CONNECTING THE HOT GAS HALO AND HIGH VELOCITY CLOUDS WITH GALAXY FORMATION

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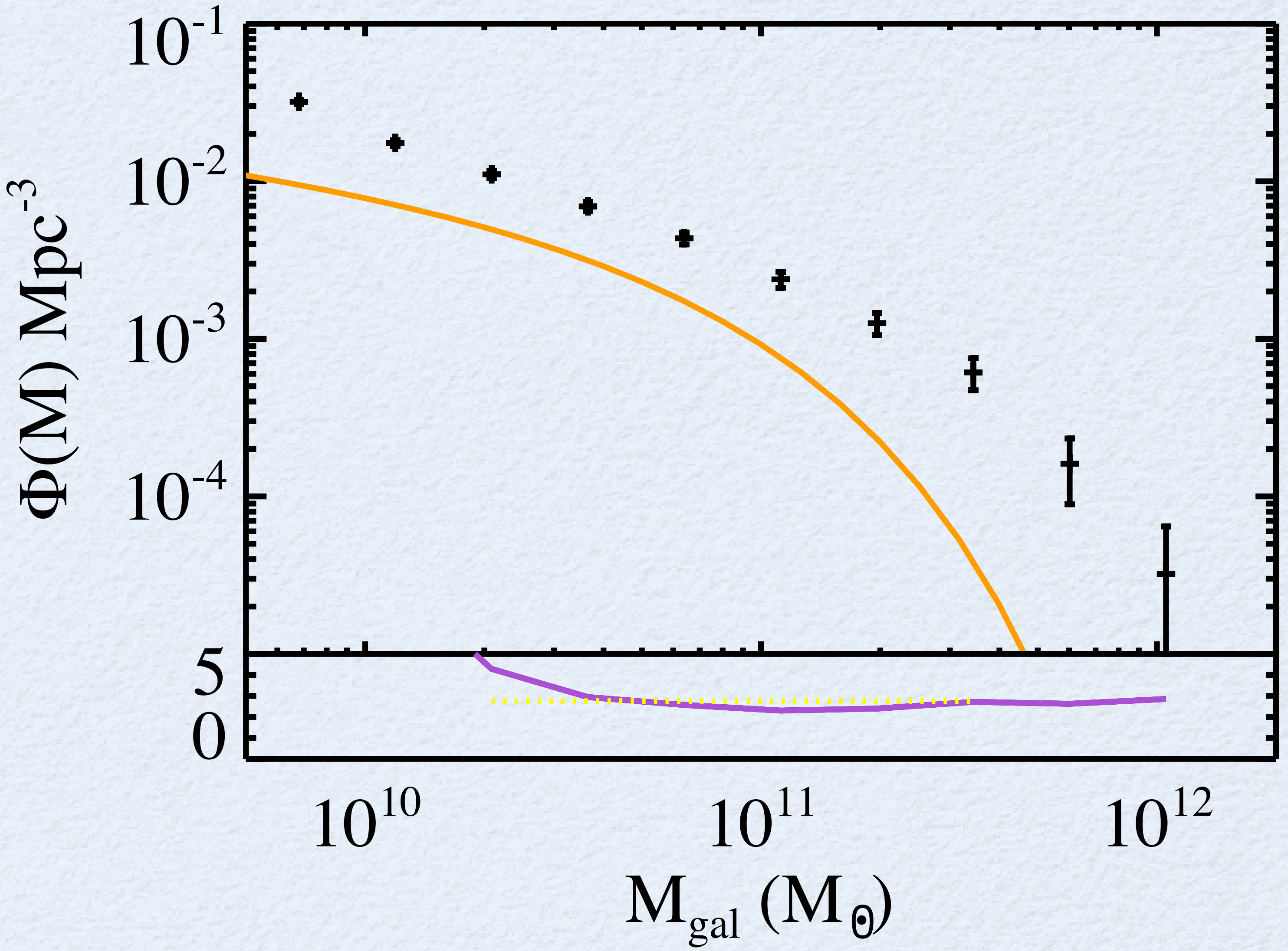
Problems in Galaxy Formation

