How much of their stellar mass have group galaxies lost to the ICL ?

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Introduction

What happens to the stellar mass of satellite galaxies once they entered their groups?

Do they keep accreting mass and forming stars ?

Is star formation quenched ? (ram pressure, group winds, tidal stripping, …)

To what extend are stars stripped from galaxies ?

Arp 188 and the Tadpole's Tail Credits : Hubble Legacy Archive, ESA, NASA

Introduction

How can we estimate the evolution of stellar mass of satellite galaxies ?

Galaxy Cluster Abell S1063 and Beyond Credits : NASA, ESA, Jennifer Lotz (STScI)

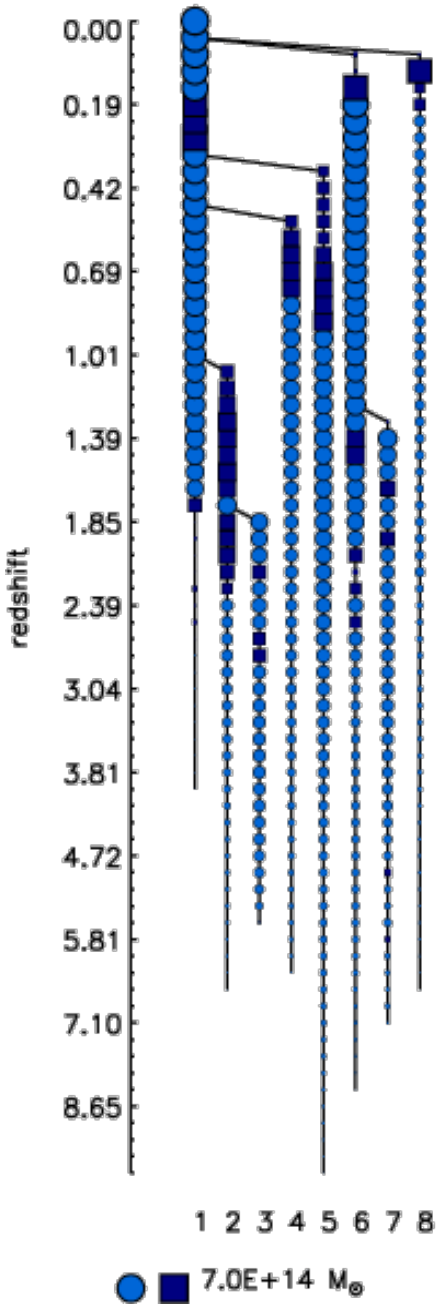
With direct observations the intracluster light (ICL) is difficult to measure.

Hydro simulations strongly depend on feedback implementation (SN & AGN).

SAMs depend on recipes for star formation, feedback, ram pressure, tidal stripping, ...

We use abundance matching.

Sarting point : an N-body simulation



Simulation of 1024^3 DM particules in a 100 Mpc^3 box.

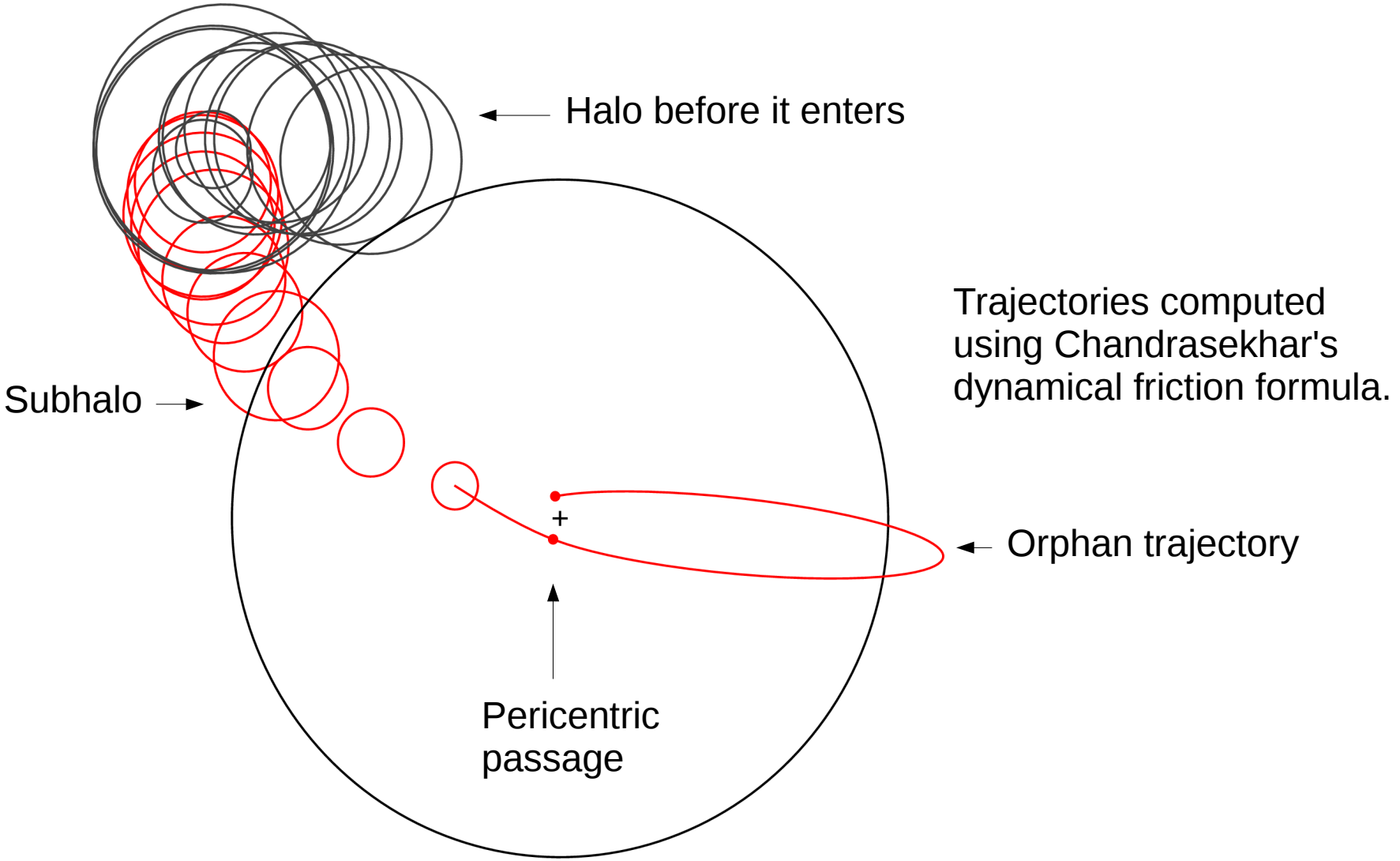
Method limited by the resolution.

We miss many haloes and subhaloes below $10^{9.5}$ M_{sol}
Haloes may overmerge and small satellites are under-represented.

