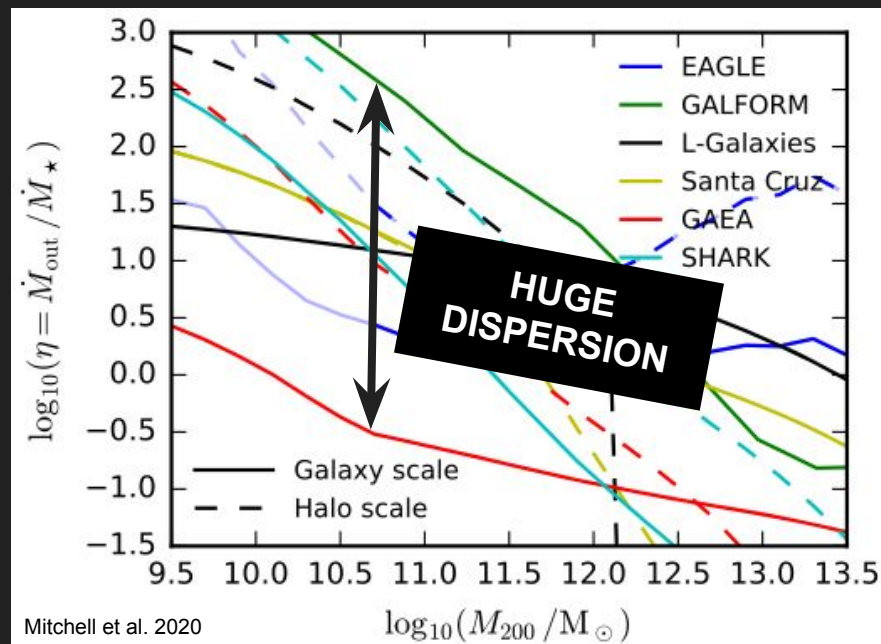
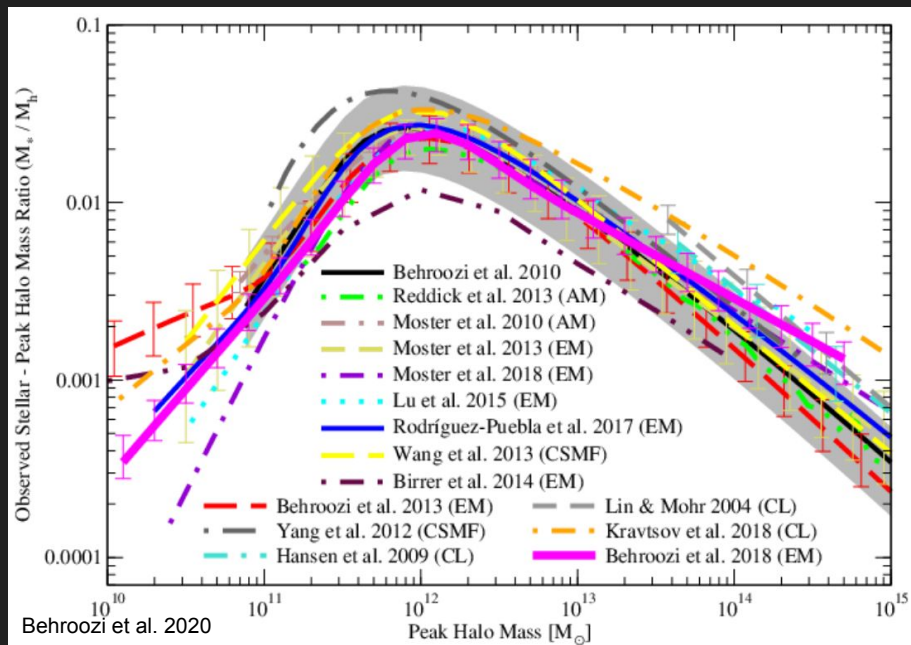