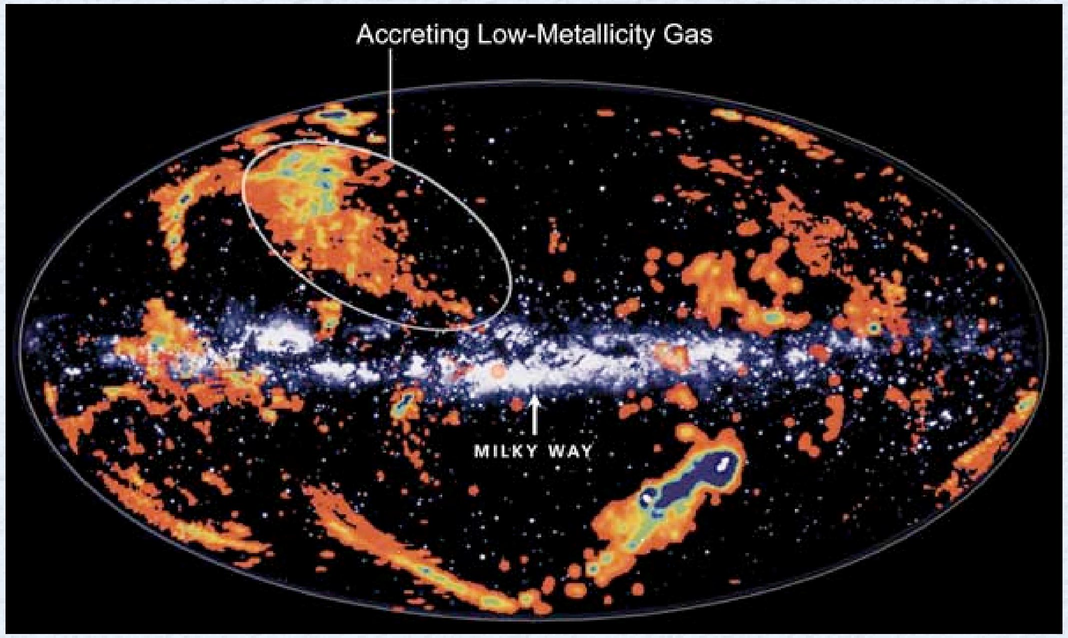
- Cooling of gas in dark matter halos produces galaxies much more massive then observed.
- People have resorted to various forms of 'feedback' (supernova, AGN, preheating, multiphase cooling, etc.) to prevent this 'over-cooling'.



The observed stellar mass function (orange) taken from Bell et al. 2003, compared to the stellar mass function (black) seen in hydrodynamical simulations. The bottom panel shows the ratio of the two. Taken from Maller et al. 2006.

Halo Gas Directly Probes Gas Cooling and Heating

- Gas that does not cool into a galaxy must remain in the halo, or be ejected into the intergalactic medium.
- This gas can therefore be observed as x-ray halos, high velocity clouds and quasar absorption systems.
- Thus observations of halo gas can tell us about cooling and any possible heating that influences galaxy formation.



Simulations of Single Galaxy Cooling

- Maller and Bullock (2004) suggested that multi-phase cooling would create a cored hot gas halo that contains most of the baryons in a Milky Way size halo.

