LSA ASTRONOMY
UNIVERSITY OF MICHIGAN

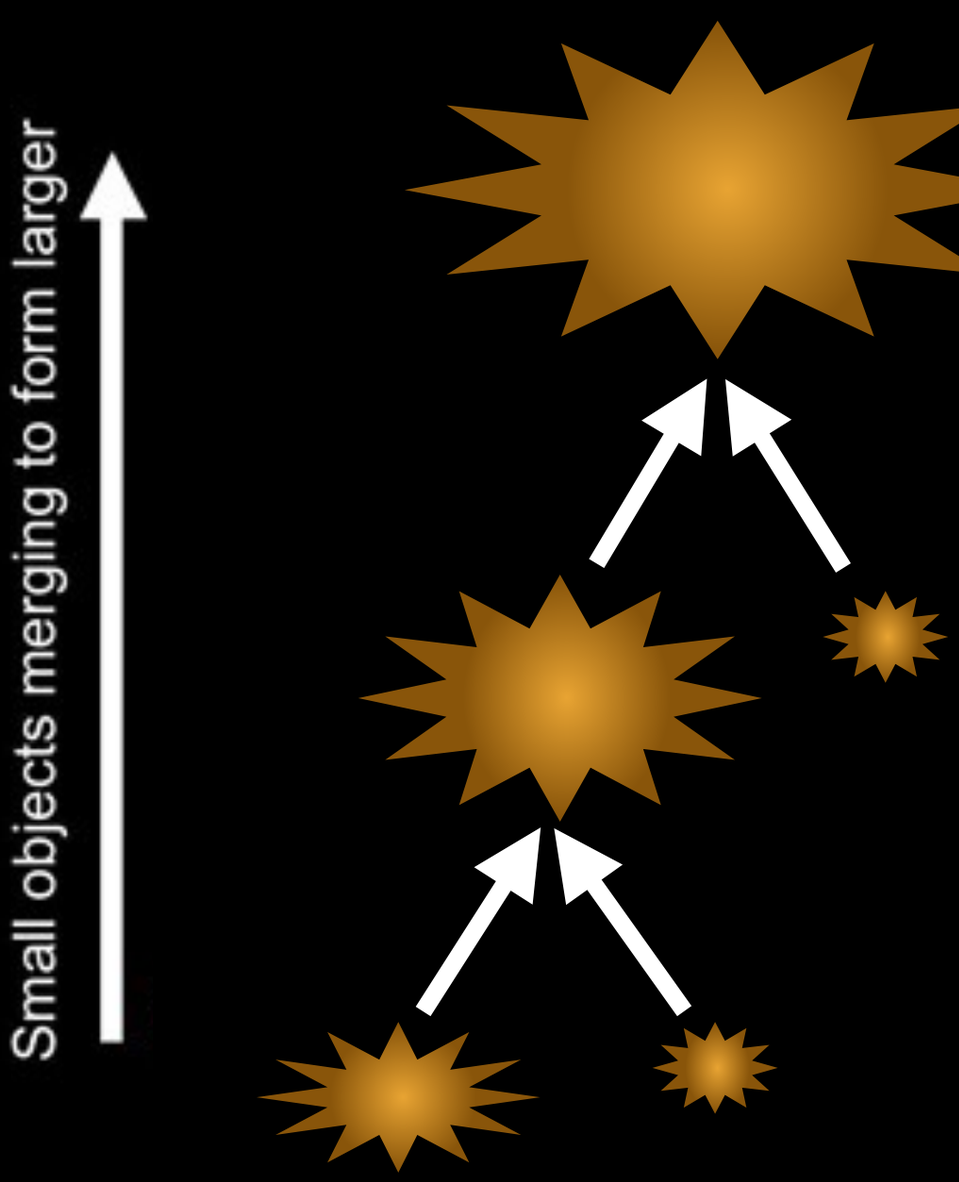
Dark matter distribution in cluster galaxies

