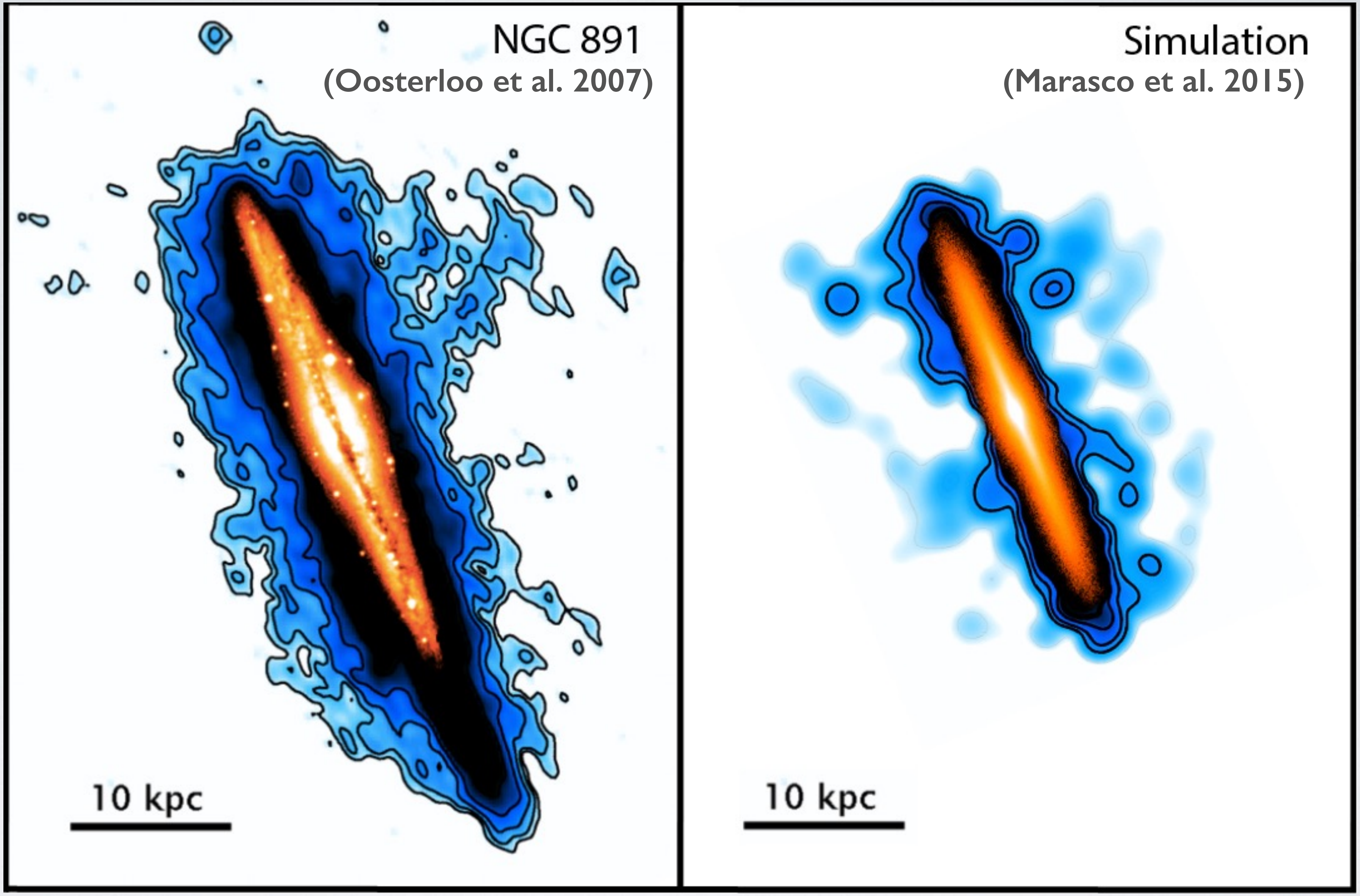


EXTRA-PLANAR HI



$M_{HI(>1kpc)}/M_{HI,tot}=0.3$

$M_{HI(>1kpc)}/M_{HI,tot}=0.05$

(see Marasco & Fraternali 2011)