Maxime Rey

# Star formation and feedback subgrid models.

Supervised by Jérémy Blaizot

# Feedback models degeneracy



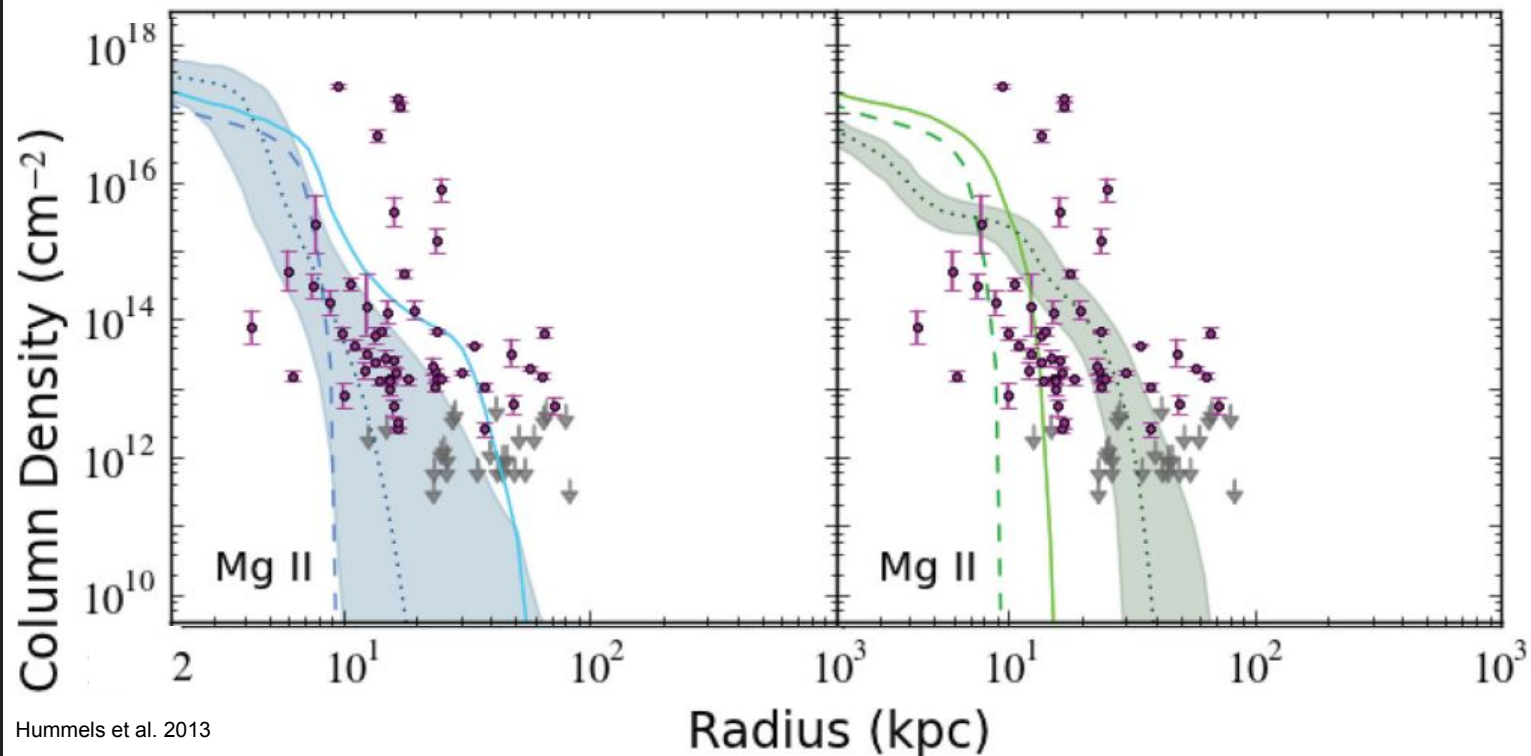
Mitchell et al. 2020

# 3 models: Agertz, Kimm & Kretschmer

|                   | <b>Star formation</b> | <b>Feedback</b>                                                     | <b>Bonus</b>                  |
|-------------------|-----------------------|---------------------------------------------------------------------|-------------------------------|
| <b>Agertz</b>     | Density threshold     | Mechanical SNII + SNIa,<br>pre-SN feedback (fast and<br>slow winds) | Oxygen                        |
| <b>Kimm</b>       | Gravoturbulent        | Mechanical SNII                                                     | Boost (x4)                    |
| <b>Kretschmer</b> | Gravoturbulent        | Mechanical SNII                                                     | Turbulence-dedicated variable |
| <b>Kimm + rnw</b> | Gravoturbulent        | Mechanical SNII                                                     | Boost (x4) + runaway stars    |

RHD (3 bins) simulations with non-equilibrium chemistry.

