Thermal Instability & Feedback

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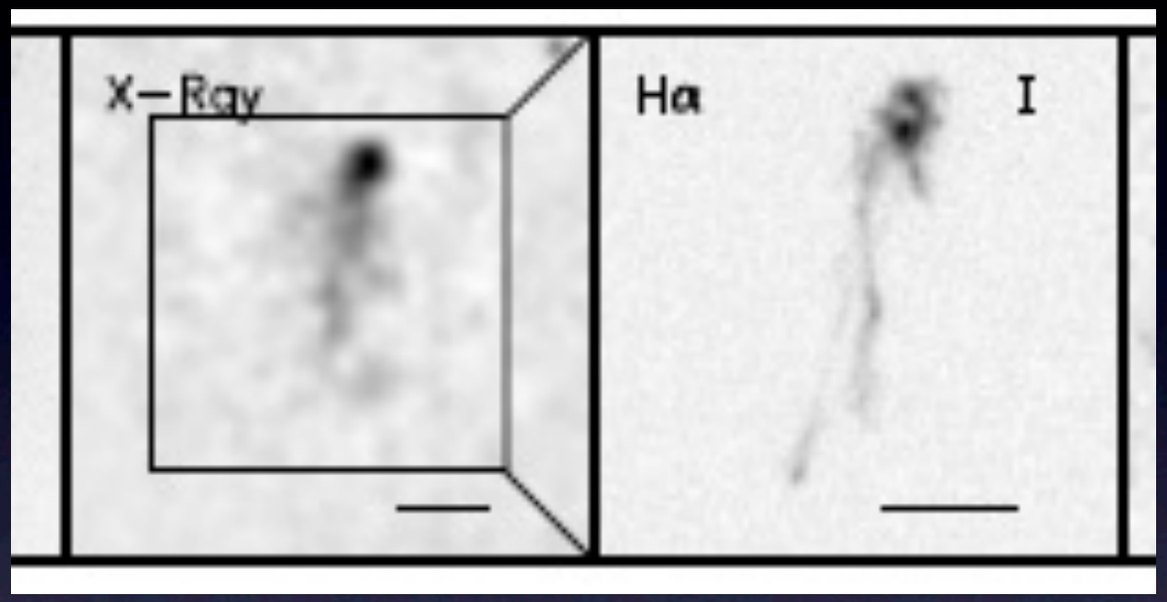
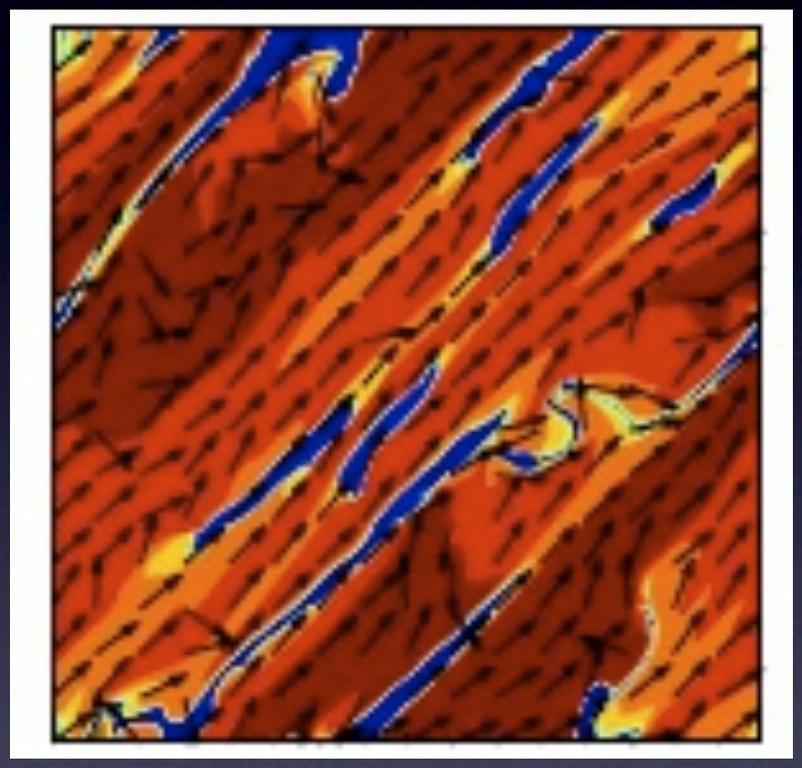
Local TI in ICM

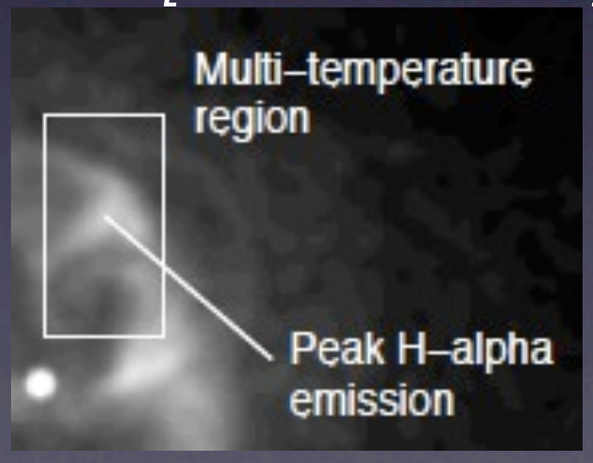
[McDonald et al. 2010]



[Sharma et al. 2010]



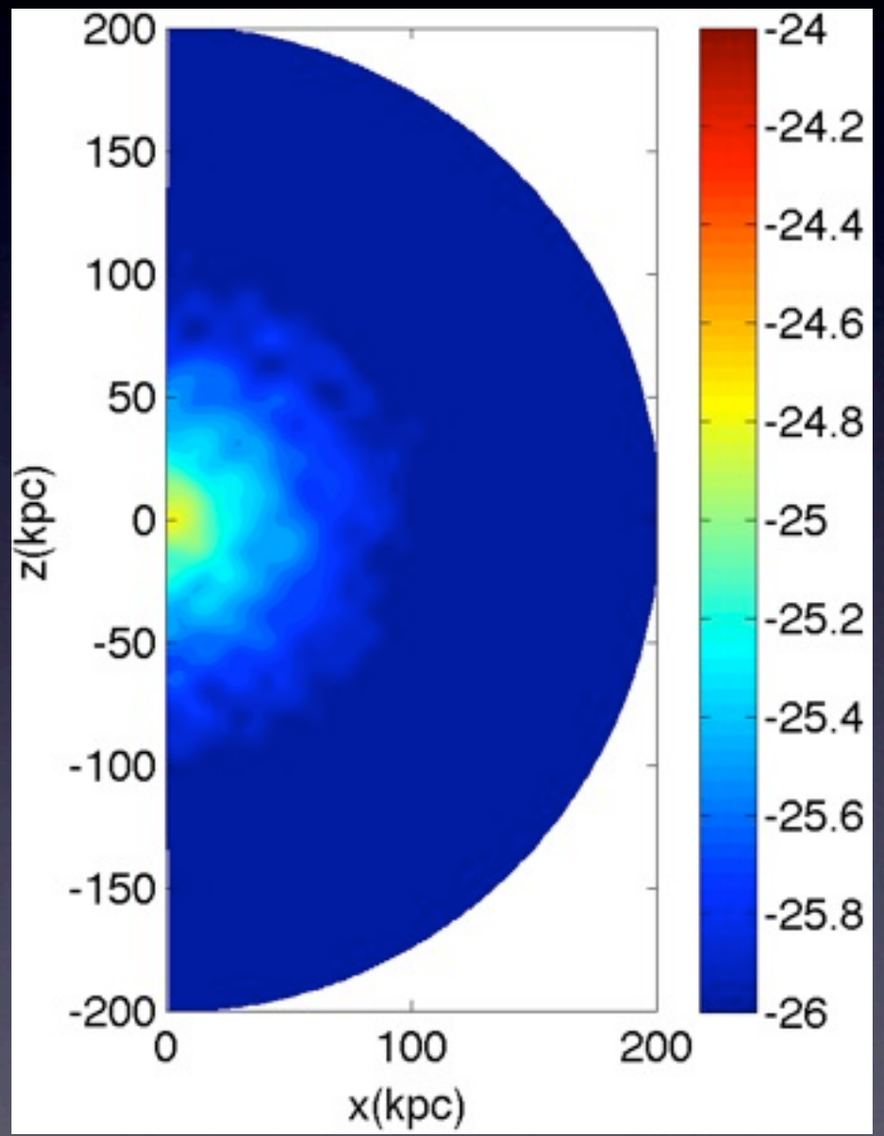
[de Plaa et al. 2010]