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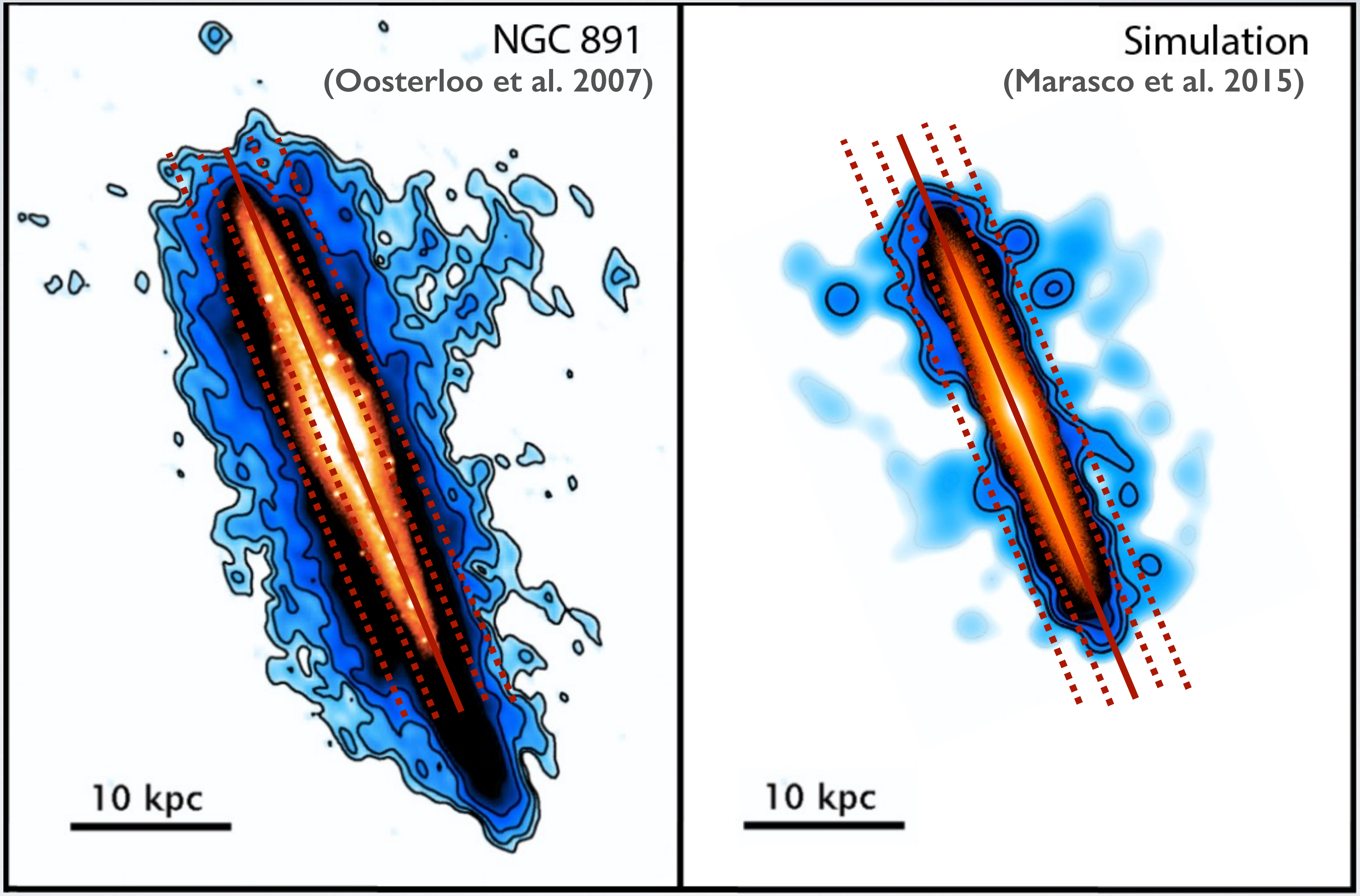

