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ABSTRACT
This is a simple template for authors to write new MNRAS papers. The abstract should briefly describe the aims, methods, and main results of the paper. It should be a single paragraph not more than 250 words (200 words for Letters). No references should appear in the abstract.

Key words: keyword1 – keyword2 – keyword3

1 INTRODUCTION

This is a simple template for authors to write new MNRAS papers. See `mnras_sample.tex` for a more complex example, and `mnras_guide.tex` for a full user guide.

All papers should start with an Introduction section, which sets the work in context, cites relevant earlier studies in the field by Others (2013), and describes the problem the authors aim to solve (e.g. Author 2012).

2 ILLUSTRIS SIMULATION

Illustris-1, also known simply as Illustris, is a highly resolved cosmological simulation which reproduces large-scale statistical features of the Universe, such as the galaxy population of massive clusters, as well as small-scale properties such as the morphology of galaxies and detailed values for their stellar and gas content.

This was achieved by following the evolution of 2×1820^3 elements with dark mass resolution of $m_{\rm DM} = 6.26 \cdot 10^6 \mathrm{M}_\odot$ and initial baryonic mass resolution of $\overline{\mathrm{m_b}} = 1.26 \cdot 10^6 \mathrm{M}_\odot$ from a glass-like configuration in a periodic box of 106.5Mpc. The ΛCDM cosmology of this run follows: $\Omega_\Lambda = 0.7274$, $\Omega_\mathrm{m} = 0.2726$, $\Omega_\mathrm{b} = 0.0456$, $\sigma_\mathrm{s} = 0.0809$, $\mathrm{n_s} = 0.963$ & $\mathrm{H_0} = 70.4 \mathrm{kms^{-1}Mpc^{-1}}$ which is consistent with the (last) Anisotropy Probe (WMAP)-9 **?**. Illustris has a constant spatial resolution of 1.4kpc for DM particles in comoving units, and for baryonic particles it has the same spatial resolution of DM for $\mathrm{z} \geq 1$, which is later modified to 0.7kpc in physical units for the rest of the simulation.

The evolution in time was performed with the hydrodynamic code AREPO **?**, which combines a moving Voronoi tessellation with the finite volume approach. Included in the evolution algorithm, there are galaxy formation models which account for the evolution of stars and SMBHs. Specifically, the physics followed by this model includes energetic feedback from supermassive black holes and supernovae, as well as stellar evolution and chemical enrichment. This level of detail in Illustris is advantageous for the analysis of the effect of the environment in galactic barionic properties and is hard to find among other simulations, i.e. post-processed runs with semi-analytical models which do not directly simulate baryons.(Expand) Describe Arepo a little bit more

The output of this simultaion consists of 136 snapshots where 61 of them were taken at $z < 3$ spaced with a cosmological scale factor $\Delta a \approx 0.02$, while the remaining 75 were taken at $z > 3$ with spacing $\Delta a \approx 0.01$. Each snapshot was post-processed with a modified version of FOF **?** to identify DM haloes with more than 32 particles using a linking length of 0.2 times the mean particle separation each of which is analyzed with the SUBFIND algorithm **?** to generate, at z=0, 7,713,601 halos (FOF) and 4,366,546 (sub)halo catalogues with their respective characterization properties.

3 THE METHOD

The principal purpose of this work is to verify if the results obtained observationally by Jones et al. **?** are supported by a similar analysis in the cosmological simulation Illustris. For this purpose, we want to adaptate the observational method as closely as posible for it to work on computational data.

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3.1 The 3^{rd} nearest neighbor method

The principal method used in Jones et al. **?** analyses the dependence of the Schechter parameters on the cosmological environment. To obtain a quantification of said cosmological environment, they calculated for each galaxy in the studied survey the projected distance in the sky to the third nearest neighbor, filtrating candidate neighbors by its radial velocity relative to the reference galaxy. According to Hubble's law, this effectively restricts the candidate galaxies to a smaller radial range, reducing apparent closer galaxies arising from the projection method. The radial relative velocity cut was chosen to be $450km/s$. Furthermore, a photometrics pre-selection was performed, selecting galaxies whose r-filter magnitude was above −19 (VERIFY).