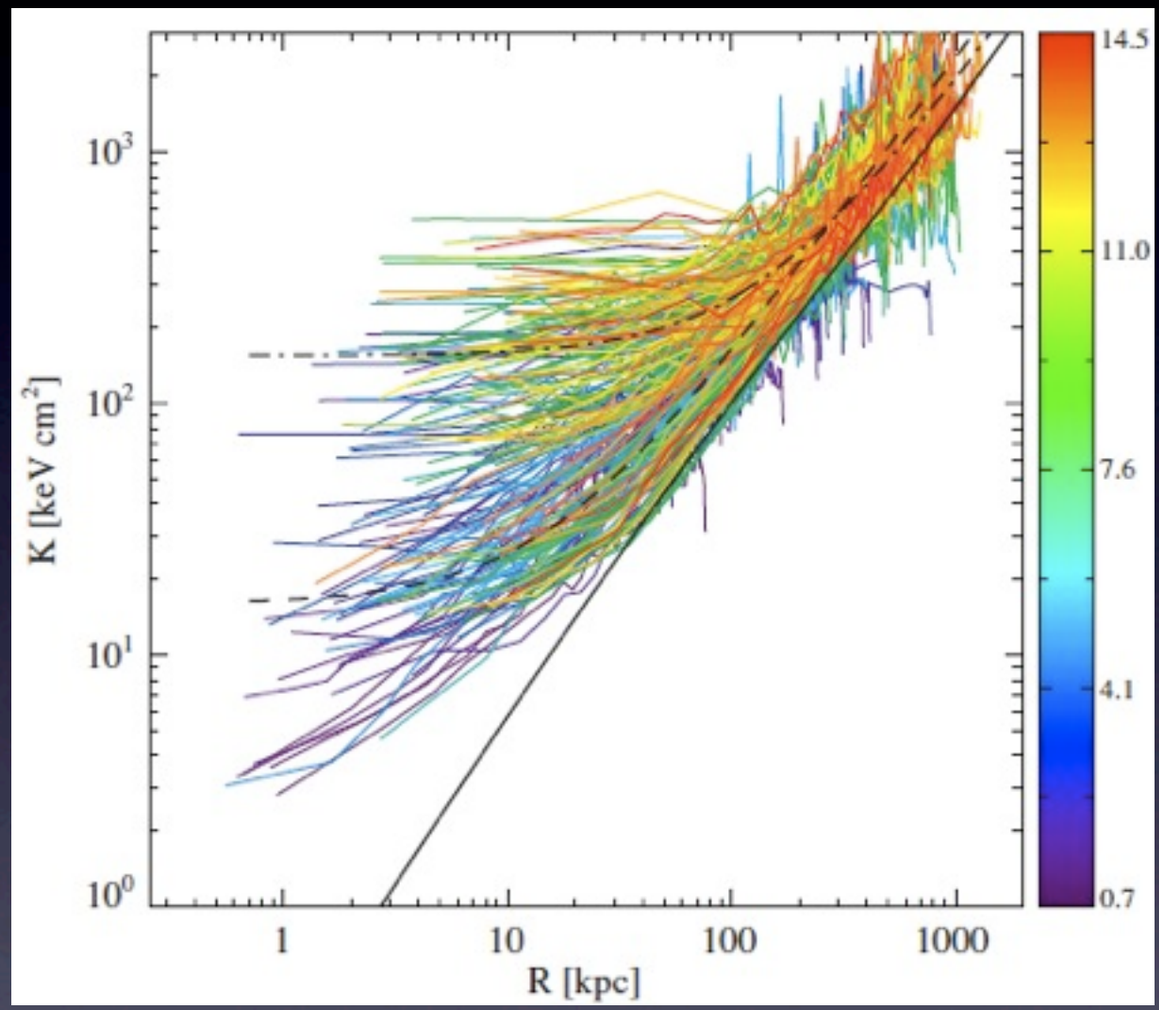


spatially resolved Hα coincident w. soft X-rays

Spherical sims.

Log_{10} density





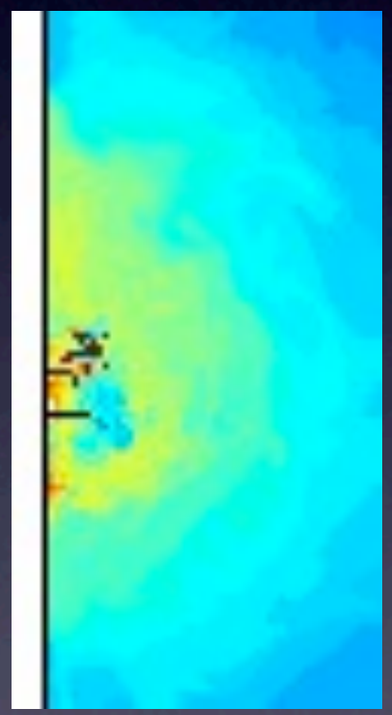
$$K(r) = K_0 + K_{100}(r/r_{100})^{\alpha}$$

$\delta\rho/\rho$~0.1; hydro. eq. in NFW potl.

