The low scatter of the stellar-to-halo mass relation

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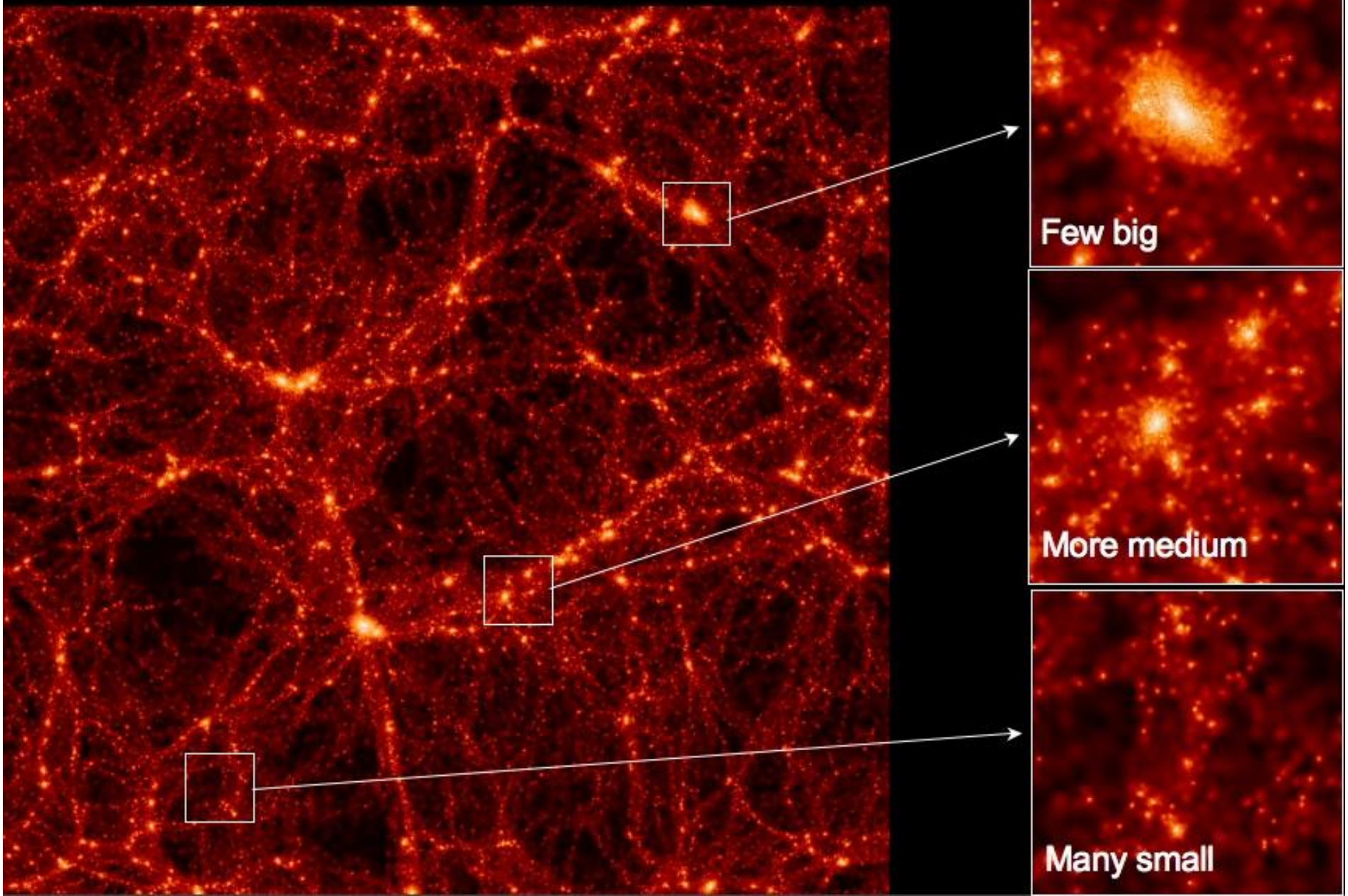