Once quantified the environment with the distance to the 3rd nearest neighbor definition for each galaxy in their post-selected survey they divided the group in four quartiles according this quantity. For each quartile, the respective HIMF was calculated, and with this, a Schechter fit was obtained. The analysis was specifically performed over the Schechter parameters of the Knee-mass and the faint-end slope.

In dark matter cosmological simulations, access to the information is istantaneous and at no cost. However, as we want to replicate as closely as possible the method effectuated by Jones et. al **?**, we also calculate the projected distance in the simulation and take the same projected velocity cut according to a specified point of view. Even when we could easily calculate the distance to the third nearest neighbor we take into account these observational simplifications, to make our study as comparable as possible to that of Jones et al. **?**.

However, as Illustris is a cosmological simulation, it is subject to numerical resolution biases, being the most important, the mass resolution biases. Each mass considered here is subject directly or indirectly to a mass resolution, and the effect it causes is specially evident in the produced mass functions. We used Illustris-3, which is a less resoluted copy of Illustris-1, to verify that the effect on the mass functions is indeed caused by mass resolution. Taking this into account, mass functions are heavily affected for masses below a certain cut and for this reason, only galaxies above said cut are considered in this study. This mass cut has no aparent systematical way to be calculated and therefore, we performed the cut having into account the performance of the respective Schechter fit.

Mass resolution reduces the size of the sample galaxies and this complicates the process of photometrics preselection. This selection significatively reduces the size of the galaxy set which is already smaller than normal due to the resolution cut. This made impossible a Schechter fit to the obtained mass functions given that the associated logarithmic errors became extremely large. For this reason, we omit the photometrics pre-selection which is the only feature that our analysis misses with respect to the one from **?**.

Table 1. This is an example table. Captions appear above each table. Remember to define the quantities, symbols and units used.

A	B	C	D
1	2	3	4
2	4	6	8
3	5	7	9

3.2 The cosmic web method

To complement the analysis performed with the third nearest neighbor method for the classification of environments, we chose a complementary method of completely different nature to verify even more the results from Jones et al.. The method chosen here was the one developed by Forero et al. **?**, which uses the Hessian of the gravitational potential obtained from the DM field to classify galaxies into (conveniently) four morphological environments.

4 RESULTS

4.1 Preliminaries

4.2 Mass functions comparison

Figures and tables should be placed at logical positions in the text. Don't worry about the exact layout, which will be handled by the publishers.

Figures are referred to as e.g. Fig. **??**, and tables as e.g. Table 1.

5 CONCLUSIONS

The last numbered section should briefly summarise what has been done, and describe the final conclusions which the authors draw from their work.

ACKNOWLEDGEMENTS

The Acknowledgements section is not numbered. Here you can thank helpful colleagues, acknowledge funding agencies, telescopes and facilities used etc. Try to keep it short.

REFERENCES

Author A. N., 2013, Journal of Improbable Astronomy, 1, 1
Others S., 2012, Journal of Interesting Stuff, 17, 198

APPENDIX A: SOME EXTRA MATERIAL

If you want to present additional material which would interrupt the flow of the main paper, it can be placed in an Appendix which appears after the list of references.

This paper has been typeset from a TEX/LATEX file prepared by the author.