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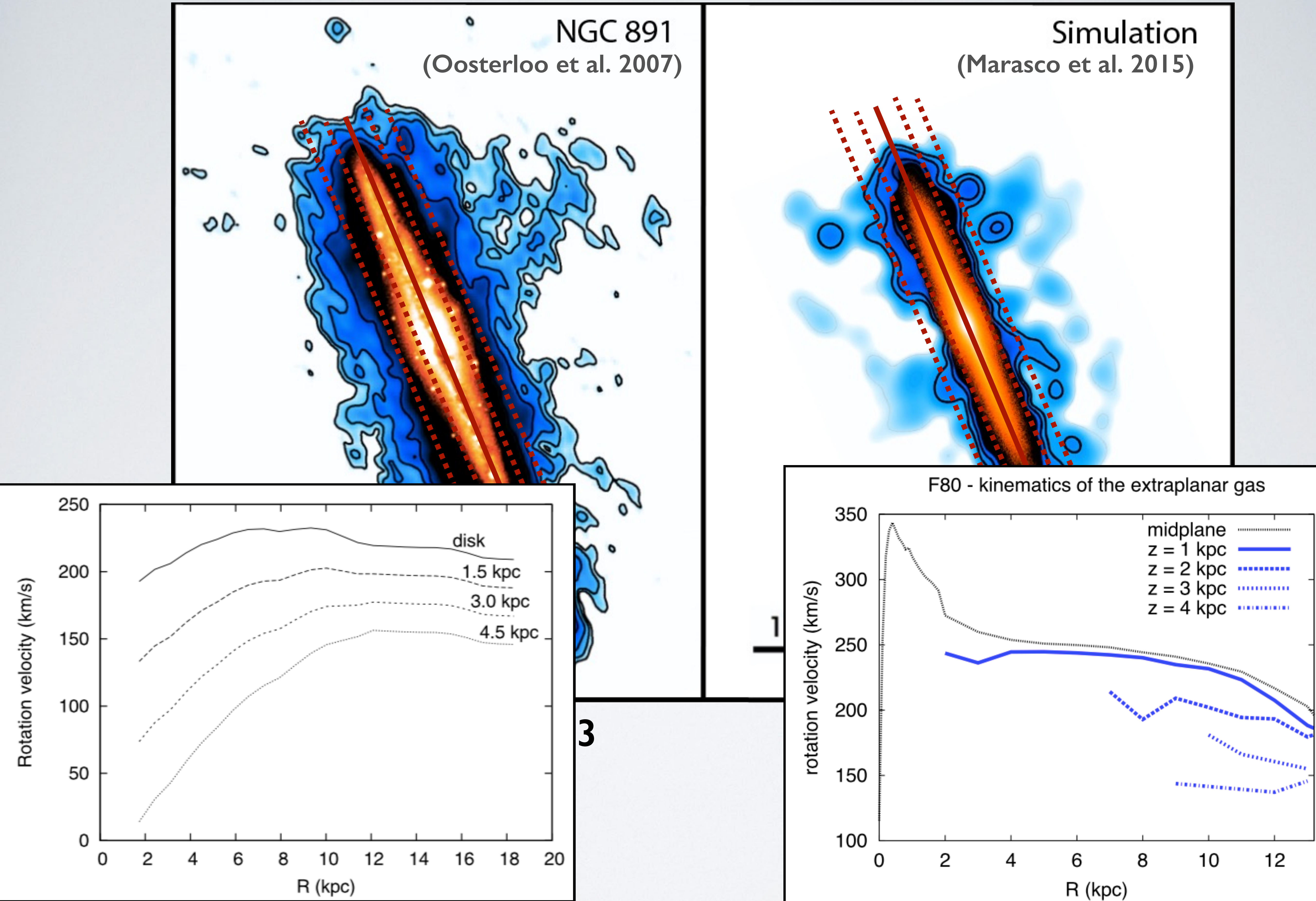