# Mg II in the CGM



# ramses\_cral



Sphinx / ramses\_cral



Developer

★ 0 Updated 2 days ago

ramses\_cral

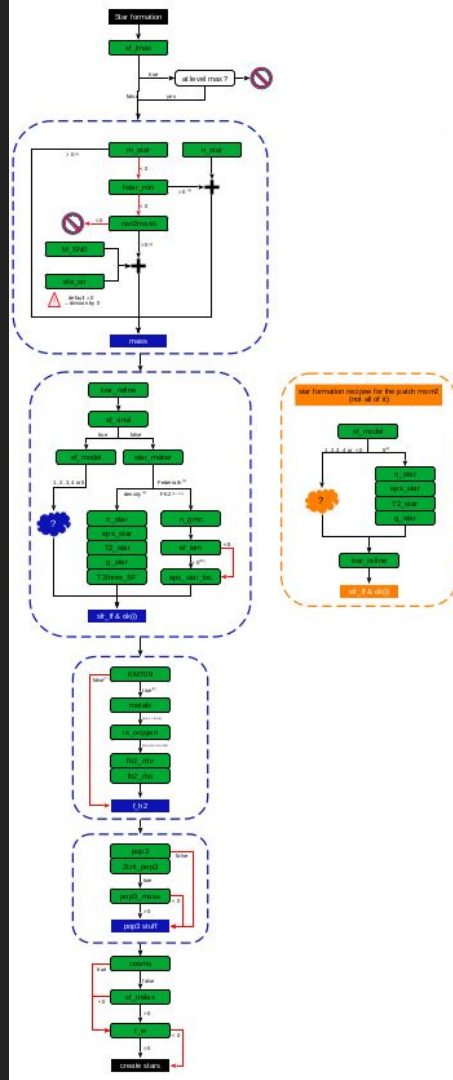


Agertz  
Kimm  
Kretschmer

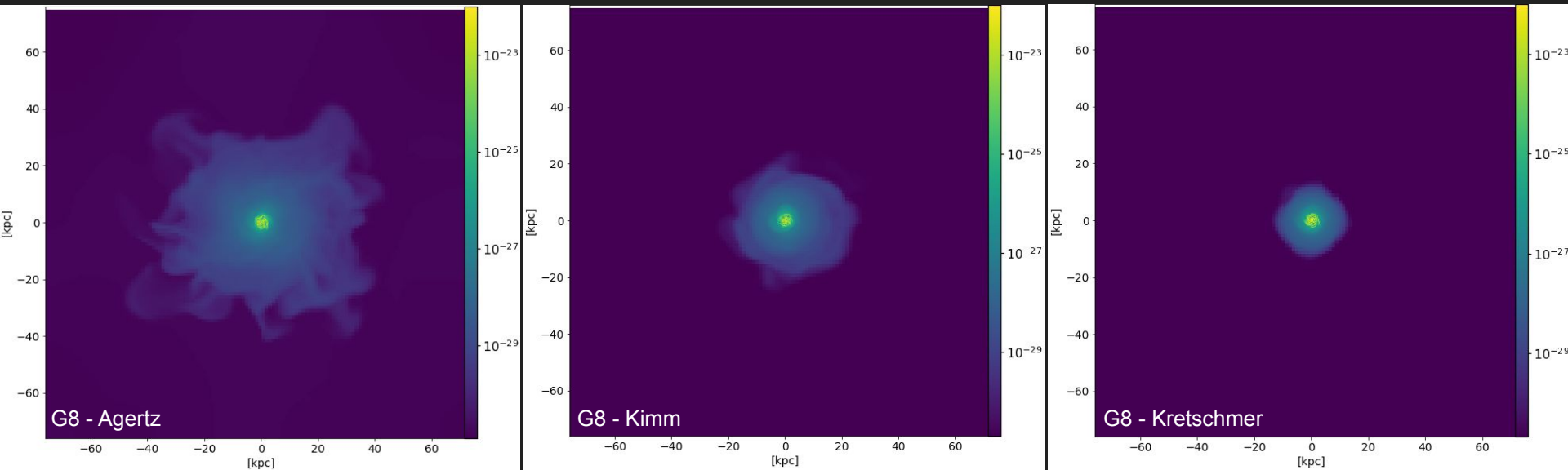
star formation  
+ feedback



Runaway  
stars

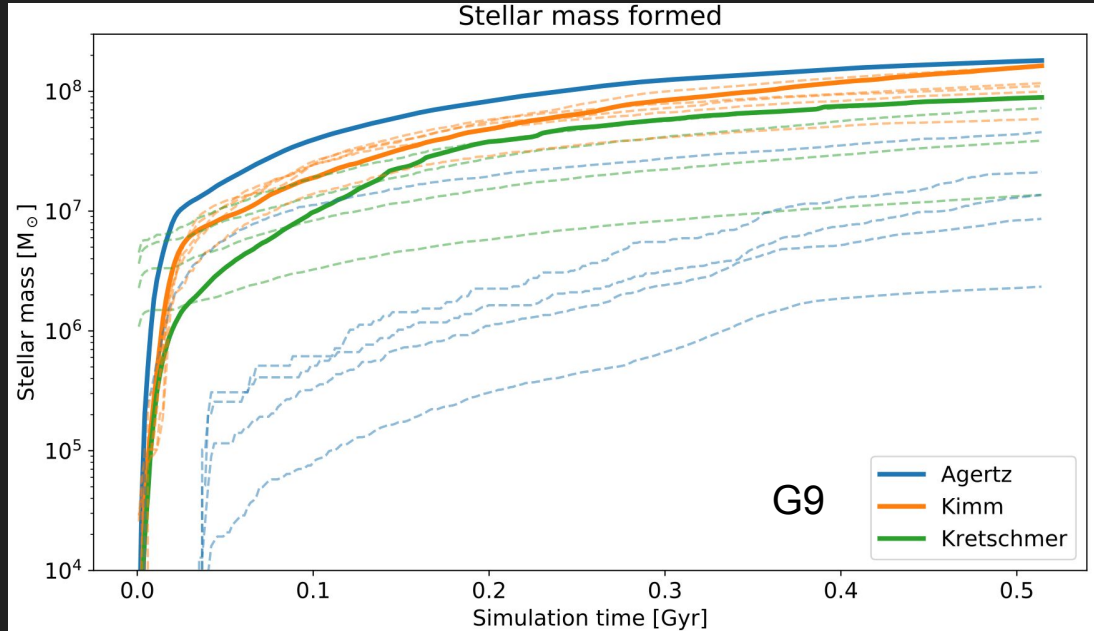


# G8 & G9 - galaxies that shine



| Galaxy acronym | $v_{\text{circ}}$<br>[km s $^{-1}$ ] | $R_{\text{vir}}$<br>[kpc] | $L_{\text{box}}$<br>[kpc] | $M_{\text{halo}}$<br>[ $M_{\odot}$ ] | $M_{\text{disk}}$<br>[ $M_{\odot}$ ] | $f_{\text{gas}}$ | $M_{\text{bulge}}$<br>[ $M_{\odot}$ ] | $N_{\text{part}}$ | $m_*$<br>[ $M_{\odot}$ ] | $\Delta x_{\text{max}}$<br>[kpc] | $\Delta x_{\text{min}}$<br>[pc] |
|----------------|--------------------------------------|---------------------------|---------------------------|--------------------------------------|--------------------------------------|------------------|---------------------------------------|-------------------|--------------------------|----------------------------------|---------------------------------|
| G8             | 30                                   | 41                        | 150                       | $10^{10}$                            | $3.5 \times 10^8$                    | 0.5              | $3.5 \times 10^7$                     | $10^5$            | 1600                     | 1171                             | 36.6                            |
| G9             | 65                                   | 89                        | 300                       | $10^{11}$                            | $3.5 \times 10^9$                    | 0.5              | $3.5 \times 10^8$                     | $10^6$            | 1600                     | 1171                             | 36.6                            |

# G8 & G9 - models stability



G8

$n_*$  (10, 25, 50, 100) H/cc  
 $m_*$  (400, 1600, 6400,..)  $M_{\odot}$

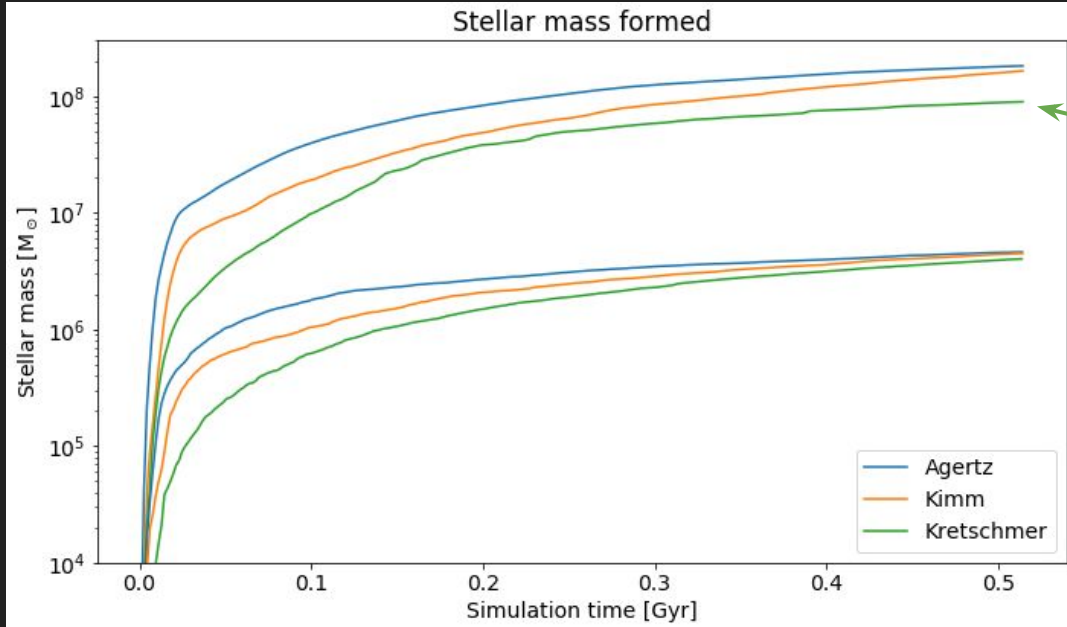
G9

$n_*$  (10,25) H/cc  
 $m_*$  (1600,12800, 51200, 102400)  $M_{\odot}$   
res (36, 144) pc

Agertz:  $n_*$  & resolution  
Kimm: ✓  
Kretschmer:  $m_*$  & resolution

- How to set  $n_*$ ,  $m_*$  ?
- Dependence in resolution ?

