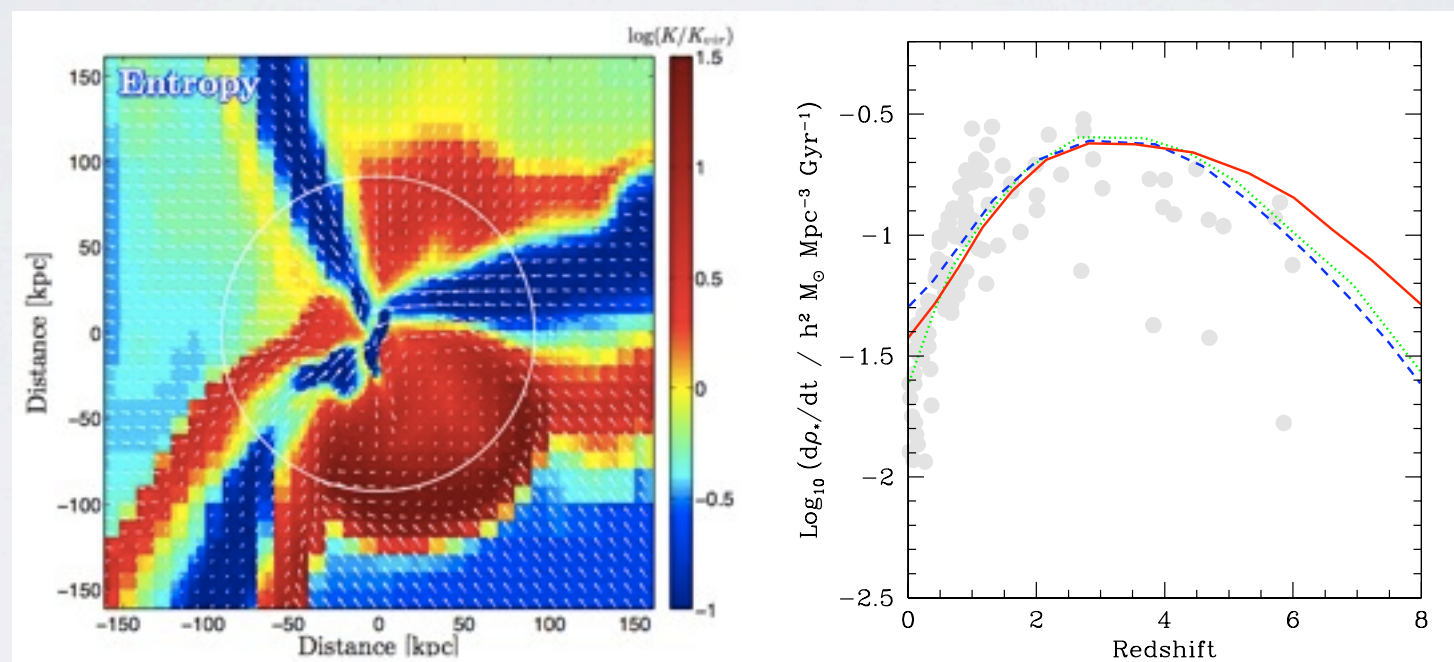


THE EFFECT OF COLD GAS INFLOW ON THE SF ACTIVITY OF HIGH-Z GALAXIES

Multiwavelength Views of the ISM in High-Redshift Galaxies
ESO Santiago, 27-30 June 2011



Nelson Padilla (PUC), Yuval Birnboim (Racah Institute), Alejandra Muñoz (PUC), Sergio Contreras (PUC), Sofía Cora (La Plata)

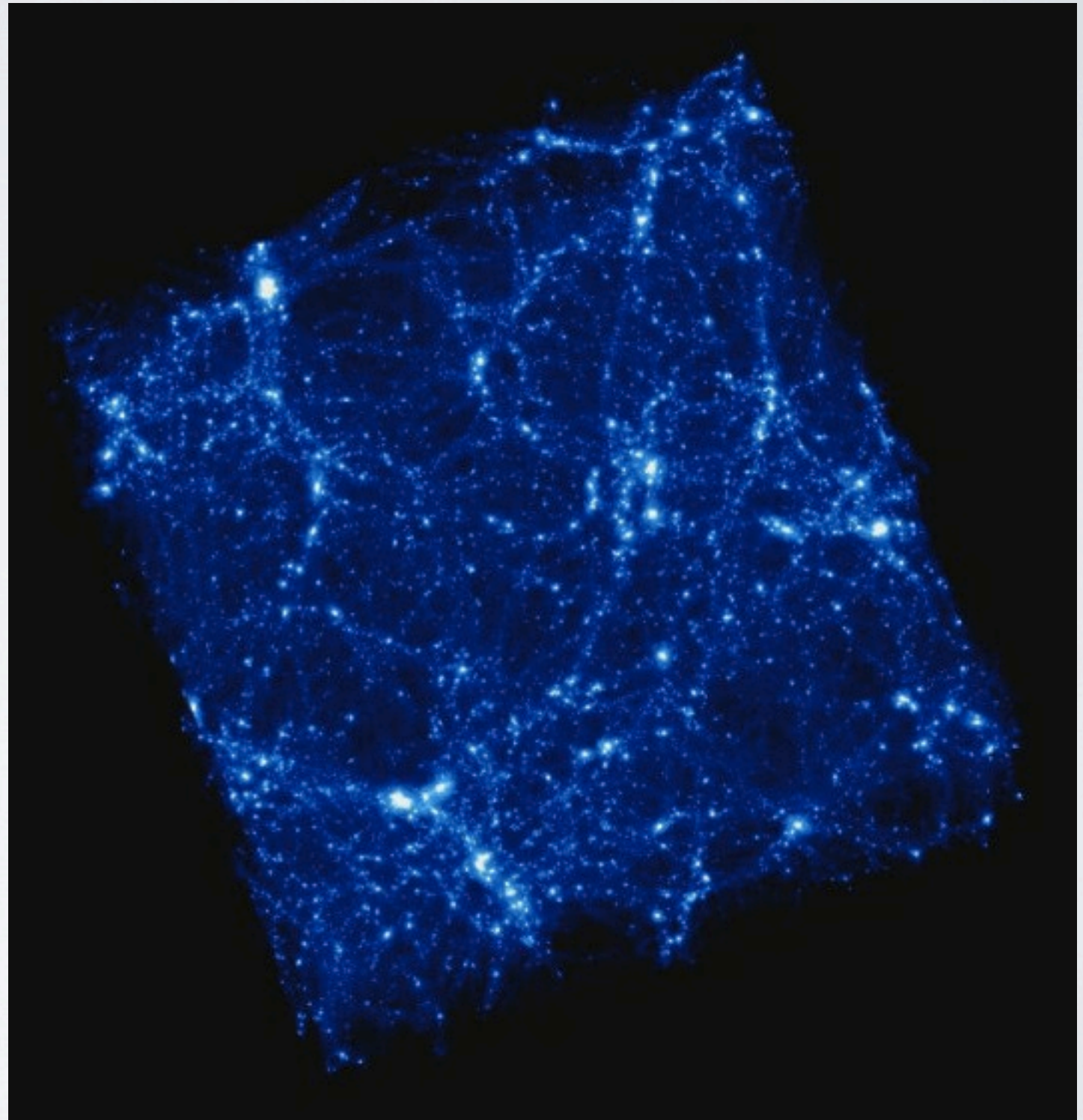
OUTLINE

- Models of galaxy formation and SF activity at high- z
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SAG: SEMI-ANALYTIC GALAXIES

Cosmological
periodic
comoving
box of $67\text{Mpc}/h$
a side.

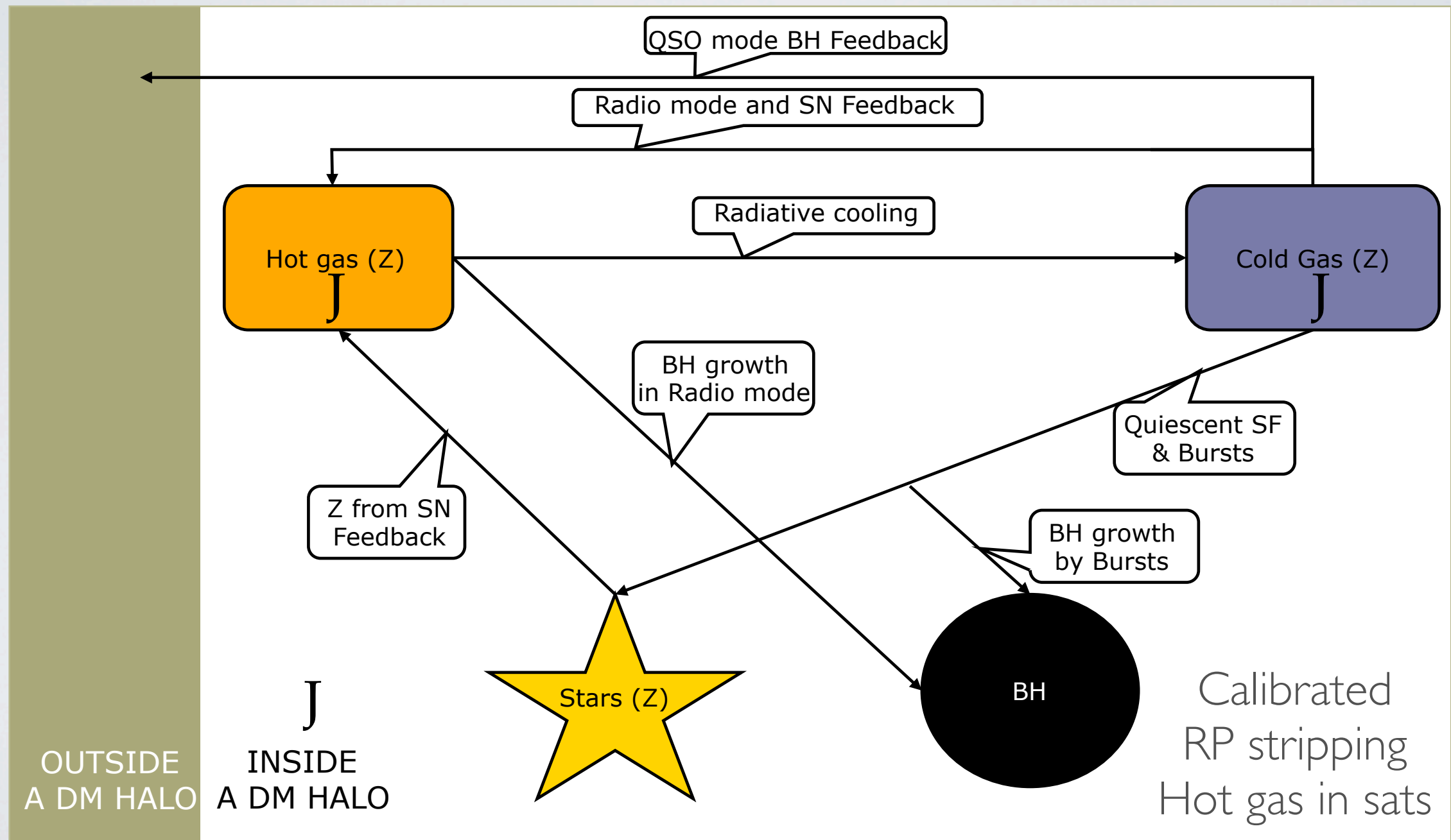
DM-only:
halos of
 $1 \leq M_{\text{sun}}$ and
up ($10+$
particles).