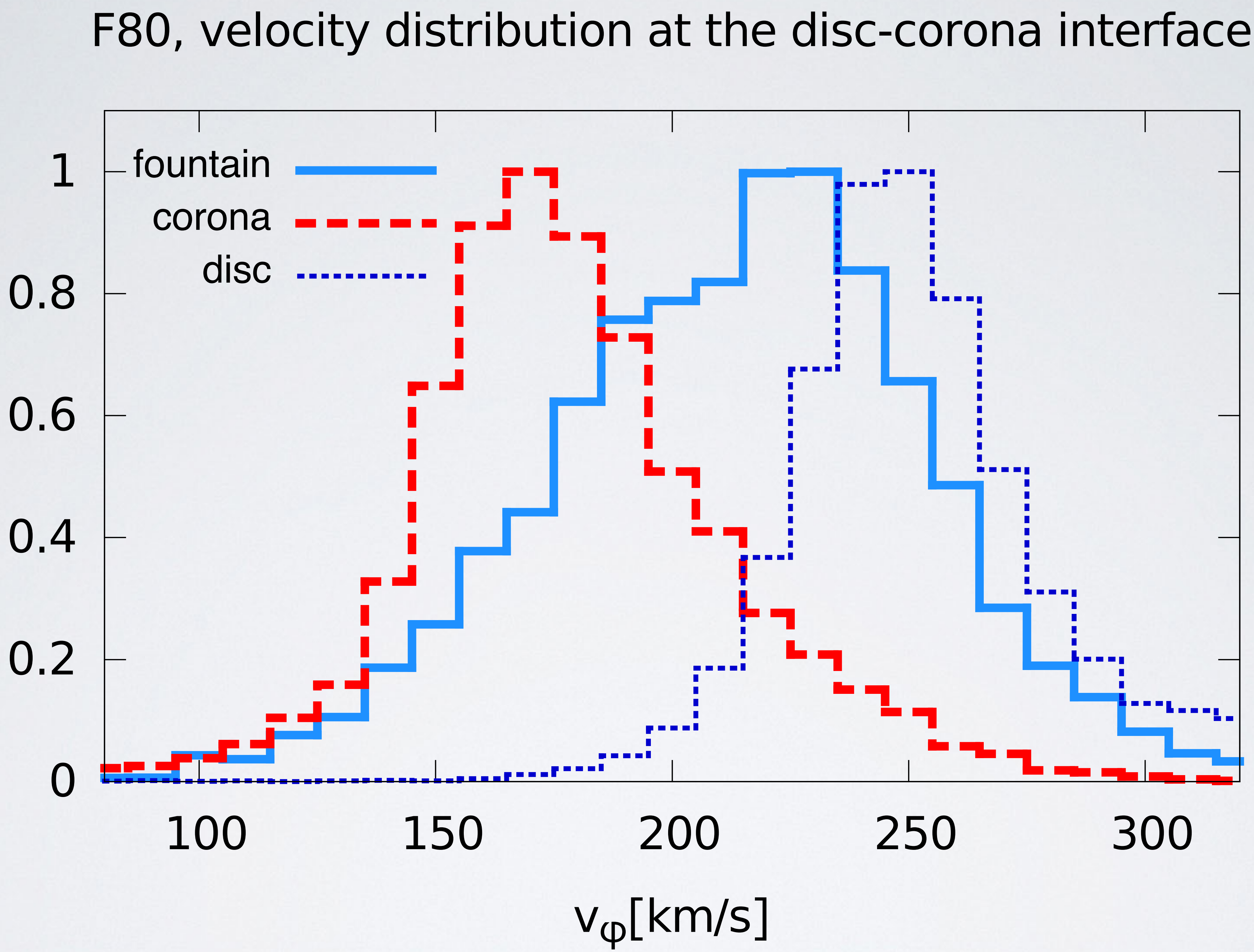
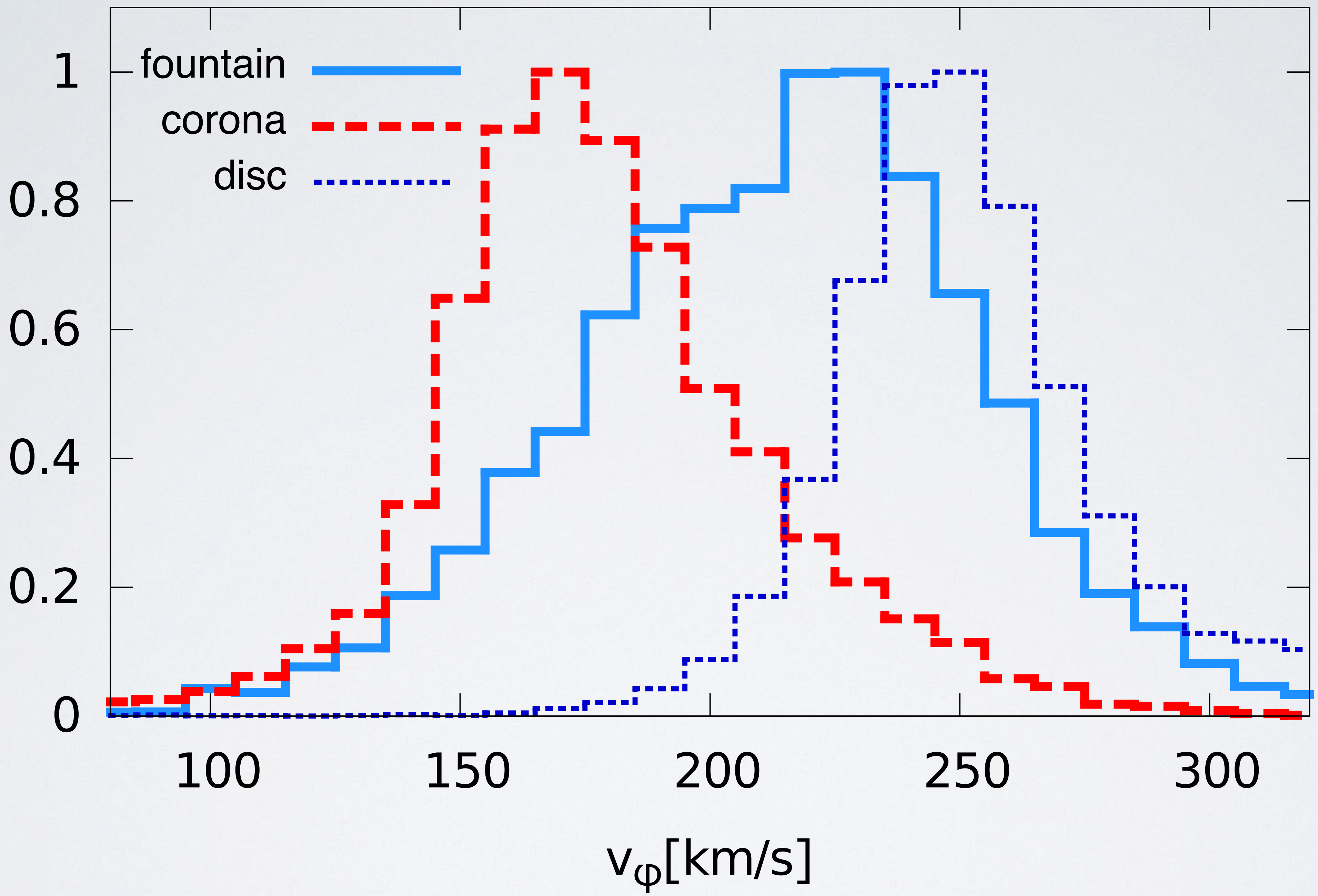