H~L

$t_{TI}/t_{ff} < 10$ => filaments

multiphase
if local $t_{cool}/t_{ff} < 10$

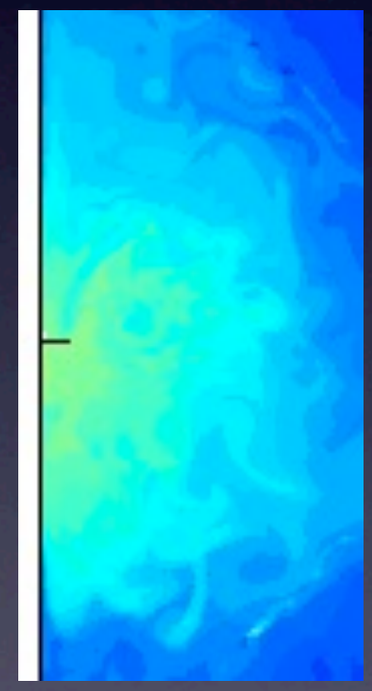


40 kpc

$tTI \approx tcool = 3/2nkT/n^2\Lambda$

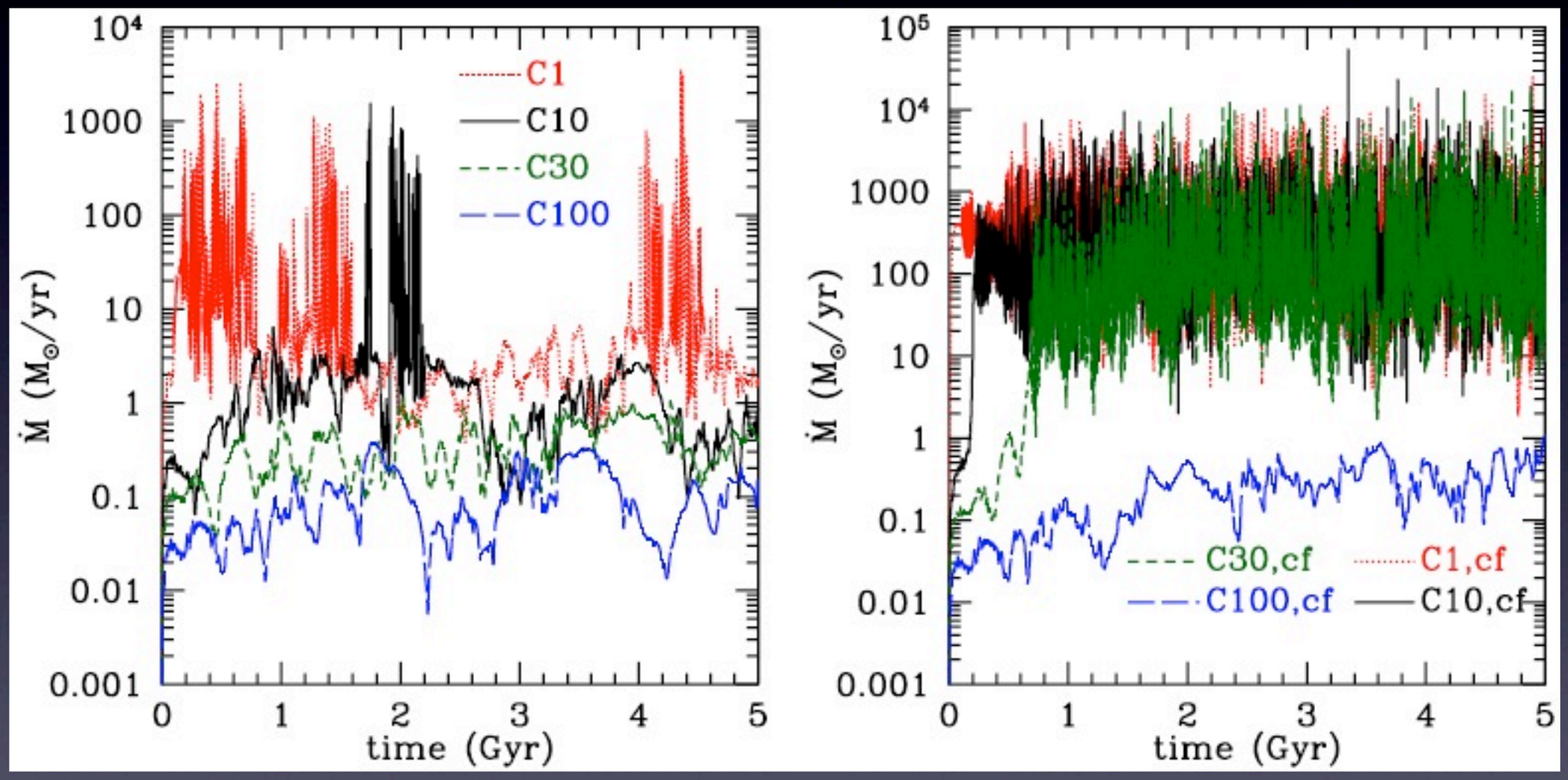
$tff = (2r/g)^{1/2}; g = d\Phi/dr$

only hot phase
if $t_{cool}/t_{ff} > 10$



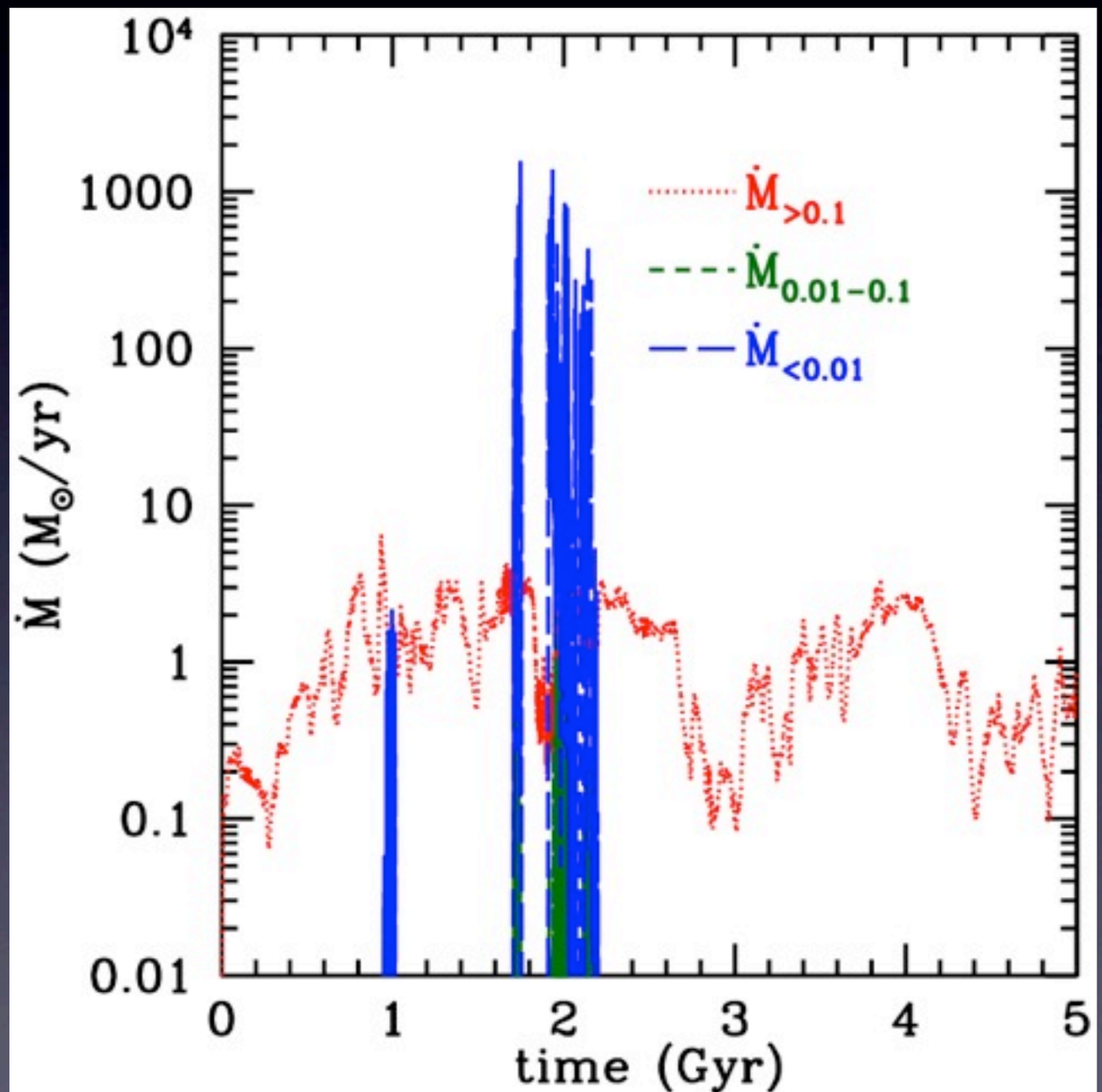
cool filaments when $t_{TI}/t_{ff} < 10$
spherical compression is quantitatively imp.

H=<L> =>small dM/dt as observed!