Lagos, Cora & Padilla (2008), Lagos, Padilla & Cora (2009), Tecce et al. (2010)

SAG: SEMI-ANALYTIC GALAXIES

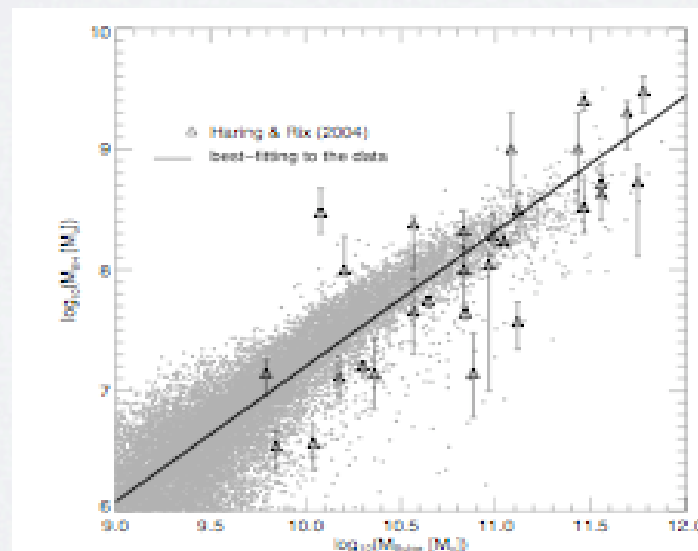
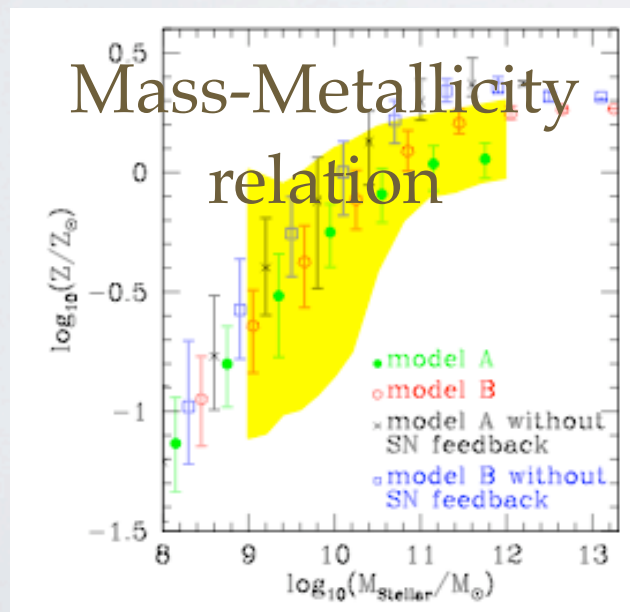
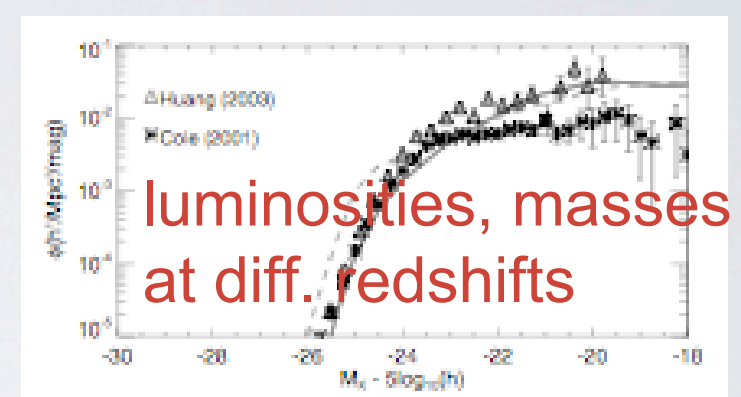
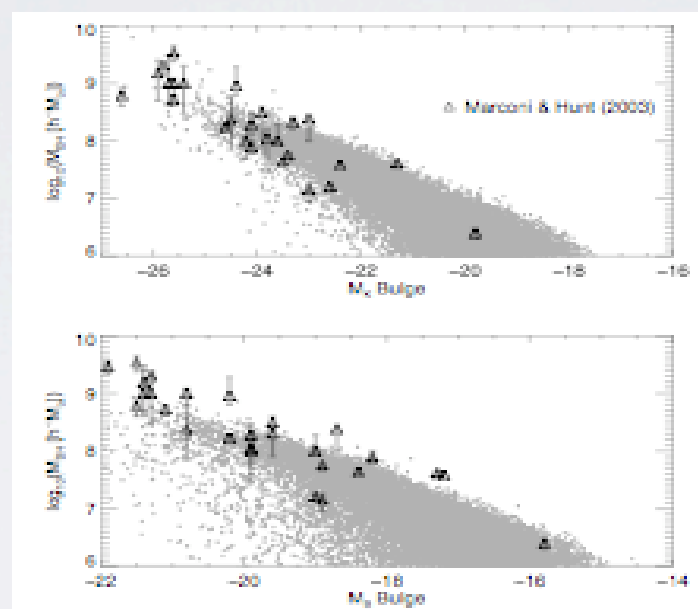
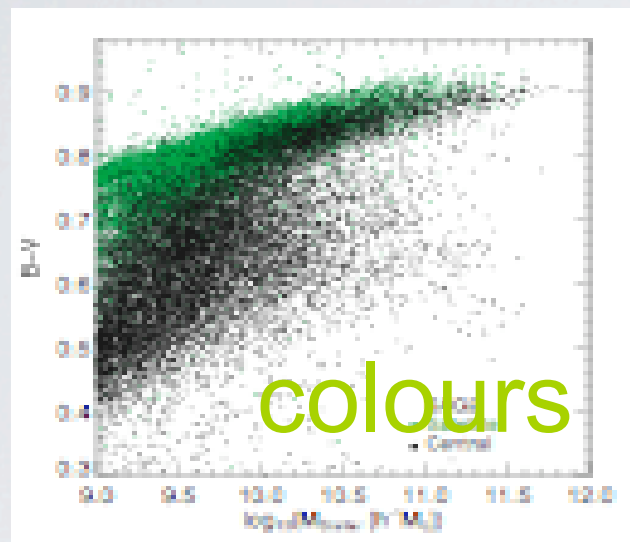
Summary of processes:



Lagos, Cora & Padilla (2008), Lagos, Padilla & Cora (2009), Tecce et al. (2010)

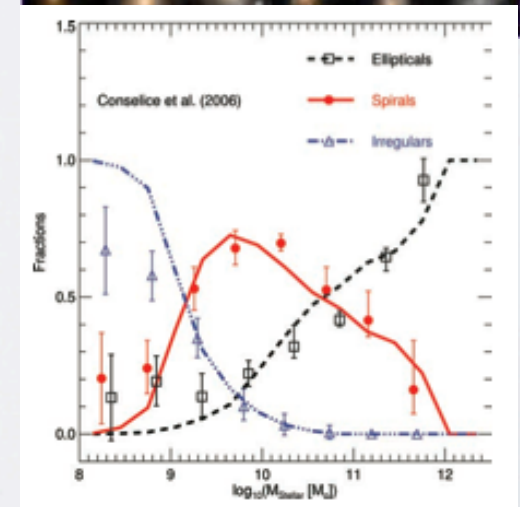
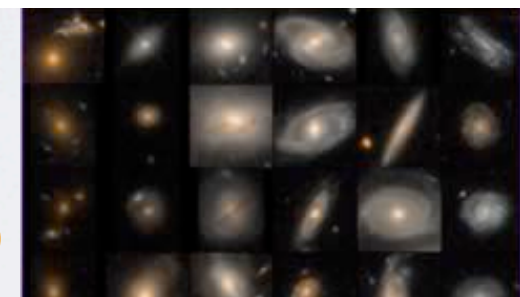
SAG: SEMI-ANALYTIC GALAXIES

Fix free parameters using a set of $z=0$ statistics:



Black hole-host relations

morphologies



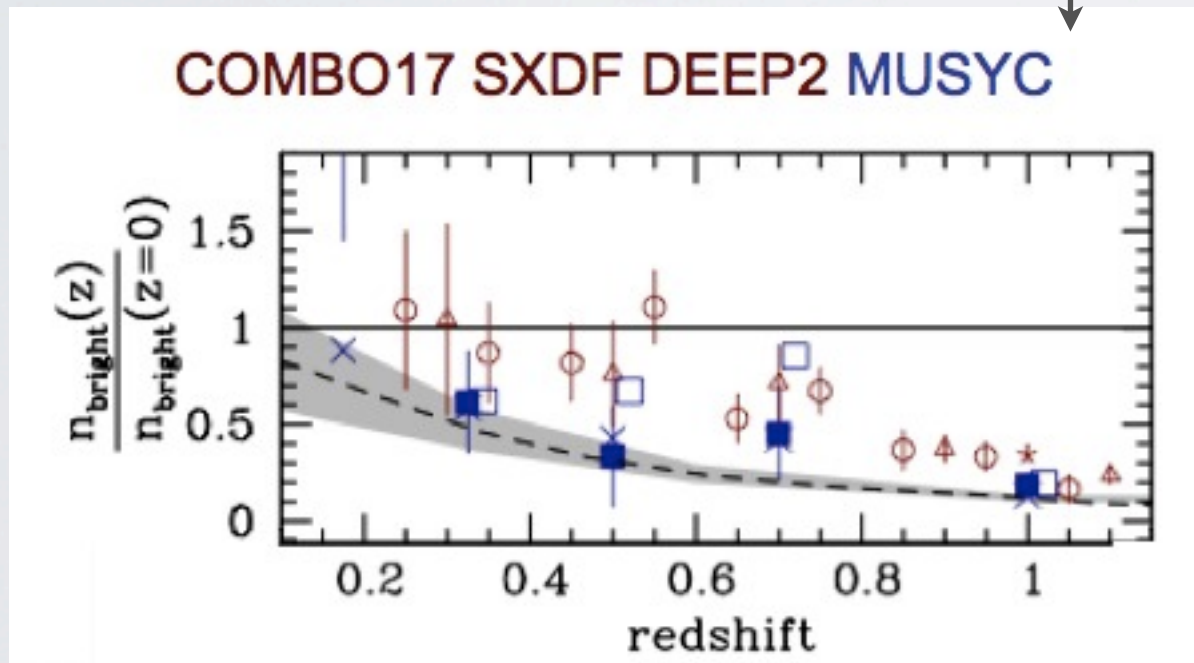
Lagos, Cora & Padilla (2008), Lagos, Padilla & Cora (2009), Tecce et al. (2010)

PERFORMANCE AT HIGH-Z

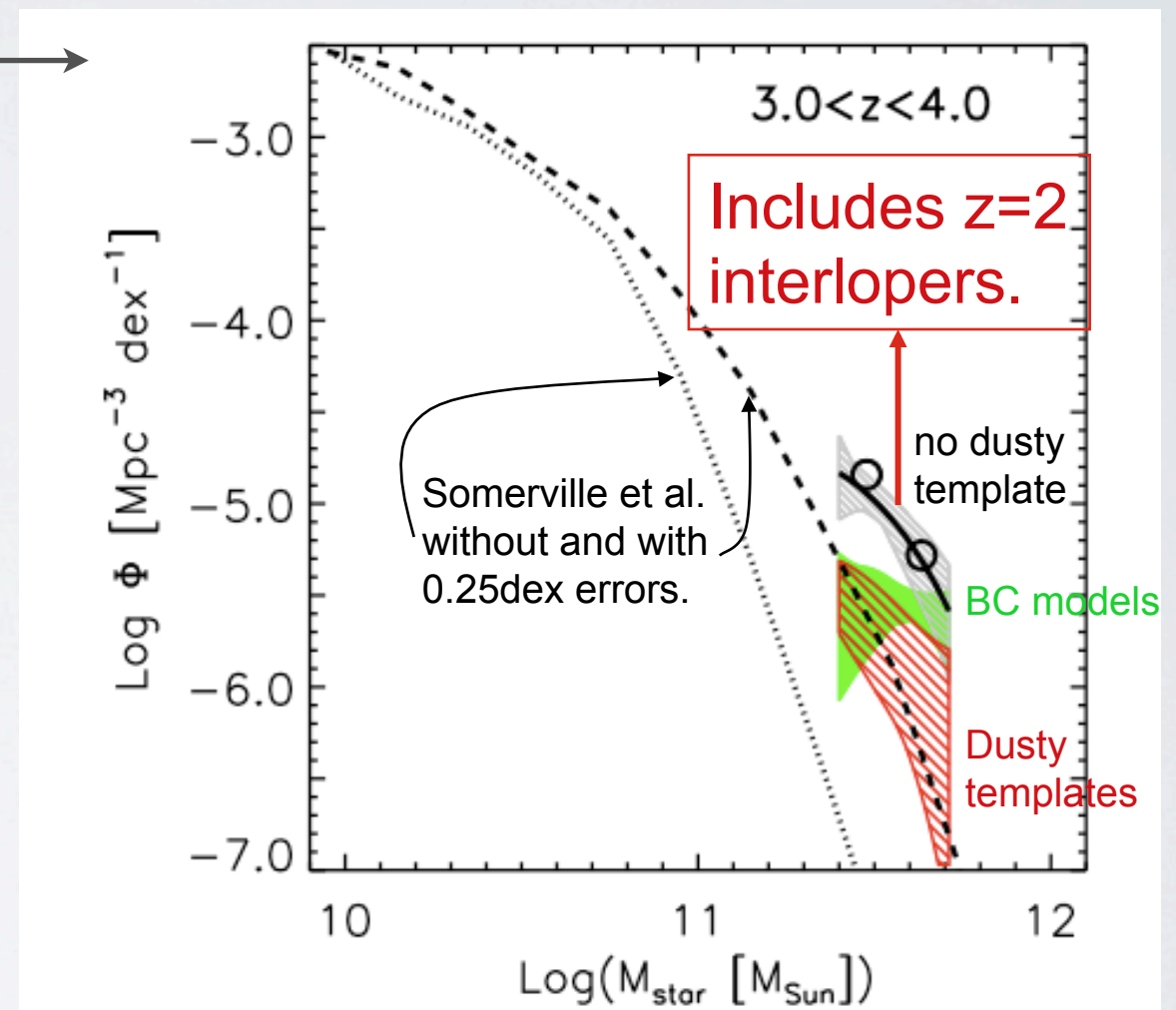
General deficit of high-z massive galaxies

At high redshifts →

At lower redshifts ↘



Padilla et al. (arXiv:1105.5642, A&A in press)
MUSYC galaxies and the
De Lucia 2006 model



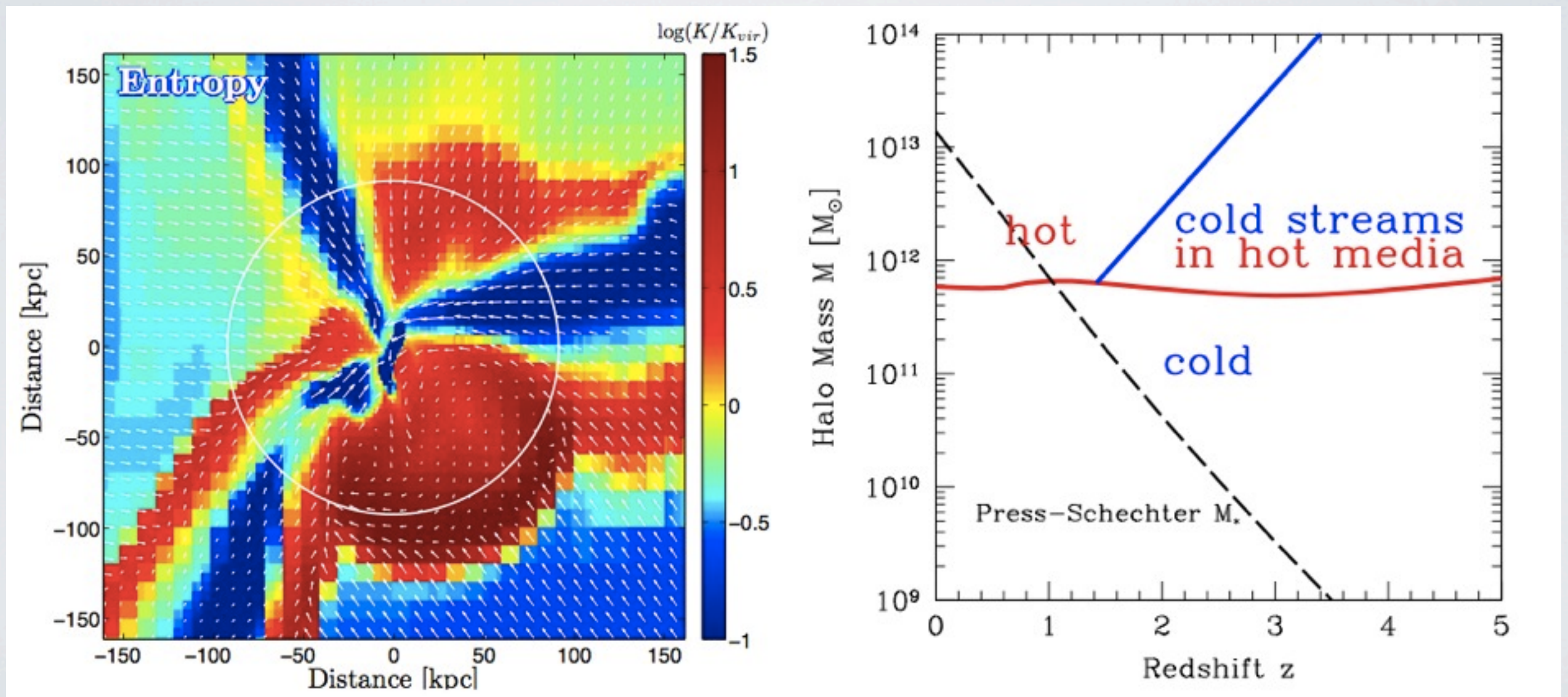
NEWFIRM Medium Band Survey
Marchesini et al. (2010)
New modelling of TP-AGB stars

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COLD GAS INFLOWS

A fraction of the gas reaching the center of a galaxy is able to arrive cold without going through a heating phase, specially at high- z and in high mass DM haloes.