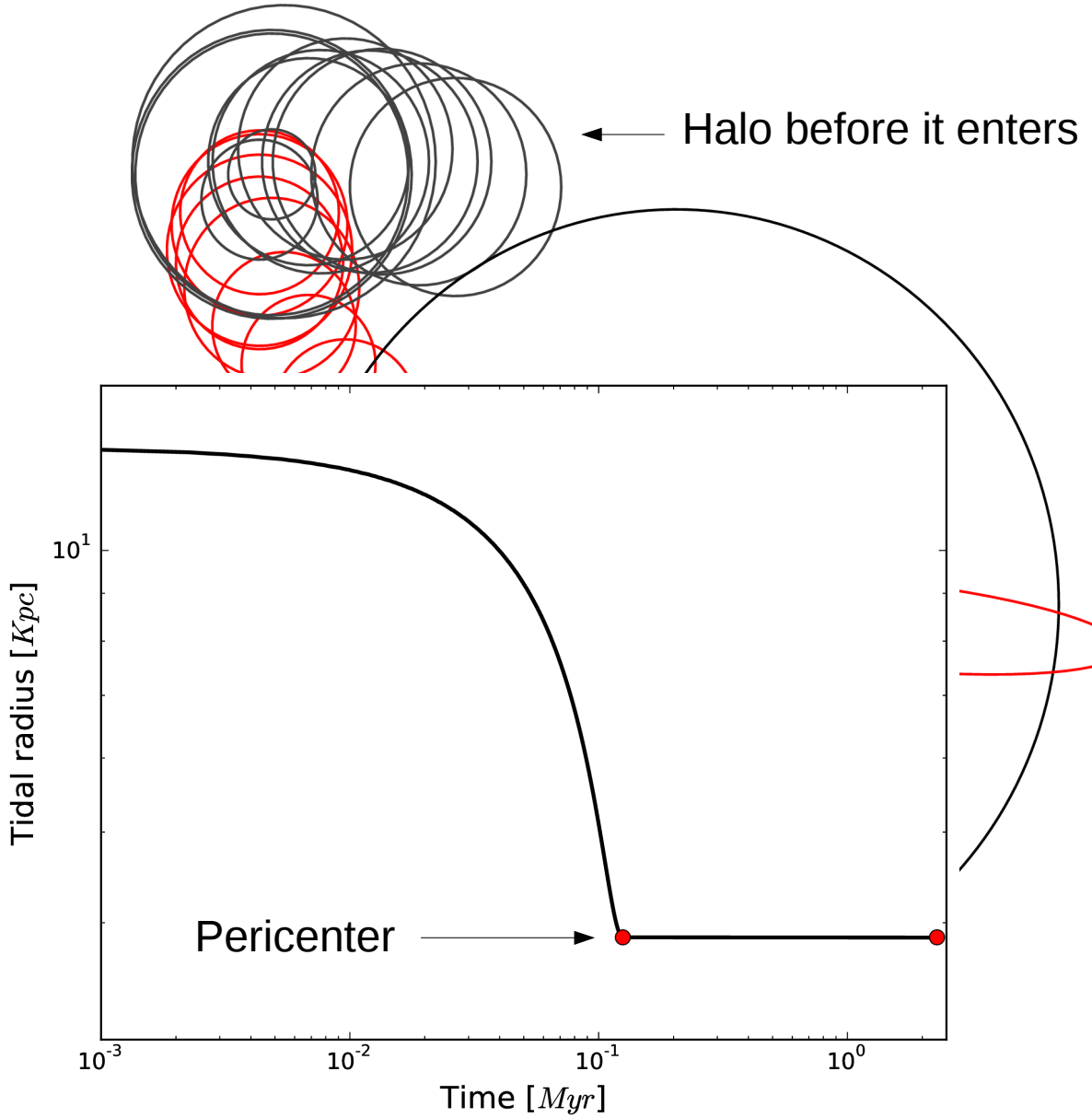
Need to handle orphan galaxies, i.e., those that have lost their subhalo.

Figure credits : Building merger trees from cosmological N-body simulations
D. Tweed - J. Devriendt - J. Blaizot - S. Colombi - A. Slyz

Orphan treatment : trajectory



Orphan treatment : mass loss

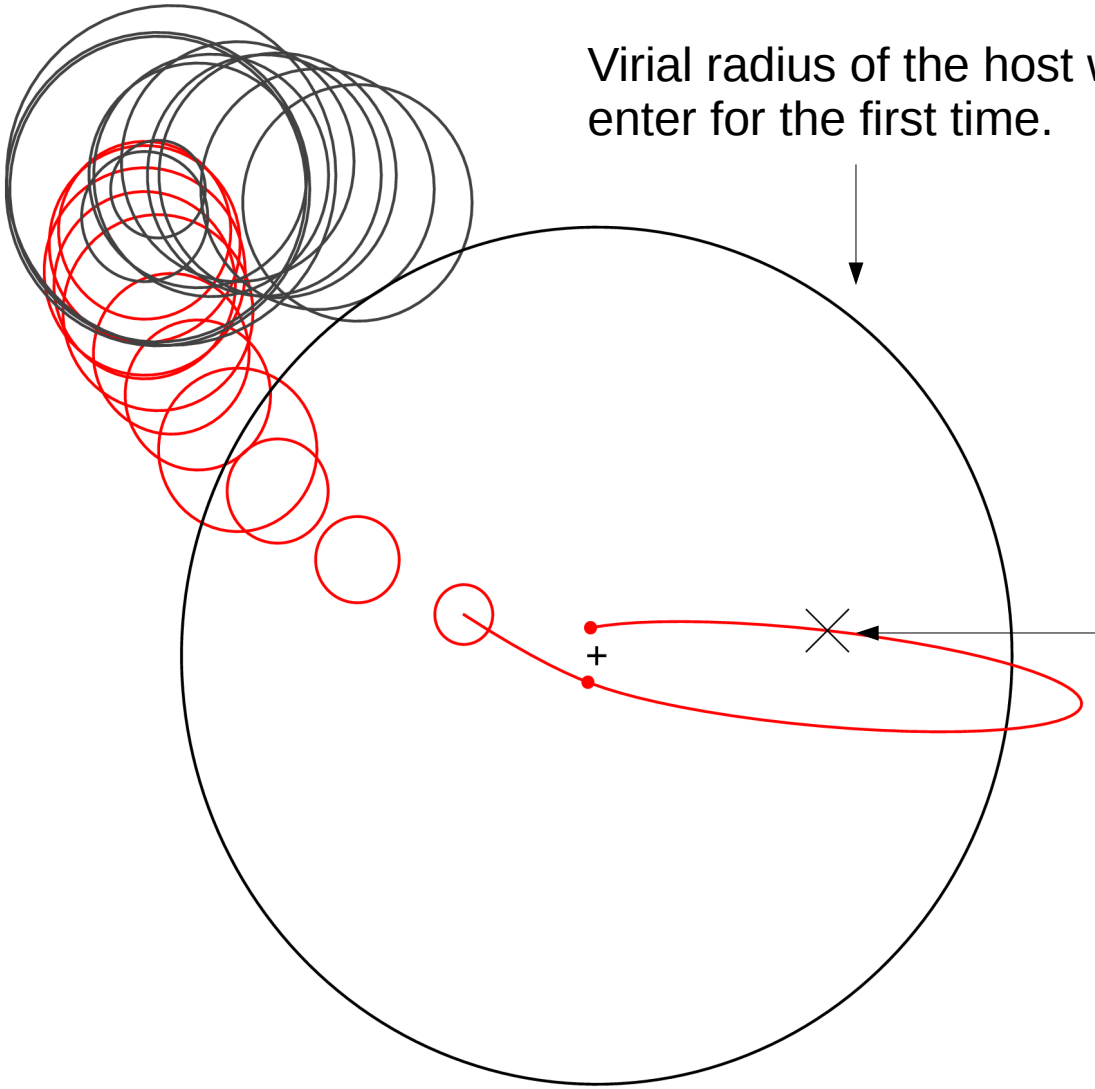


Trajectories computed using Chandrasekhar's dynamical friction formula.

Orphan trajectory

Mass is stripped outside of tidal radius calculated with an instantaneous formula.

Orphan treatment : survival time



Virial radius of the host when the satellite enter for the first time.

$$t_{df} = A \frac{M_{vir}/m}{\log\left(1+M_{vir}/m\right)} \frac{r_{vir}}{v_{vir}}$$

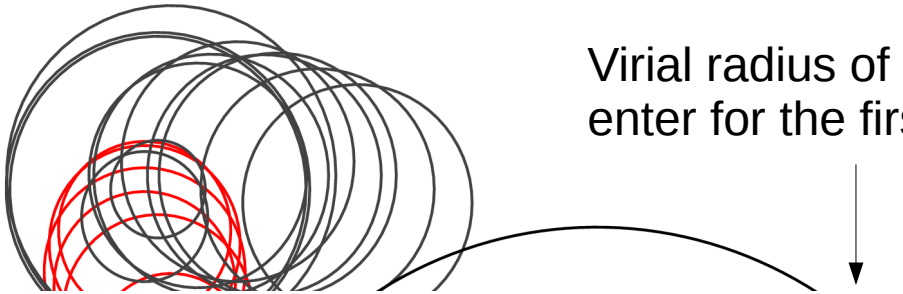
$$A = 1.17\left(0.94\,\varepsilon^{0.6}+0.6\right)$$

Jiang et al. 2008

Dynamical friction time (t_{df}) is over.

