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PROBING INHOMOGENEOUS BLAZAR HEATING WITH THE LYα FOREST

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ABSTRACT

1. INTRODUCTION

2. COSMOLOGICAL SIMULATIONS

Our simulations are very similar to the simulations presented in Paper I and are performed at higher resolution. In this section we remind the reader of their relevant characteristics.

We perform our simulations with GADGET-3, which is and upgraded version of GADGET-2 (**?**). It is based on a Smoothed Particle Hydrodynamics (SPH) scheme and solves the gravitational evolution of gas and dark matter with a TREE-PM N-body method. The equations of hydrodynamics are solved with an entropy conserving scheme based on (Springel & Hernquist 2002). Our simulations are based on the cosmological parameters based on the *Planck* data combined with lensing, *WMAP* and high multipole measurements (Planck Collaboration et al. 2014): $\Omega_M = 0.305$, $\Omega_\lambda = 0.694$, $\Omega_B = 0.0481$, $h = 0.679$, $\sigma_8 = 0.827$ and $n_s = 0.962$. These values are slightly updated with respect to the simulations presented in (**??**). **[I don't expect this to have any influence, is that correct?]**

We start our simulations based on initial conditions evolved up to redshift $z = 110$ and stop our simulations at $z = 1.74$, beyond which observational date is sparse **[I'm considering to go to lower z and look if we can solve the "photon underproduction crisis"].**. As this work focusses on the IGM, we use a simplified model for star formation, where gas particles with density $\delta_{\rm gas} \geq 1000$ and $T \leq 10^5$ are directly converted into stars (Viel et al. 2004). While this can yield inaccurate galaxy properties, it does not affect the low-density IGM and significantly speeds up the simulations. We also neglect direct black hole feedback.

[Paragraph about UV background and related stuff here]

We perform a set of three simulations, one without any blazar heating, one with uniform blazar heating and one with inhomogeneous blazar heating. The uniform blazar heating model is identical to the "intermediate heating" model presented in **?**. Our inhomogeneous model has the same total amount of energy injected by blazars while accounting for regions receiving more or less heating according to their proximity to heating sources. The model is fully described in Paper I and is based on an analytic formalism relating the distribution of the heating rate to the underlying dark matter distribution. It results in the filtering function shown on Fig. 1, which removes small scale fluctuations and enhances fluctuations beyond $\simeq 10$ h^{-1} Mpc at $z = 4$ and $\simeq 40$ h^{-1} Mcp at $z = 2$. The shape and redshift evolution of the window function is set by the mean free path of the VHEGR combined with the bias of the heating sources. While we presented two models in Paper I, with galaxy bias and quasar bias, in this work we focus on the model with quasar bias, which is probably more representative of the bias of TeV blazars.

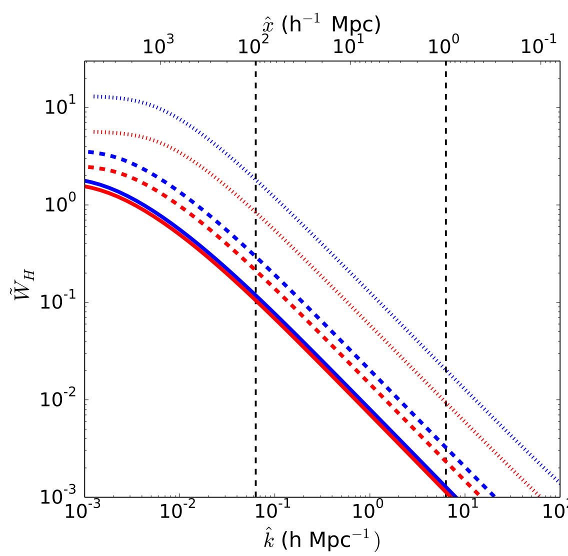

Fig. 1.— Window function for TeV blazar heating from $z = 1$ (solid lines), $z = 2$ (dashed lines) and $z = 4$ (dotted lines) for the galaxy bias model (red) and the quasar bias model (blue). The vertical dashed lines indicate the minimal and maximal comoving wavenumber modeled in the simulation. **Placeholder, will remove galaxy bias and add more appropriate redshift lines**