Dekel, Birnboim, et al., 2009

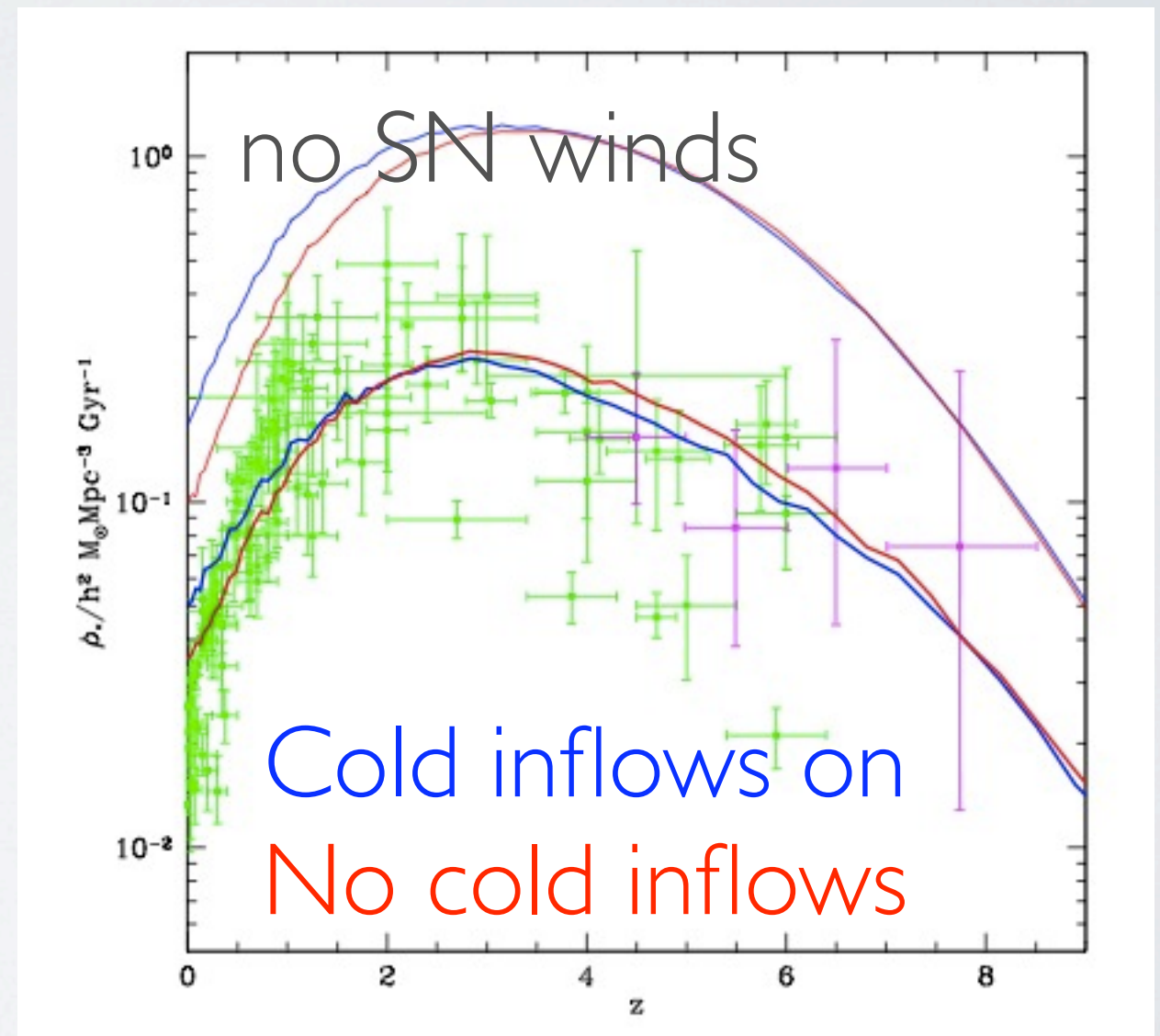
see also Keres et al., 2009, van de Voort et al., 2011, etc.

COLD GAS INFLOWS

Implemented in the GALFORM semi-analytic model by Benson & Bower (2010):

- Analytic approximation.
- Assume infalling cold gas relaxes in halo (also relaxed).

As a result, even though there is more cold gas in galaxies at high- z , the discs are larger: not an important effect on the SFR.