Orphans survive until the pericentric passage corresponding to a lifetime as close as possible to t_{df}.

Orphan treatment : survival time



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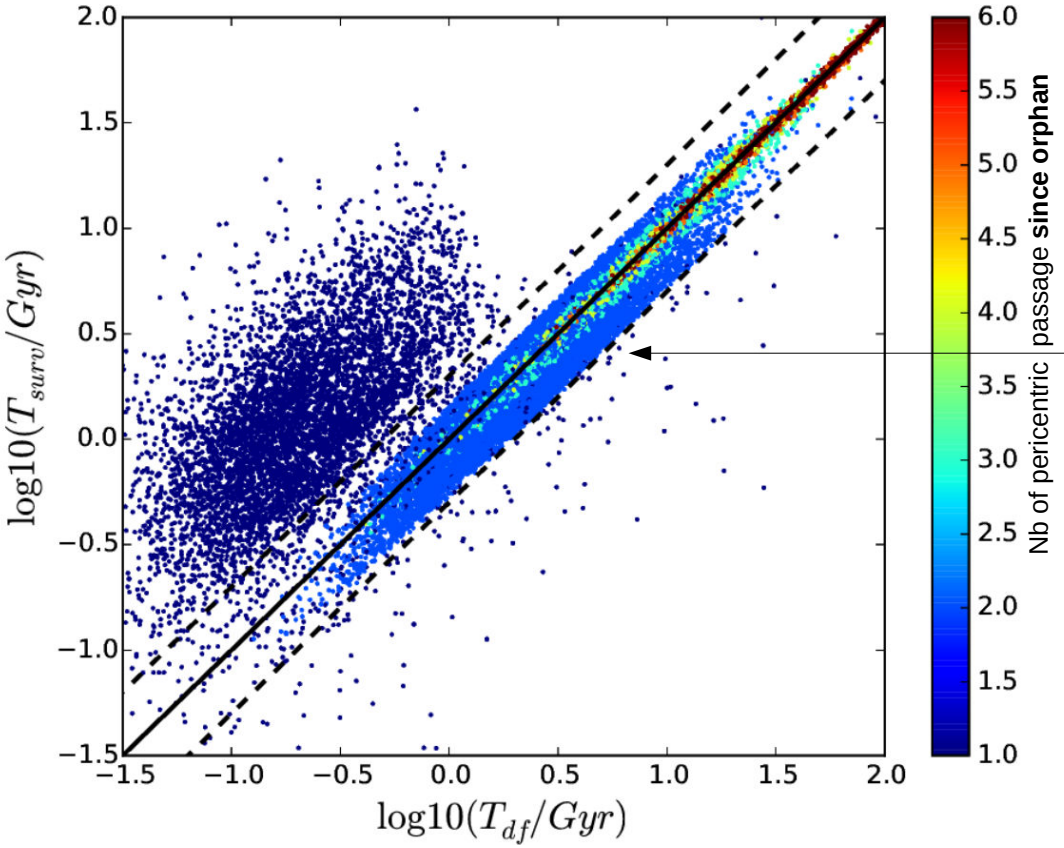


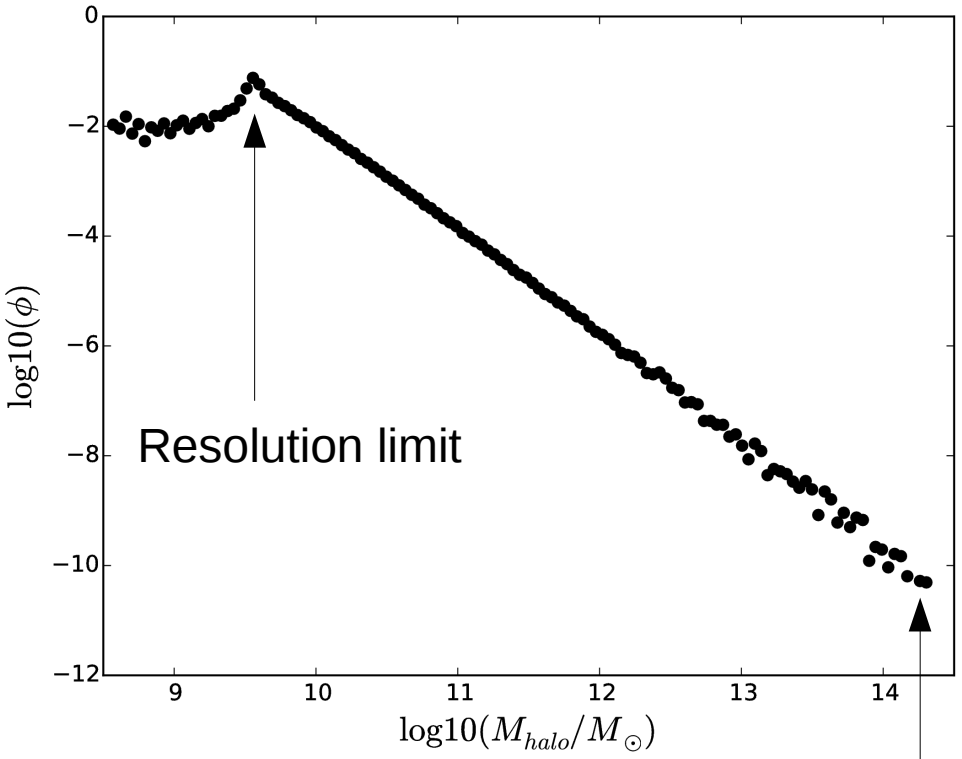
For 73% of the orphans both times correlate very well.

Orphans survive until the pericentric passage corresponding to a lifetime as close as possible to t_{df}.

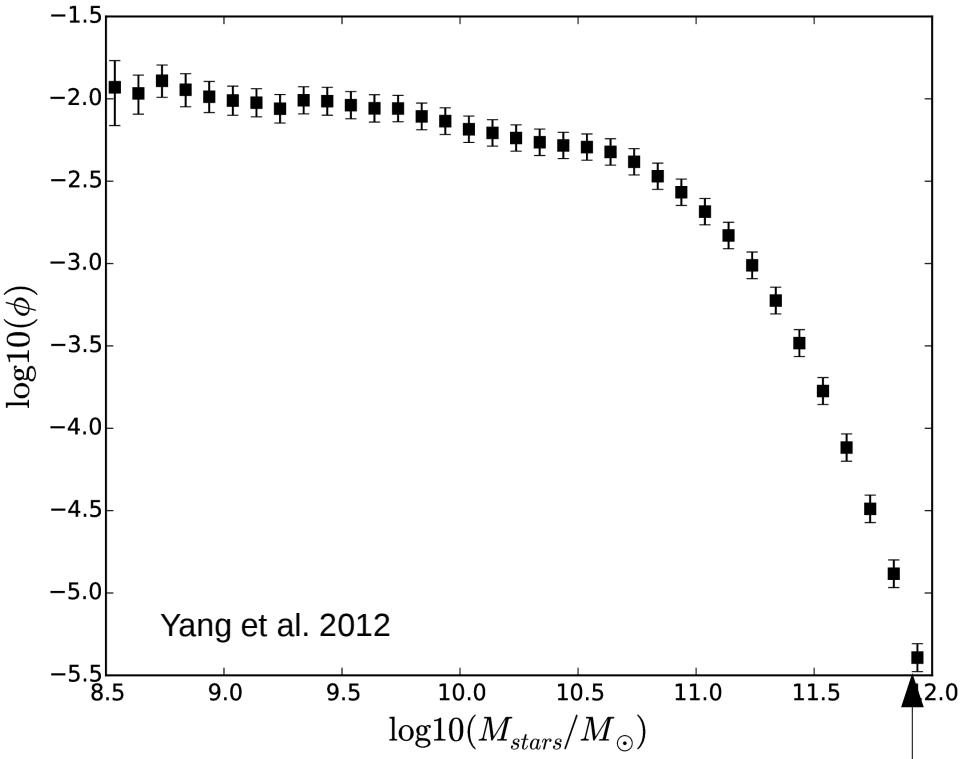
Abundance matching : introduction

The most massive galaxy live in the most massive halo.