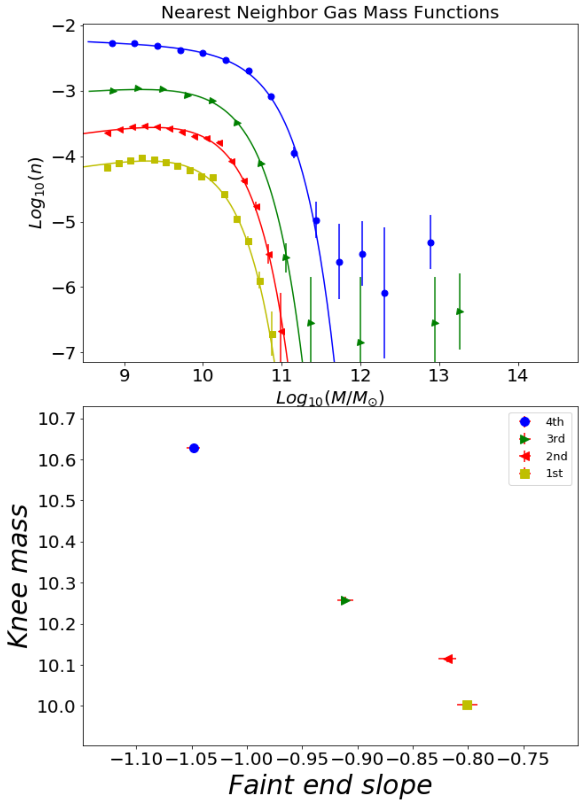

Figure 1. Upper side: Schechter fits of each gas mass function for each environmental quartile using the 3rd nearest neighbor definition.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.

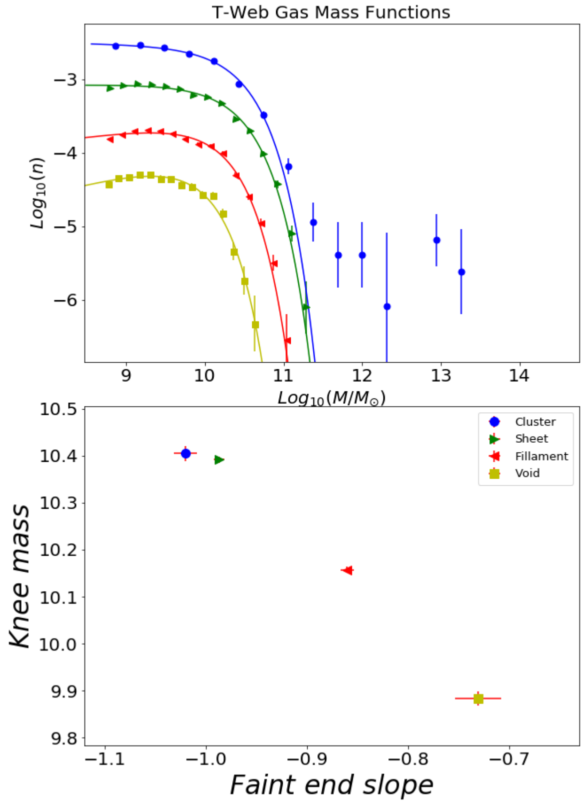

Figure 2. Upper side: Schechter fits of each gas mass function for each morphological environment characterized by the T-Web algorithm proposed by Forero et al.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.

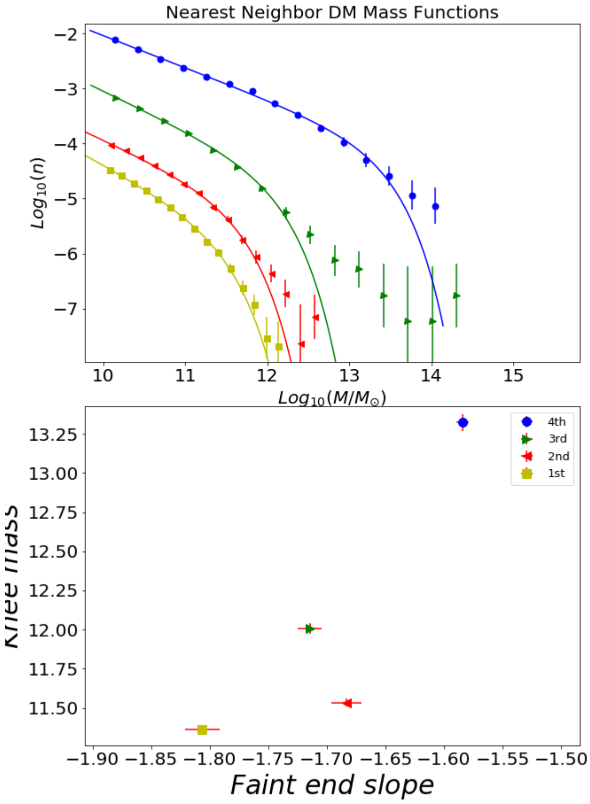

Figure 3. Upper side: Schechter fits of each DM mass function for each environmental quartile using the 3rd nearest neighbor definition.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.