# G8 & G9 - calibration



G9, 36 pc

G8, 36 pc

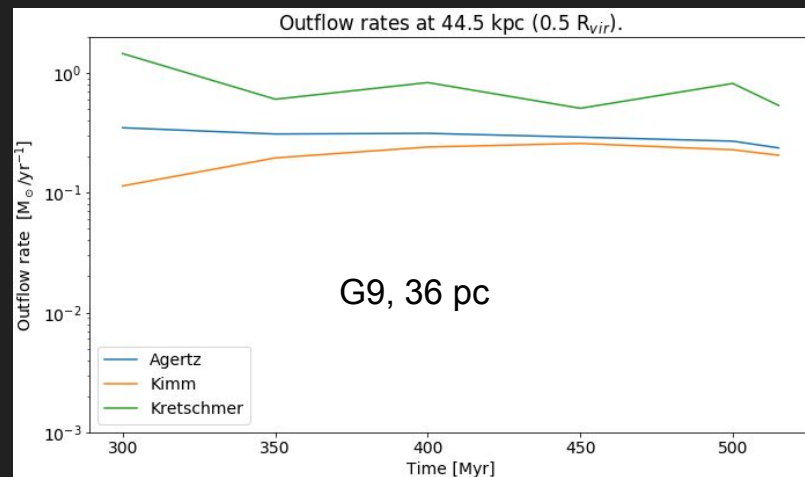
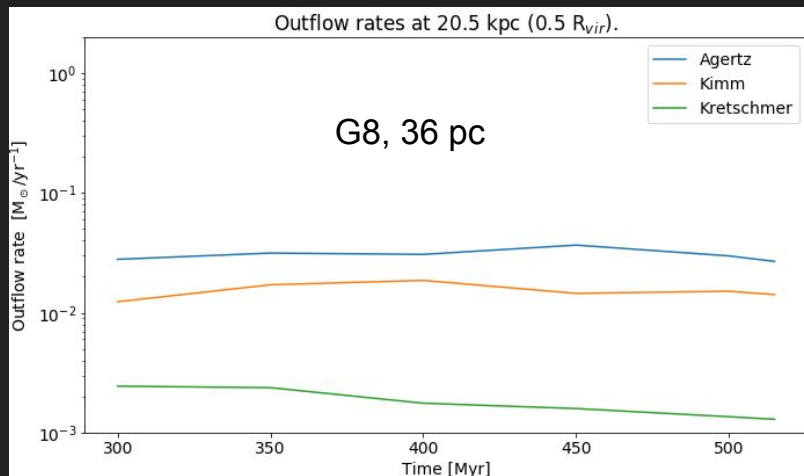
Should be a bit higher,  
photoionisation x2

Calibration worked for

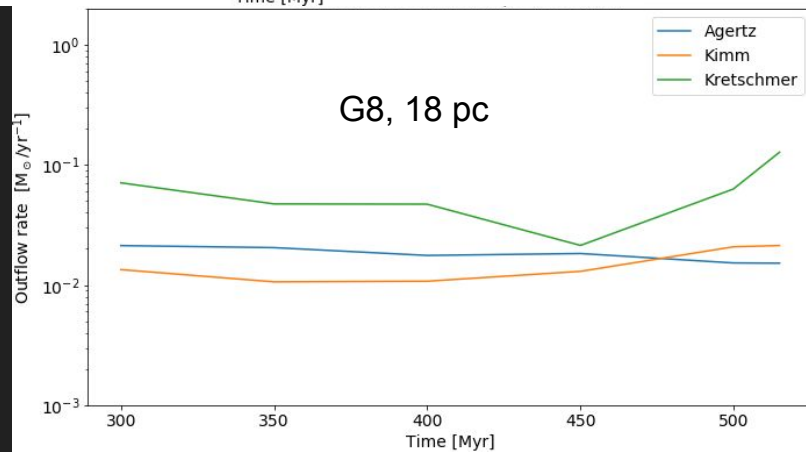
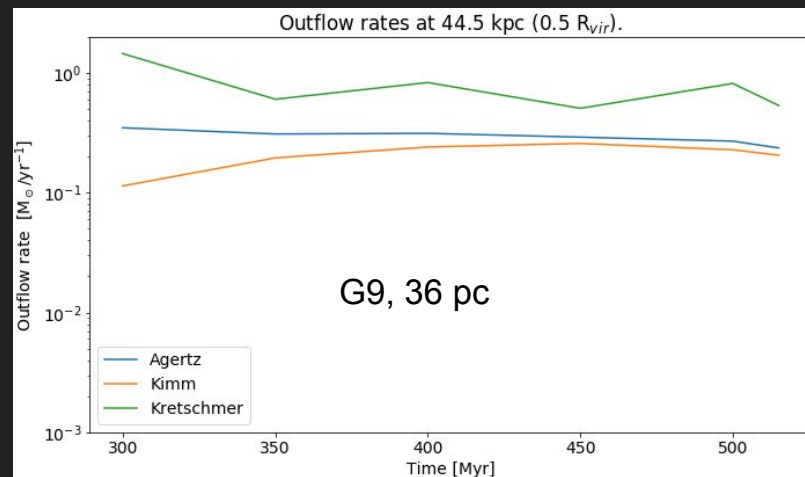
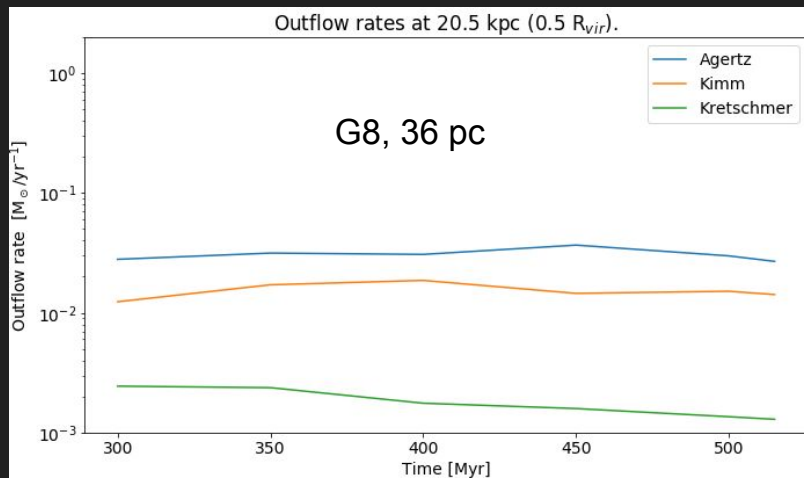
- G8 at 36 pc
- G9 at 36 pc
- ~~G9 at 144 pc~~
- G8 at 18 pc