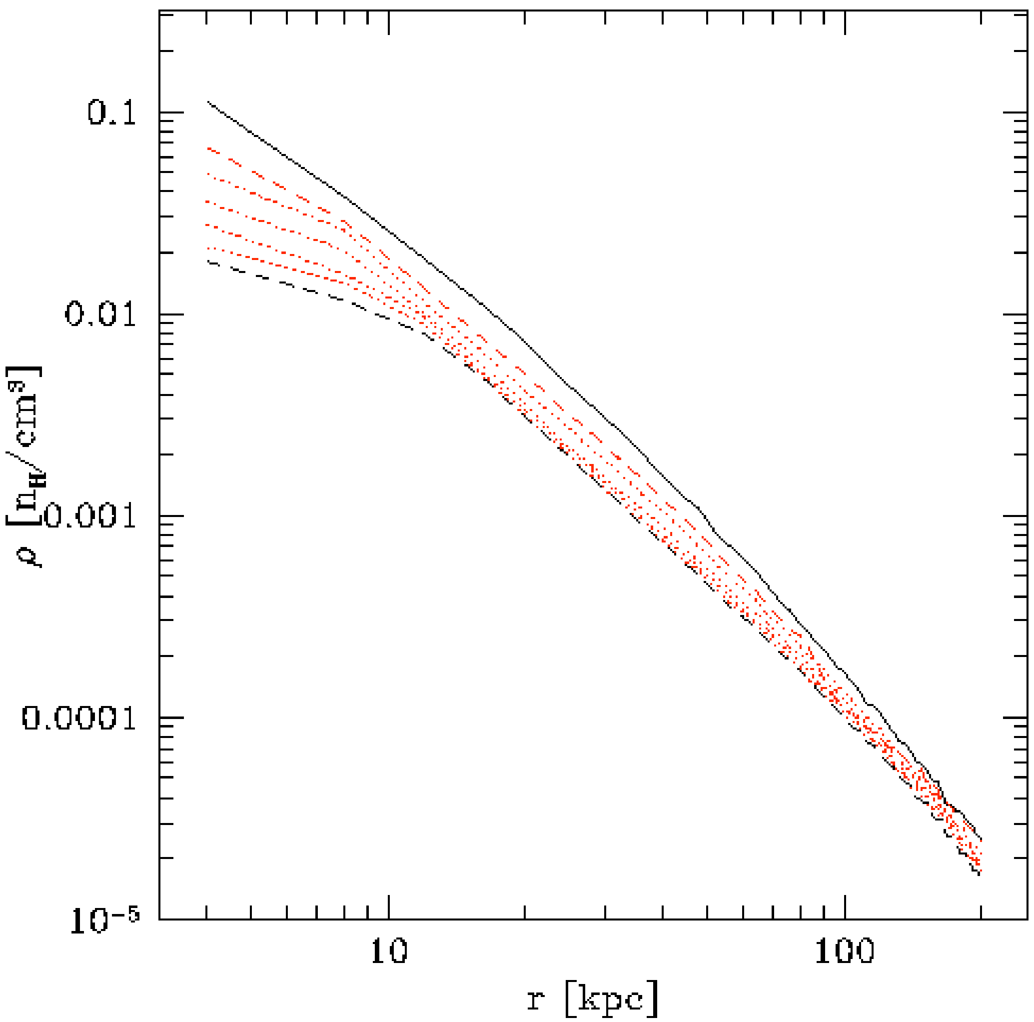
- We explore the evolution of such a hot gas halo compared to a hot gas halo that has a profile like the dark matter. Each simulation starts with the cosmological baryon fraction in hot gas and is run for 10 Gyr.