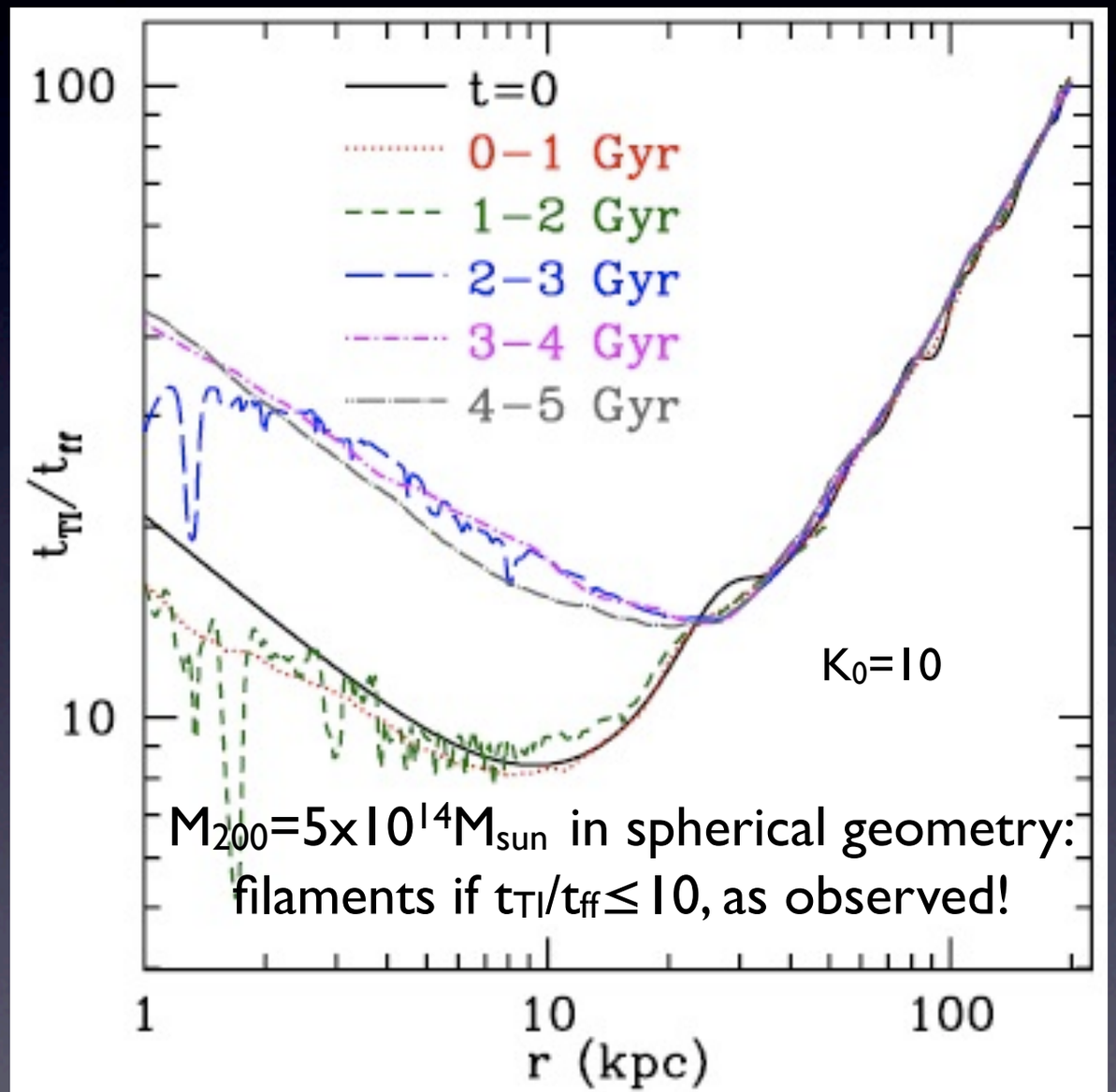
cold filaments drop out, hot phase maintained by H