Because of the typical length scale of the heating rate fluctuations, our simulation have a comoving sidelength of a 100 h^{-1} Mpc. Tests in Paper I showed that this is a sufficiently large size to properly sample the full range of temperature fluctuations. **Discuss resolution here**

3. COMPARISON WITH OBSERVATIONS

3.1. *Post-processing the simulations*

- Global flow , potential caveats
- Details about subdividing LOS in chunks for VP-

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3.2. *Lyα forest statistics*

3.3. *Thermal state of the IGM*

1. Compare with Rorai 2016
2. Maybe compare with low-z results
3. Rudie and other b-Nh distributions

4. DISCUSSION

5. CONCLUSIONS

REFERENCES

Planck Collaboration, Ade, P. A. R., Aghanim, N., et al. 2014, A&A, 571, A16
Springel, V., & Hernquist, L. 2002, MNRAS, 333, 649
Viel, M., Haehnelt, M. G., & Springel, V. 2004, MNRAS, 354, 684

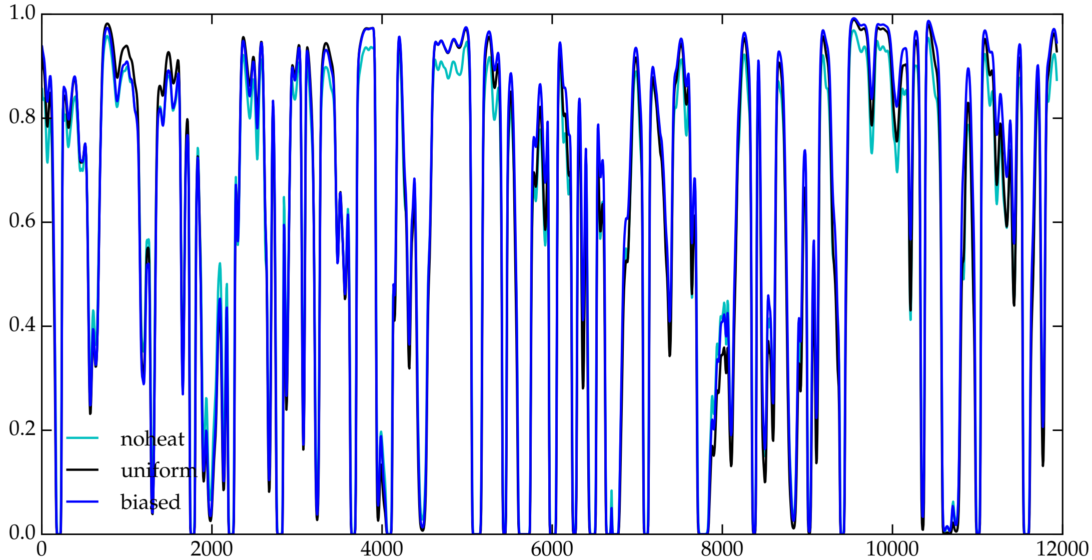

FIG. 2.— Lyα absorption spectrum at $z = 2.2$ in the three models. **[Placeholder, will be improved]**

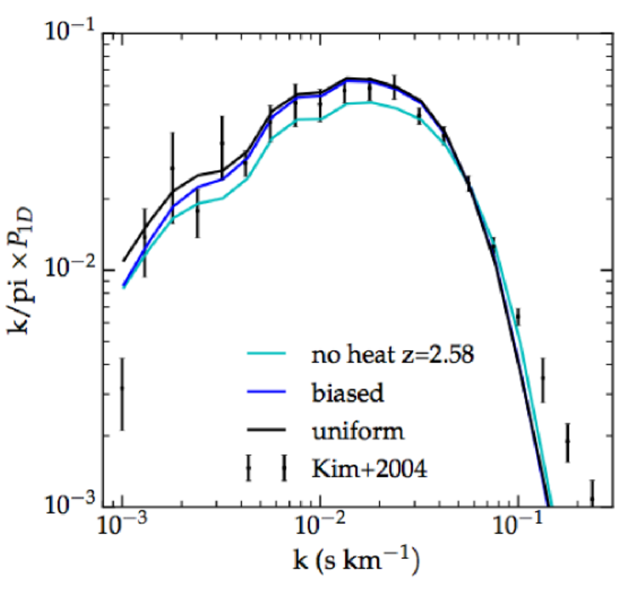

FIG. 3.— Power spectrum at different redshifts compare with observations **[Placeholder, will be improved]**