EXTRA-PLANAR HI: KINEMATICS



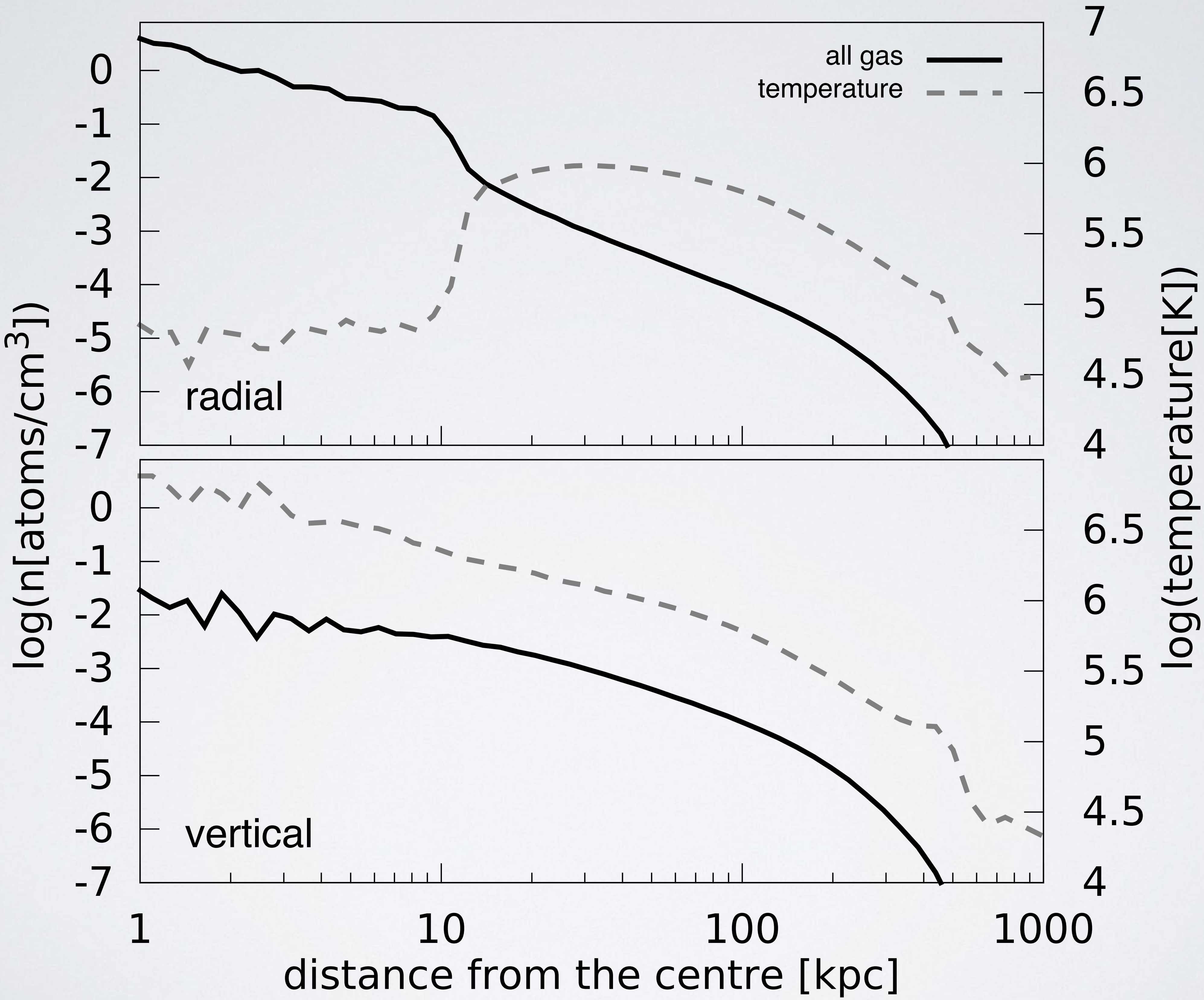
EXTRA-PLANAR HI: KINEMATICS

F80, velocity distribution at the disc-corona interface



Velocity drop caused by
hydrodynamical interaction with coronal gas
(see Fraternali & Binney 2008)

CIRCUMGALACTIC MEDIUM



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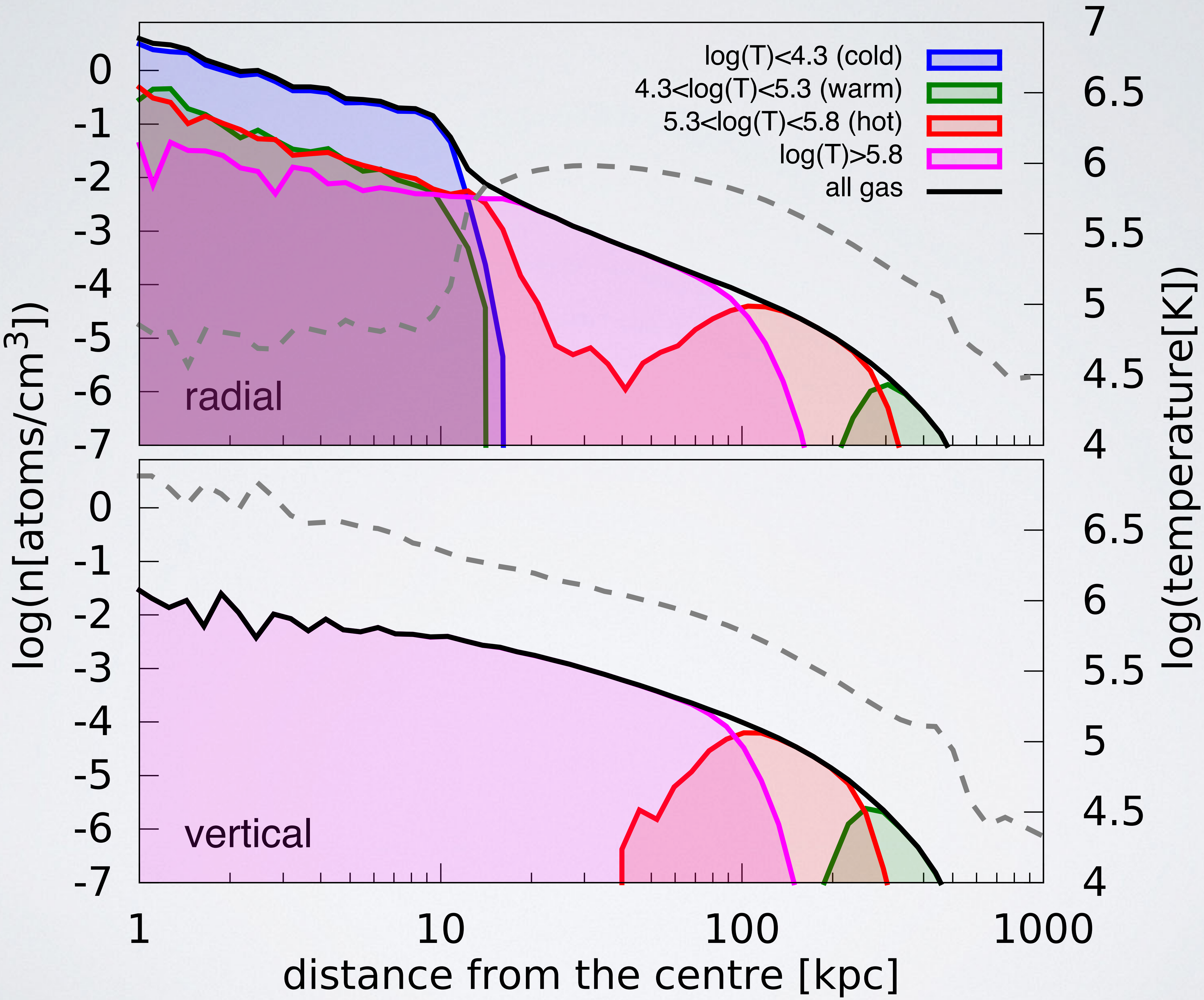