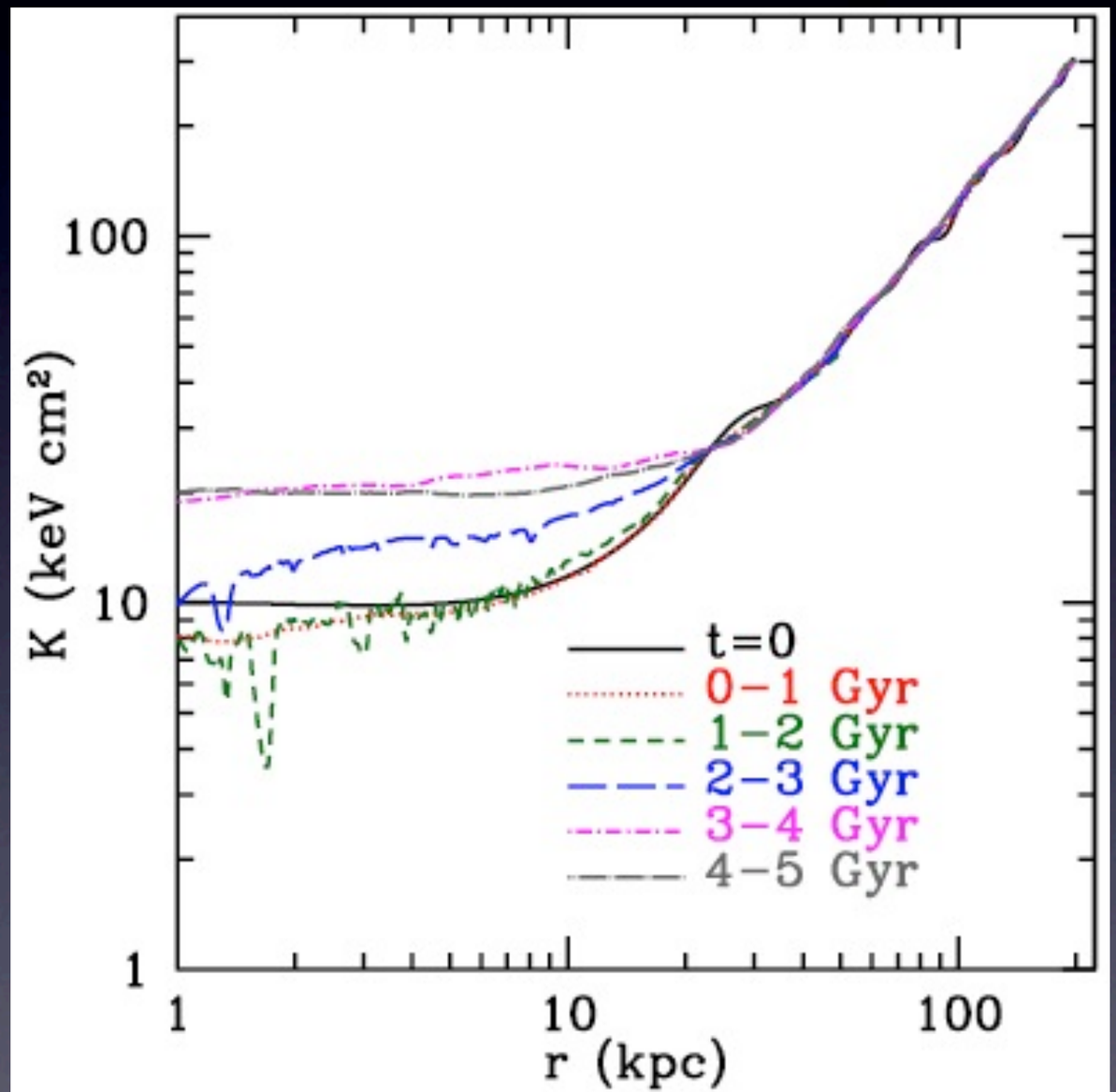
Cold blobs => big dM/dt



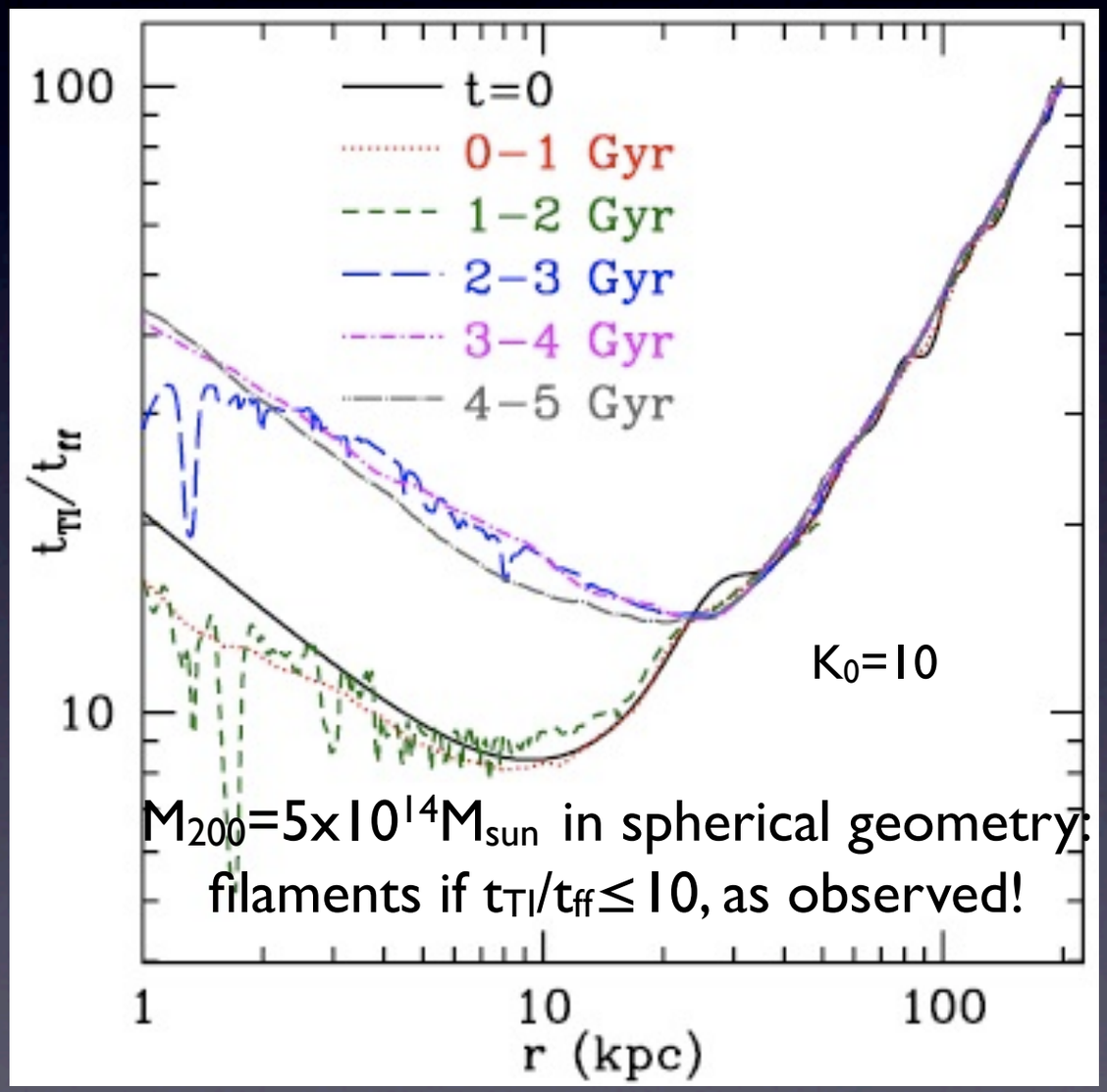
K_0=10 keVcm^2

K & t_{TI}/t_{ff}

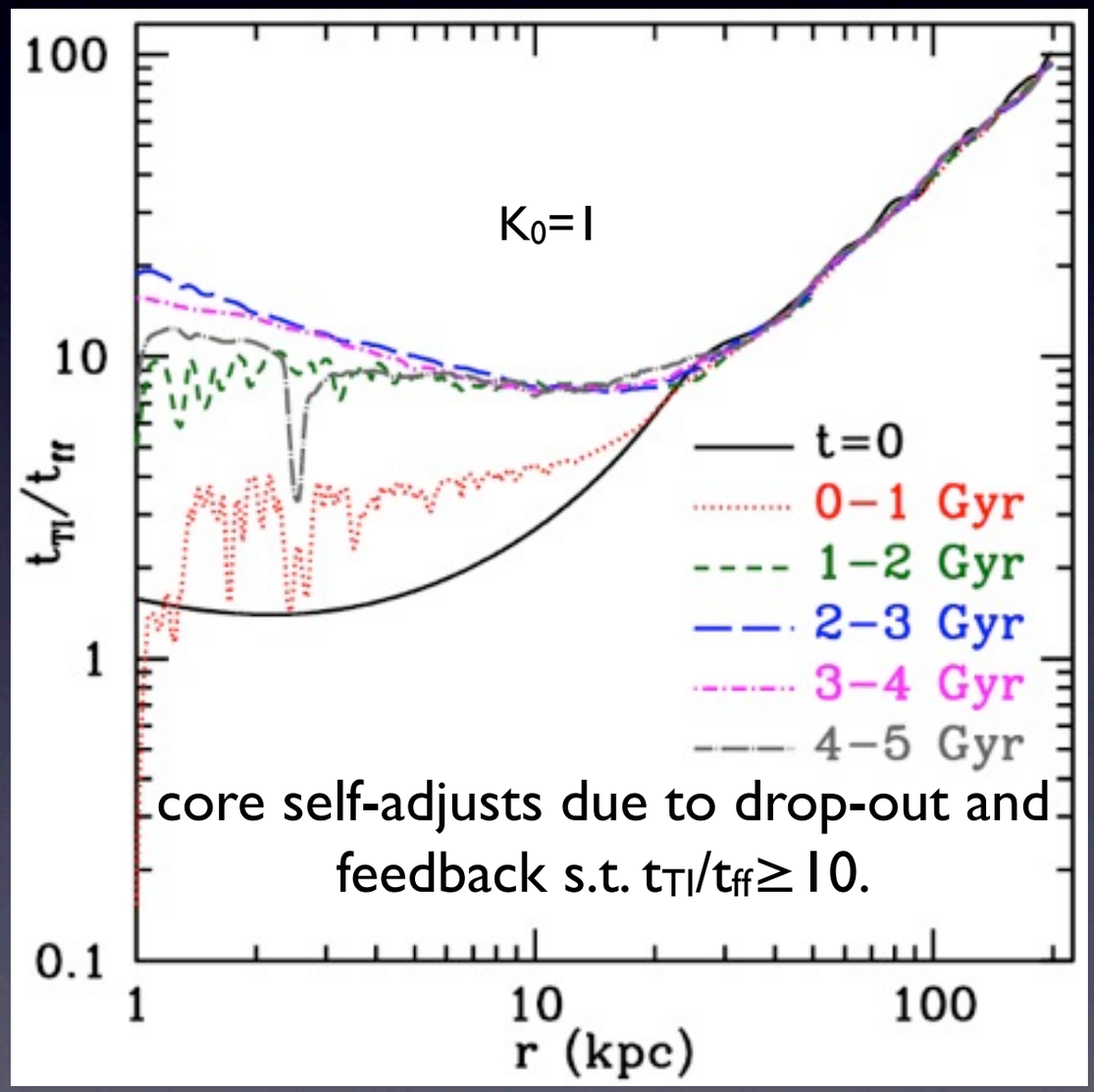

100
10
t=0
0–1 Gyr
1–2 Gyr
2–3 Gyr
3–4 Gyr
4–5 Gyr
t_{TI}/t_{ff}
K_0=10
M_{200}=5x10$^{14}M_{sun}$ in spherical geometry:
filaments if $t_{TI}/t_{ff} \leq 10$, as observed!
1
10
100
r (kpc)