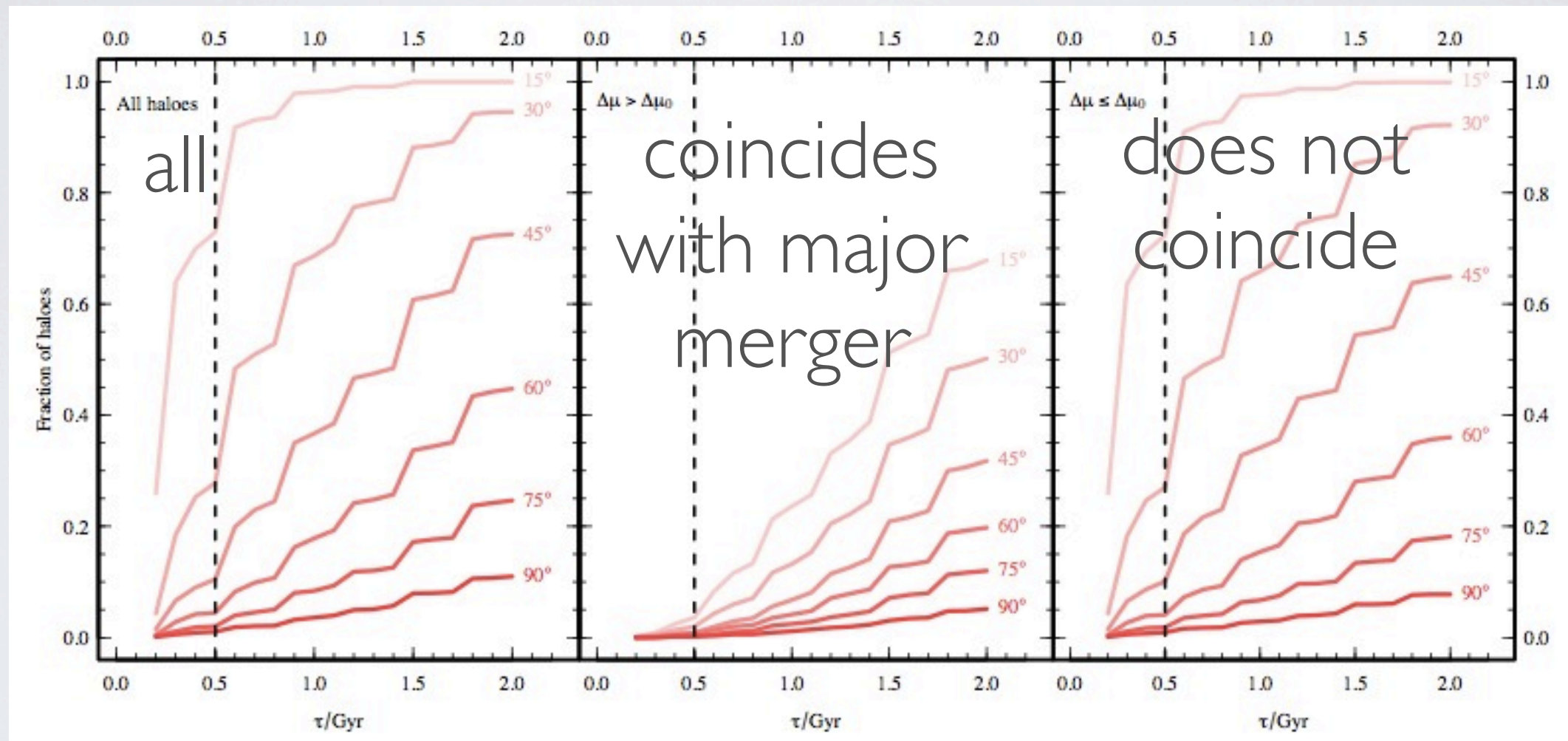


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ANGULAR MOMENTUM

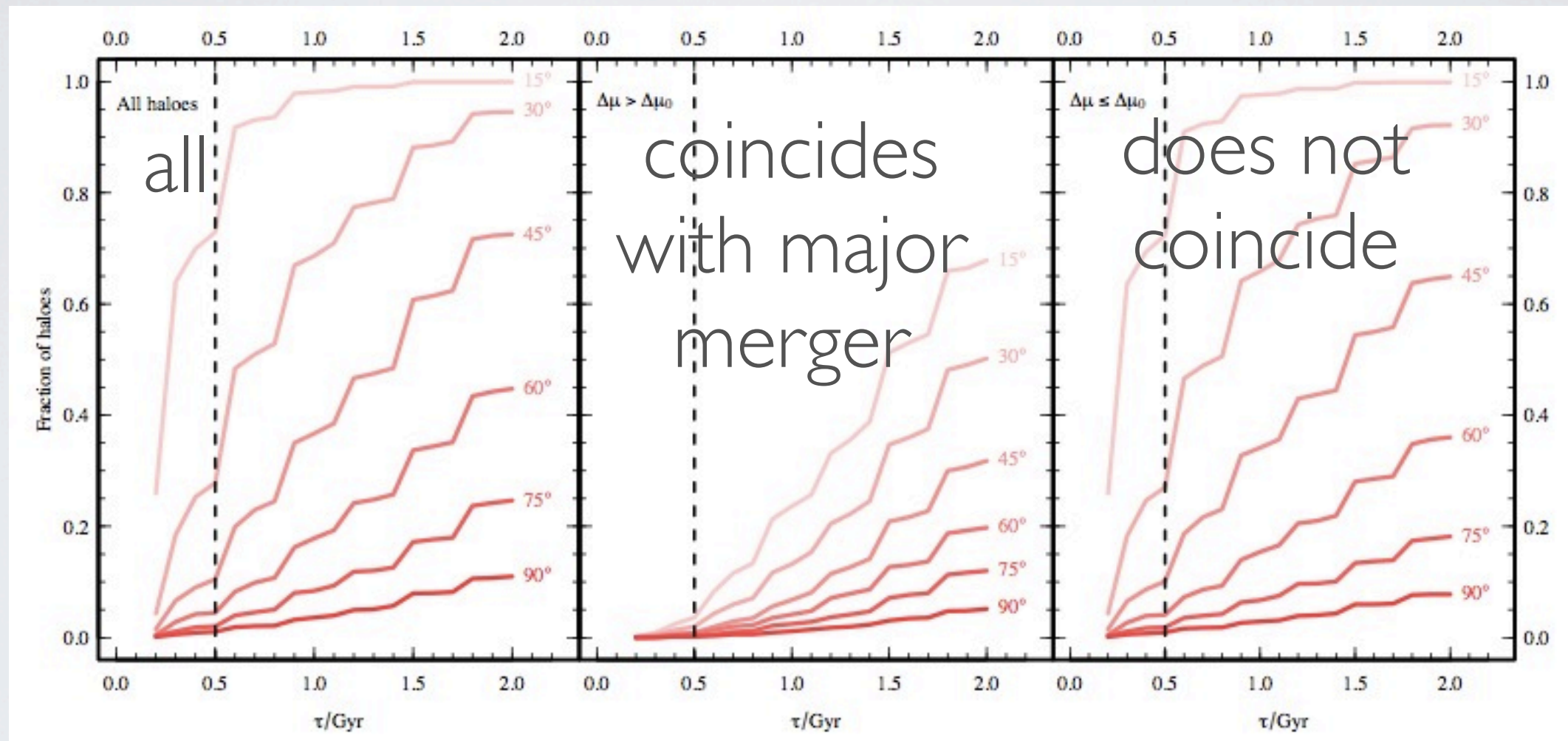
Bett & Frenk (2011) study the occurrence of spin flips in a high resolution simulation:



flips produced by infalling material with angular momentum misaligned with that of DM halo.

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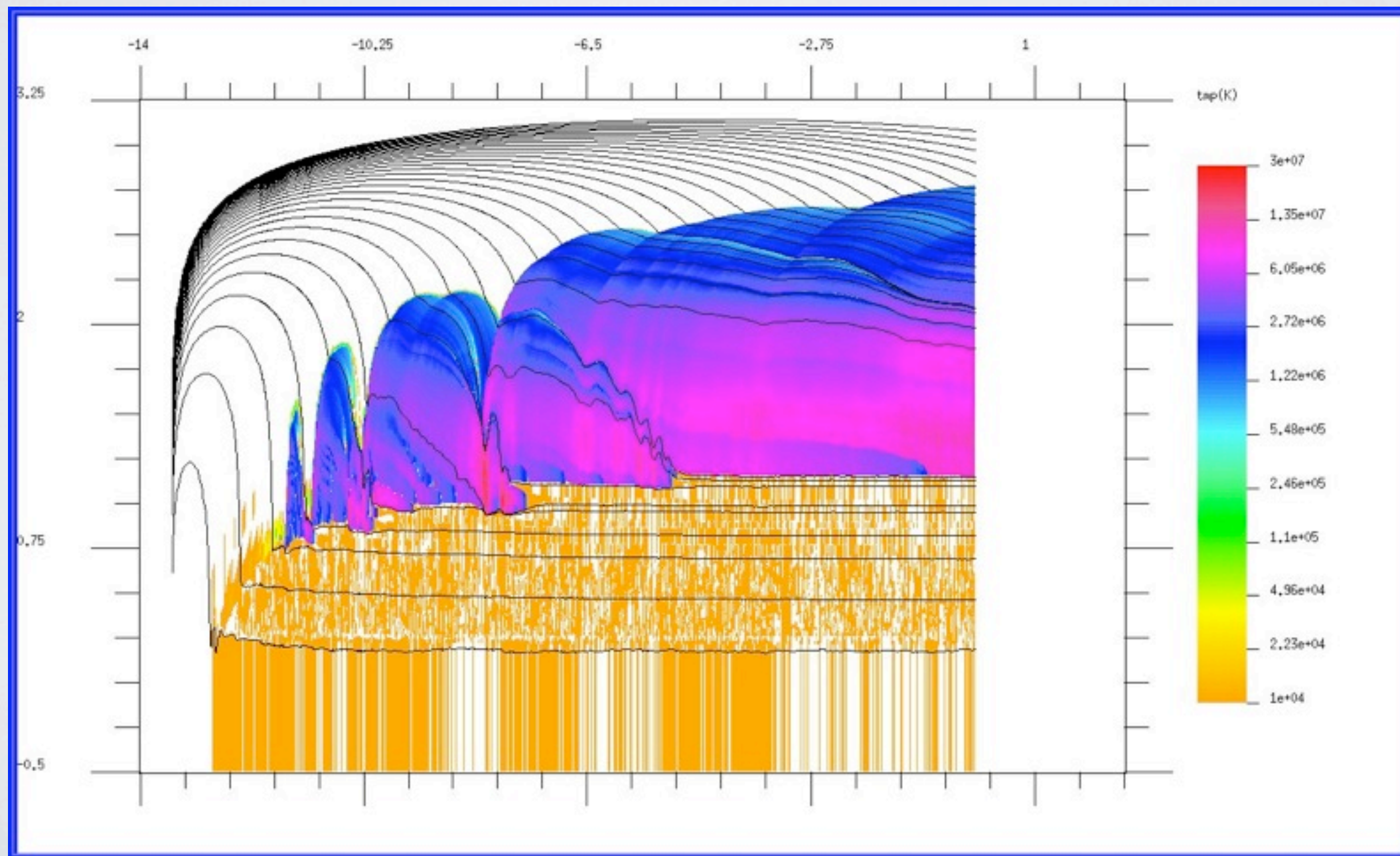


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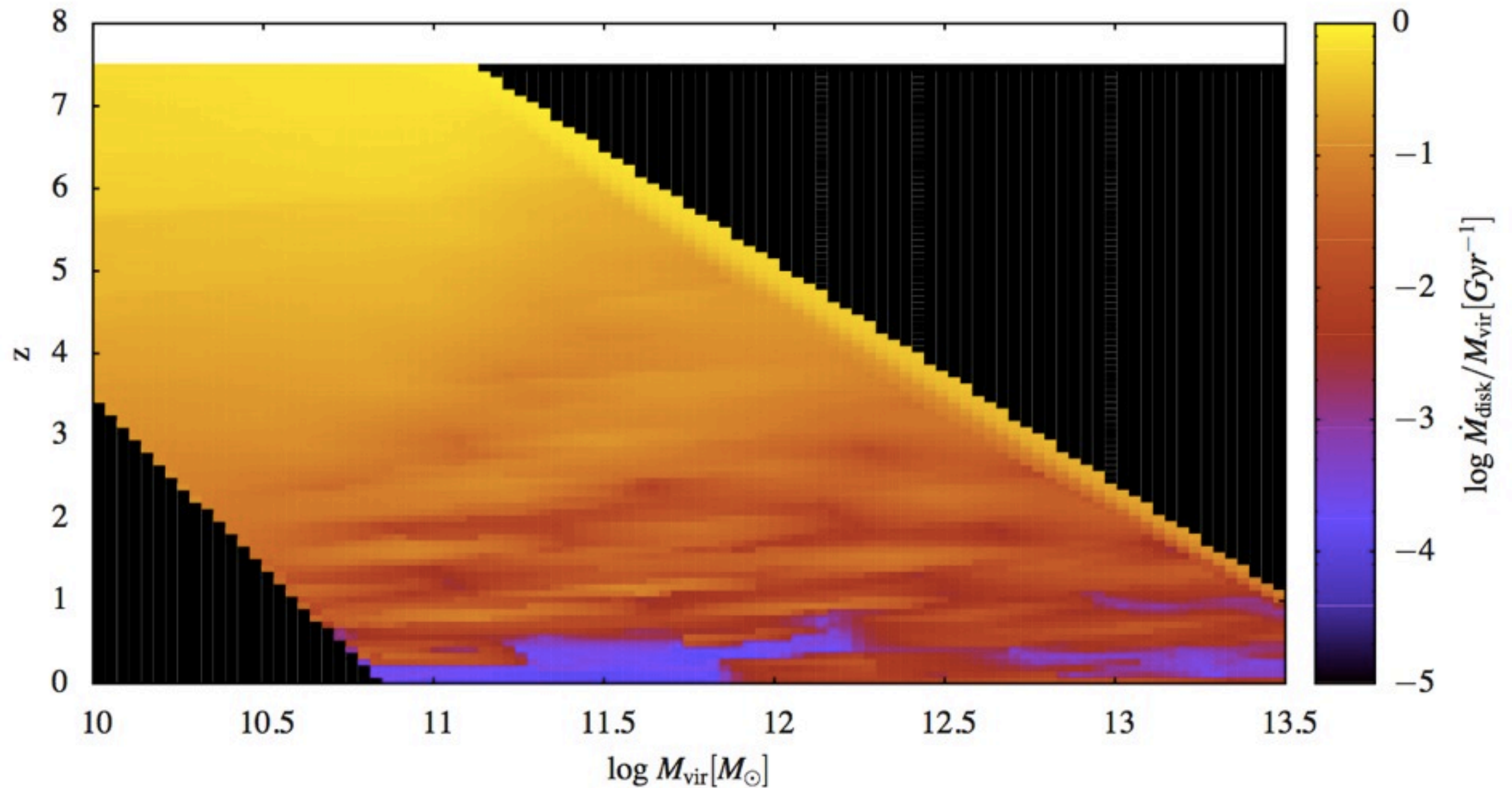
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COLD INFLOWS FROM HYDRODYNAMICAL SIMULATIONS:



RATE OF COLD GAS INFLOW:



incorporated in SAG via metallicity dependent look-up tables

SFR TREATMENT

Using the SF law from Croton et al. (2006) which considers a threshold surface density of gas to form stars.