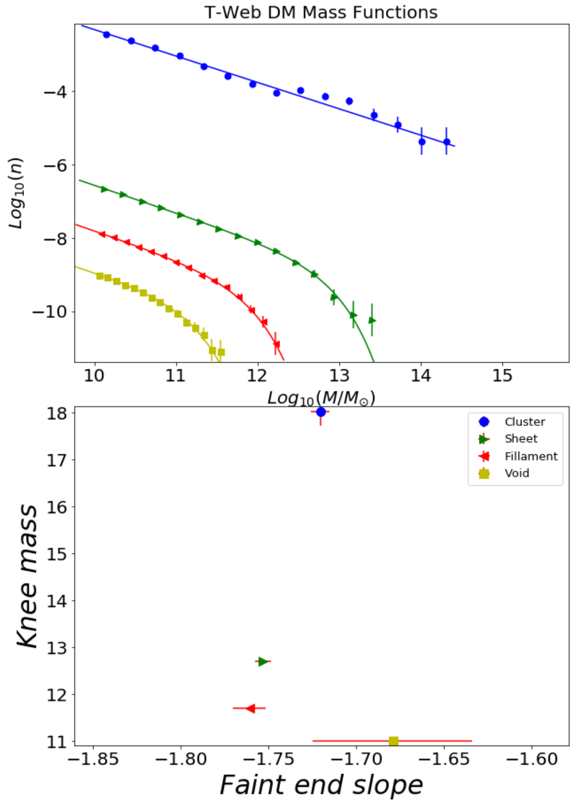

Figure 4. Upper side: Schechter fits of each DM mass function for each morphological environment characterized by the T-Web algorithm proposed by Forero et al.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.

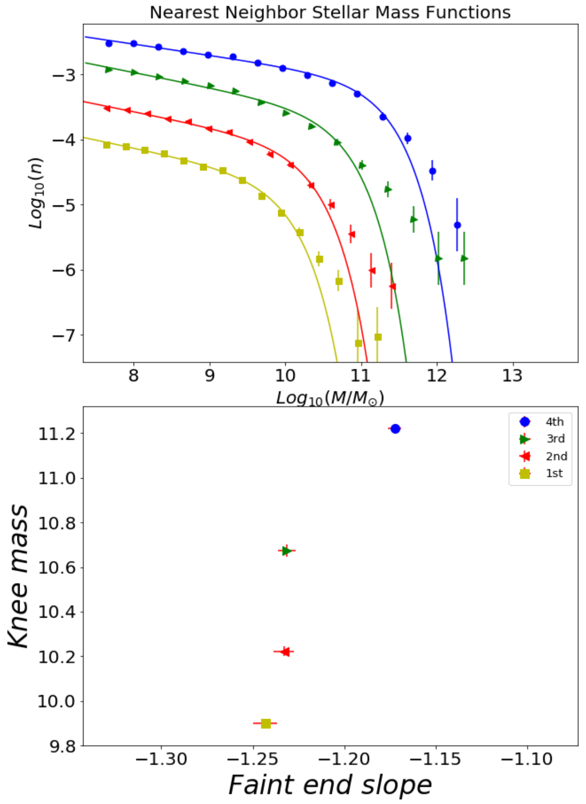

Figure 5. Upper side: Schechter fits of each stellar mass function for each environmental quartile using the 3rd nearest neighbor definition.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.