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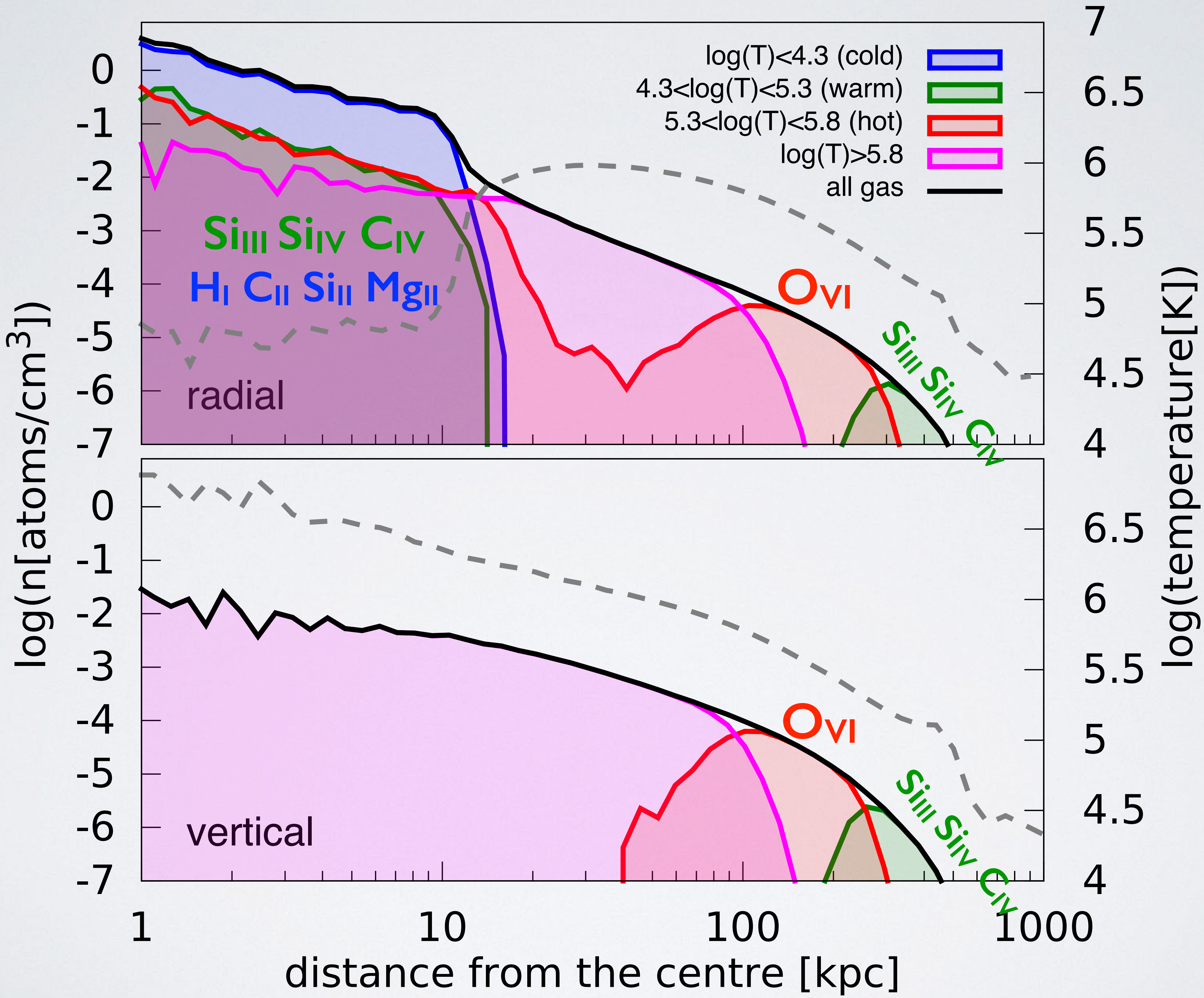