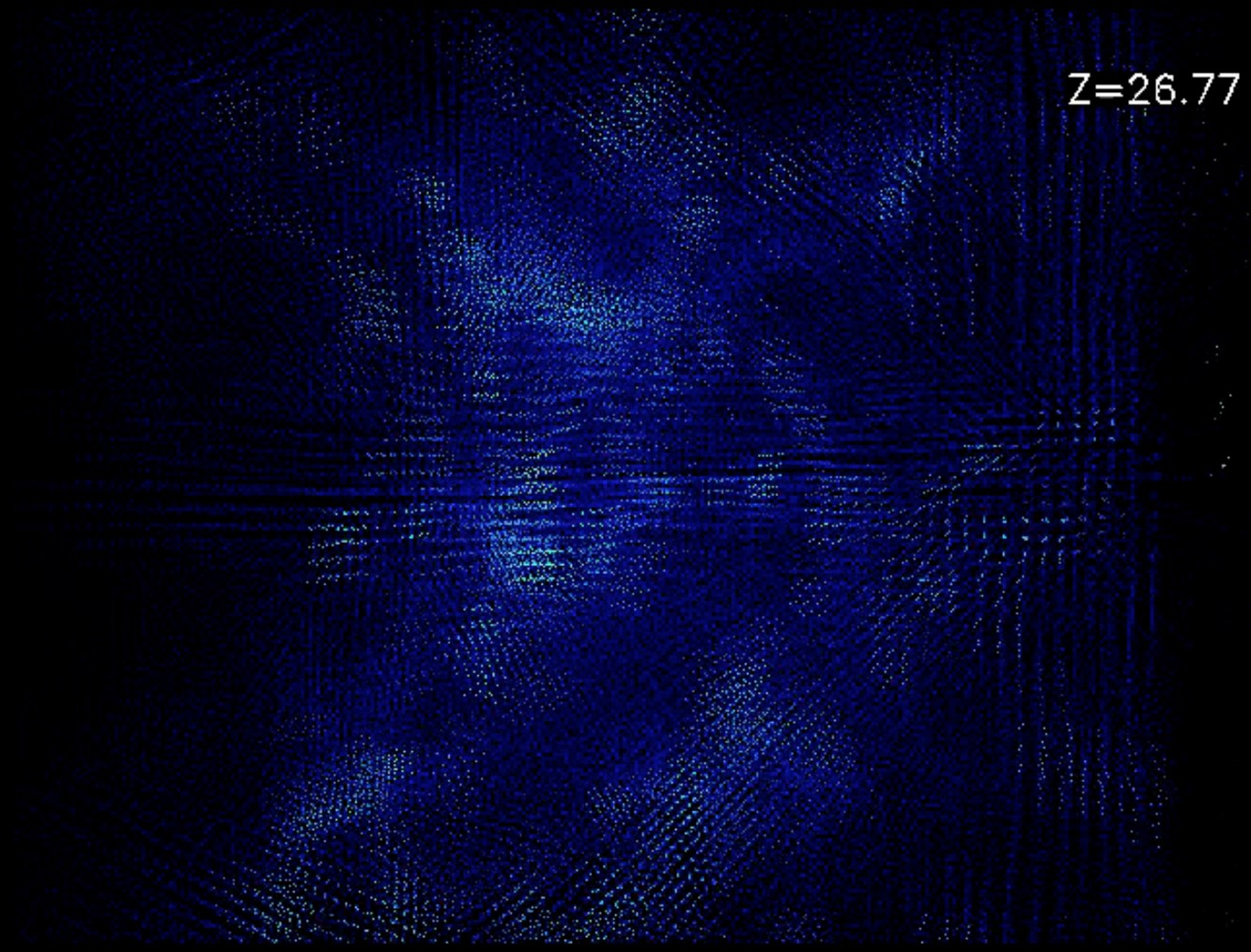
Anna NIEMIEC

Eric Jullo, Marceau Limousin, Carlo Giocoli, Mathilde Jauzac, …

SF2A days - 17/05/2019

From halos to large scale structures: hierarchical formation

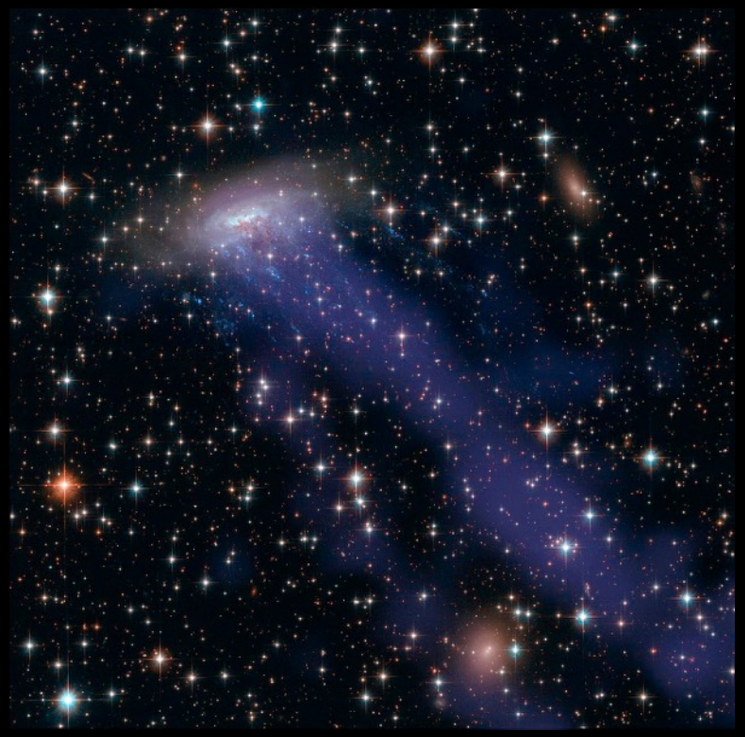




Yepes et al. 2002

Interactions in the cluster environment

- **Baryonic matter :**
  - **Ram-pressure stripping**



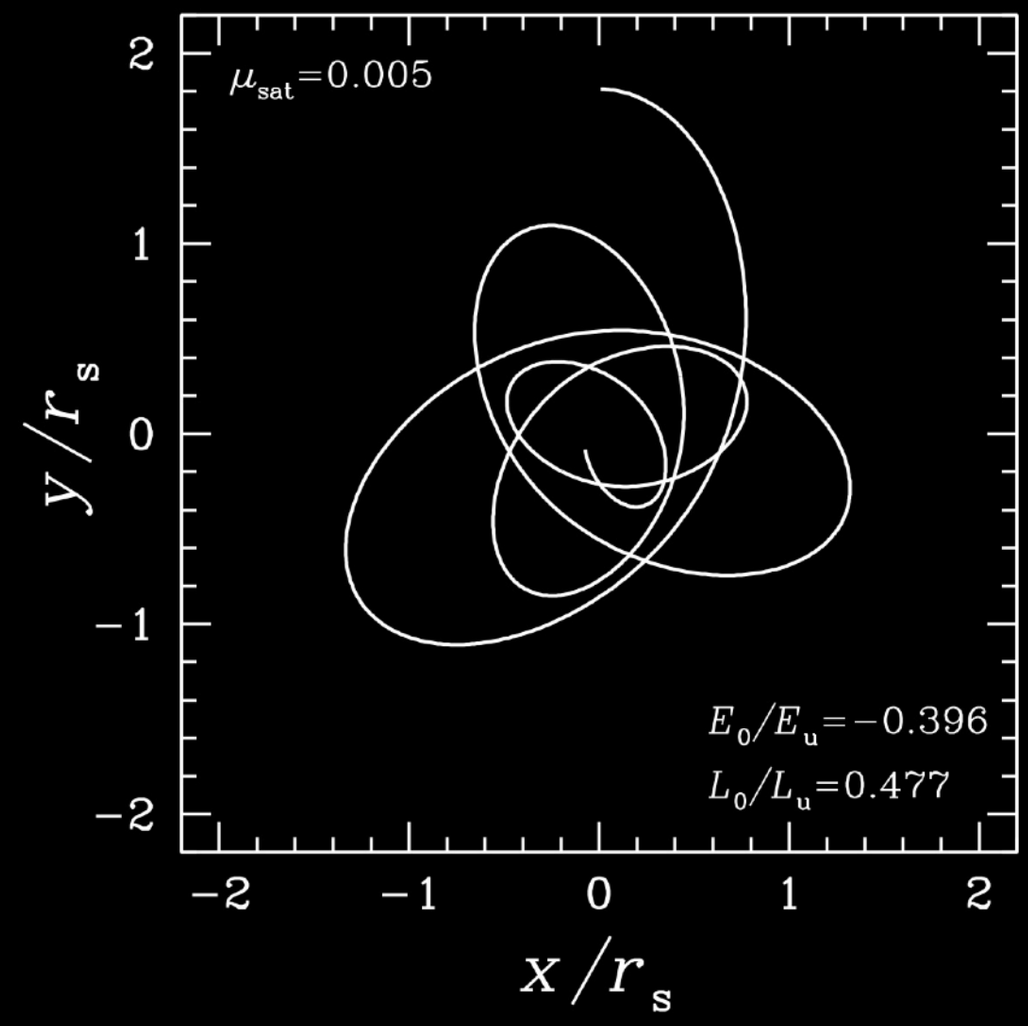
  - **Harassment**

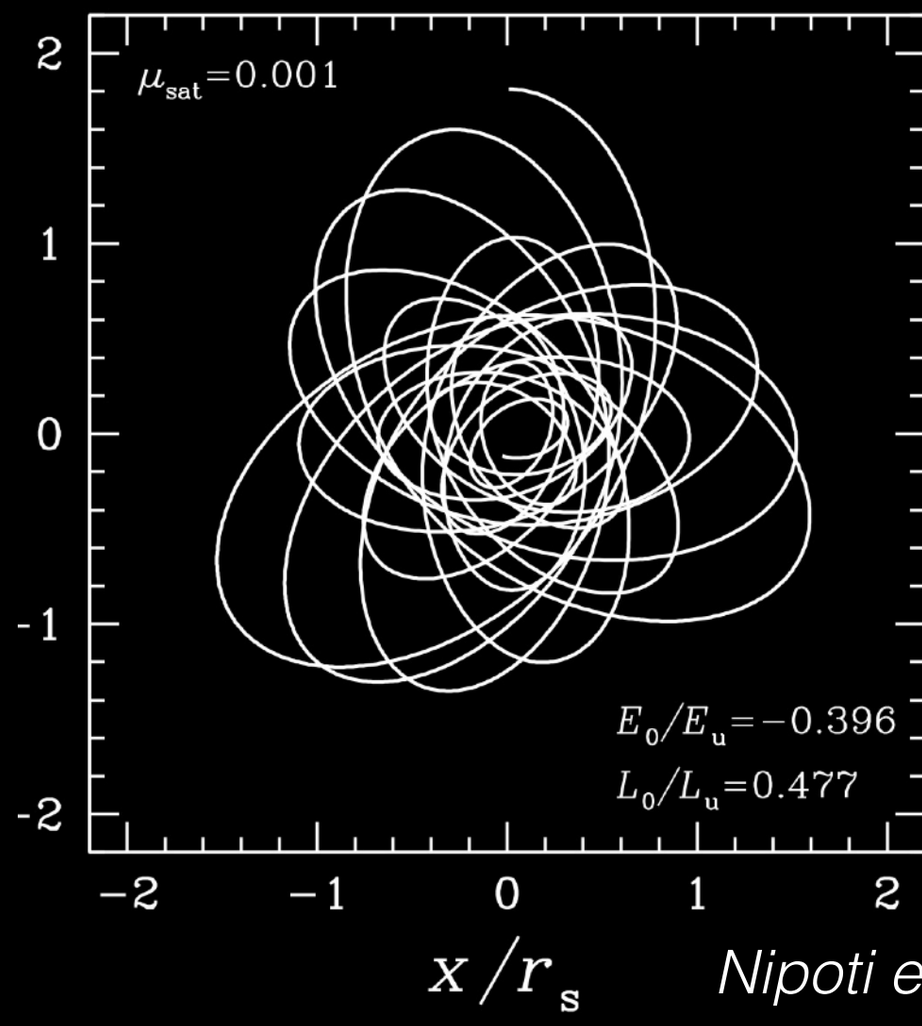
  - **Mergers**

Credit: NASA/ESA

Interactions in the cluster environment

- **Dark matter:**
  - **Dynamical friction**

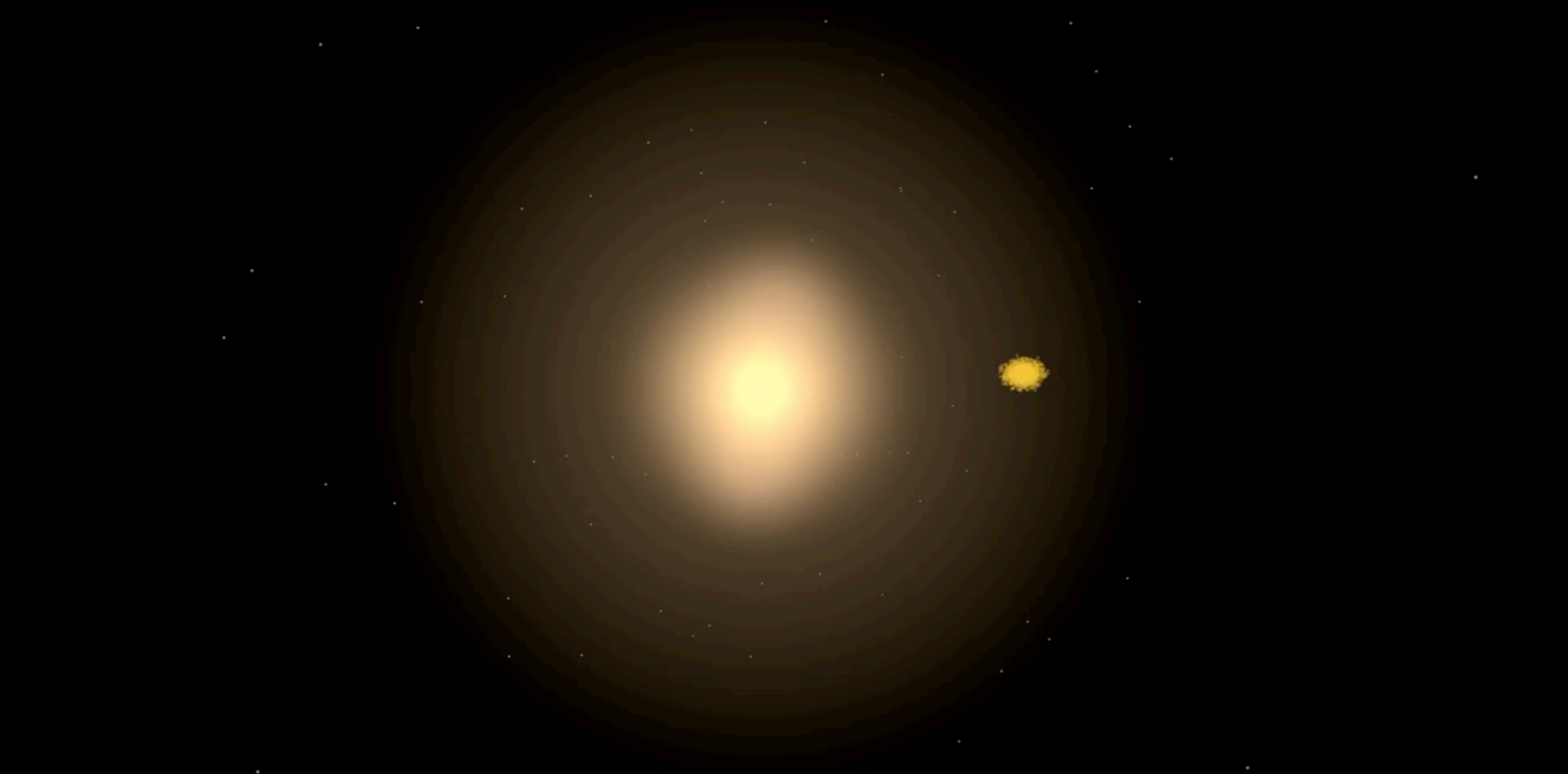




