DEEP-Theory Meeting   23 October 2017

Expected at 4 pm: Elliot Eckholm, Viraj Pandya, Graham Vanbenthuysen **Not coming:** Vivian, James, Clayton

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

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.

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.

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.

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

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.

Abundance matching is independent of environmental density — Radu Dragomir, Aldo, Christoph paper soon

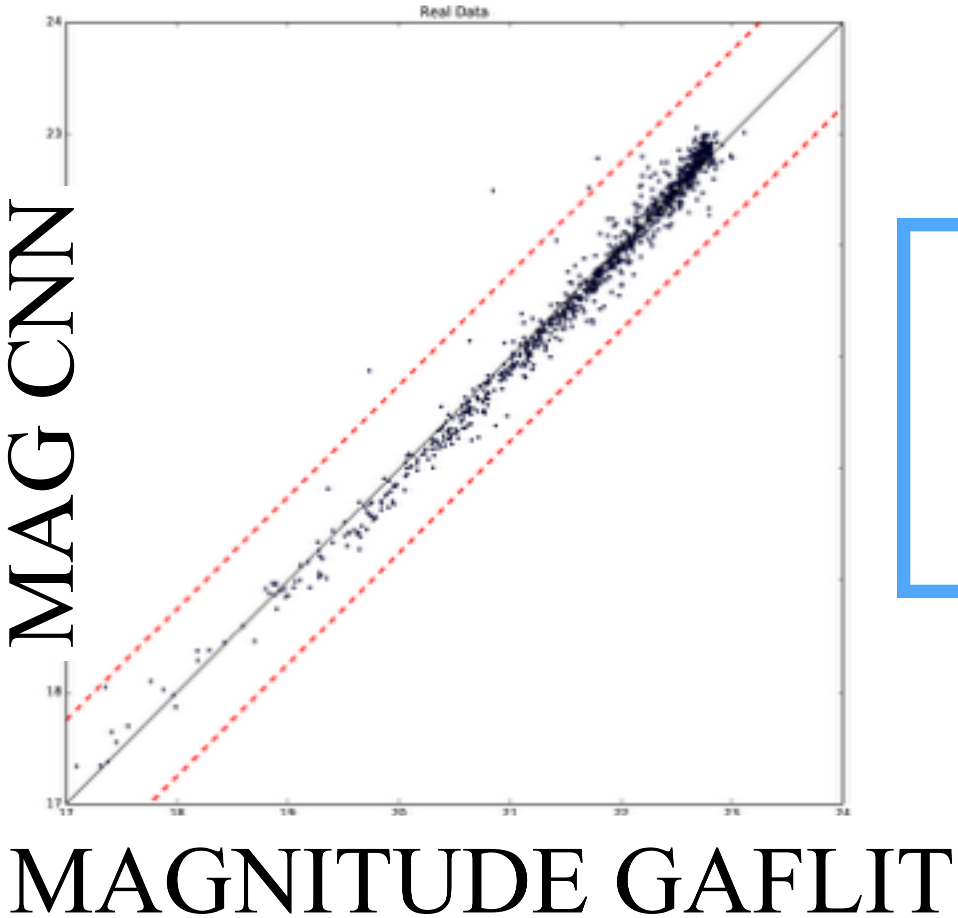
Halo properties like concentration, accretion history, and spin are mainly determined by environmental density rather than by location within the cosmic web — we are finishing the paper led by Tze Goh

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.

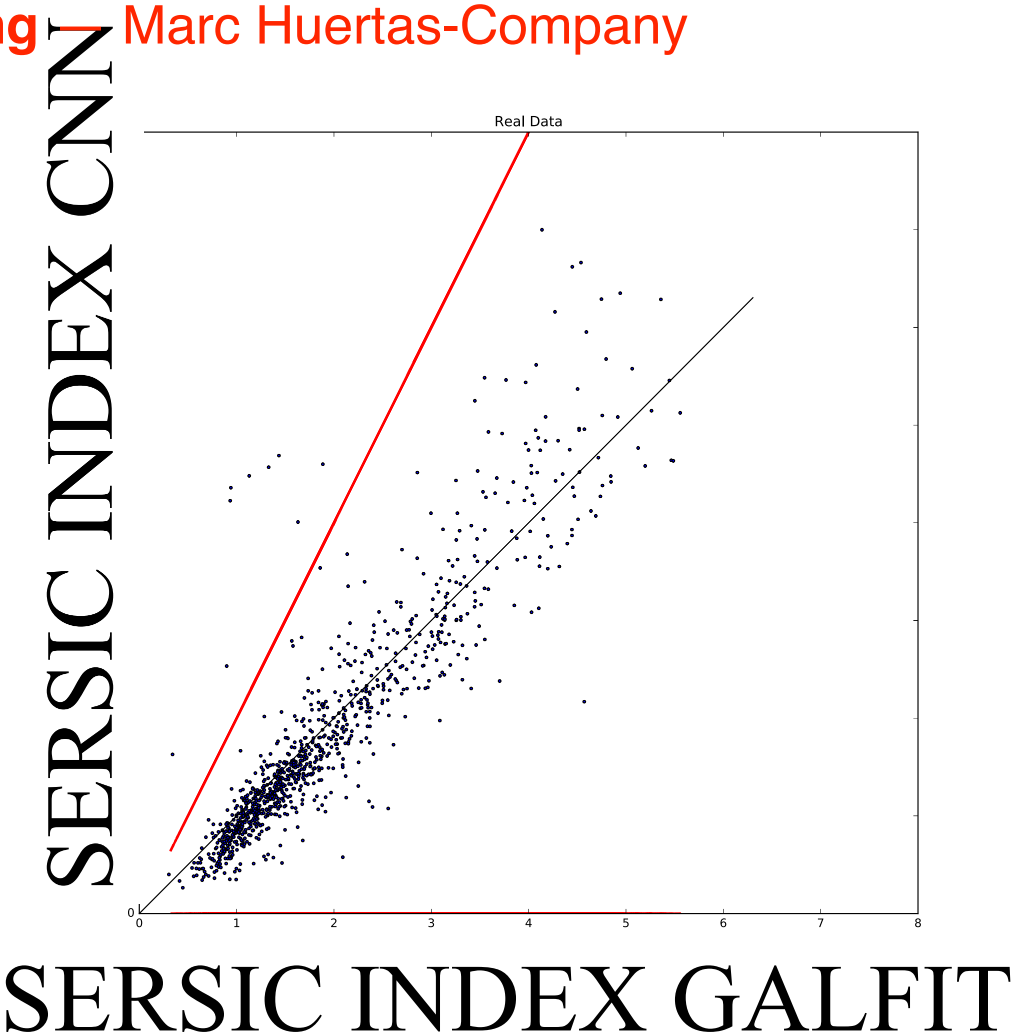
Simulations of CGM & winds vs. observations — Clayton Strawn, Hassen Yesuf

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

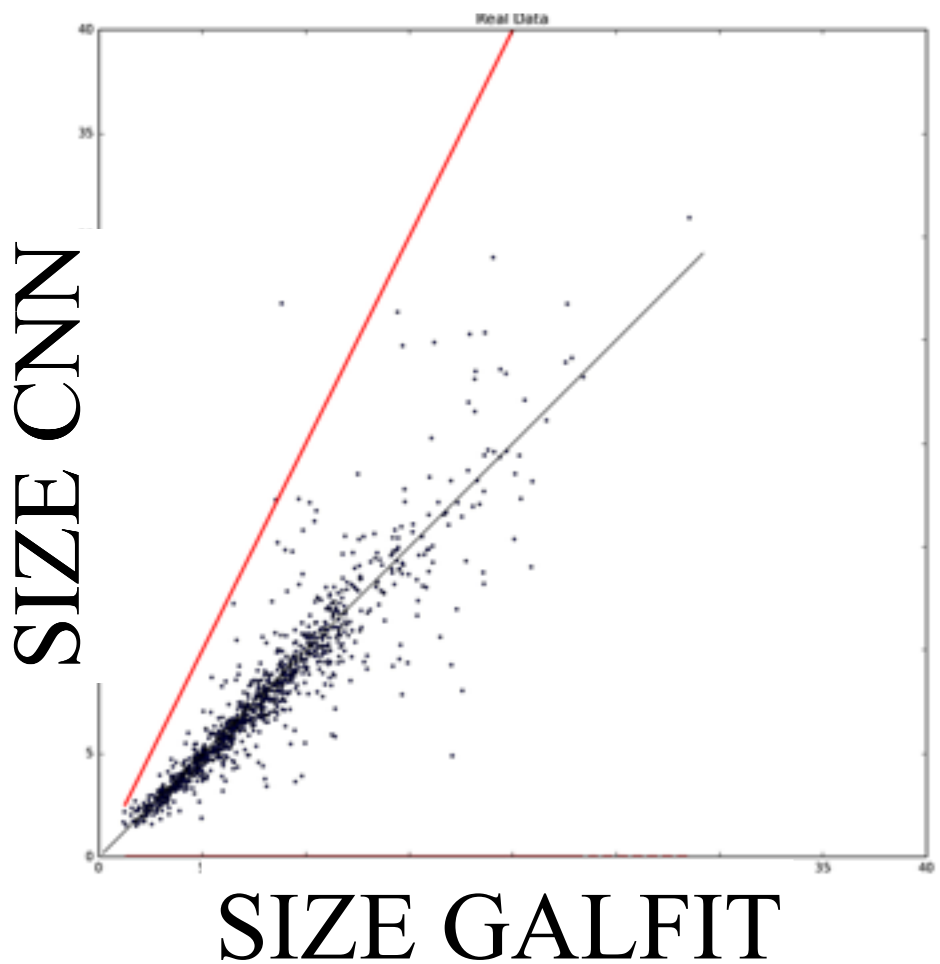
GALFIT-type analysis of VELA simulations using deep learning — Marc Huertas-Company



FITS ALL CANDELS IN FEW SECS!

