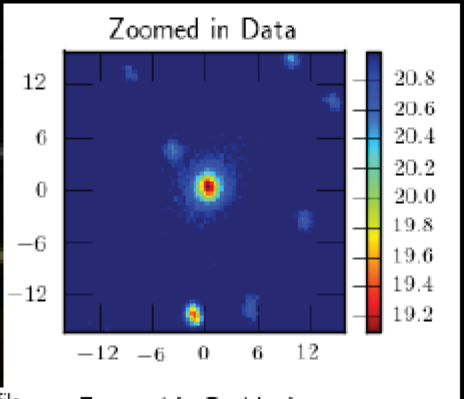
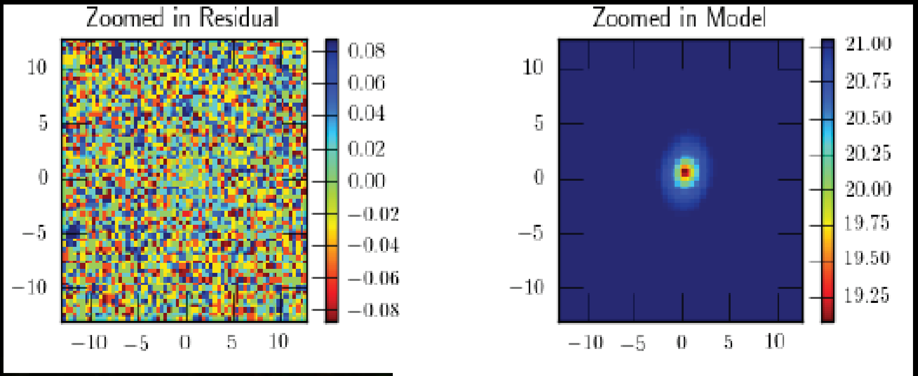
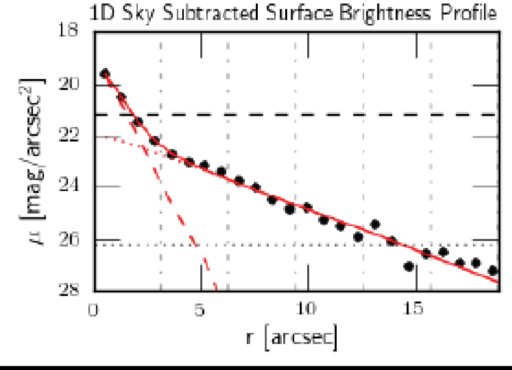
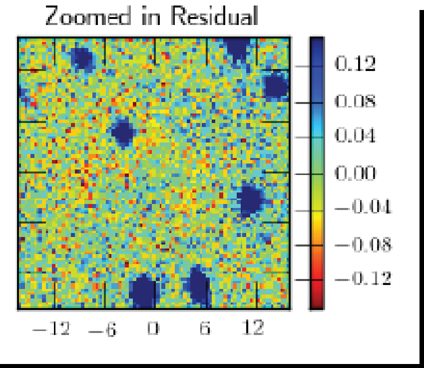
Clues on Elliptical galaxy formation from SDSS galaxy profiles

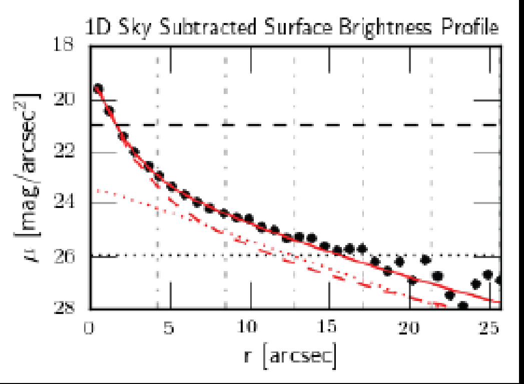
M. Bernardi, A. Meert et al.
UPenn



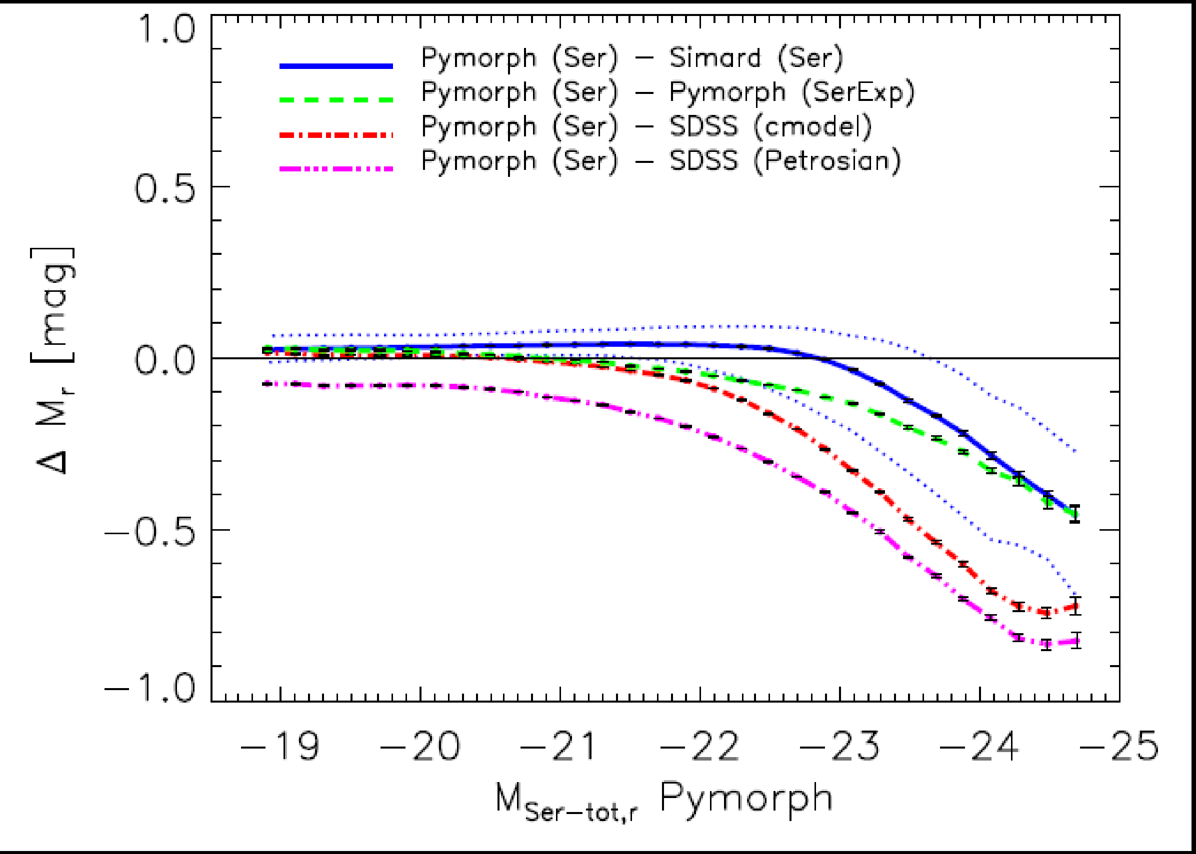








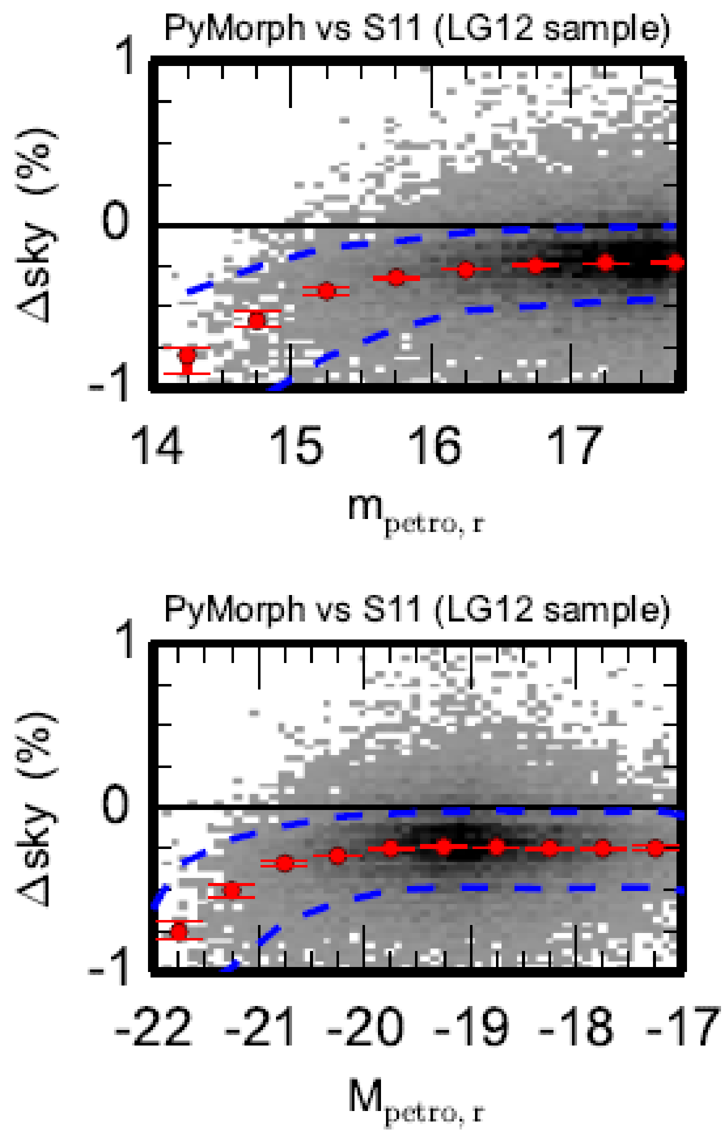
Better photometry of the SDSS brightest galaxies .....



- Dependence on fitting model
- Dependence on sky

Bernardi et al. 2013

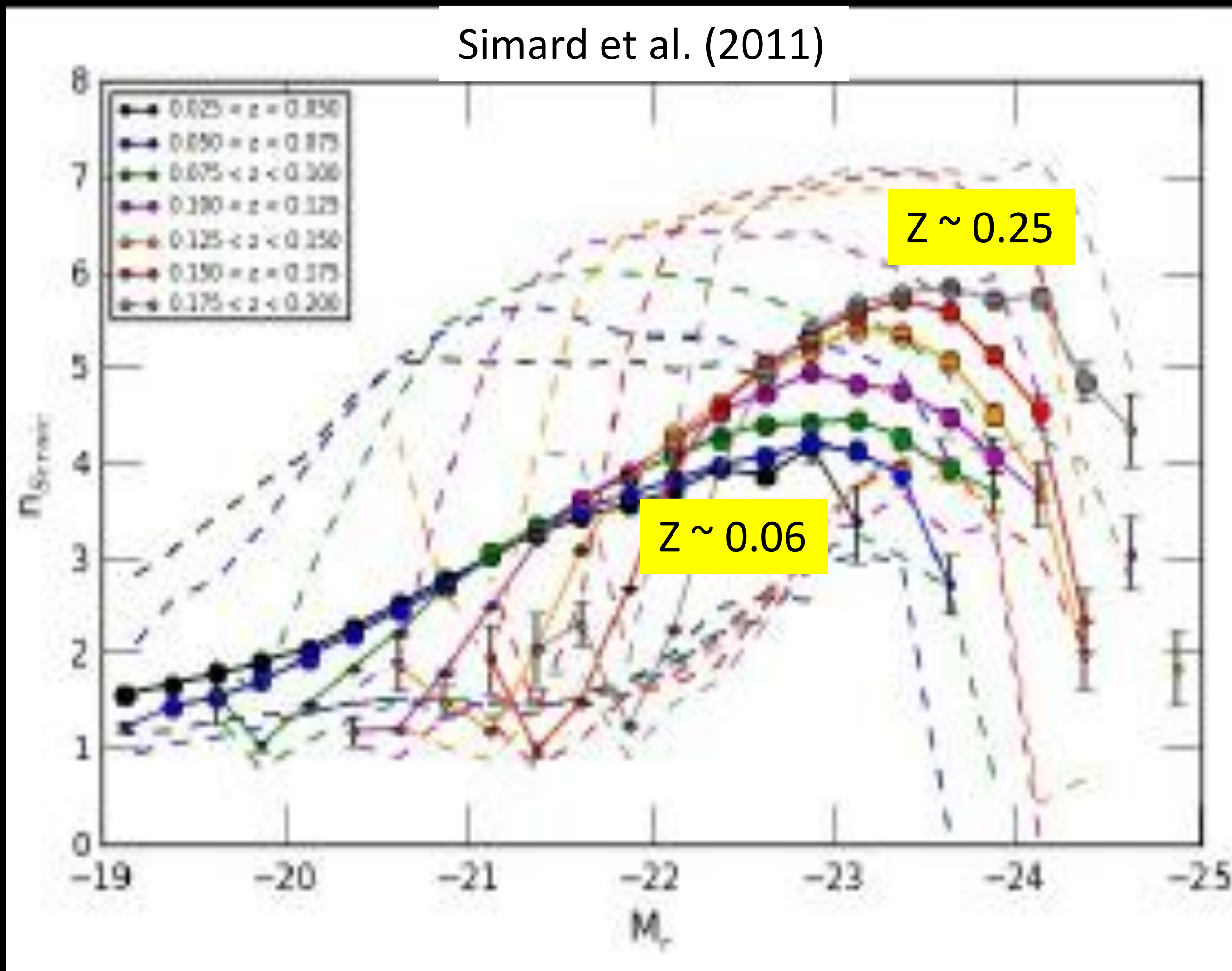
Dependence on sky



Meert , Vikram & MB 2014

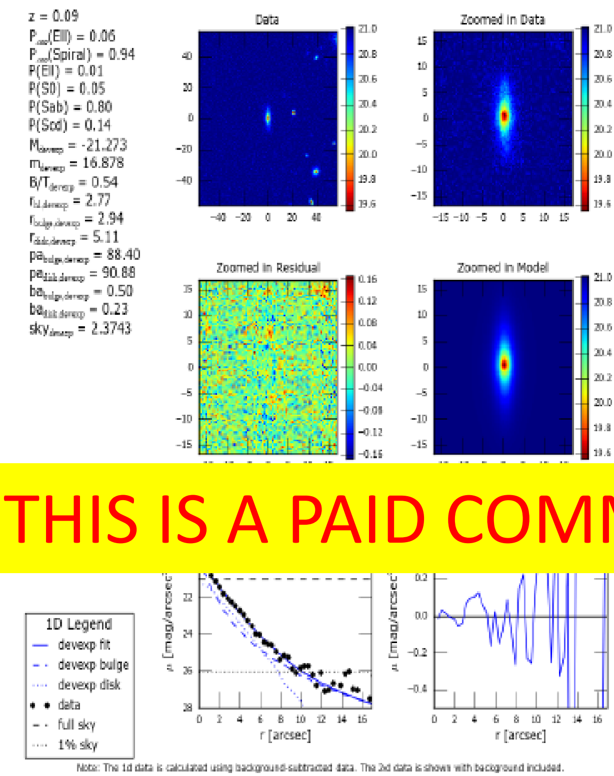
Sky subtraction problems also affect n_{Ser}

Bernardi et al 2014a



Welcome to the UPenn SDSS PhotDec Catalog!

Meert, Vikram & Bernardi (arXiv:1406.4179)



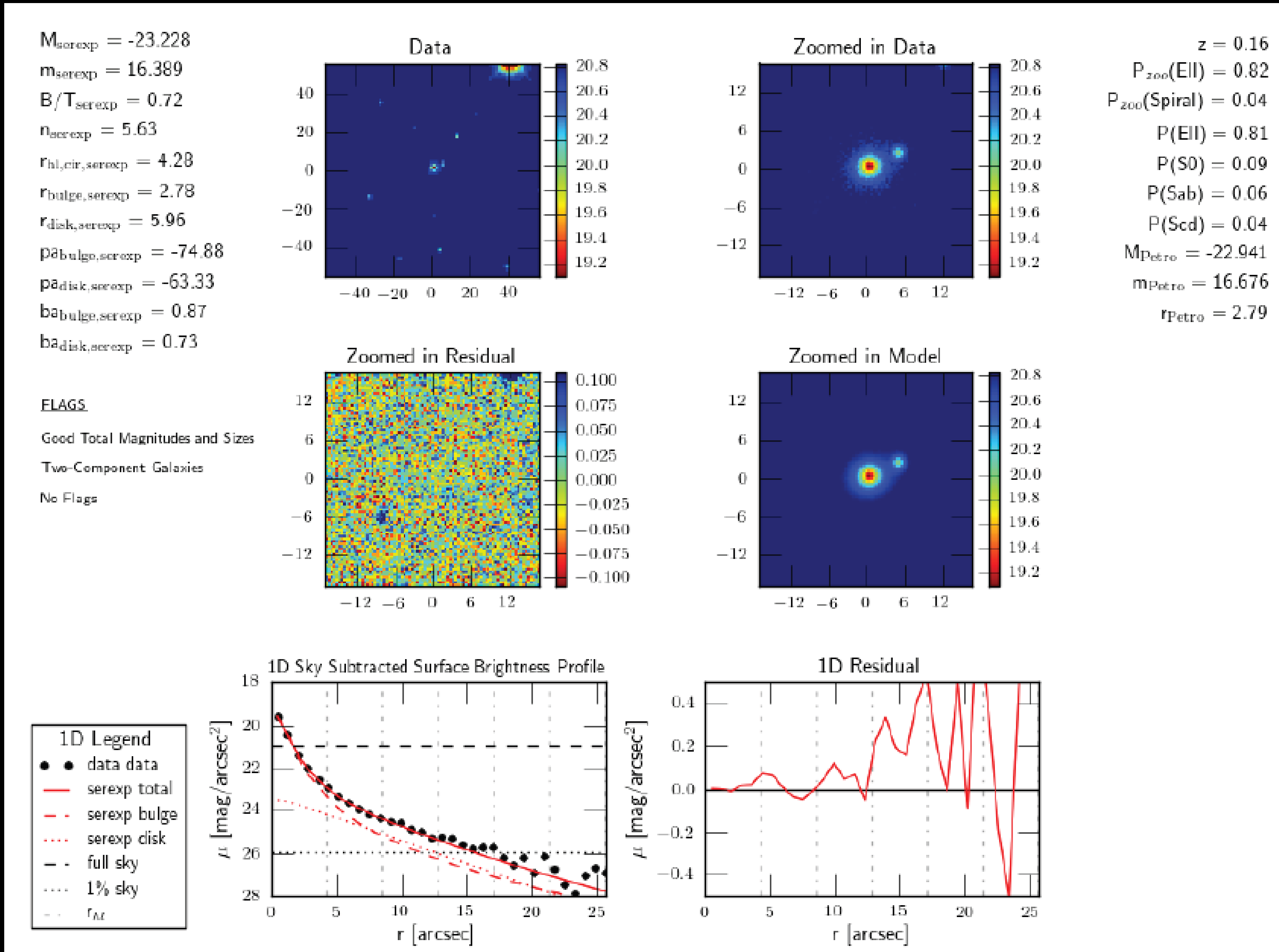
!!THIS IS A PAID COMMERCIAL ANNOUNCEMENT!!

The UPenn SDSS PhotDec Catalog provides 2-d galaxy profile fits in several visible bands using SDSS data. Additional data collected from other sources is provided to facilitate analysis. The catalog is constructed and maintained by Mariangela Bernardi, Alan Meert and Vinu Vikram. To learn more about the catalog visit the other sections.

Explore the Catalog

About the Catalog
PLOTS!!! Radius vs. Magnitude | Sersic vs. Radius | Sersic vs. Magnitude
View the Galaxies
Classify the Galaxies
Download the Catalog Data

http://shalaowai.physics.upenn.edu/~ameert/fit_catalog/



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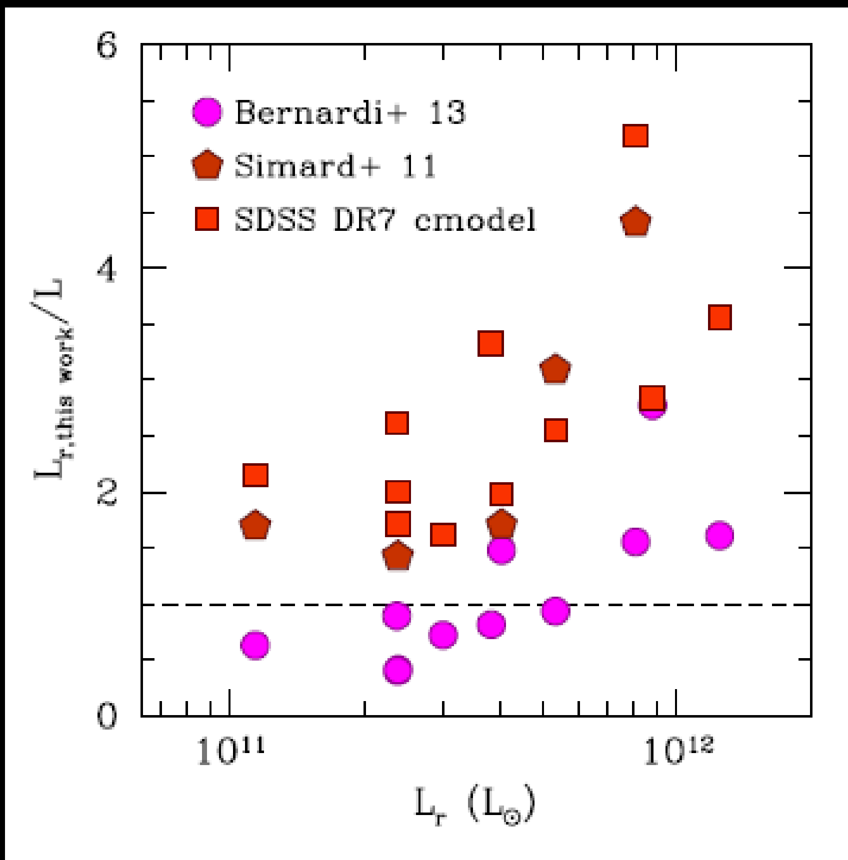
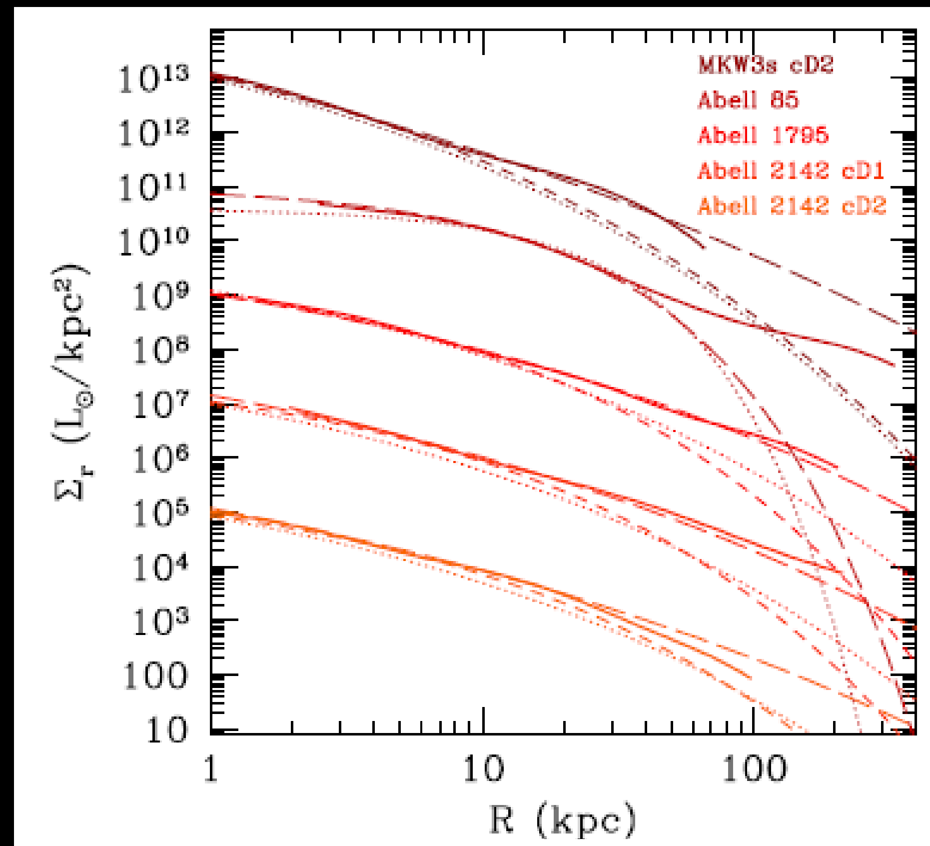
m_serexp = 16.389
B/T_serexp = 0.72
n_serexp = 5.63
r_hl,cir,serexp = 4.28
r_bulge,serexp = 2.78
r_disk,serexp = 5.96
pa_bulge,serexp = -74.88
pa_disk,serexp = -63.33
ba_bulge,serexp = 0.87
ba_disk,serexp = 0.73
FLAGS
Good Total Magnitudes and Sizes
Two-Component Galaxies
No Flags
Data
Zoomed in Data
Zoomed in Residual
Zoomed in Model
z = 0.16
P_zoo(Ell) = 0.82
P_zoo(Spiral) = 0.04
P(Ell) = 0.81
P(S0) = 0.09
P(Sab) = 0.06
P(Scd) = 0.04
M_Petro = -22.941
m_Petro = 16.676
r_Petro = 2.79
1D Legend
data data
serexp total
serexp bulge
serexp disk
full sky
1% sky
1D Sky Subtracted Surface Brightness Profile
μ [mag/arcsec²]
r [arcsec]
1D Residual

Measurements in close agreement with other photometry of nearby clusters



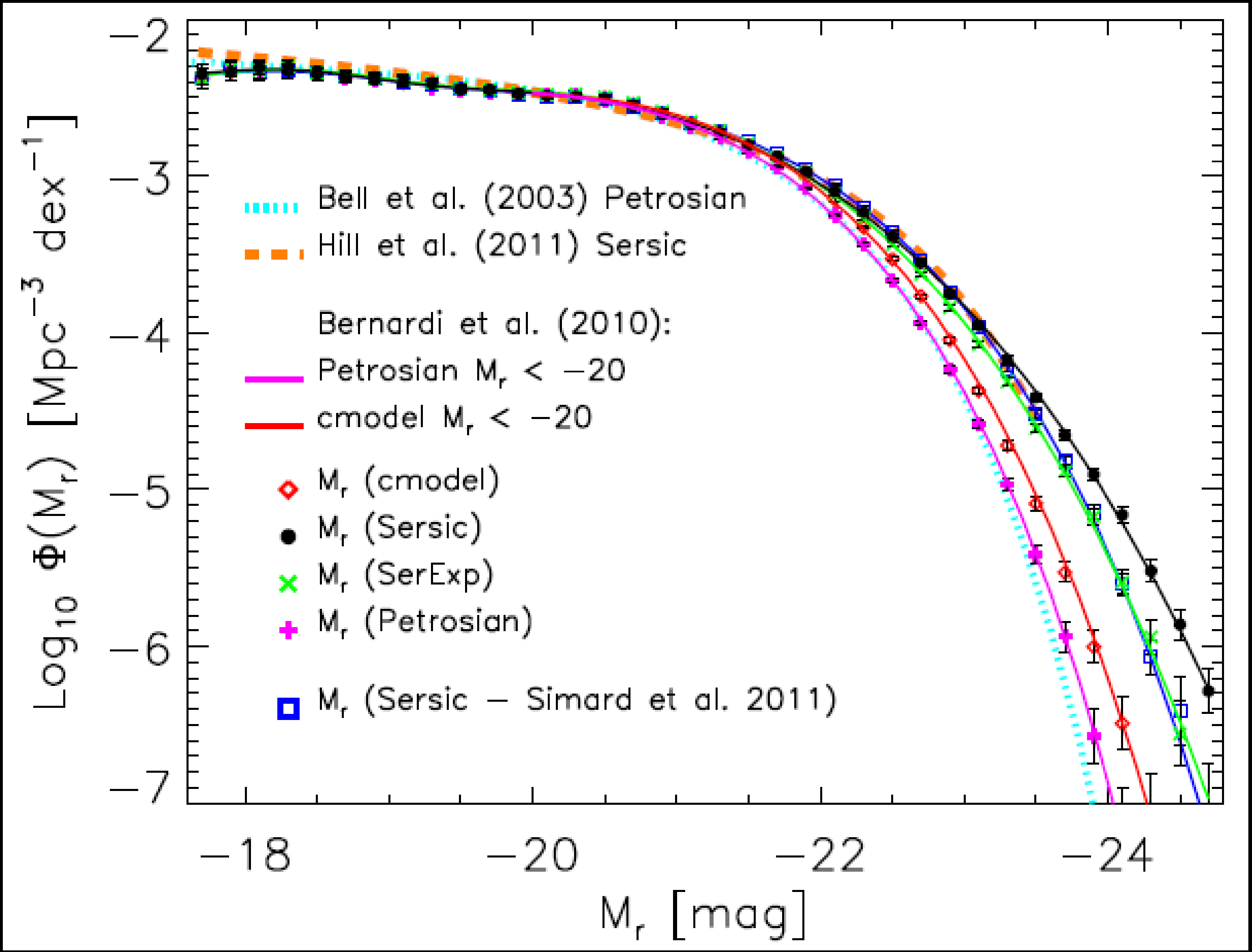
Kravtsov et al. 2014



Kravtsov et al.
Meert, Vikram & MB
Simard et al.

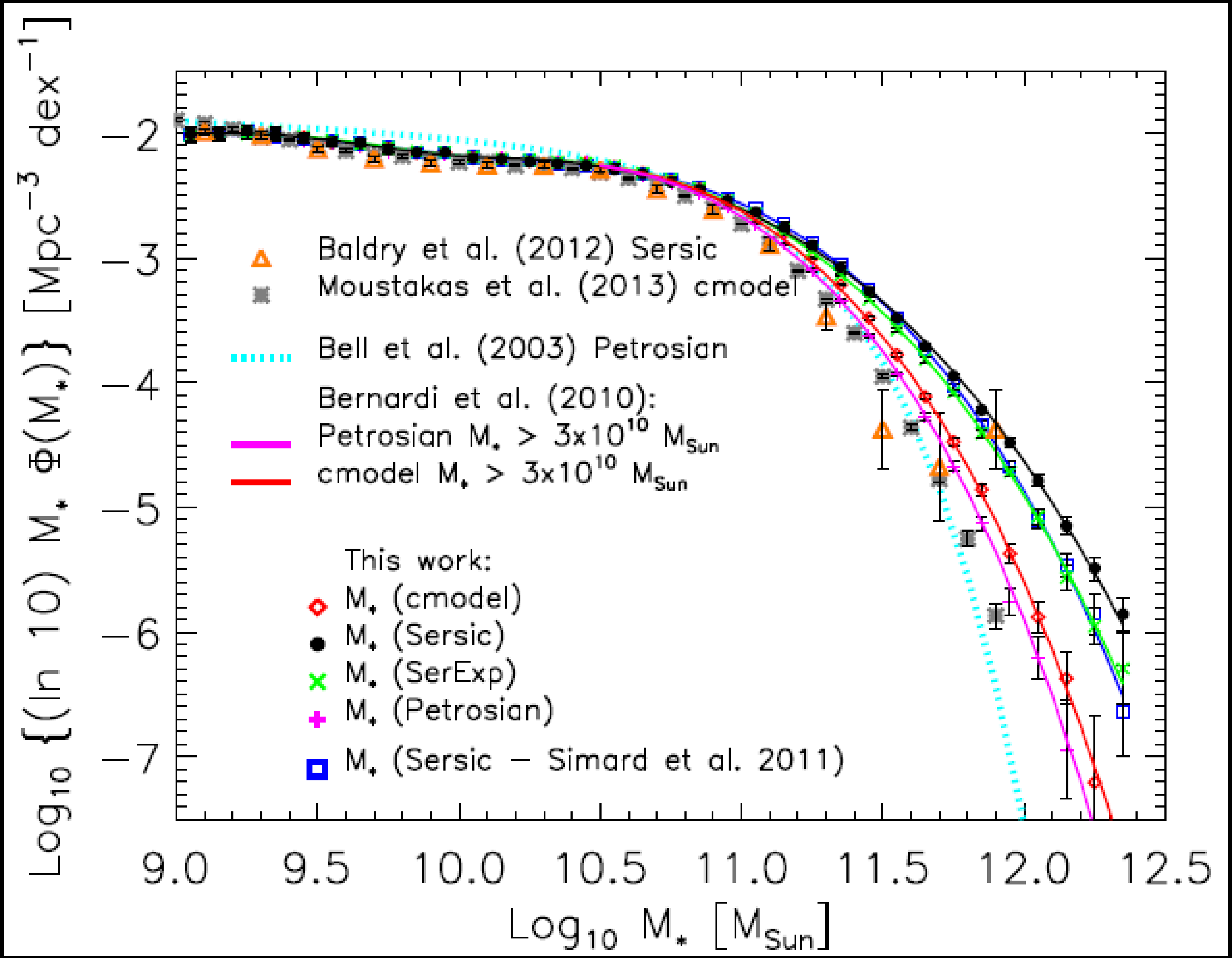
Luminosity Function

Bernardi et al. 2013

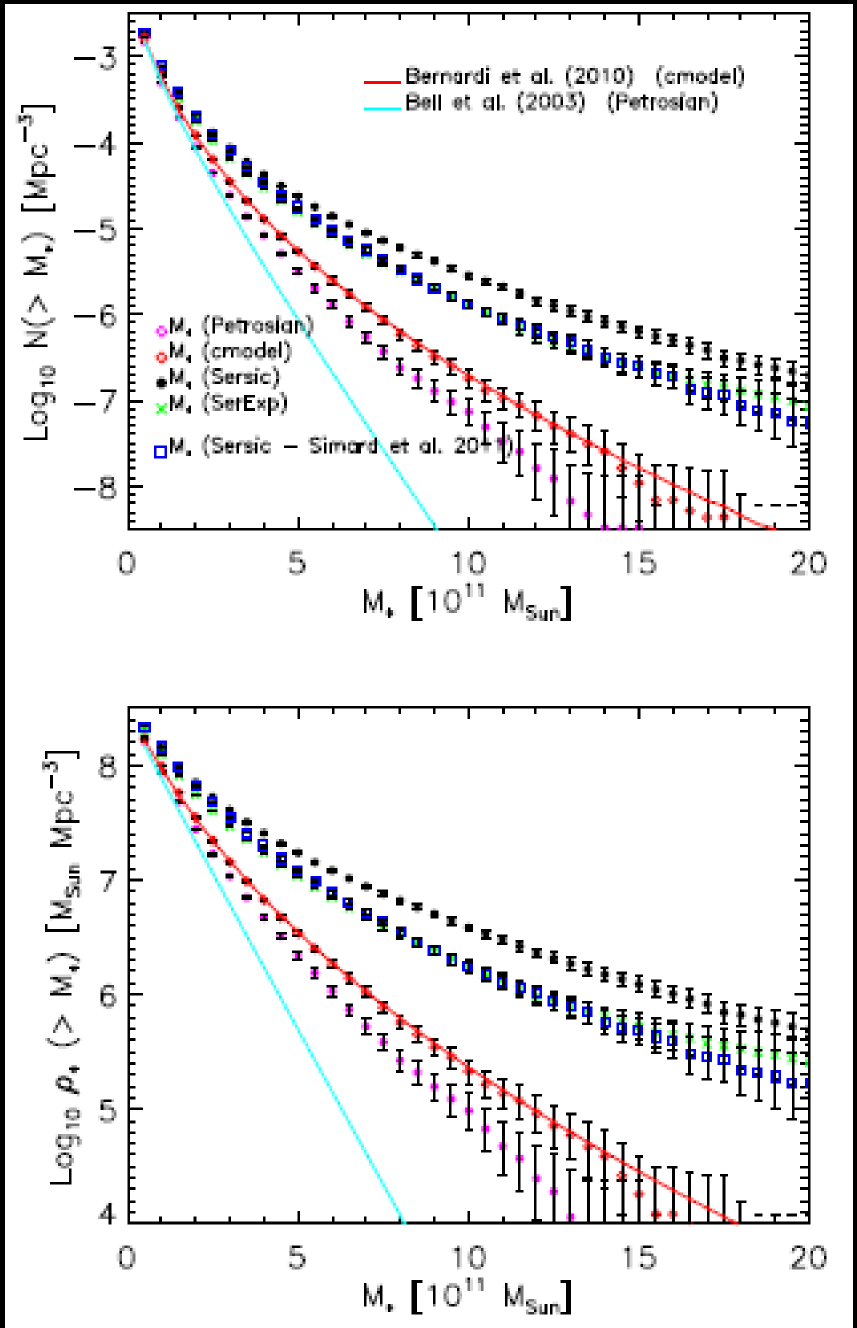


M* Function

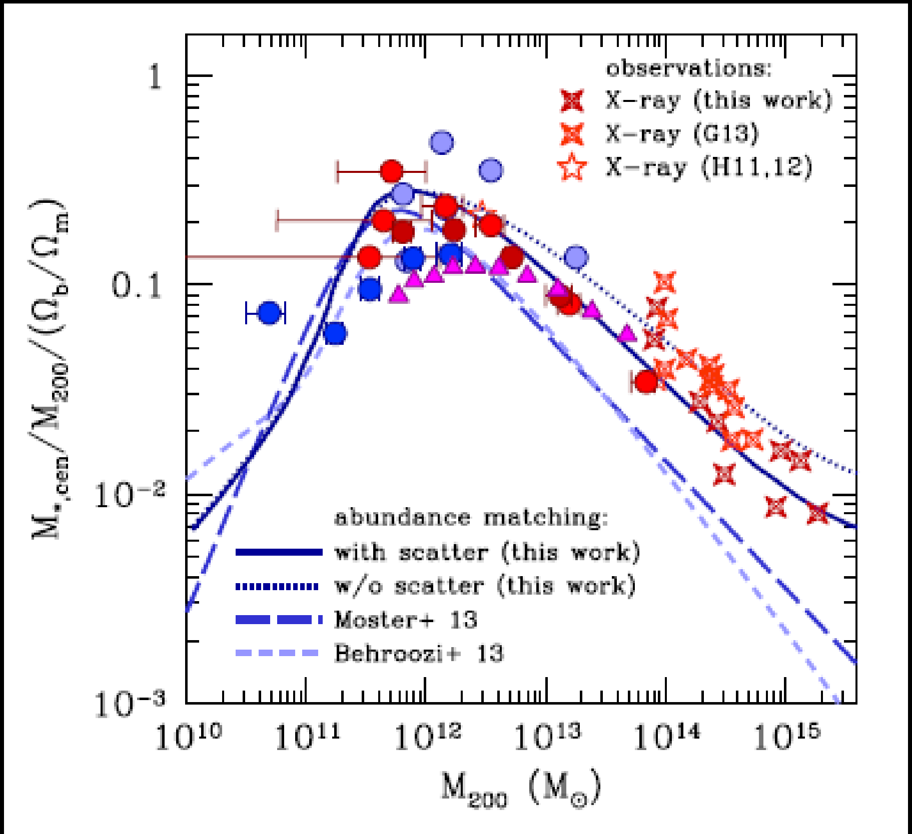
Bernardi et al. 2013



Bernardi et et al. (2013)



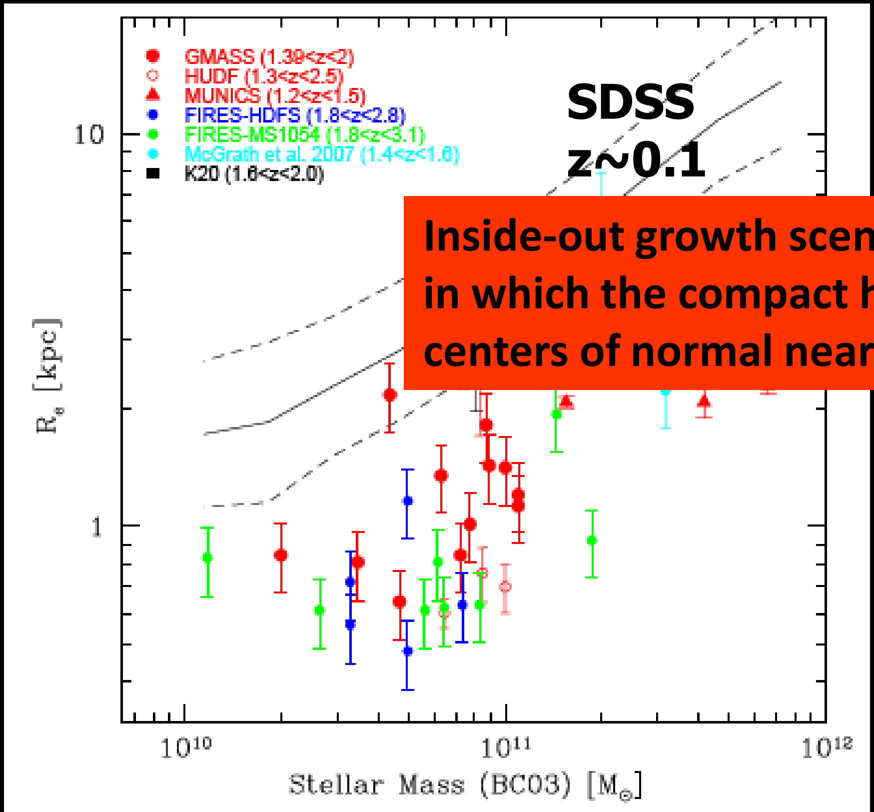
Kravtsov et al. (2014)



- impacts HOD/SHAM M^*-M_{halo} relations
- reduces required feedback at high M

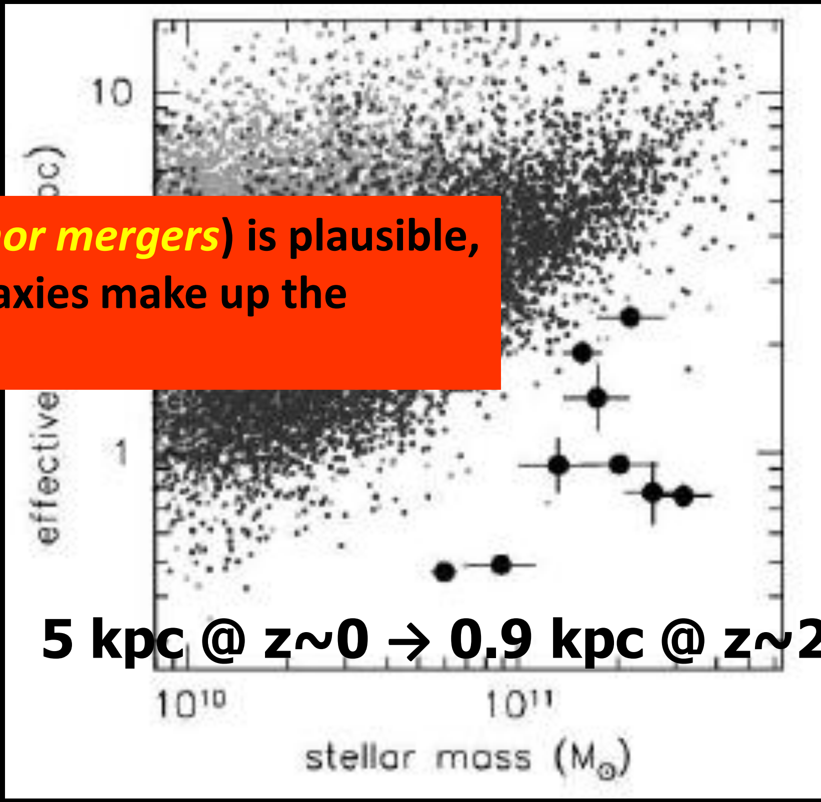
The assembling of massive galaxies and the growth of sizes …..

At fixed stellar mass, high-z sizes are smaller by $(1+z)^{-1}$ or more (e.g. Trujillo et al. 2007; Cimatti et al. 2008; van Dokkum et al. 2008; Saglia et al. 2011; Bruce et al. 2012; Fan et al. 2013)



Cimatti et al. 2008

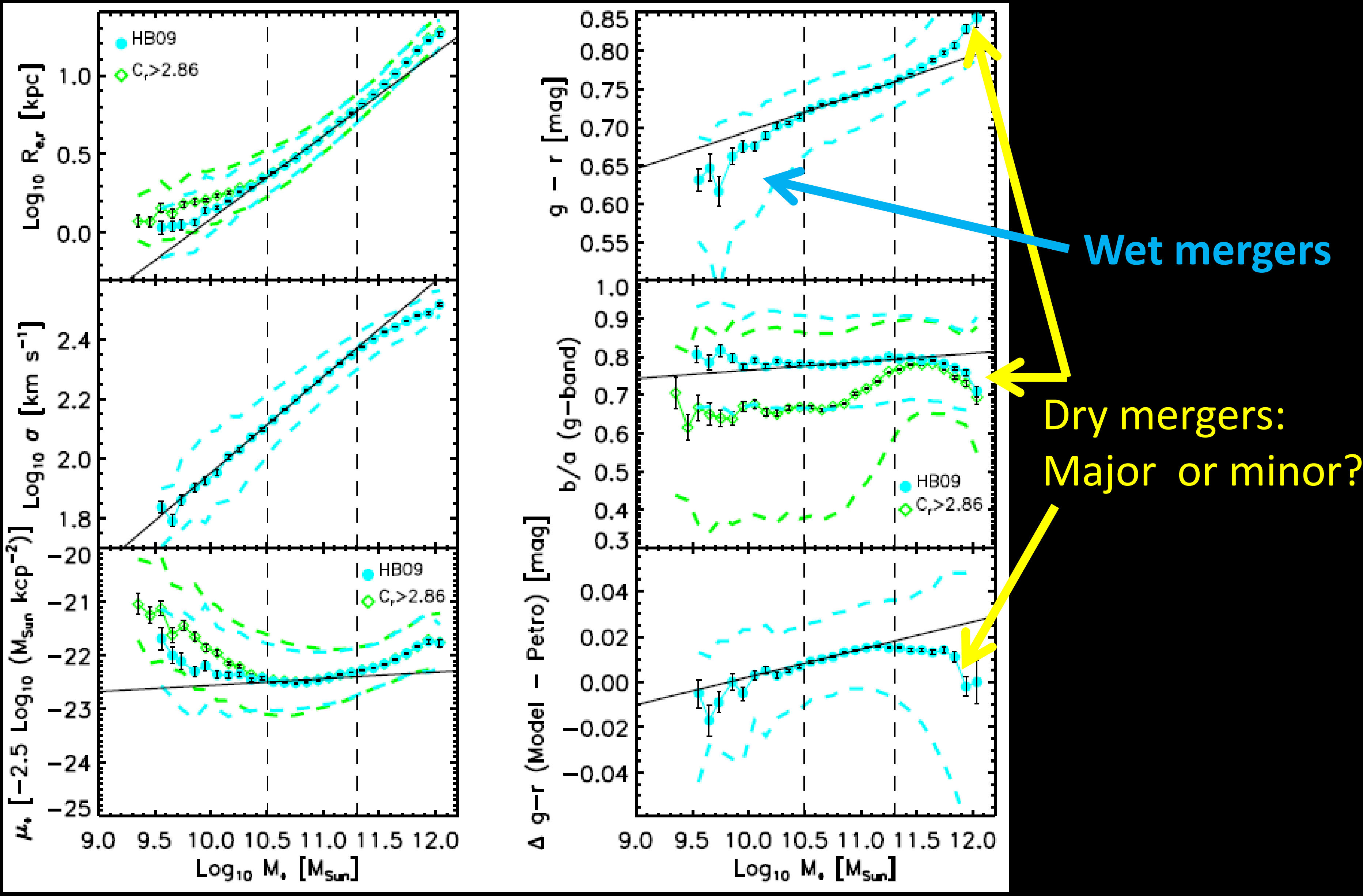
Inside-out growth scenario (*minor mergers*) is plausible, in which the compact high z galaxies make up the centers of normal nearby Es.



5 kpc @ z~0 → 0.9 kpc @ z~2

van Dokkum et al. 2008

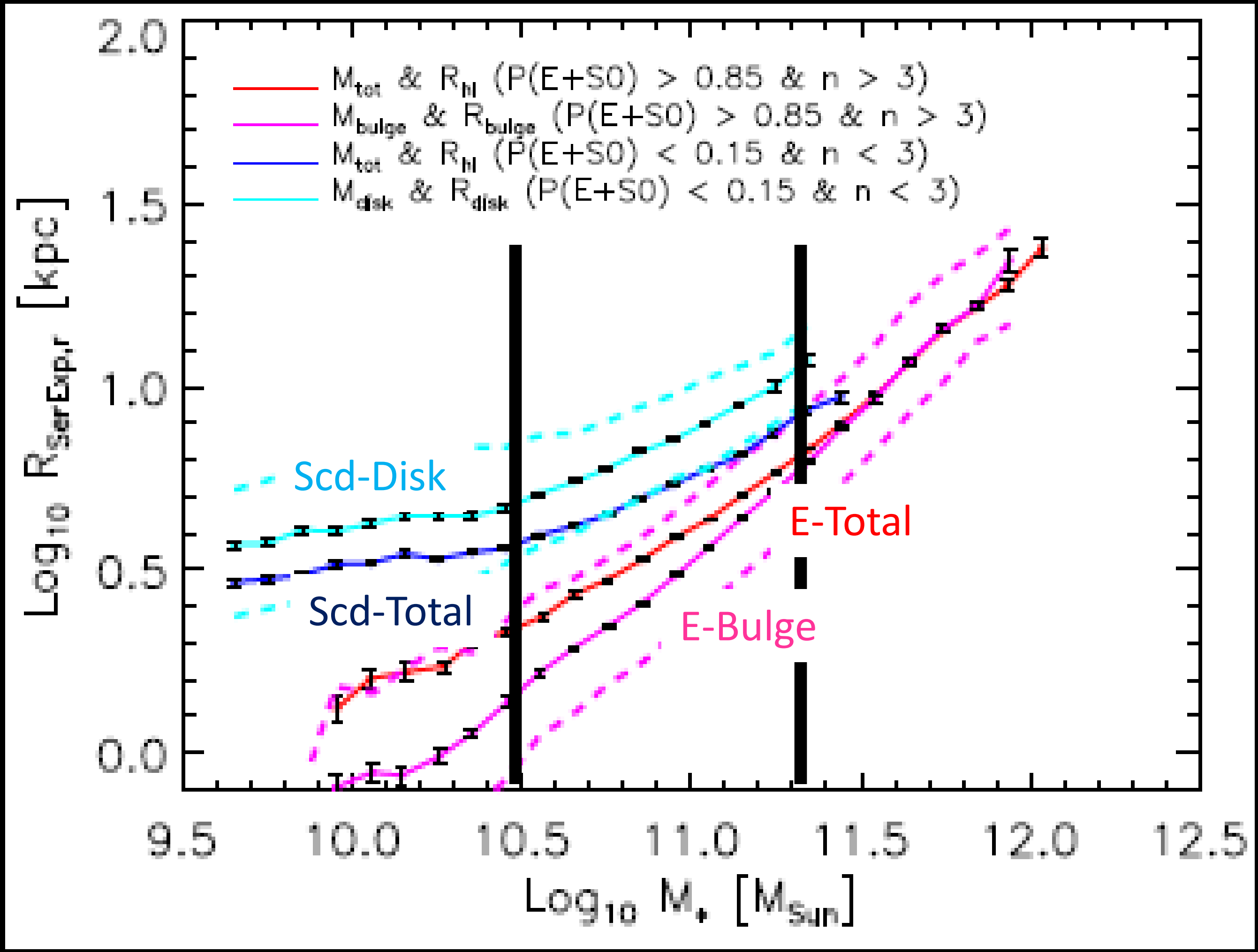
Two scales are important: 3×10^{10} and $2\times10^{11} M_{Sun}$



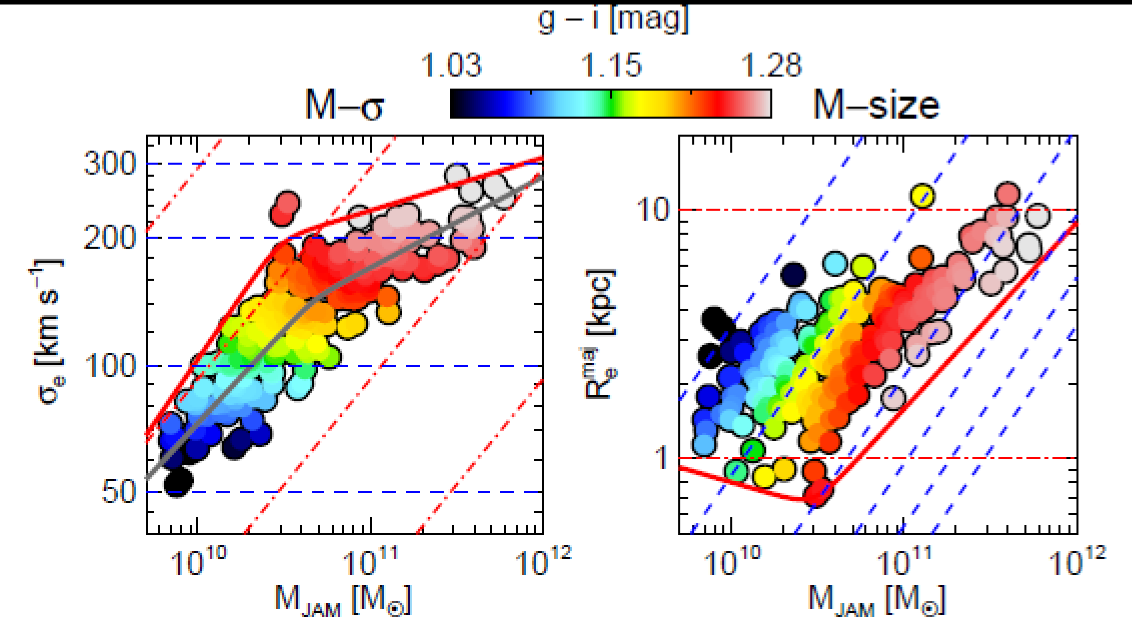
Bernardi et al. 2011b

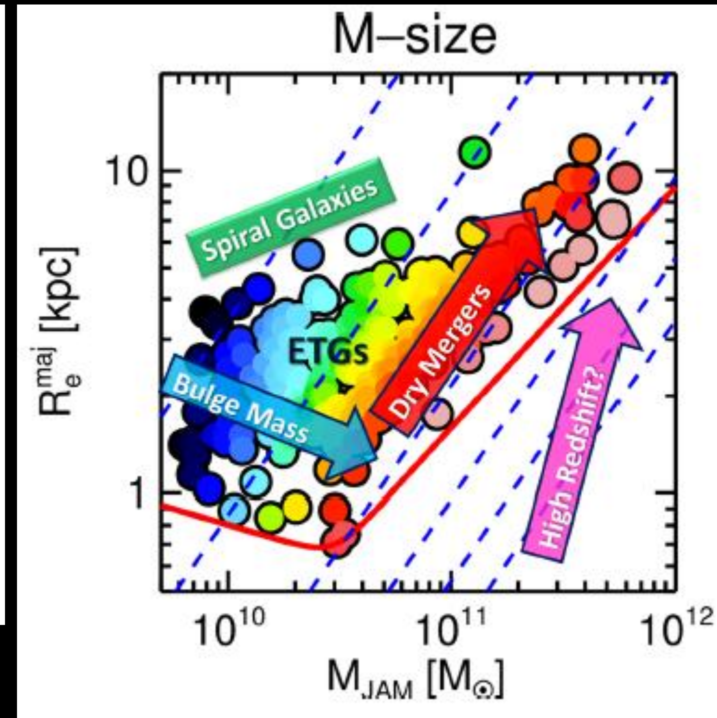
The two mass scales are important also for the bulge and disk M*-R relation

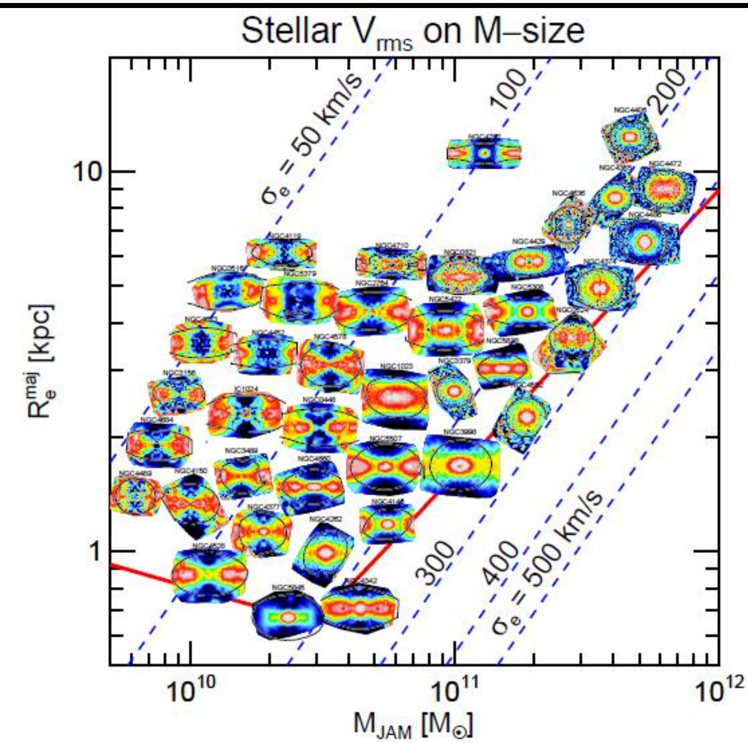
Bernardi et al. 2014a

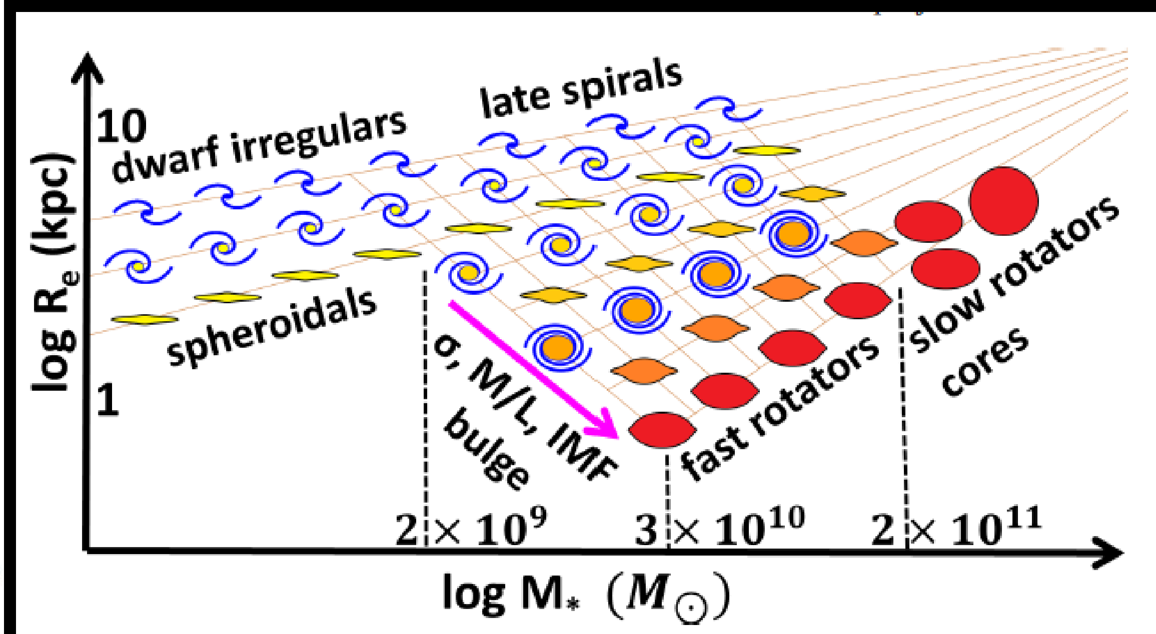


Capellari et al. (2013)





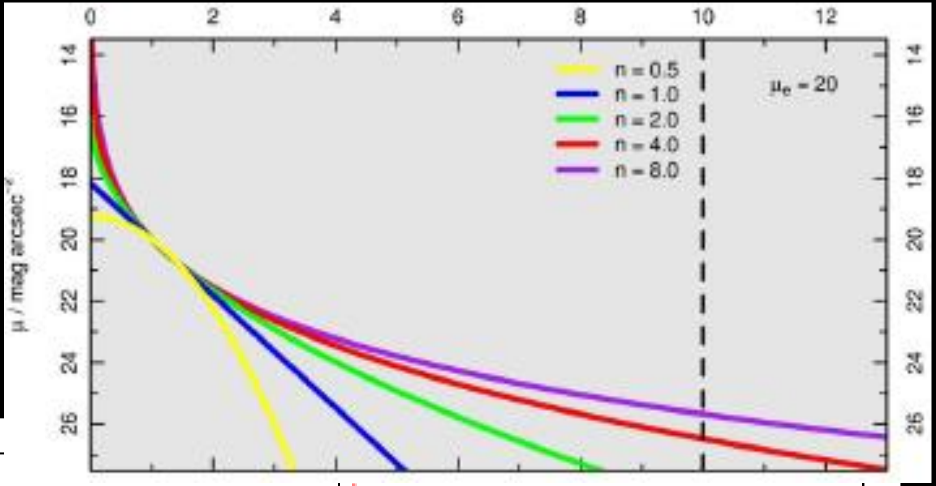


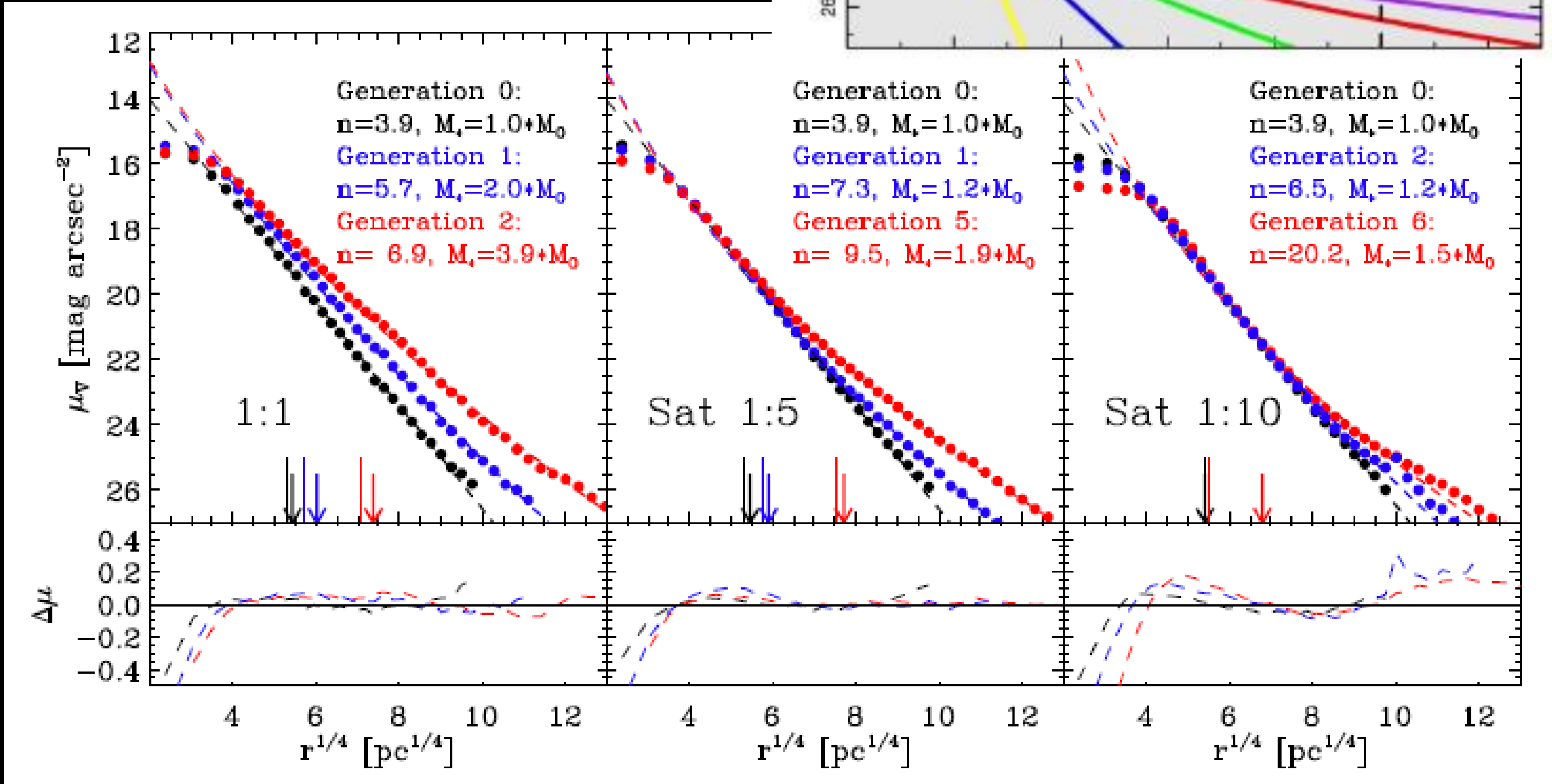


Minor vs Major dry mergers

Using the Sersic profile

Hilz et al. (2013)



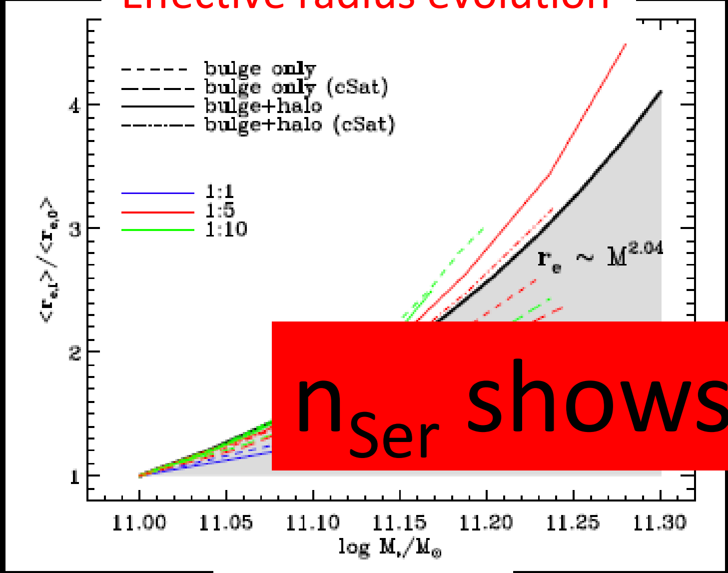


Minor vs Major dry mergers

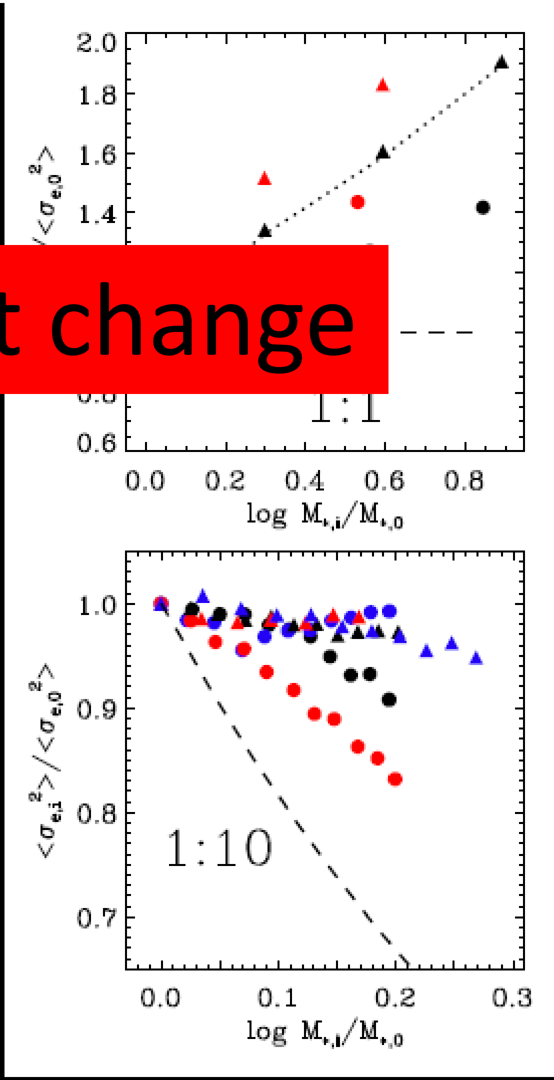
Hilz et al. (2013)

Hilz et al. (2012)

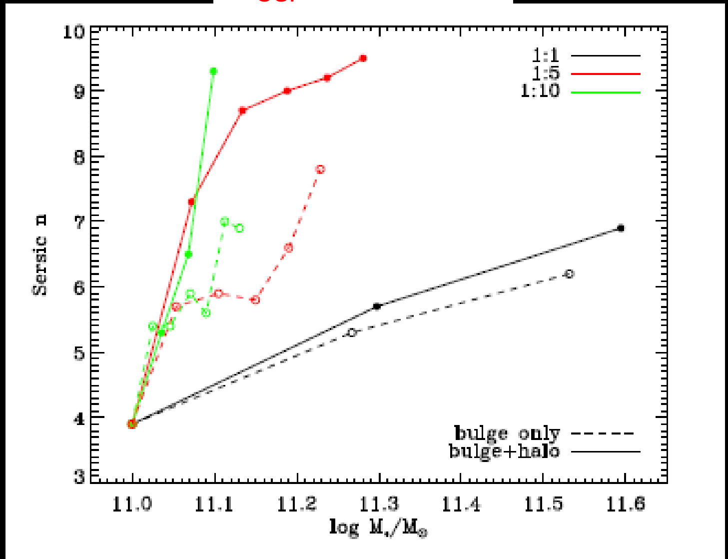
Effective radius evolution



Velocity dispersion evolution



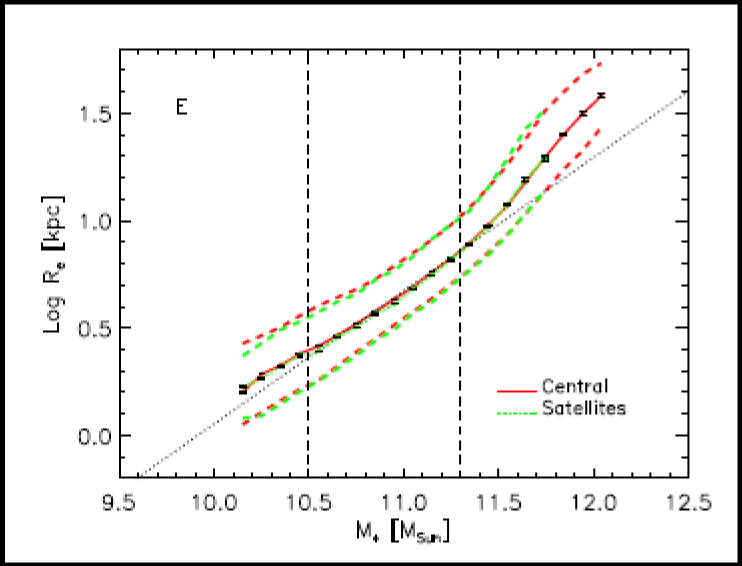
n_{Ser} evolution

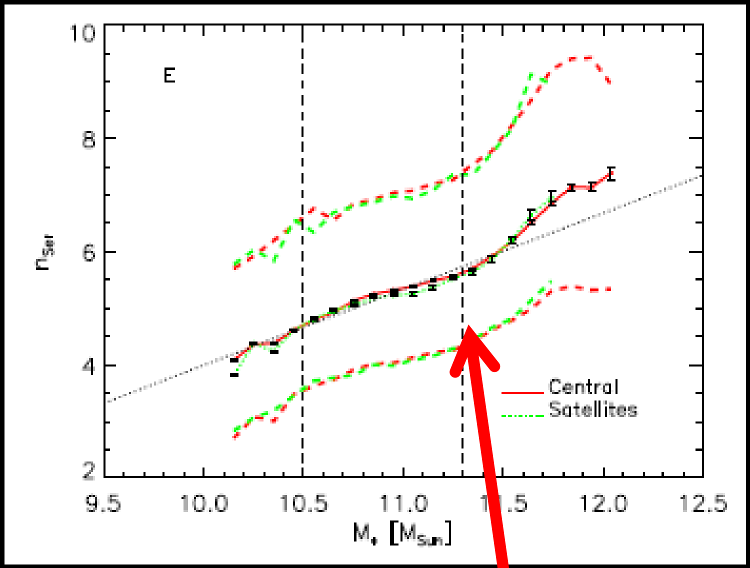


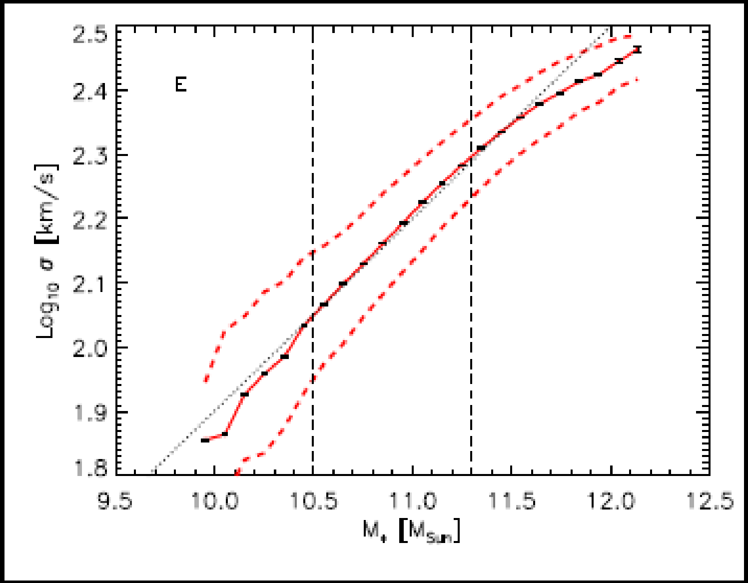
n_{Ser} shows largest change

The two mass scales: 3×10^{10} & 2×10^{11} M_{sun}

Bernardi et al. 2014b

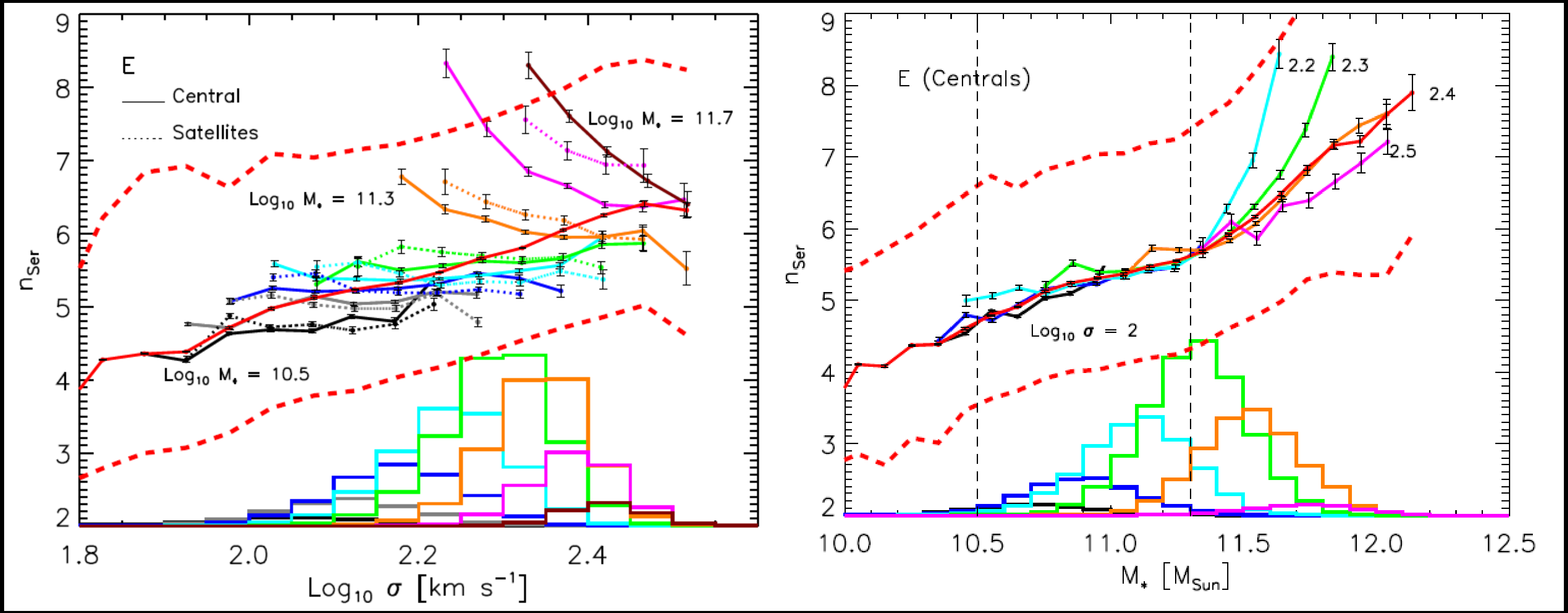






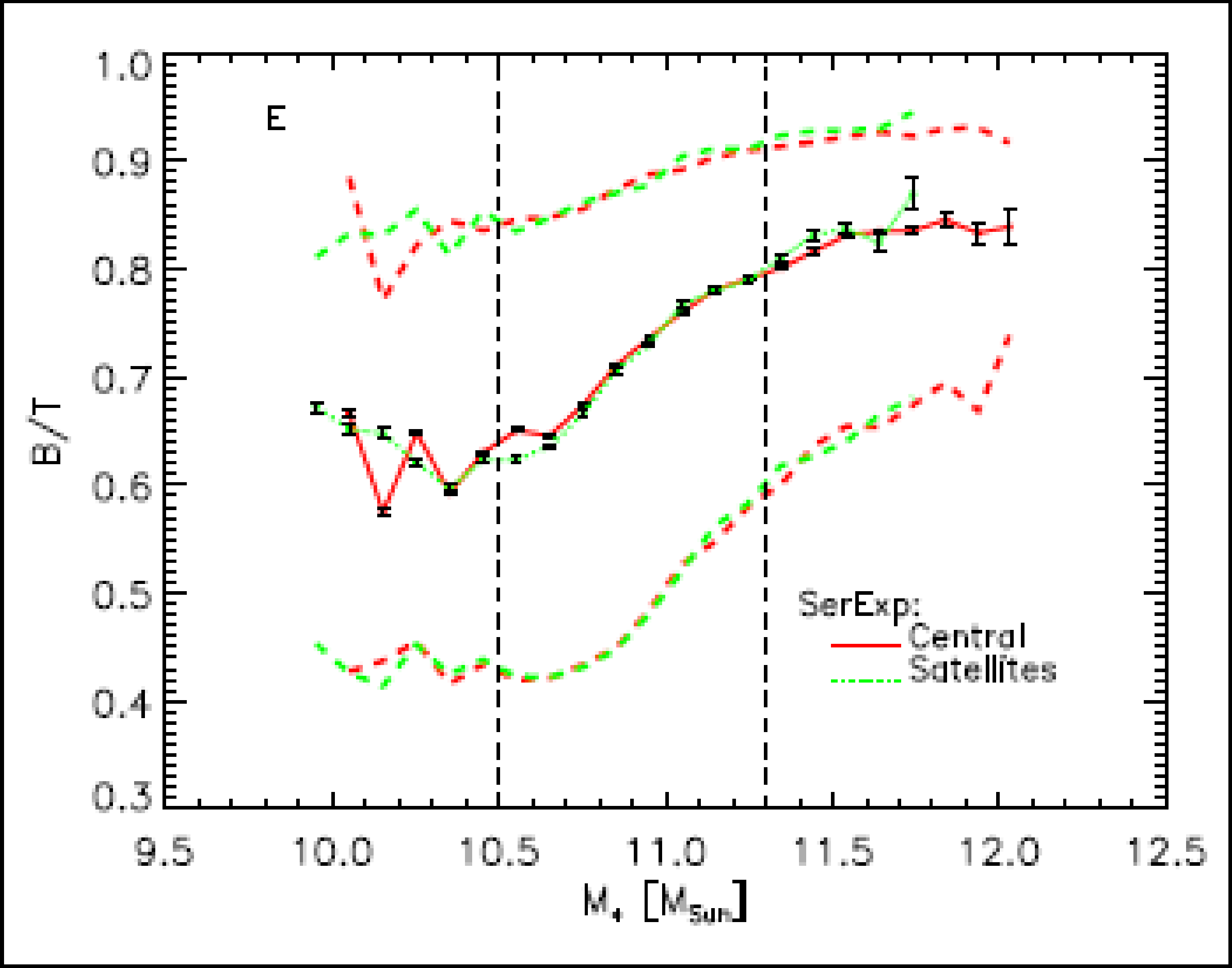
Also in n_{Ser} !!

Analysing n_{Ser}



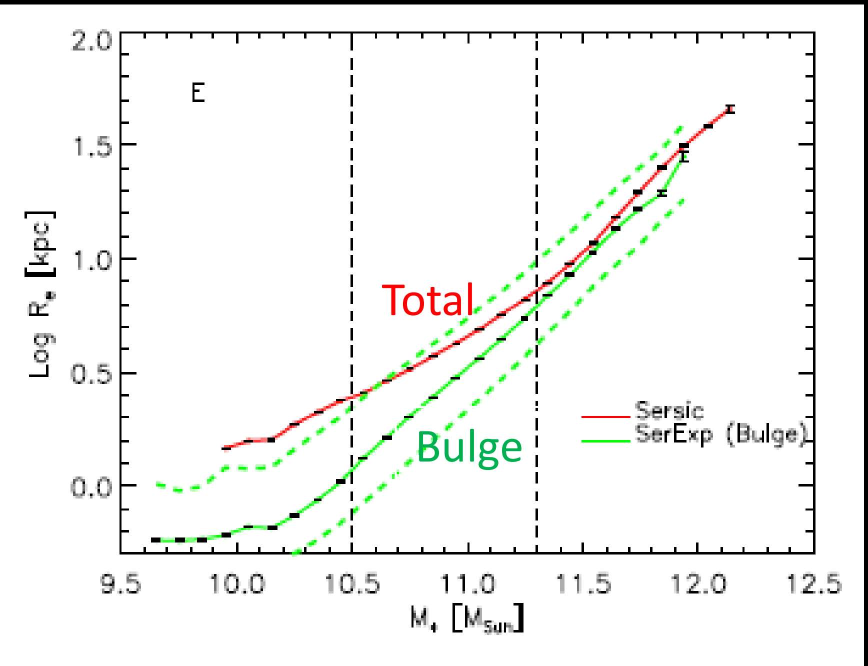
At fixed M_* larger n_{Ser} have smaller σ

But we should look at B/T

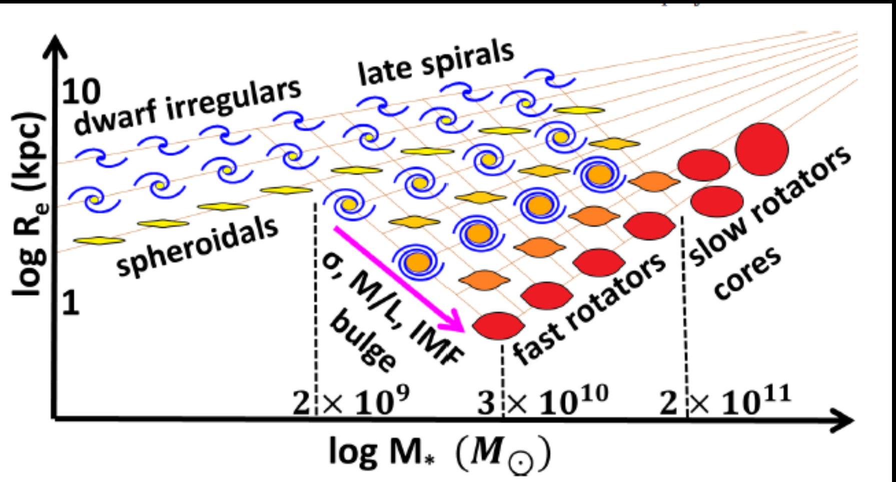


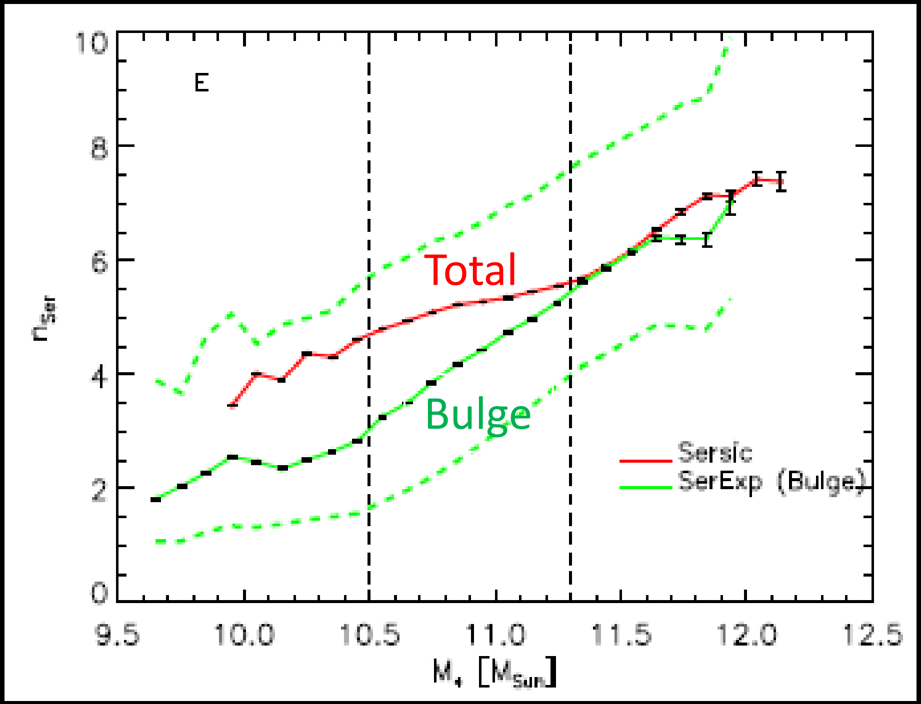
The high mass scale: 2×10^{11} M_{sun}

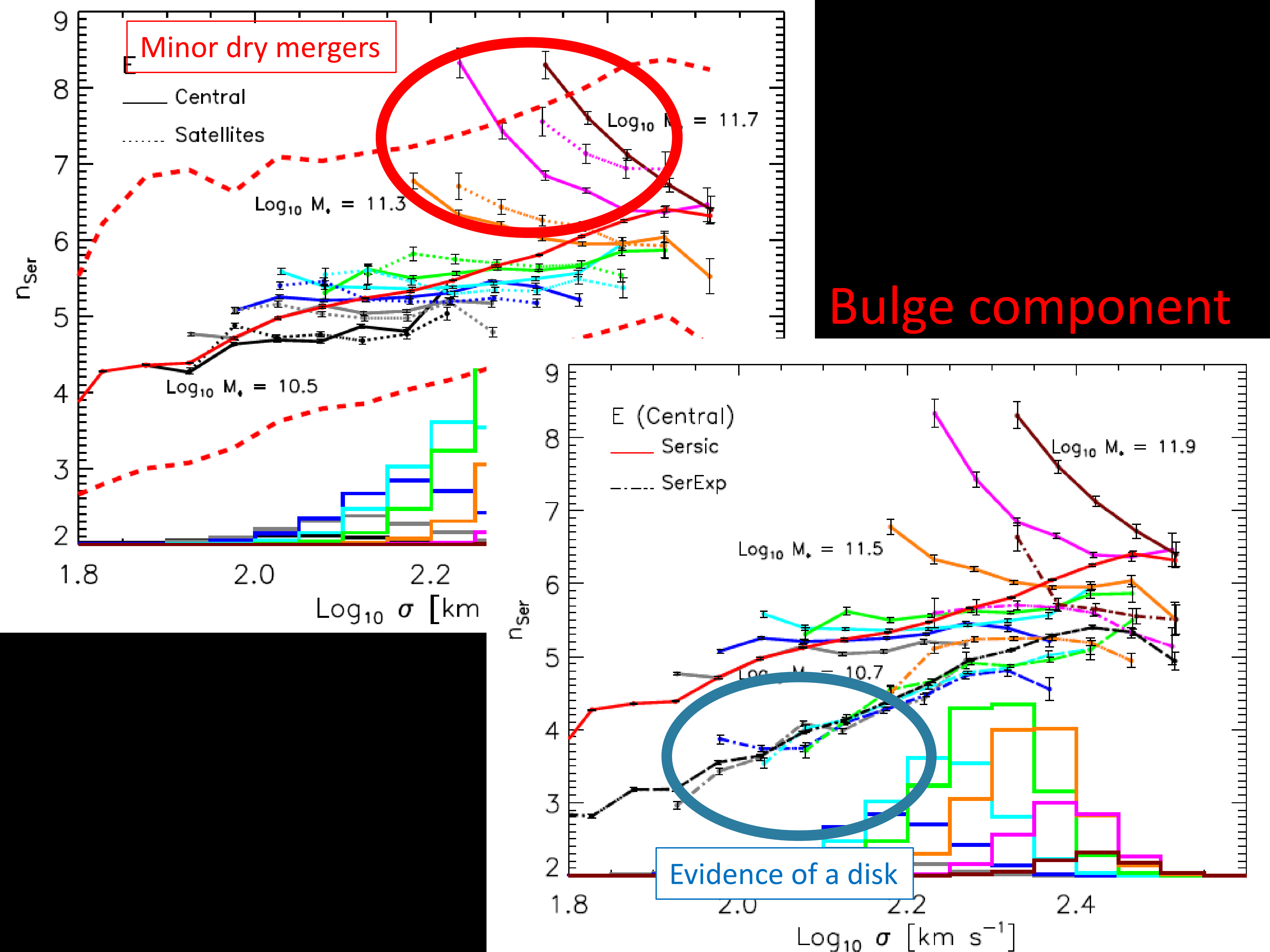
Bernardi et al. 2014b



A break for a disk component and increased evidence of minor dry mergers

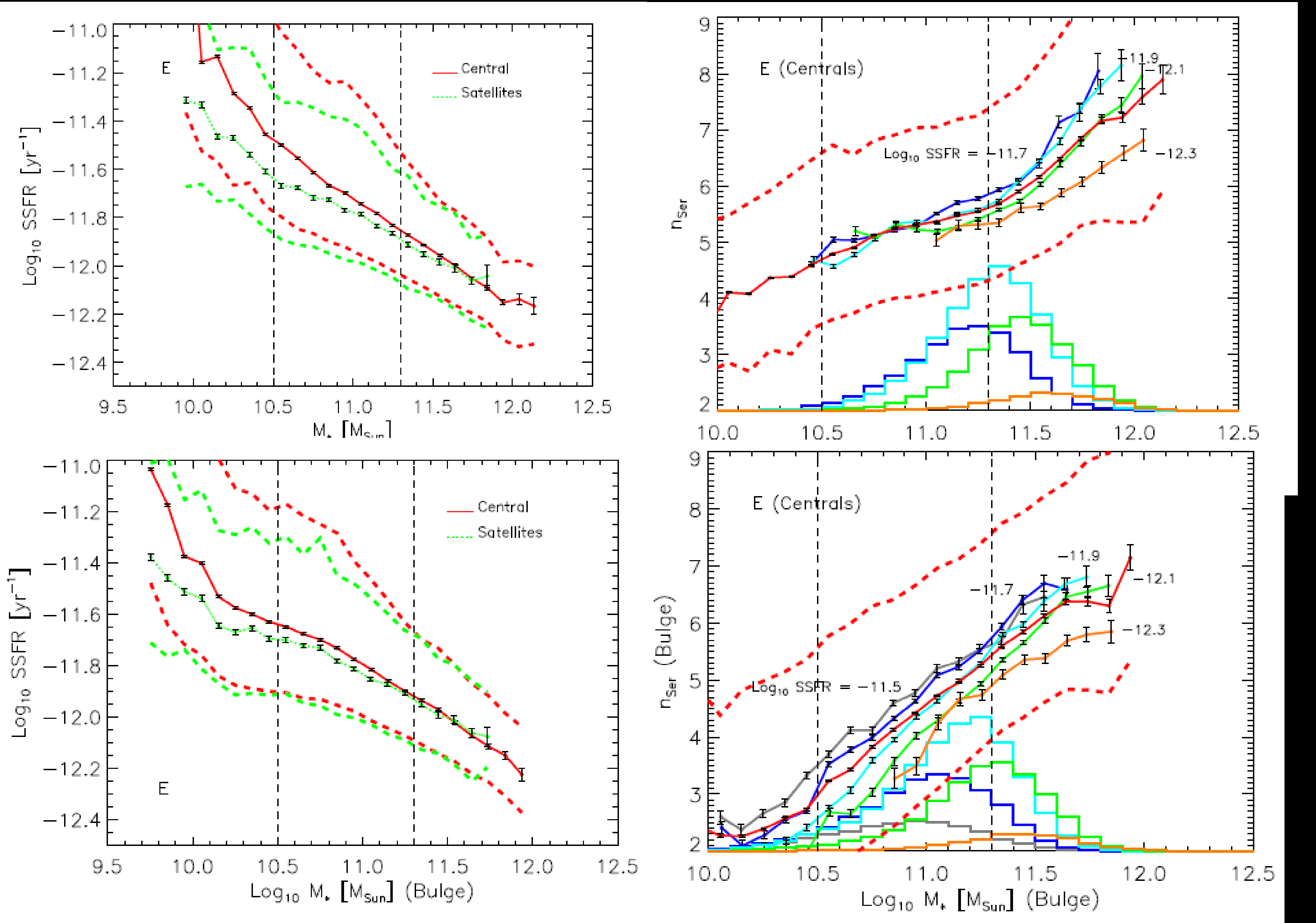




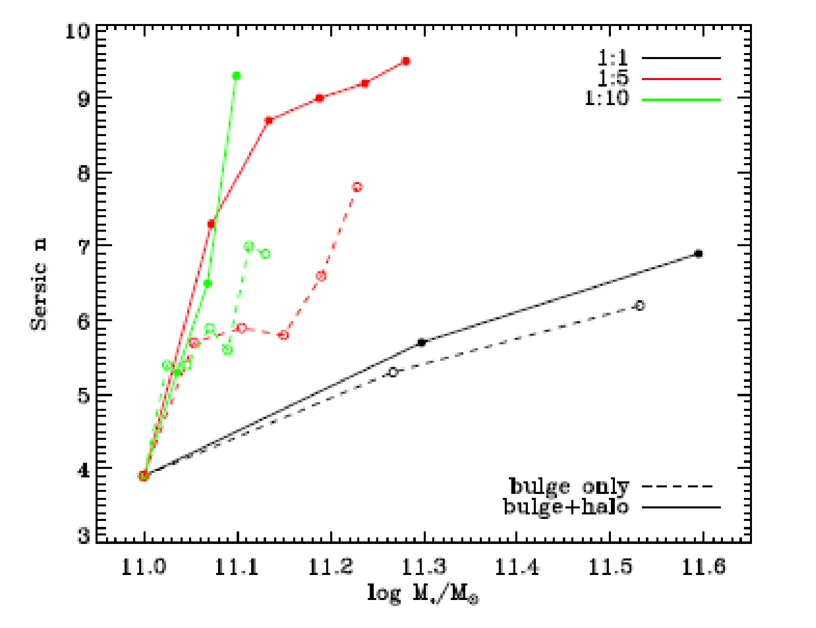


Minor dry mergers
E
Central
Satellites
Log_{10} M_* = 11.7
Log_{10} M_* = 11.3
Log_{10} M_* = 10.5
n_{Ser}
Log_{10} σ [km
Bulge component
E (Central)
Sersic
SerExp
Log_{10} M_* = 11.9
Log_{10} M_* = 11.5
Log_{10} M_* = 10.7
n_{Ser}
Evidence of a disk
Log_{10} σ [km s^{-1}]

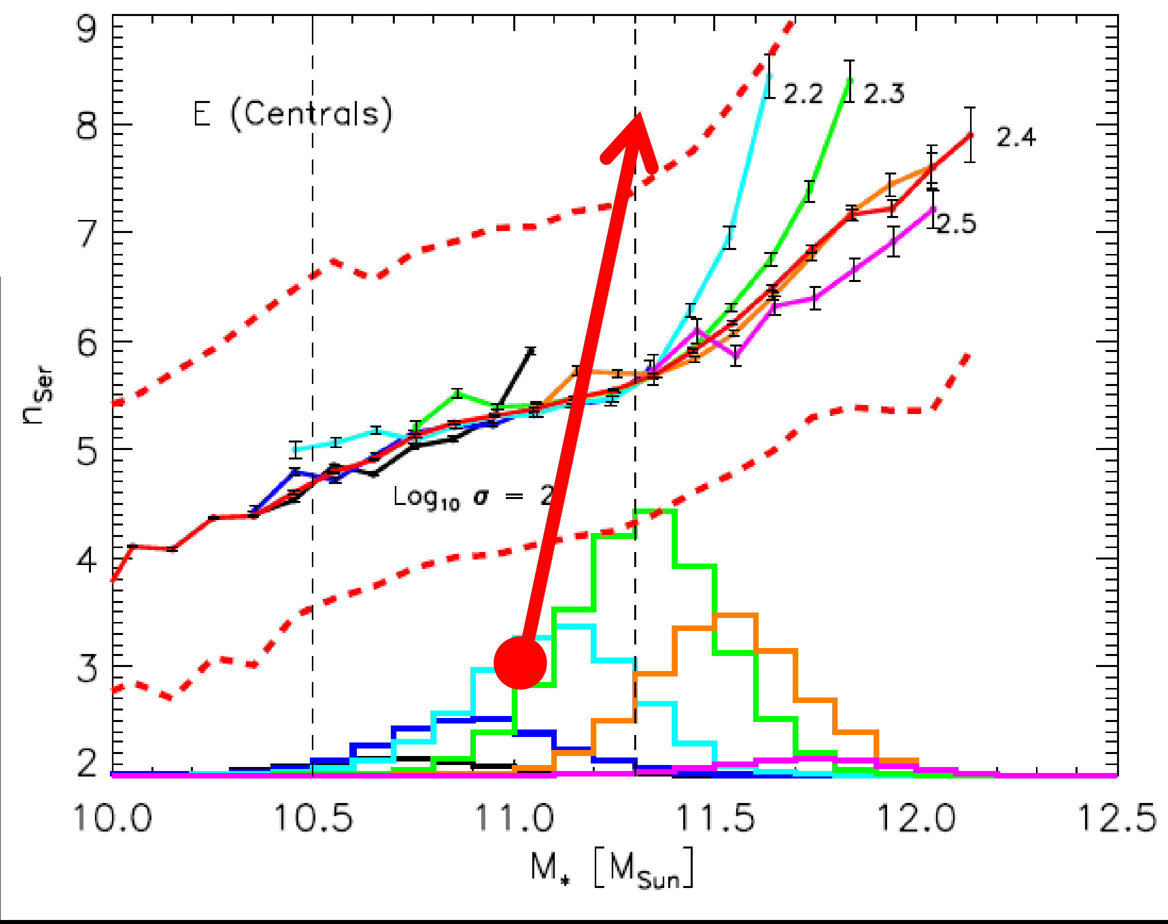
At fixed M_* larger n_{Ser} have higher SSFR



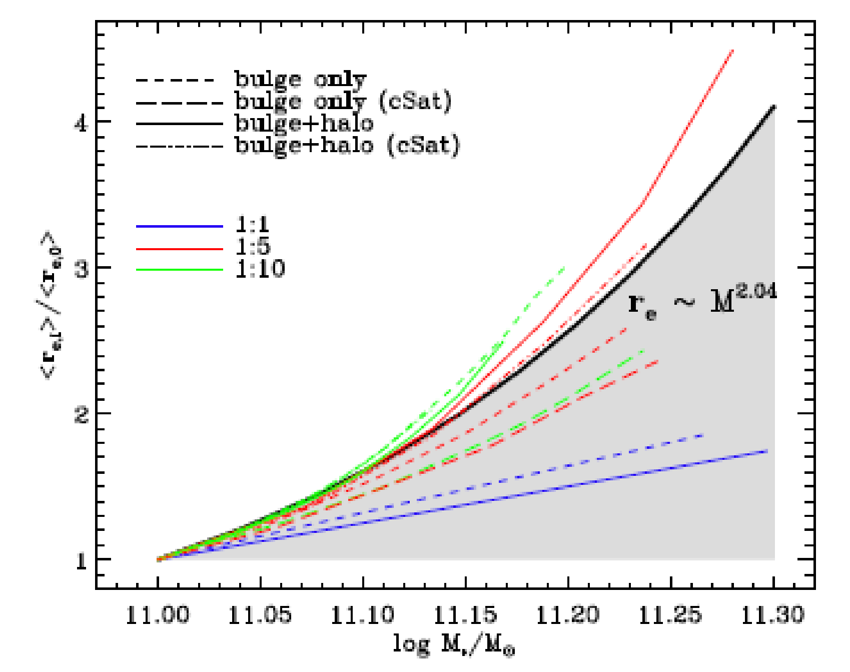
How did the compact high-z galaxies evolve?

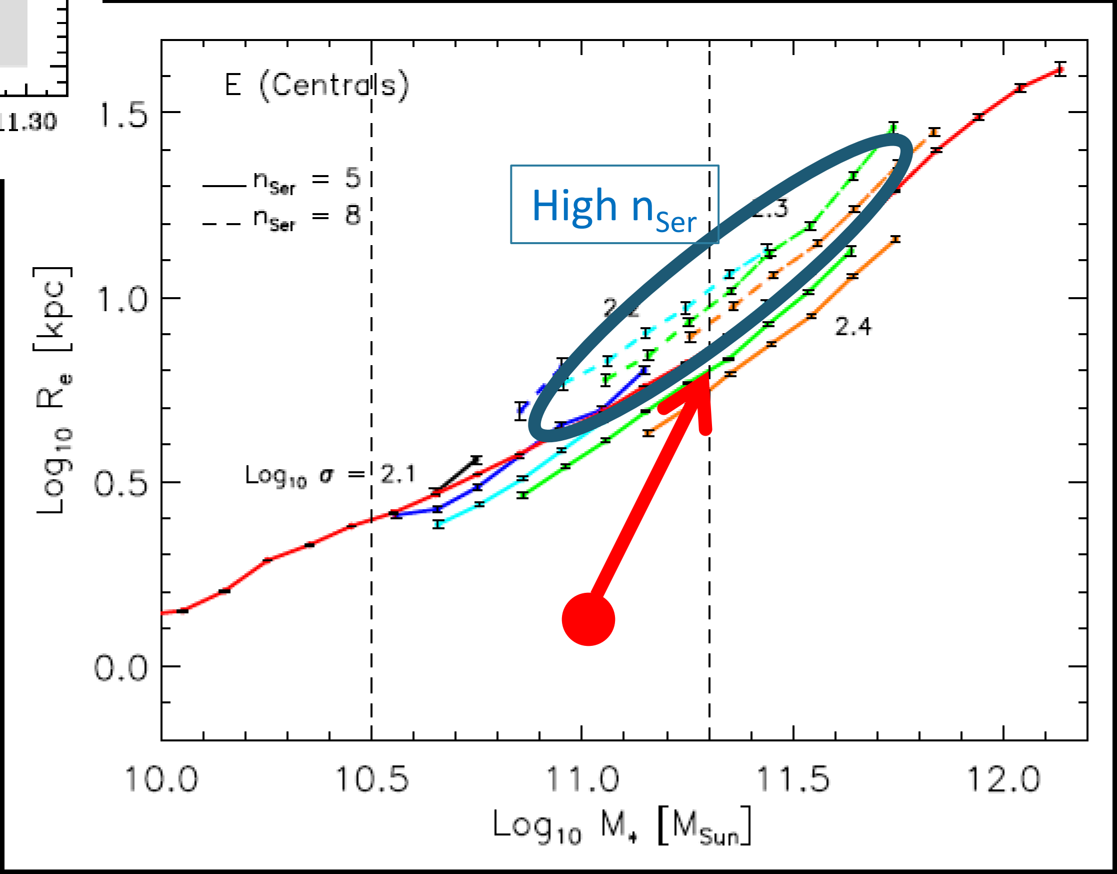


Evolution of n_{Ser}, σ and M_*

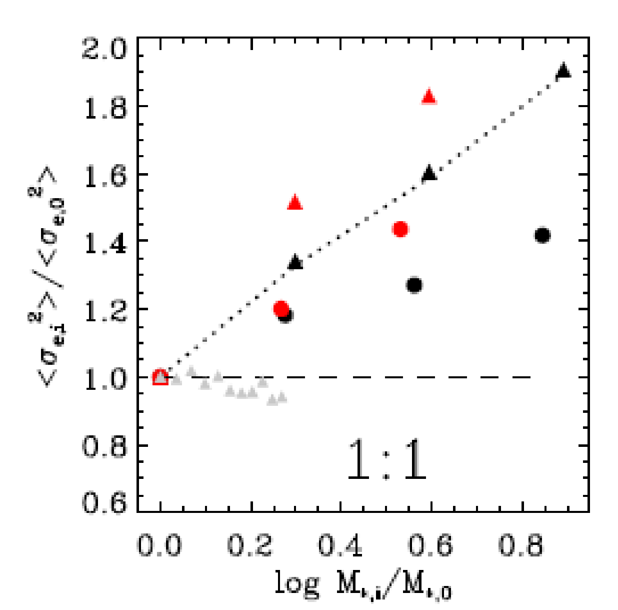


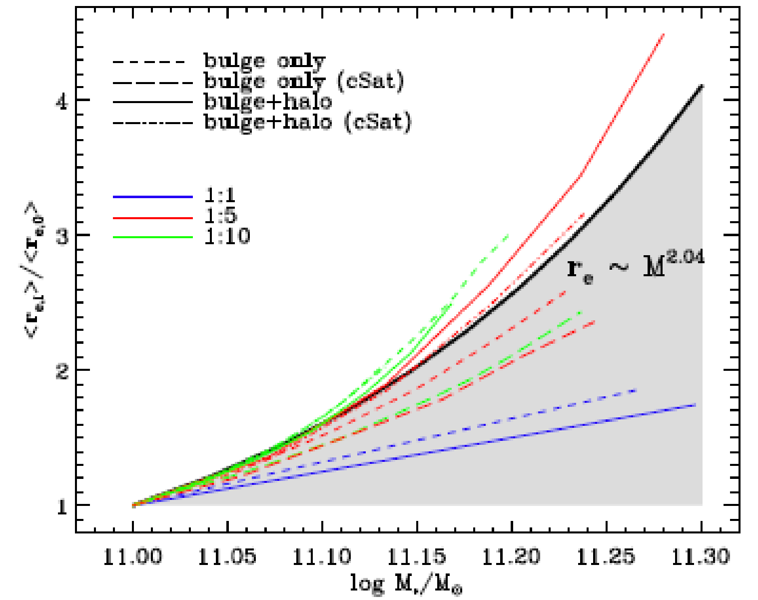
Evolution of R_e, n_{Ser}, and M_*

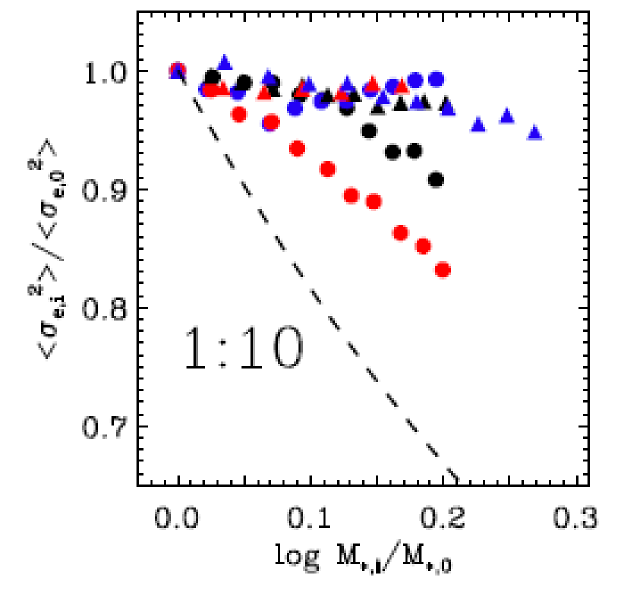


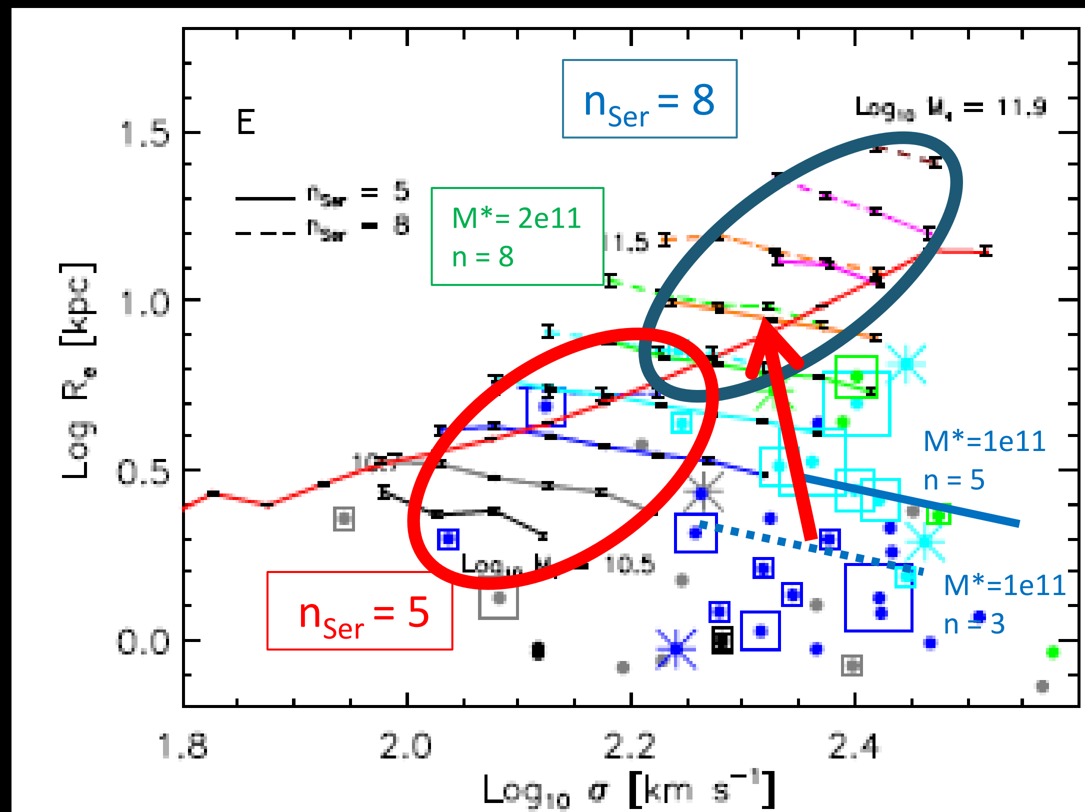


Evolution of R_e, n_{Ser}, σ and M_*

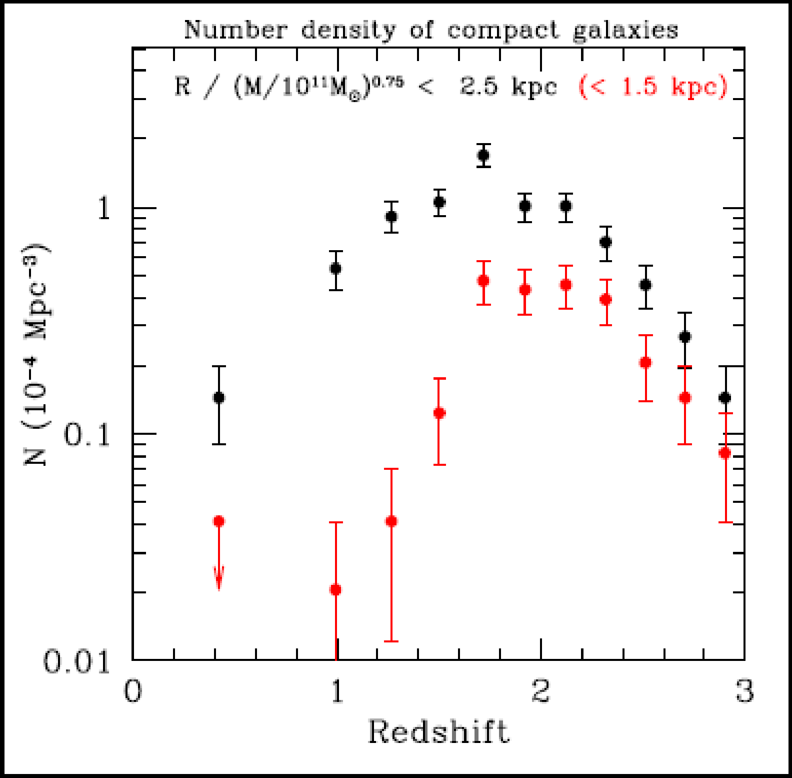




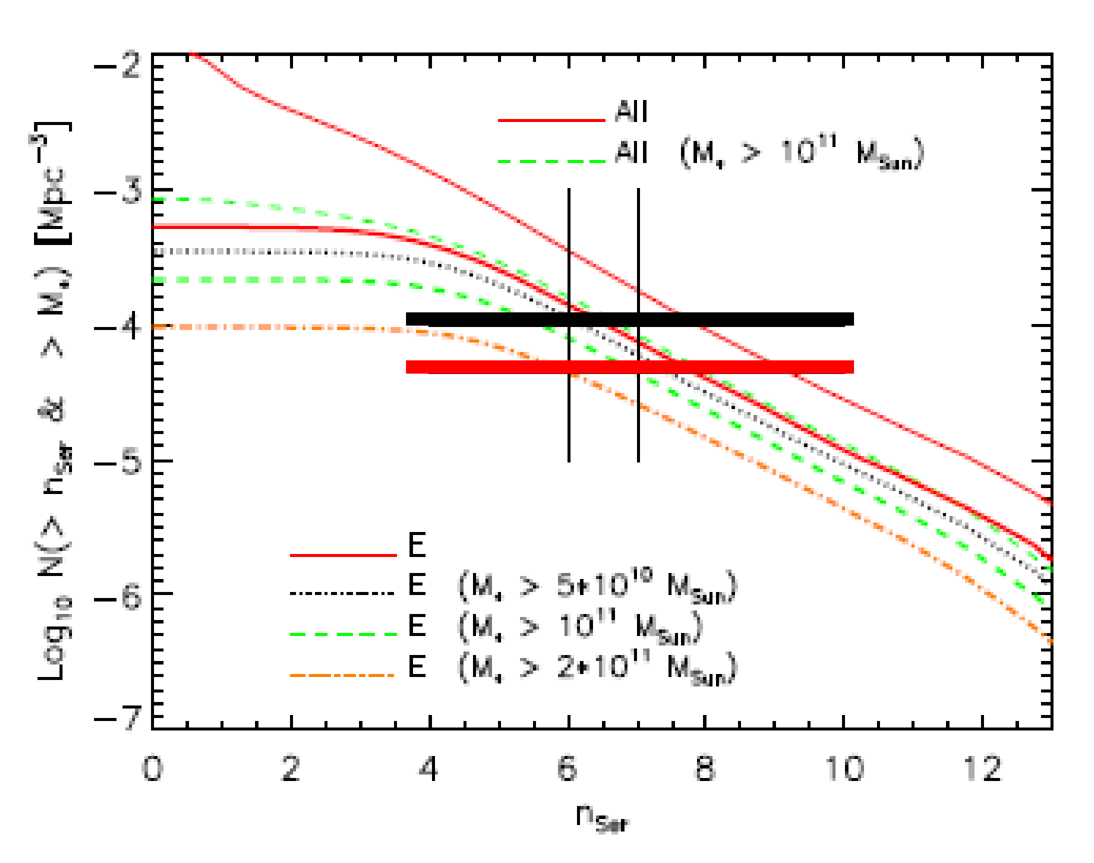




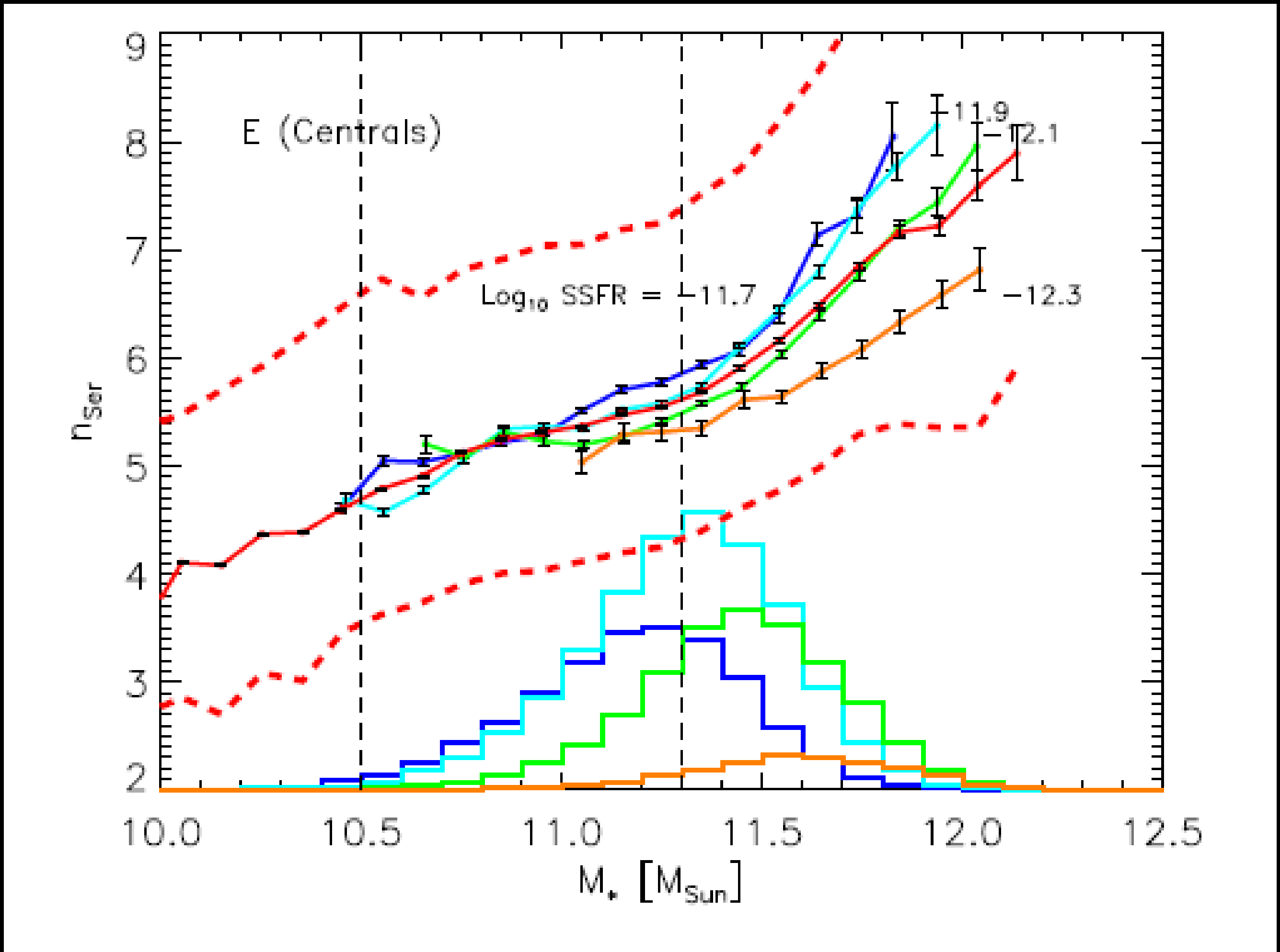
van der Wel et al. 2014



Bernardi et al. 2014b



In addition larger n_{Ser} have higher SSFR ….

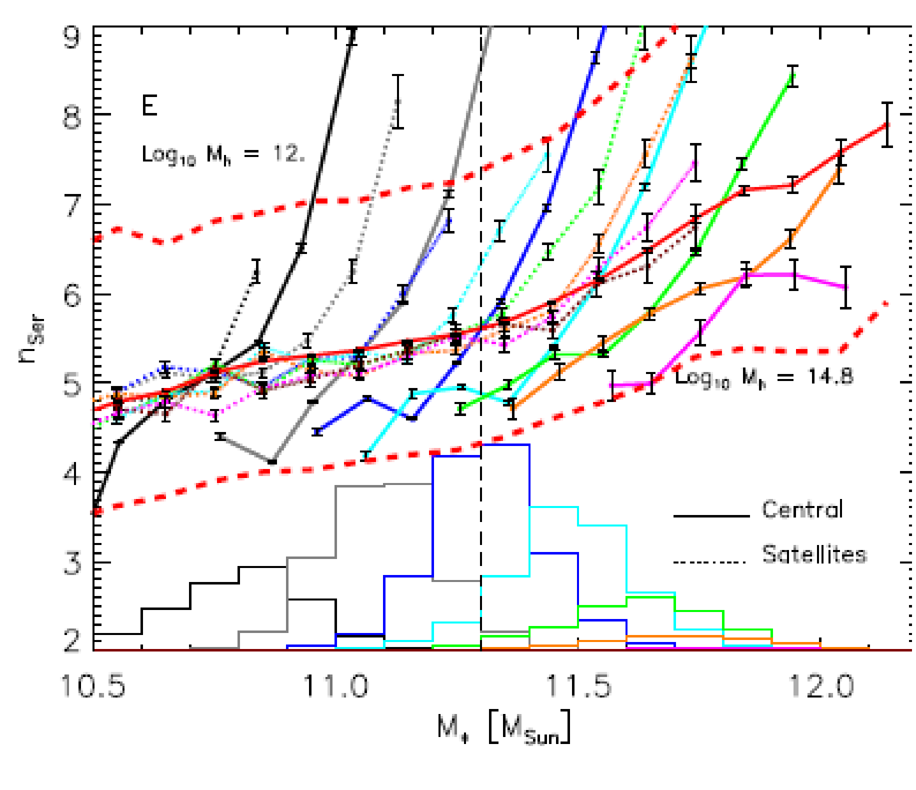


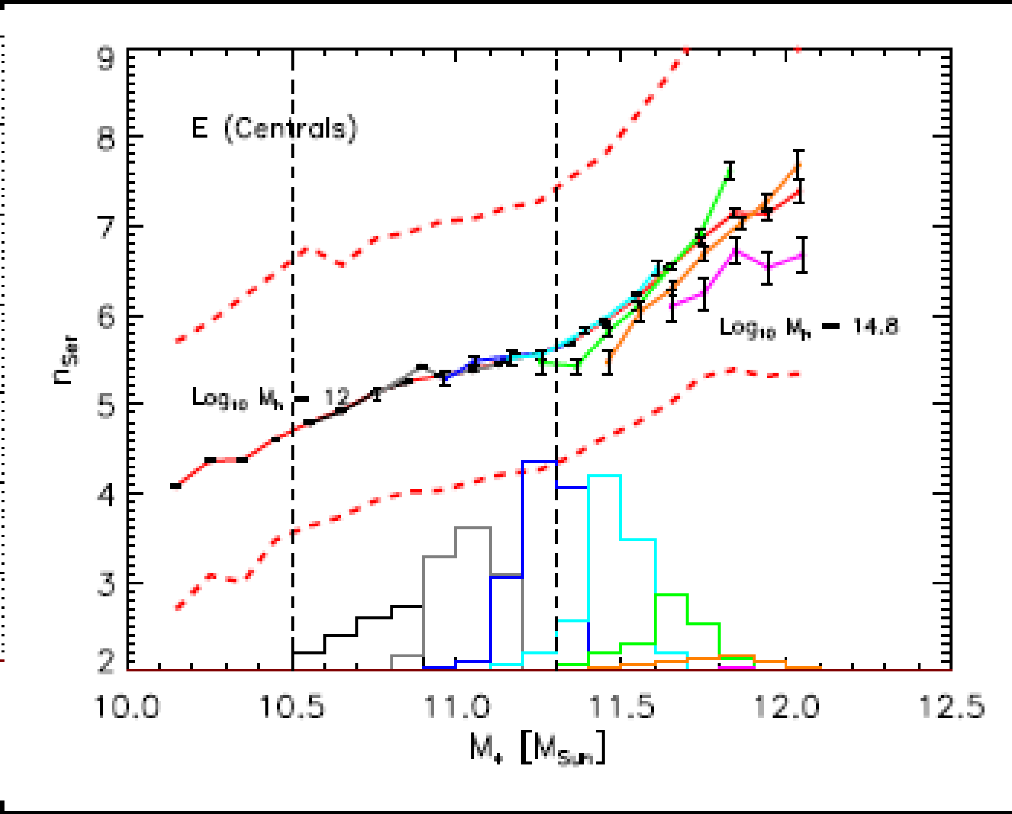
Dependence on Halo Mass (using the Yang et al. catalog)

Bernardi et al. 2014b

- Not completely trivial
- Yang et al. have no scatter in L_{tot} vs M_{halo} and very low scatter in L_{cen} vs M_{halo} especially at low M_{halo}
- Simply using our new L_{tot} gives spurious results, so
  - We rank order in our new L_{tot} and assign M_{halo} accordingly; this will alter V_{halo}-M_{halo} relation
- We also account for fact that new Ls sometime mean another object in group is brightest; we define ‘central’ to be brightest

Analysing n_{Ser} - M_* - M_{halo}



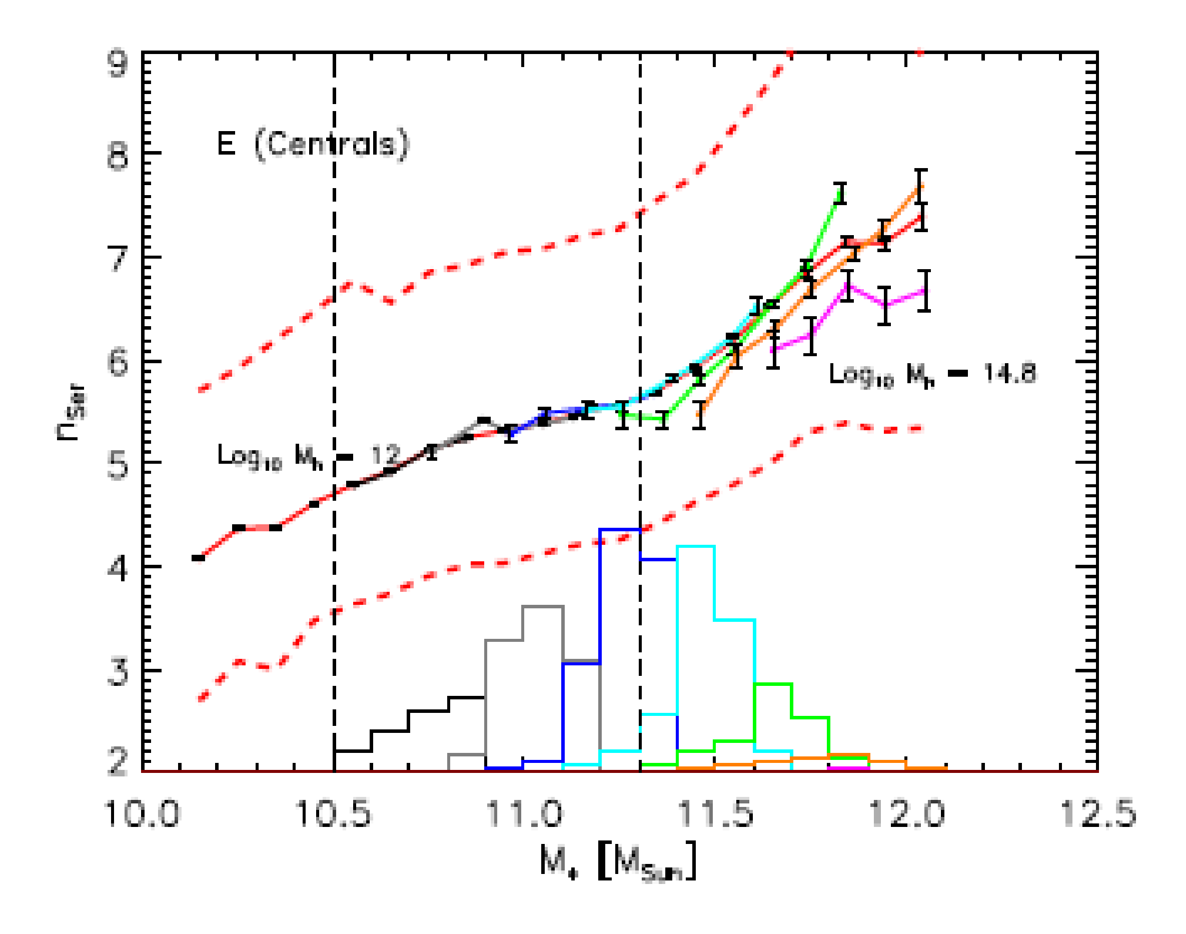


ONLY CHANGE L

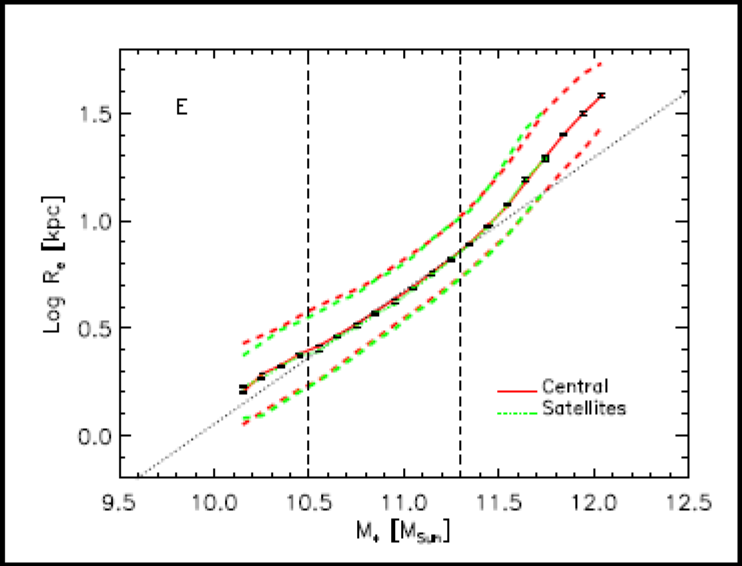
CHANGE L AND RE-SORT L_{tot}

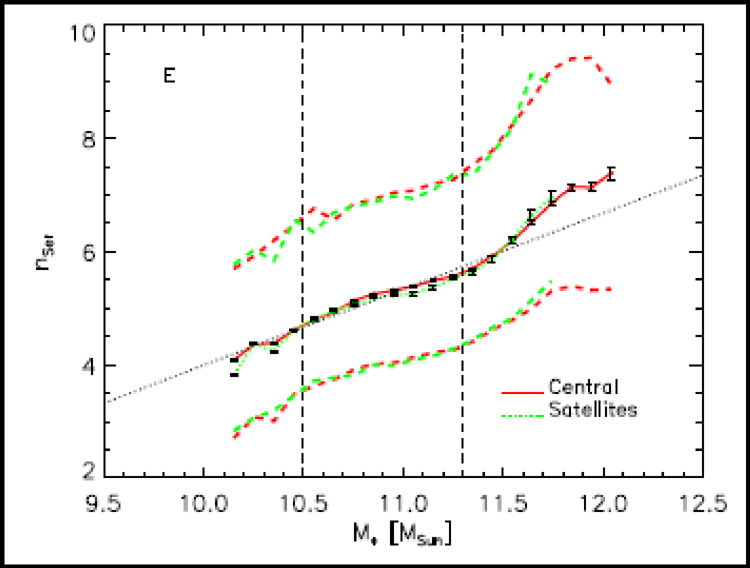
Analysing n_{Ser} - M_* - M_{halo}

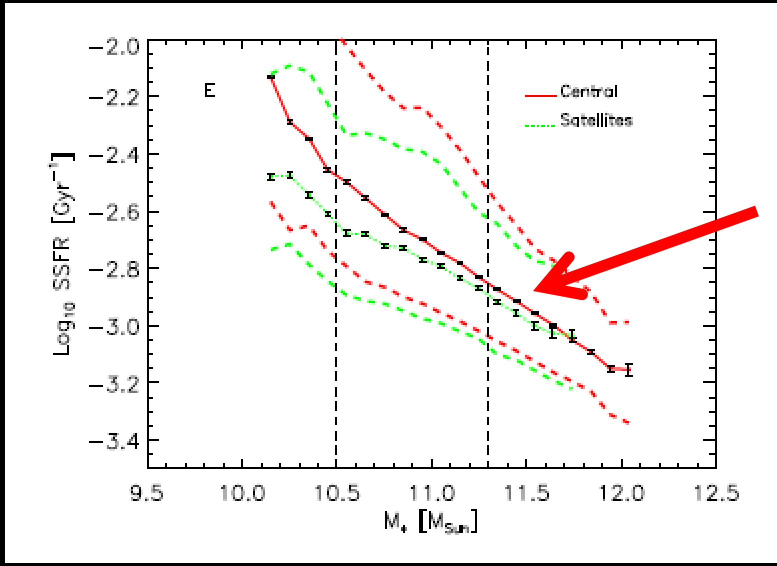
At fixed M_* centrals in larger M_{halo} have smaller n_{Ser}



Central vs Satellites







Small difference in SSFR

Bernardi et al. 2014b

Conclusions from our fitting profiles:

- Sky-subtraction + Sersic/SerExp fits suggest more objects at M_*>2e11 than previous work:
  - impacts HOD/SHAM M*-Mhalo relations
  - reduces required feedback at high M
  - alleviates tension between ρ_* and SFR(z)
- Two mass scales are important: 3e10 and 2e11: M_*>2e11 special even more pronounced in n-M_*
  - Difference between total and bulge dramatic at M_*<2e11 (suggestive of fast/slow rotator dichotomy)
- Sersic n>6 at M_*>2e11 suggestive of minor dry mergers
  - n-σ at fixed M_* particularly useful
  - At fixed M* smaller σ have larger n; larger SSFR have larger n; smaller M_{halo} have larger n
  - Evolution of compact high-z galaxies = > high n_{Ser} galaxies at z~0? Evidence of minor mergers?