Halo mass function



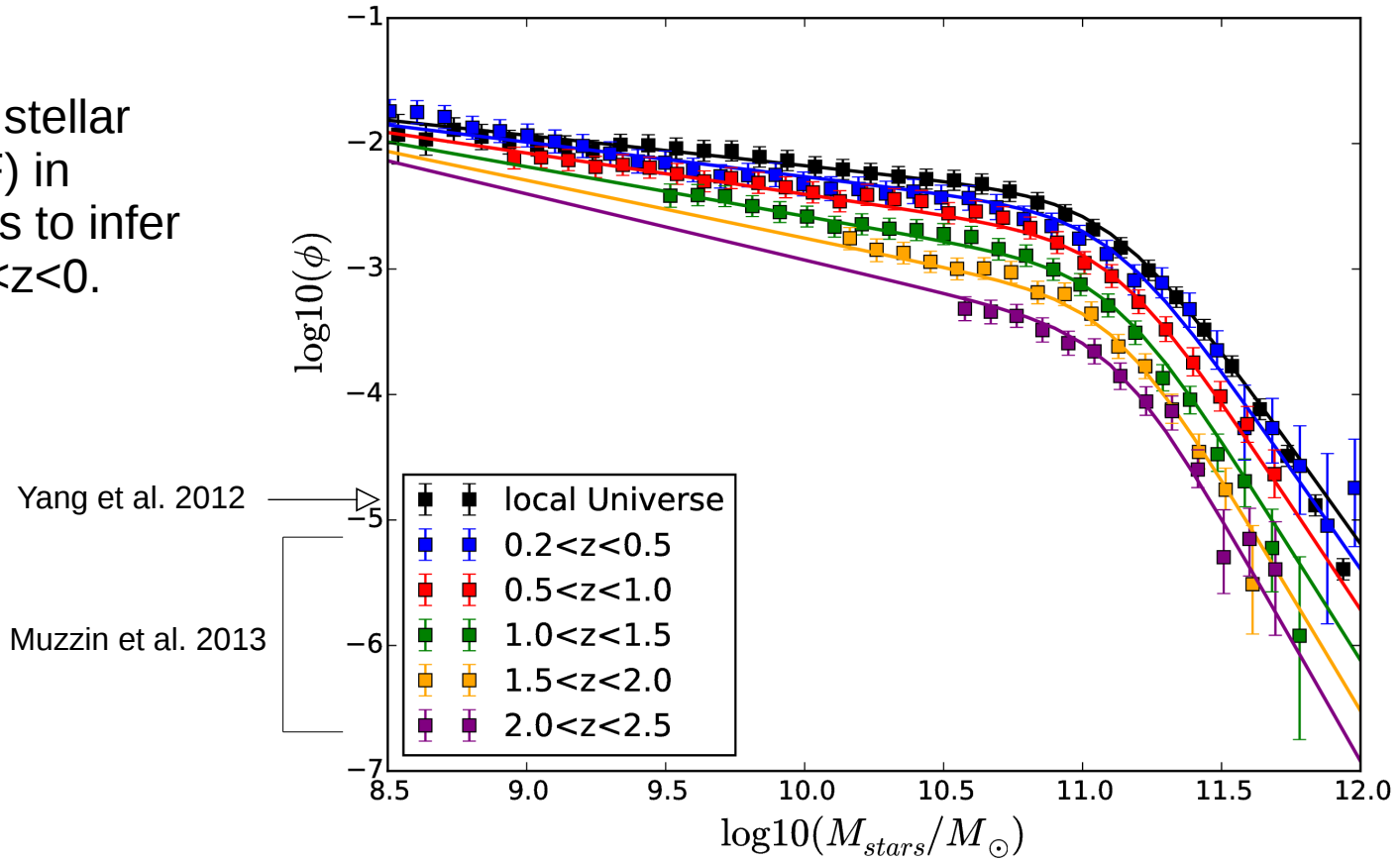
Stellar mass function



$$\int_{m_{star}}^{\infty} n_{star}\left(m'_{star}\right) dm'_{star} = \int_{M_h}^{\infty} n_h\left(M'_h\right) dM'_h$$

Abundance matching at all redshift

We fit the observed stellar mass function (SMF) in different redshift bins to infer the SMF at any 2.5<z<0.