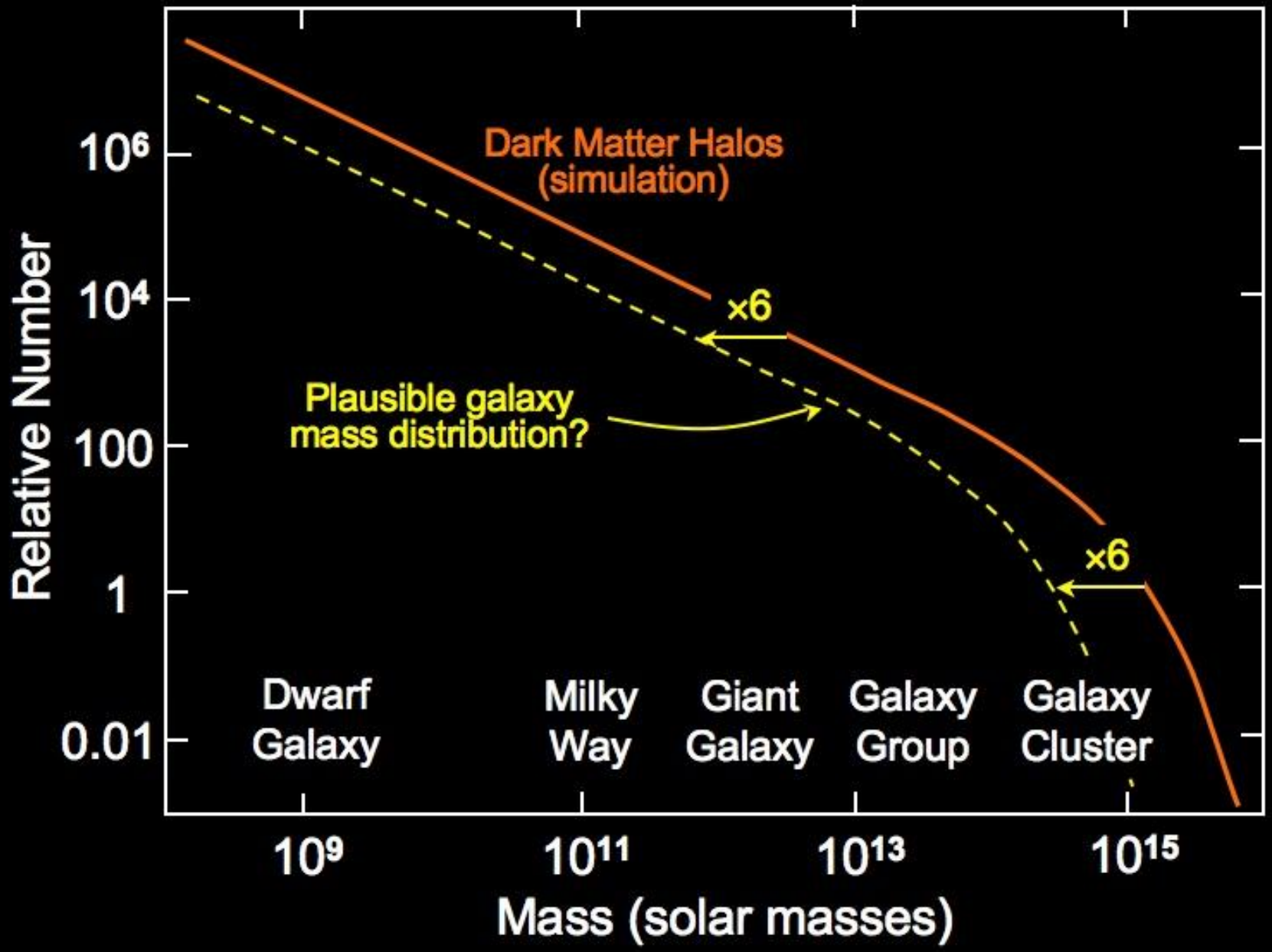
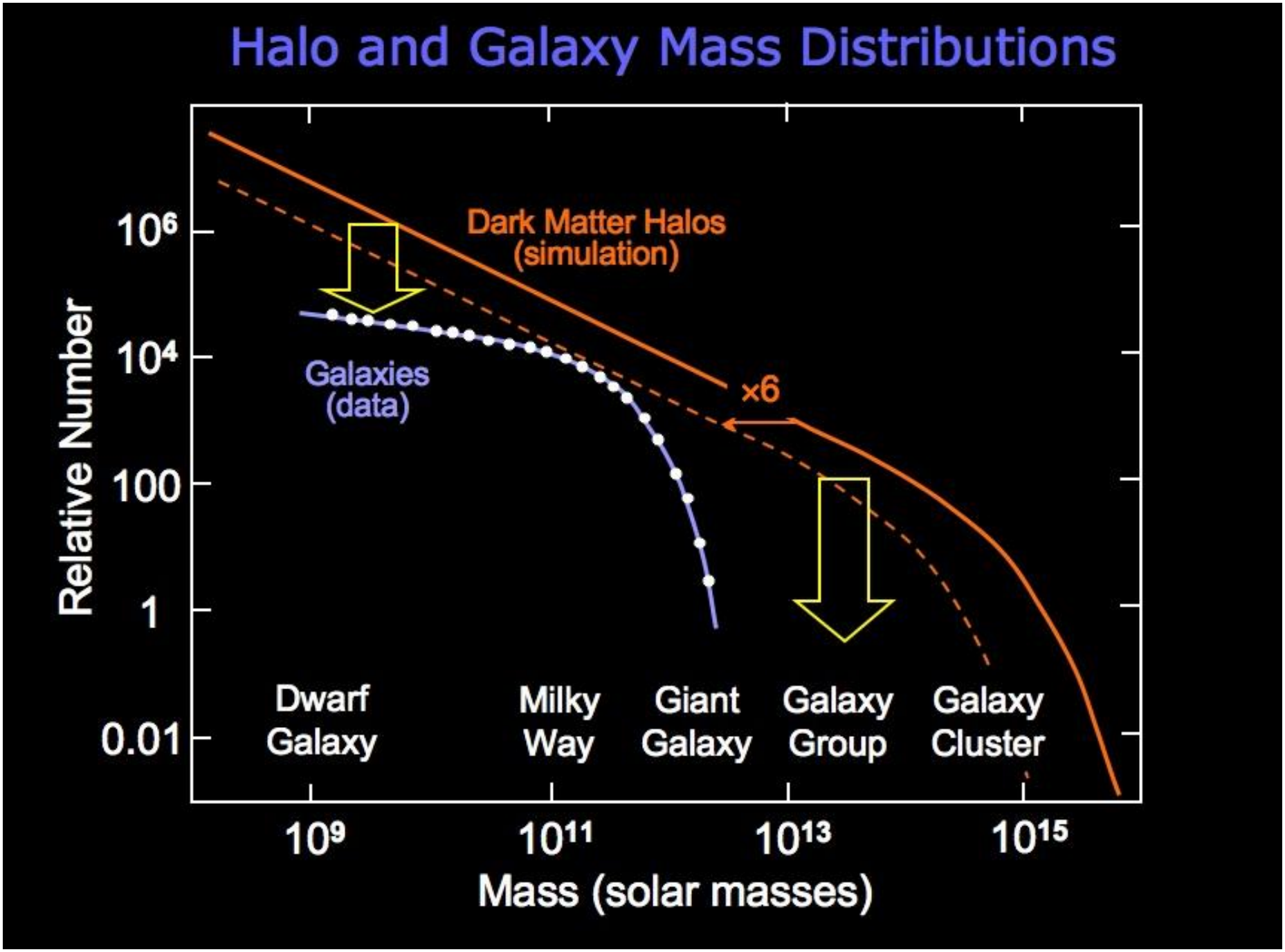
Cosmology on the Beach, Los Cabos, Mexico – 2014 January 17

The Web of Dark Matter Halos



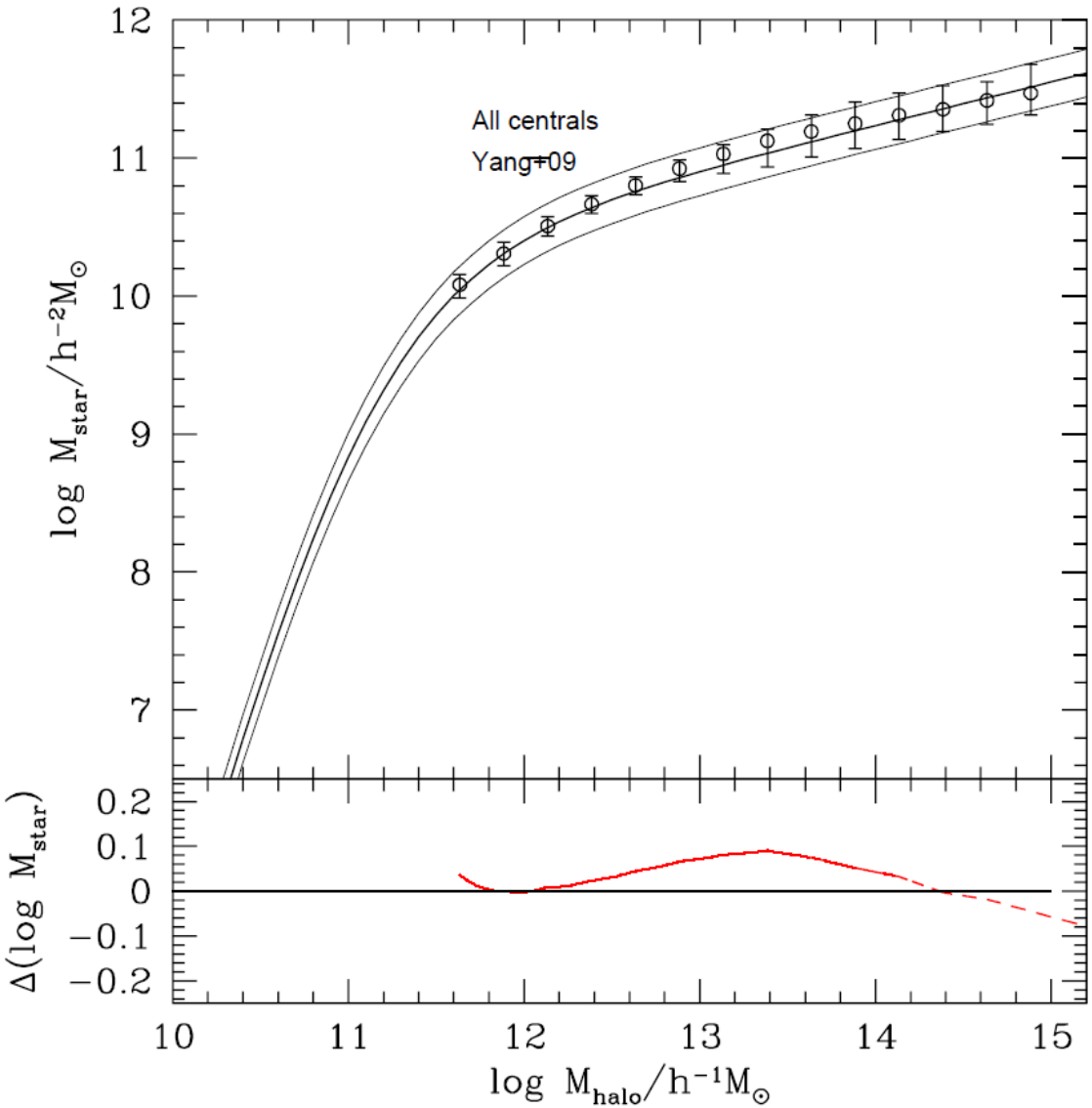
Halo and Galaxy Mass Distributions




Halo and Galaxy Mass Distributions
Dark Matter Halos
(simulation)
Galaxies
(data)
×6
Relative Number
10⁶
10⁴
100
1
0.01
Dwarf
Galaxy
Milky
Way
Giant
Galaxy
Galaxy
Group
Galaxy
Cluster
10⁹
10¹¹
10¹³
10¹⁵
Mass (solar masses)

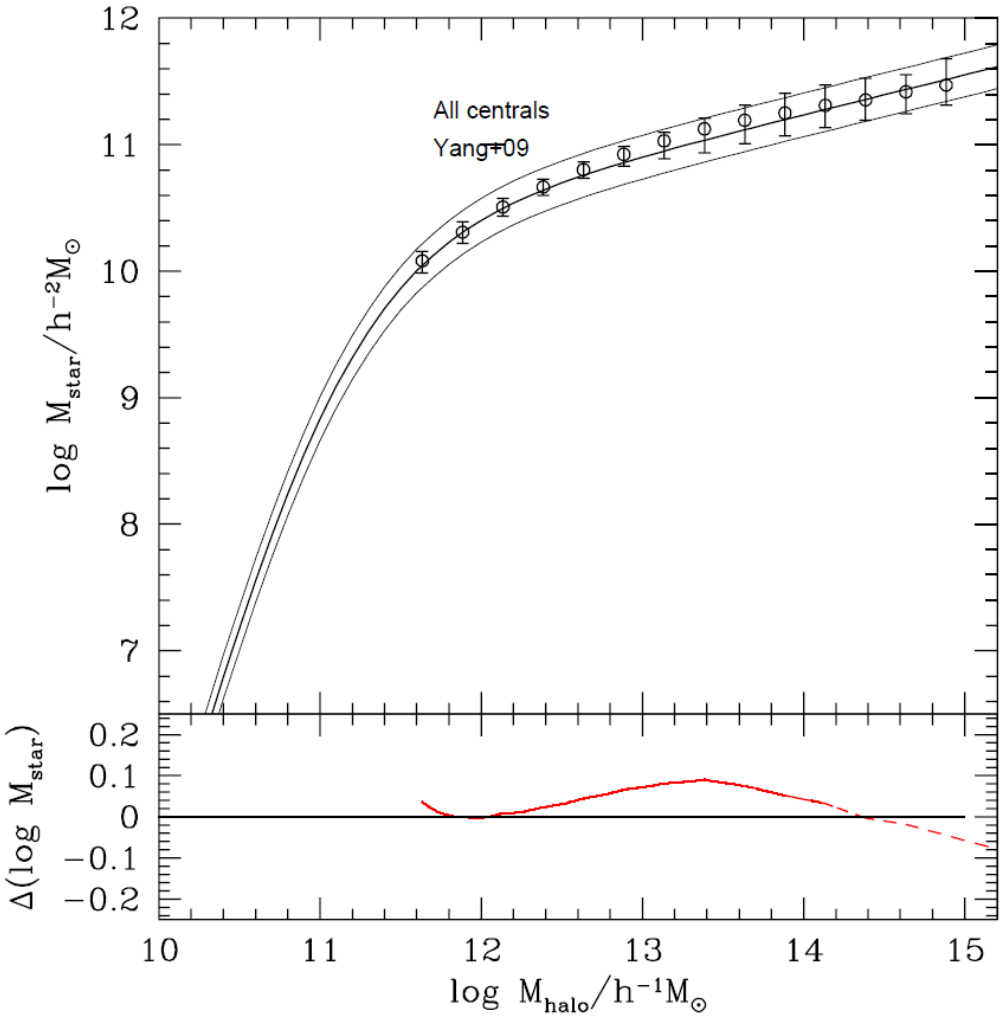
M_s-M_h relation of central galaxies

$\sigma \sim 0.17$ dex



Does the M_s-M_h relation depend on the environment?

How about its scatter? $\sigma \sim 0.17$ dex

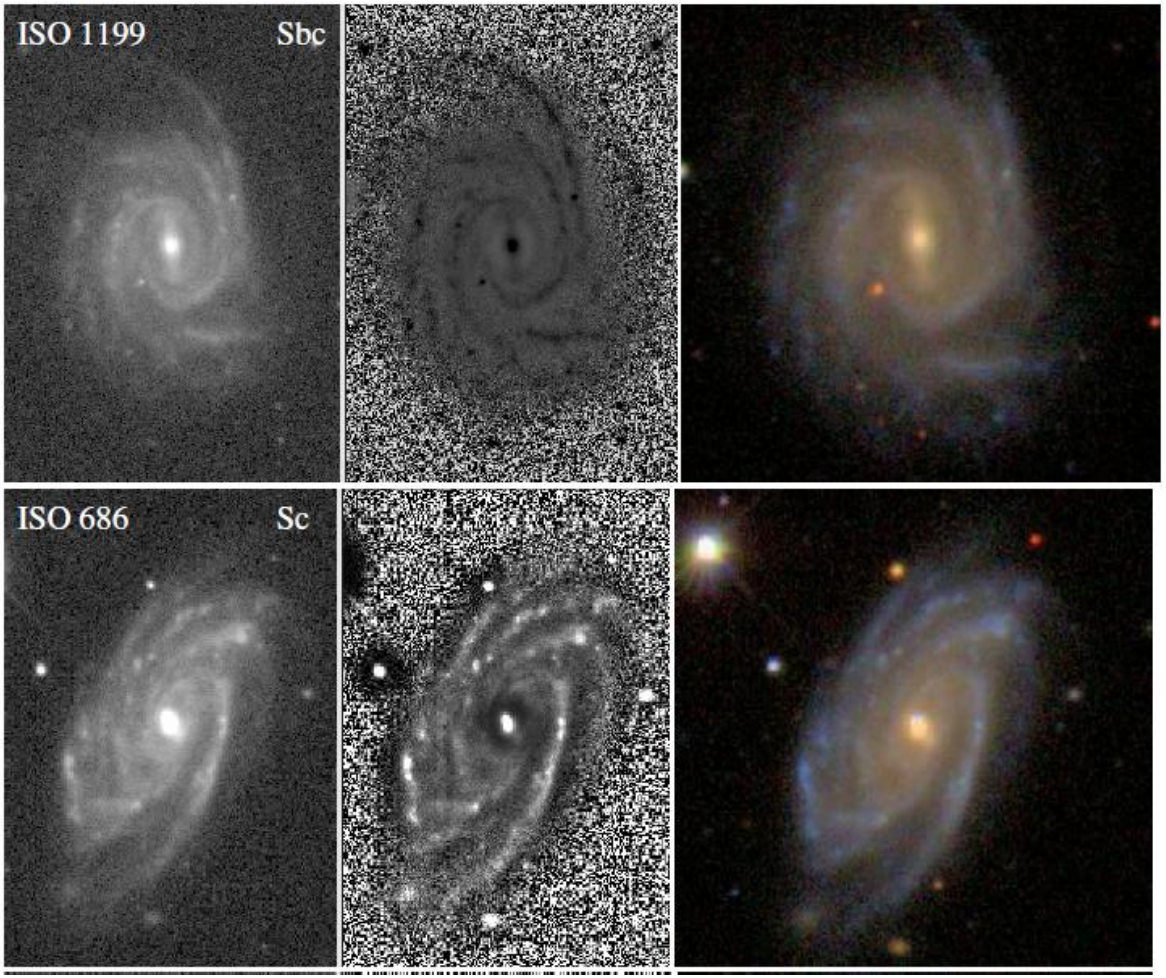


Galaxy Catalogs

- 369,447 galaxies from SDSS DR4
  - Yang et al. (2007, 2008, 2009)
  - 80% are central galaxies

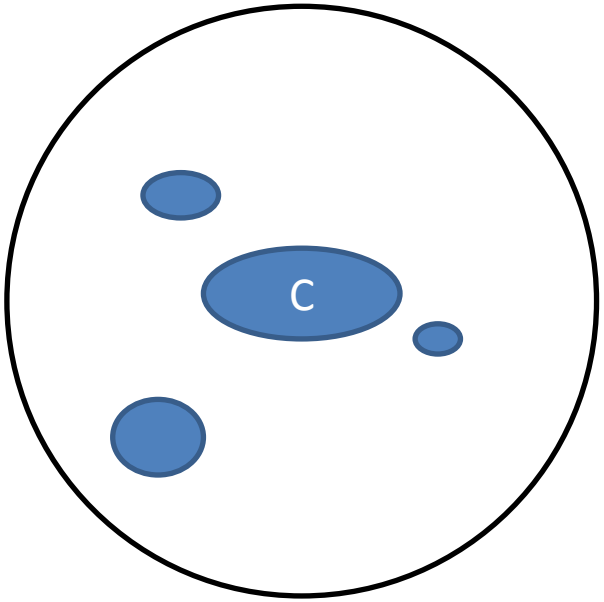
1520 Isolated galaxies:
UNAM-KIAS

Hernández-Toledo et al. (2010)



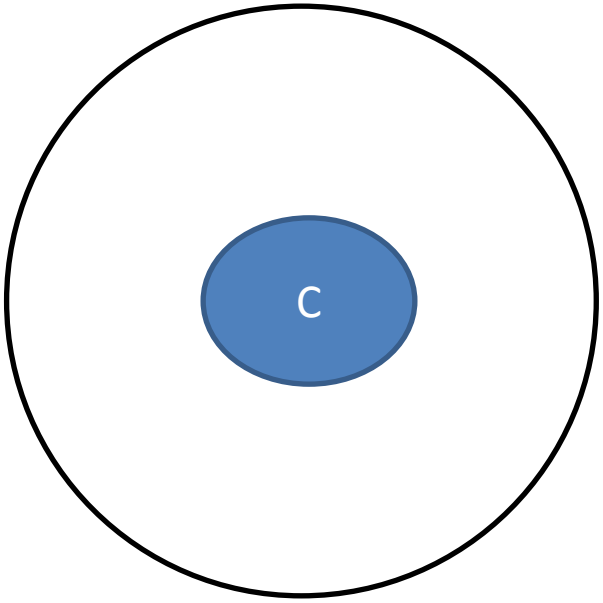
Group central

N > 1



Field central

N = 1

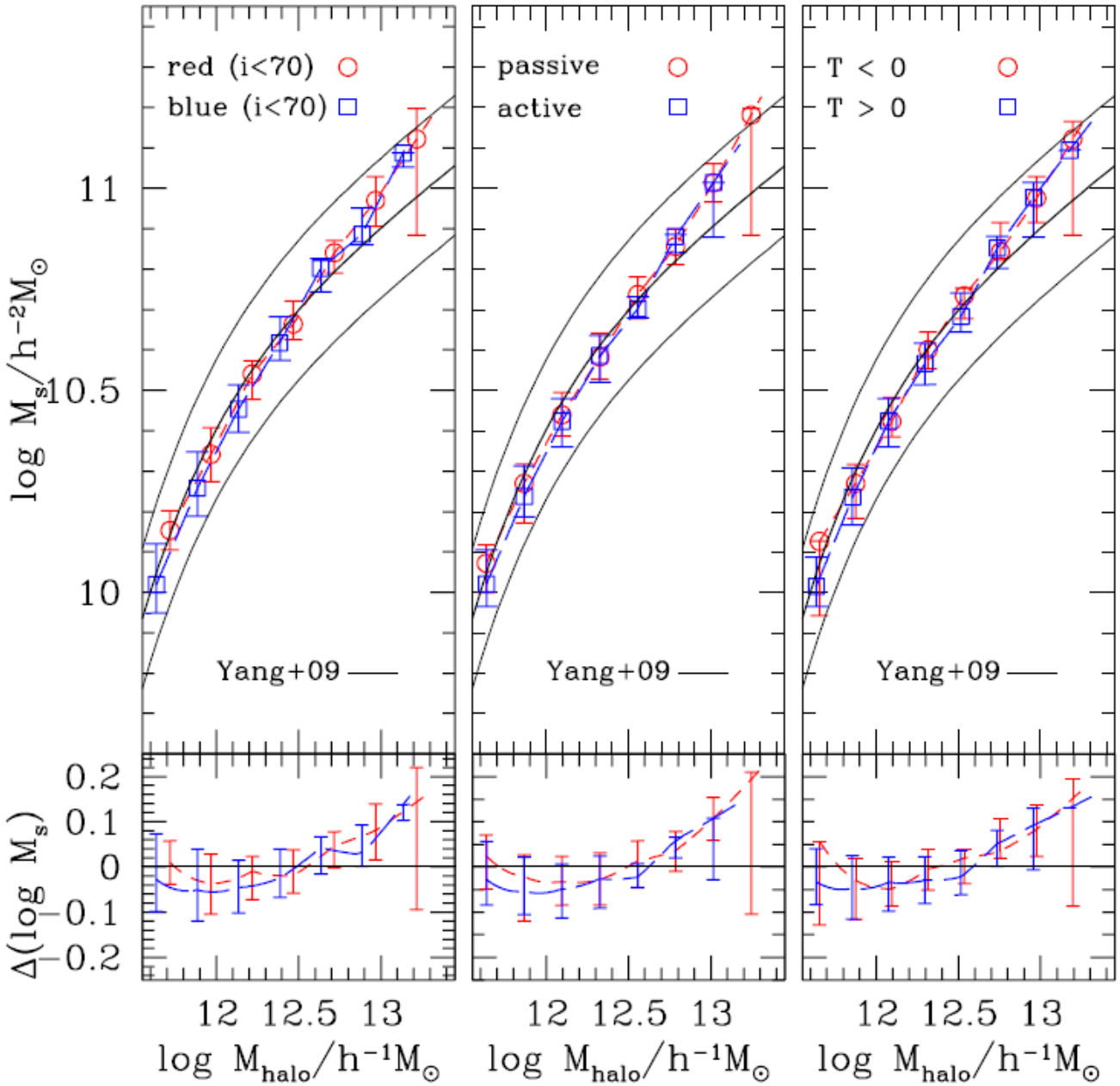


Group, Field and Isolated central galaxies

General properties of the central galaxy samples

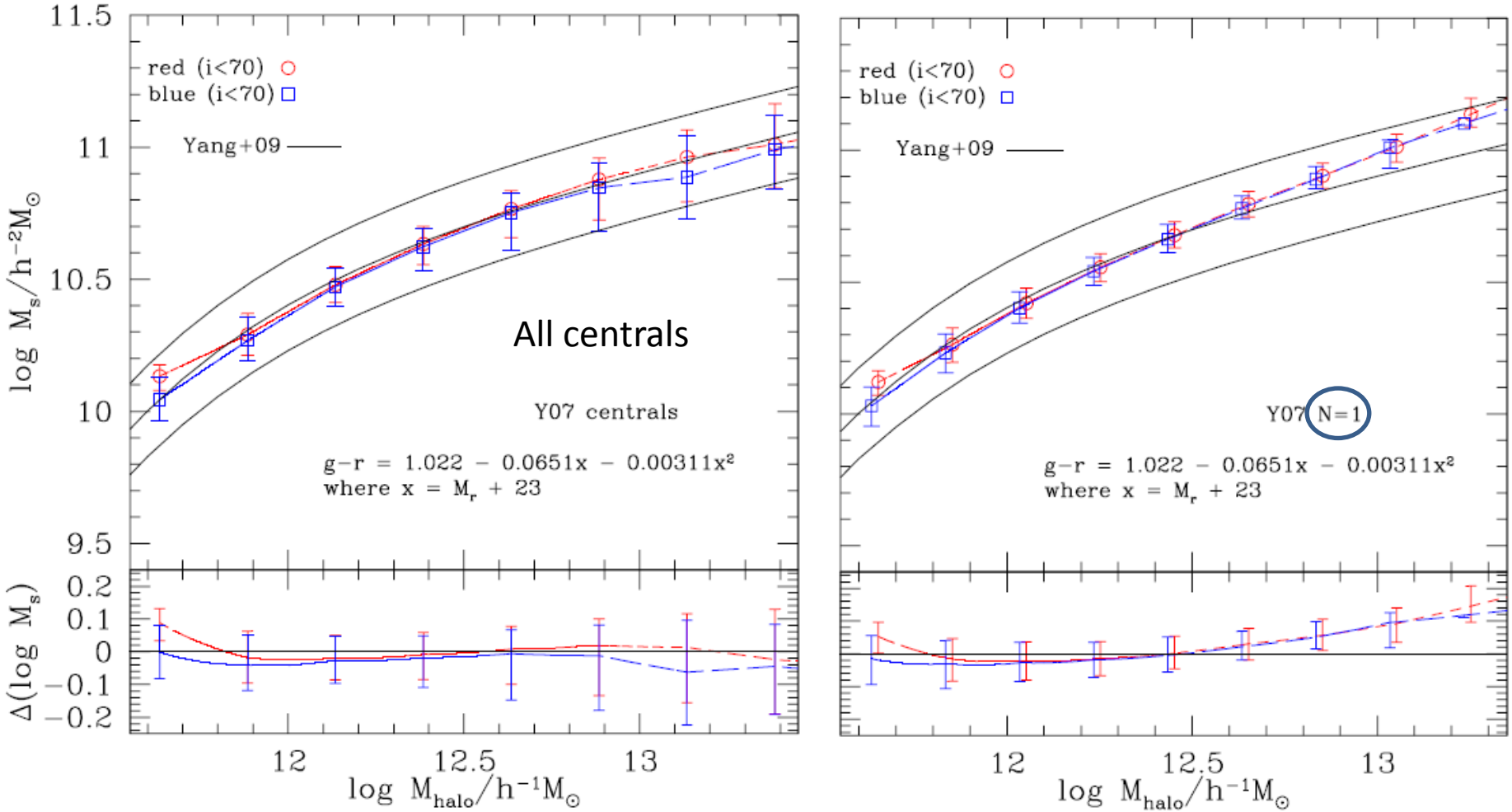
sample (1)	N (2)	source catalog (3)	z-range (4)	m_r limit (5)	n (6)	n_{M_h} (7)
group	> 1	Y07	$0.01 \leq z \leq 0.08$	< 17.77	10708	9271
field	$= 1$	Y07	$0.01 \leq z \leq 0.08$	< 17.77	40551	28043
bright field[a]	$= 1$	Y07	$0.01 \leq z \leq 0.08$	< 15.2	4358	3420
isolated[b]	$= 1$	UNAM-KIAS	$0.01 \leq z \leq 0.08$	< 15.2	822	663

M_s-M_h relation for isolated galaxies



Lacerna et al.
arXiv:1311.6473

Shape and scatter of M_s-M_h relation depend on the mass distribution inside the halo



Lacerna et al.
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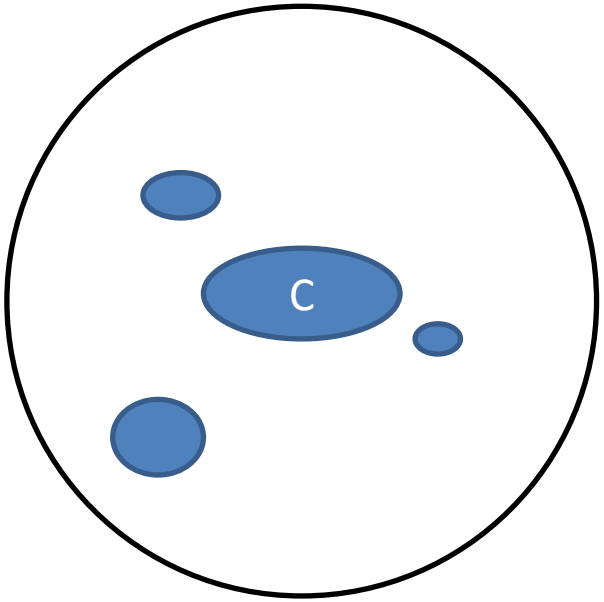
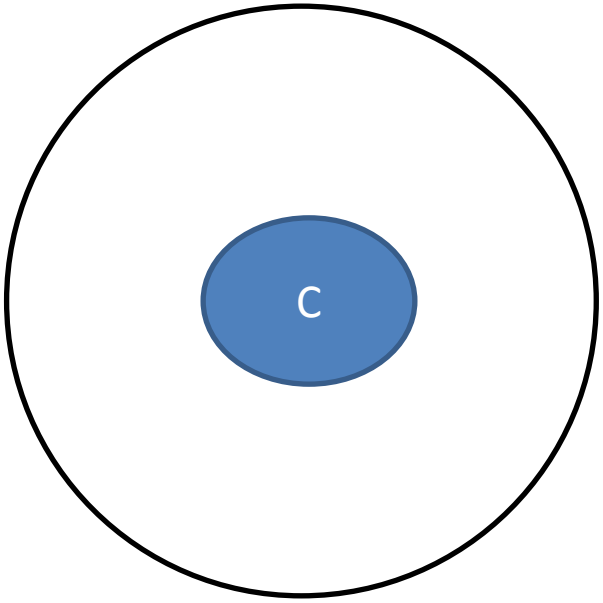
Group central

N > 1

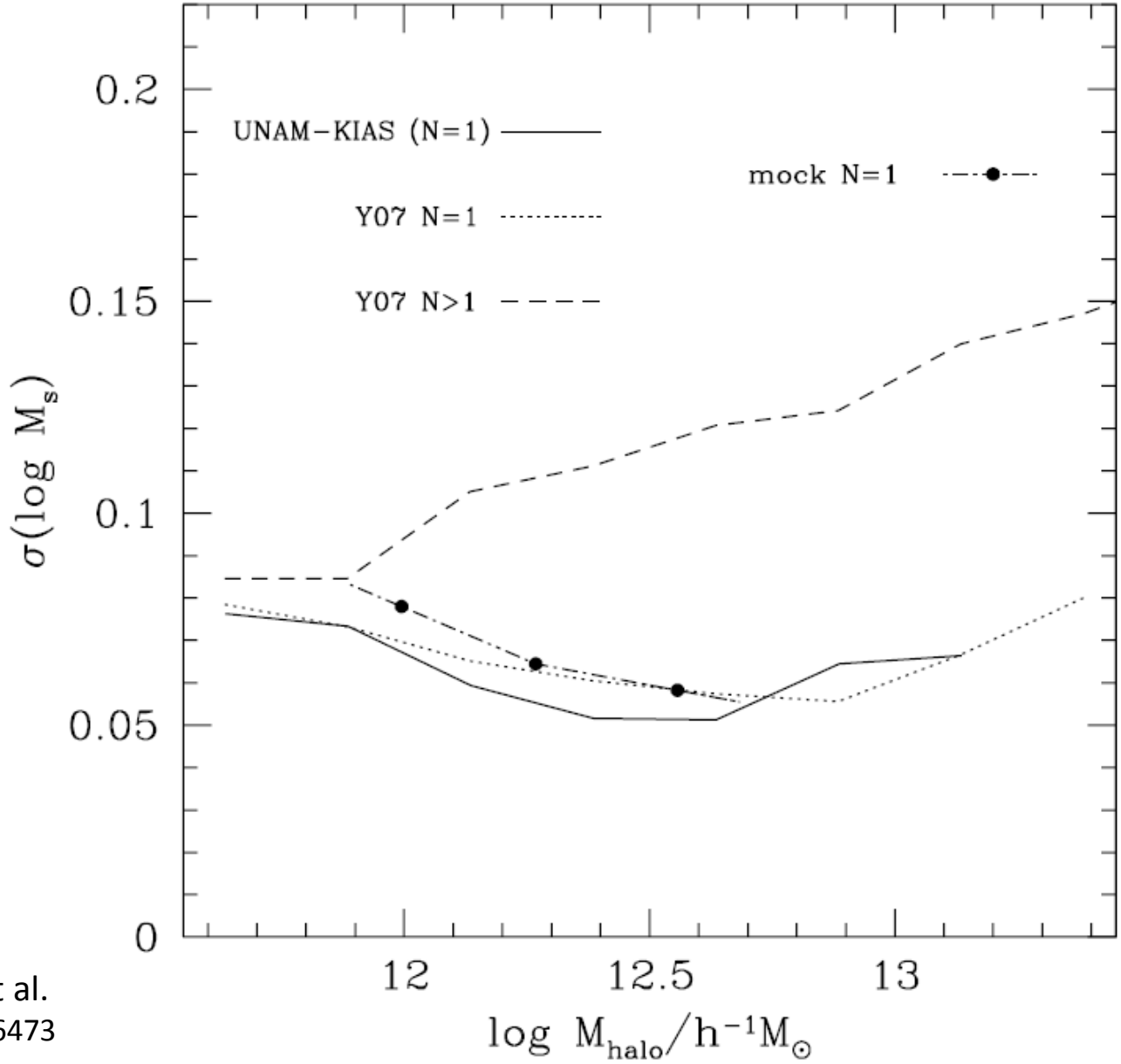


Field central

N = 1



Shape and scatter of M_s-M_h relation depend on the mass distribution inside the halo



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Conclusions

- Scatter around M_s-M_h relation of isolated and field central galaxies (both N=1) is smaller than 0.08 dex and roughly constant with M_h.
  - For group centrals (N>1) it is higher than 0.1 dex and increases with M_h
- Halo mass is the main driver of the stellar mass growth for central galaxies.
- Disentangling the reasons behind this small scatter will help us to understand the internal processes related to galaxy properties and their connection with halos.

Thanks!

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Isolated galaxies: UNAM-KIAS

- 1520 isolated galaxies from SDSS DR5
  - Hernández-Toledo et al. (2010)
- Selection criteria

$m_{r,i} < 15.2$

$$\Delta d \geqslant 100 \times R_j \quad (1)$$

$$\text{or } \Delta V \geqslant 1000 \text{ km s}^{-1}, \quad (2)$$

Δd: projected separation from a neighbor galaxy across the line of sight

R_j: (i-band) Petrosian radius of neighbor galaxy *j*

ΔV: radial velocity difference

Or the conditions

$$\Delta d < 100 \times R_j \quad (3)$$

$$\Delta V < 1000 \text{ km s}^{-1} \quad (4)$$

$$m_{r,j} \geqslant m_{r,i} + \Delta m_r, \quad (5)$$

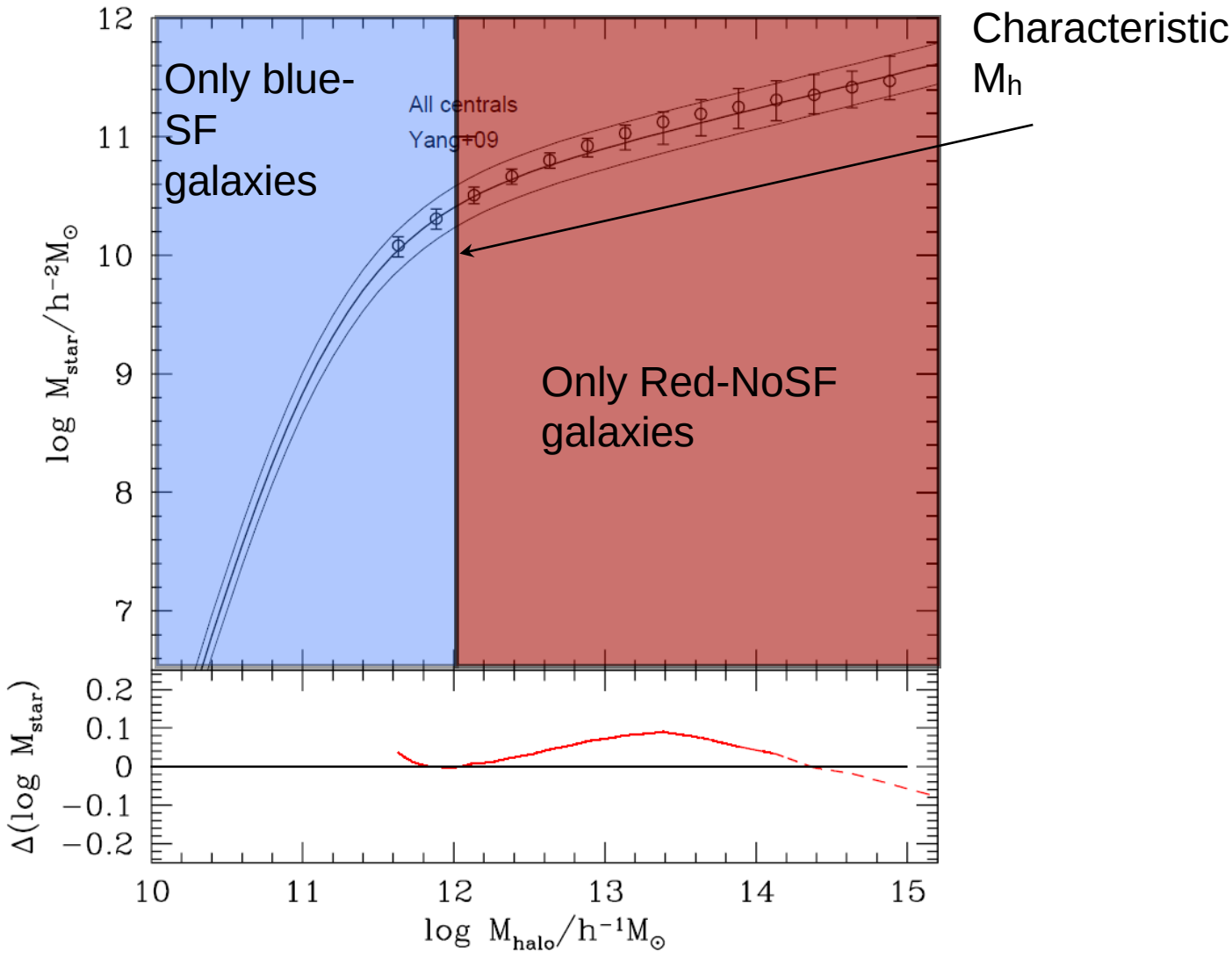
$$\Delta m_r = 2.5$$

$m_{r,i}$: *r*-band apparent magnitude of the candidate galaxy *i*

Δm_r: *r*-band apparent magnitude difference between the candidate galaxy *i* and the neighbor galaxy *j*

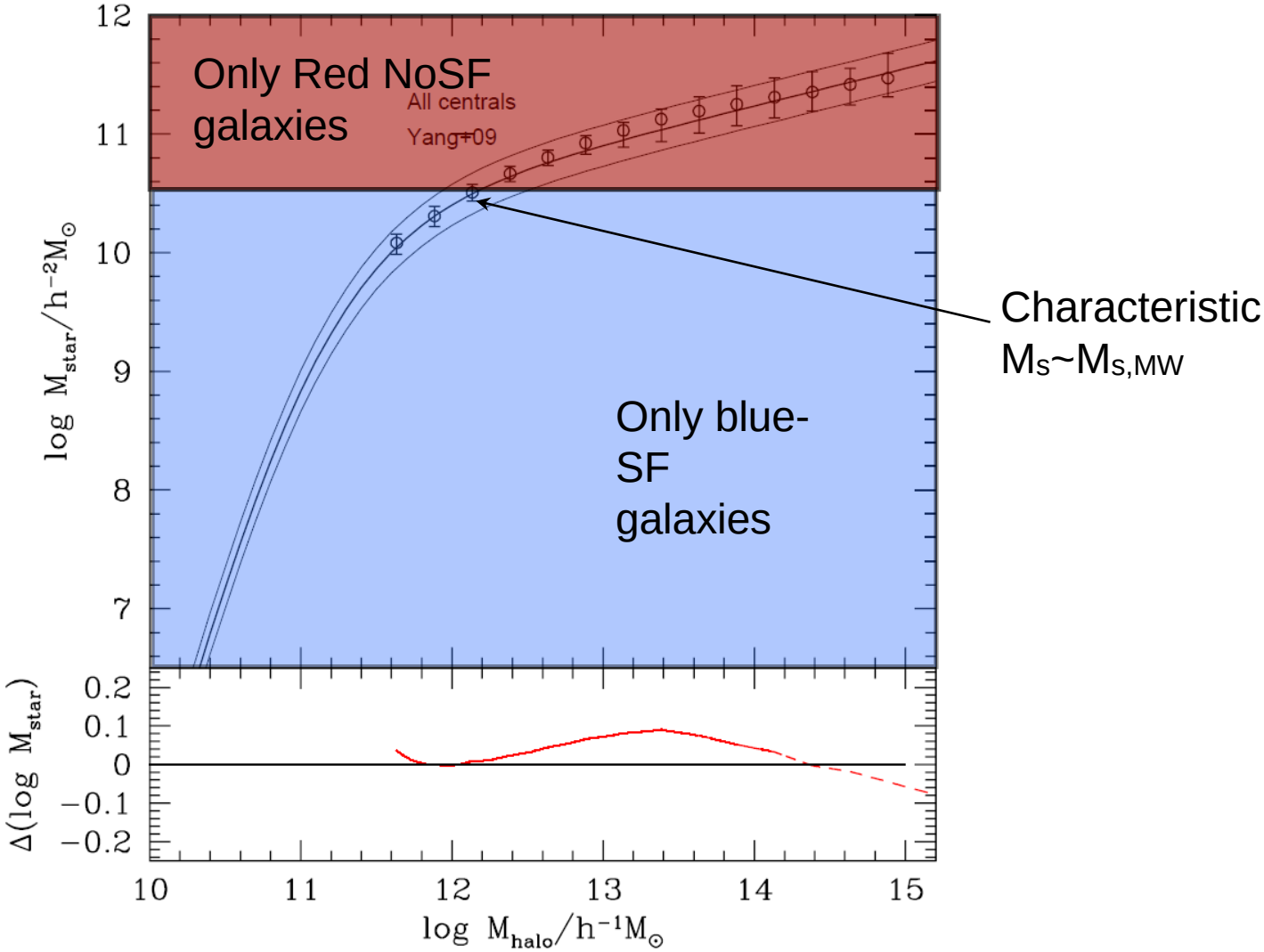
M_s-M_h relation of central galaxies

Case i: Halo mass is the main driver for the galaxy quenching

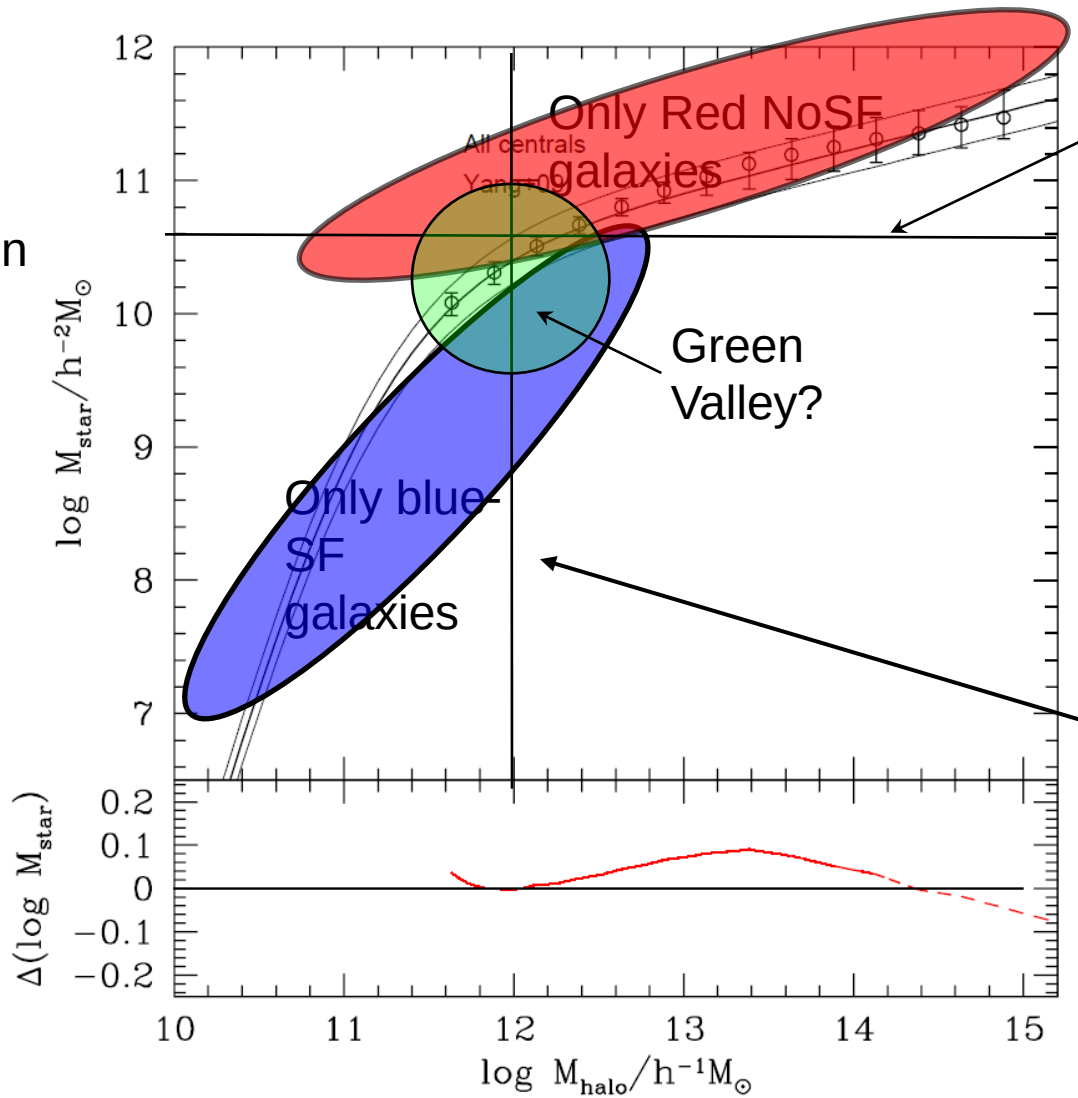


M_s-M_h relation of central galaxies

Case ii: Galaxy mass/Internal processes as the main drivers for the galaxy quenching



M_s-M_h relation of central galaxies

Case iii: Both halo and galaxy mass as the main drivers for the galaxy quenching

The M_s-M_h relation of red galaxies lies above of blue ones