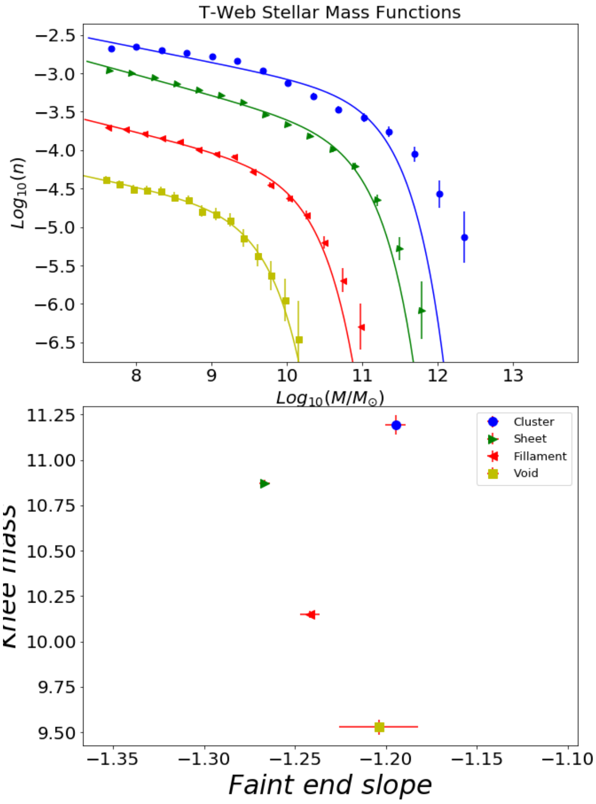

Figure 6. Upper side: Schechter fits of each stellar mass function for each morphological environment characterized by the T-Web algorithm proposed by Forero et al.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.

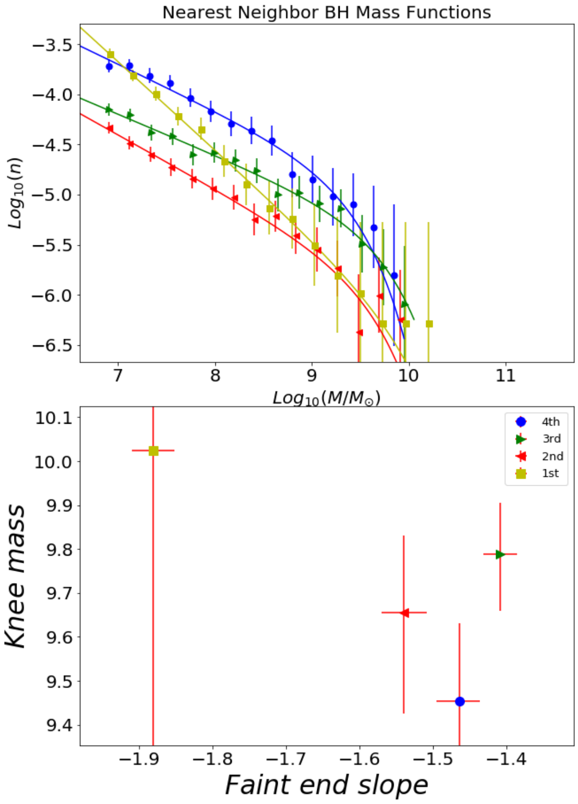

Figure 7. Upper side: Schechter fits of each BH mass function for each environmental quartile using the 3rd nearest neighbor definition.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.

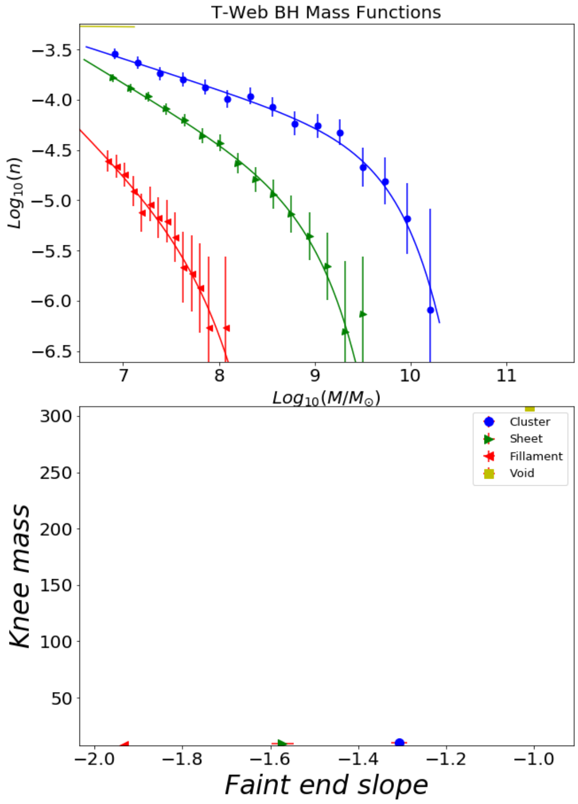

Figure 8. Upper side: Schechter fits of each BH mass function for each morphological environment characterized by the T-Web algorithm proposed by Forero et al.**Down side**: Knee-mass m_* and the faint end slope α values obtained from the Schechter fits for each curve shown above.