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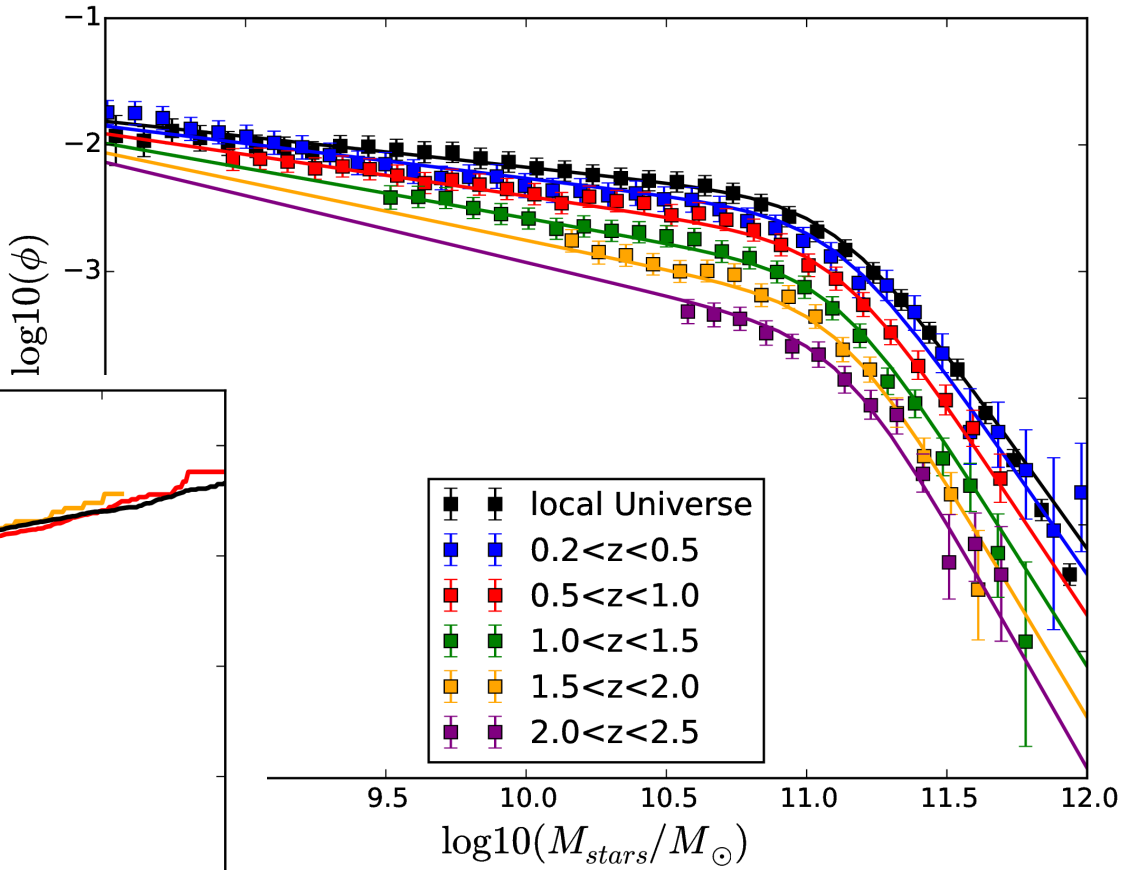
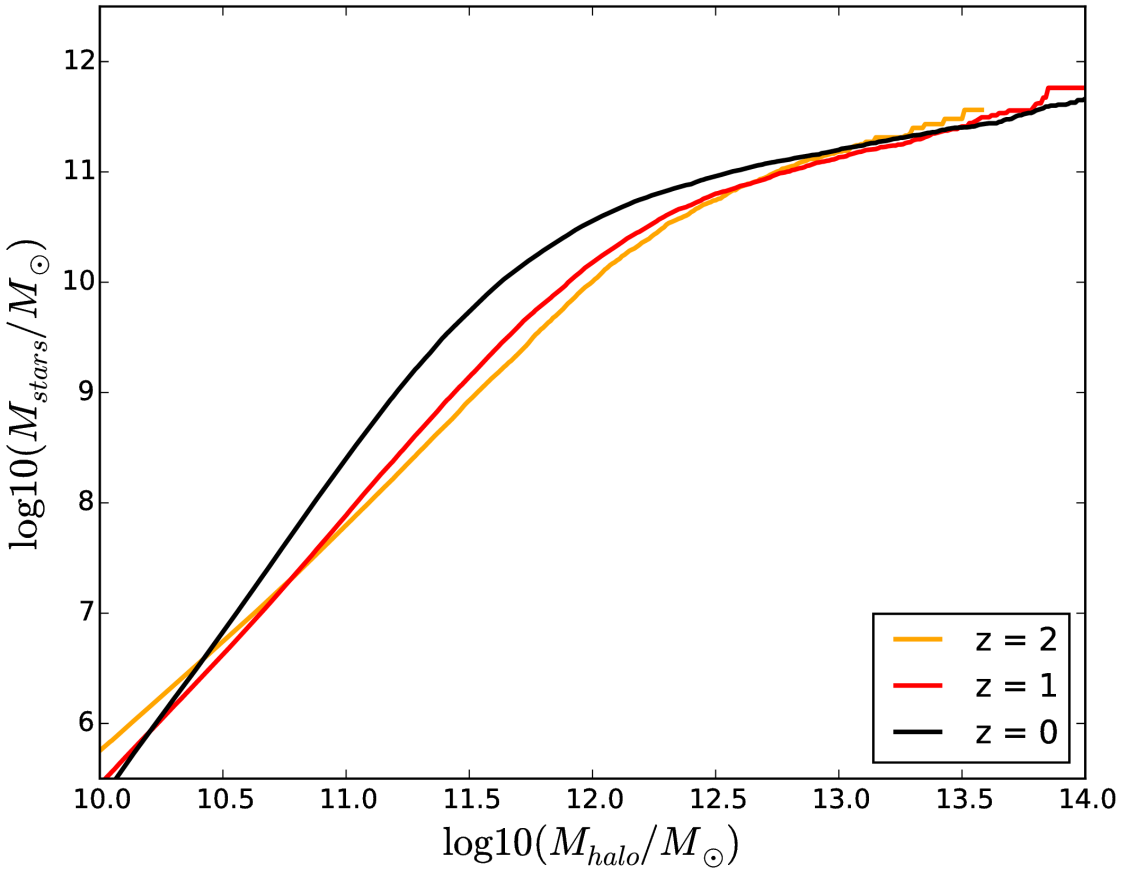
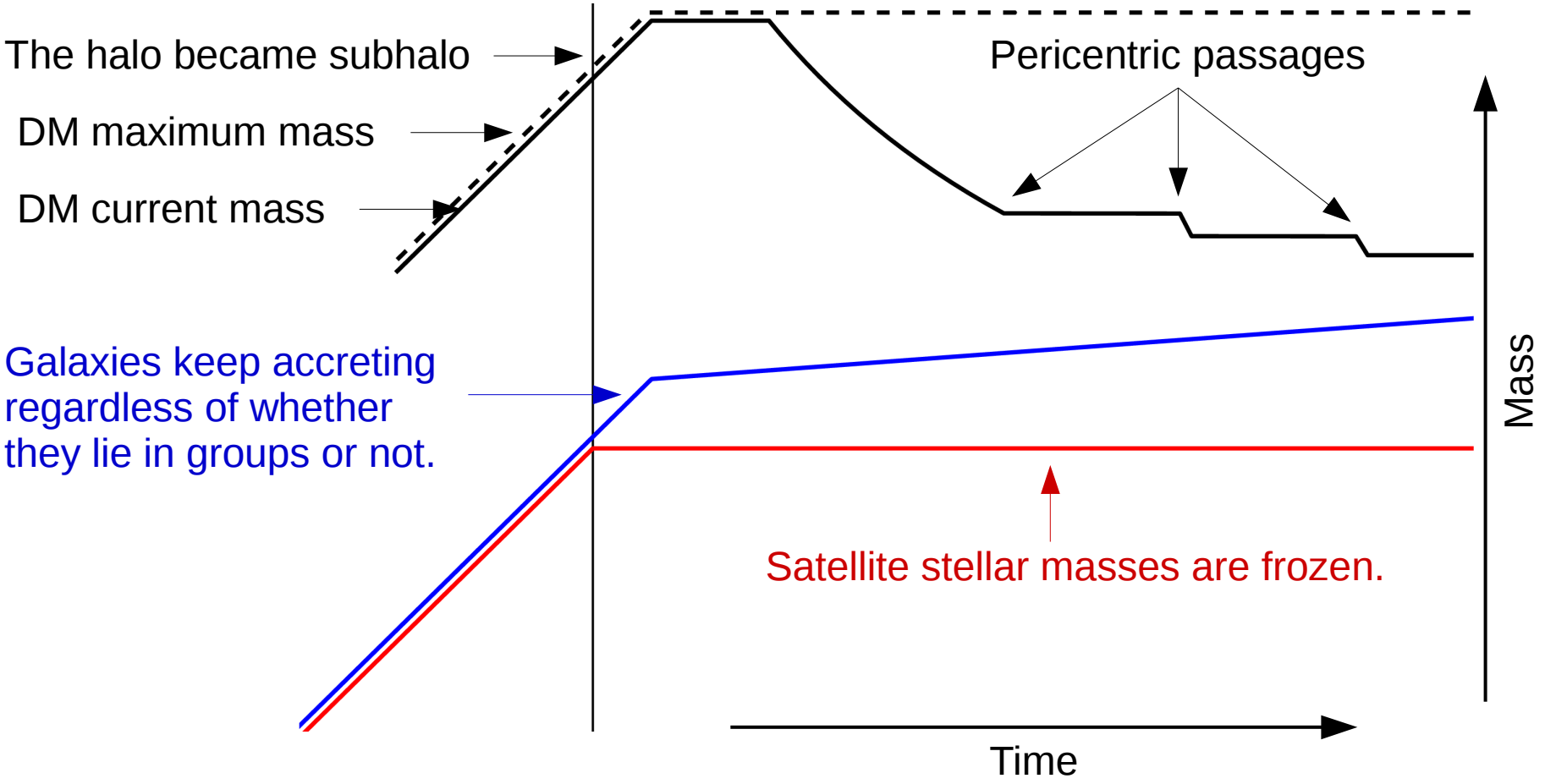




We match it with our halo mass function has explain before to obtain $M_{star}(M_{halo},z)$.