100
10
1
K (keV cm²)
t=0
0–1 Gyr
1–2 Gyr
2–3 Gyr
3–4 Gyr
4–5 Gyr
1
10
100
r (kpc)

Self-regulation of halos



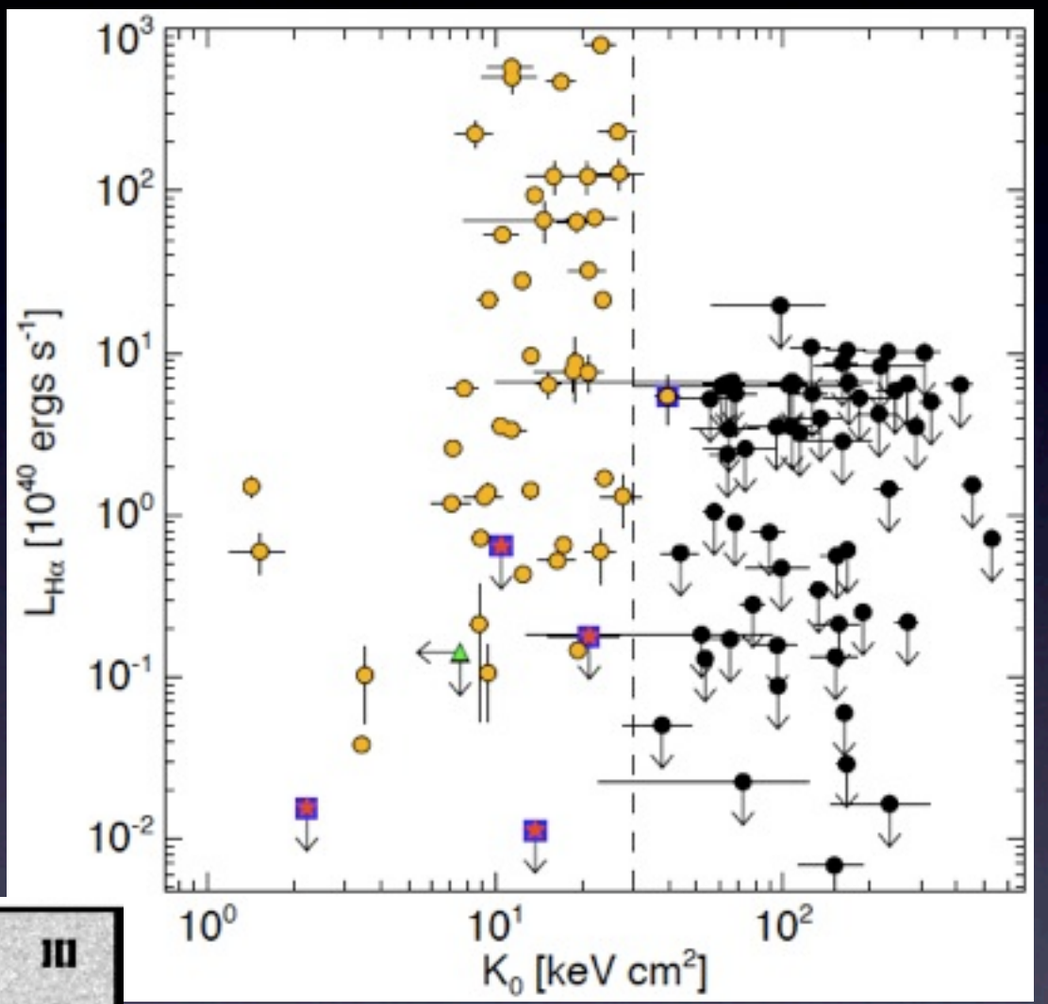
$M_{200}=5x10^{14}M_{sun}$ in spherical geometry: filaments if $t_{TI}/t_{ff} \leq 10$, as observed!



core self-adjusts due to drop-out and feedback s.t. $t_{TI}/t_{ff} \geq 10$.

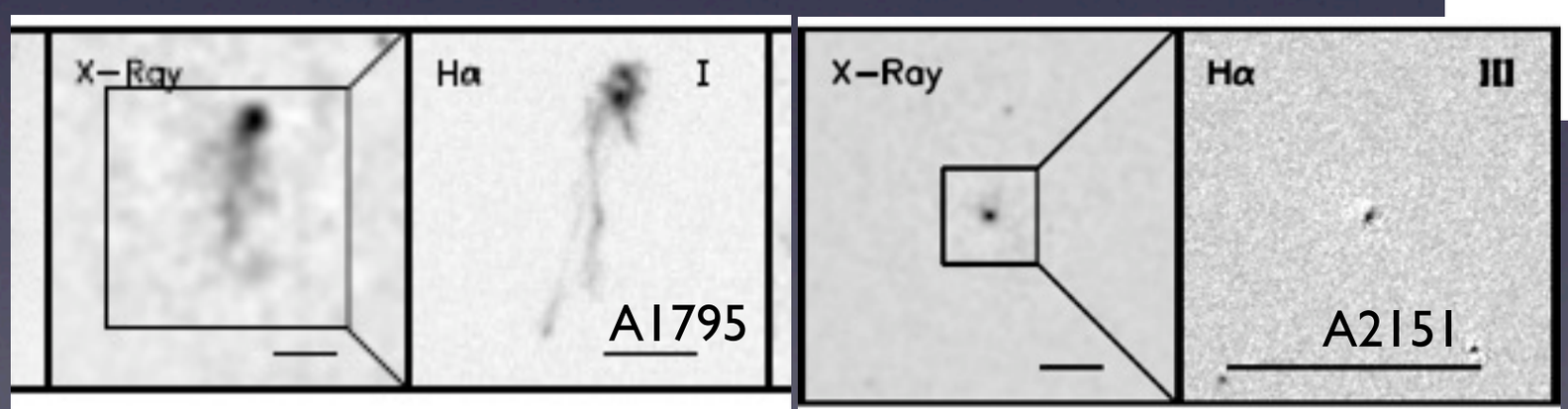
Cool Core vs non-CC

[Cavagnolo et al. 2008]

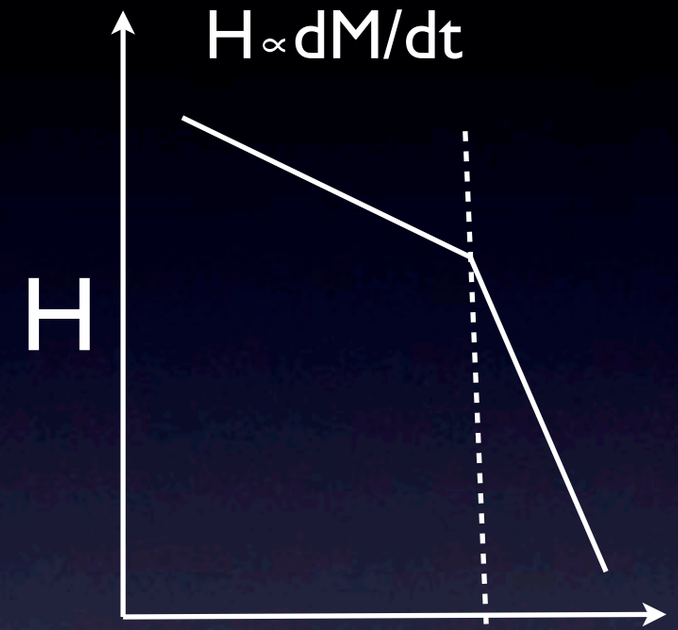


filaments (AGN fb) a fn. of entropy/ cooling time

[McDonald et al. 2010]



Feedback Sims.