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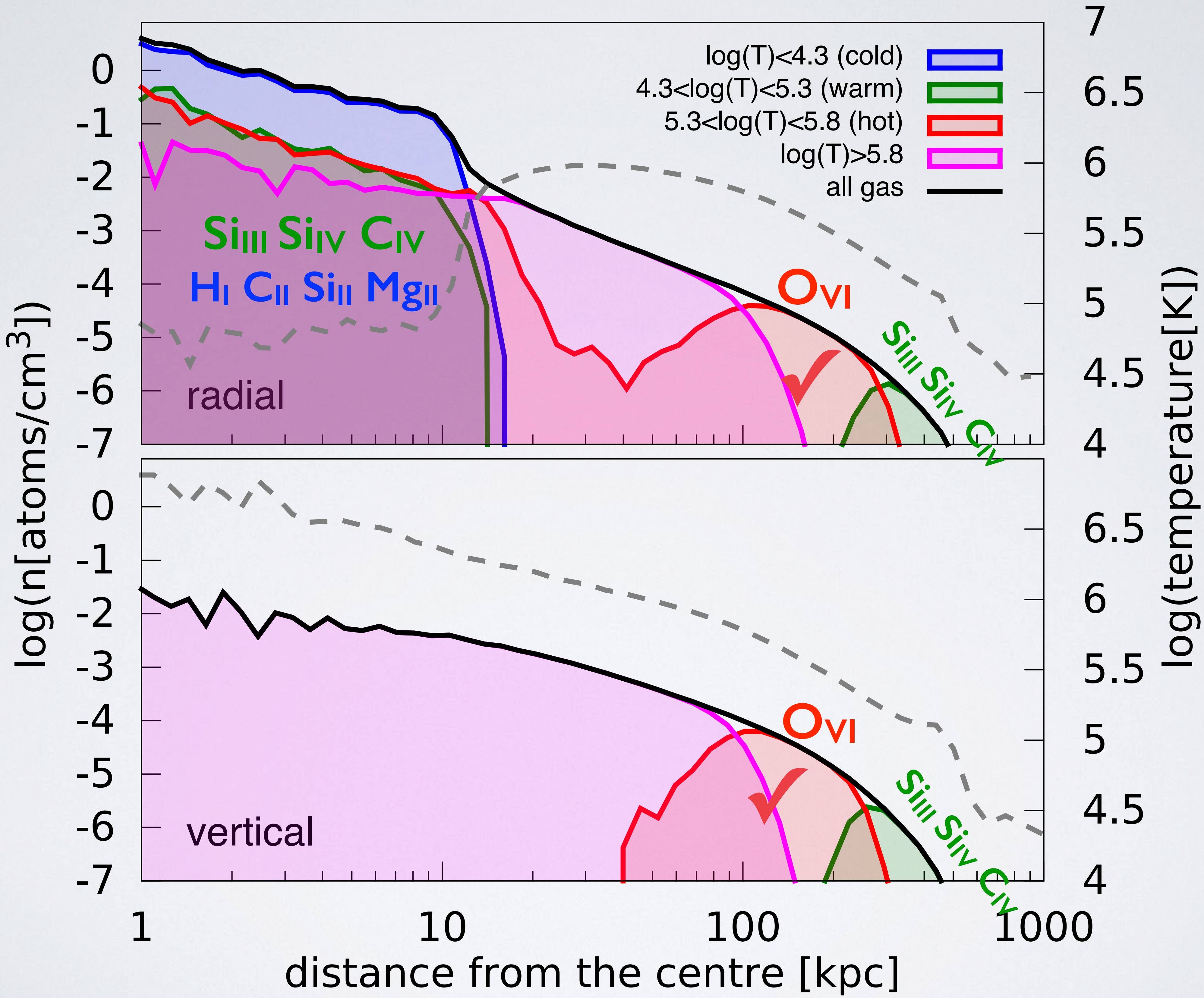

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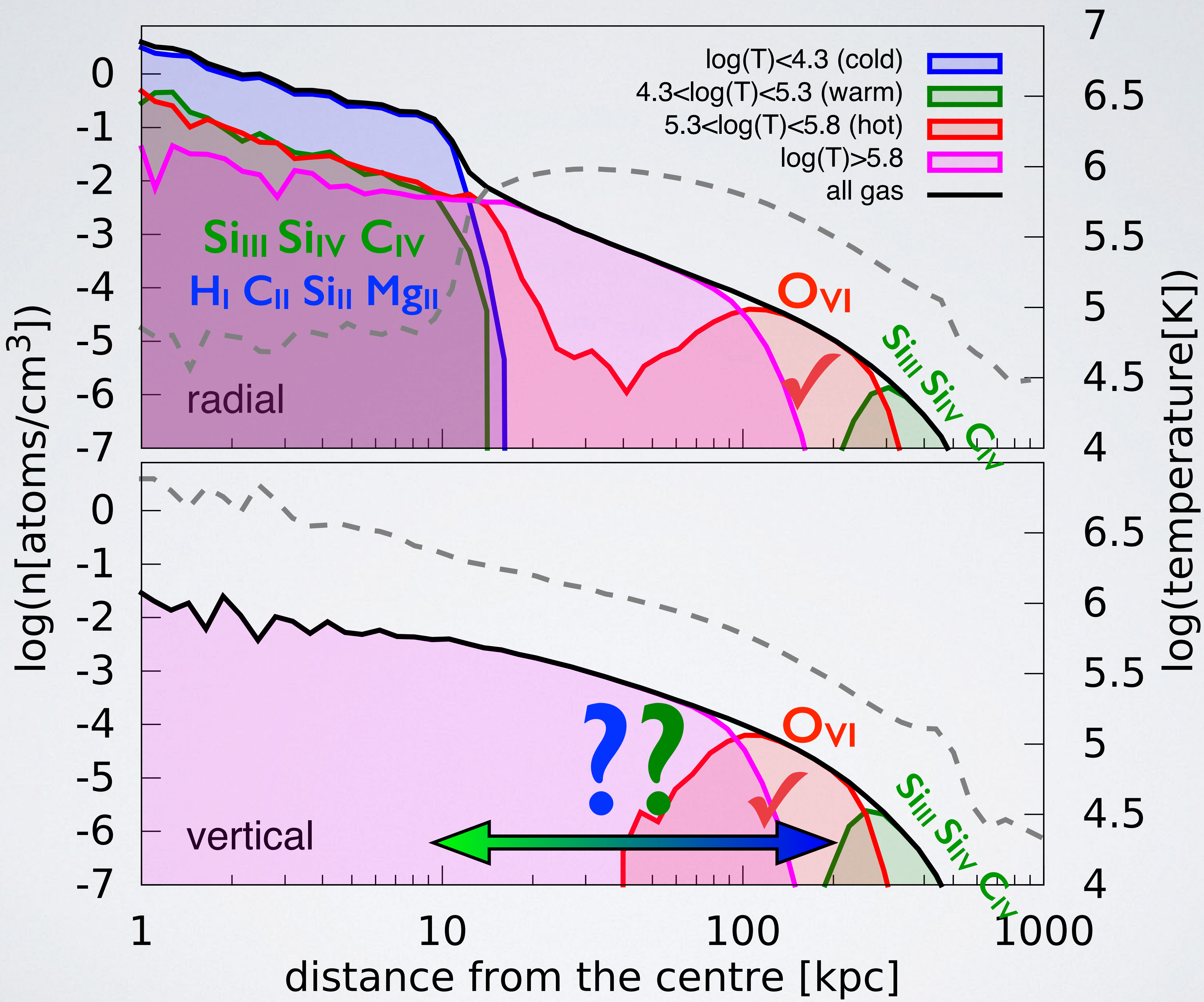