Populating subhaloes : starvation and accretion

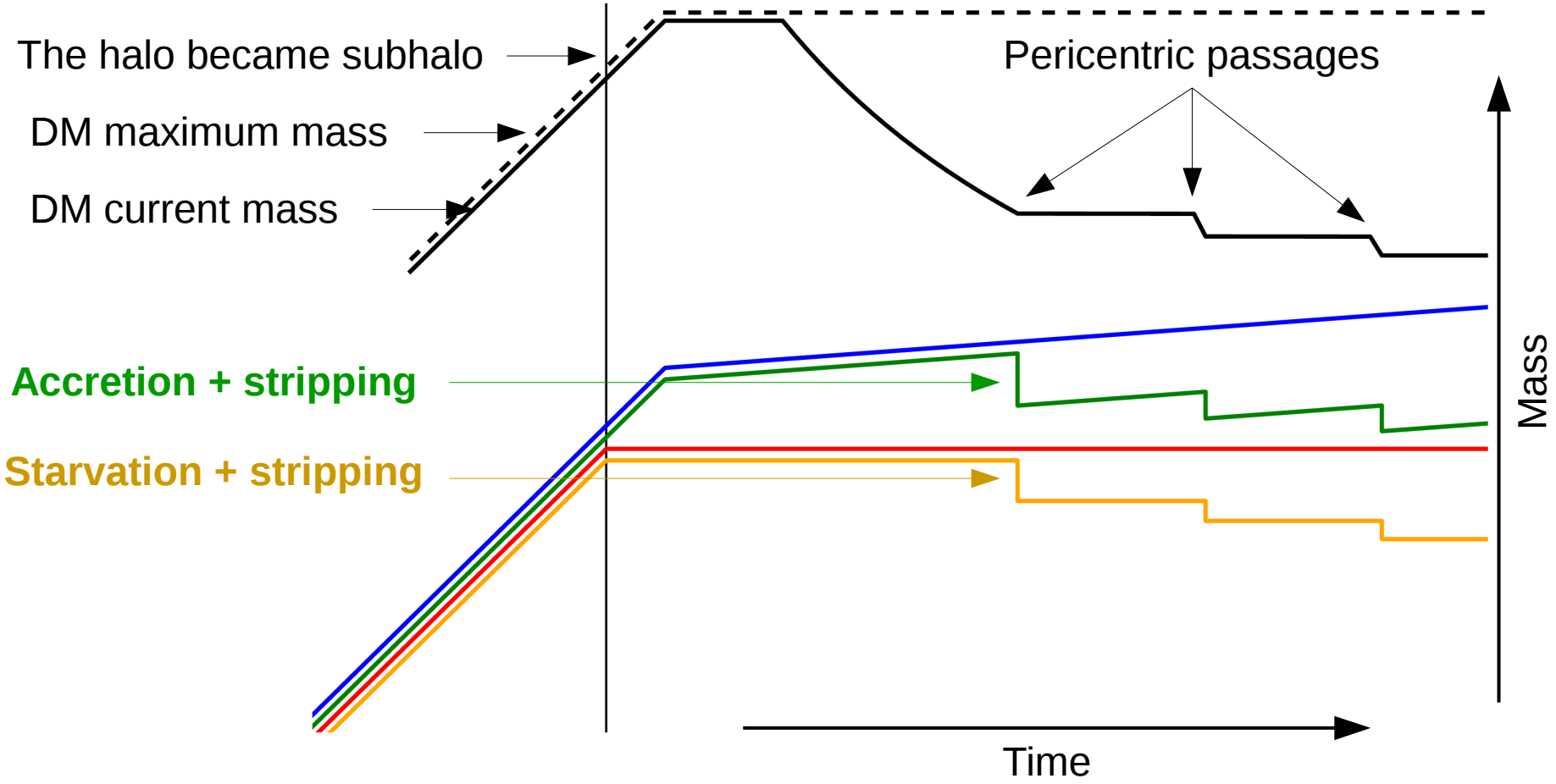
For field galaxies, at each timestep, their stellar mass is updated with the $M_{star}(M_{halo},z)$ at the current age. The stellar mass can't diminish.
For satellites we expose two extreme scenario called starvation and accretion.



Populating subhaloes : stripping

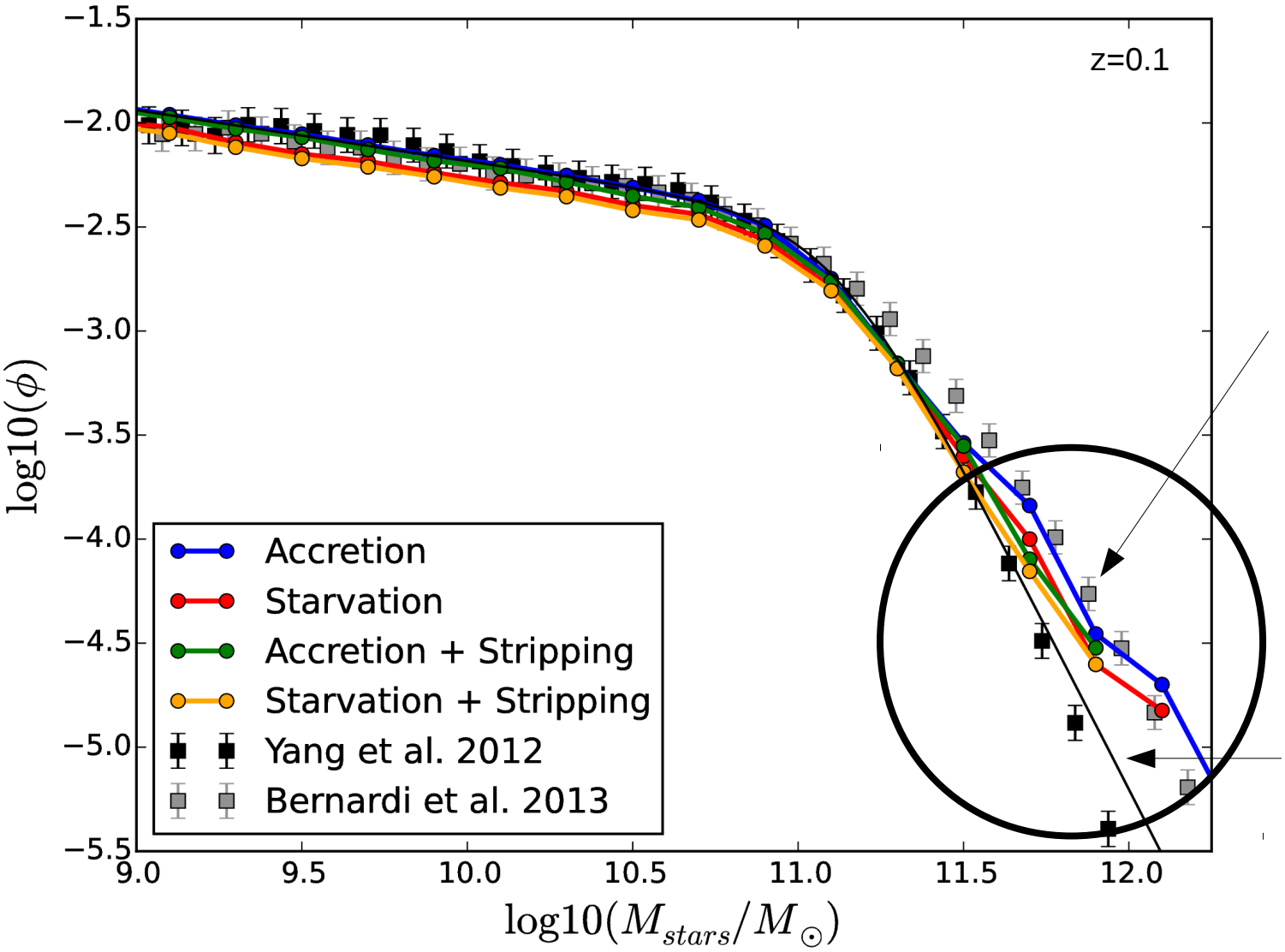
Because galaxies are much more compact than DM haloes, stars can only be stripped effectively at pericenter. **We use a model of impulsive tidal stripping.**

See simulations from Klimentowski et al. 2009



Rebuilding the stellar mass function

We recover the stellar mass function between Yang et al. and Bernardi et al.