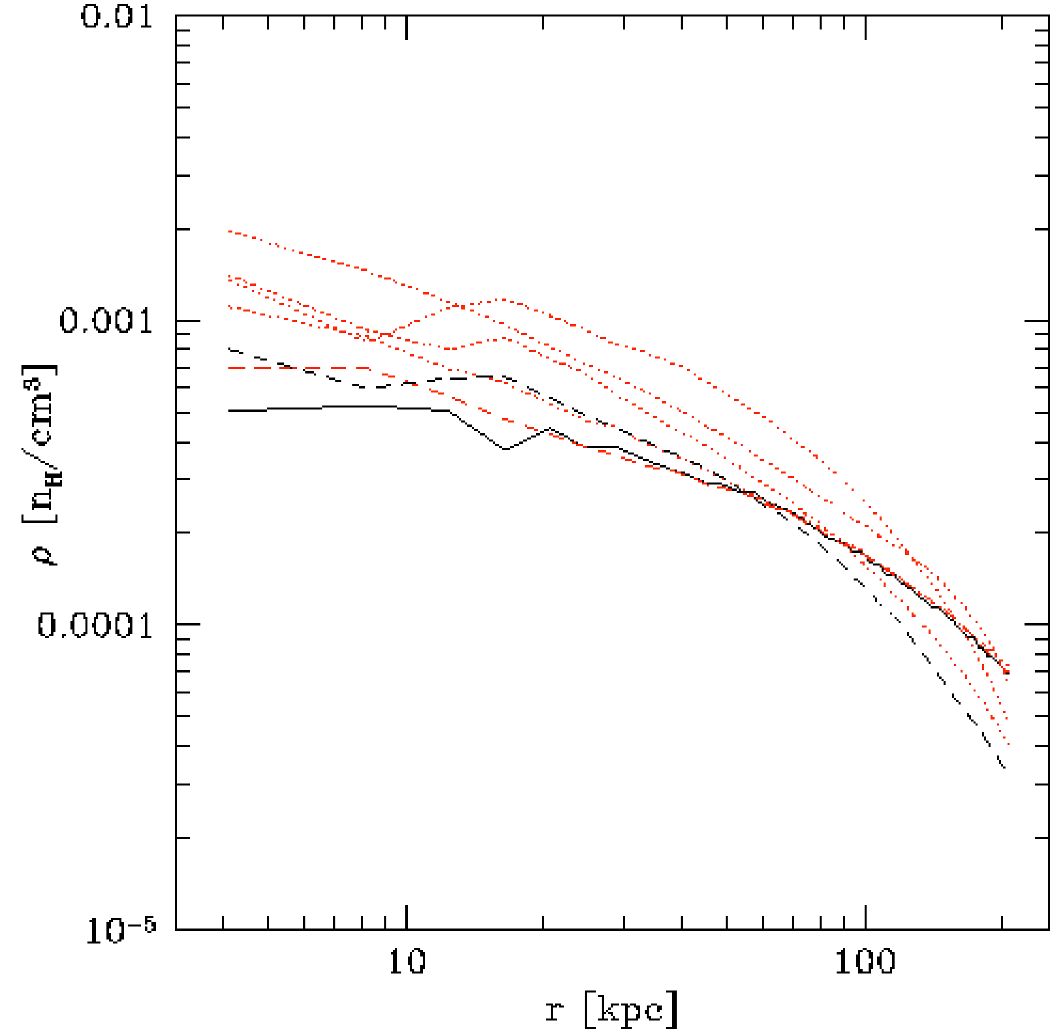
- The NFW hot gas halo has a central density of 0.1 n_H / cm^3.

- The cored hot gas halo starts with a central density of 0.0005 n_H / cm^3.

- After 10 Gyr, the cored profile produces a galaxy with half the mass of the NFW hot gas profile, without any further feedback.