Nipoti et al. 2016

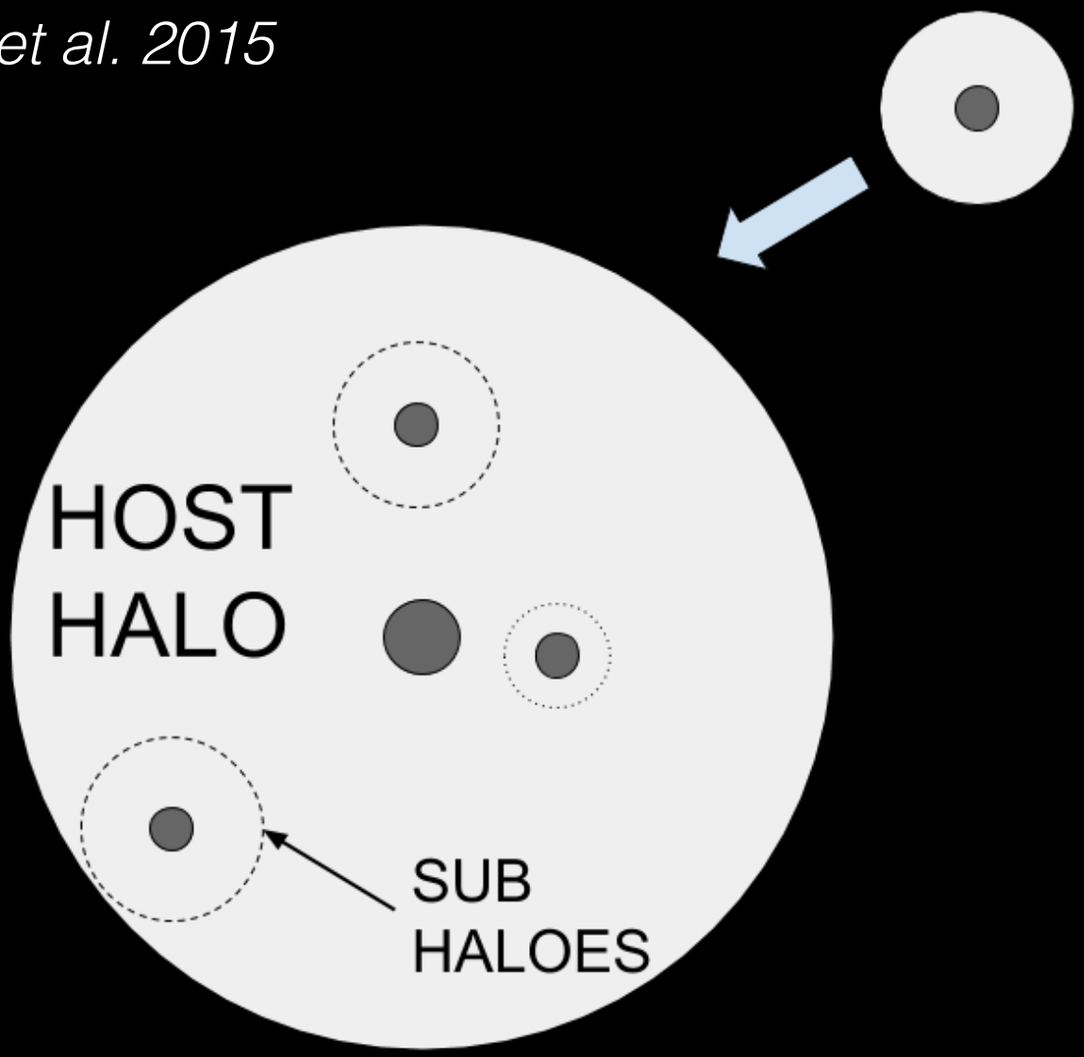
Interactions in the cluster environment

- **Dark matter:**
  - Dynamical friction
  - **Tidal stripping**

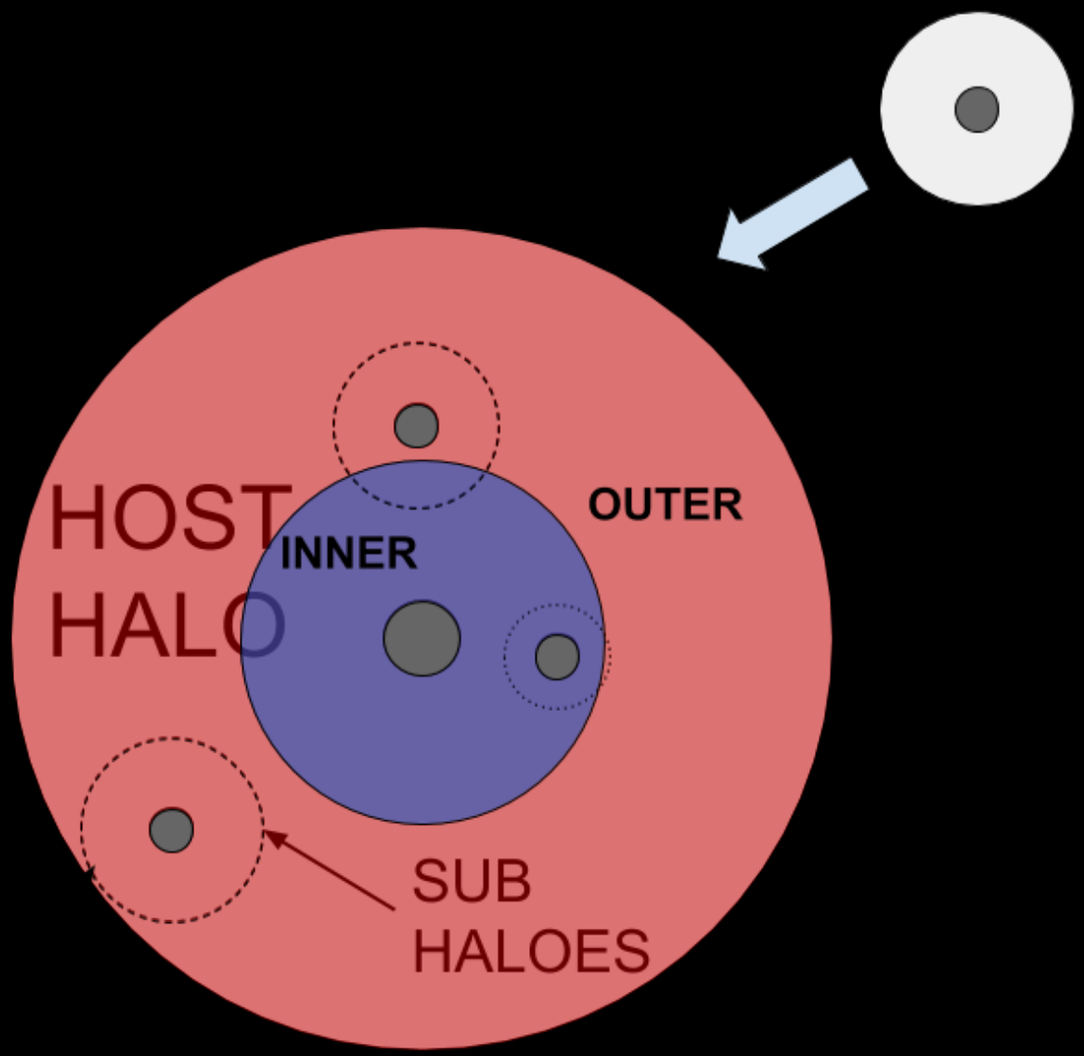


Sandoval et al. 2015

See also:
Gillis et al. 2013
Li et al. 2015
Sifón et al. 2015



How is the dark matter halo affected during infall?



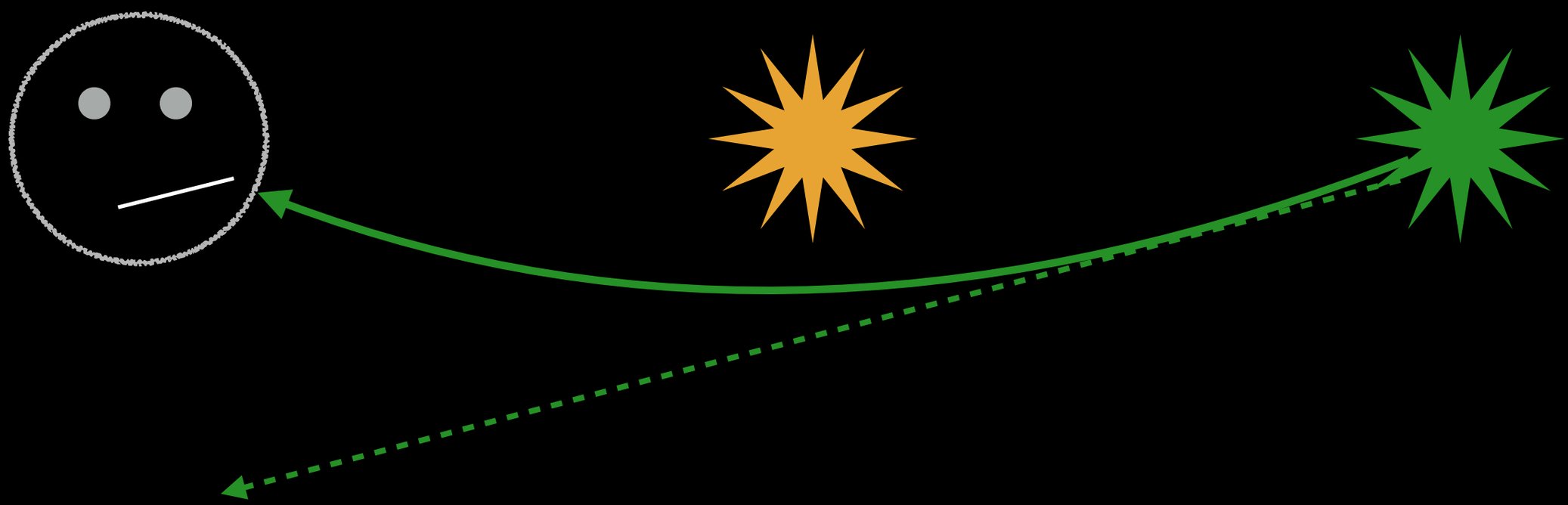
We need :

- Projected distance to cluster centre R_{sat} ~ infall redshift
(*eg vandenBosch 2015*)
- Stellar mass ~ infall mass (*eg Nagai&Kravtsov 2005*)
- Subhalo mass

—> **M_{sub}/M_{star}** in the **inner** part of the cluster vs in the **outer** part