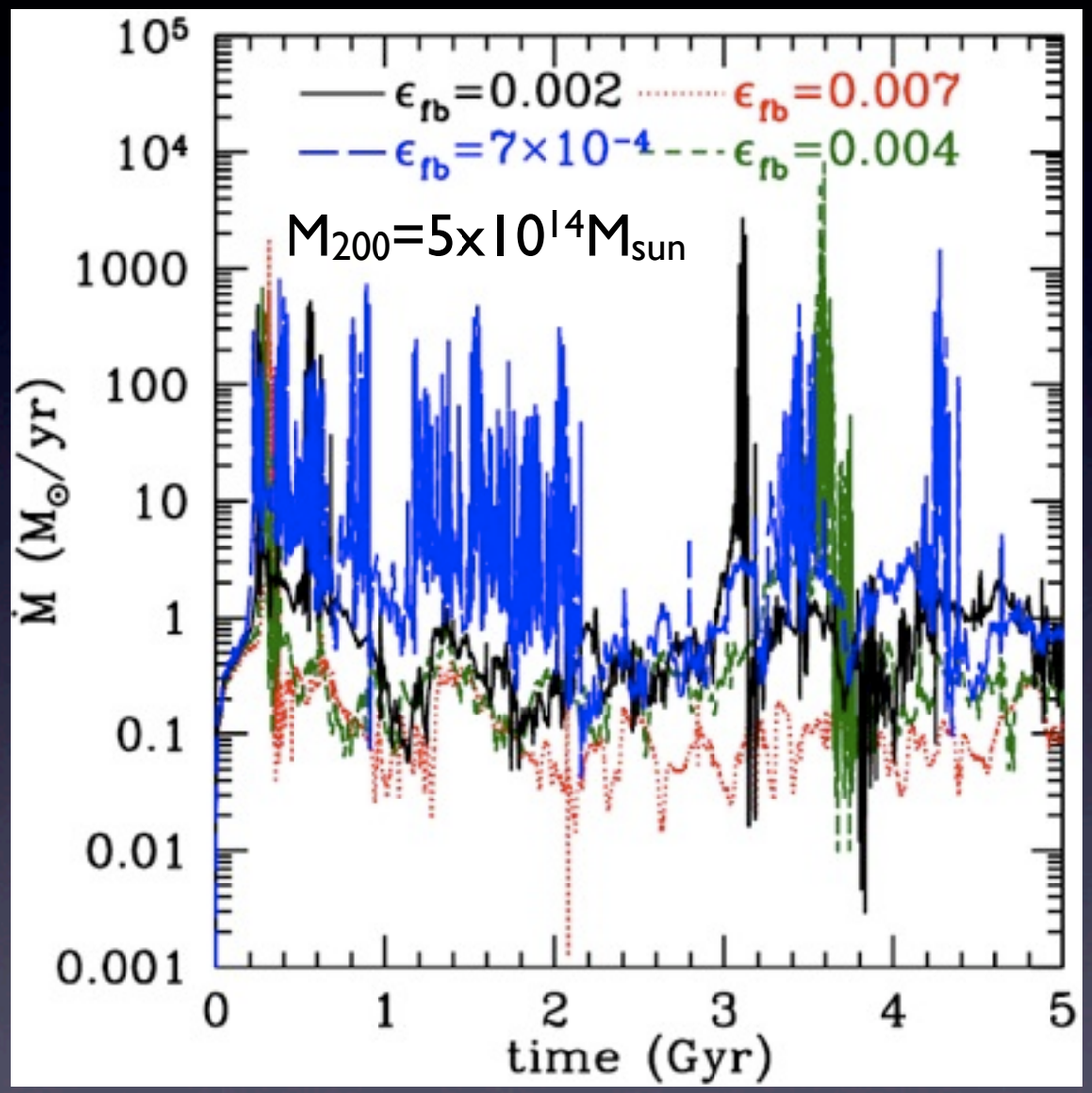


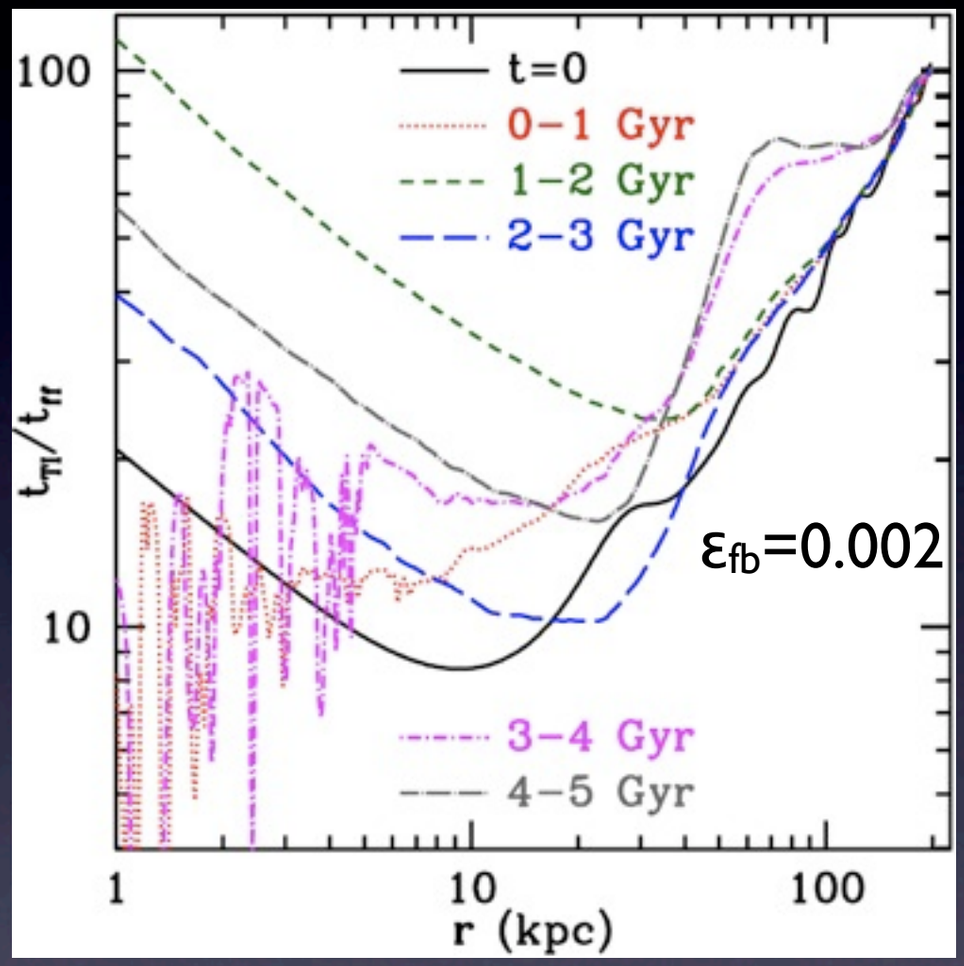
isotropic, $H \propto dM/dt$ at r_{in}

most power deposited at r_{cool}

in reality anisotropic jets!

Feedback Sims.