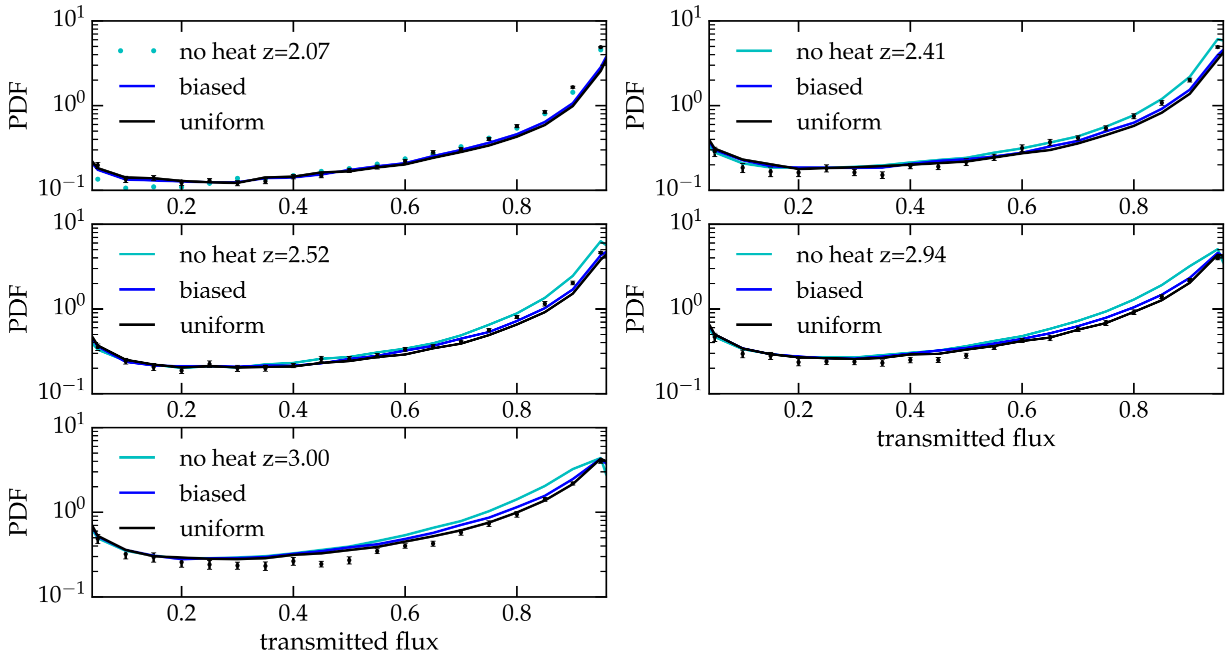

FIG. 4.— Flux PDF at different redshifts compare with observations **[Placeholder, will be improved]**

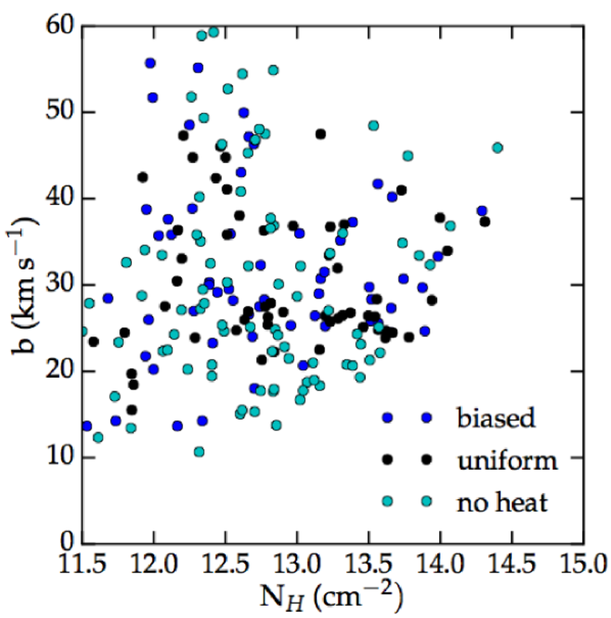

FIG. 5.— Column density - Doppler with distribution in the different models **[Placeholder, will be improved]**