# G8 & G9: outflow rates

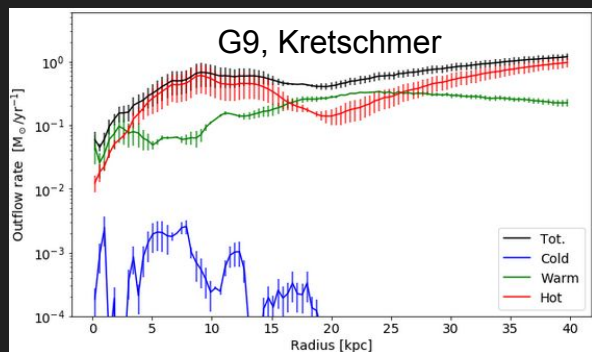
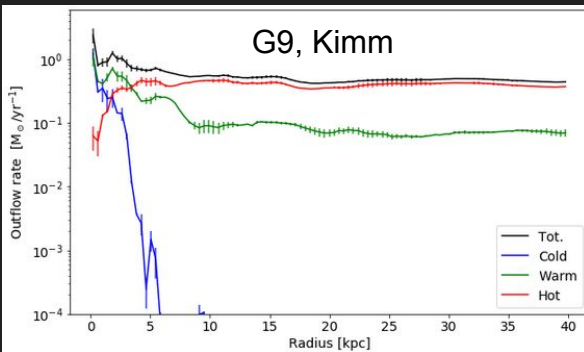
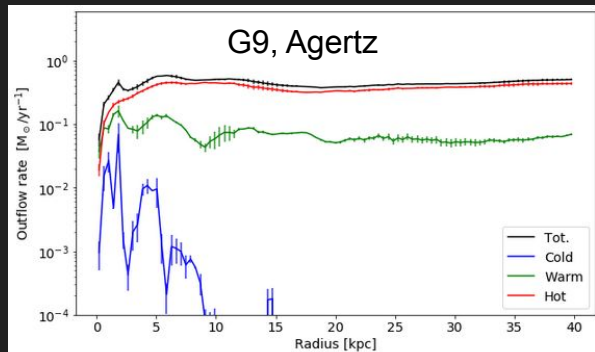
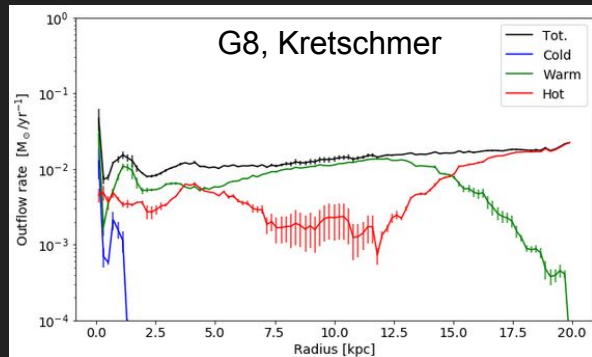
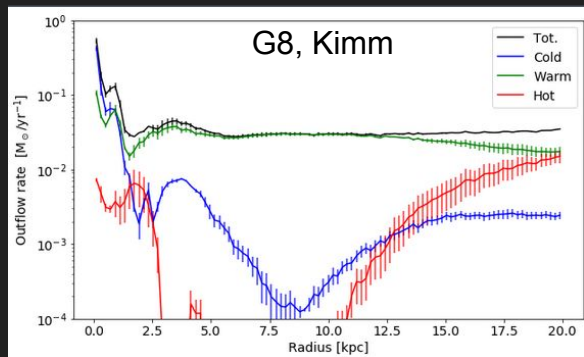
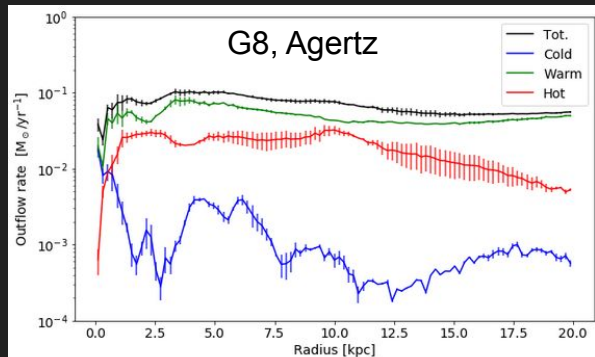