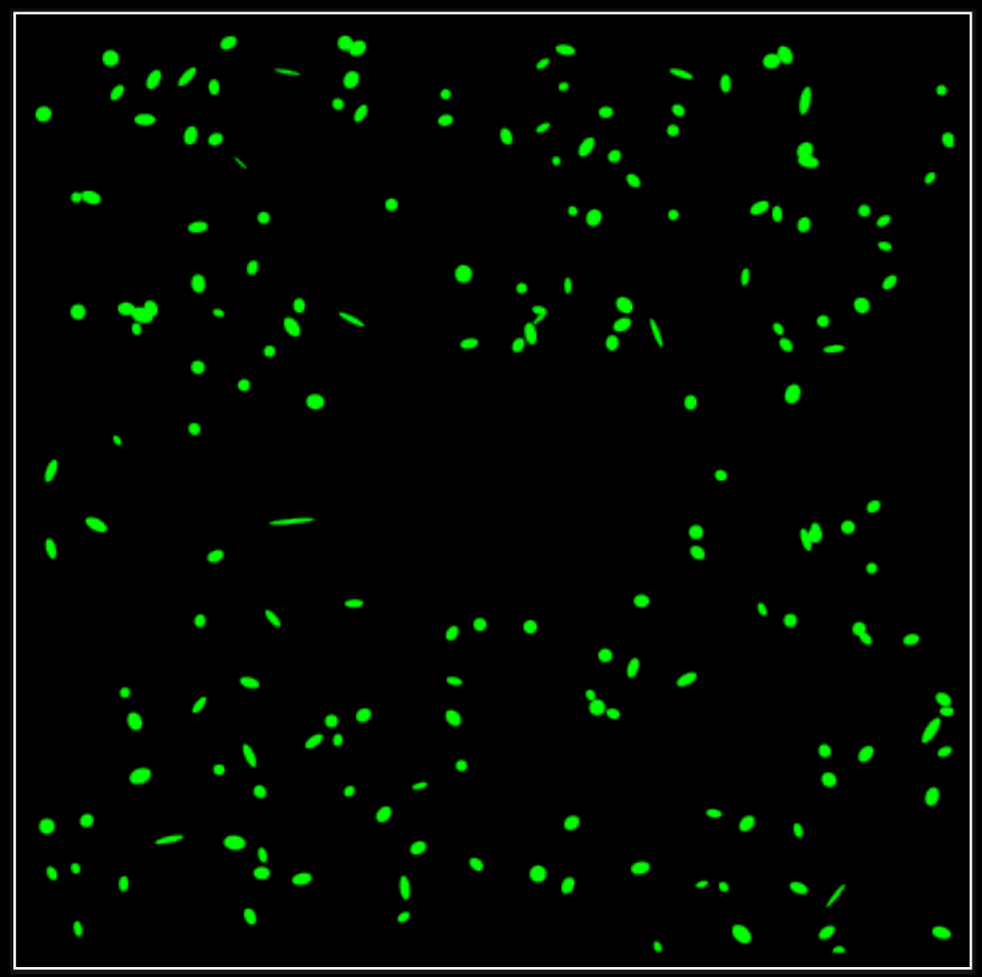
Dark matter halo mass

—> Gravitational lensing

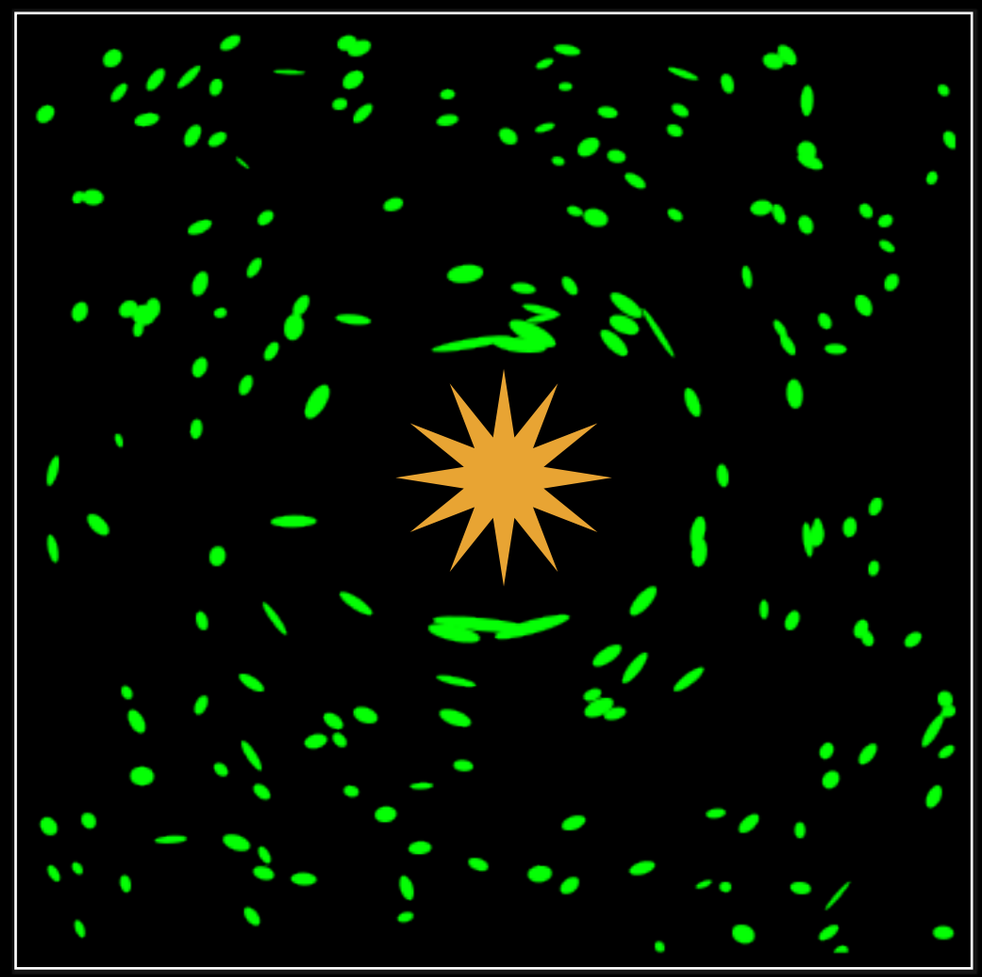


Weak lensing

Unlensed

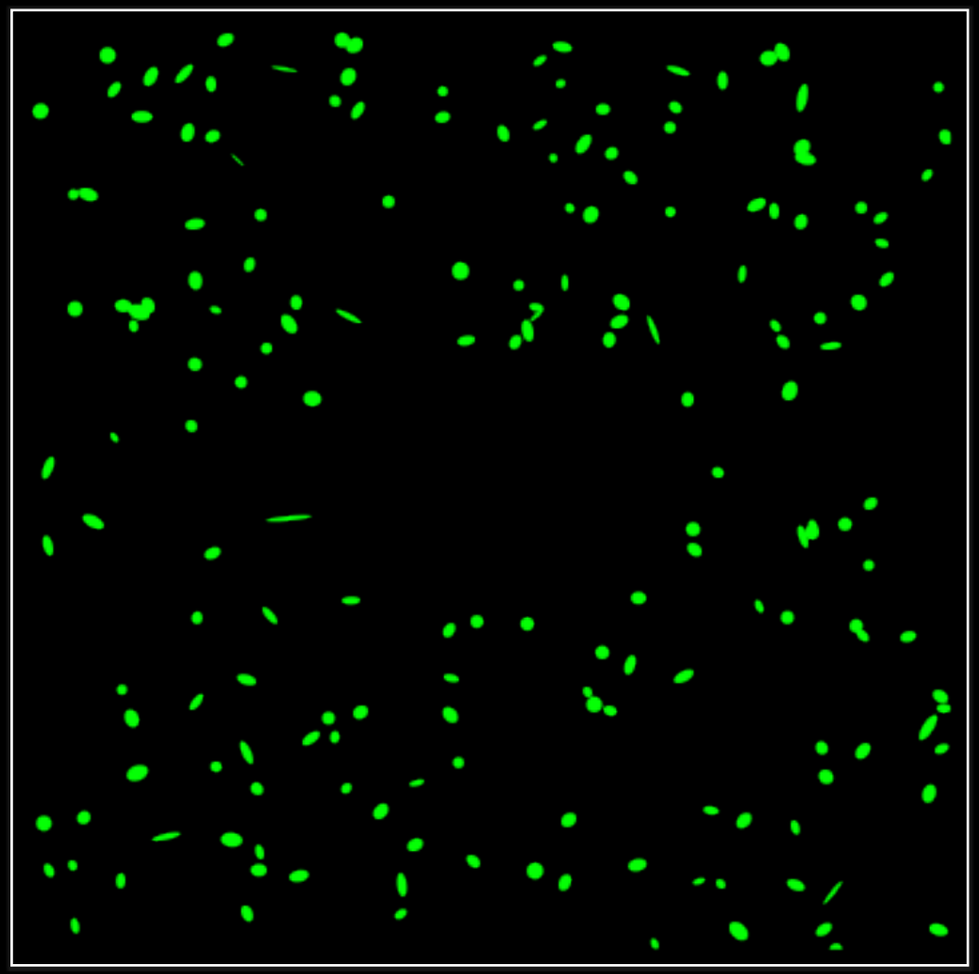


Lensed

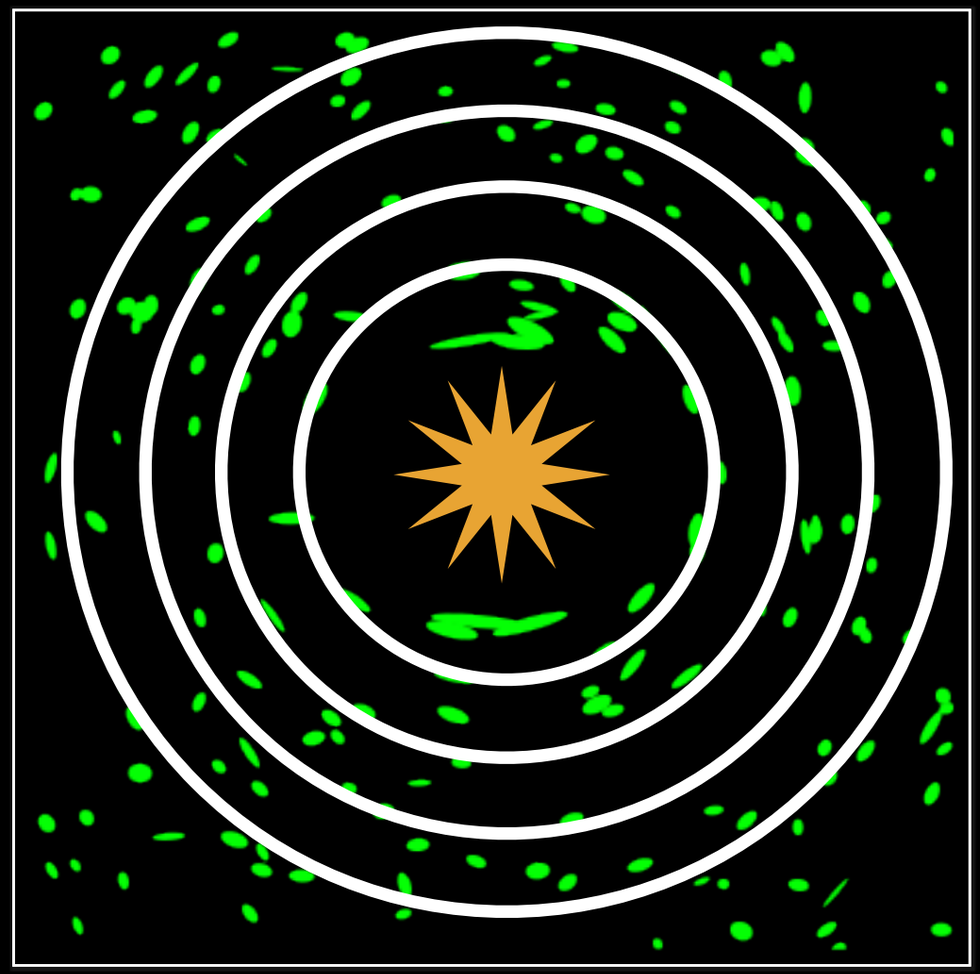


Weak lensing