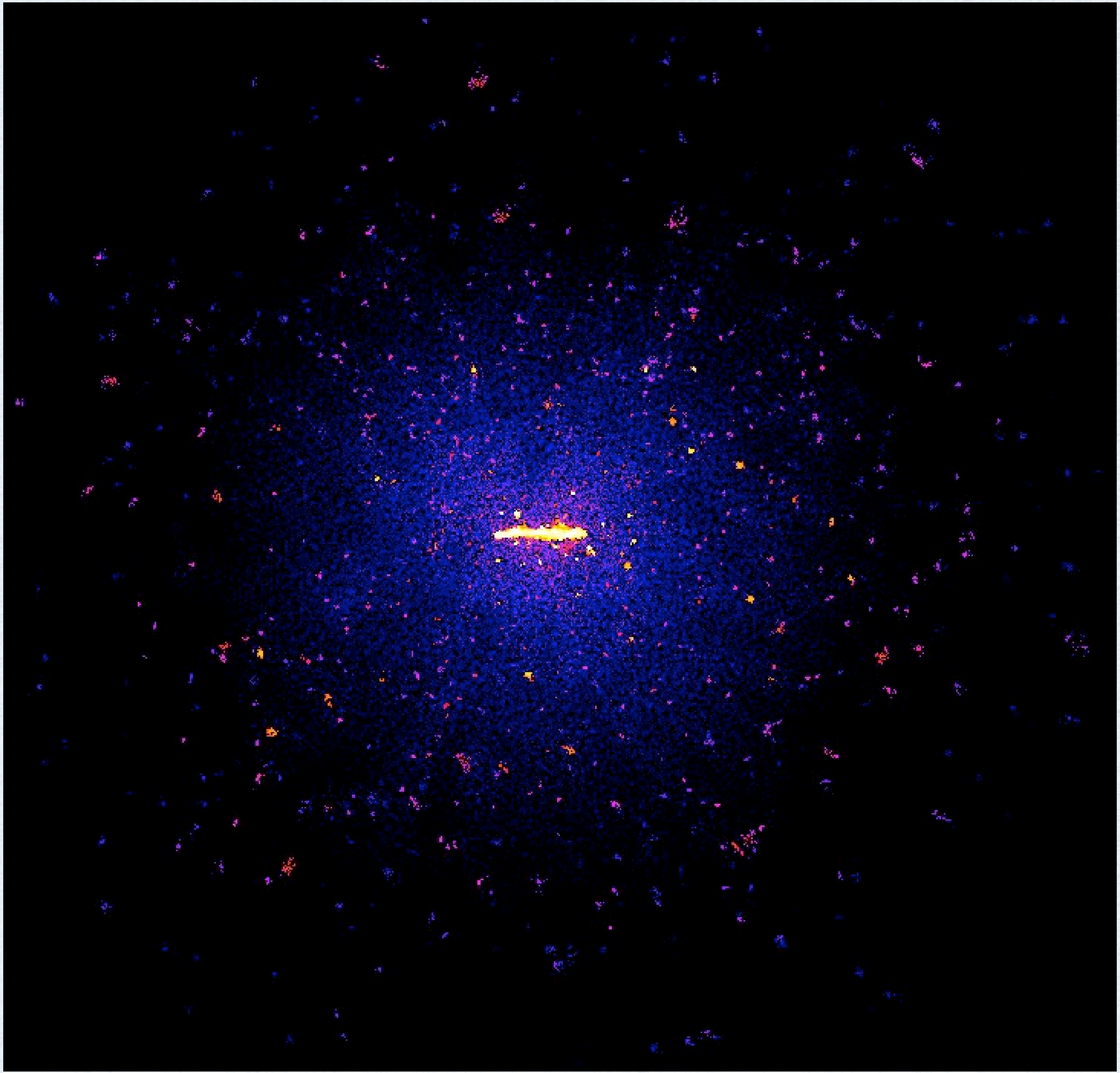
Comparison of hot gas profiles



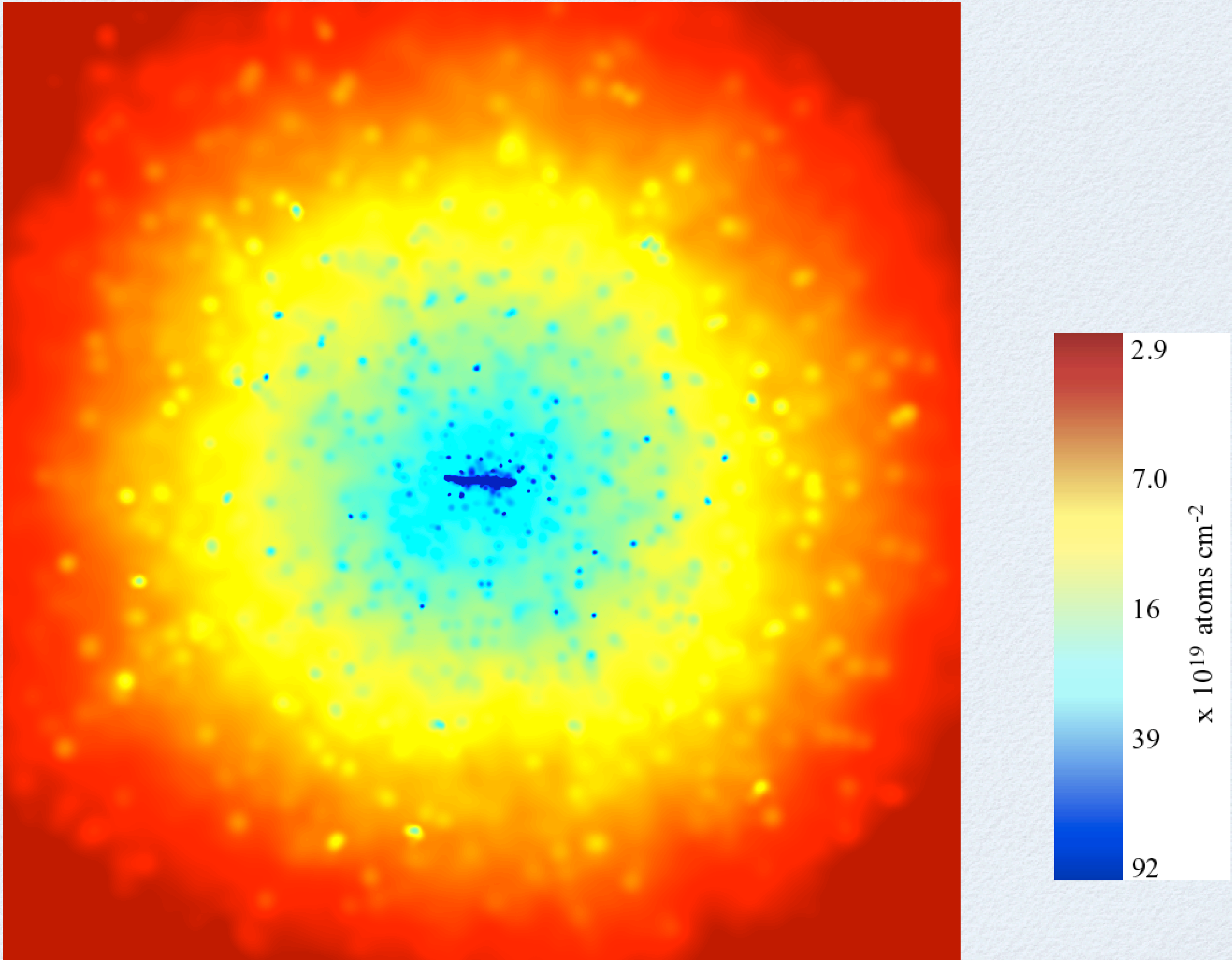


Evolution of a NFW (left) and cored (right) hot gas halos over 10 Gyr. The central density in the NFW case decreases by a factor of 10 forming a massive central galaxy. For the cored gas the central density oscillates around its starting value creating a galaxy like those observed.

Cooling gas in the halo produces many hundreds of warm clouds that would be identified as high velocity clouds.



The hot gas halo can be probed with x-ray emission and x-ray absorption to constrain possible models



Conclusions

- The number and distribution of high velocity clouds can be used to study gas cooling in dark matter halos (e.g. Peek et al. 2007).
- The density distribution of hot gas determines the rate at which gas cools in a dark matter halo.
- Observations of high velocity clouds and hot gas in galactic halos, are our best approach to understanding the physics of galaxy formation.