SF inversely proportional to disc scale radius (among other factors).

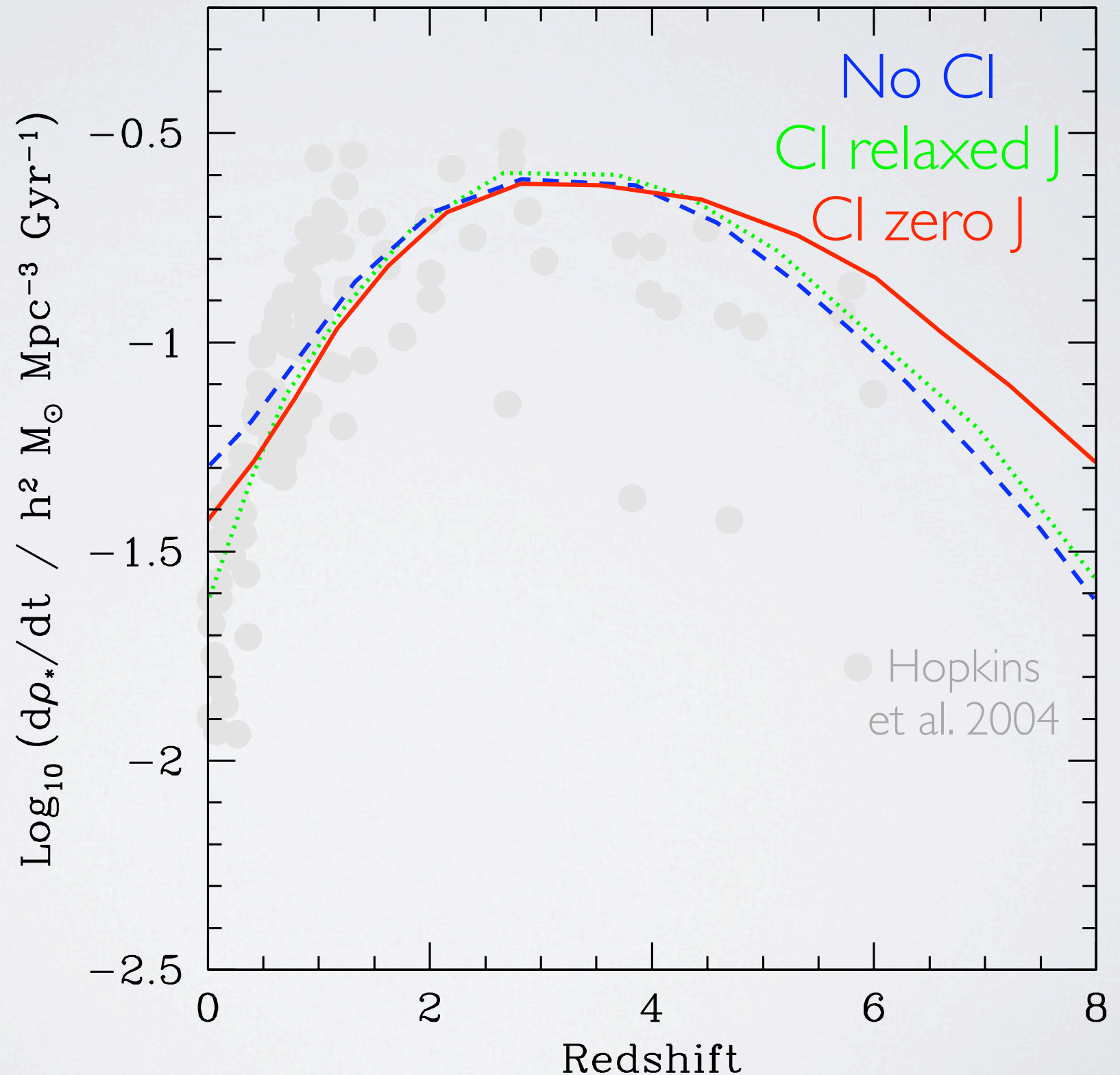
Two different treatments:

- Angular momentum of filament gas as that of a relaxed DM halo: more gas, larger disc, may not increase SF.
- Angular momentum assumed to be zero for cold inflows, and of relaxed DM halo for cooling gas: smaller gas disc.


RESULTS: MADAU PLOT

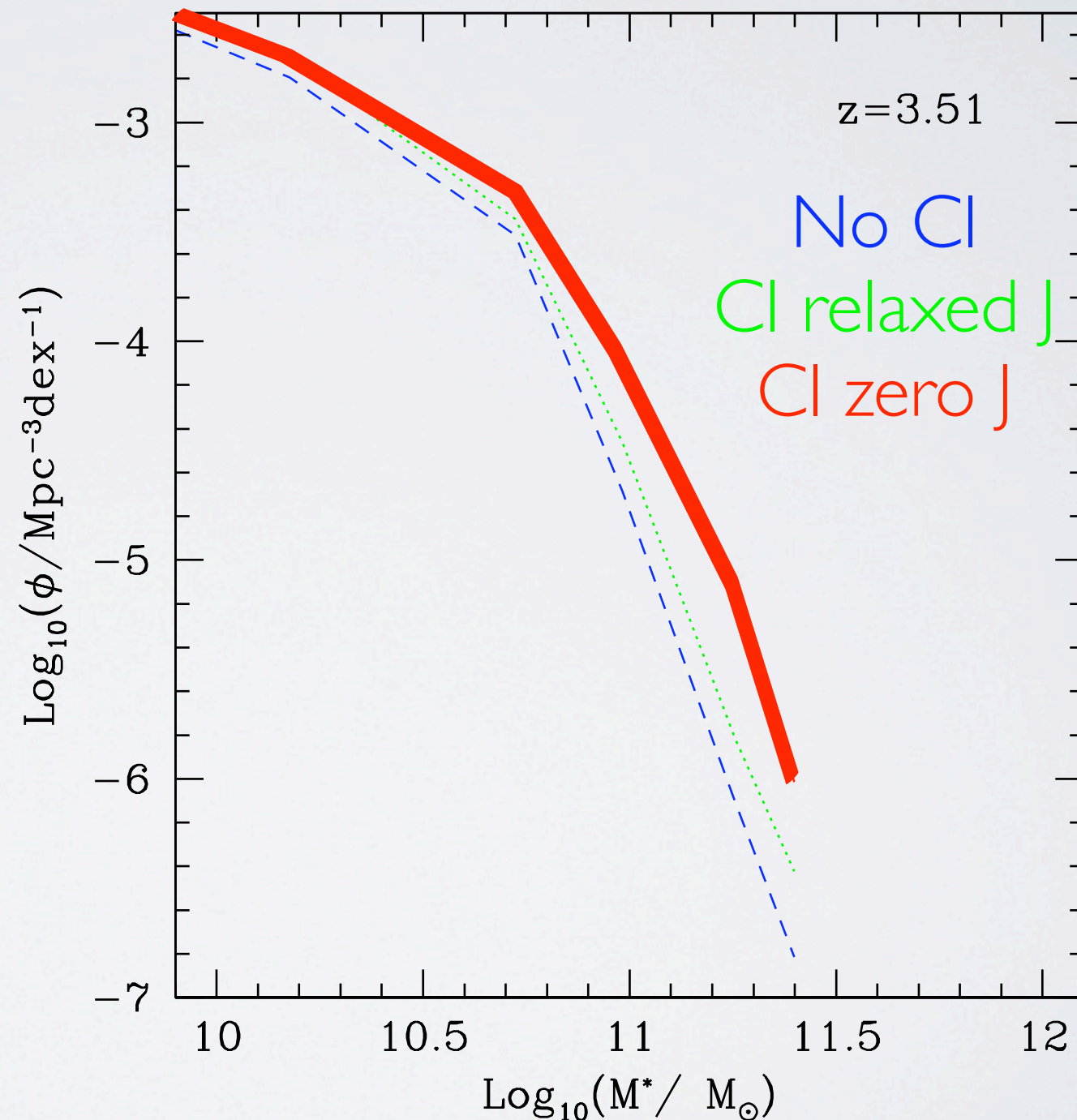
● Almost no effect from cold-inflows when relaxing filaments.

● Factor of up to x2 increase in high-z SFR in zero J case.