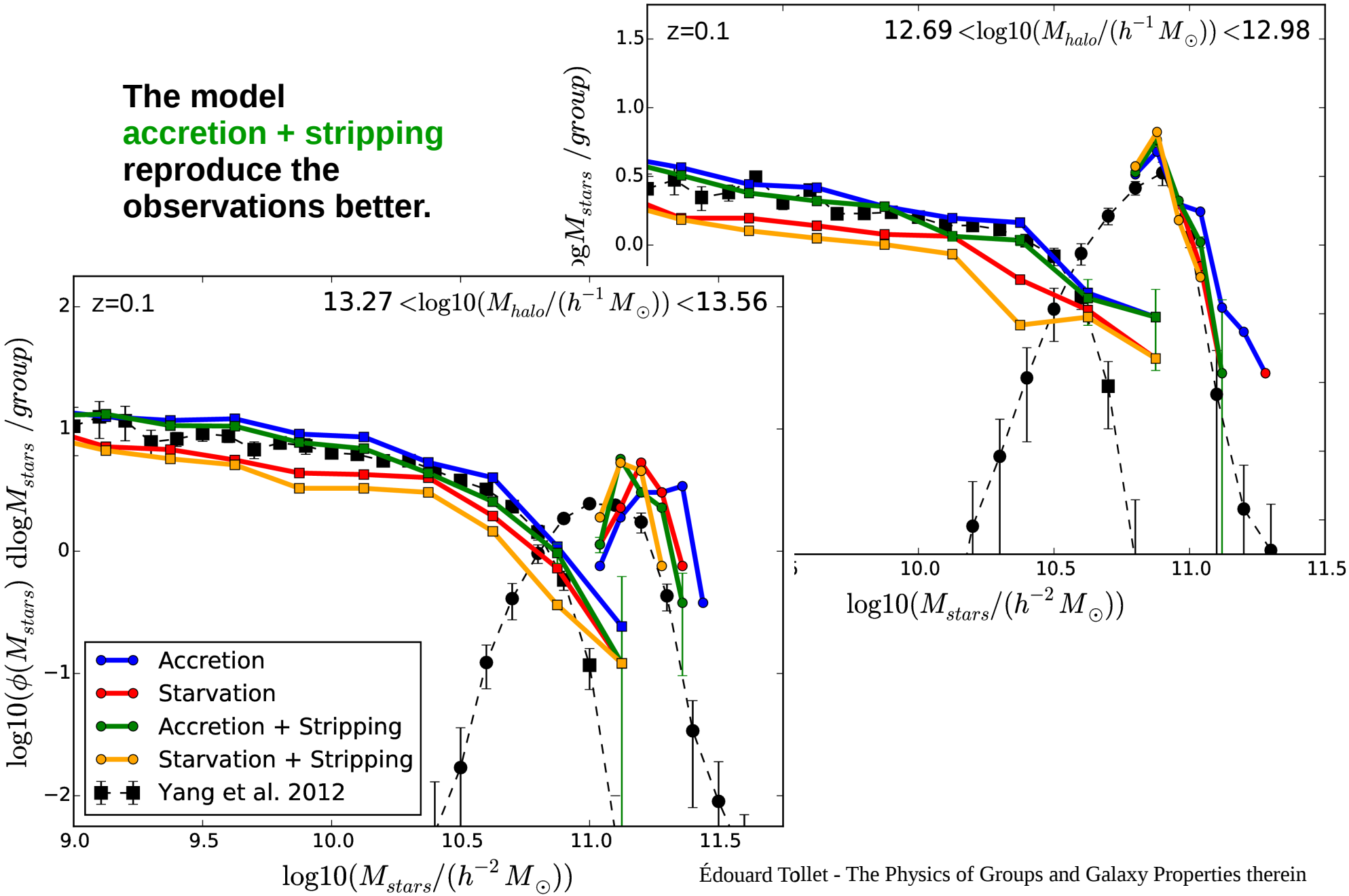


Bernardi et al. tend to include most of the ICL in the central galaxy.

Fit used to build the abundance matching.

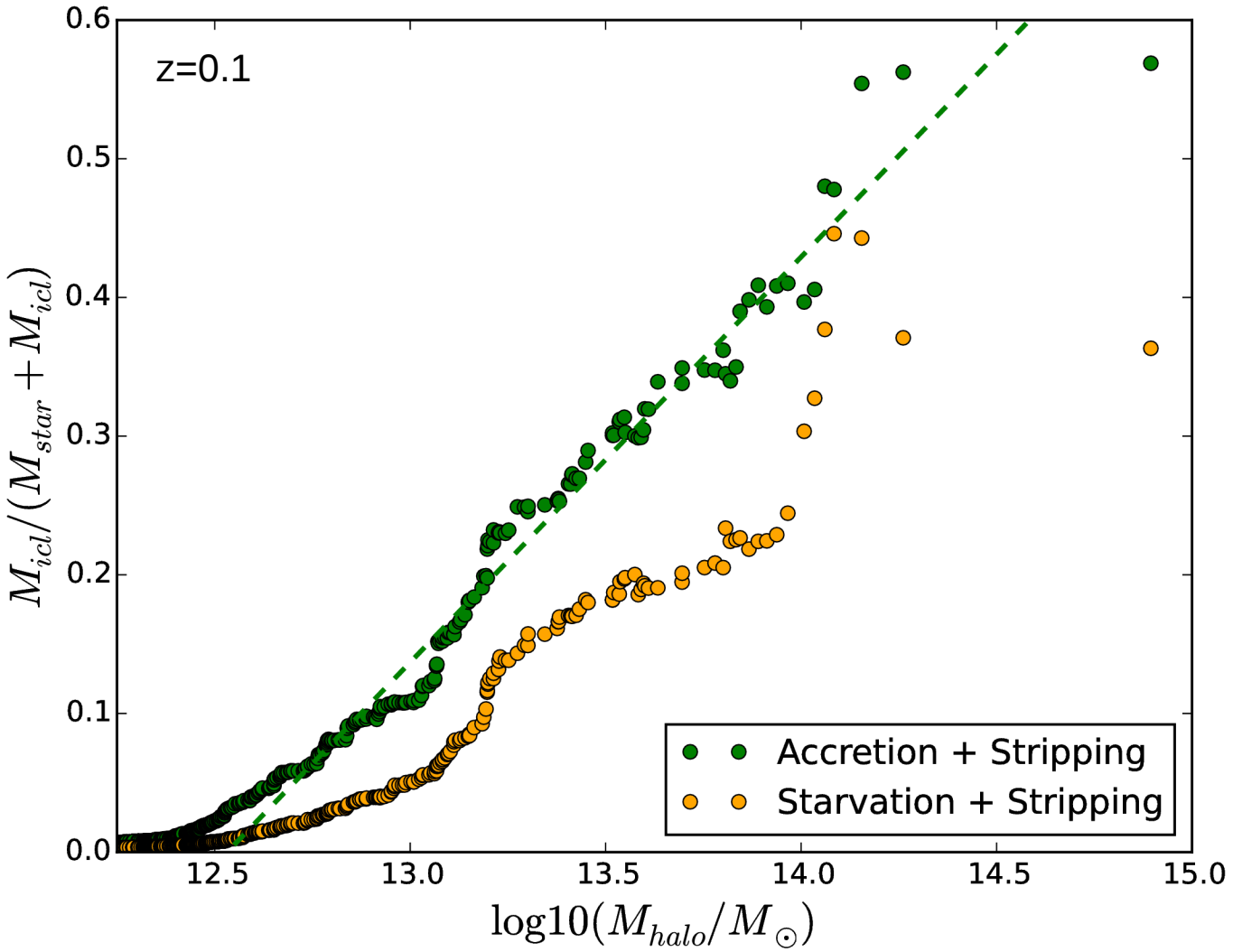
Group stellar mass function

The model
accretion + stripping
reproduce the
observations better.



Prediction for the intercluster light

The fraction of stars in the ICL increases with the central halo mass up to ≈50%.



Comparison with observations soon !

Conclusion and perspectives

Impact of stripping and ICL fraction are difficult to quantify.

Abundance matching to minimize physic model input.