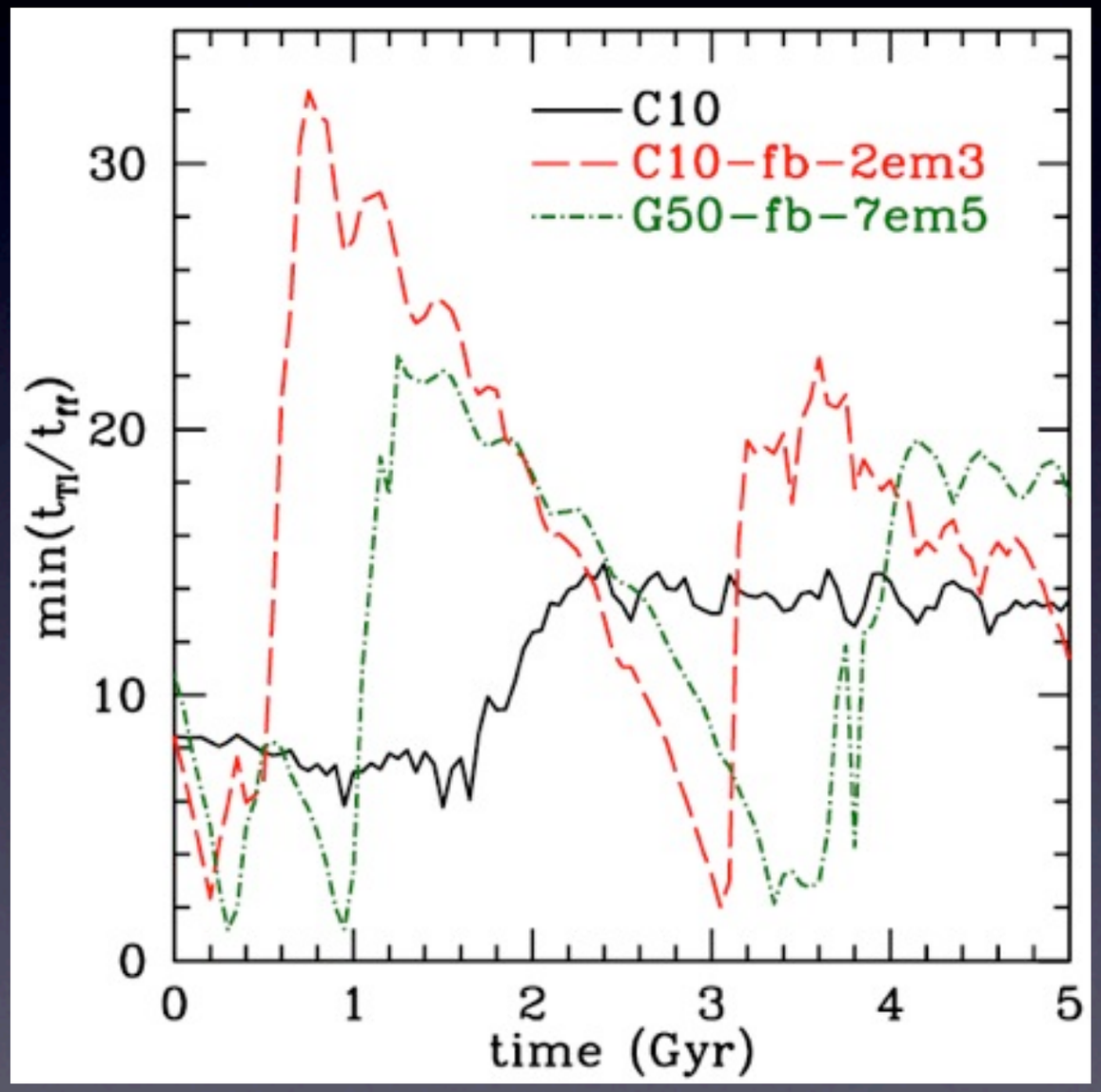




reach a quasi-state where H≈L
TI => filaments whenever t_{TI}/t_{ff}<10

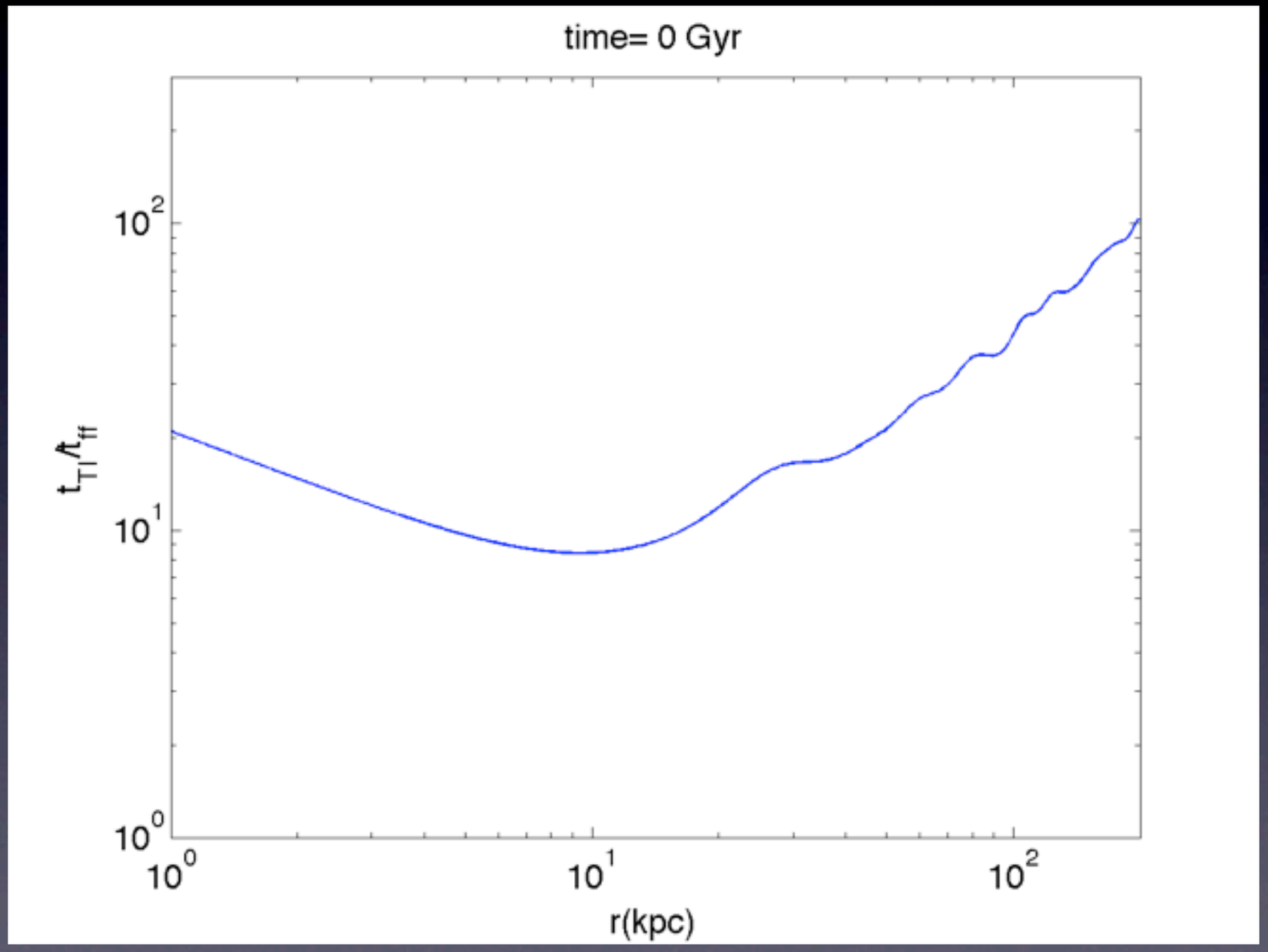
smaller ε required for lower mass halos bec. dM/dt similar in cold phase but M_g much smaller in lower mass halos

FB vs. idealized H



larger thermal imbalance w. FB

FB model self reg.



Conclusions

- H=<L> ansatz gives similar results as FB models, i.e., cool fils. when $t_{TI}/t_{ff}<10$
- very different from a cooling flow; dM/dt ~ few Msun/yr
- peaks in dM/dt due to cool filaments
- self-adjustment of halos s.t. $t_{TI}/t_{ff}\geq 10$
- smaller FB eff. for groups than clusters