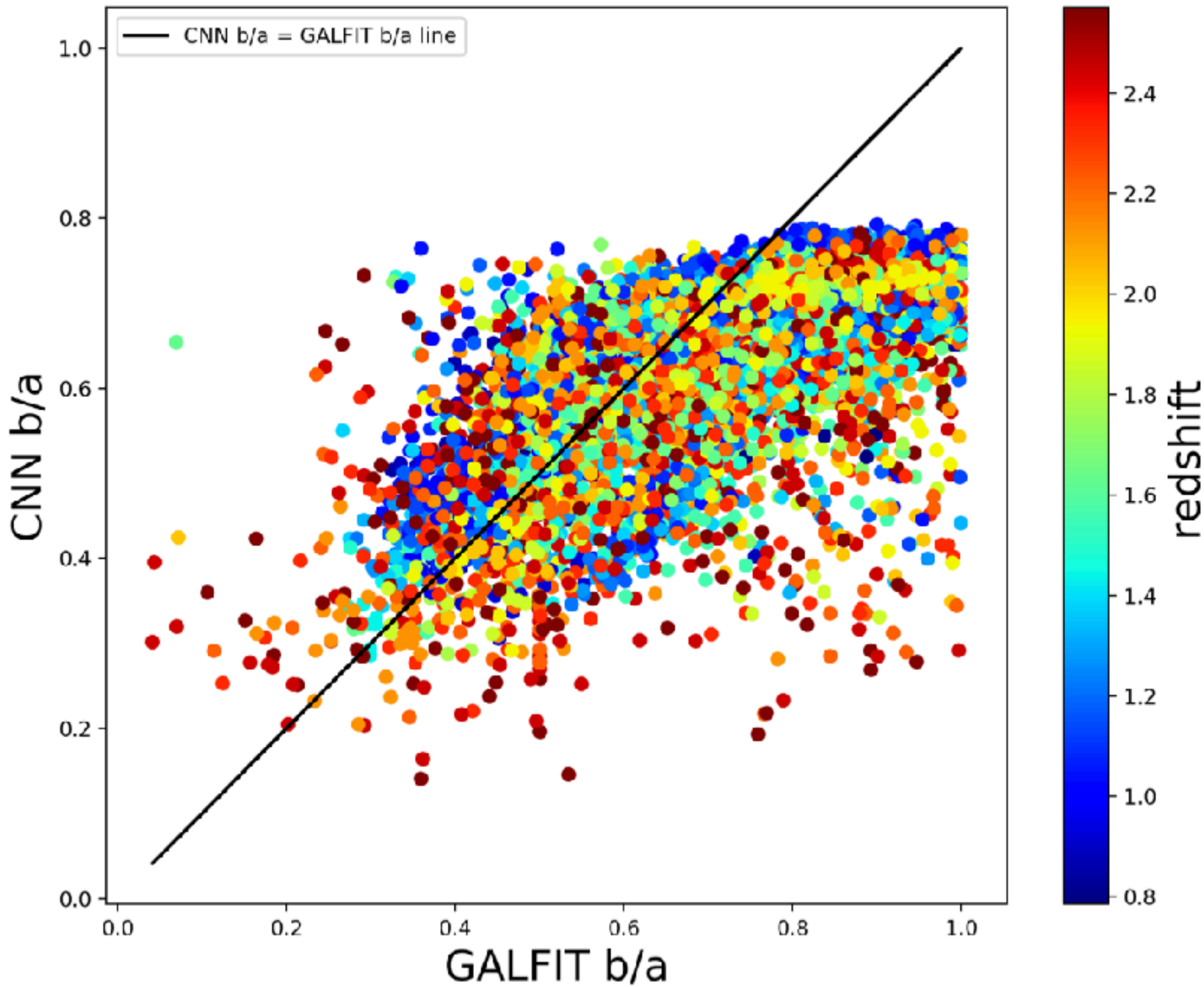


<u>SEE POSTER</u>



Tuccillo, MHC+17

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



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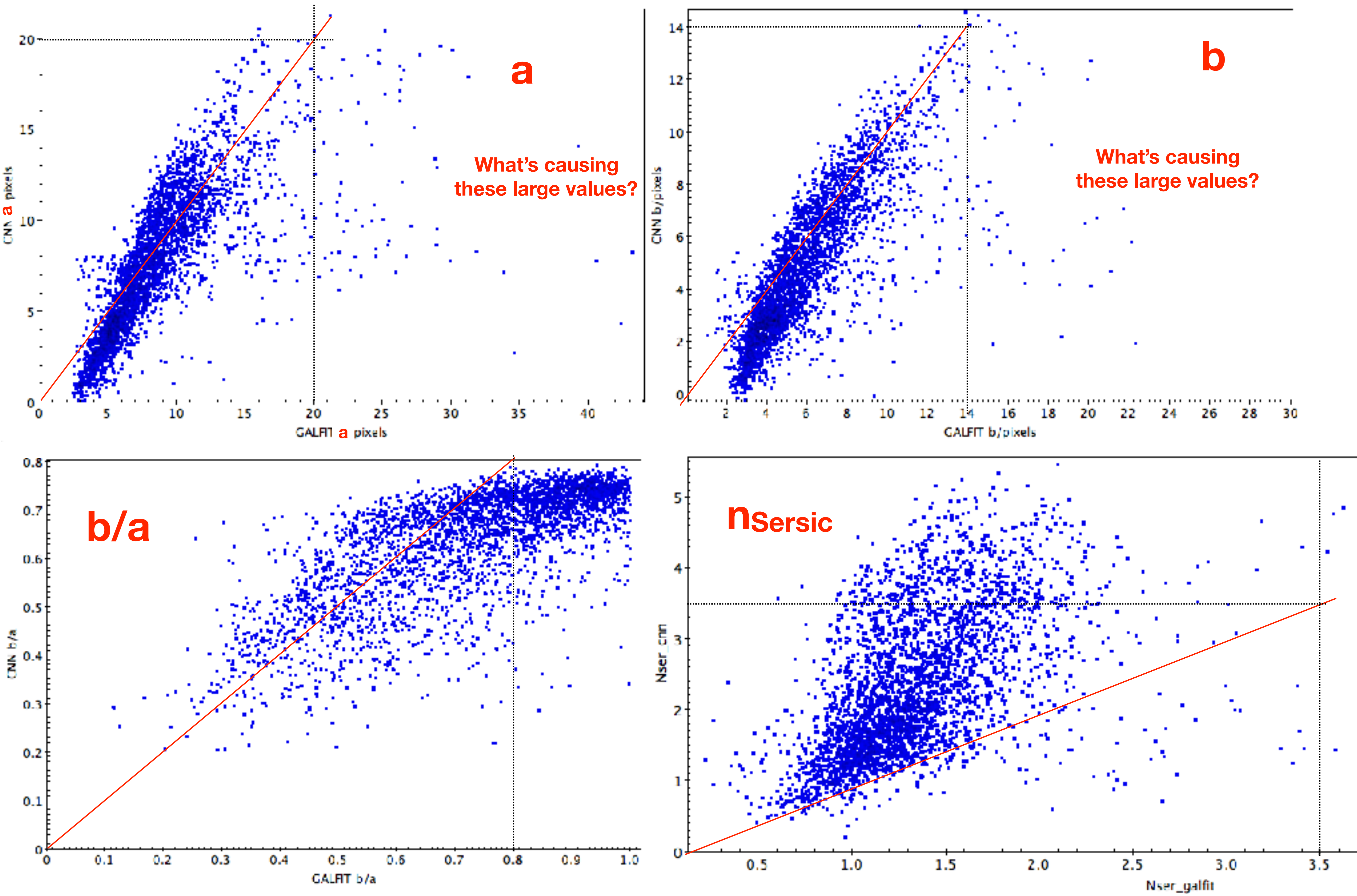

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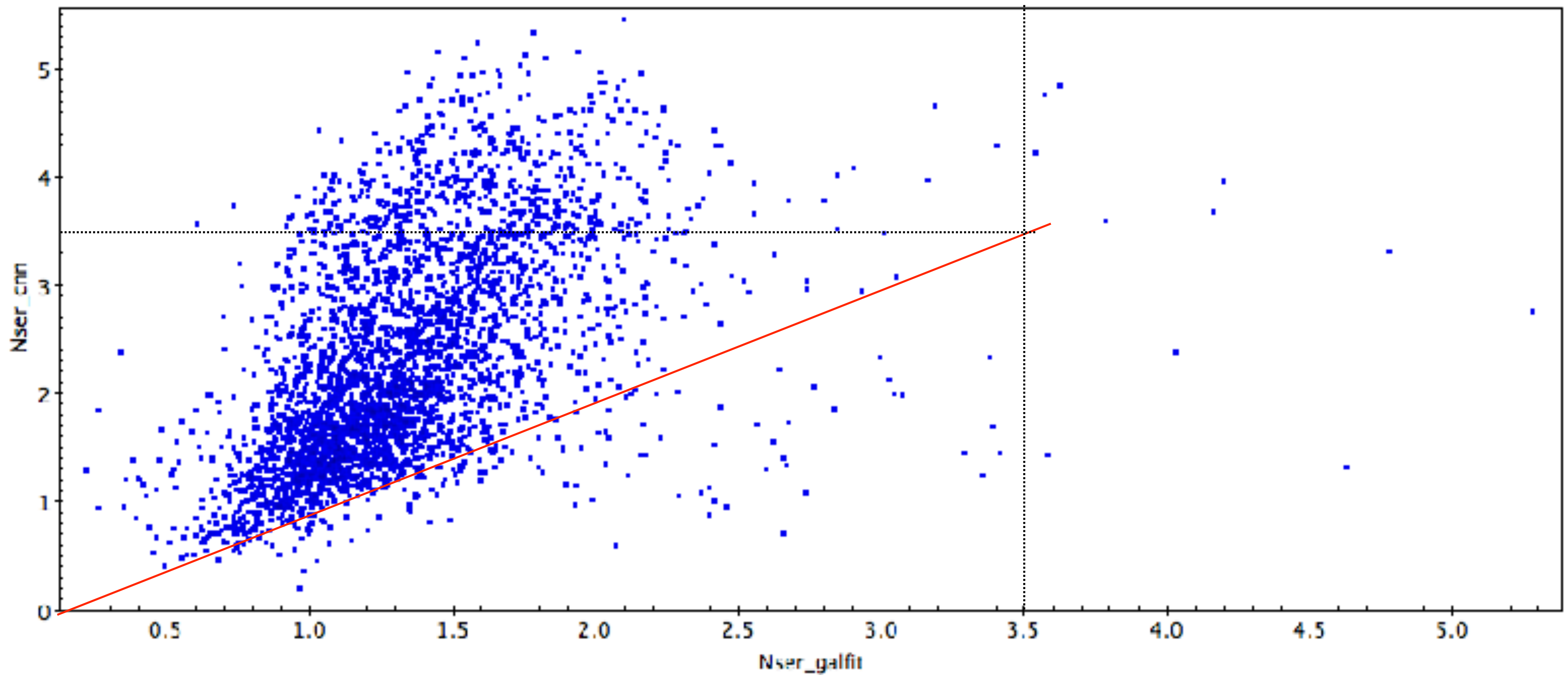
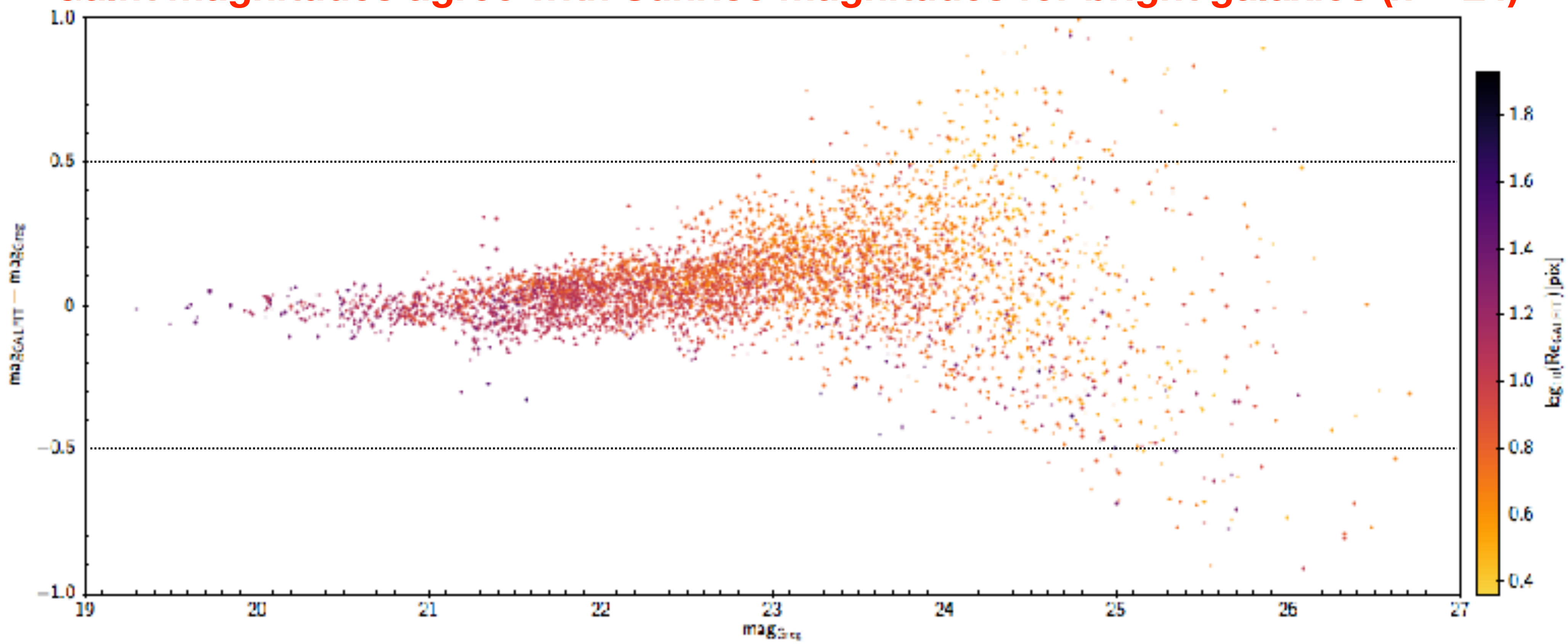
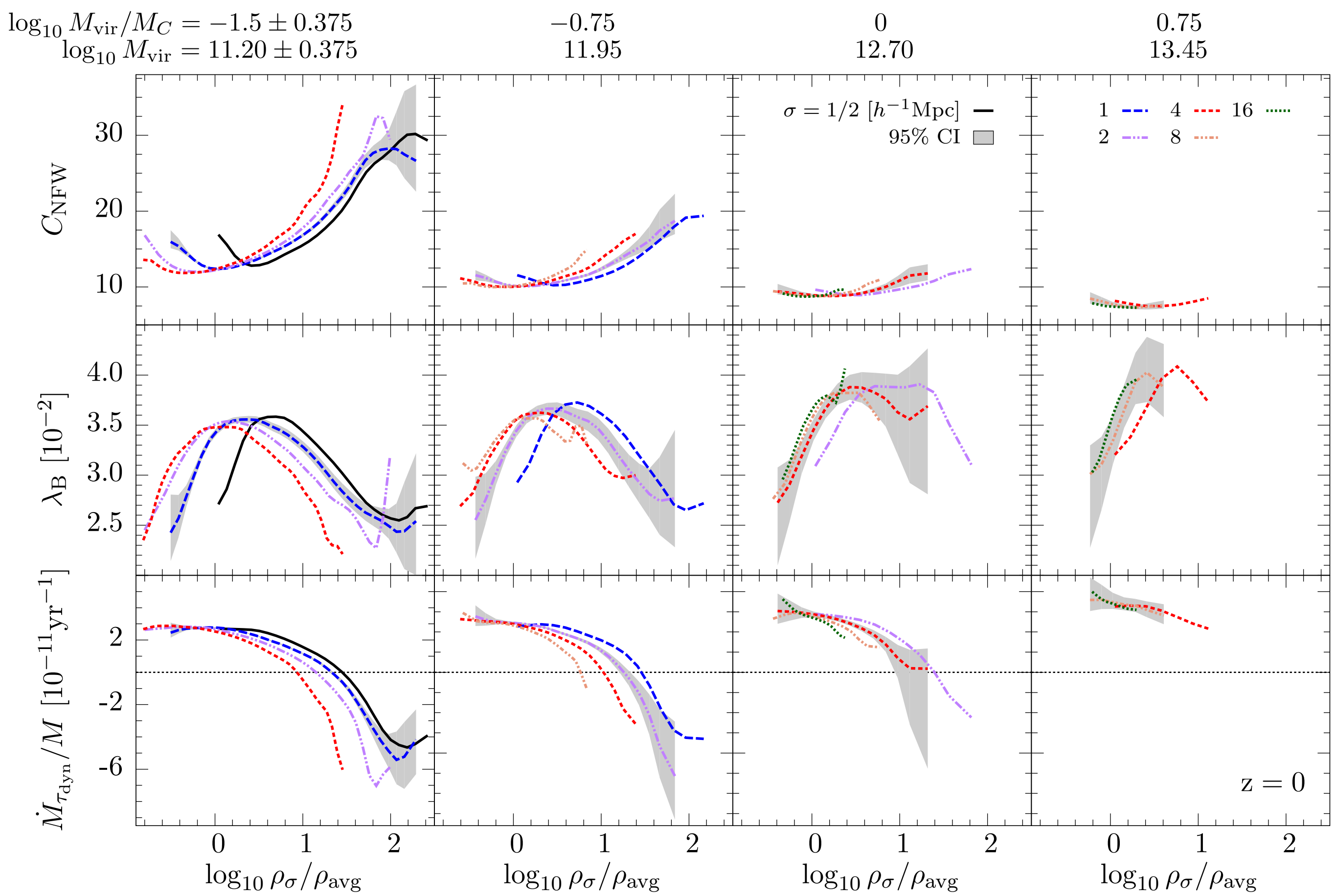
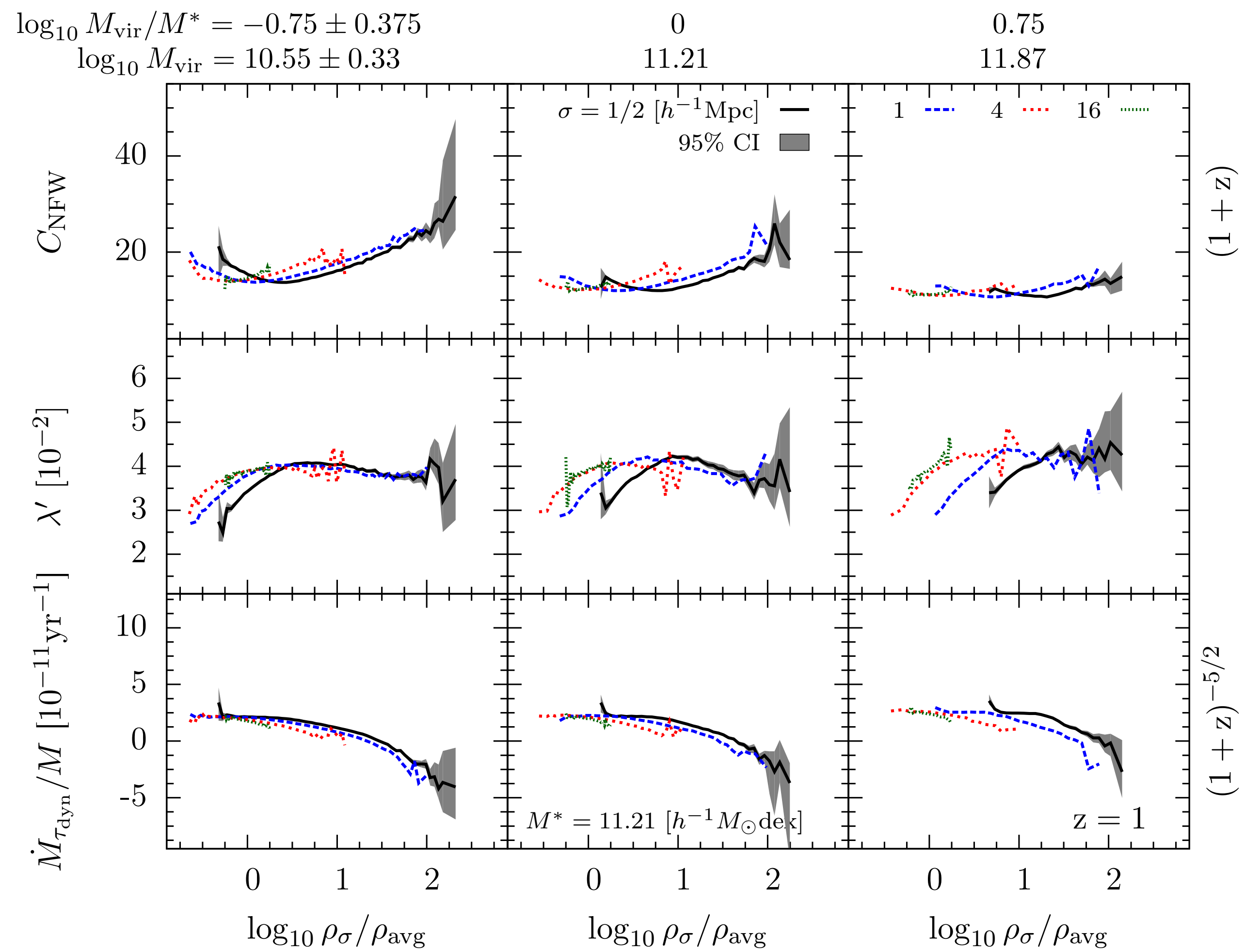