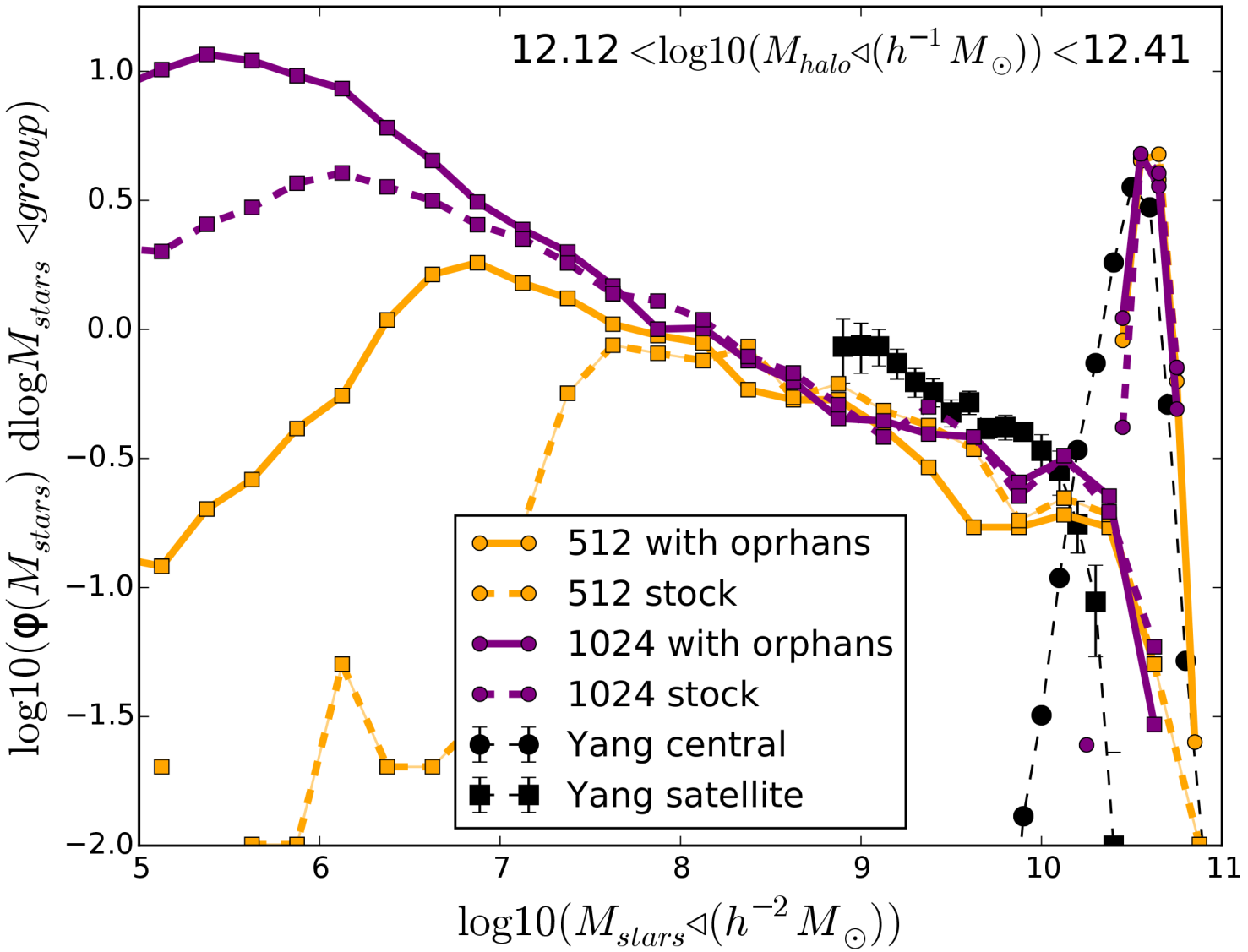
Observations reproduced with a simple model.

Add scatter in the M_{star} vs M_{halo} relation.

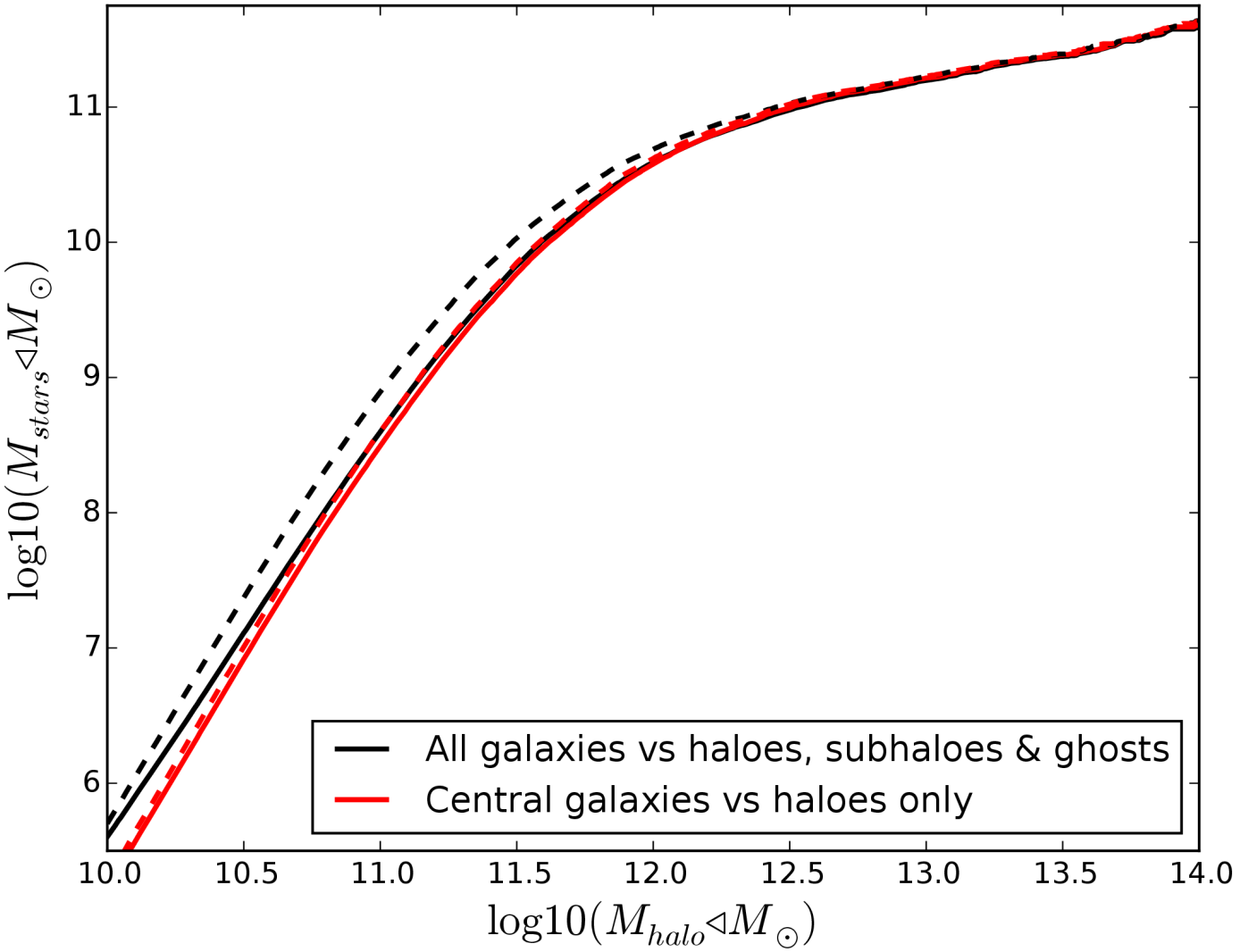
Improved merger tree to be used with GalICS 2.0 semi-analytic model.

Compare the prediction for ICL fraction with observations.

Resolution and convergence



Haloes and subhaloes mixed ?



Dotted lines :
with current virial mass

Solid lines :
with maximum virial mass