# G8 & G9: outflow rates



Cold  $T < 10^4$   
 Warm  $10^4 < T < 10^5$   
 Hot  $10^5 < T$

# G8 & G9: hot and cold outflows

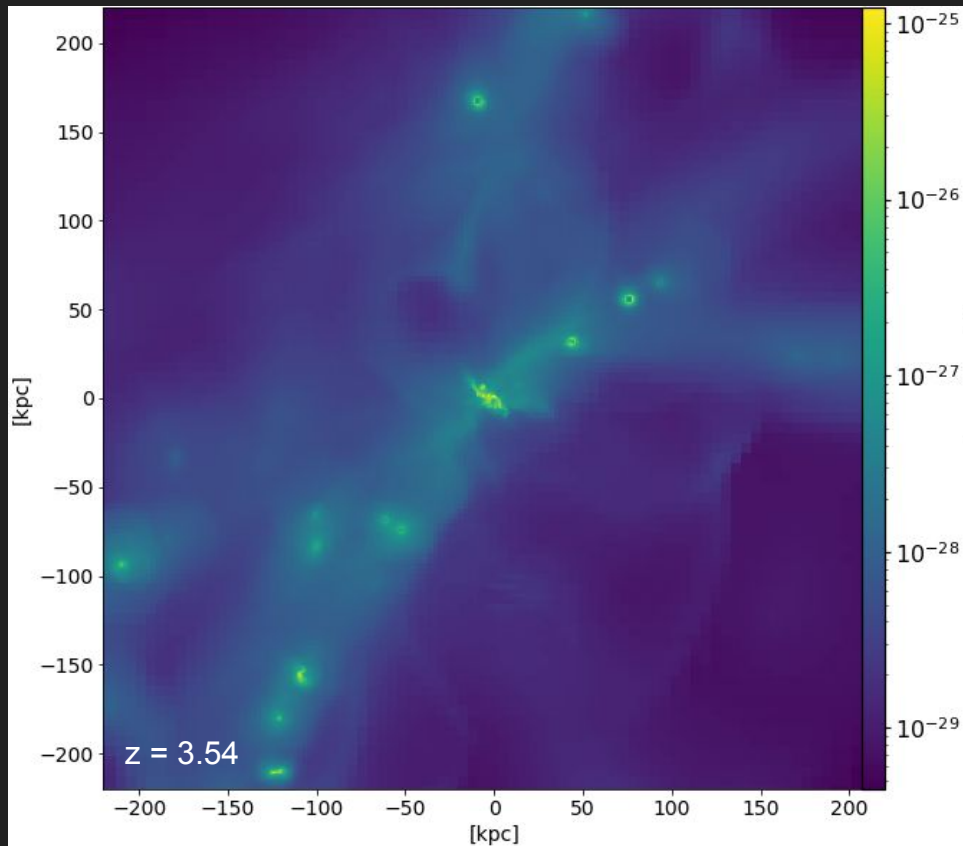


# Zoom simulation of an isolated galaxy

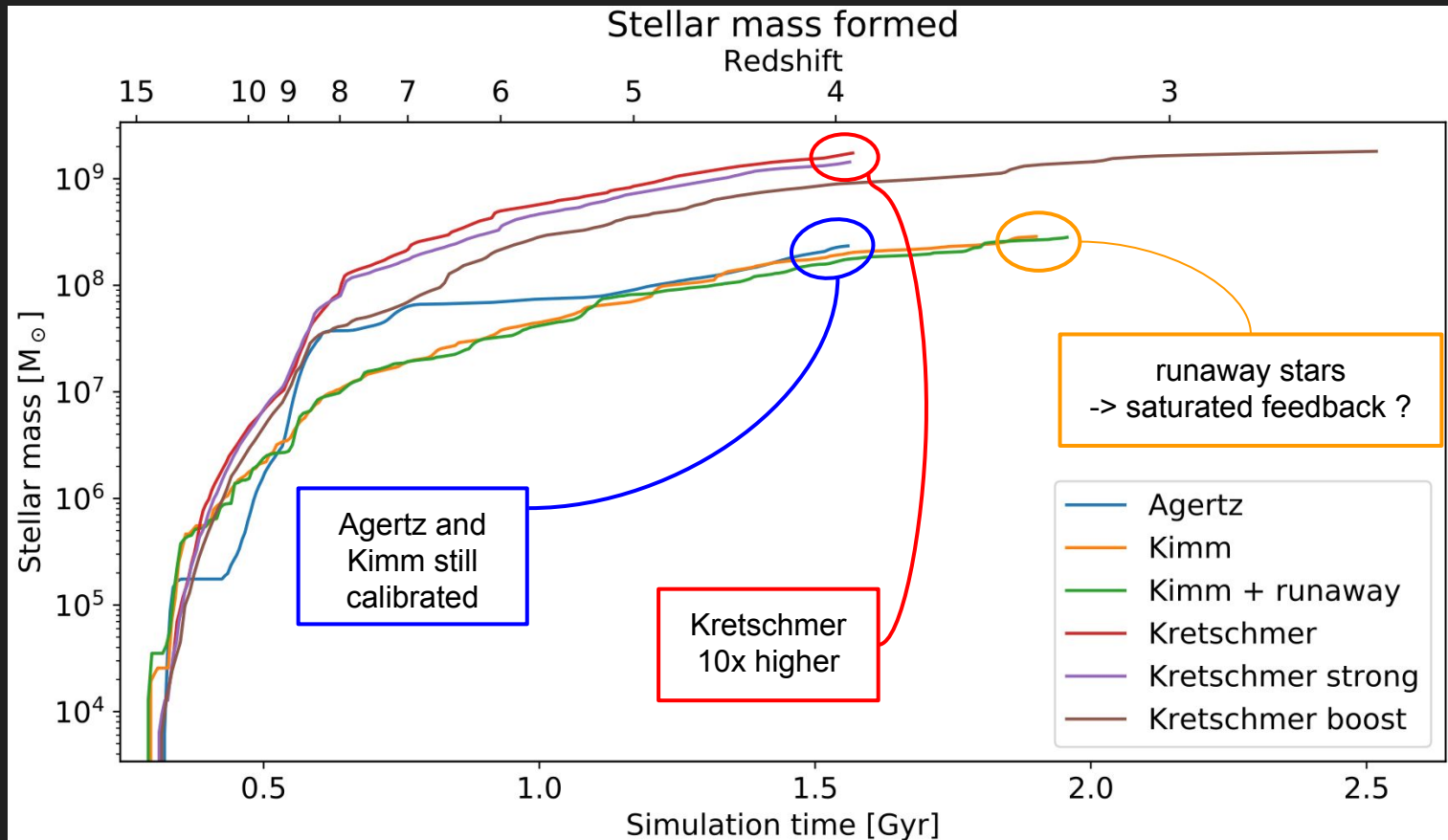
|                   |                      |
|-------------------|----------------------|
| Box size          | 30 cMpc/h            |
| $m_{\text{DM}}$   | $3.5e5 M_{\odot}$    |
| $m_{\text{halo}}$ | $5e10 M_{\odot}$     |
| $R_{200}$         | 22 kpc at $z = 2.85$ |
| Zoom              | $5 R_{\text{vir}}$   |
| Res.              | 330 kpc to 20 pc     |

Also:

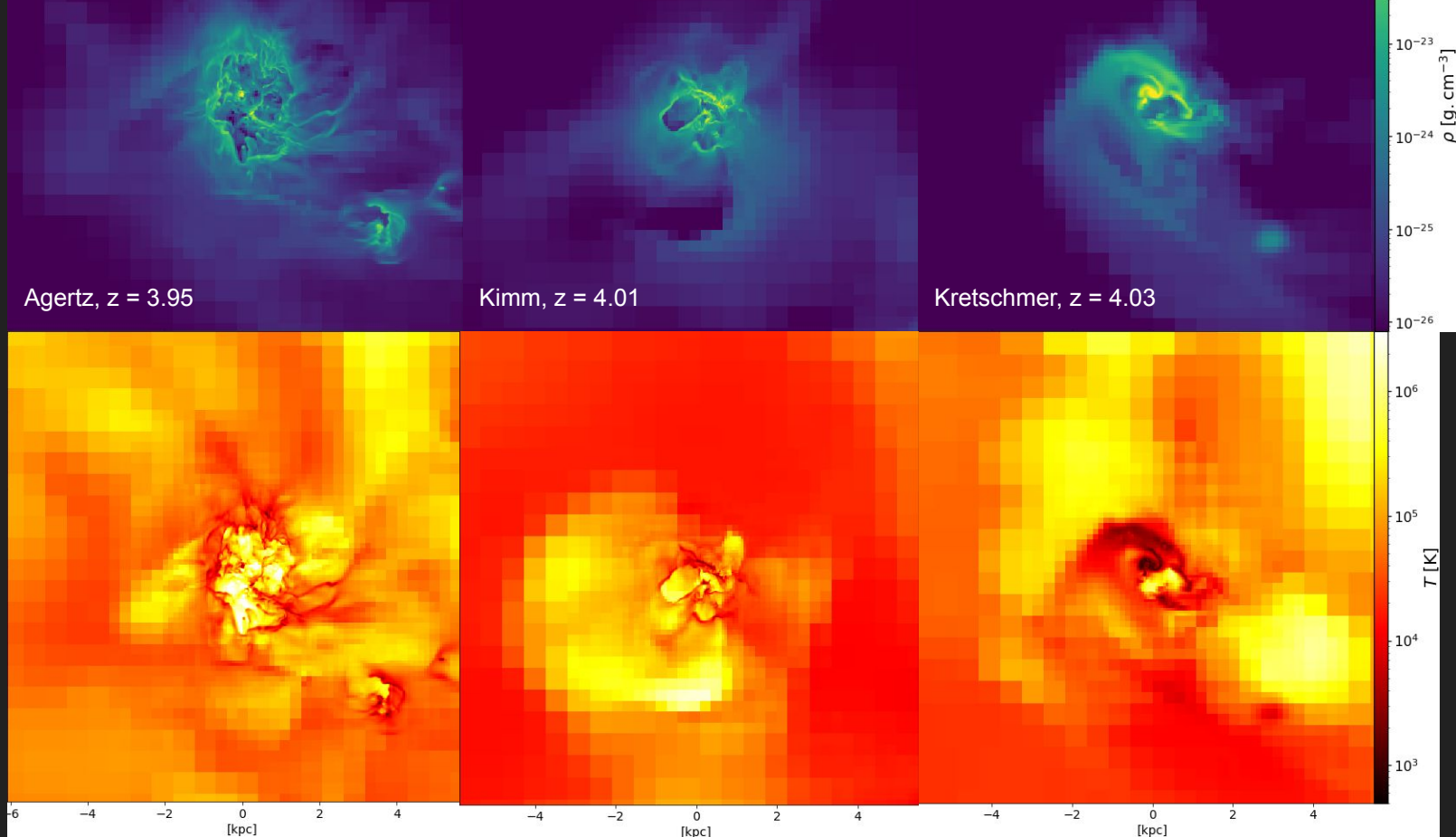
```
jeans_refine = -1, -1, -1, -1, 30*4.  
sf_lmax      = .true.
```