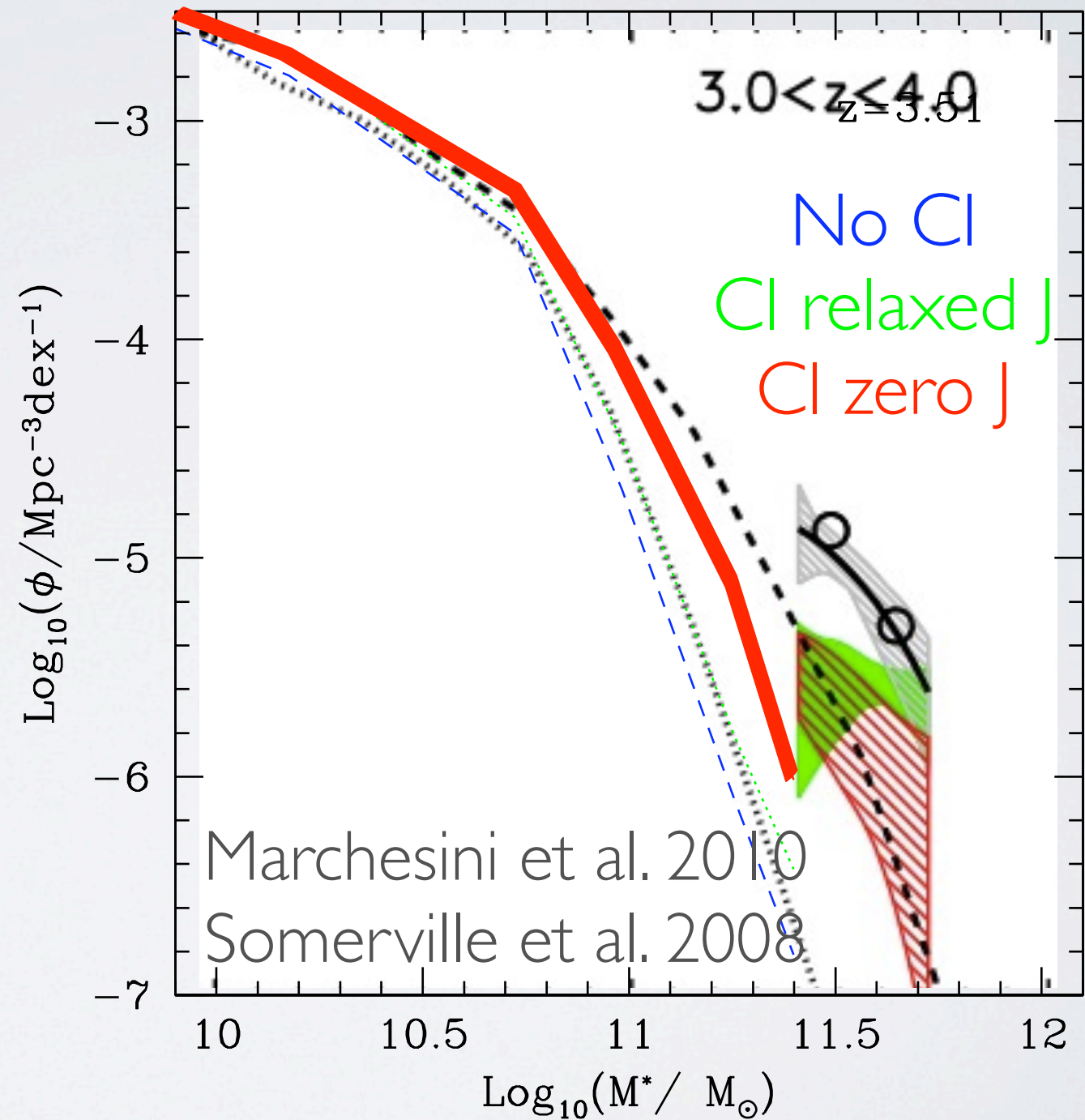
RESULTS: STELLAR MASS FN.

 Stellar mass function at high- z increased high-mass end for zero J cold inflows.



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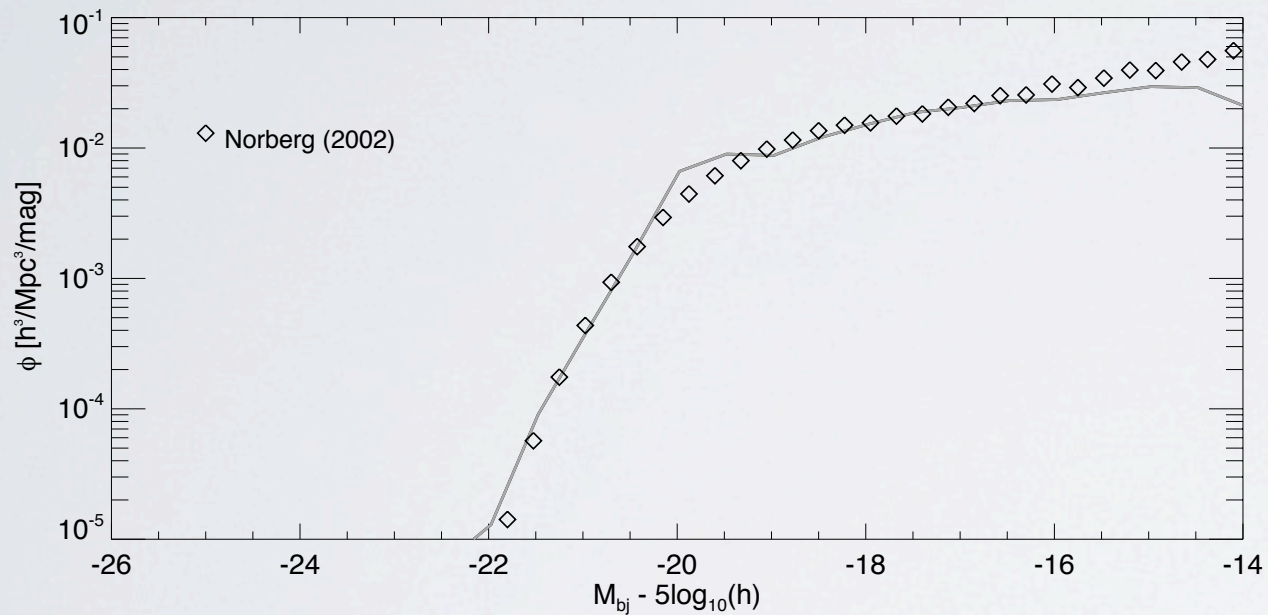
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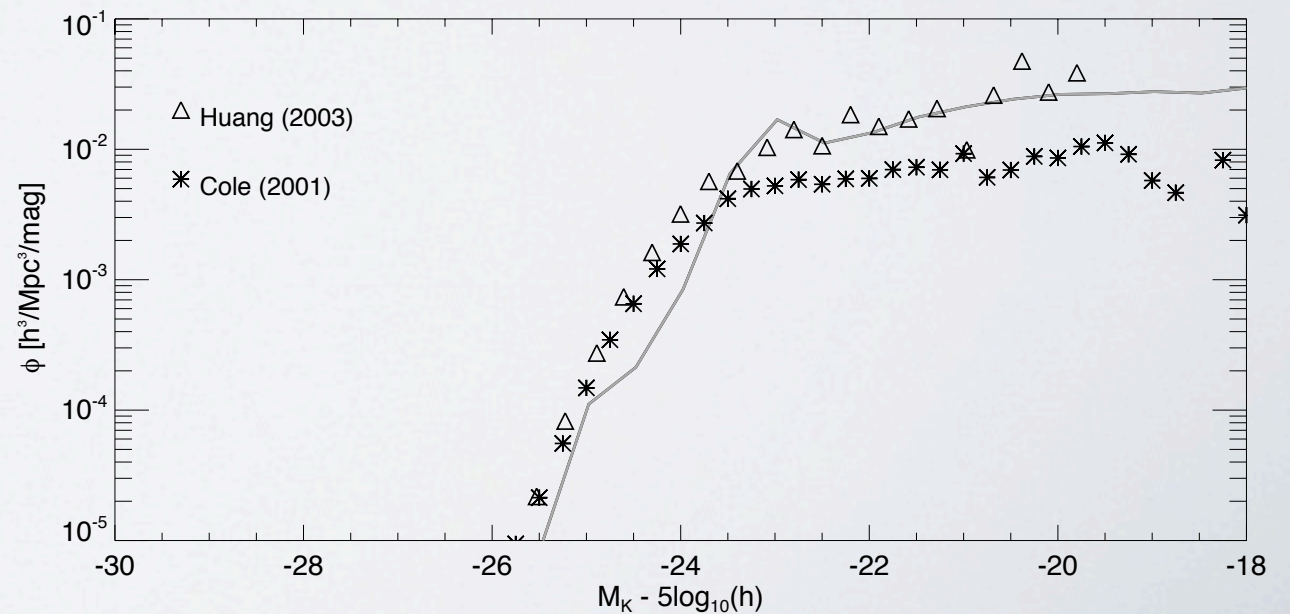
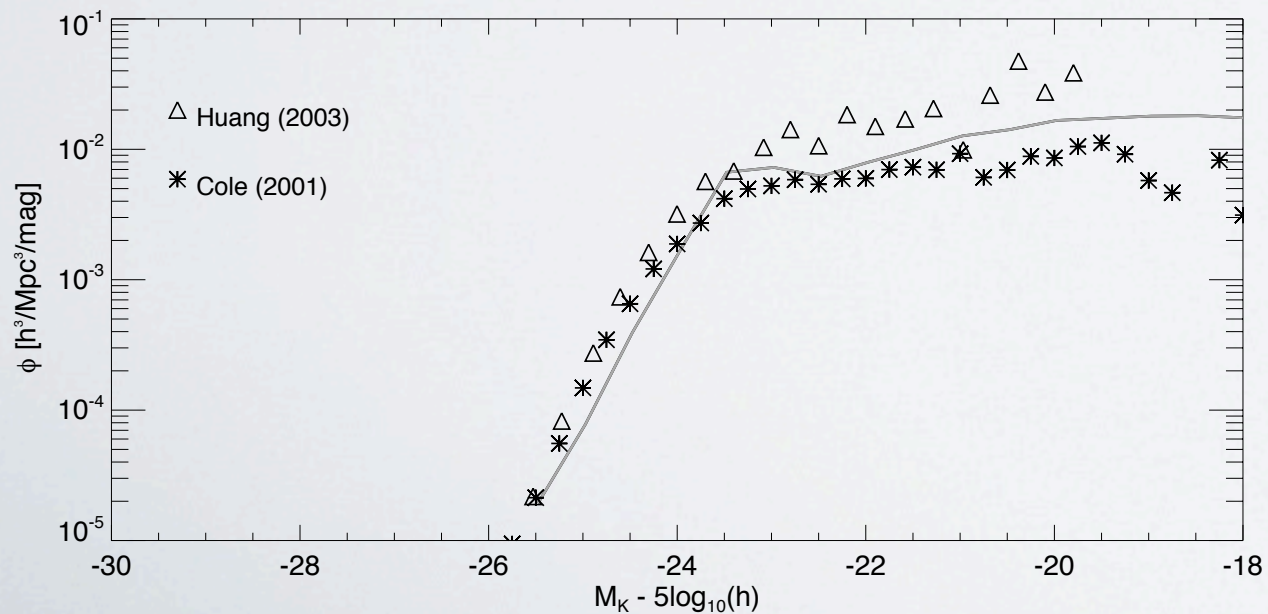
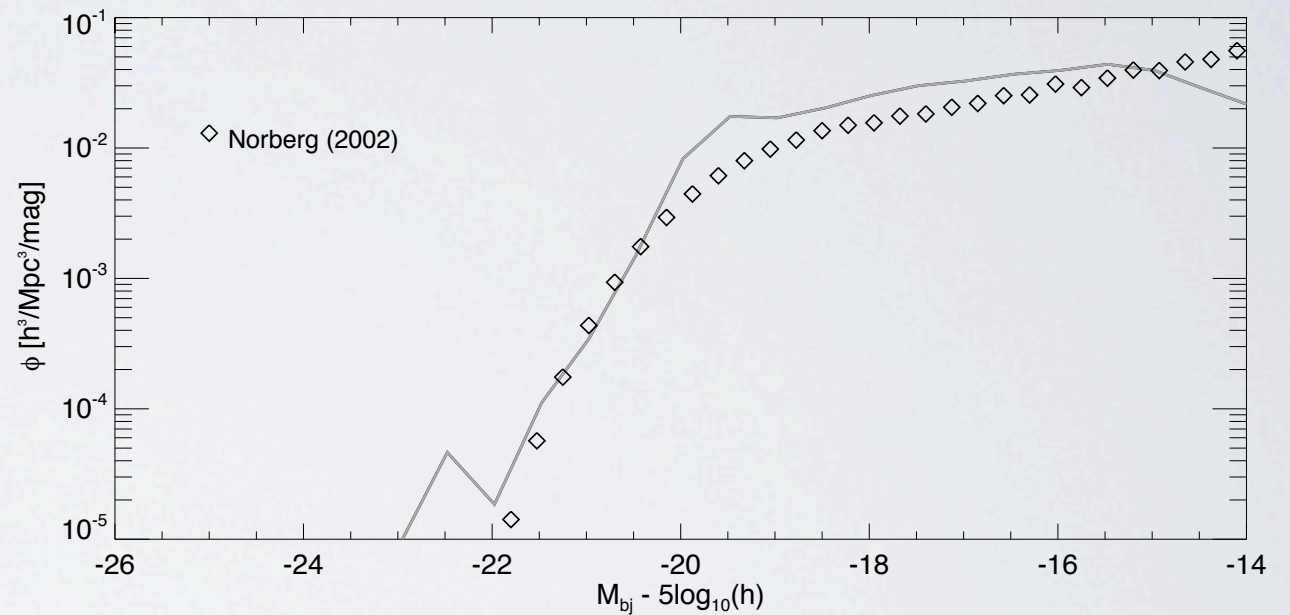
RESULTS: $Z=0$ LF