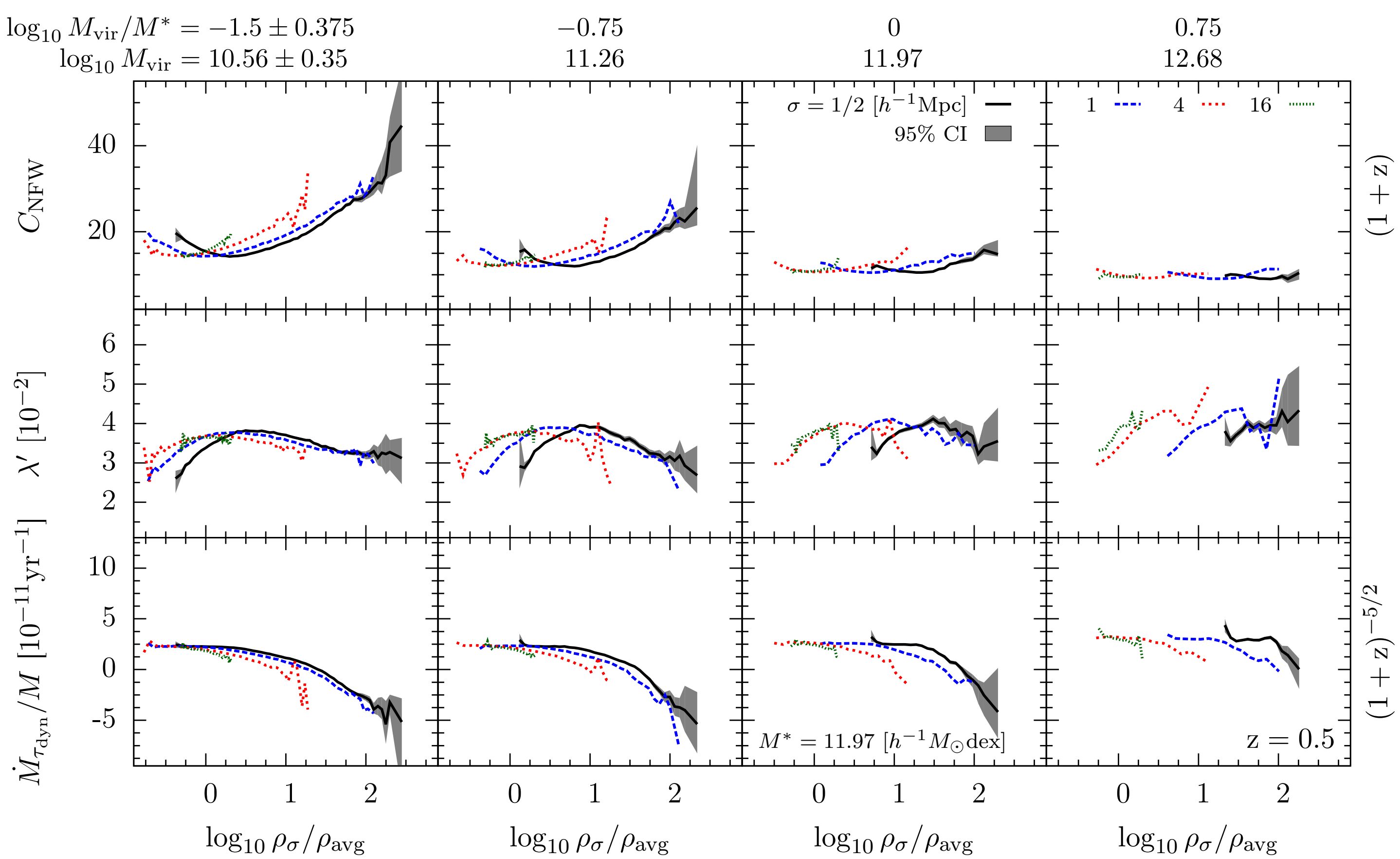
Galfit magnitudes agree with Sunrise magnitudes for bright galaxies ($h \lesssim 24$)