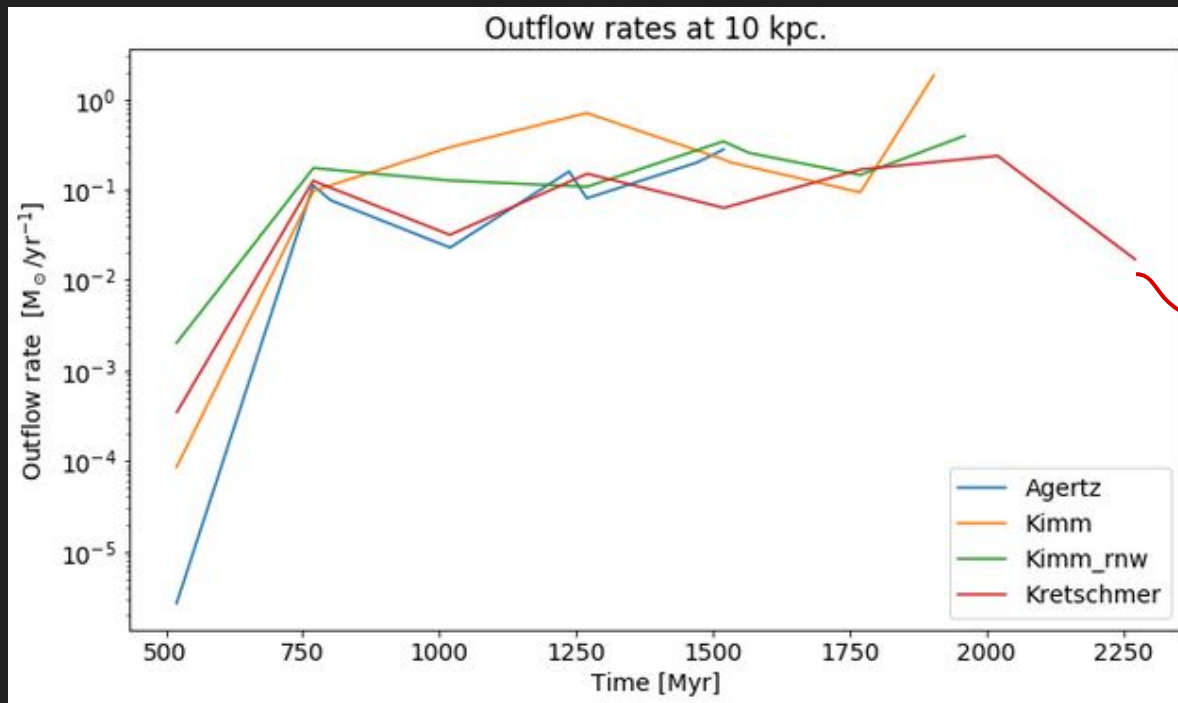
# Zoom simulation of an isolated galaxy - calibration



# Zoom simulation of an isolated galaxy



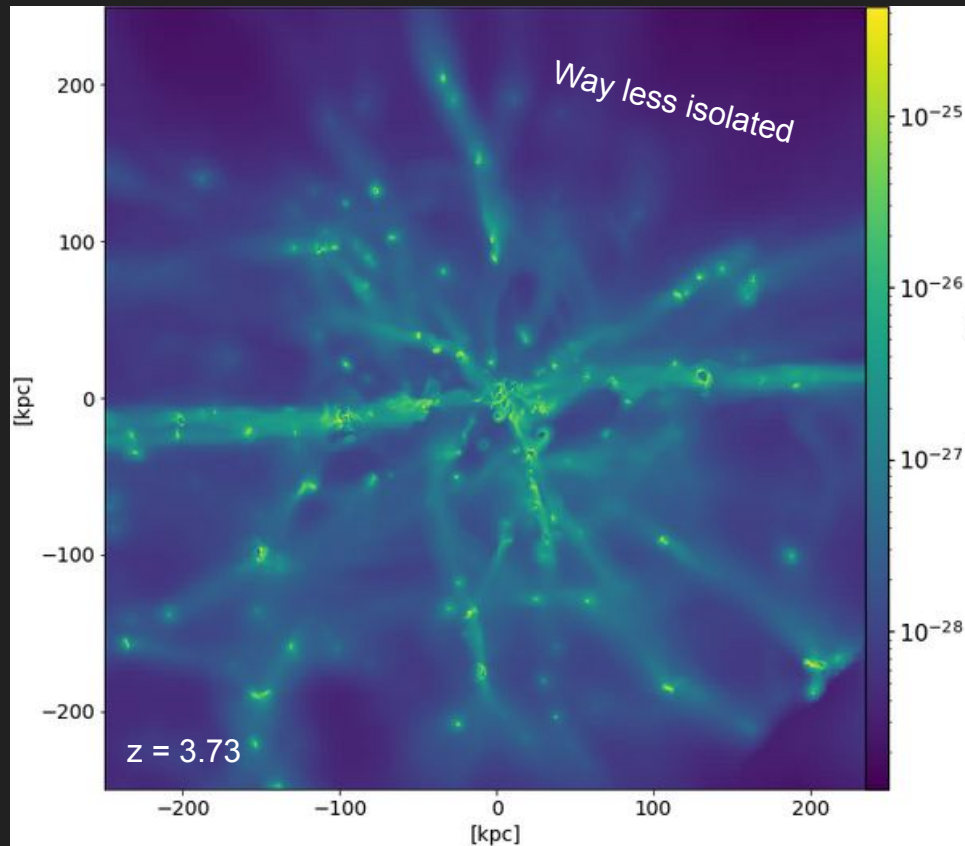
# Zoom simulation of an isolated galaxy - outflows