see Tumlinson+13, Werk+13,14

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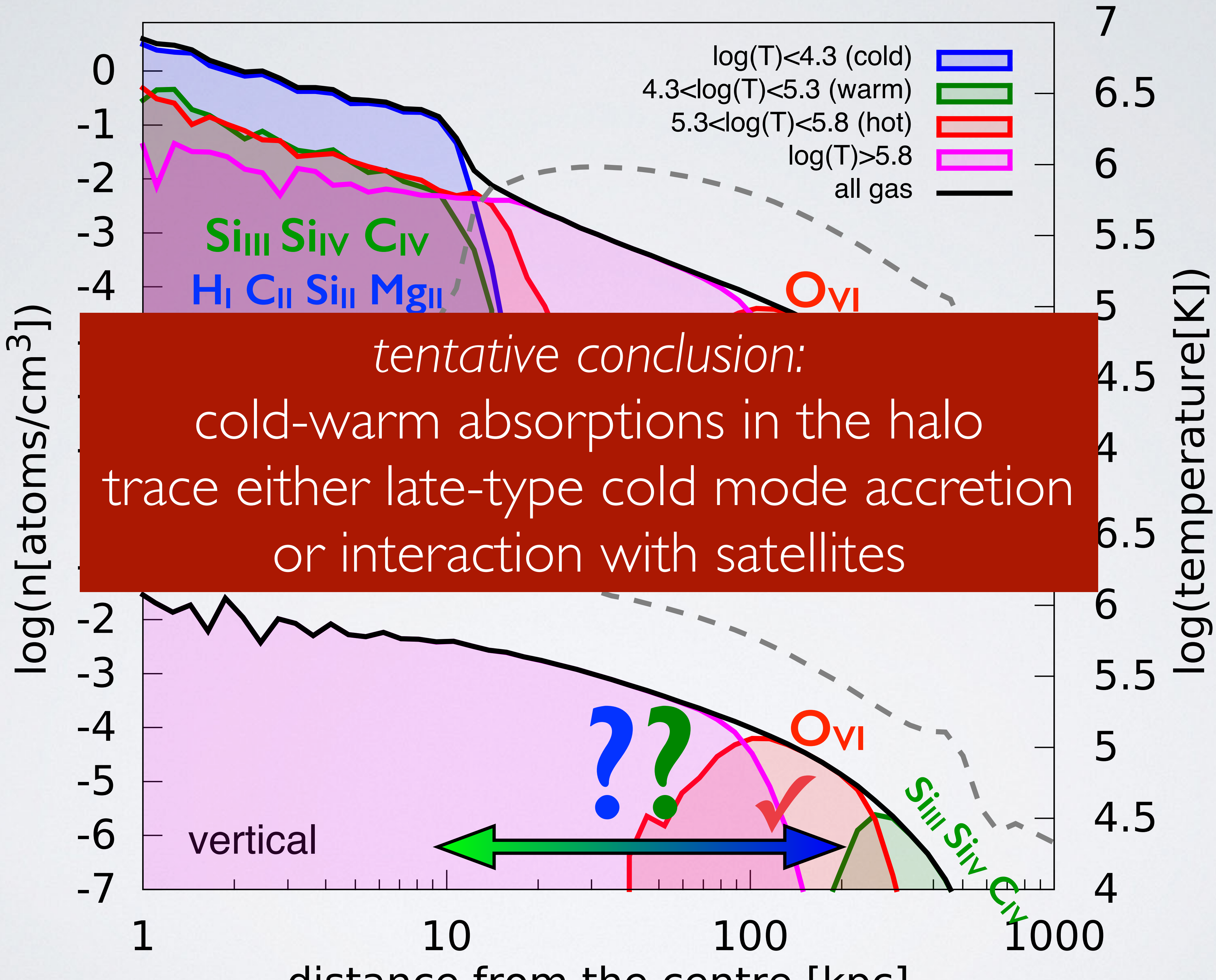

tentative conclusion:

cold-warm absorptions in the halo trace either late-type cold mode accretion or interaction with satellites

see Tumlinson+13, Werk+13,14

CONCLUSIONS

A model of pure hot-mode mass assembly predicts the following:

Property	comparison with the MW
Star formation rate	within a factor of 2
Star formation history	✓
Mass distribution	✓ (but not in the centre)
Kinematics	✓ (but not in the centre)
Extra-planar gas	✓✓ (if feedback is large)
Hot absorbers in halo	✓
Warm absorbers in the halo	✗
Cold absorbers in the halo	✗

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Future plan: larger feedback, interaction with satellites