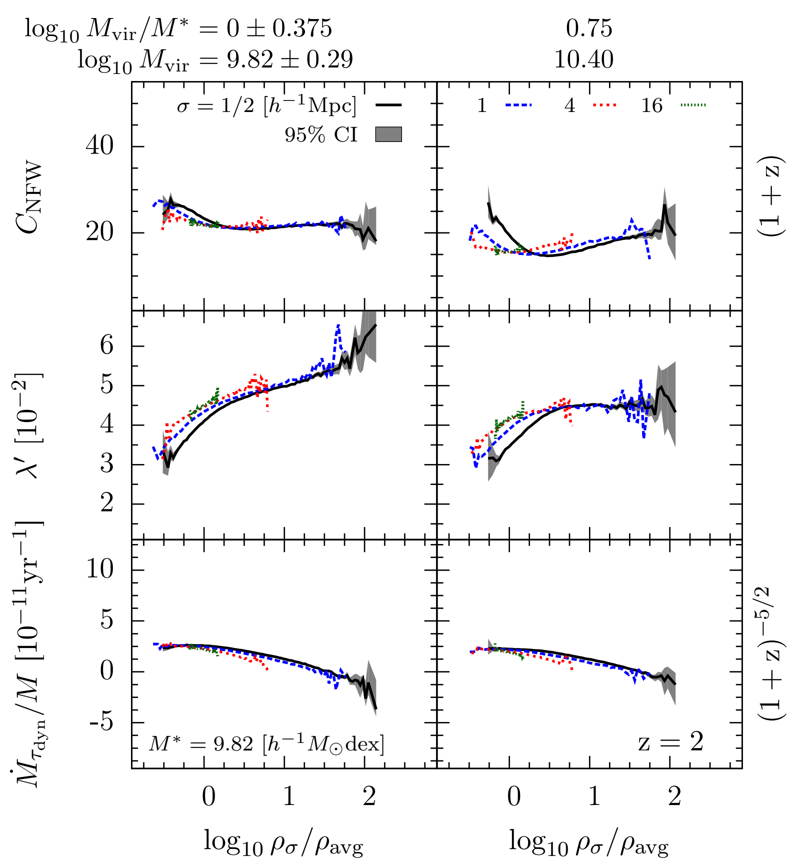


Evolution with Redshift of Density Dependence of C_{NFW}, λ_B, $\dot{M}/M$









z = 0 Density Dependence of C_{NFW}, Rs, Rs $(C_{NFW}/7)^{0.4}$

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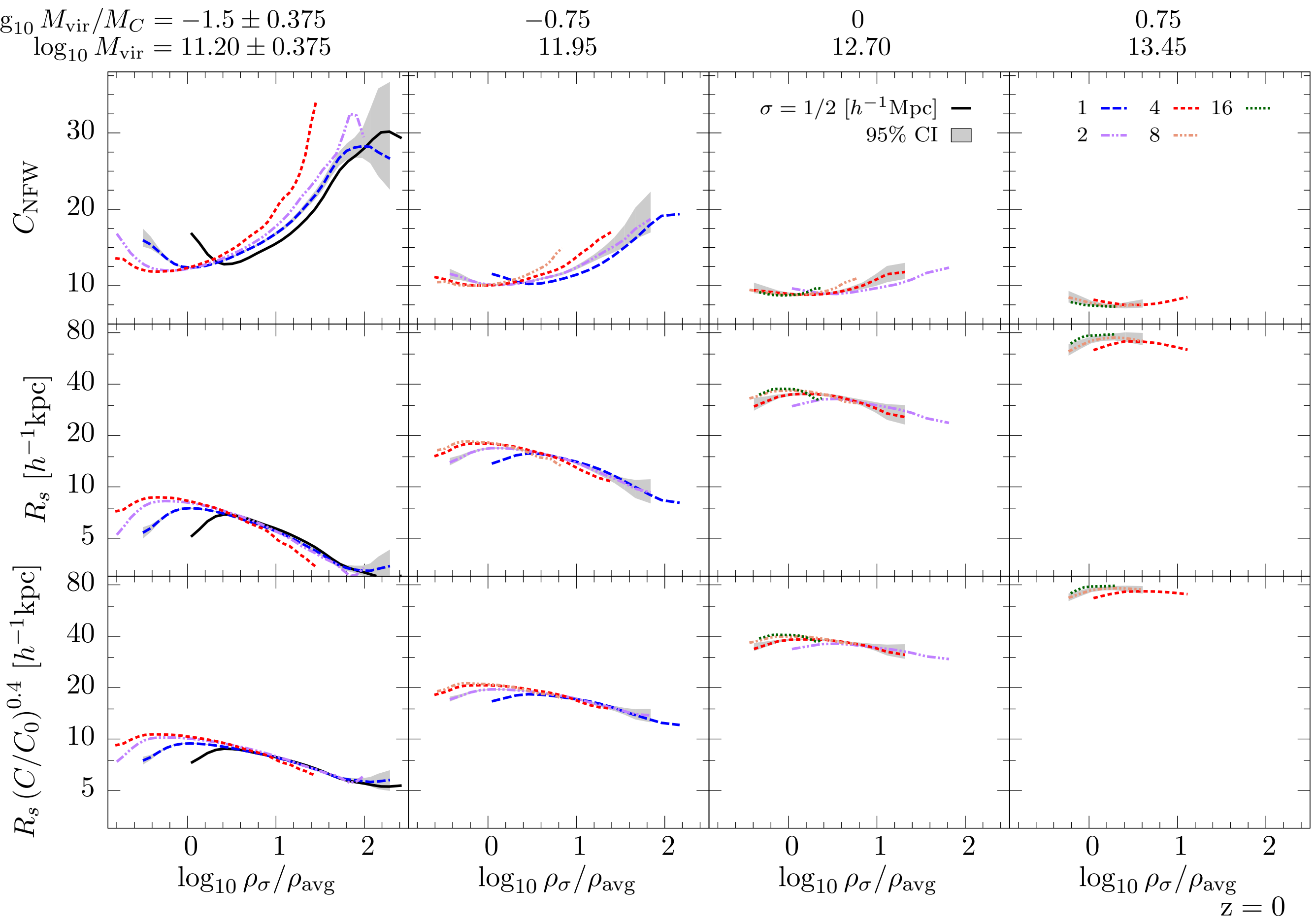
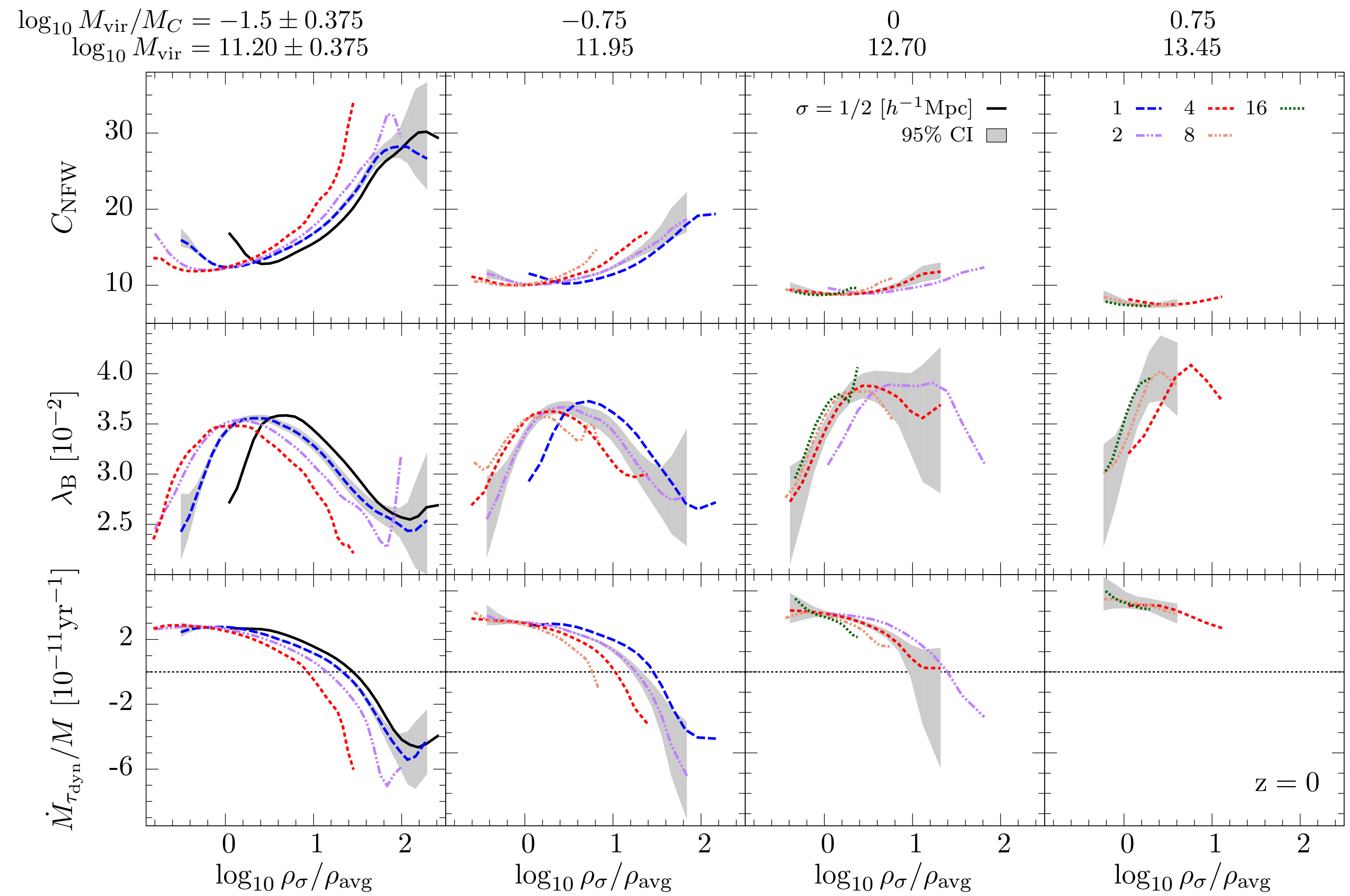
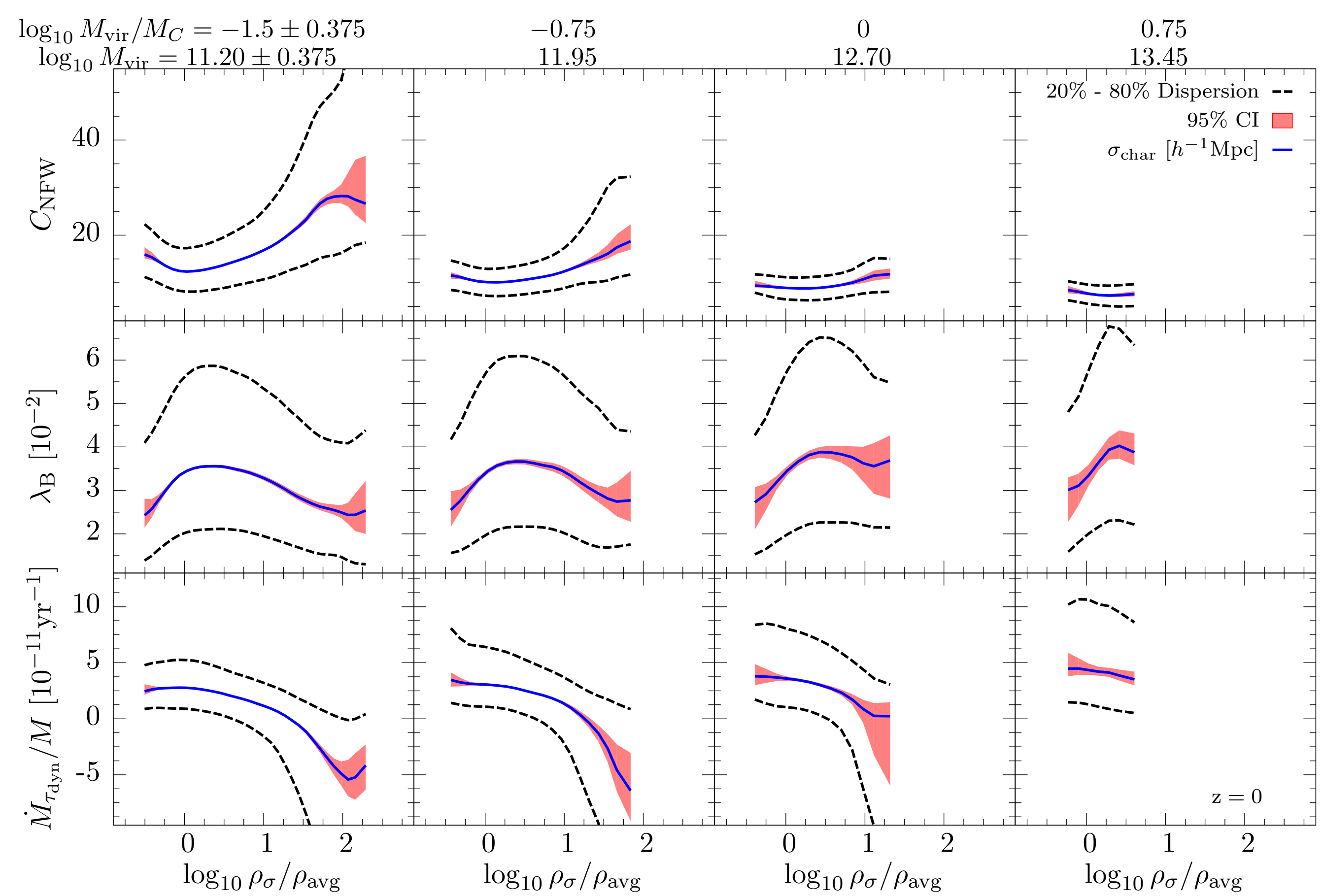
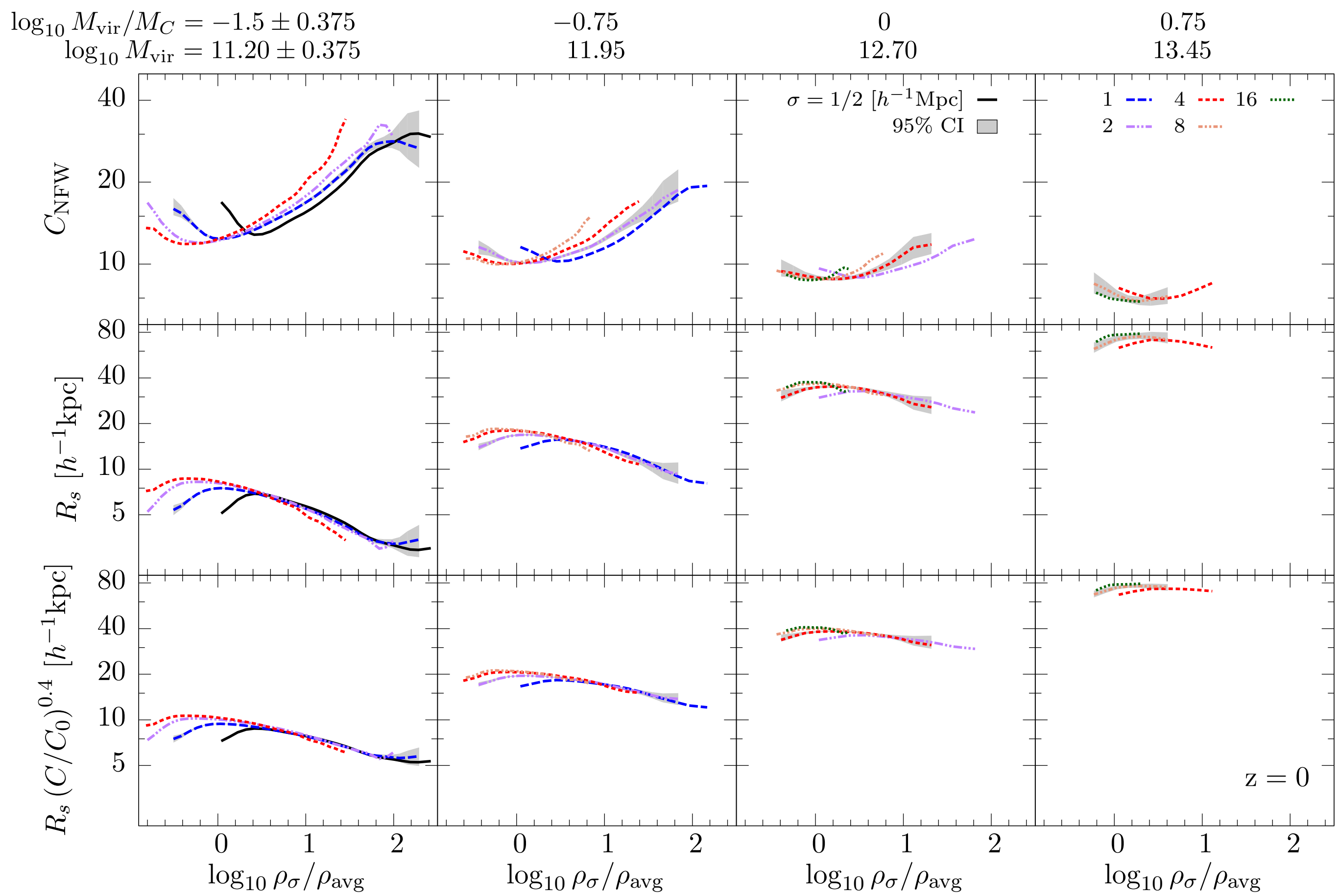




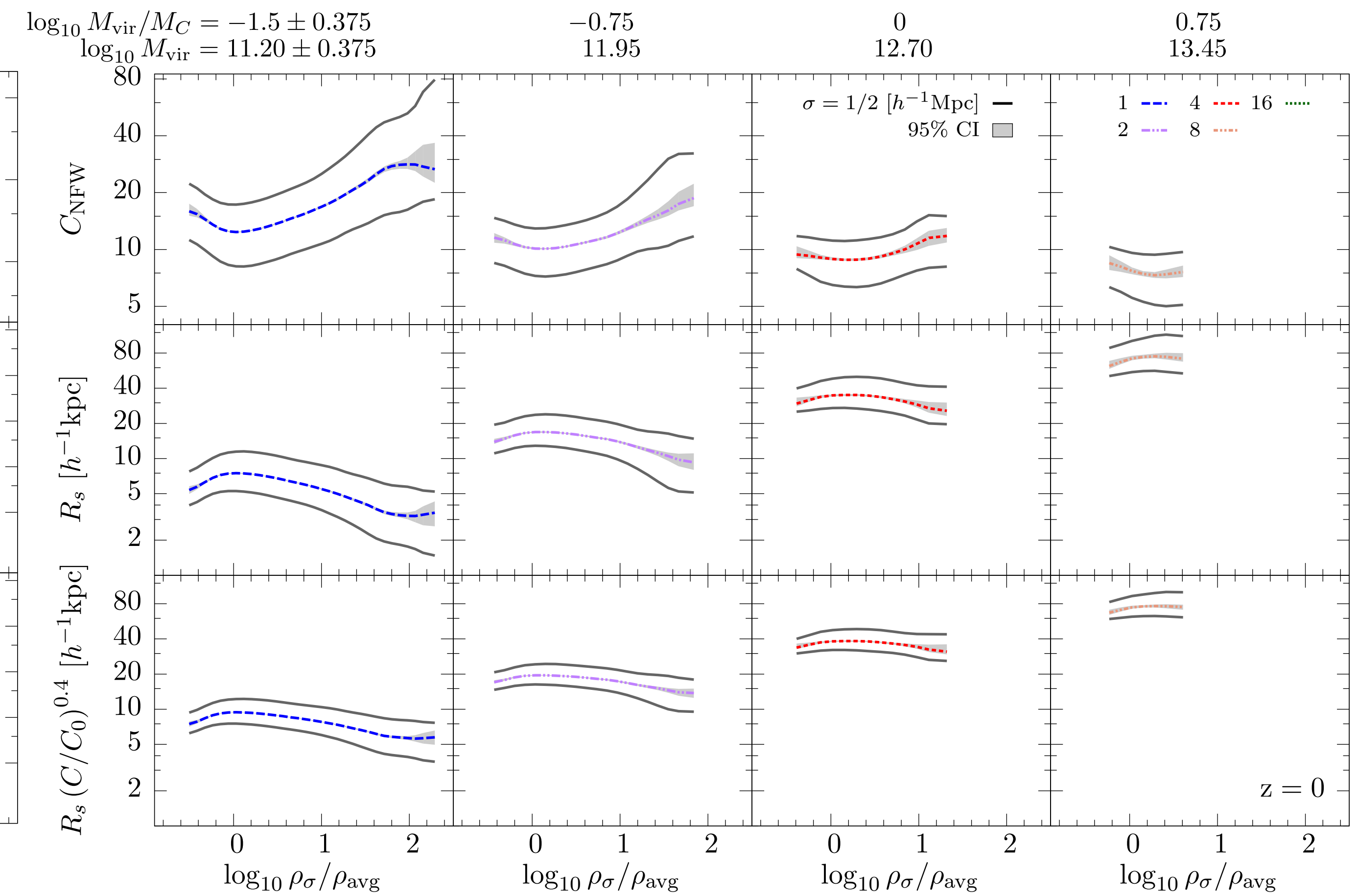


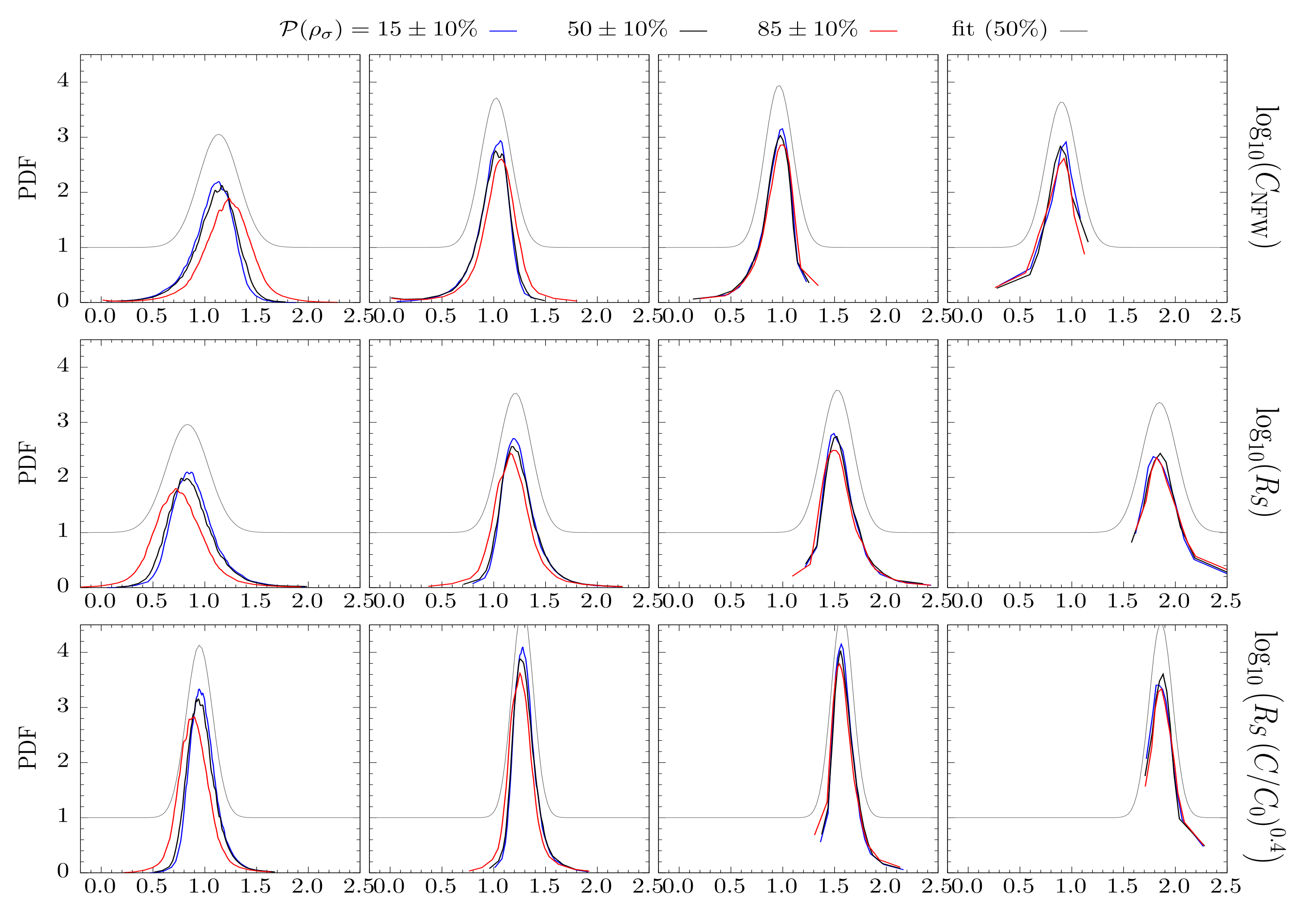
We also need to know the dispersion in R_S and $R_S(C_{NFW}/7)^{0.4}$. We know that the dispersion of λ_B and galaxy radius are log-normal. If either R_S or $R_S(C_{NFW}/7)^{0.4}$ control galaxy radii, as Fangzhou Jiang claims is true for NIHAO and VELA simulations, these quantities should also have log-normal dispersion in mass bins. Christoph Lee is looking at this.

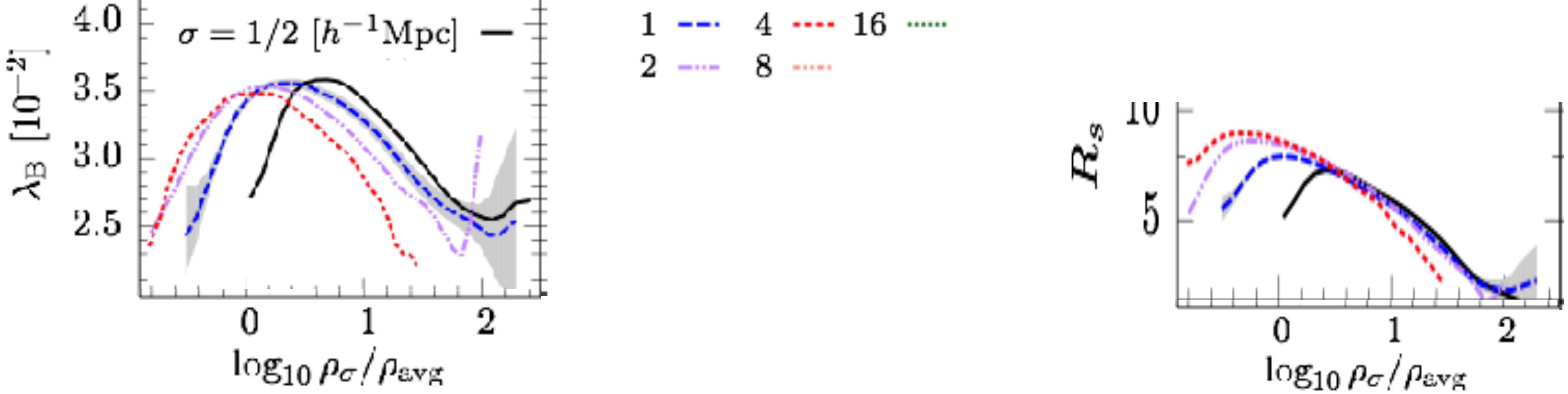
z = 0 Density Dependence of C_{NFW}, Rs, Rs $(C_{NFW}/7)^{0.4}$



C_{NFW}, Rs, Rs $(C_{NFW}/7)^{0.4}$ Are Log-normal

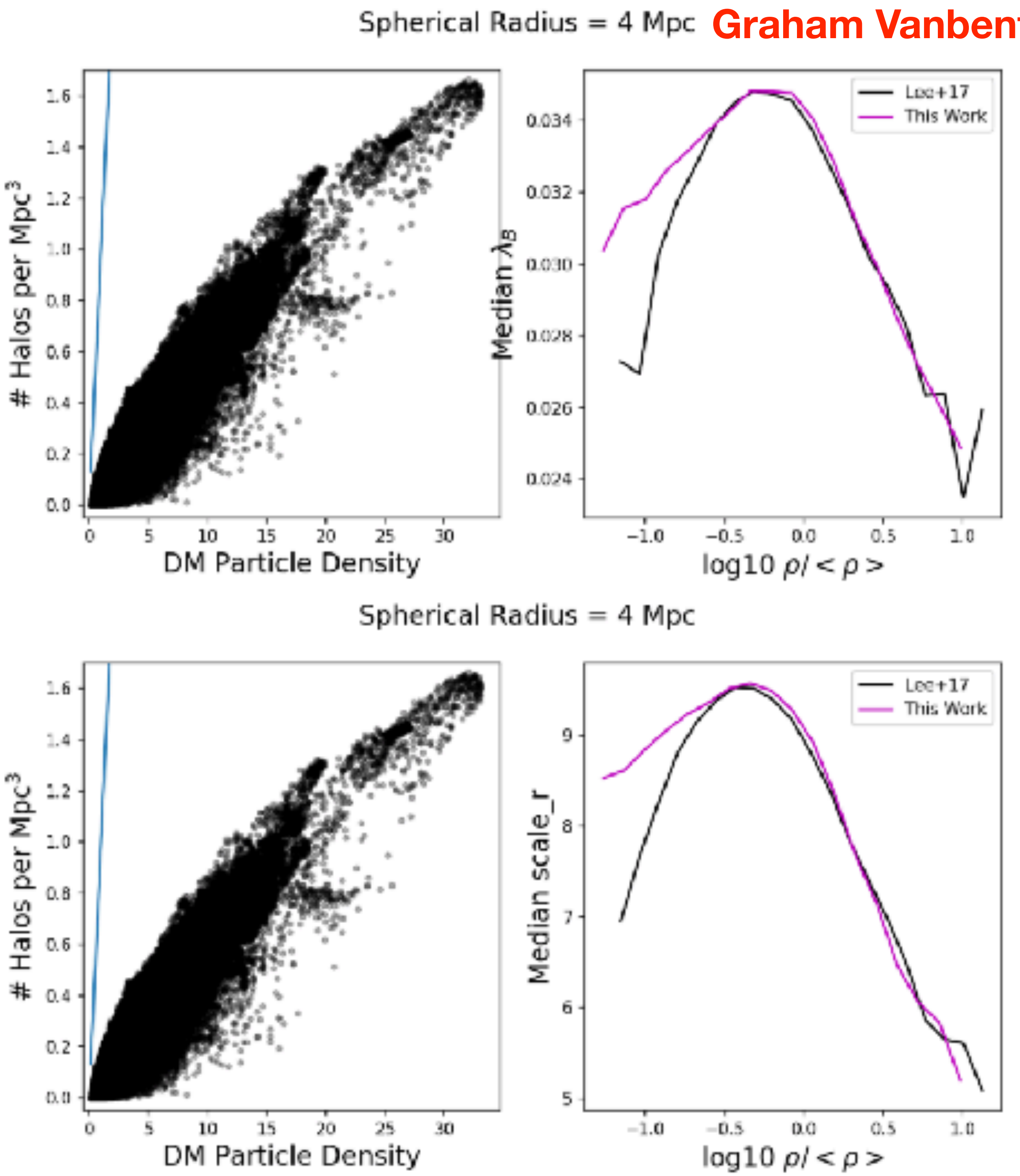


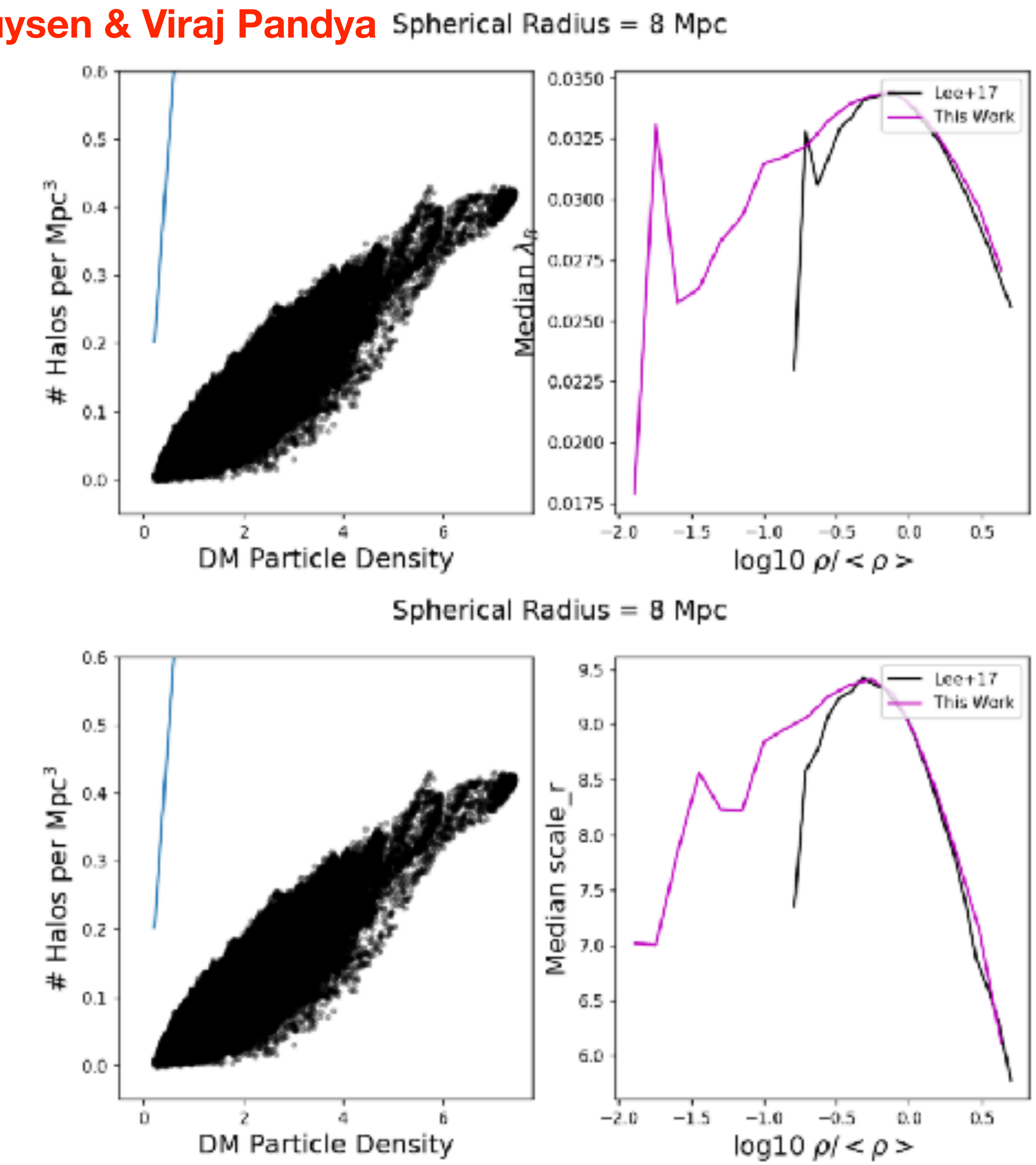




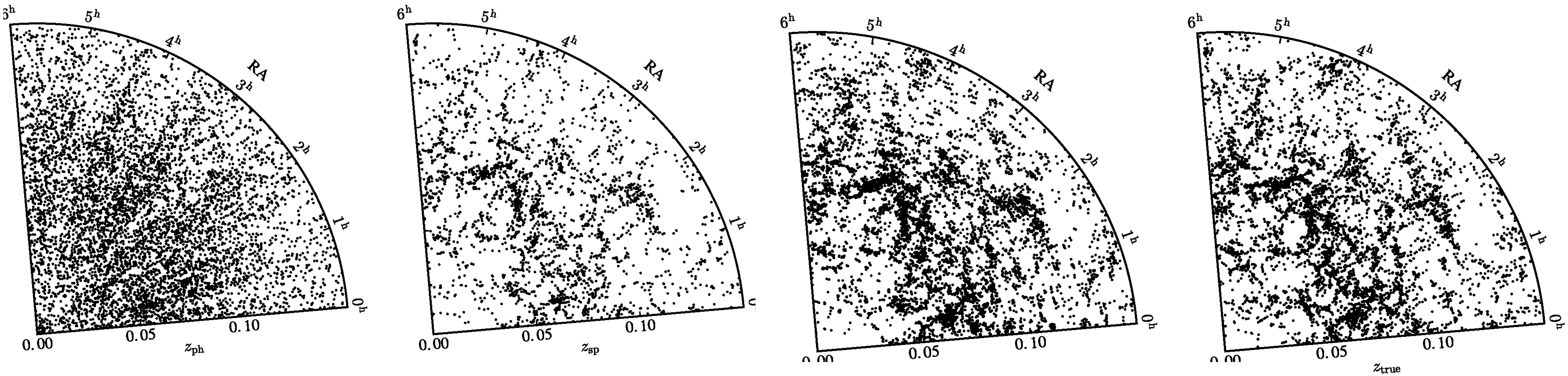
Measuring λ_B and R_s vs. Density in Spheres of 4 and 8 h^{-1} Mpc

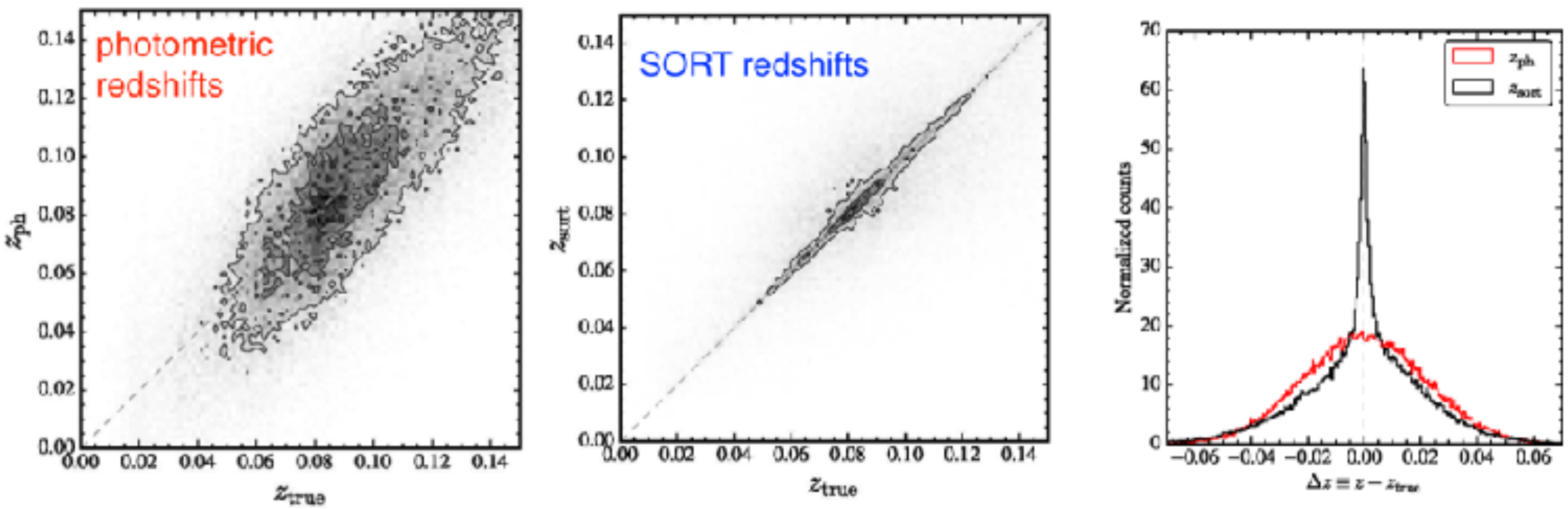
Graham Vanbenthuysen & Viraj Pandya





Deep Learning for Galaxy Environment project — The SORT paper by Nicolas Tejos, Aldo Rodriguez-Puebla, and me is now published: Stochastic Order Redshift Technique (SORT): a simple, efficient and robust method to improve cosmological redshift measurements, MNRAS, 473. 366. James Kakos, Viraj Pandya, 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.





2nd stage: Improve the treatment in the Tejos, Rodriguez-Puebla, Primack SORT paper. This paper used a mock SDSS sample as the test case. This is a large-area survey, but the SORT method is designed for pencil-beam surveys, like CANDELS and other distant redshift/imaging surveys. (The complementary method due to Bryce Menard is designed for large-area surveys.) So let's first apply SORT to a mock CANDELS-type pencil beam survey, using the 8 mock backward light cones for each of the 5 CANDELS fields, based on the Bolshoi-Planck simulation. Also, let's assign spectroscopic redshifts (from the backward light cones) to the brighter (higher Vmax) galaxies, photometric redshifts (degraded by an appropriate Gaussian spread Δz $(1+z)$) to the fainter galaxies, and possibly also intermediate-accuracy grism redshifts. Goal: see how much improvement we can get in determining the environment (density, cosmic web) around galaxies using SORT.

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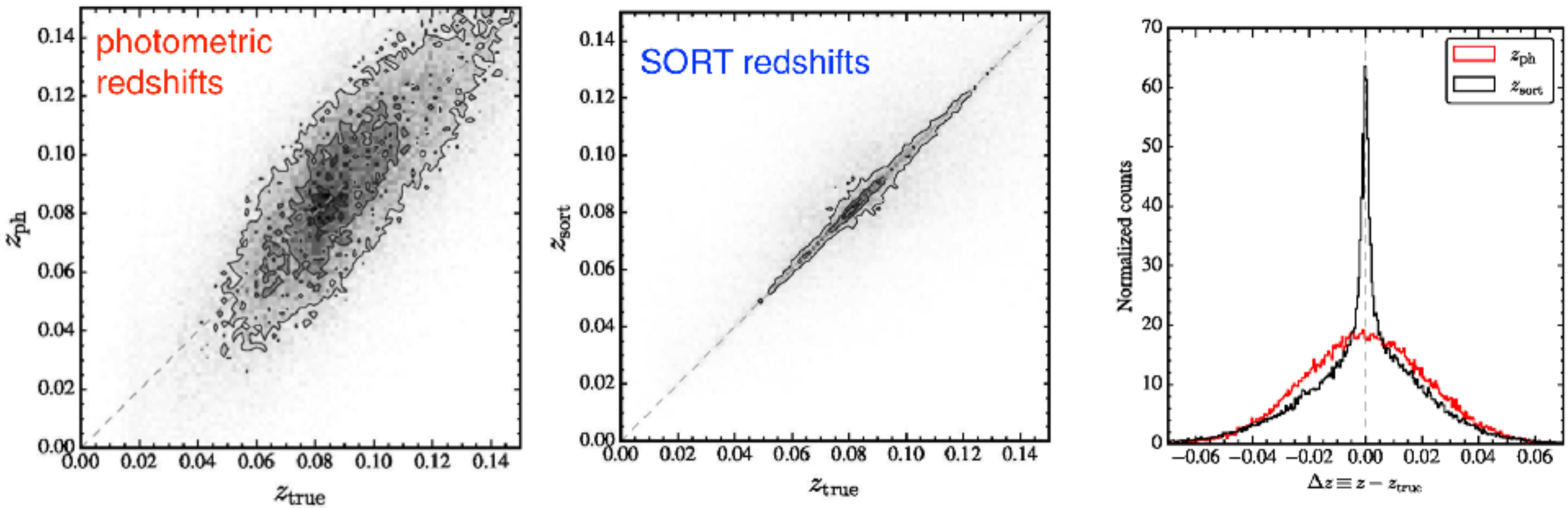

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Deep Learning: The training set will be the same combination(s) of spec-z, photo-z, and possibly grism-z measurements as for the 2nd stage, plus the true redshifts from the simulation. We will then see how well the DL code can predict the true environments of distant galaxies. The challenge in designing the DL will be that this is a 3D point project, unlike the 2D images that face recognition and our “face recognition for galaxies” project analyzes. We hope that our Google friends will help us design an appropriate DL setup.

Does the Galaxy-Halo Connection Vary with Environment?

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ABSTRACT
SubHalo Abundance Matching (SHAM) assumes that one (sub)halo property, such as mass $M_{\rm vir}$ or peak circular velocity $V_{\rm peak}$, determines properties of the galaxy hosted in each (sub)halo such as its luminosity or stellar mass. This assumption implies that the dependence of Galaxy Luminosity Functions (GLFs) and the Galaxy Stellar Mass Function (GSMF) on environmental density is determined by the corresponding halo density dependence. In this paper, we test this by determining from an SDSS sample the observed dependence with environmental density of the *ugriz* GLFs and GSMF for all galaxies, and for central and satellite galaxies separately. We then show that the SHAM predictions are in remarkable agreement with these observations, even when the galaxy population is divided between central and satellite galaxies. However, we show that SHAM fails to reproduce the correct dependence between environmental density and color for all galaxies and central galaxies, although it correctly reproduces the color dependence on environmental density of satellite galaxies.

Key words: Galaxies: Halos - Cosmology: Large Scale Structure - Methods: Numerical

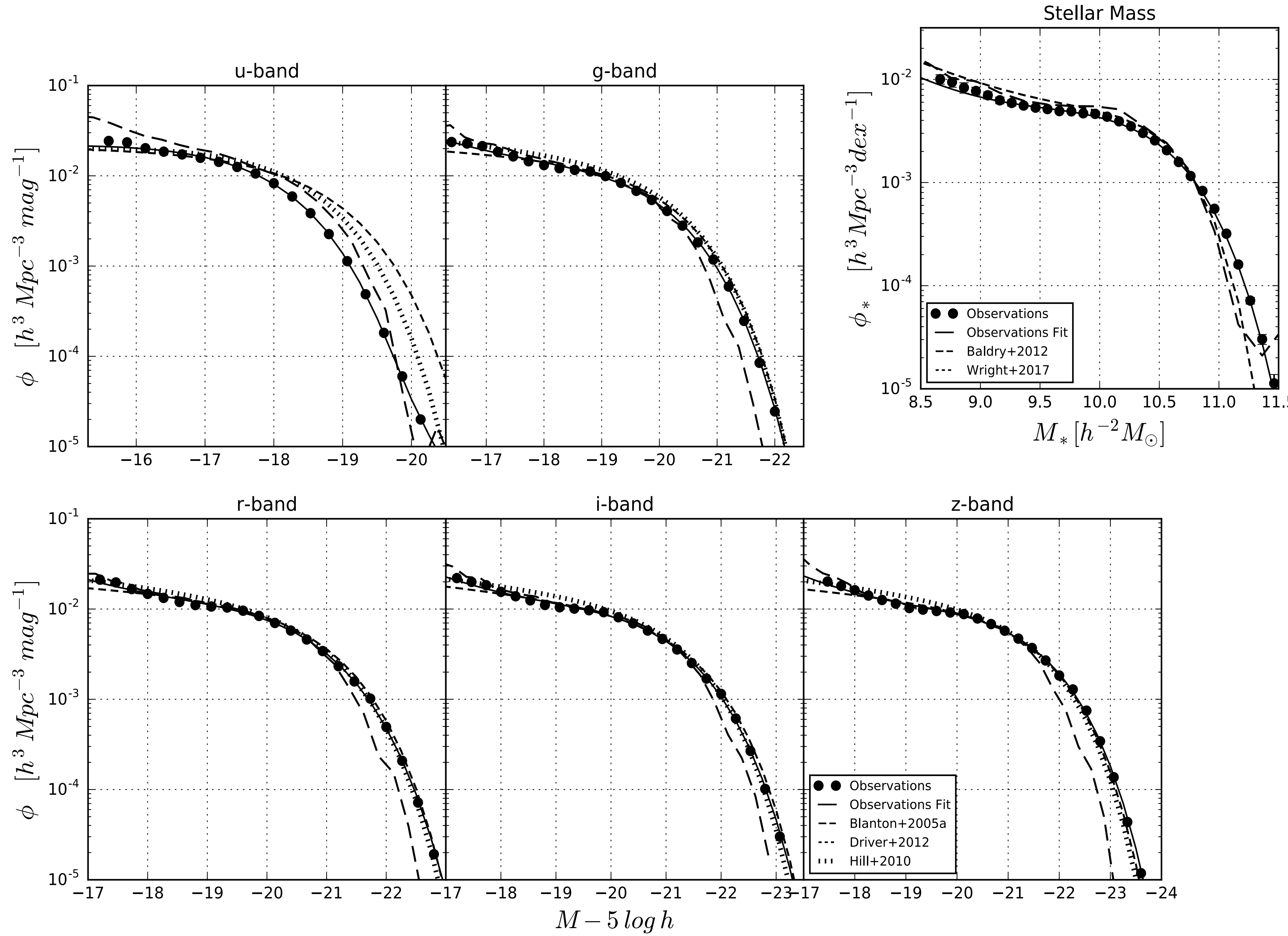

Figure 1. The global *ugriz* galaxy luminosity function. Our derived *ugriz* GLFs and GSMF are shown with the black circles with error bars. For comparison we reproduce the *ugriz* GLFs from Blanton et al. (2005a, black long dashed lines) based on the SDSS DR2; Hill et al. (2010, dotted lines) by combining the MGC, SDSS DR5 and the UKIDSS surveys; and Driver et al. (2012, short dashed lines) based on the GAMA survey. As for the stellar masses we compare with the GSMF from Baldry et al. (2012) and Wright et al. (2017), black long and short dashed lines, respectively.

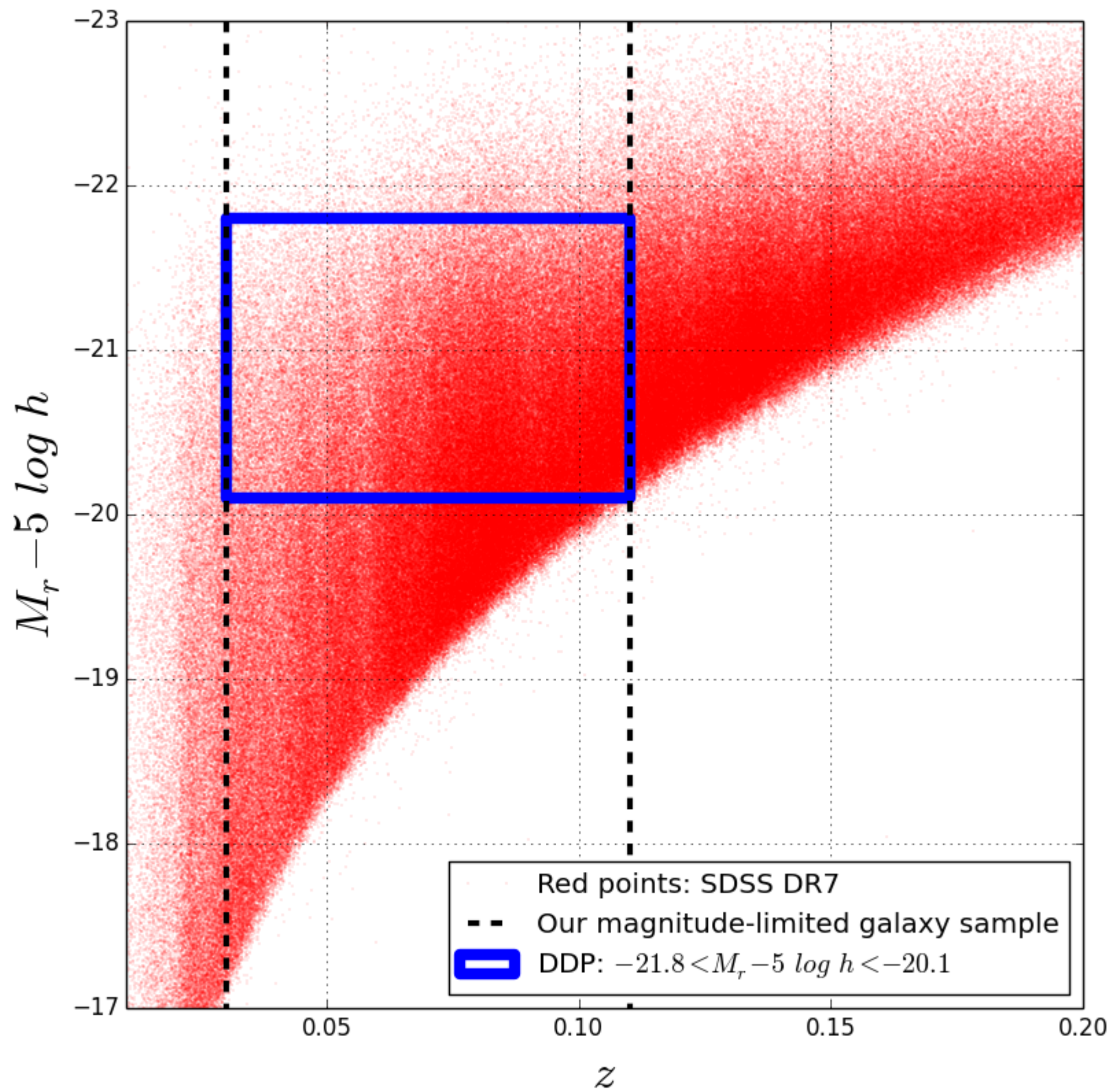

Figure 2. Absolute magnitude in the $r-$band as a function of redshift for our magnitude-limited galaxy sample. The blue solid box shows our volume-limited DDP sample. Note that our DDP sample restricts to study environments for galaxies between $0.03 \leqslant z \leqslant 0.11$ as shown by the dashed lines.

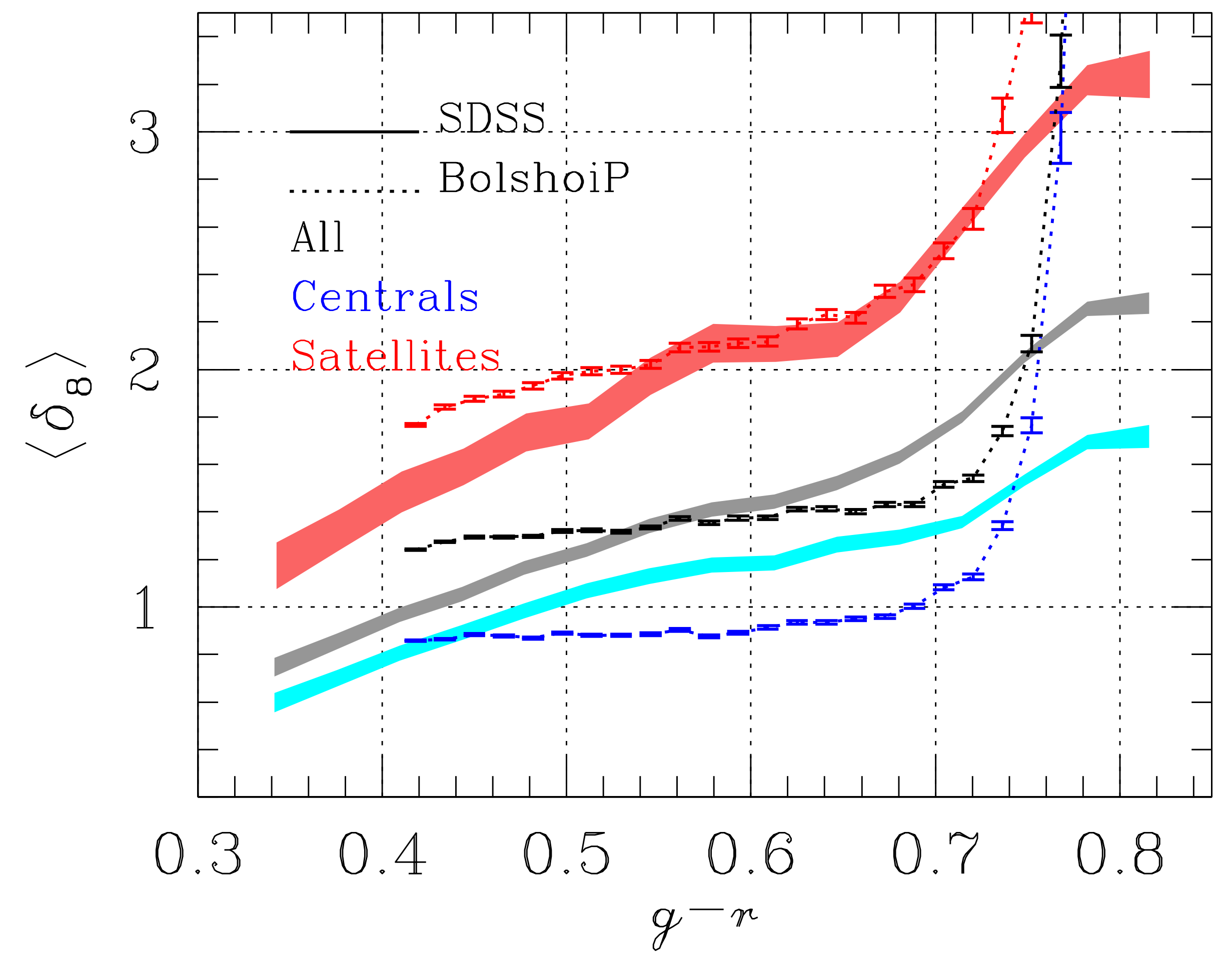

Figure 11. Mean density as a function of galaxy $g-r$ color, from the SDSS DR7 (shaded regions) and the mean density predicted by SHAM based on the BolshoiP simulation, dotted lines with error bars. We present the mean density for all, central, and satellite galaxies as indicated by the labels. SHAM fails to predict the correct relationship between mean density and galaxy colors for all galaxies and central galaxies. In contrast, the SHAM prediction for satellite galaxies is in better agreement with observations.

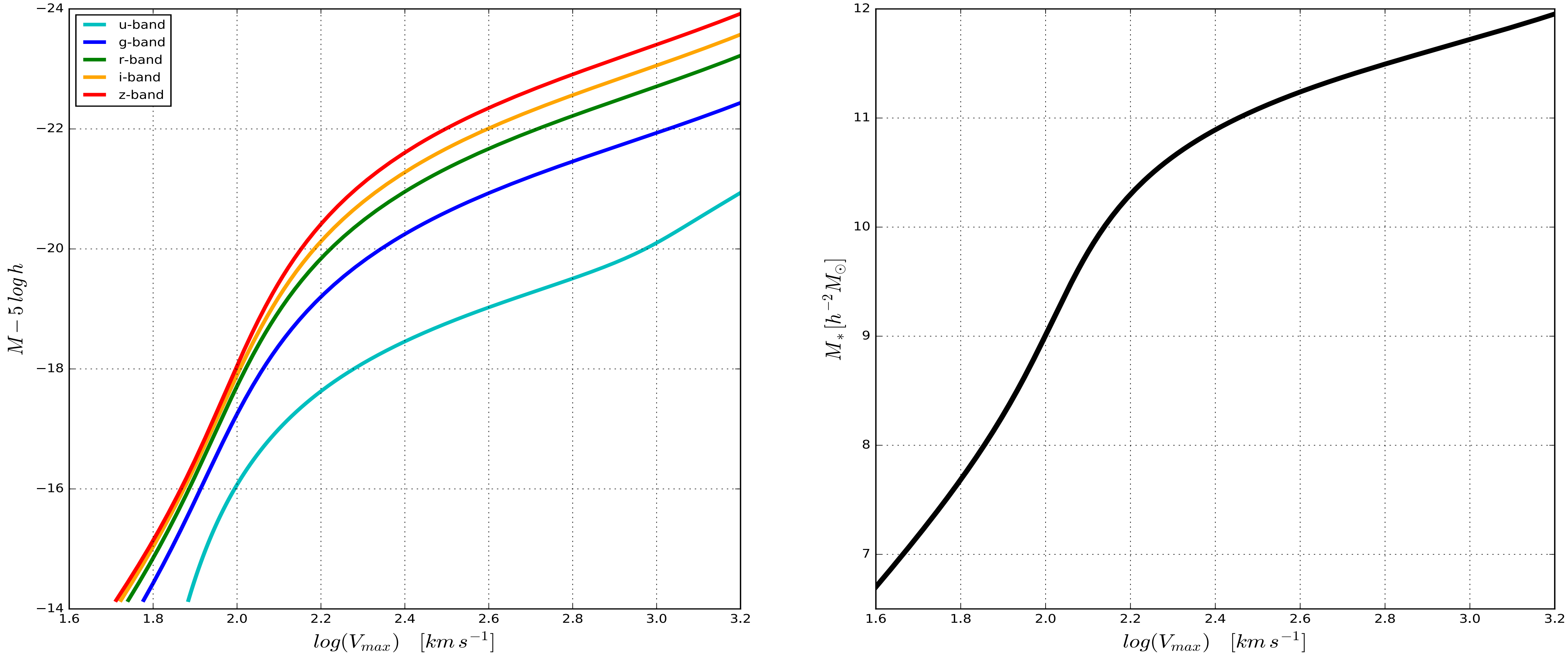

Figure 3. Left Panel: Luminosity-to-$V_{\rm max}$ relation from SHAM. The different colors indicate the band utilized for the match. **Right Panel:** Stellar mass-to-$V_{\rm max}$ relation. Recall that SHAM assumes that these relations are valid for centrals as well as for satellites. In the case of centrals $V_{\rm max}$ refers to the halo maximum circular velocity, while for satellites $V_{\rm max}$ represents the highest maximum circular velocity ($V_{\rm peak}$) reached along the subhalo's main progenitor branch. SHAM assumes that $V_{\rm max}$ fully determines these statistical properties of the galaxies.

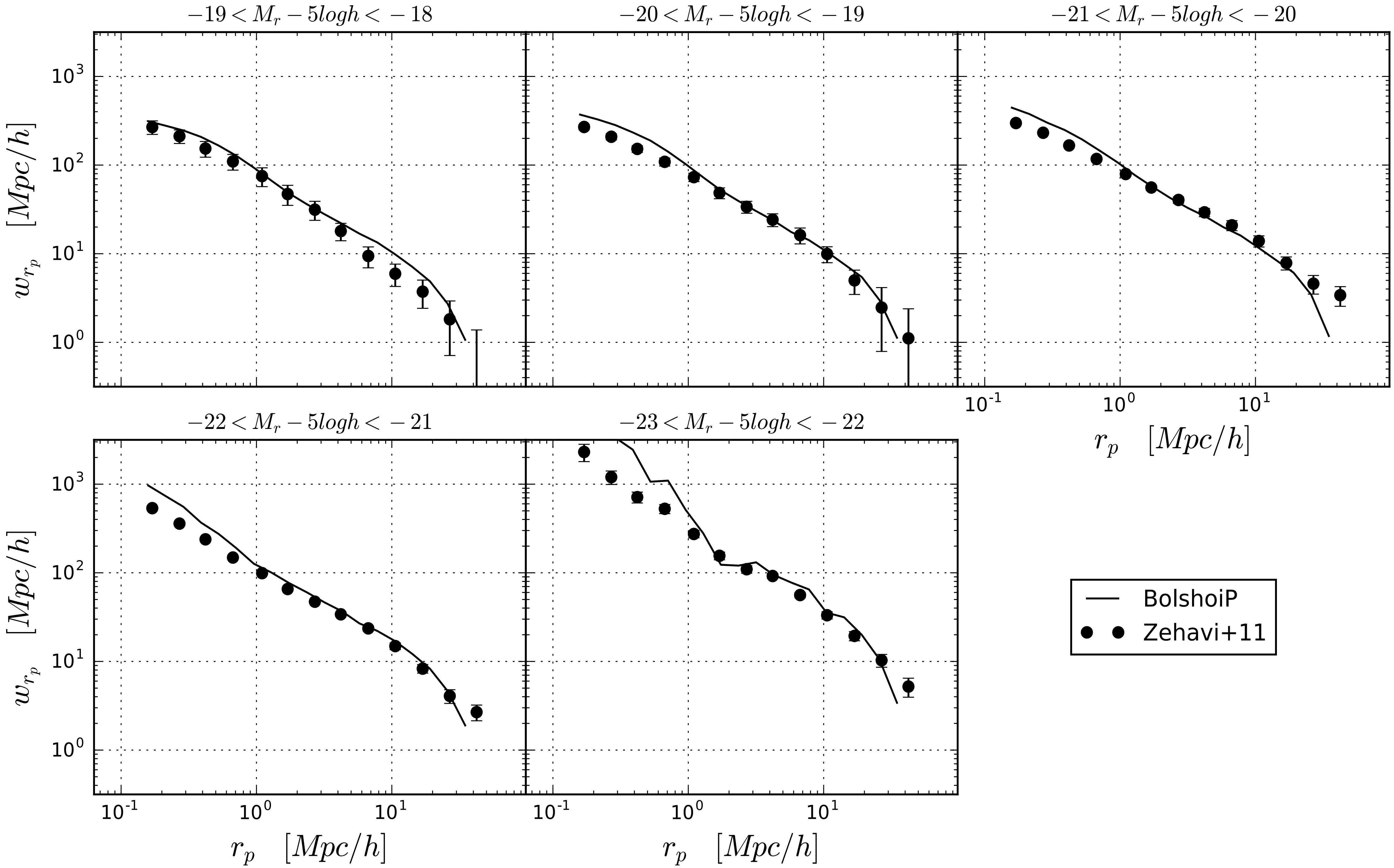

Figure 4. Two-point correlation function in five luminosity bins at $z = 0.1$. The solid lines show the predicted two-point correlation based on our r-band magnitude-to-$V_{\max}$ relation from SHAM, while the circles with error bars show the same but for the SDSS DR7 (Zehavi et al. 2011).

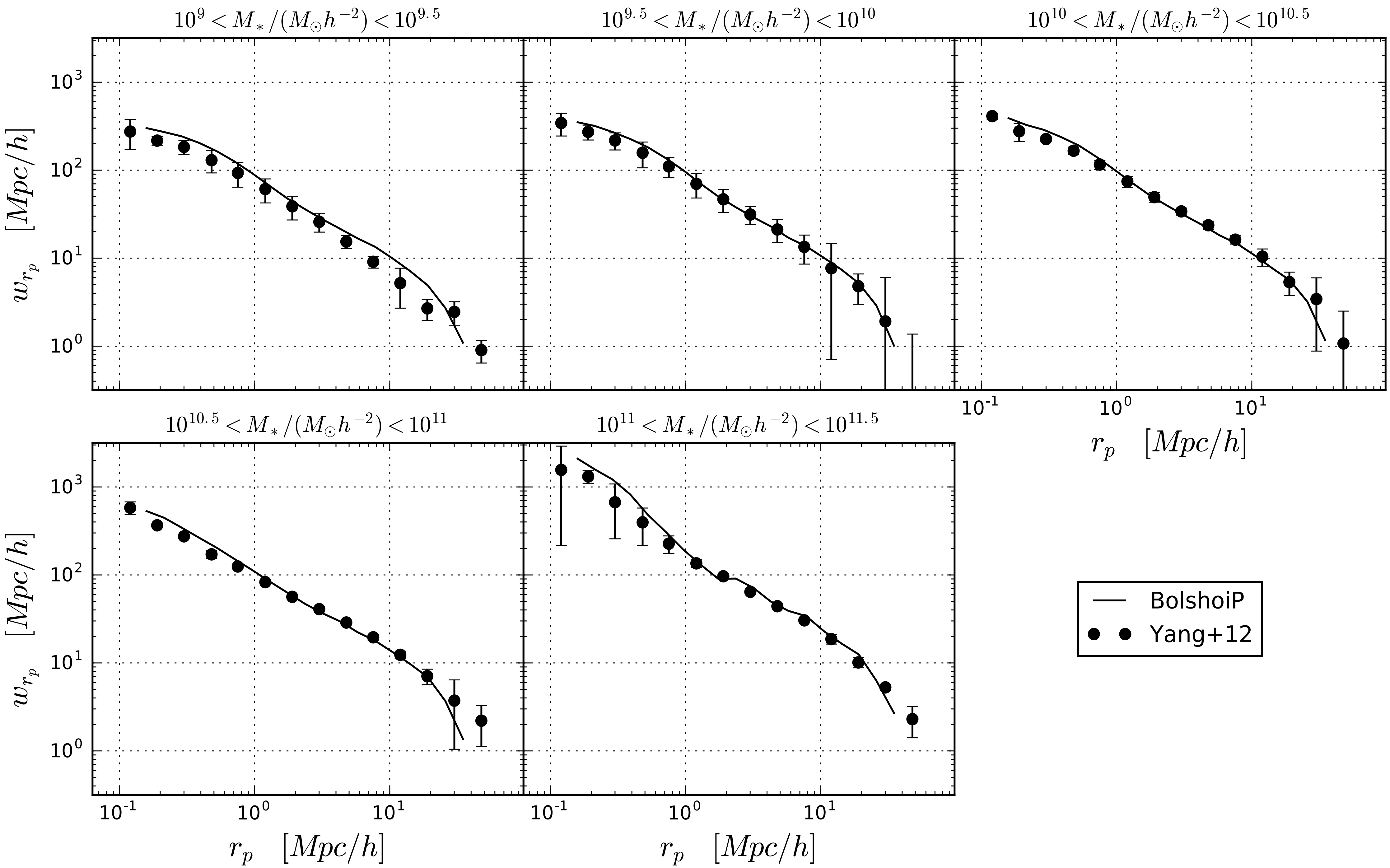

Figure 5. Two-point correlation function in five stellar mass bins. The solid lines show the predicted two-point correlation based on our stellar mass-to-$V_{\rm max}$ relation from SHAM, while the circles with error bars show the same but for SDSS DR7 (Yang et al. 2012).

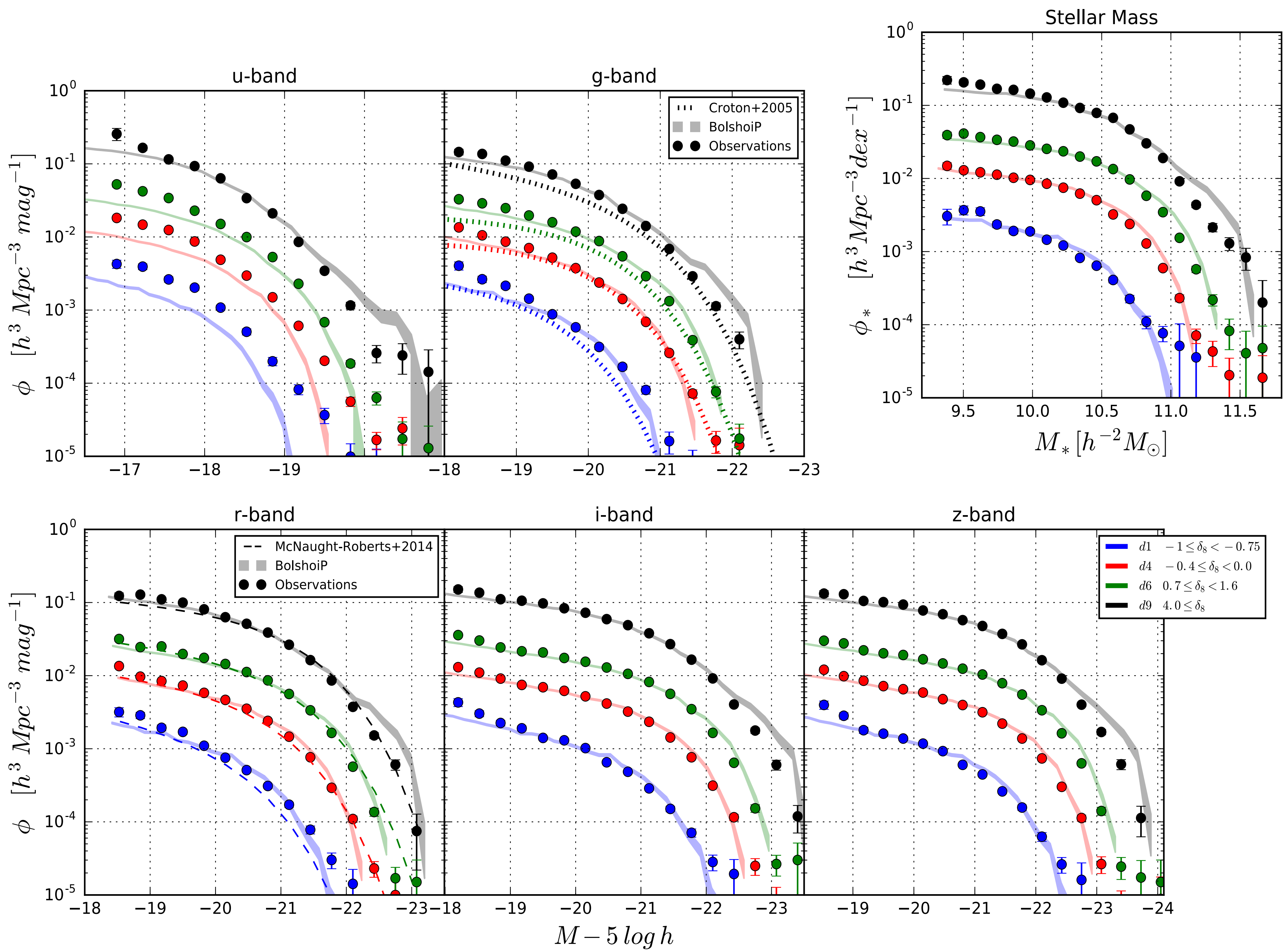

Figure 6. Comparison between the observed SDSS DR7 *ugriz* GLFs and GSMF, filled circles with error bars, and the ones predicted based on the BolshoiP simulation from SHAM, shaded regions, at four environmental densities in spheres of radius 8 h^{-1}Mpc. We also reproduce the best fitting Schechter functions to the r-band GLFs from the GAMA survey (McNaught-Roberts et al. 2014). Observe that SHAM predictions are in excellent agreement with observations, especially for the longest wavelength bands.

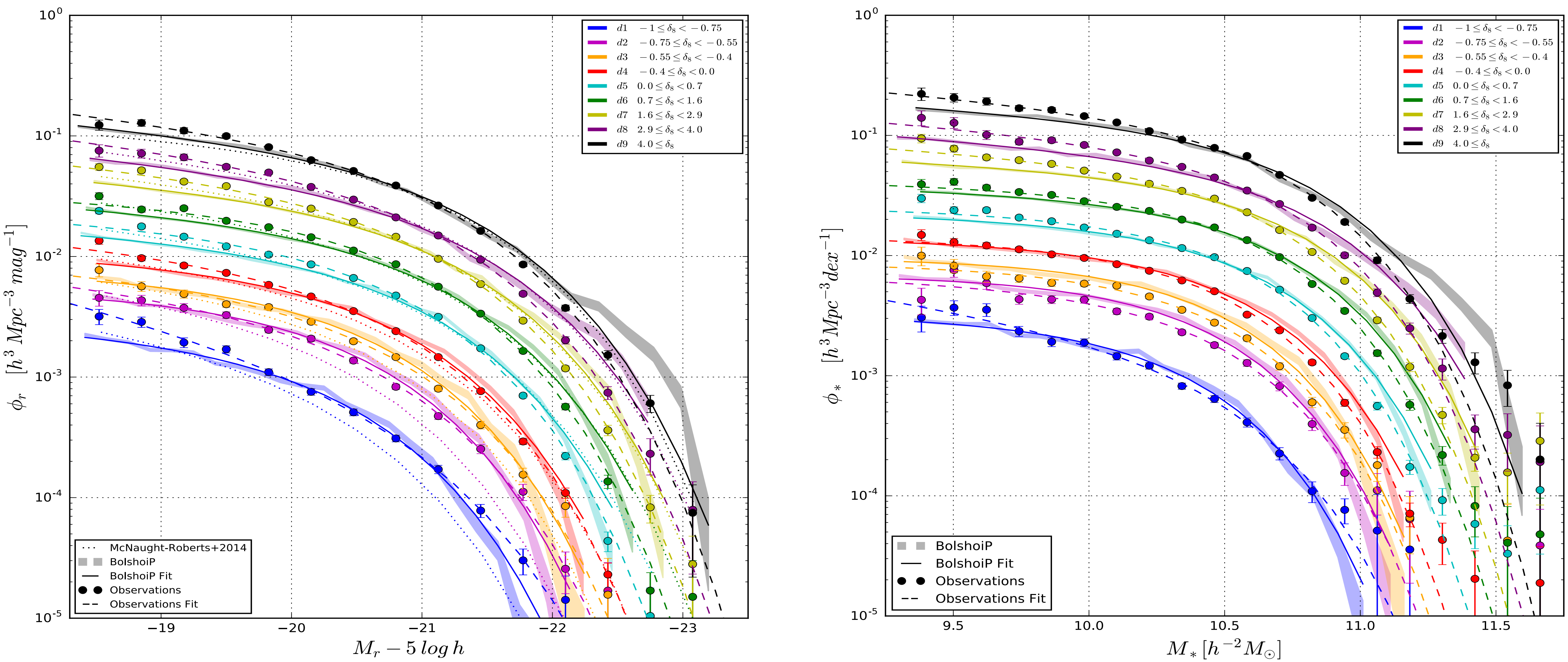

Figure 7. Left Panel: Comparison between the observed $r-$band GLF with environmental density in spheres of 8 h^{-1}Mpc, filled circles with error bars, and the ones predicted based on the BolshoiP simulation from SHAM, shaded regions. The dashed lines show the best fitting Schechter functions to the r-band GLFs from the GAMA survey (McNaught-Roberts et al. 2014). **Right Panel:** Similar to the left panel but for the GSMF with environmental density. Here again the dashed lines are the best fitting Schechter functions.