$R_{\text{vir}} = 22$  ( $z = 2.85$ )

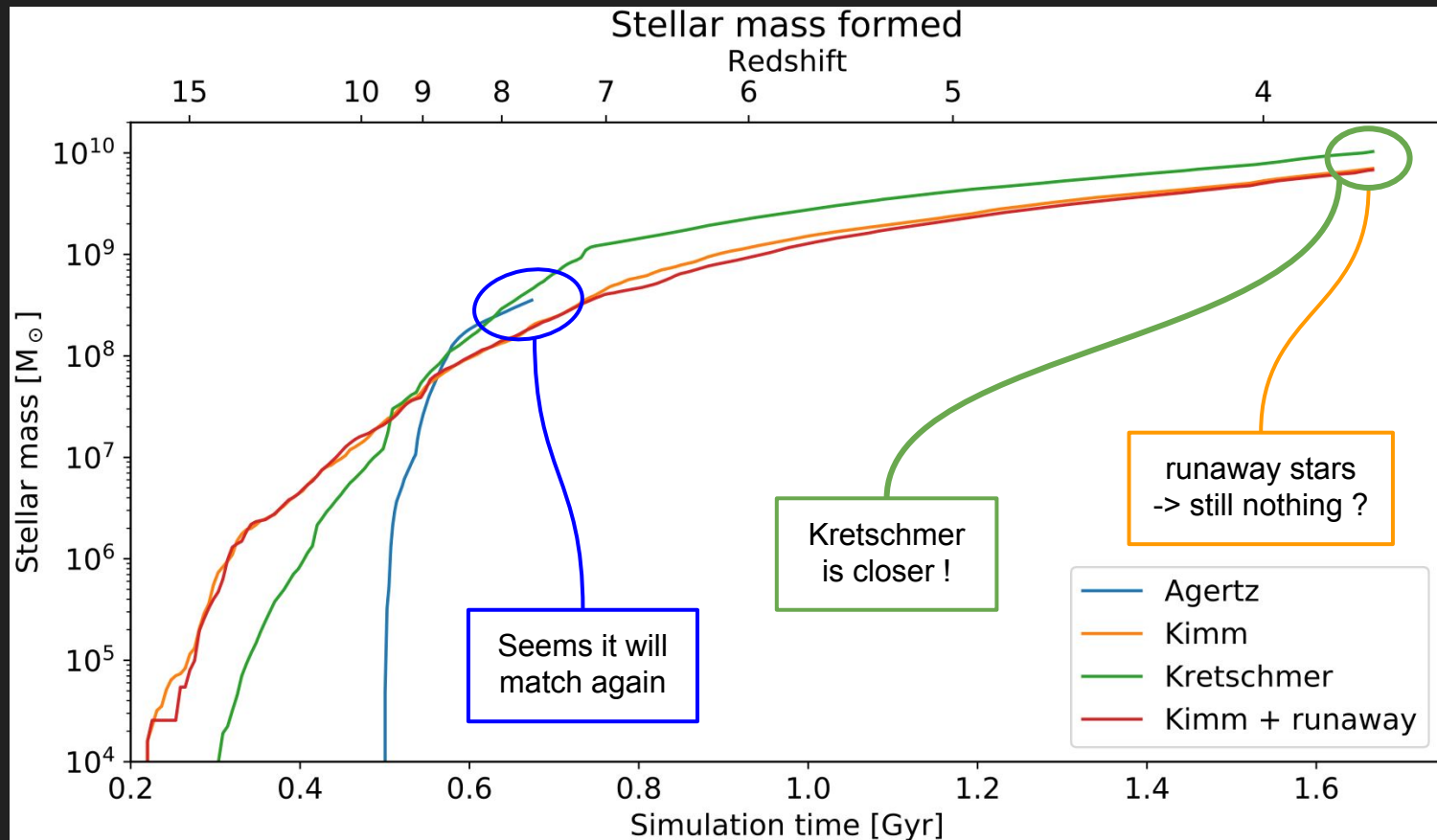
# A more massive, less isolated galaxy

|                   |                        |
|-------------------|------------------------|
| Box size          | 30 cMpc/h              |
| $m_{\text{DM}}$   | 347304 $M_{\odot}$     |
| $m_{\text{halo}}$ | 5e11 $M_{\odot}$       |
| $R_{200}$         | 27.4 kpc at $z = 3.73$ |
| Zoom              | 1 $R_{\text{vir}}$     |
| Res.              | 330 kpc to 20 pc       |





# A more massive, less isolated galaxy

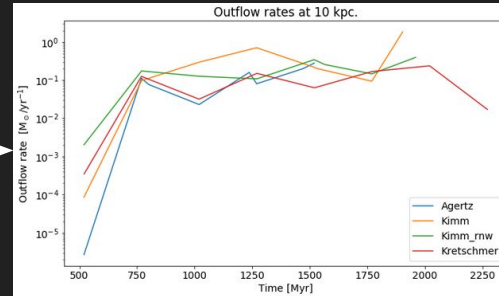
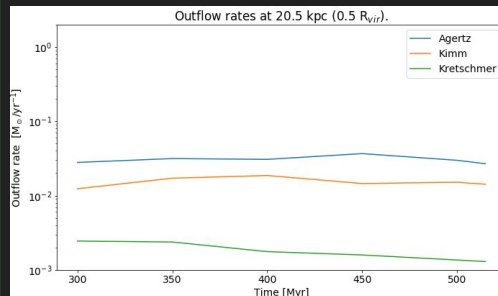
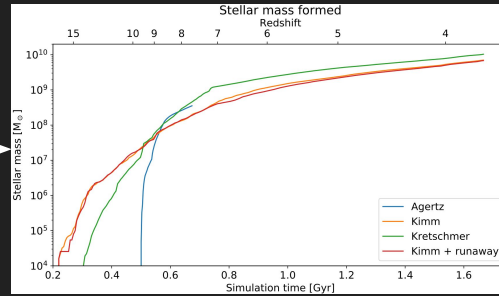
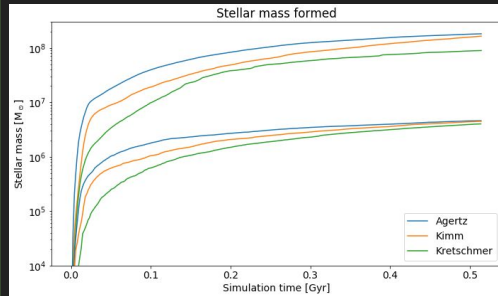


# Summary



Sphinx / ramses\_cral Developer

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G8 & G9

Zoom simulations