Do we still reproduce $z=0$ properties?

No cold inflows

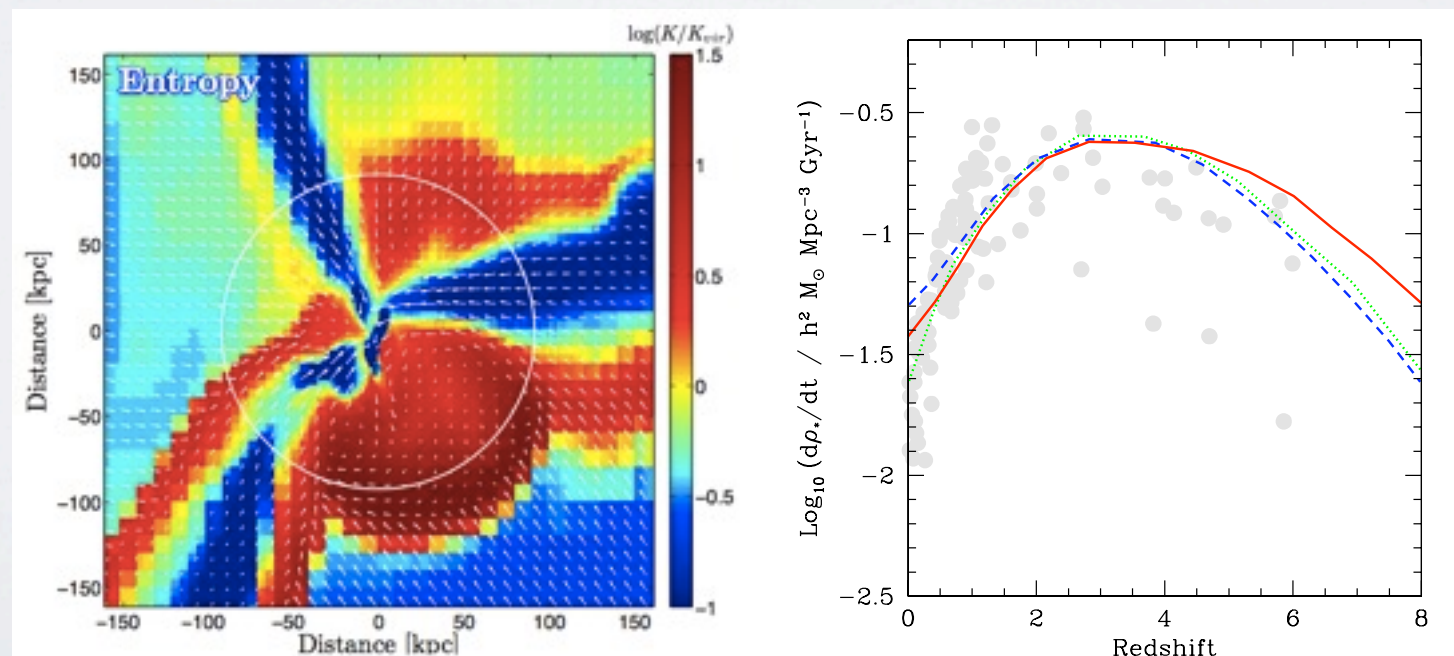


Cold inflows zero J

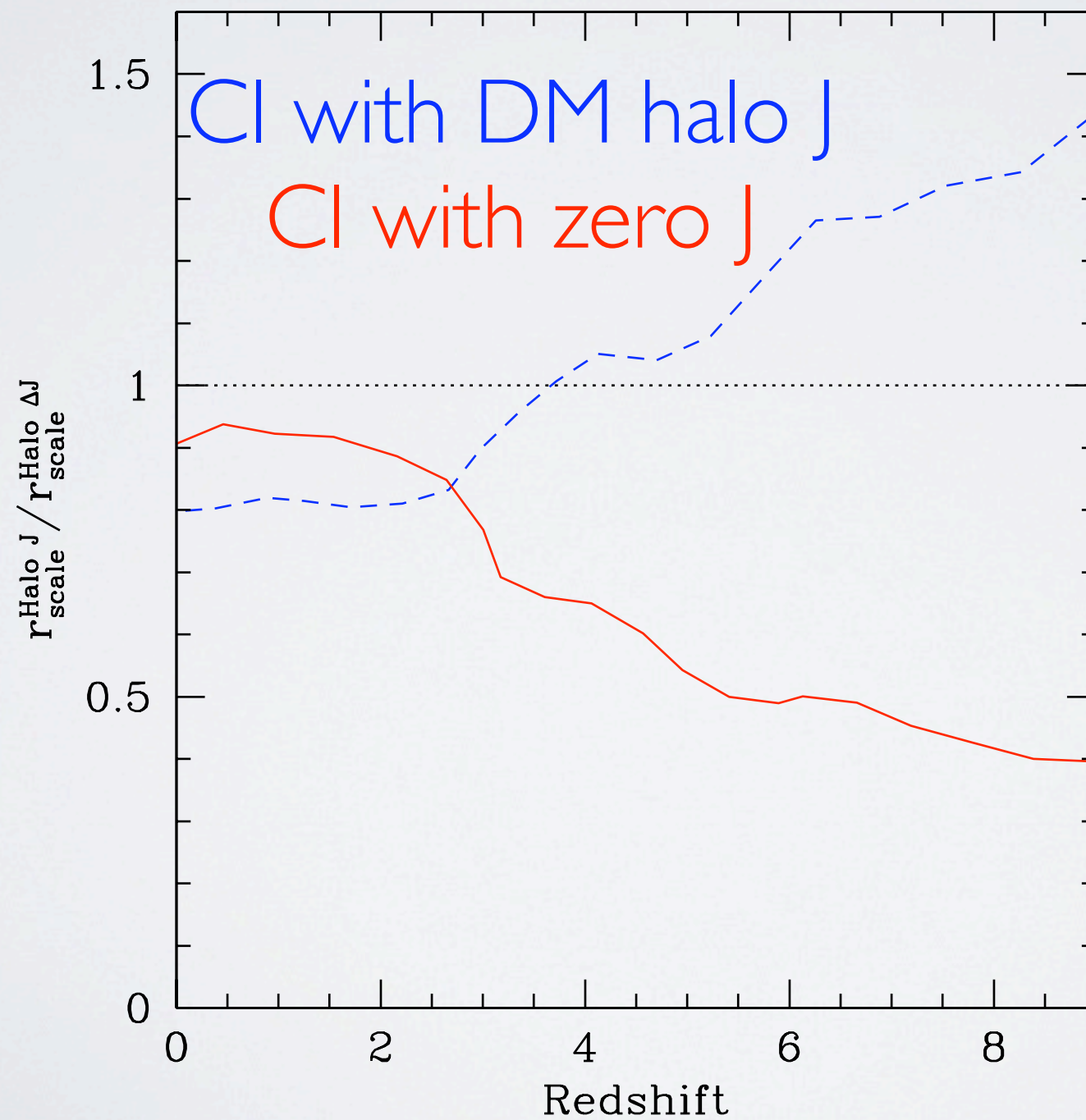


CONCLUSIONS

- High redshift abundances in models and observations have been difficult to reconcile. Observational and modeling techniques are still evolving...
- Cold gas inflows in massive haloes at high redshift could increase the abundance of high- z massive galaxies, only if their angular momentum is assumed to be misaligned (or on average, zero) with that of the already formed disc.
- The expected effect is still smaller than observational errors, and other mechanisms such as SN feedback have a much larger impact.



Average disc scale radii as a function of redshift:



Filament vs. cooling inflow of cold gas:

