DEEP-Theory Meeting   30 October 2017

Expected at 4 pm: Elliot Eckholm; **Not coming today:** Vivian Tang, Graham Vanbenthuysen

Prolate galaxies: observation-simulation comparison —Haowen Zhang and Vivian Tang: analysis of CANDELS b/a vs. Δa data & mocks; half-stellar-mass radius r_0.5 vs. half-stellar-light radius r_e from simulations.

GALFIT analysis of VELA simulations — Marc Huertas-Company Deep Learning GALFIT emulator vs. Haowen Zhang running them through GALFIT.

Galaxy size vs. local density project — Graham Vanbenthuysen, Viraj Pandya, Christoph Lee, Doug Hellinger, Aldo Rodriguez-Puebla, David Koo, Lin Lin — We are measuring λ vs. density by various methods in Aldo's mock catalogs from Bolshoi-Planck and MultiDark-Planck, and SDSS galaxy radii vs. density by the same methods. Christoph will show how R_s and $R_s(C_{NFW}/7)^{0.4}$ depend on environmental density.

Abundance matching is independent of environmental density — Radu Dragomir, Aldo, Christoph **paper sub.**

Elongated galaxies aligned with cosmic filaments? — Viraj Pandya is working on observations & mocks.

Deep Learning for Galaxy Environment project — The paper by Nicolas Tejos, Aldo Rodriguez-Puebla, and me is now published in MNRAS. James Kakos, Dominic Pasquale, and Matthew Casali plan to use DL for a project to improve z and local environment for a mixture of spectroscopic and (mostly) photometric redshifts.

Deep Learning for Galaxies project — Analysis of VELA Gen3 simulations is ongoing by Raymond Simons at JHU, Christoph Lee and Sean Larkin, along with Avishai's student Tomer Nussbaum: finding all satellites. Christoph is also using the DL code that classified CANDELS images to classify VELA mock galaxy images.

Halo properties like concentration, accretion history, and spin are mainly determined by environmental density rather than by location within the cosmic web — we are finishing the paper led by Tze Goh

DM halo mass loss paper being finished — Christoph Lee, Doug Hellinger. Related work this summer on **halo radial profile** by SIP students Shawn Zhang and Peter Wu with Christoph.

Simulations of CGM & winds vs. observations — Clayton Strawn, Hassen Yesuf

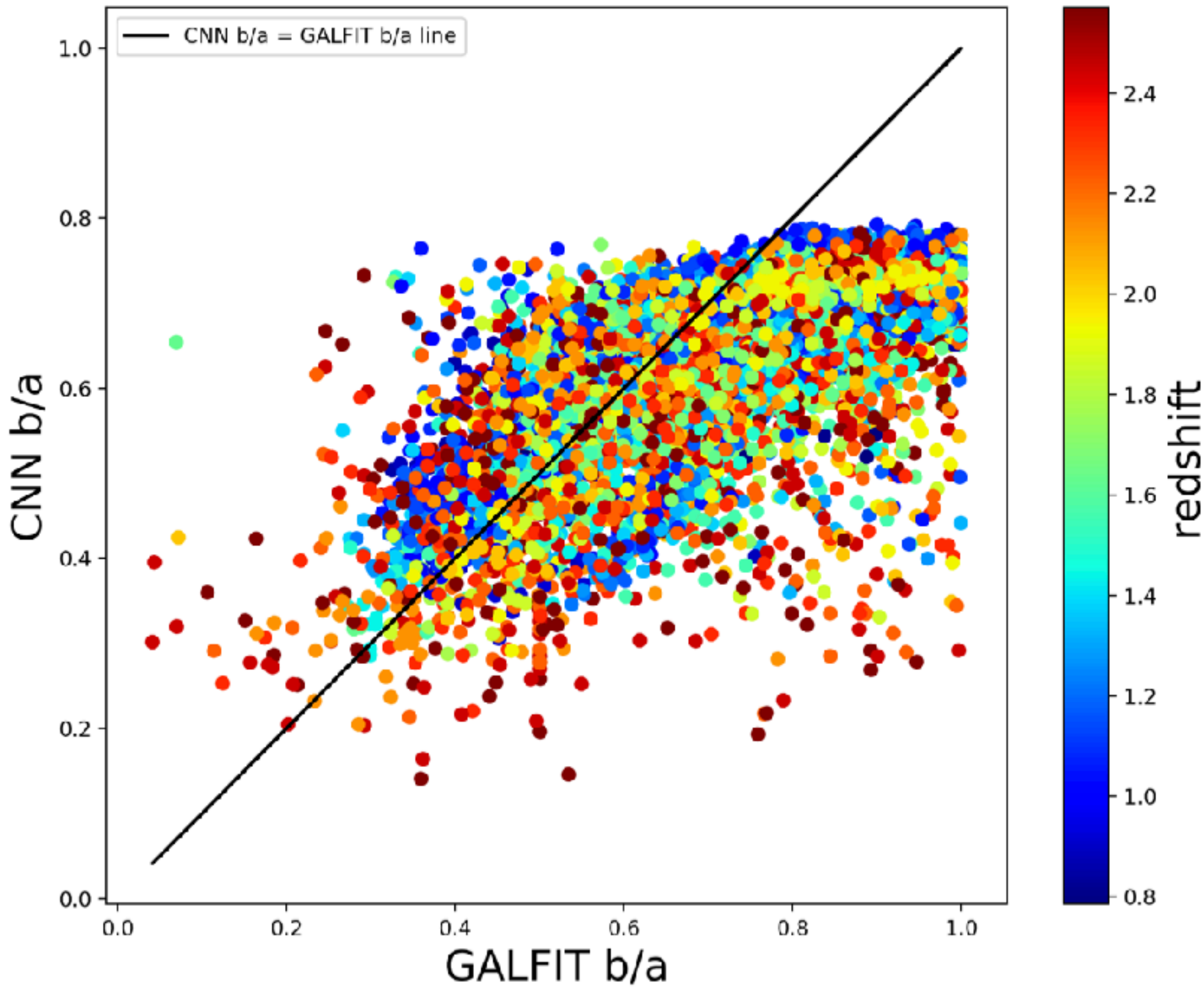
Improved Santa Cruz Semi-Analytic Model of galaxy population evolution, including insights from high-resolution hydro simulations — Viraj Pandya, Christoph Lee, Rachel Somerville, Sandy Faber

Comparison between GALFIT measurements of CANDELized VELA images and other things

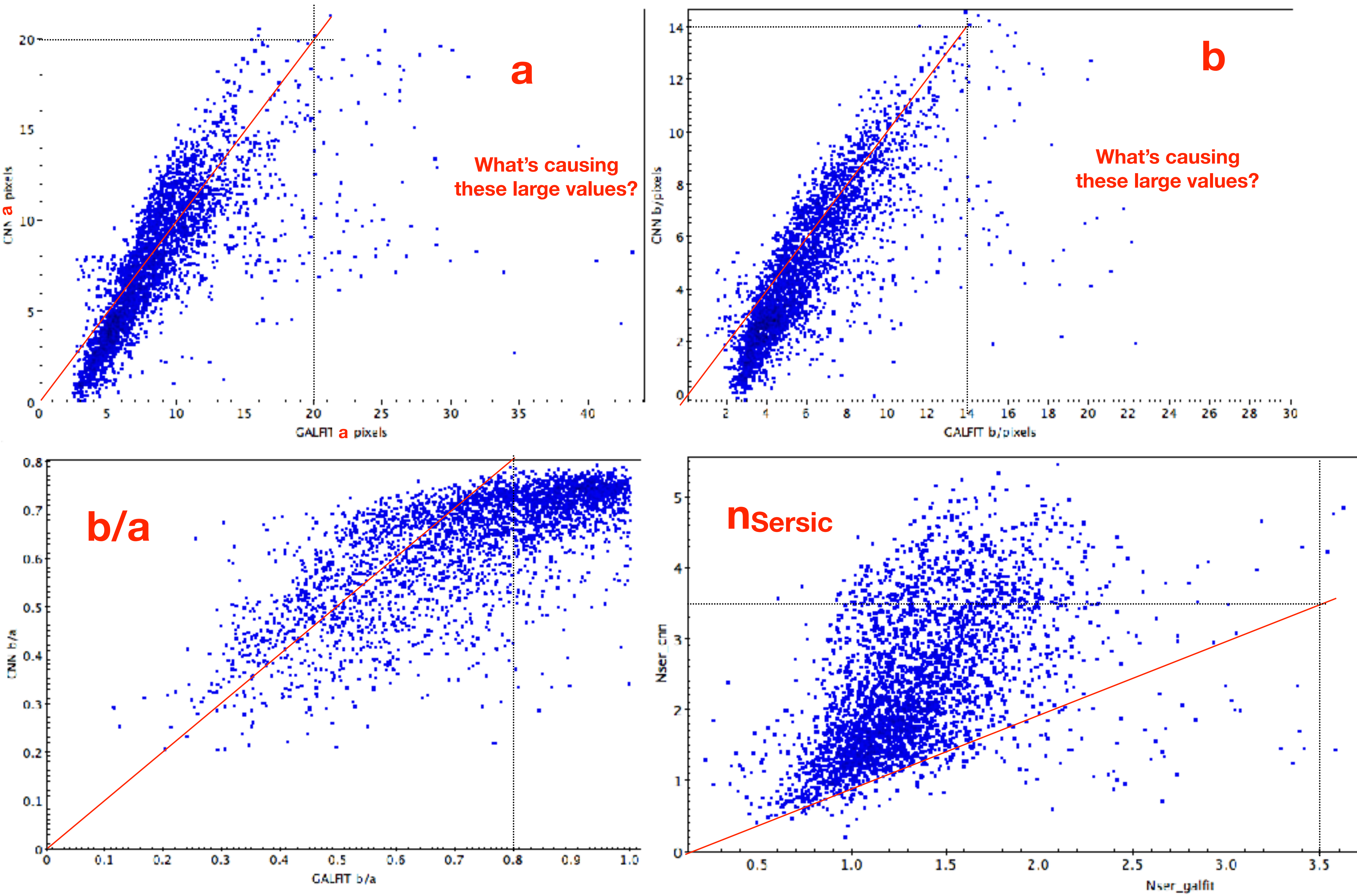
Haowen Zhang

Note: first 3 slides are from Oct 23

CNN Galfit Emulator (Marc Huertas-Company) vs. Galfit (Haowen Zhang)
Applied to VELA Gen3 CANDELized Images



CNN Galfit Emulator (Marc Huertas-Company) vs. Galfit (Haowen Zhang)
Applied to VELA Gen3 CANDELized Images



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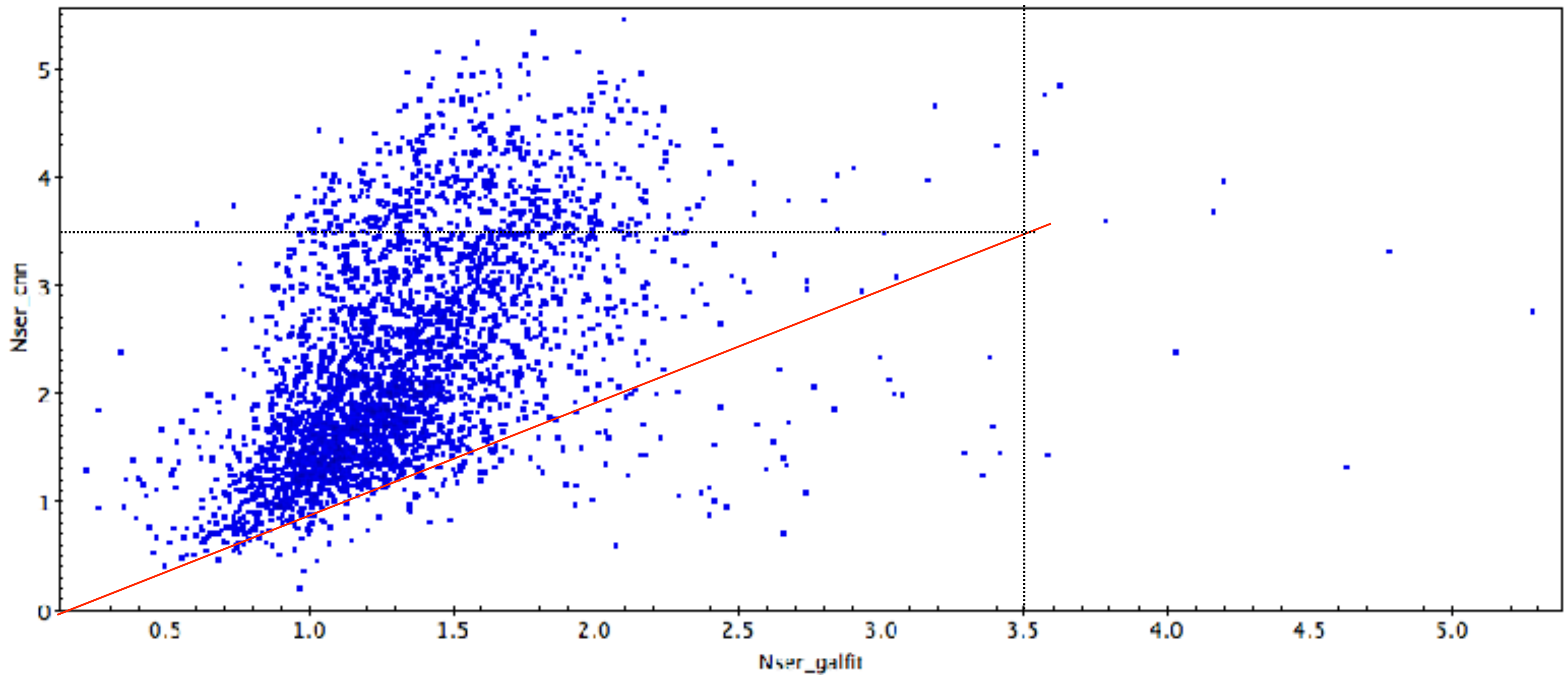
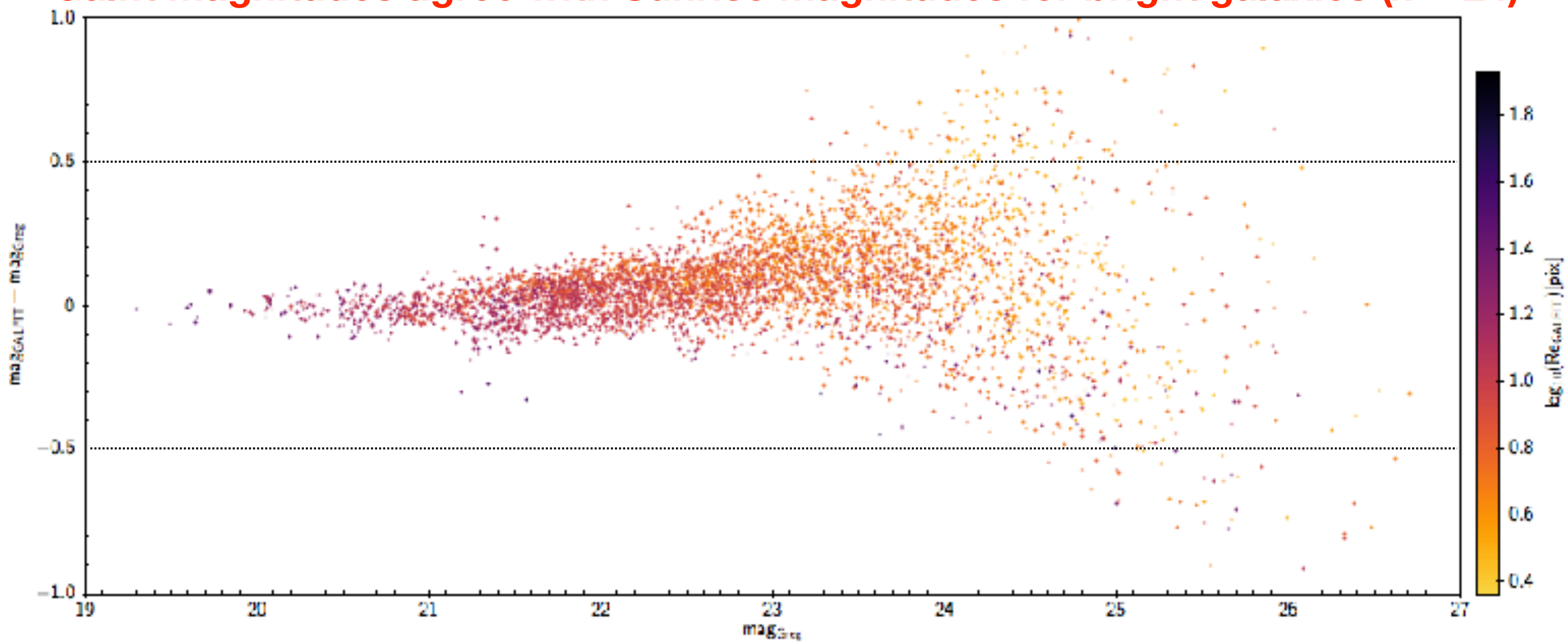
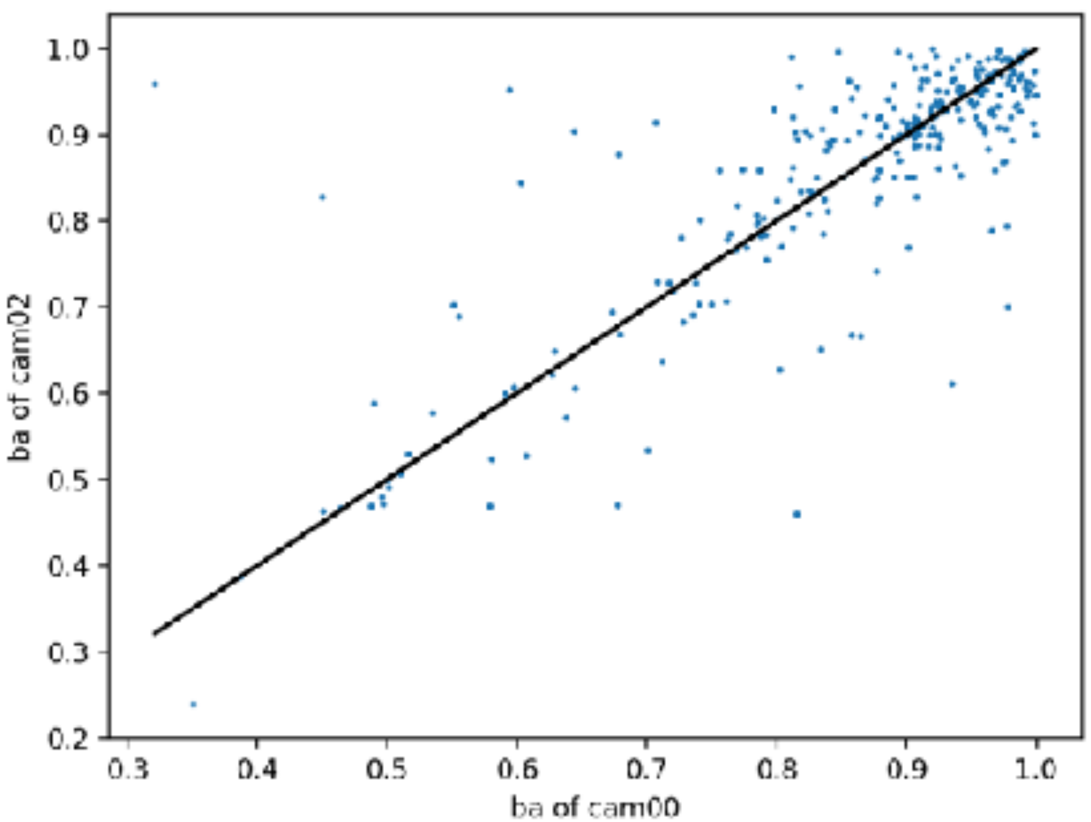
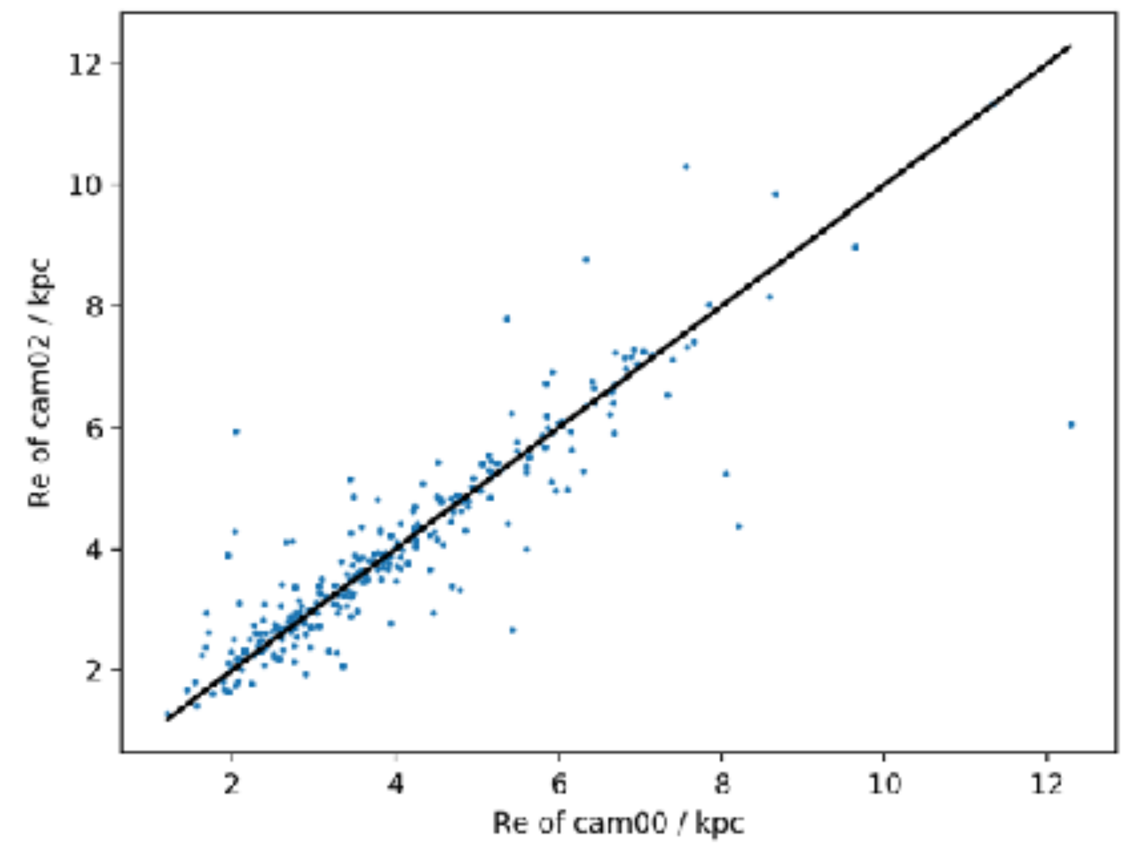


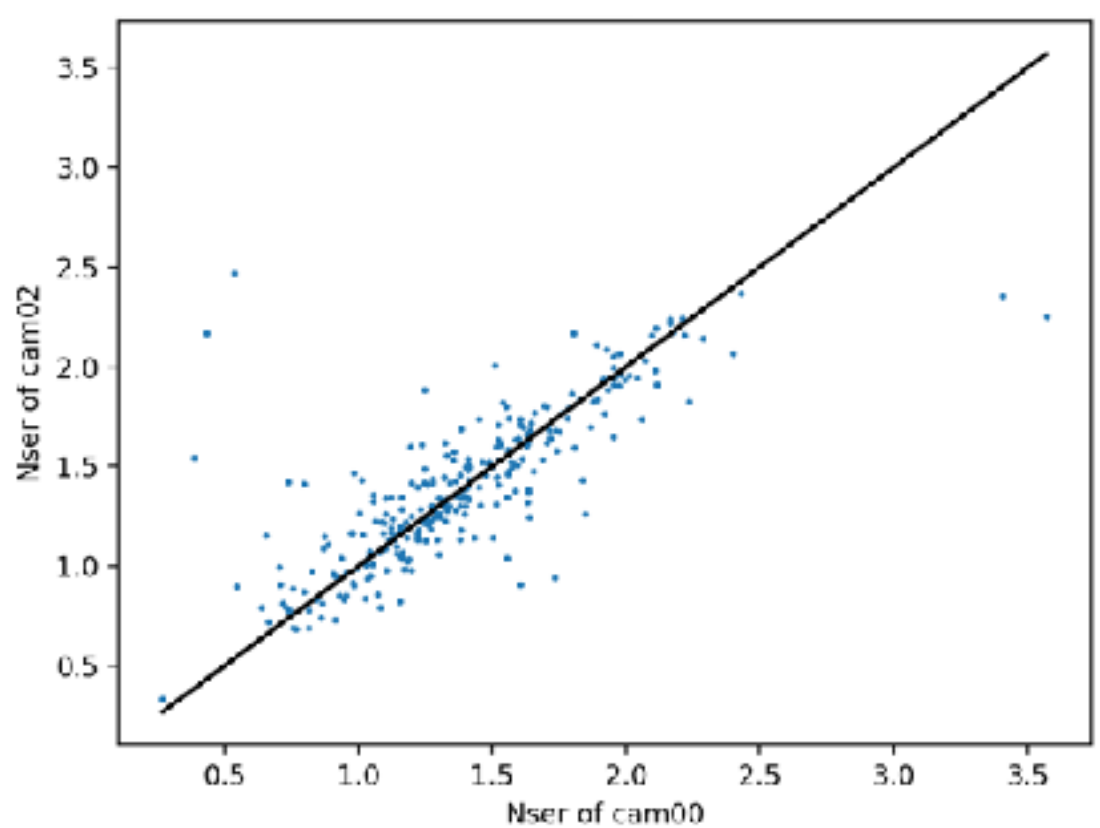
Galfit magnitudes agree with Sunrise magnitudes for bright galaxies ($h \lesssim 24$)



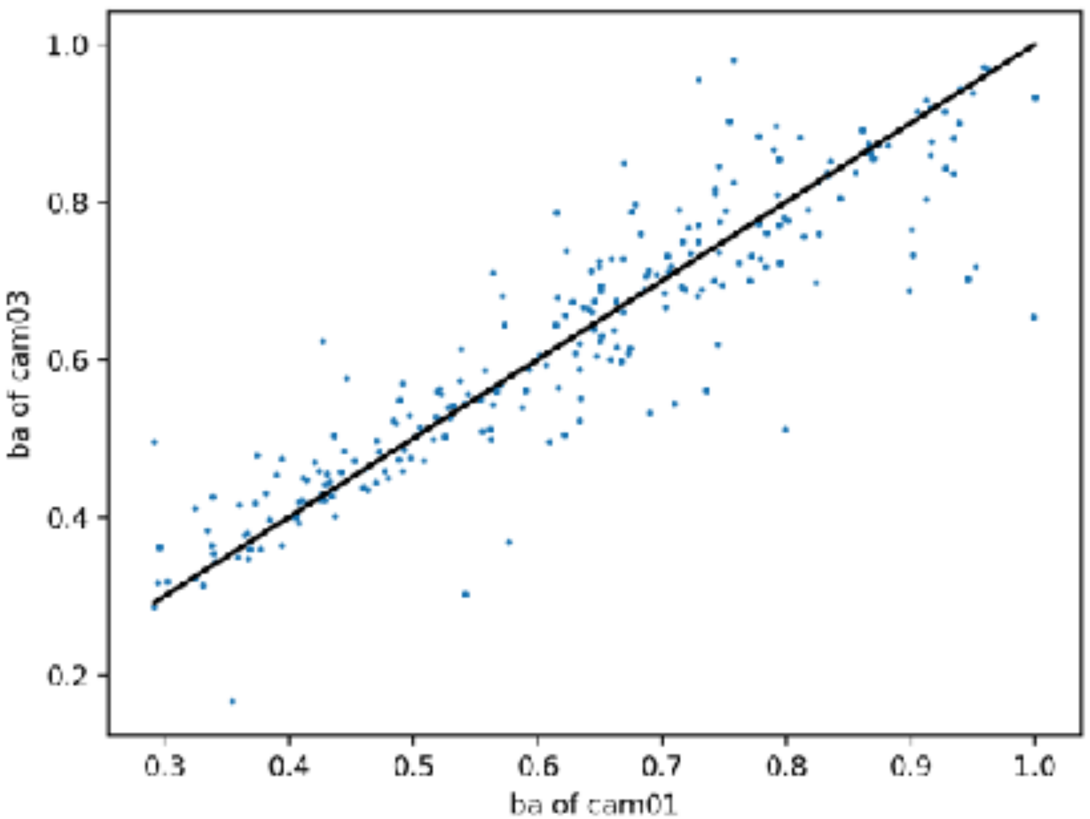
Cam00 vs. cam02
&& Cam01 vs. cam03

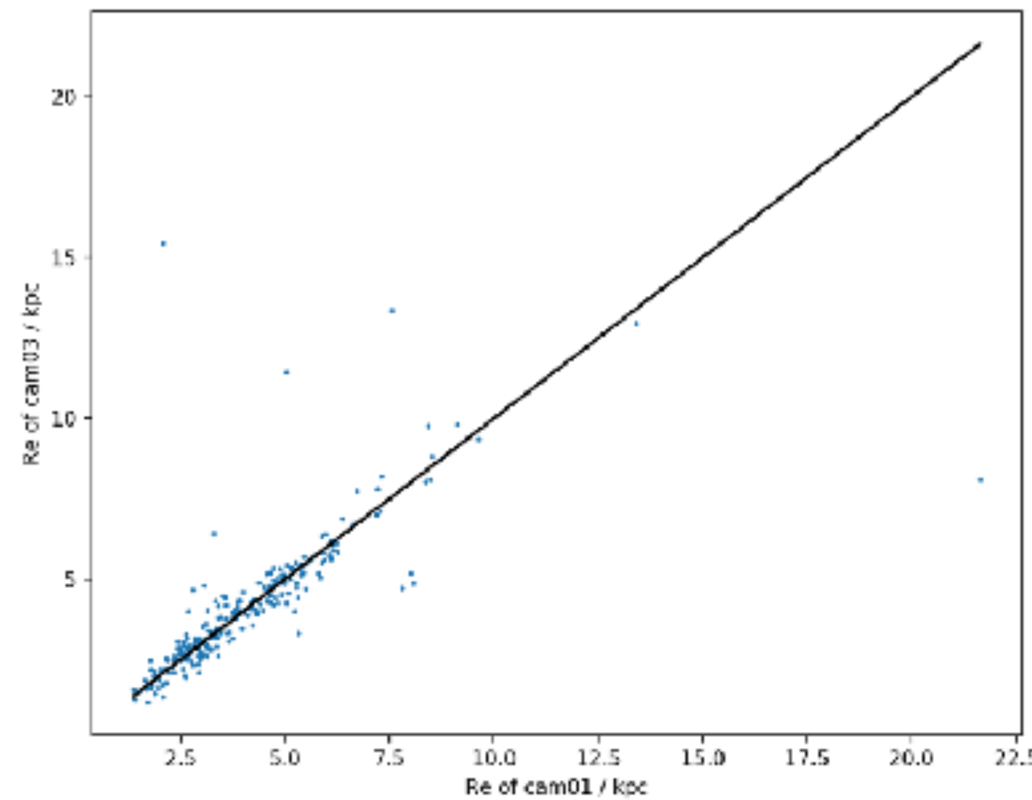


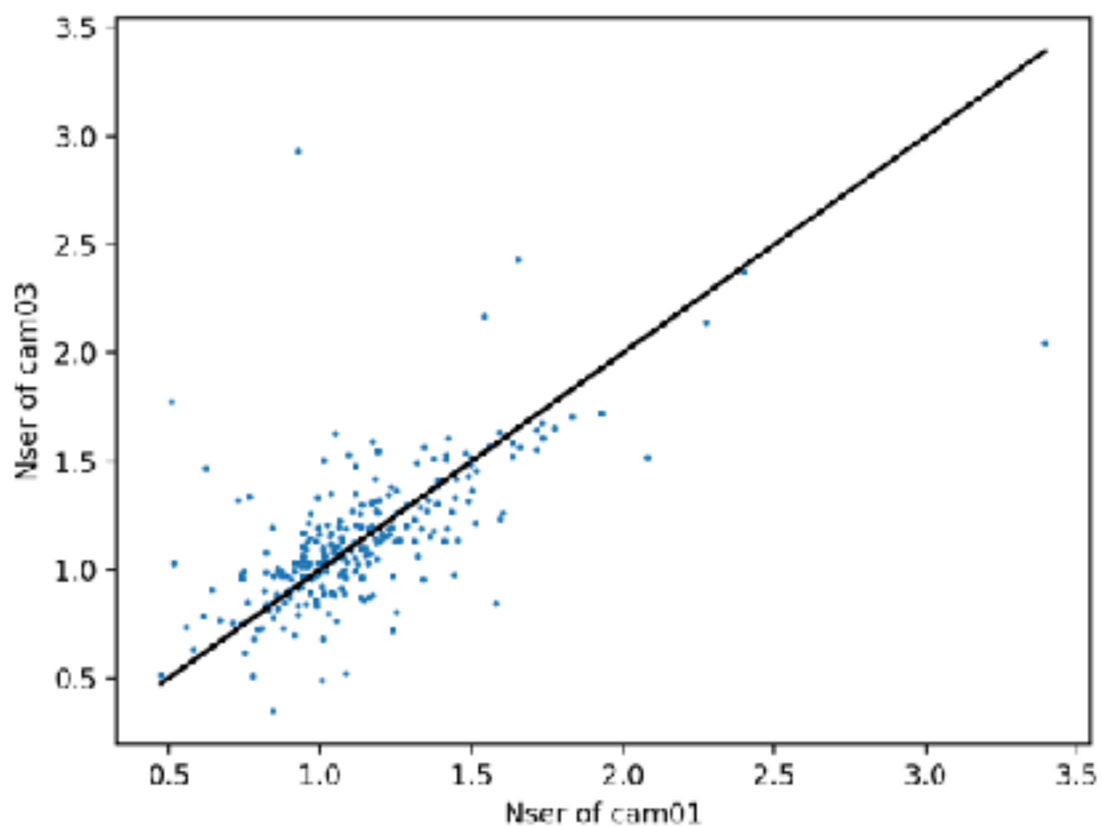




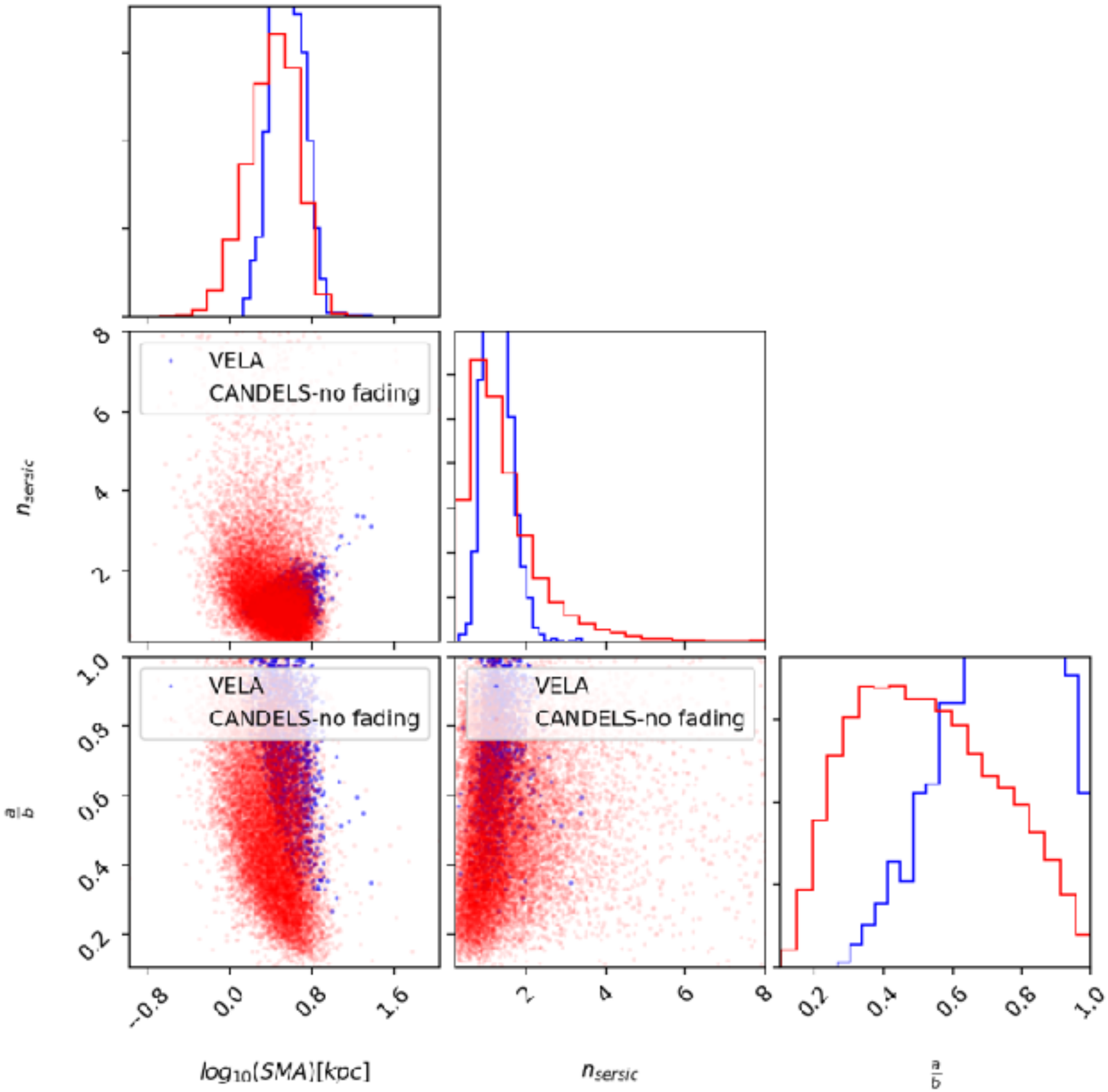
Cam00 vs. cam02
&& Cam01 vs. cam03



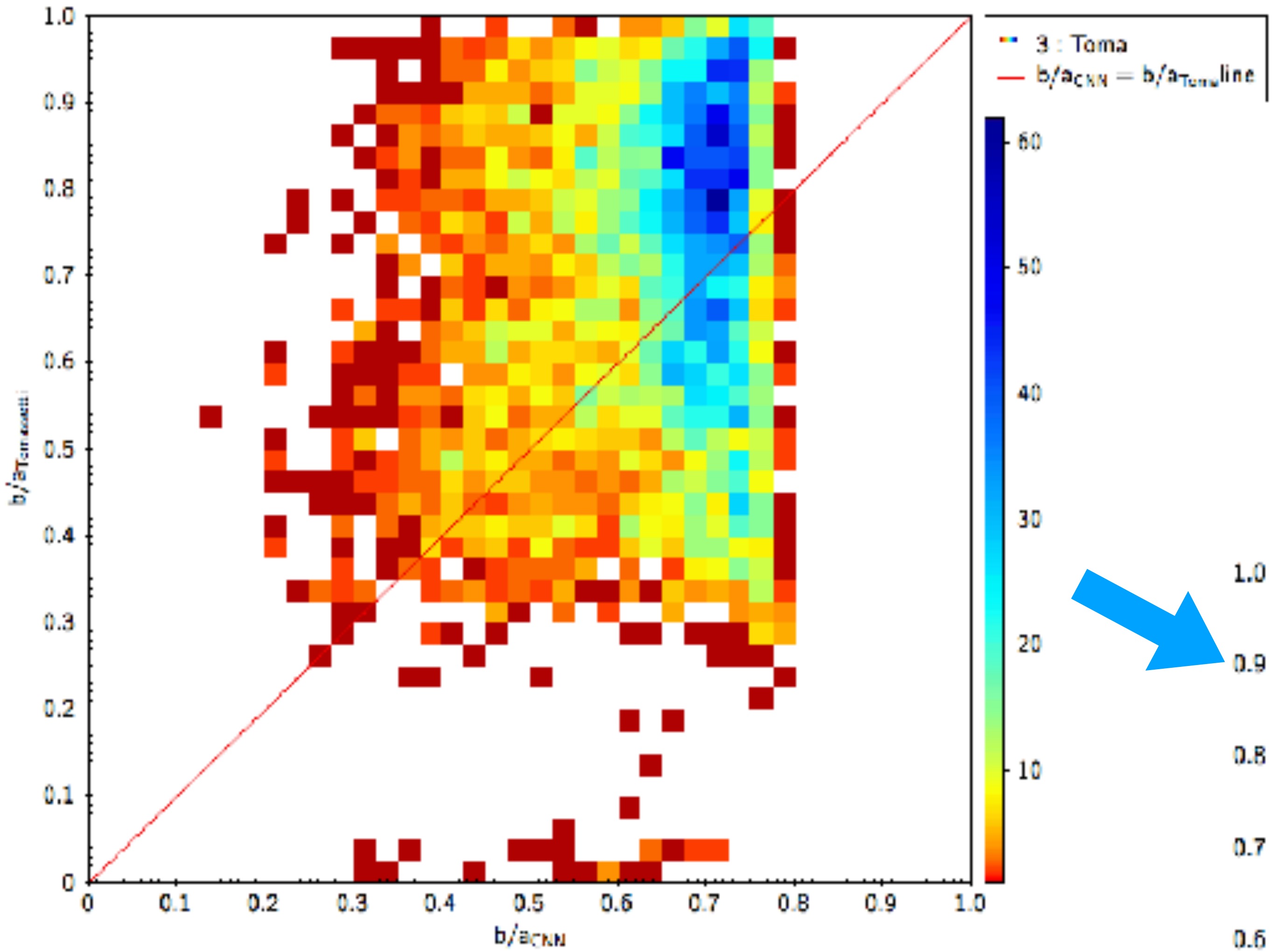




Comparison between VELA GALFIT and CANDELS

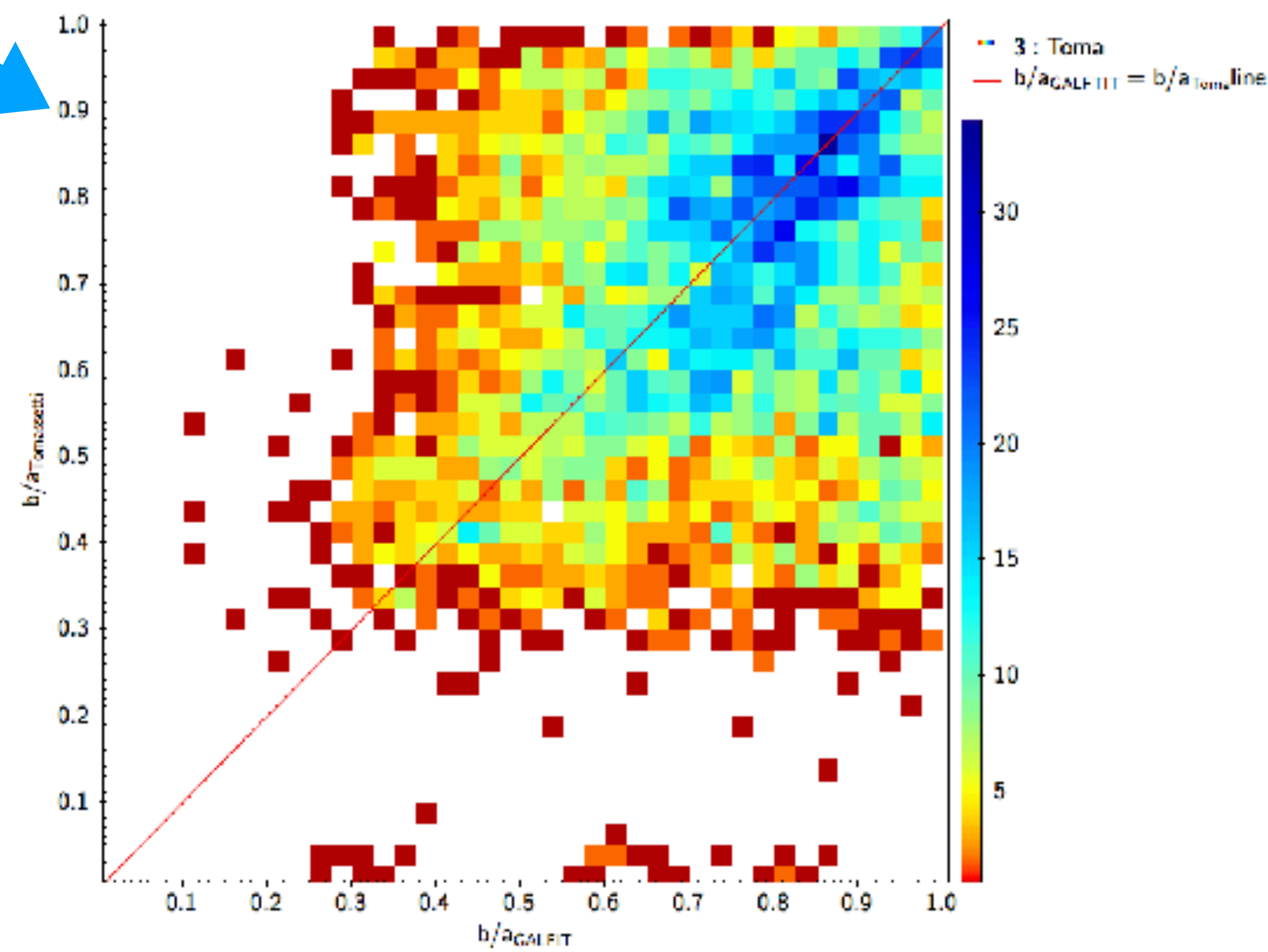


Tomassetti mass profile vs. CANDELized light profile: b/a

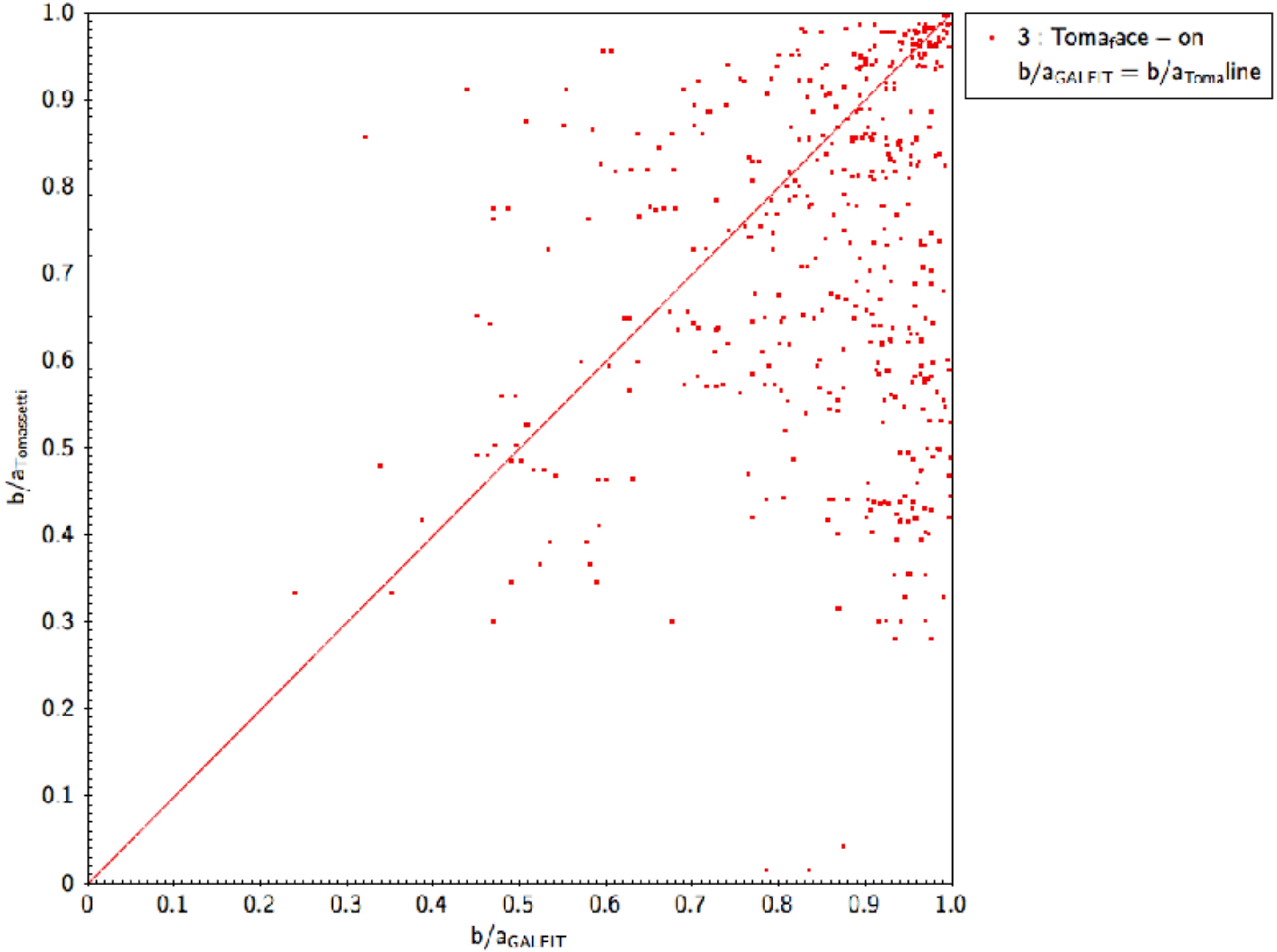


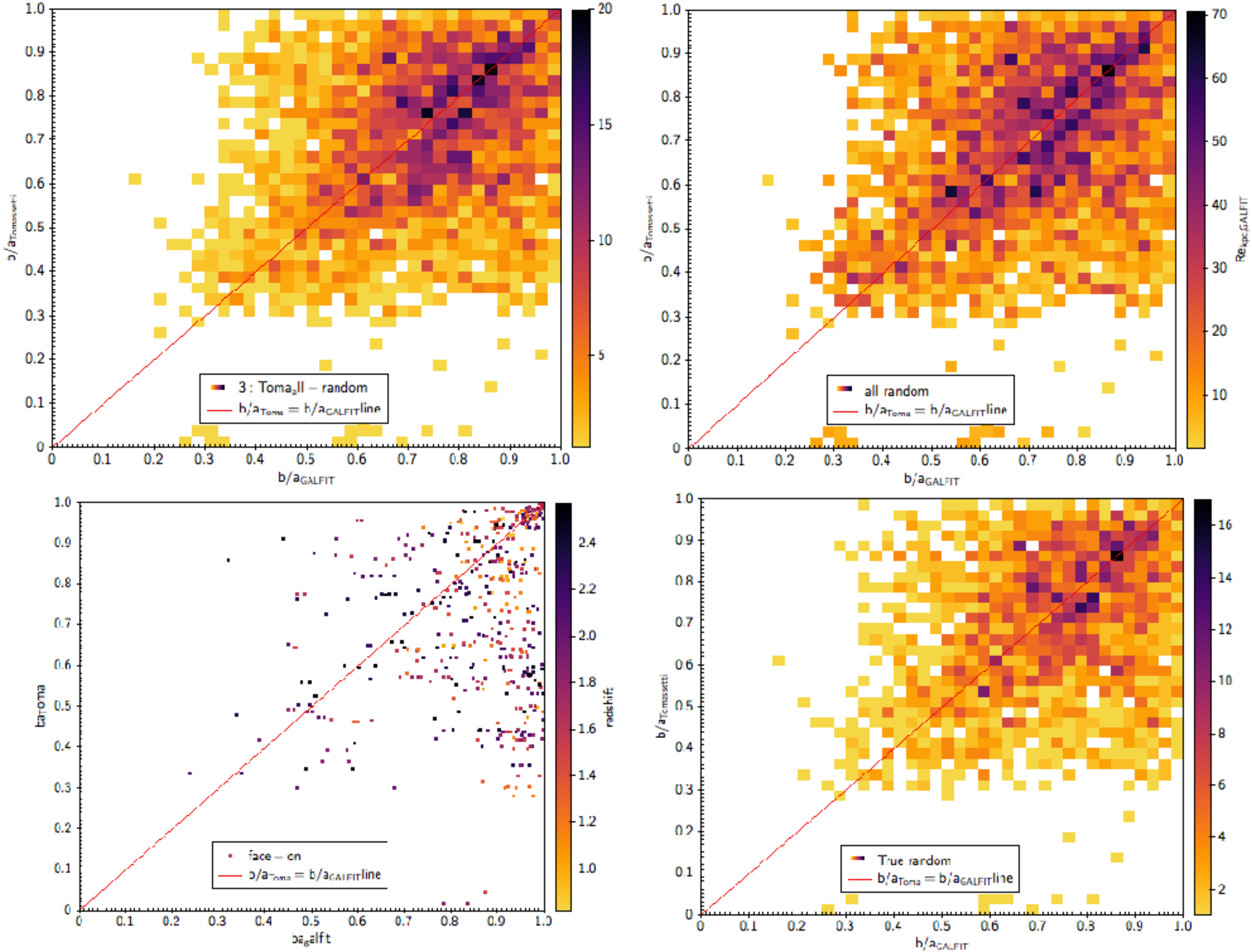
GALFIT emulator

GALFIT



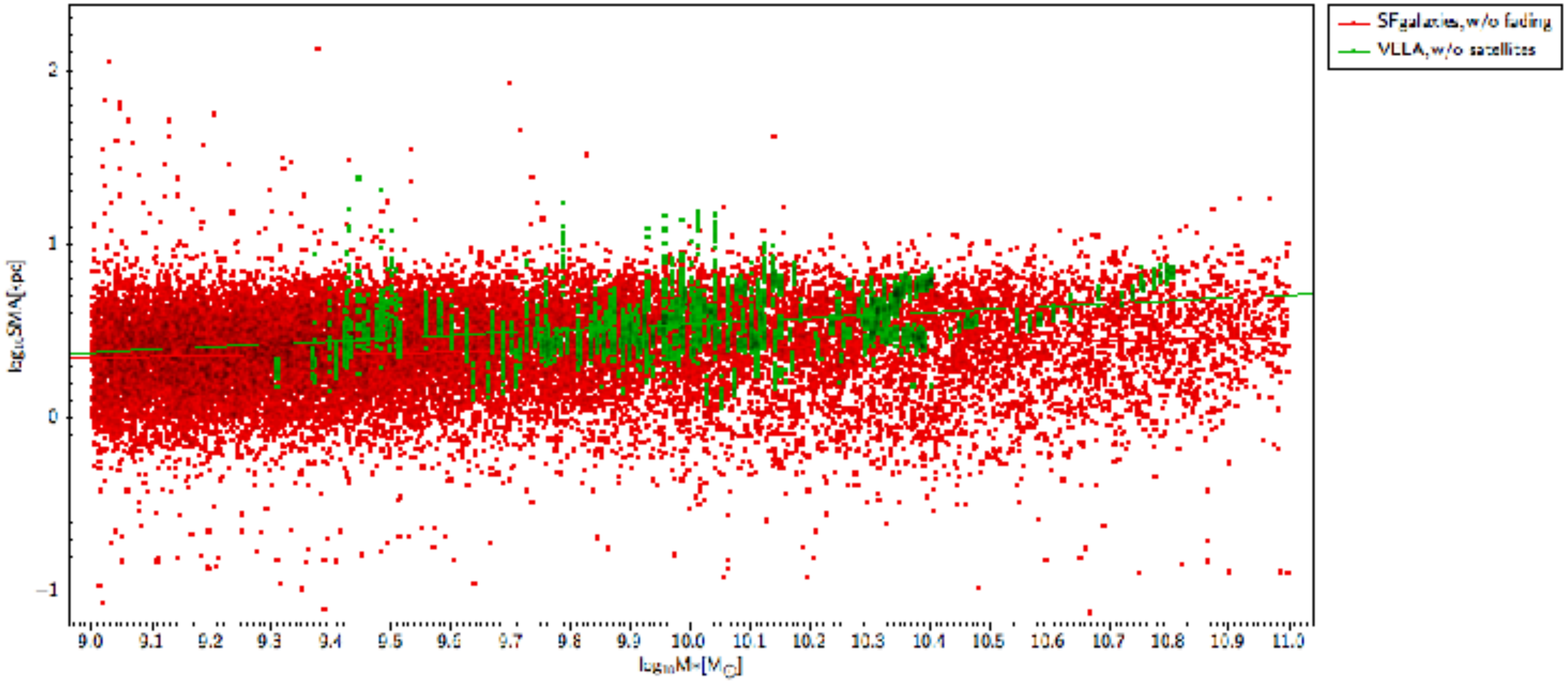
Tomassetti mass profile vs. CANDELized light profile: b/a

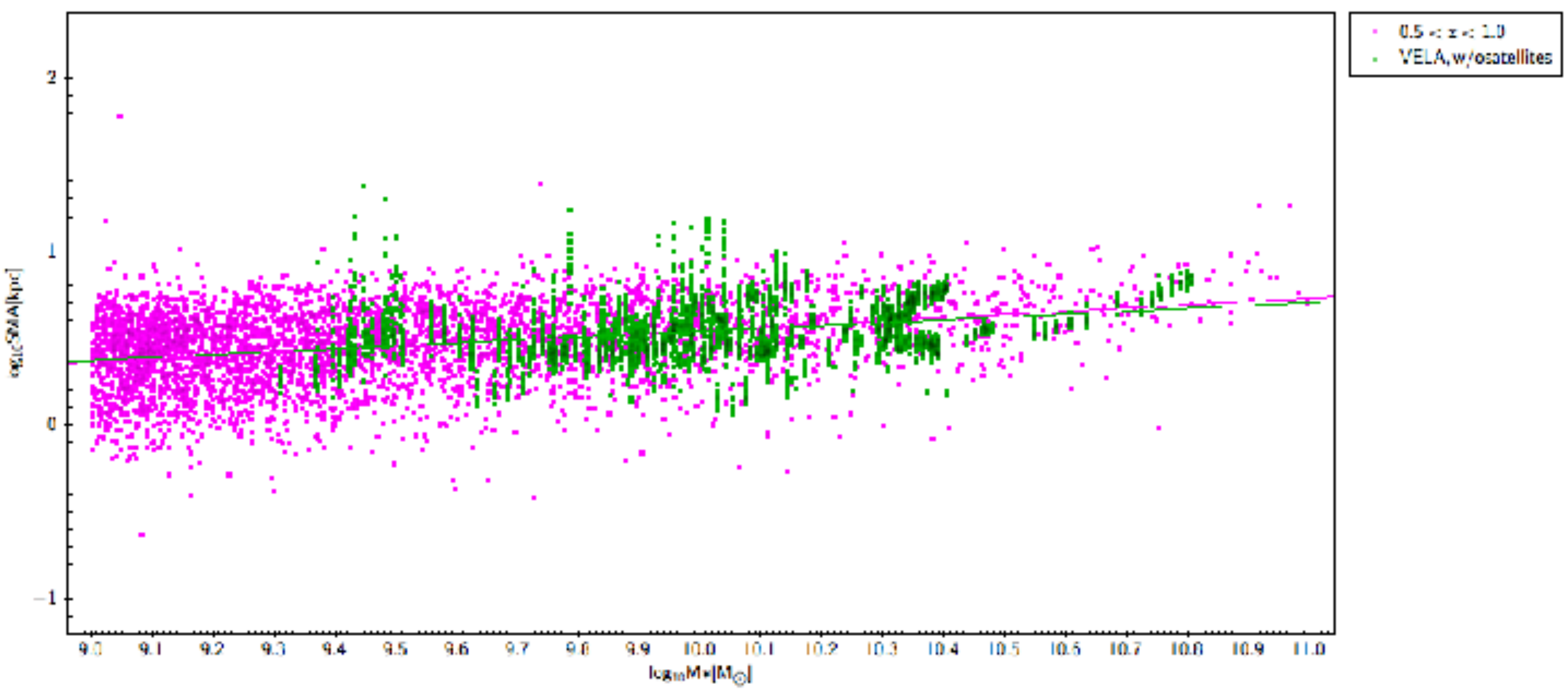


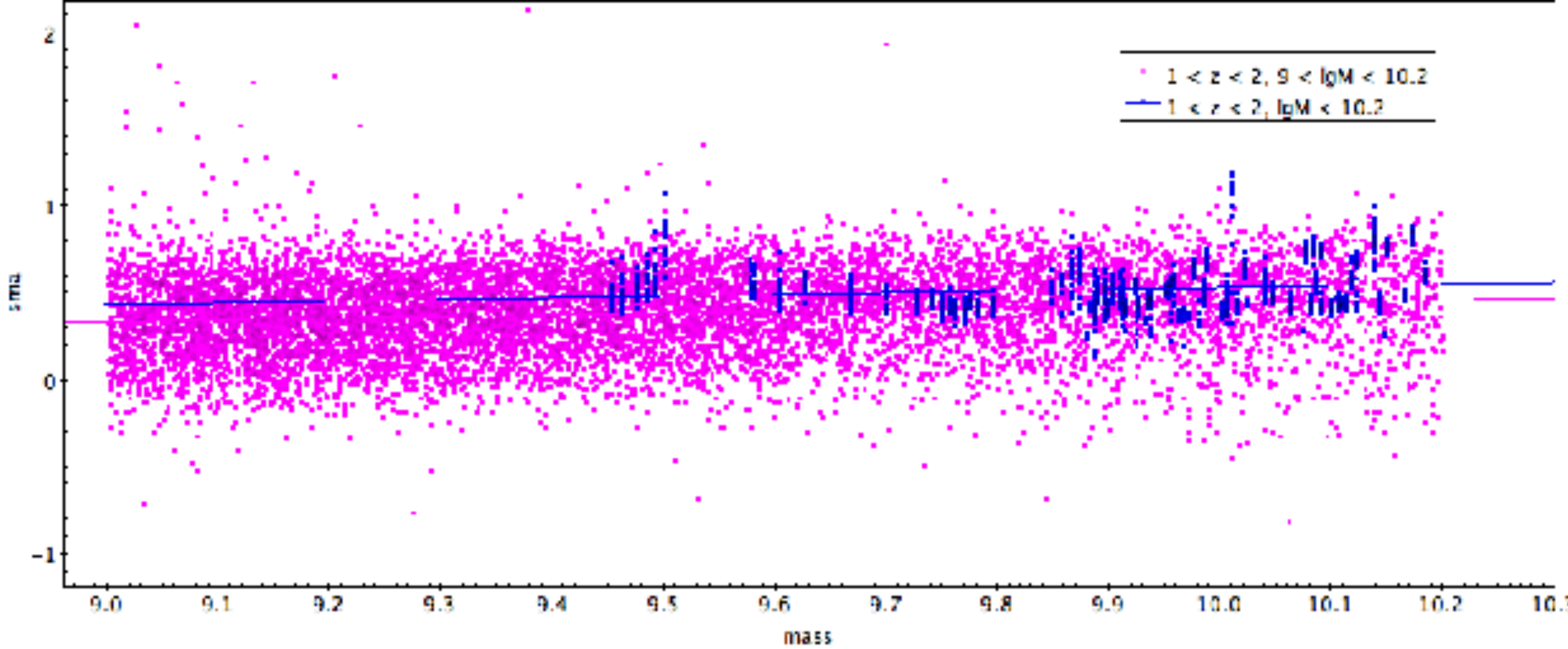


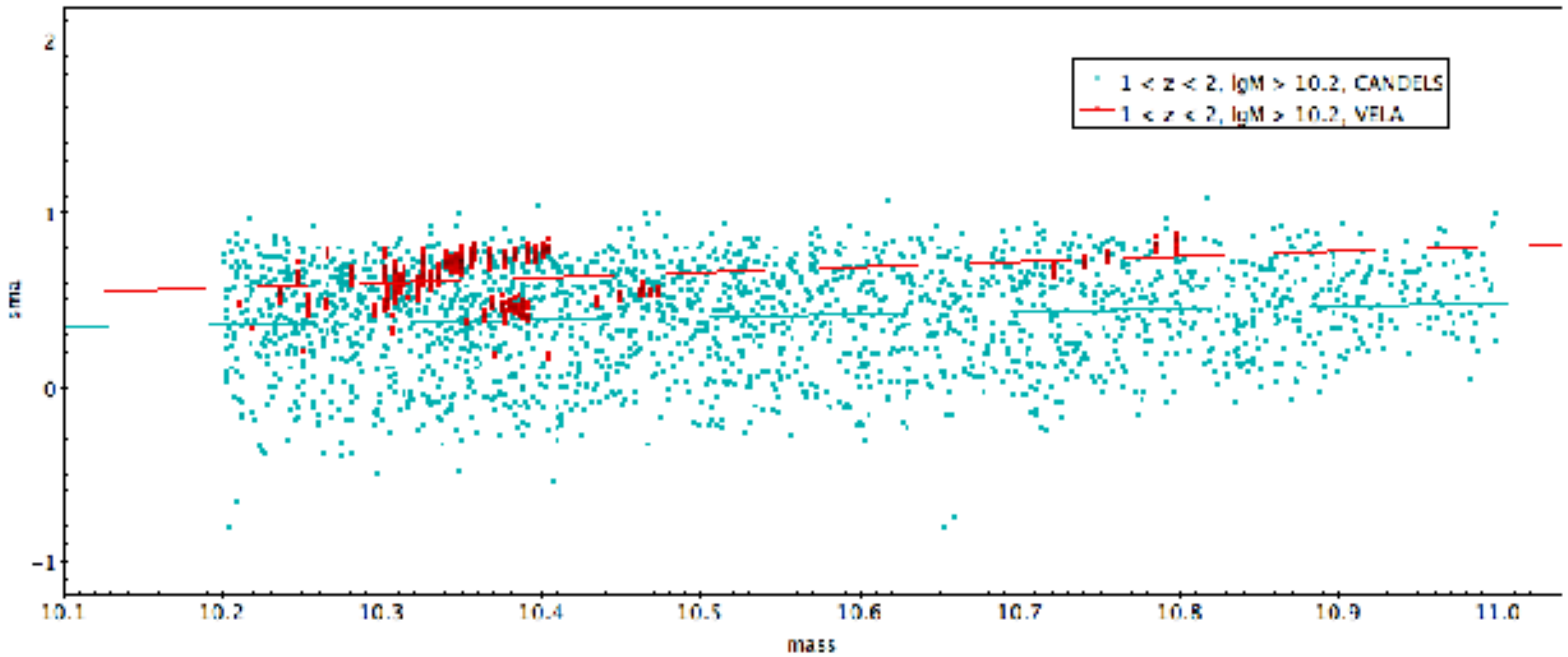
3 : Toma_all – random
b/a_Toma = b/a_GALFIT line
b/a_GALFIT
b/a_Tomassetti
all random
b/a_Toma = b/a_GALFIT line
b/a_GALFIT
b/a_Tomassetti
Re_kpc,GALFIT
face – on
b/a_Toma = b/a_GALFIT line
ba_galfit
ba_toma
redshift
True random
b/a_Toma = b/a_GALFIT line
b/a_GALFIT
b/a_Tomassetti

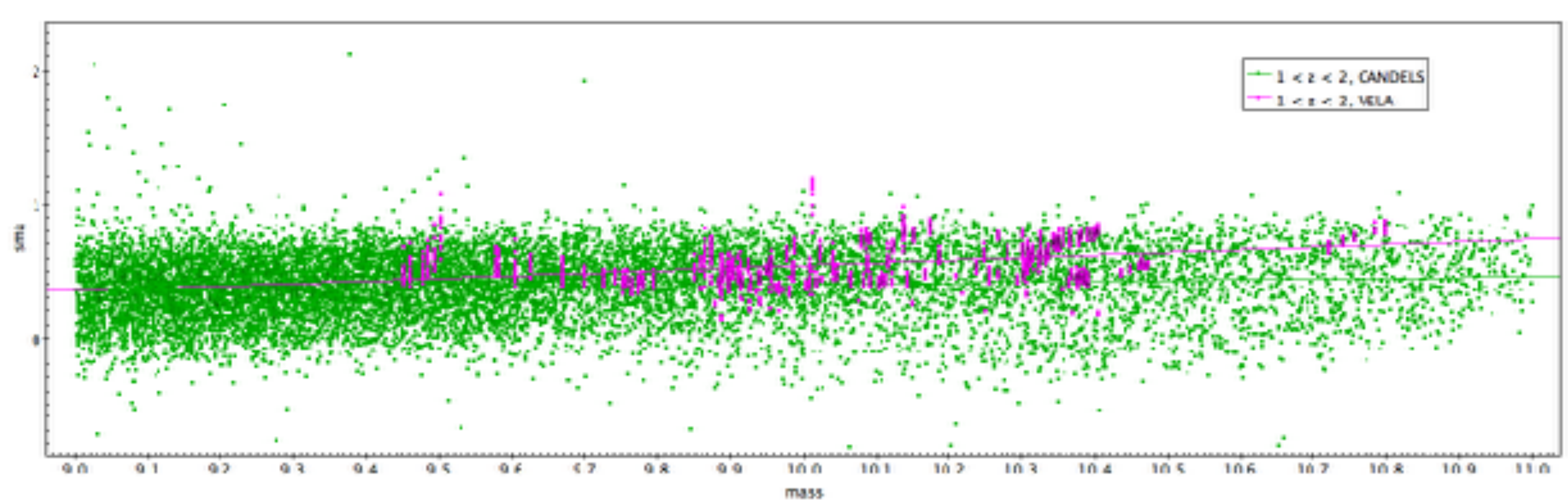
Comparison between VELA GALFIT and CANDELS

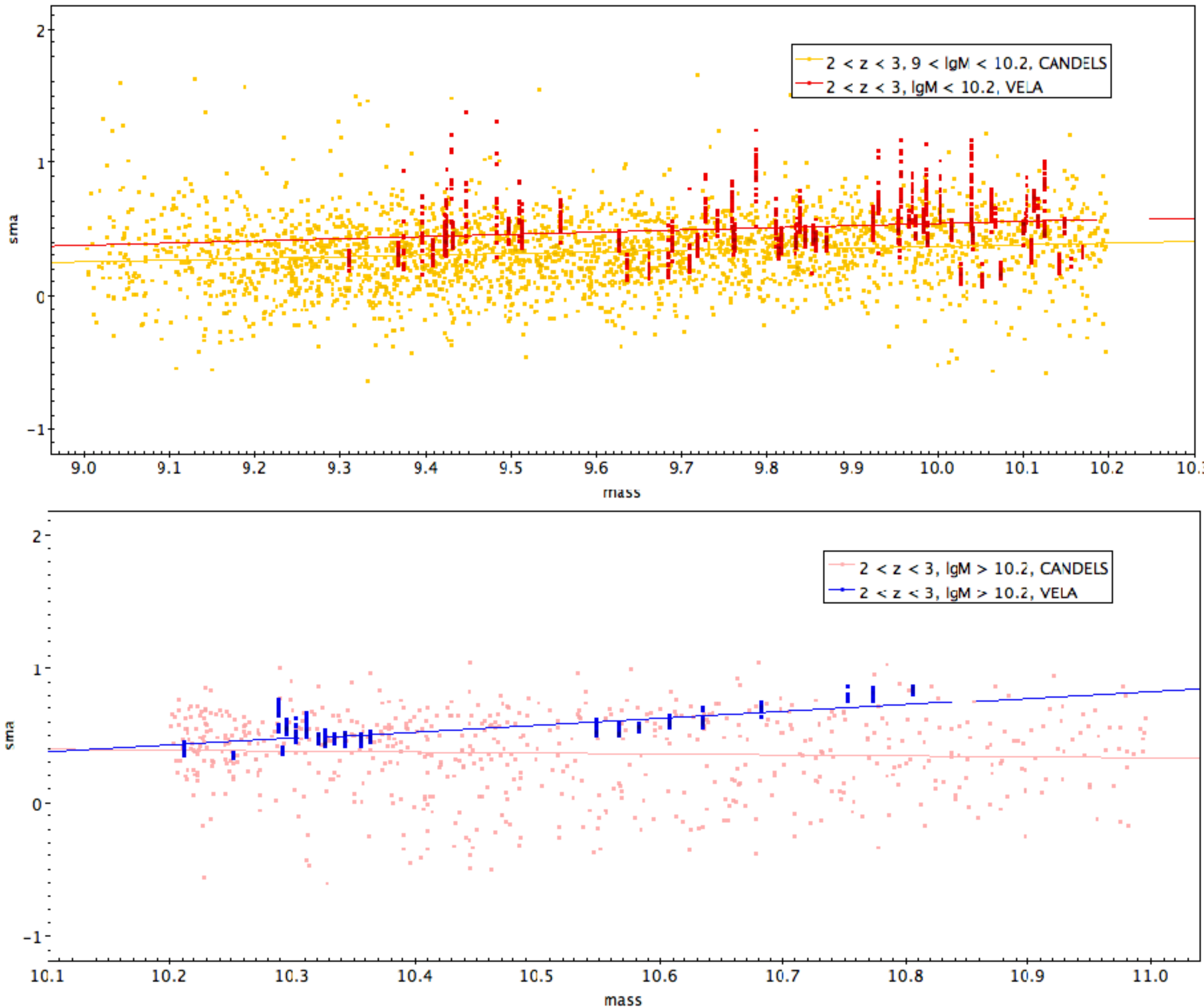




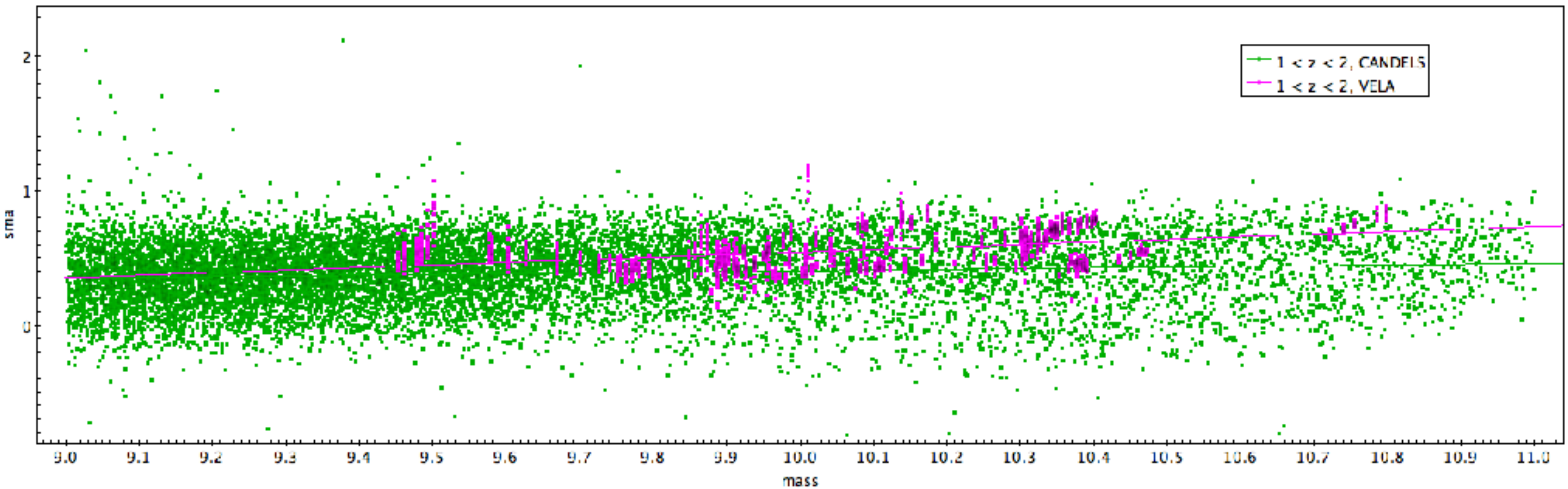

1 < z < 2, 9 < lgM < 10.2
1 < z < 2, lgM < 10.2
sma
mass

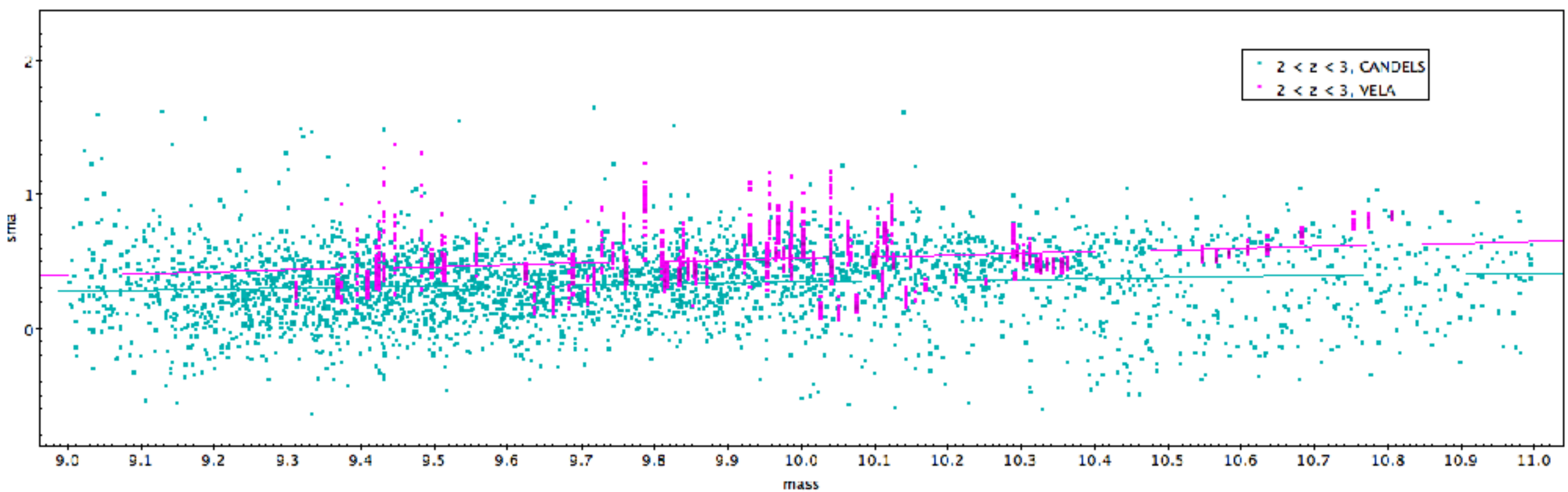

1 < z < 2, lgM > 10.2, CANDELS
1 < z < 2, lgM > 10.2, VELA
sma
mass

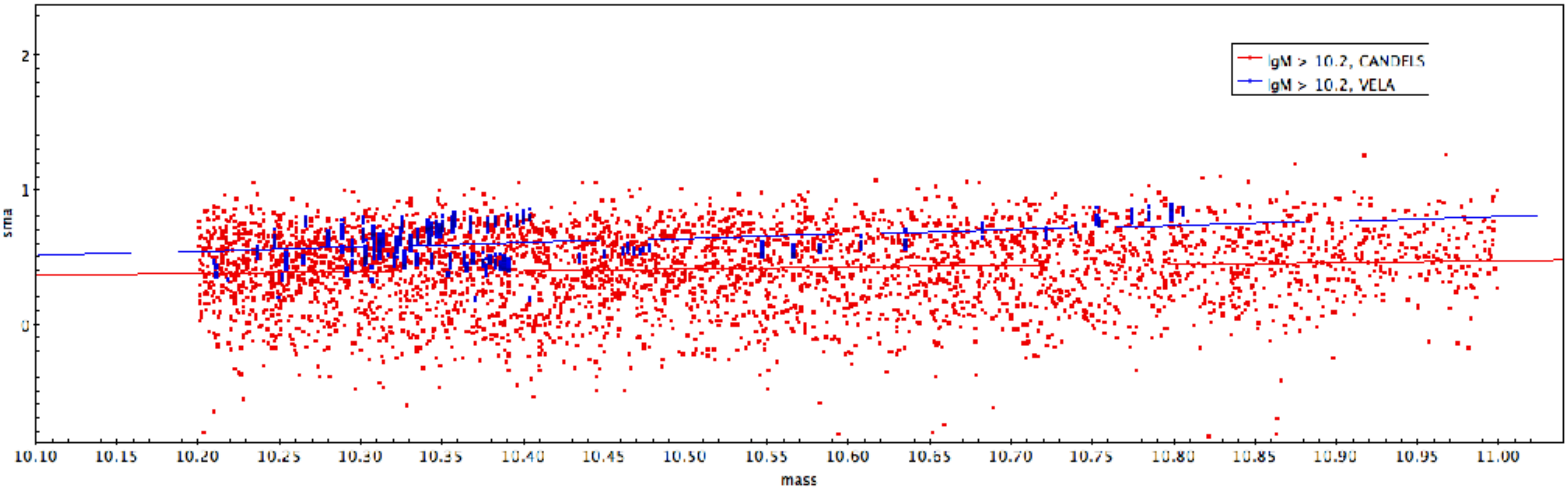

1 < z < 2, CANDELS
1 < z < 2, VELA
sma
mass



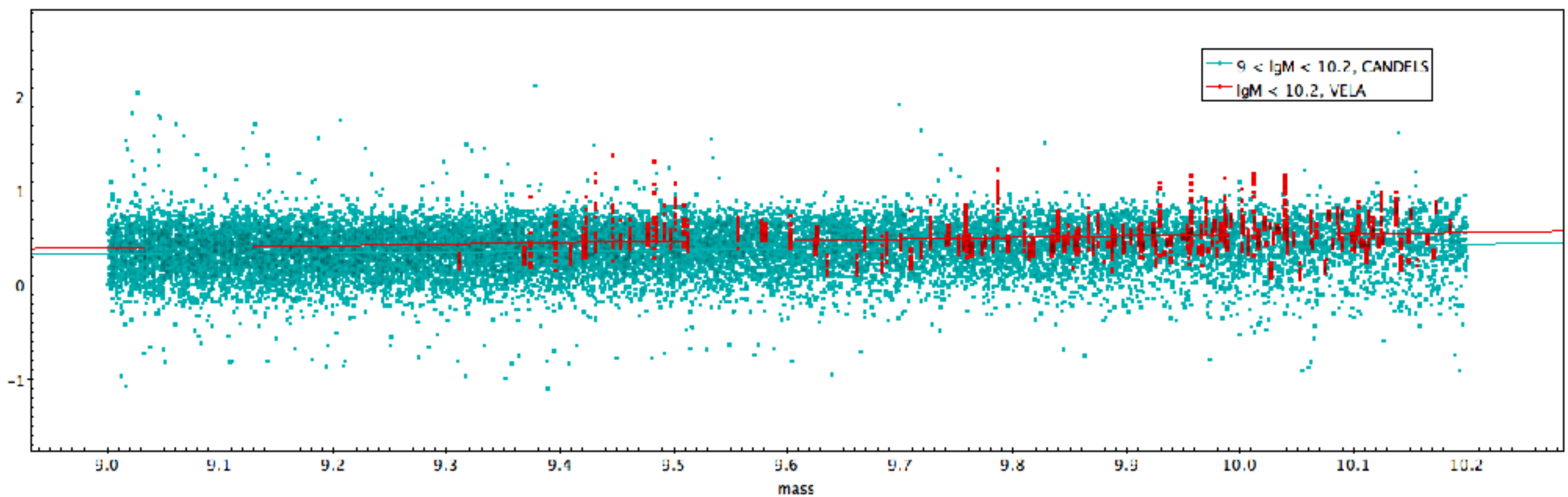
2 < z < 3, 9 < lgM < 10.2, CANDELS
2 < z < 3, lgM < 10.2, VELA
sma
mass
2 < z < 3, lgM > 10.2, CANDELS
2 < z < 3, lgM > 10.2, VELA
sma
mass


1 < z < 2, CANDELS
1 < z < 2, VELA
sma
mass
2
1
0
9.0
9.1
9.2
9.3
9.4
9.5
9.6
9.7
9.8
9.9
10.0
10.1
10.2
10.3
10.4
10.5
10.6
10.7
10.8
10.9
11.0

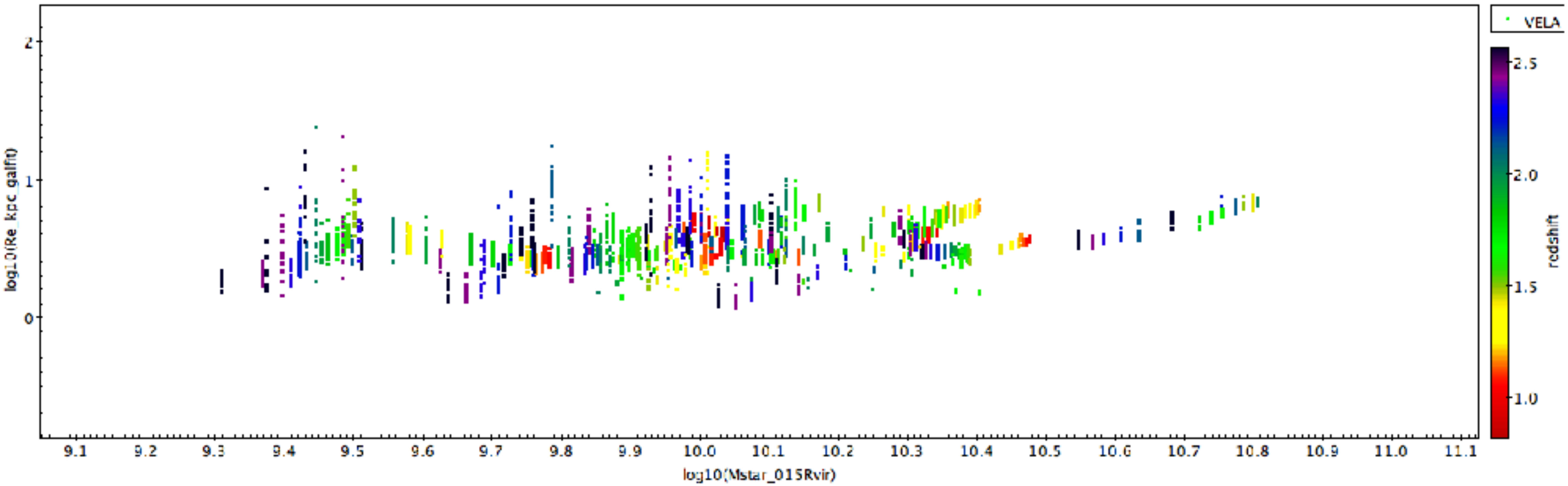

2 < z < 3, CANDELS
2 < z < 3, VELA
sma
mass
2
1
0
9.0
9.1
9.2
9.3
9.4
9.5
9.6
9.7
9.8
9.9
10.0
10.1
10.2
10.3
10.4
10.5
10.6
10.7
10.8
10.9
11.0

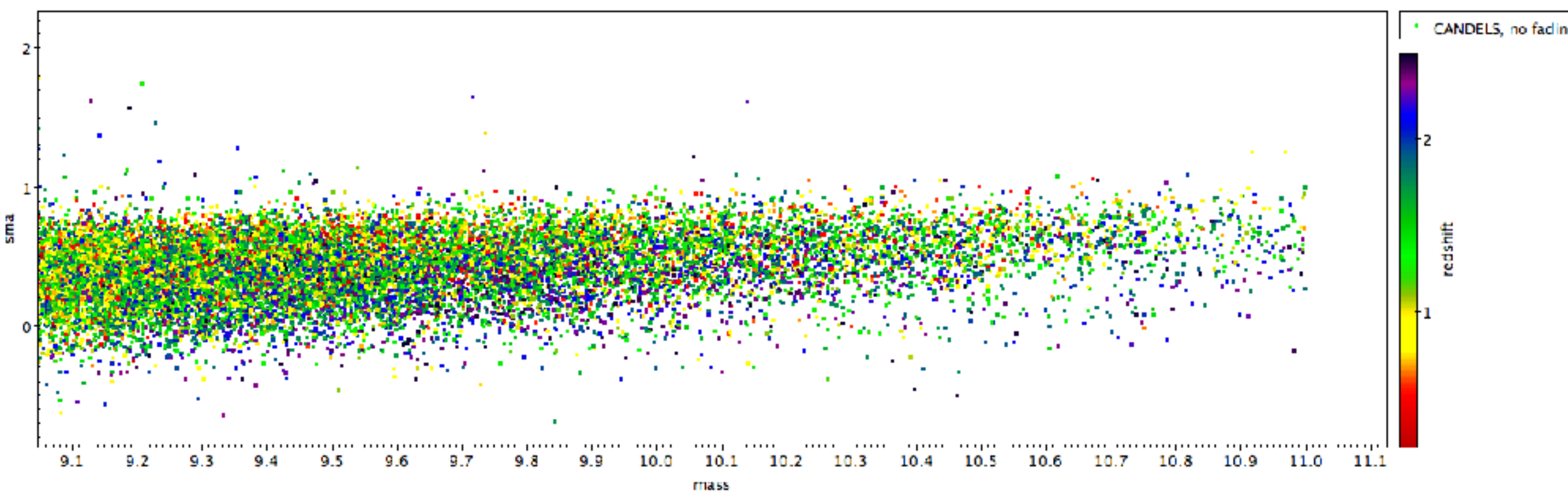


lgM > 10.2, CANDELS
lgM > 10.2, VELA
sma
mass



9 < lgM < 10.2, CANDELS
lgM < 10.2, VELA
sma
mass


VELA
redshift
log10(Re_kpc_galfit)
log10(Mstar_015Rvir)


CANDELS, no fading
redshift
sma
mass

What controls the sizes of galaxies in the NIHAO and VELA simulations?

Fangzhou Jiang

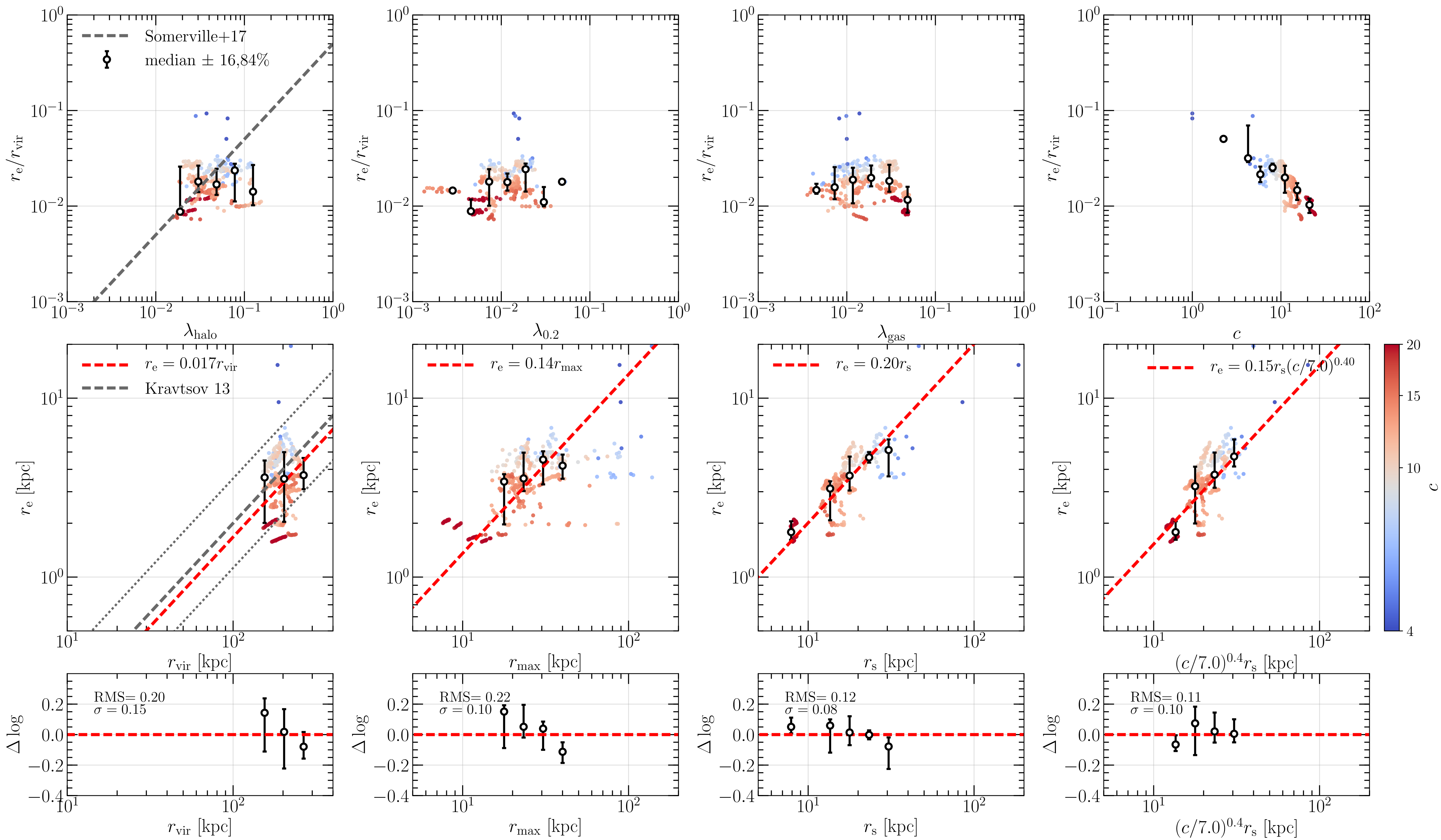
Sandy: You have already partially made the plot I want to see, as you have plotted r_e vs r_vir, and the latter goes as M-vir^0.33. You have colored by C, which is what I wanted. (Nihou plots)

Fangzhou: Right. Note however, r_vir ~ M_vir^0.33 is for a fixed redshift. Take the redshift scaling into account, r_vir ~ a * M_vir^0.33 , where a = 1/(1+z) is the expansion factor. So I am not exactly making the plot you asked, but this is not very important.

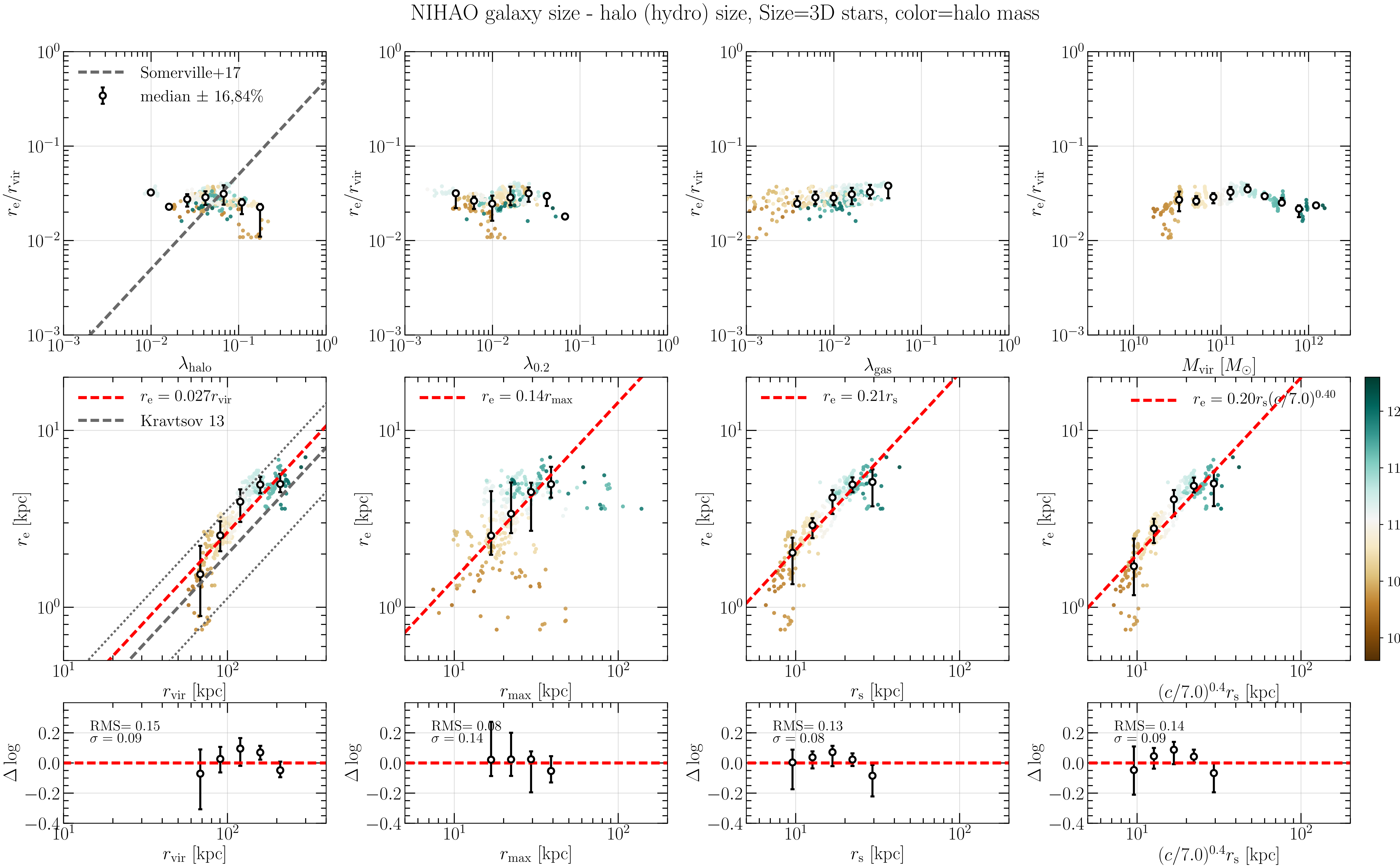
The average c-M_vir-z relation goes as c ~ M_vir^-0.11 / (1+z).

I only choose galaxies (snapshots) with M_vir = 10^11.5-12 at z=0-0.3. M_vir = 10^11.5-12 at z=0-0.3 makes r_vir>100kpc. The bins are narrow enough that the variation in c according to the average c-M_vir-z relation is only 20%, so a strong scaling between r_e/r_vir and c, over a large range in c, show that it is not due to the c-M_vir-z relation. With sightly adjusted dynamical range in the color bar, you can see the color trend better. The upper right panel plots r_e / r_vir as a function of c -- you can see the strong scaling with c, which goes roughly as c^-0.6, as we use.

NIHAO galaxy size - halo (hydro) size, Size=3D stars, color=concentration

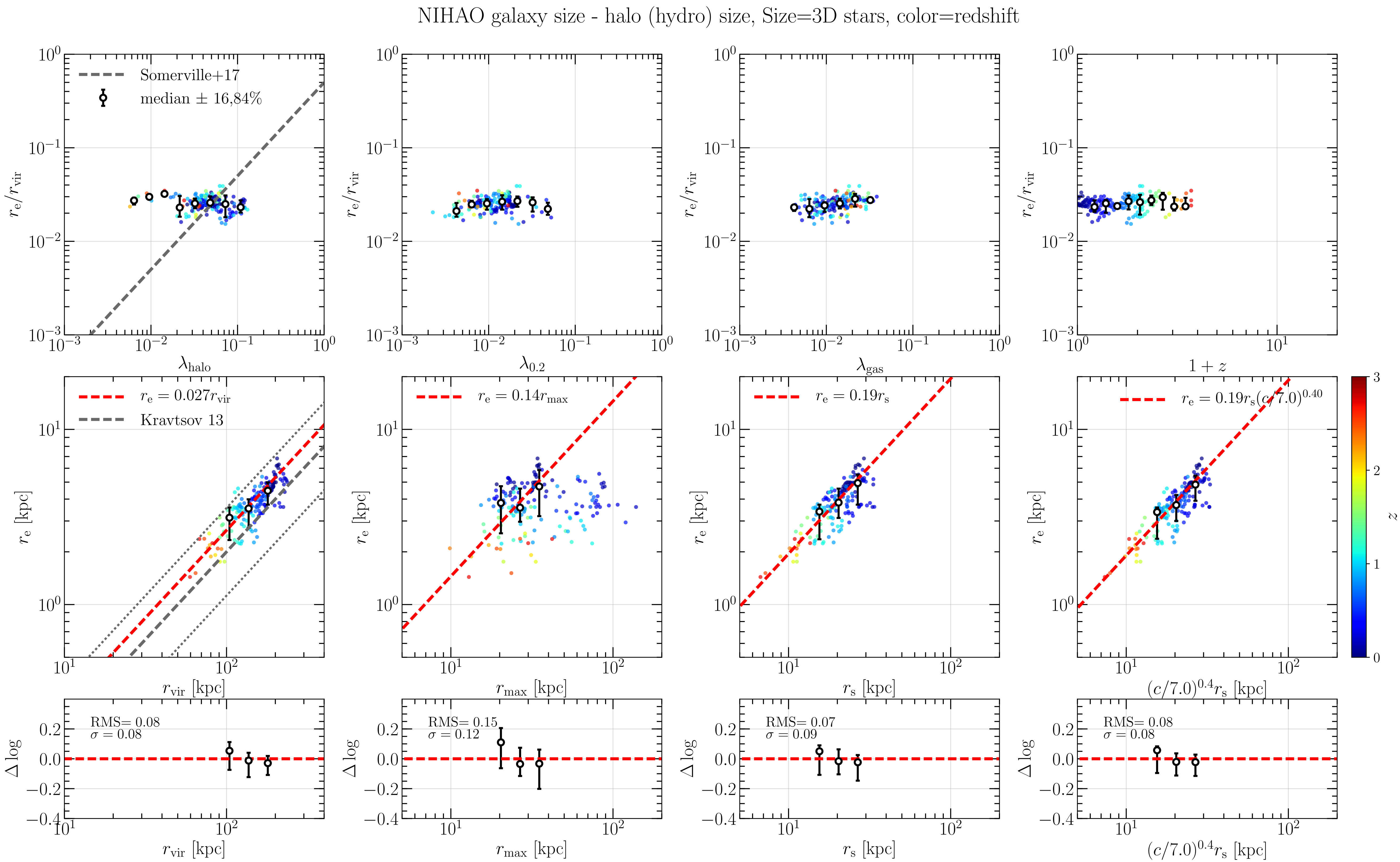


To further convince you, in **2.FixedConcentrationRedshift** (below) I fix c and z in narrow bins of c=6-9 and z=0-0.3, and color the points by halo mass -- you can see again from the upper right-hand panel that r_e/r_vir is almost independent of halo mass. Similarly, "3.FixedConcentrationMass.pdf" shows that r_e/r_vir doesn't depend on z at fixed M_vir and c. To sum up, it is really the concentration parameter that matters, instead of z- or M_vir-dependences that come in via c(M_vir,z)



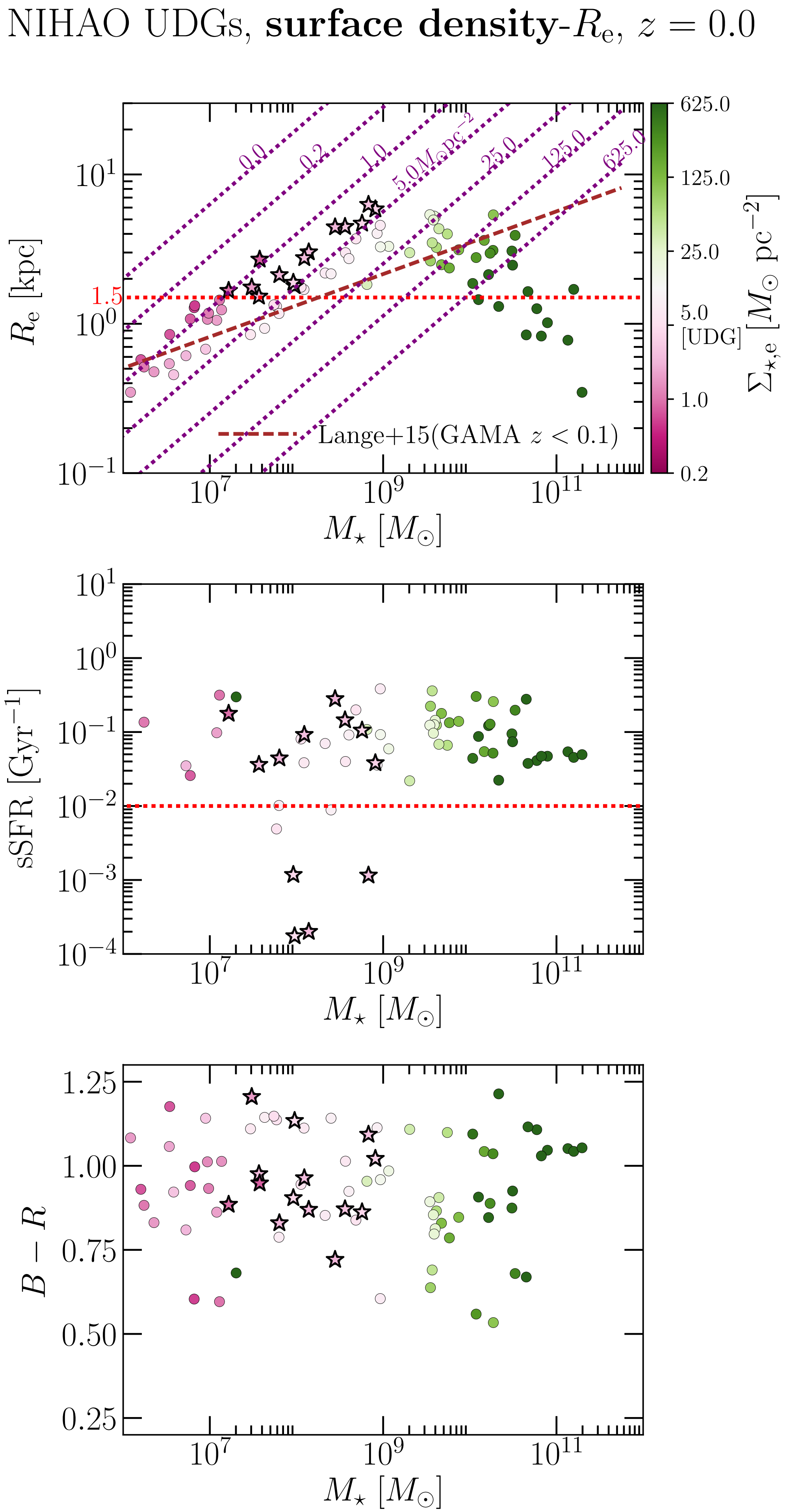
3.FixedConcentrationMass (figures below) shows that r_e/r_vir doesn't depend on z at fixed M_vir and c. To sum up, it is really the concentration parameter that matters, instead of z- or M_vir-dependences that come in via c(M_vir,z)

The size-stellar mass plot is a very different story -- First, you probably don't want to color it by c, but by observables (n_Sersic, Delta MS, etc). It would be great if you can inform me what you are after so that I can make the plot with appropriate color coding or with appropriate sample selection. I can do this in no time for both VELA and NIHAO, well with the quantities that I have computed...

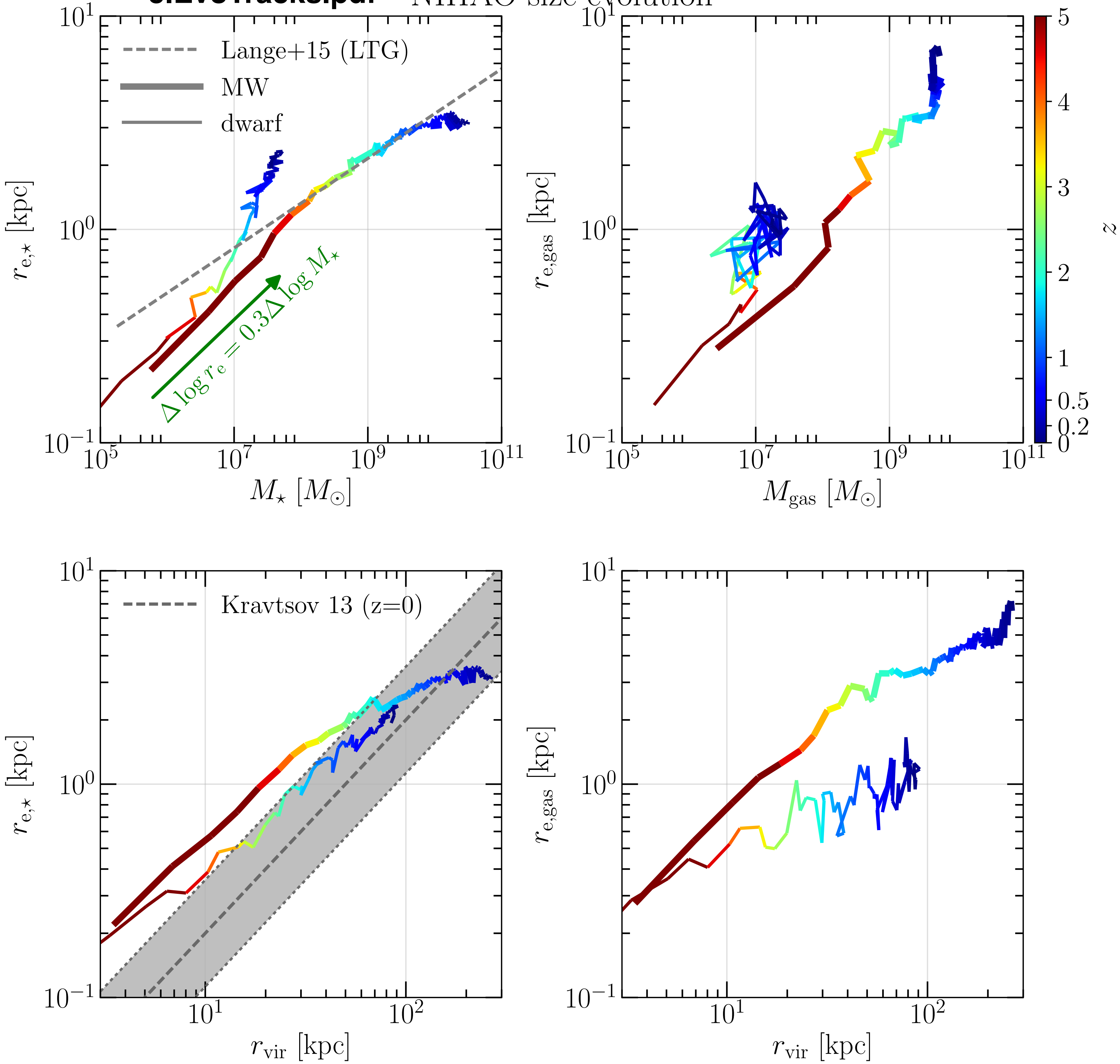


I attached two r_e - M* plots for NIHAO — **4.UDGdiagnostics** (top panel) showing the z=0 size-mass relation and comparing it with the Lange+15 observational result for nearby LTGs (almost all NIHAO galaxies are late types, with n<2.5); **5.EvoTracks** showing the average evolution tracks of MW- and dwarf-size galaxies in NIHAO on various parameter spaces, including r_e - M_star (upper left). The main messages with the two r_e - M* plots are: NIHAO produces a lot of ultra diffuse galaxies in the mass range 10^7-9; - the evolution of NIHAO galaxies follow the toy-model motivated by observations, i.e, Delta log(r_e) ~ 0.3 Delta log(M_star), at high-z. At low z, the MWs in NIHAO approach the nearby observational relation, the dwarfs in NIHAO shoot up in r_e and easily become ultra diffuse galaxies.

4. UDGdiagnostics



5.EvoTracks.pdf NIHAO size evolution



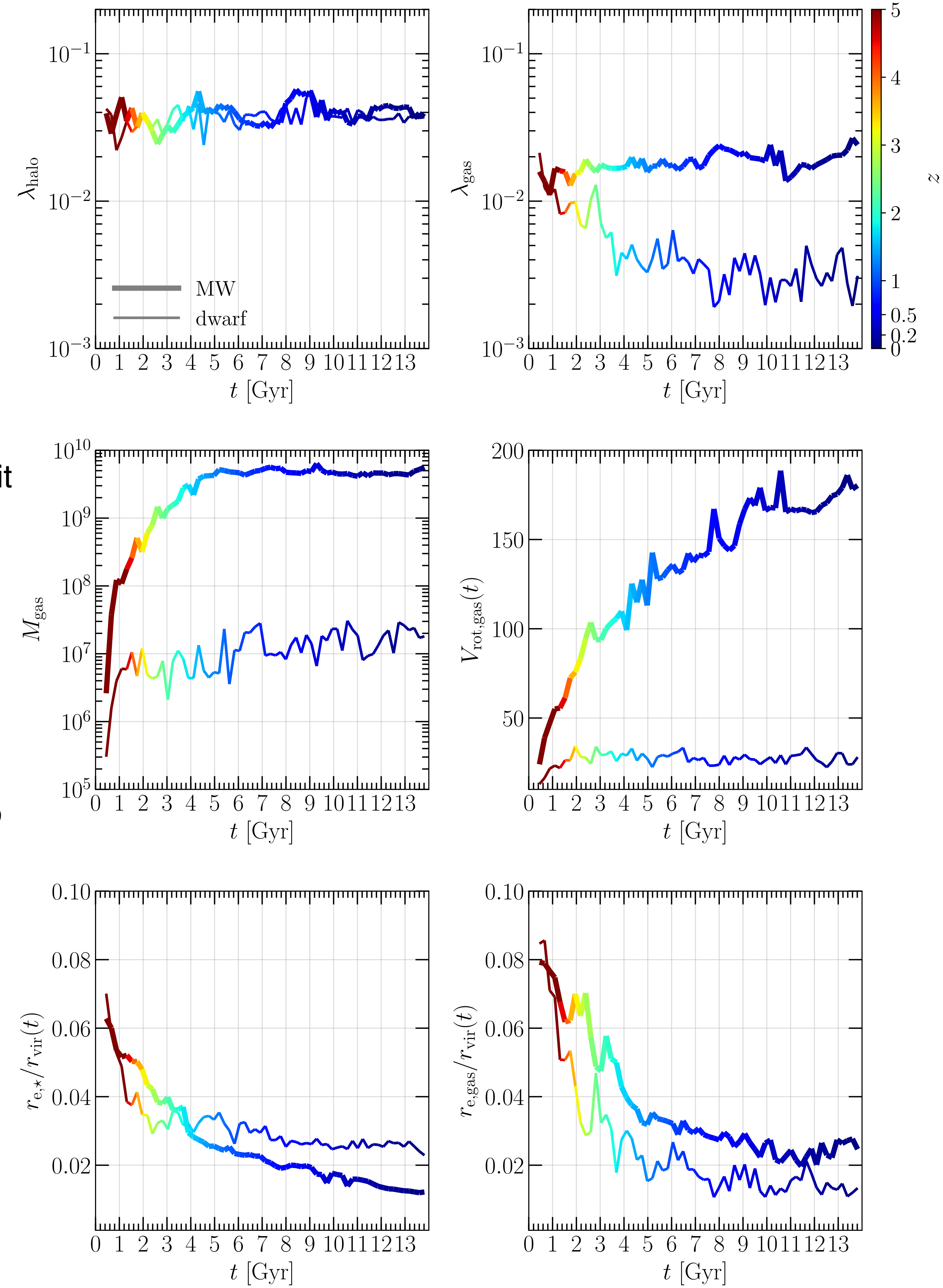
Sandy: Time behavior: Can you plot C and r_e/r_vir for the Nihou and VELA data as a function of time? Use Nihou with and without the baryons. Do halos maintain their C over time, and do galaxies with small r_e stay small, and vice versa?

Fangzhou: c as a function of time is the c-M-z relation I referred to earlier. Individual halos will deviate from the average relation, due to detailed accretion histories and baryonic processes. r_e / r_vir evolution can be seen in **6.SpinHistories,** bottom left.

Why I used r_s c^0.4? Because of the process of finding it out -- I first tried r_e = 0.17 r_s and r_e = 0.1 r_max, both without concentration (r_max is the radius where circular velocity peaks). Then I find that r_s works better, and adding a c-scaling improves it.

There are other halo parameters, say, the Einasto shape (alpha) that can help further, but I don't know if it is worth the effort, given that the improvement is going to be marginal. The whole idea of using halo properties alone to pin down galaxy size is going to hit a limit, as the galaxy only sits at the very center of the halo ... one can keep shrinking the scatter of r_e vs r_e_predicted(r_vir, c, alpha, halo param x_4, halo param x_5,…) by adding more x_i, but the scatter is going to converge to an intrinsic scatter, I think.

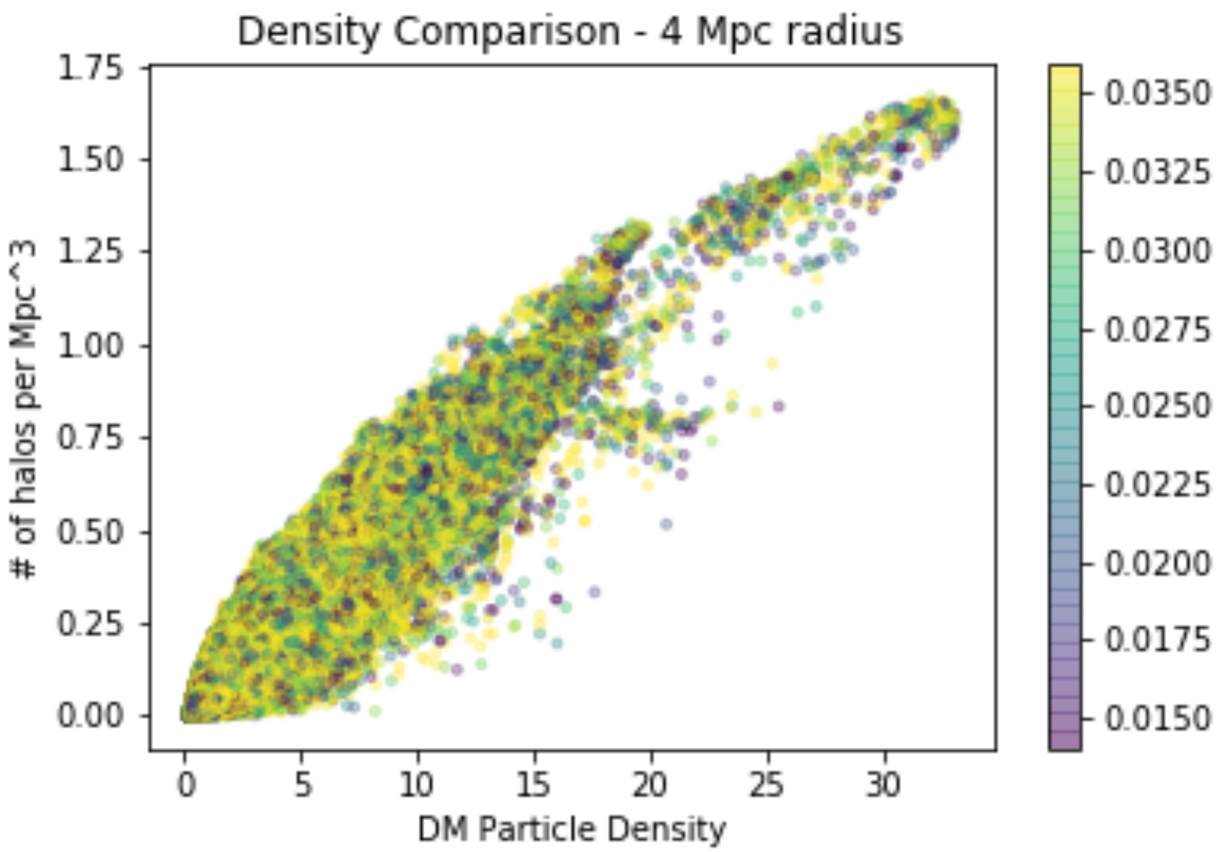
6.SpinHistories NIHAO spin-, size- histories

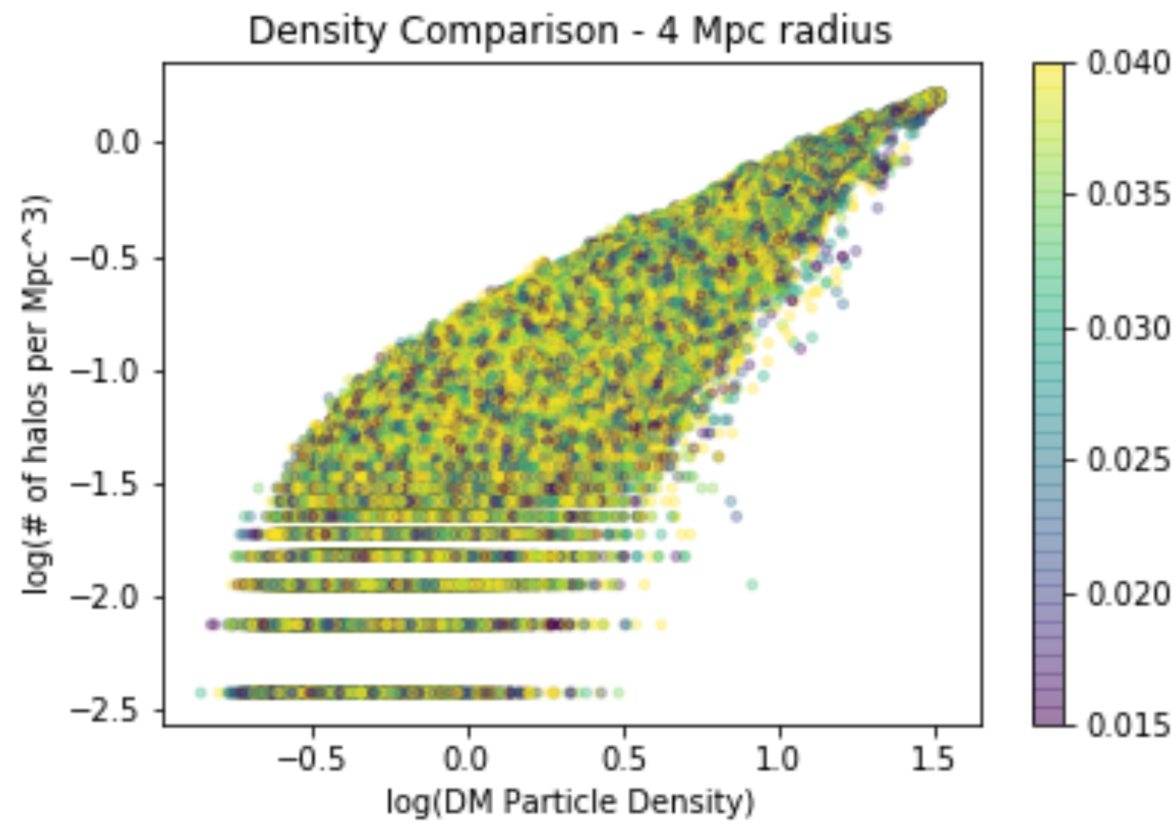


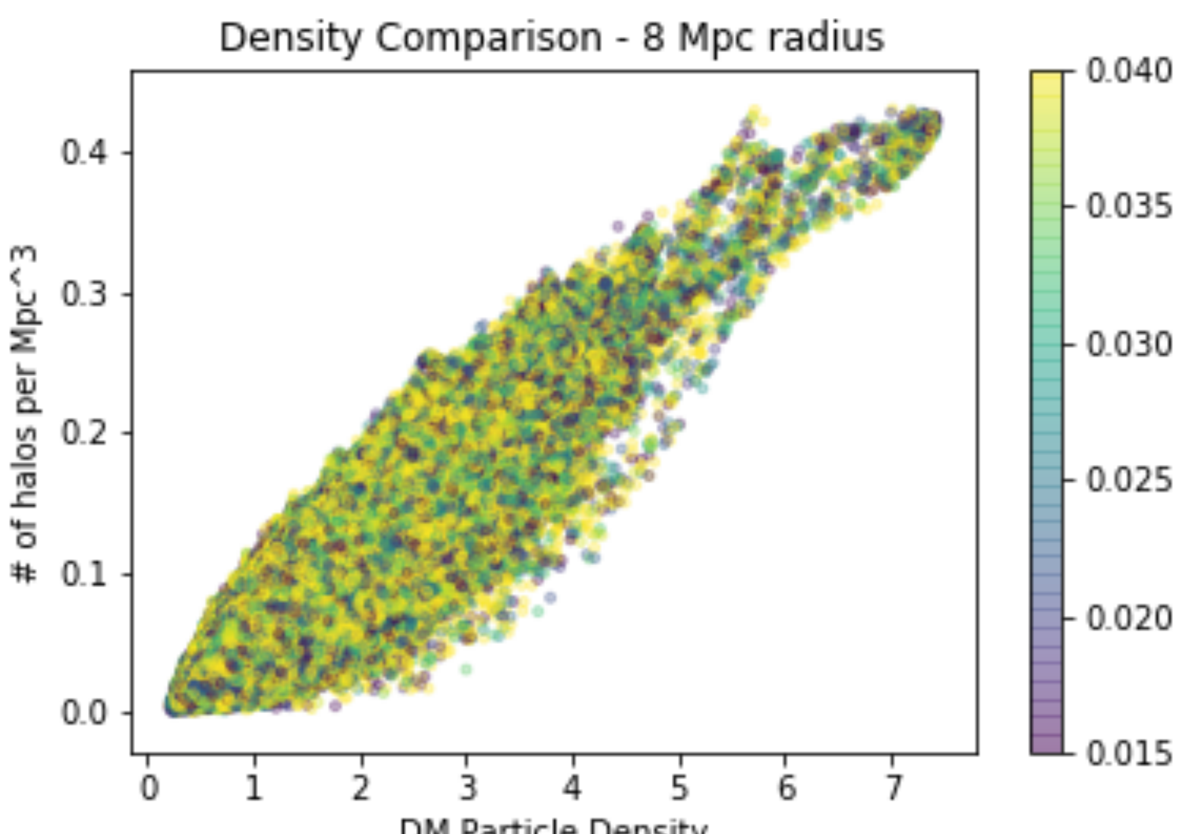
DM density vs. Density by Counting Galaxies within 4 and 8 Mpc/h

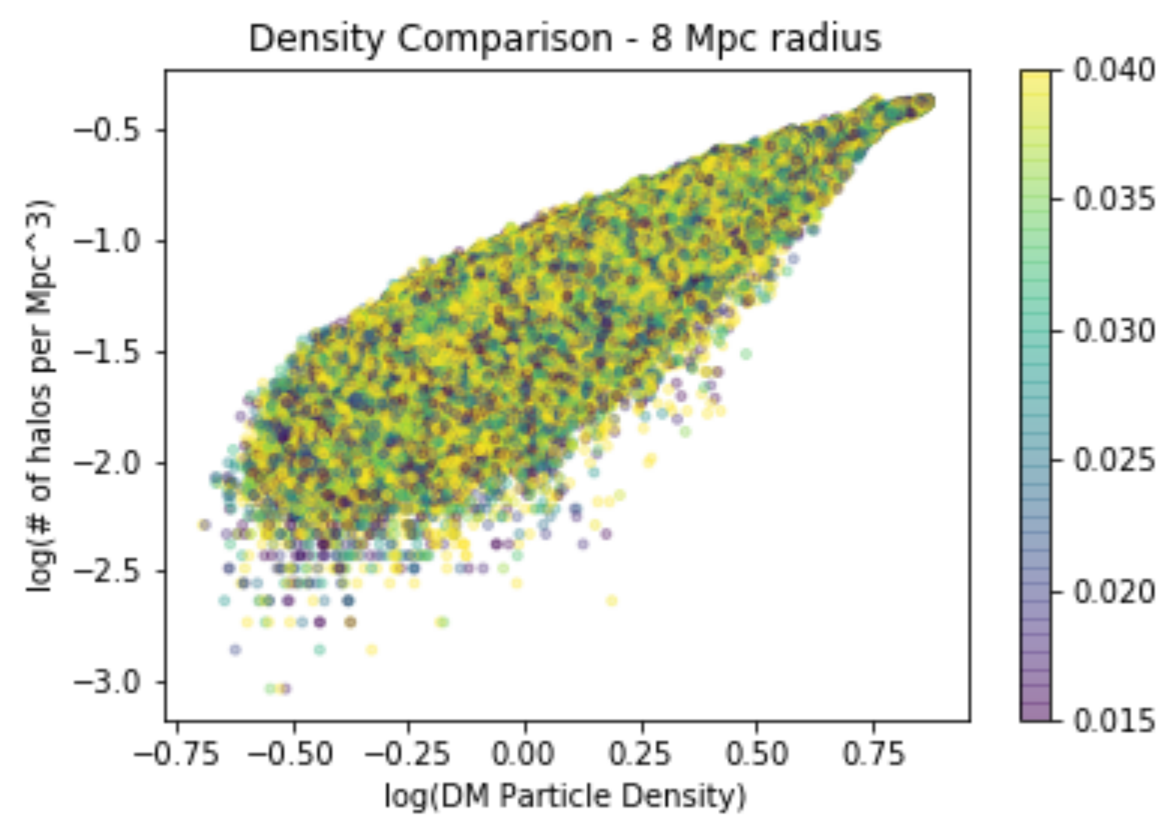
Graham Vanbenthuysen

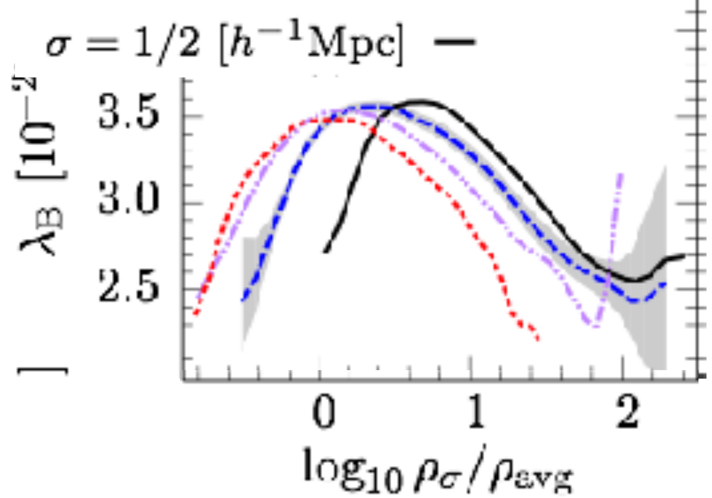
Dear Joel — I'm sorry to say I won't be attending the meeting this afternoon. Just so you know where we're at, I've calculated the nth-nearest densities and am currently working on calibrating those densities for comparison with Christoph's work. I've also color-coded our previous scatter plots by spin parameter, though I don't see any obvious trends from these by initial inspection. Do you think I should split these graphs into bins to see a more pronounced effect? — Graham 10/30/2017

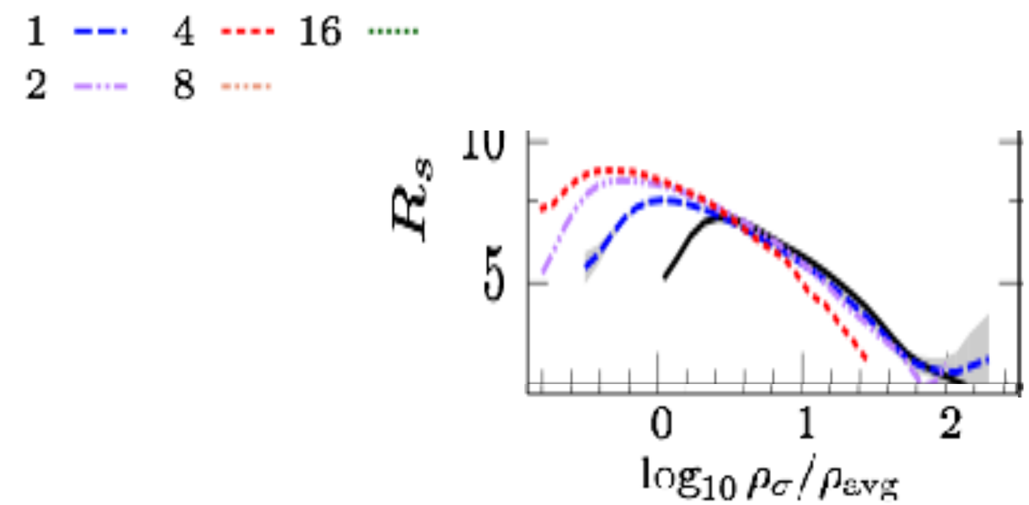








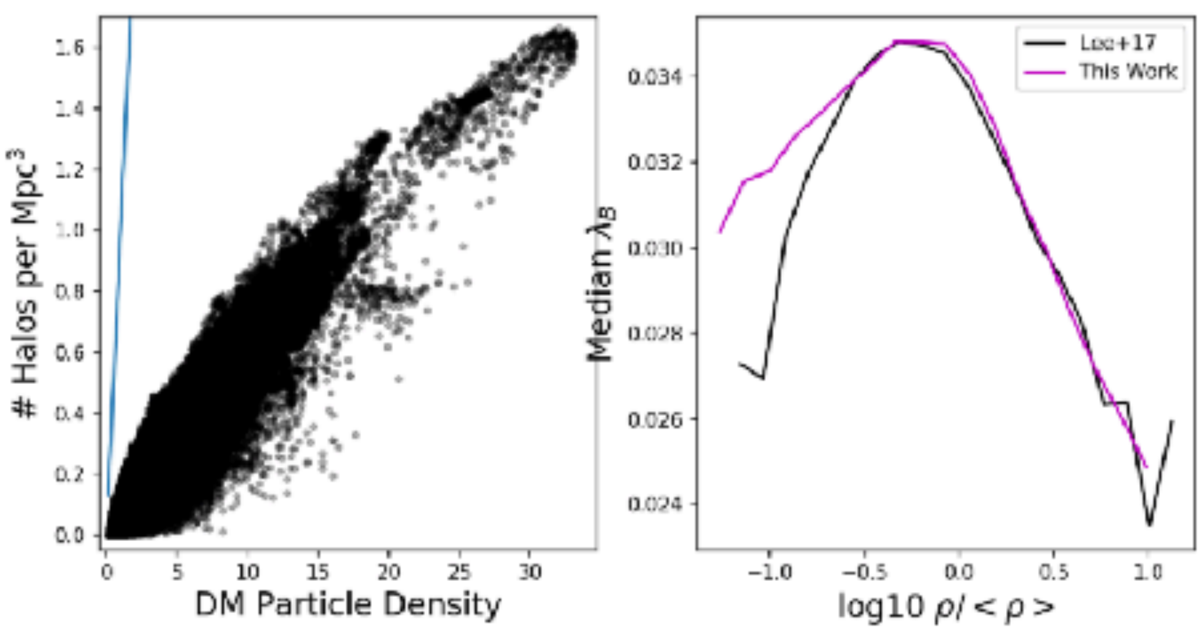


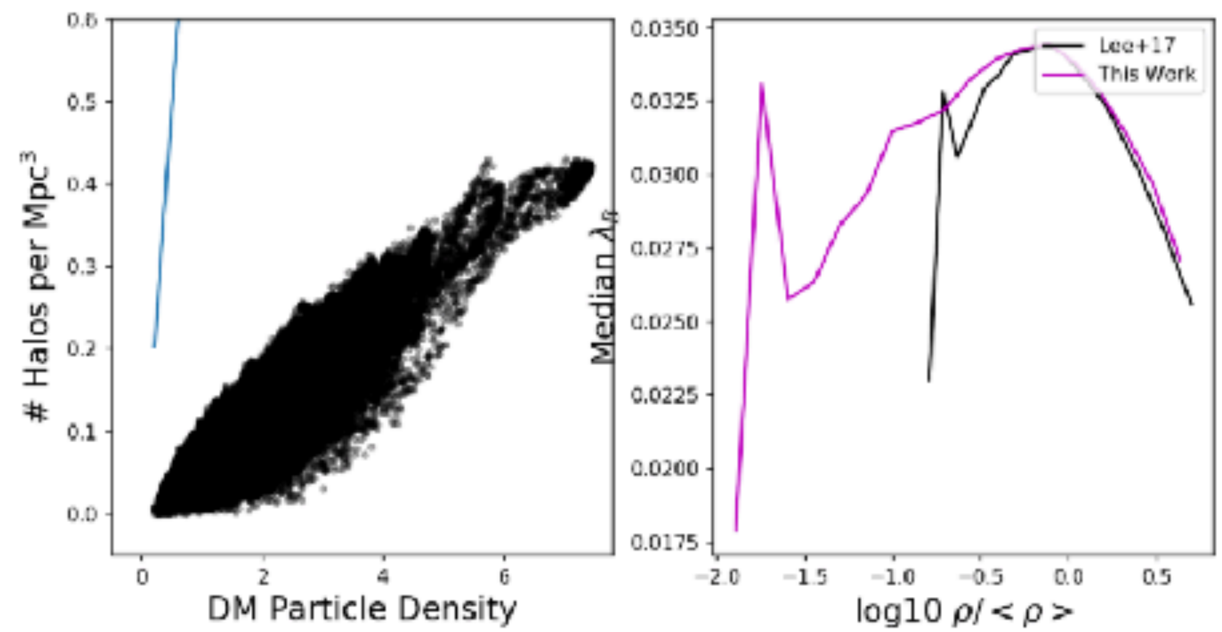


Figures by Graham
Shown 23 Oct

Measuring λ_B and R_S vs. Density in Spheres of 4 and 8 h^{-1} Mpc

Spherical Radius = 4 Mpc **Graham Vanbenthuysen & Viraj Pandya** Spherical Radius = 8 Mpc





Spherical Radius = 4 Mpc

Spherical Radius = 8 Mpc