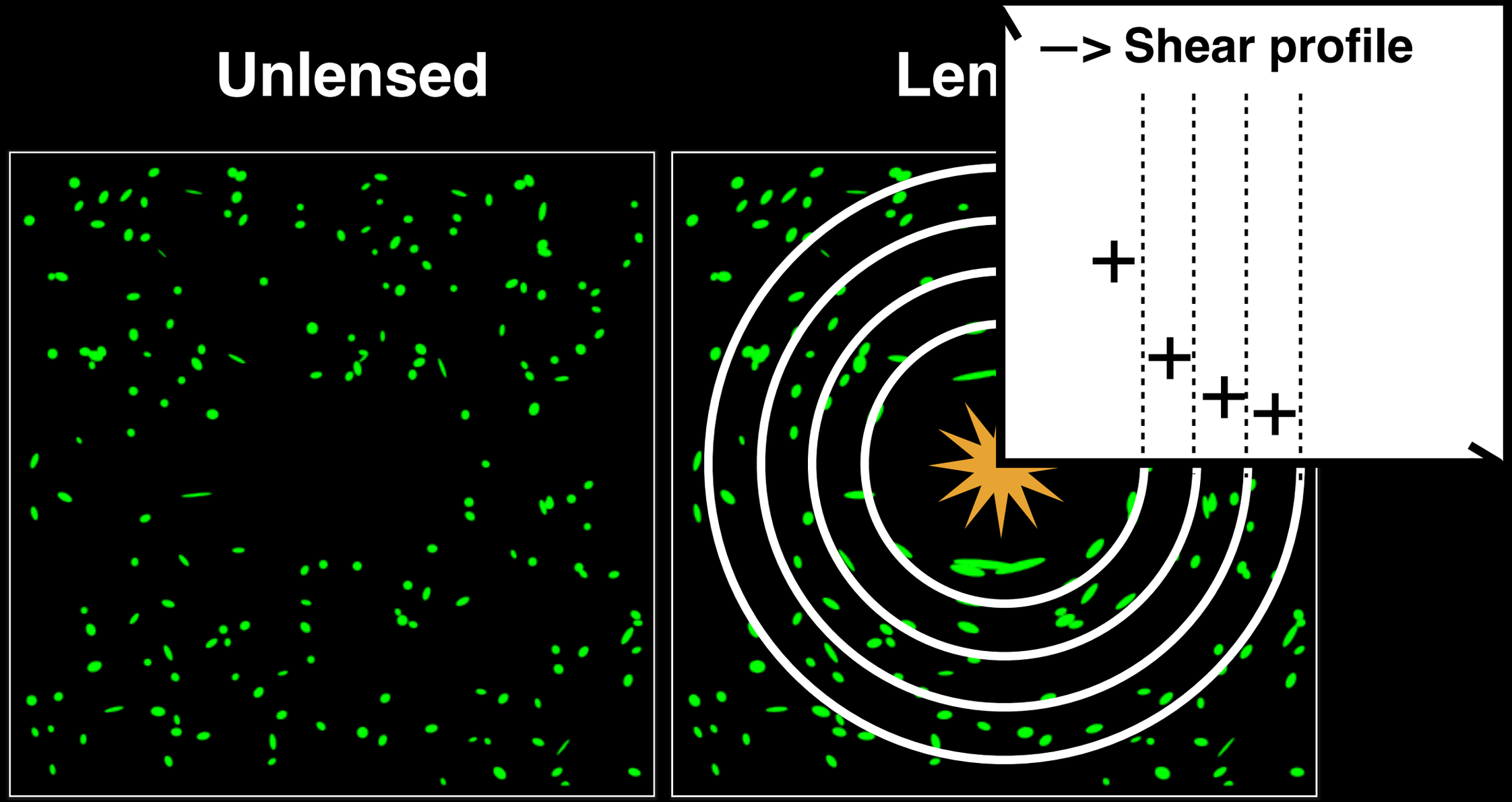
Unlensed



Lensed



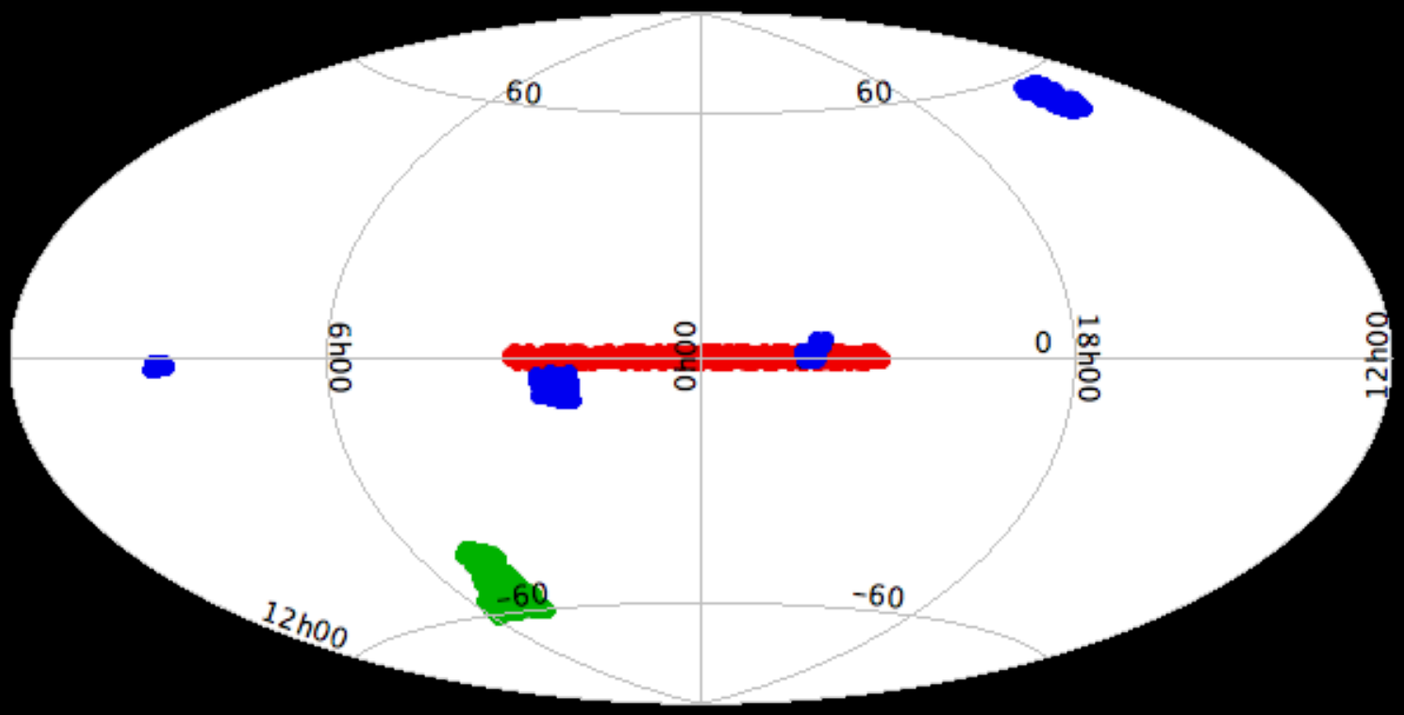
Weak lensing



The lenses

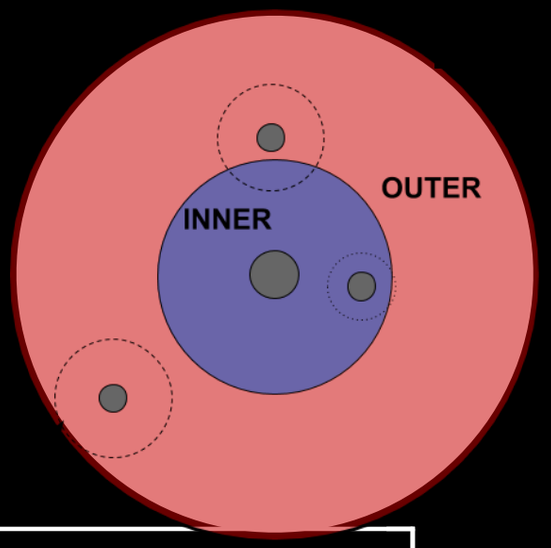
- redMaPPer satellites :
  - 130 deg^2 **CFHT-Stripe82**
  - 154 deg^2 **CFHTLenS**
  - 138 deg^2 **DES-sv**

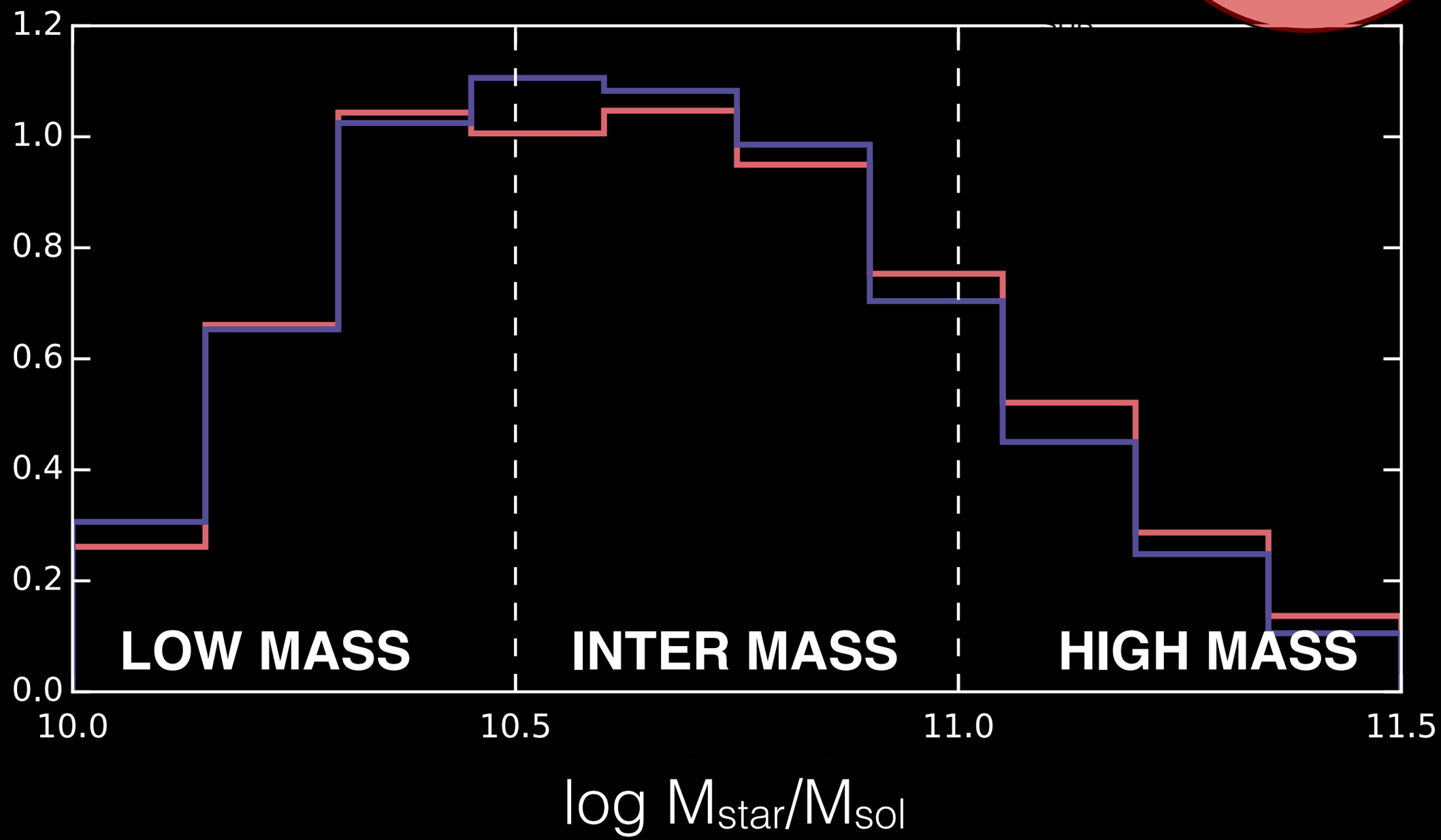
    ➡ **422 deg^2**



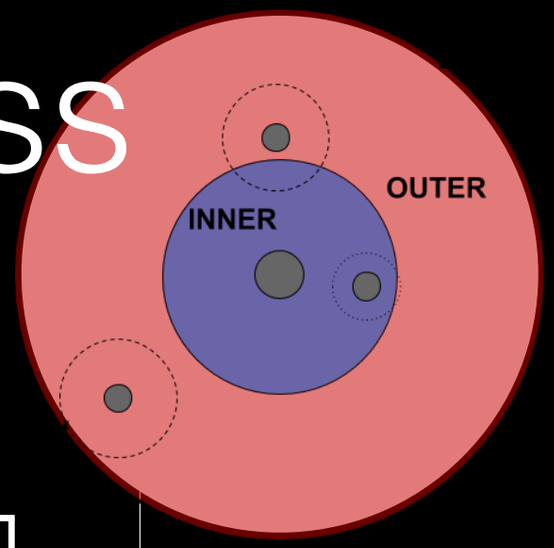
- 2 parameters classification :
  - Stellar mass ~ infall mass
  - Projected distance to cluster centre ~ environment

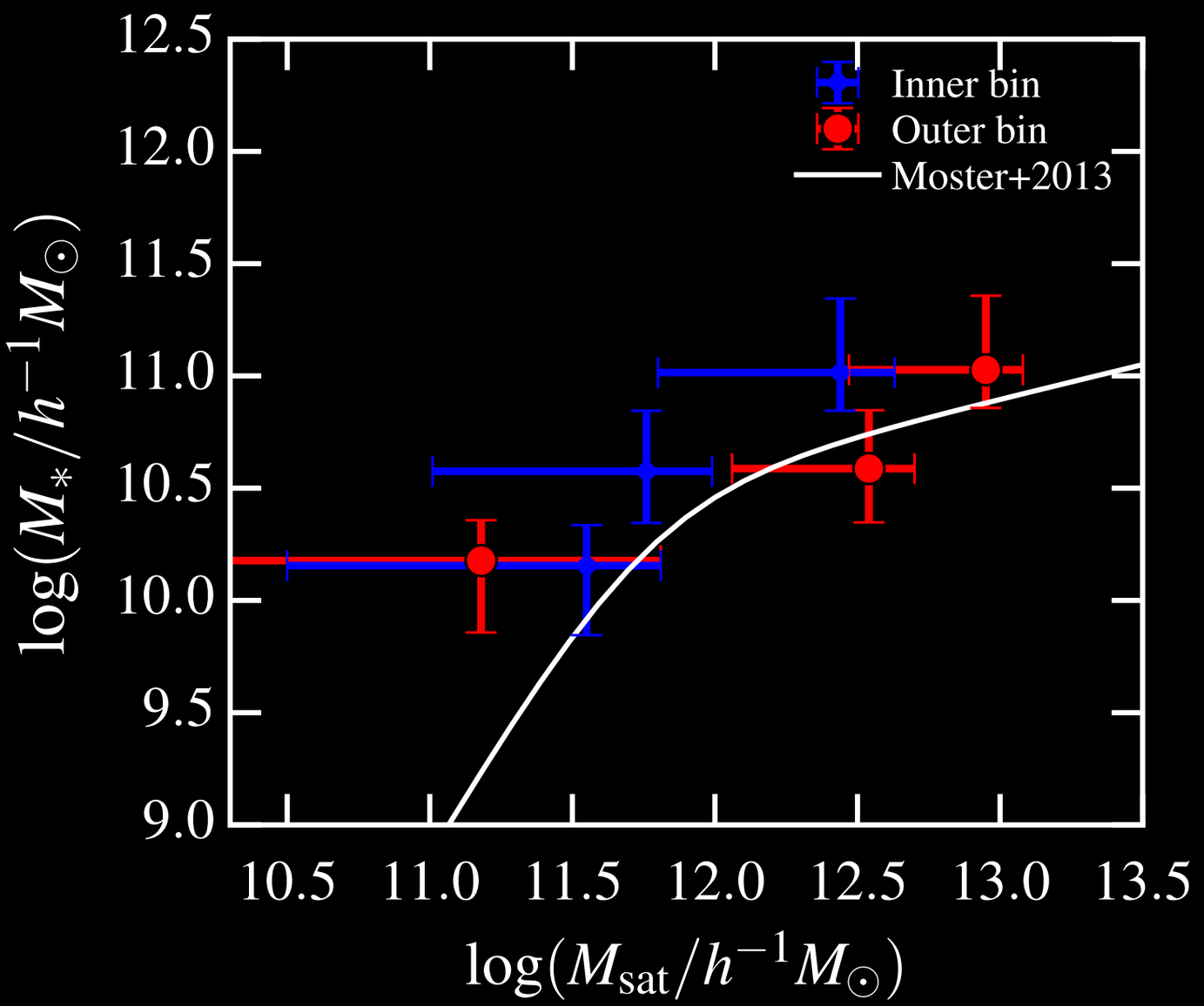
The lenses


OUTER
INNER


1.2
1.0
0.8
0.6
0.4
0.2
0.0
LOW MASS
INTER MASS
HIGH MASS
10.0
10.5
11.0
11.5
log Mstar/Msol

Stellar-to-halo mass relation





Stellar mass evolution during infall

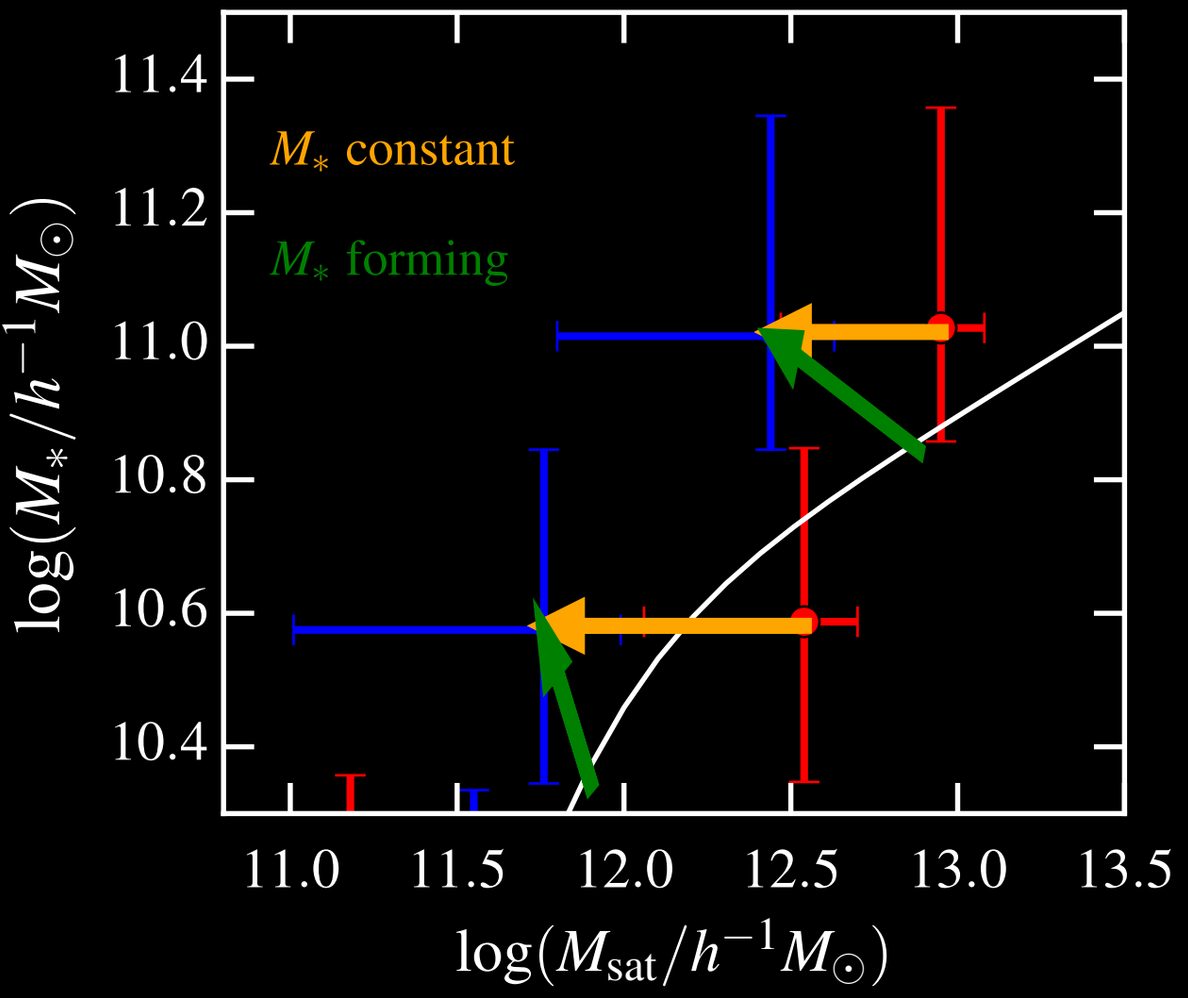
- **No star formation**

$$M_{*,\mathrm{inf}} = M_*$$

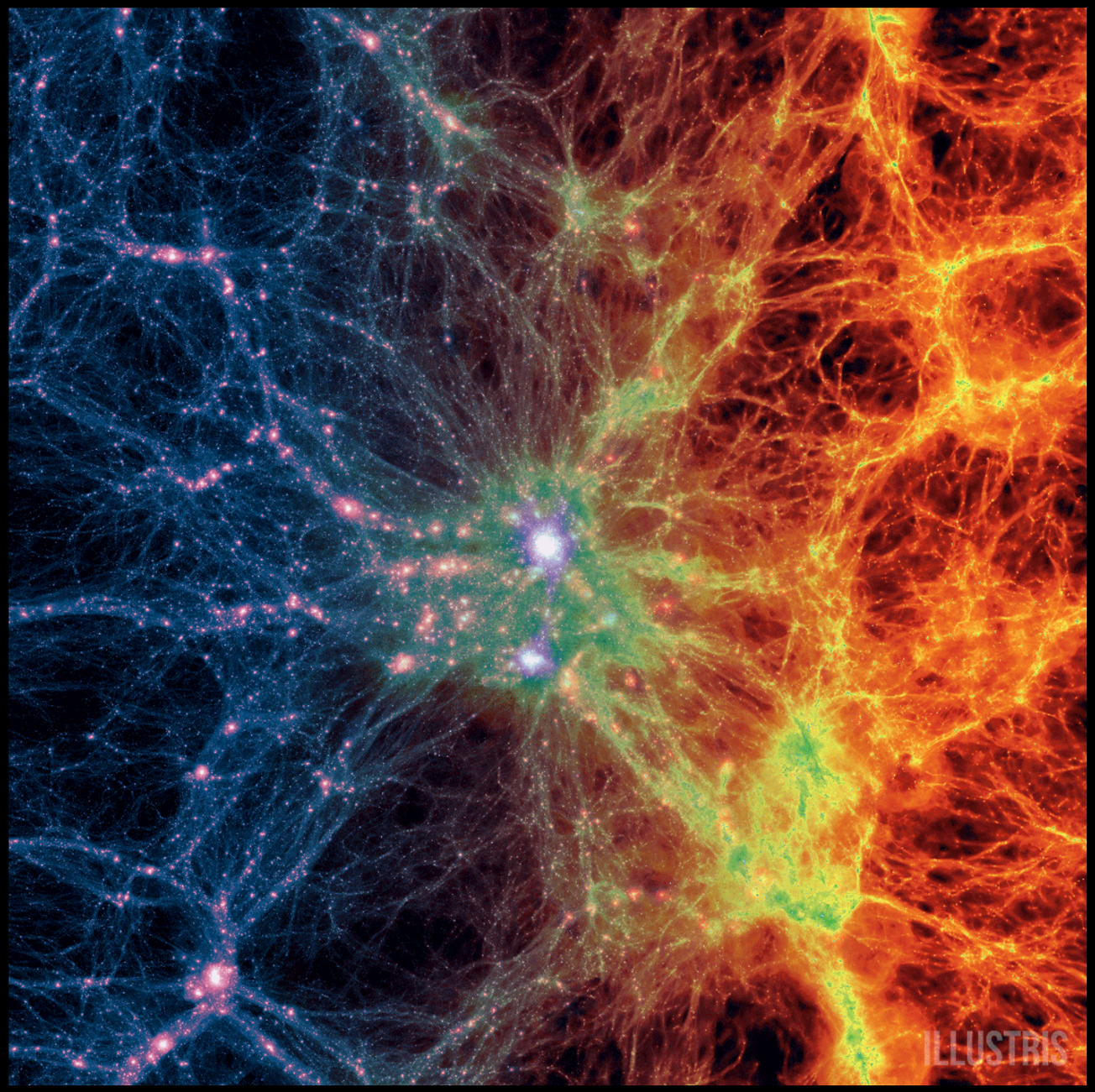
- **Star formation**

$$M_{*,\mathrm{inf}} = M_* - t_{\mathrm{inf}}\mathrm{SFR}(z_{\mathrm{inf}})$$

t_{inf} from *Giocoli et al. 2008*
SFR from *Buat et al. 2008*



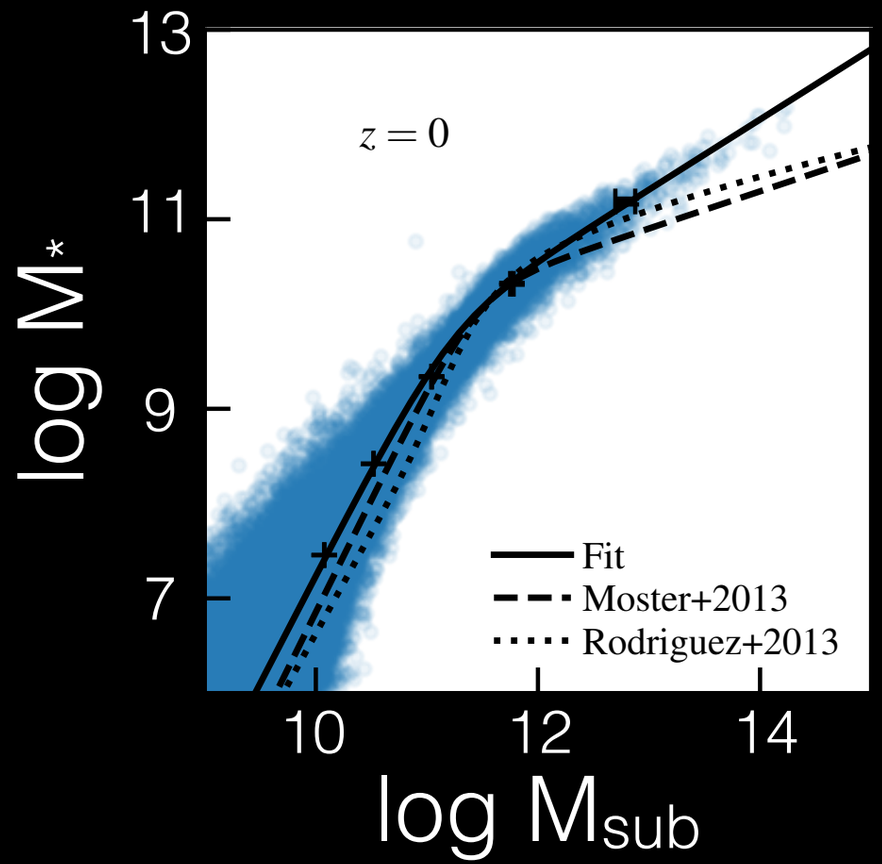
The Illustris simulation



- 3 cluster-like haloes: $M_{200} > 10^{14} h^{-1} M_{sol}$

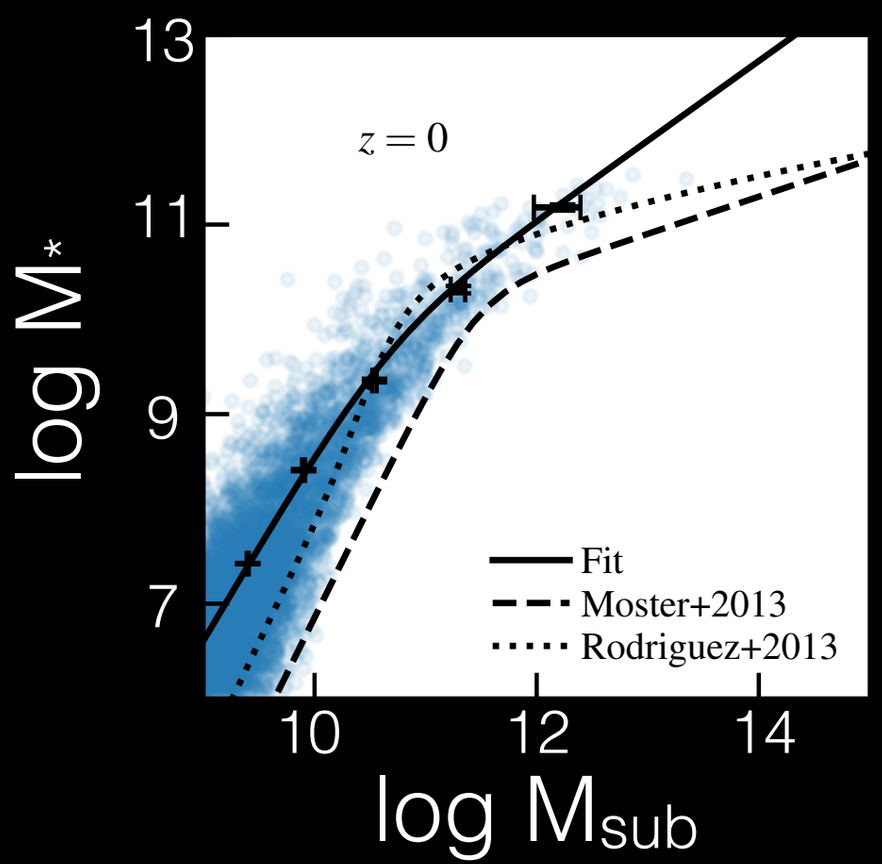
Vogelsberger et al. 2014 a et b

SHMR in the Illustris-1 simulation



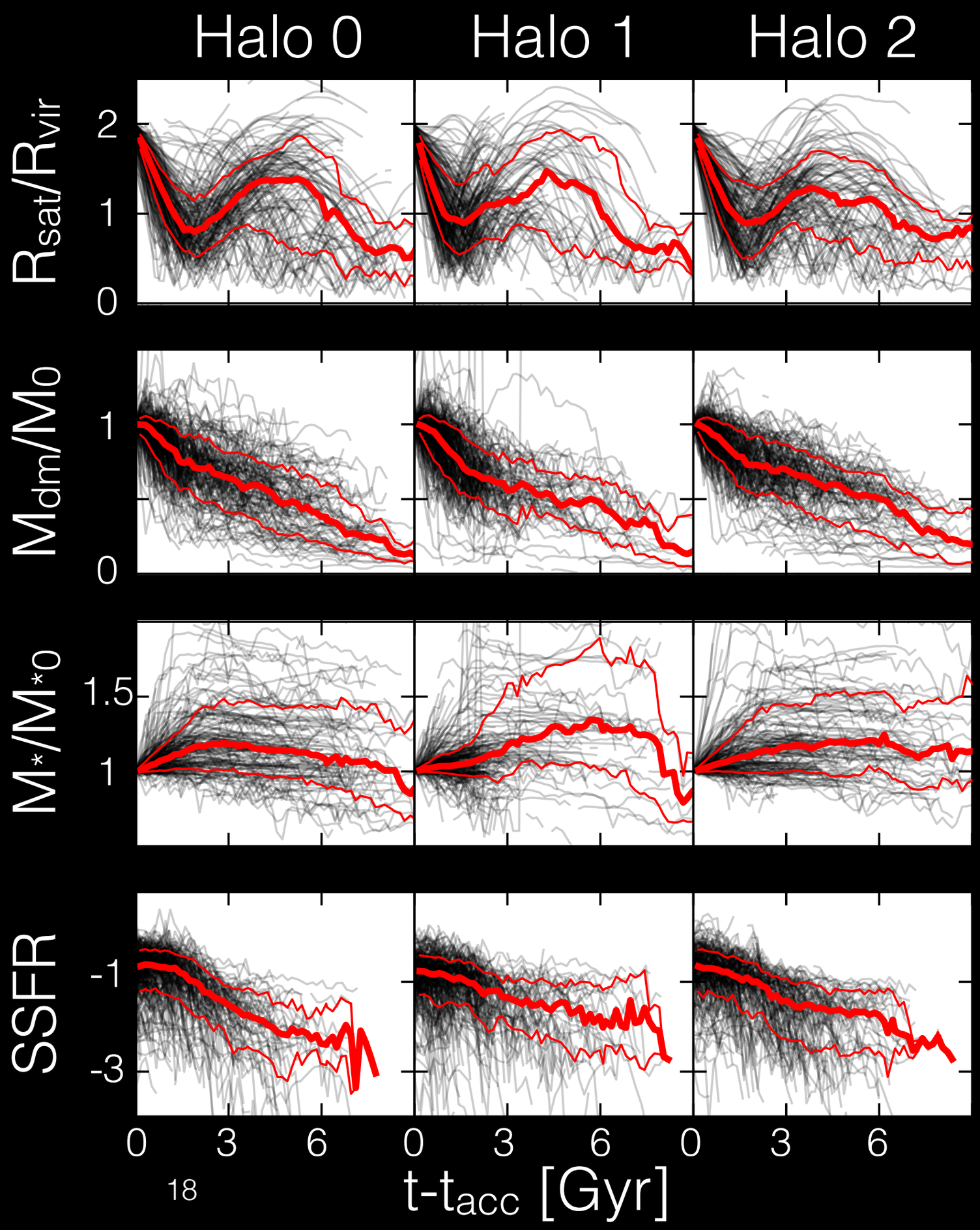
Haloes

Msub/Mh ~0.3
for each M*

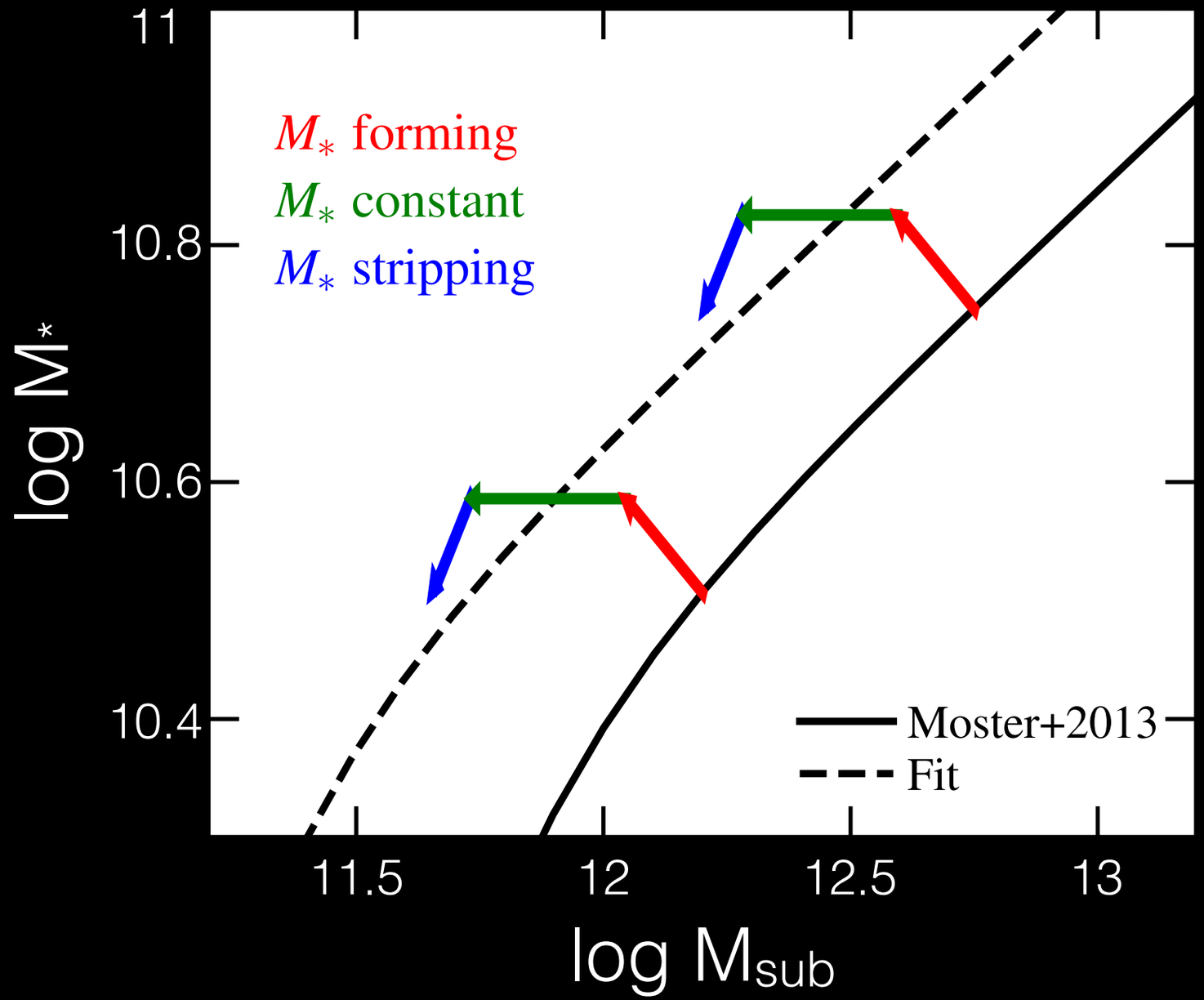


Subhaloes

- Evolution since the time of accretion
- Subhaloes: $M_{sub} > 10^{10}h^{-1}M_{sol}$
- Follow since *first* crossing of $R_{sat} = 2R_{vir}$



Evolution of the Stellar-to-Halo Mass relation



Summary

- Measure of Msub/Mstar for satellites at different cluster centric distances
- redMaPPer satellites & weak lensing surveys: CS82, CFHTLenS, DES-sv
- Dark matter tidal stripping shifts the stellar to halo mass relation to smaller halo masses (MNRAS 2017)
- Coevolution of satellite galaxies and their subhaloes in the Illustris simulation (submitted to MNRAS)

What’s next ?

- **Observations** : improve measurement of satellite SHMR -> more data (e.g DES) or better data (e.g BUFFALO)

- **Simulations** : full prediction of the expected lensing signal, more stats with IllustrisTNG