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Simulated evolution of the DM LSS

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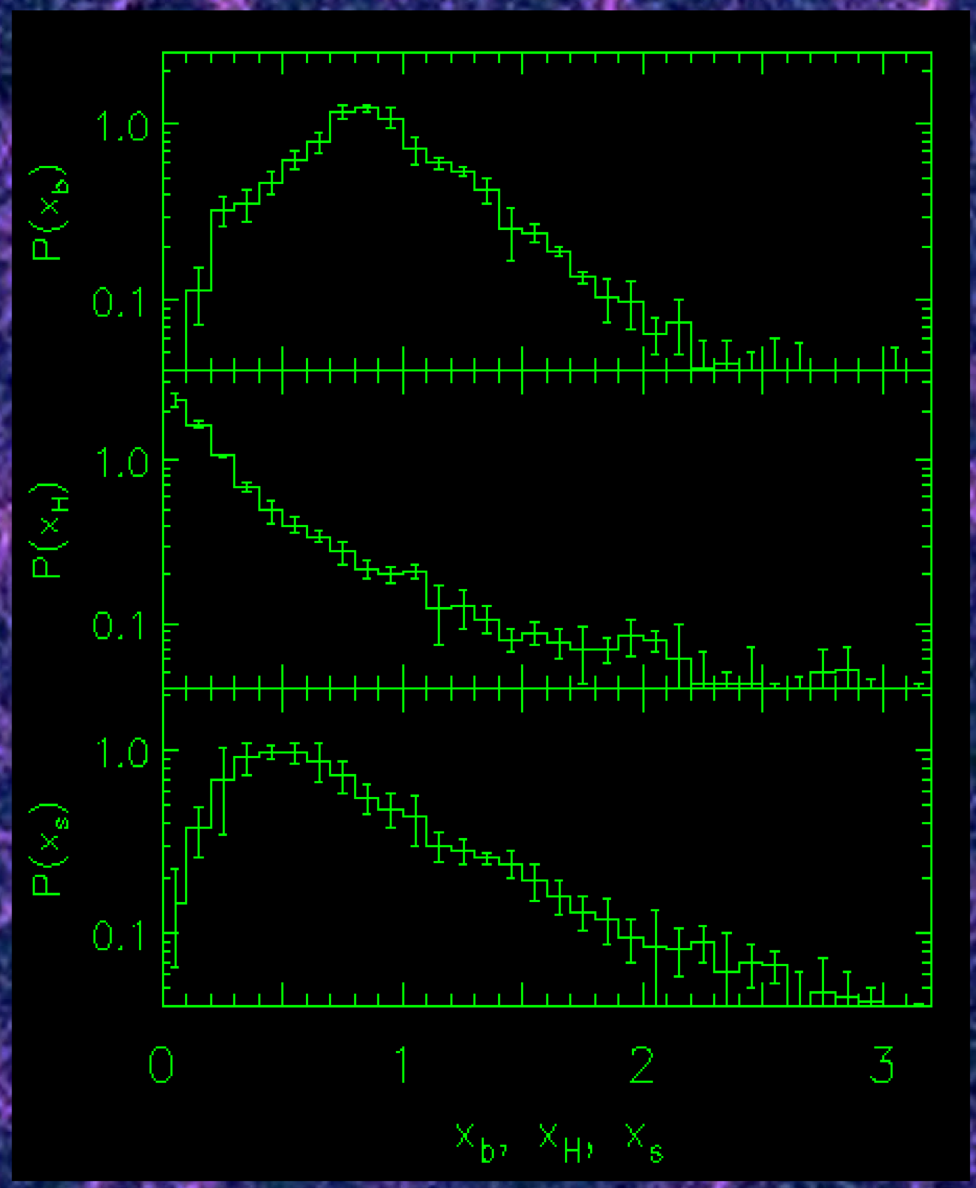
We focus our main attention on the regular trends in the evolution of the simulated LSS and their comparison with observations of properties of Ly-α forest in a wide range of redshifts. The most interesting result of our analysis is the self similar character of the LSS evolution. The self similarity in simulations at z<4-5 is due to the balance of the creation of new low mass LSS elements and the integration of earlier created elements to the richer multiconnected elements. At larger redshifts self similarity is a natural consequence of the Zel'dovich theory.



The Forest

The PDFs of main characteristics of Ly-α absorbers are presented at the figure. These characteristics are: the Doppler parameter *b*, the column density of neutral hydrogen N_{HI} and the mean separation of absorbers *s*. The PDFs are normalized by the mean values and averaged over three redshift bins. The scatter do not exceed 10%. The absorbers were selected at $1.6 \le z \le 4$ (see Demiański, Doroshkevich, Turchaninov, 2006).

The self similarity in the forest observations is indicated as surprisingly weak redshift dependence of PDFs of main properties of Ly-α absorbers while their mean values demonstrate regular redshift variations.

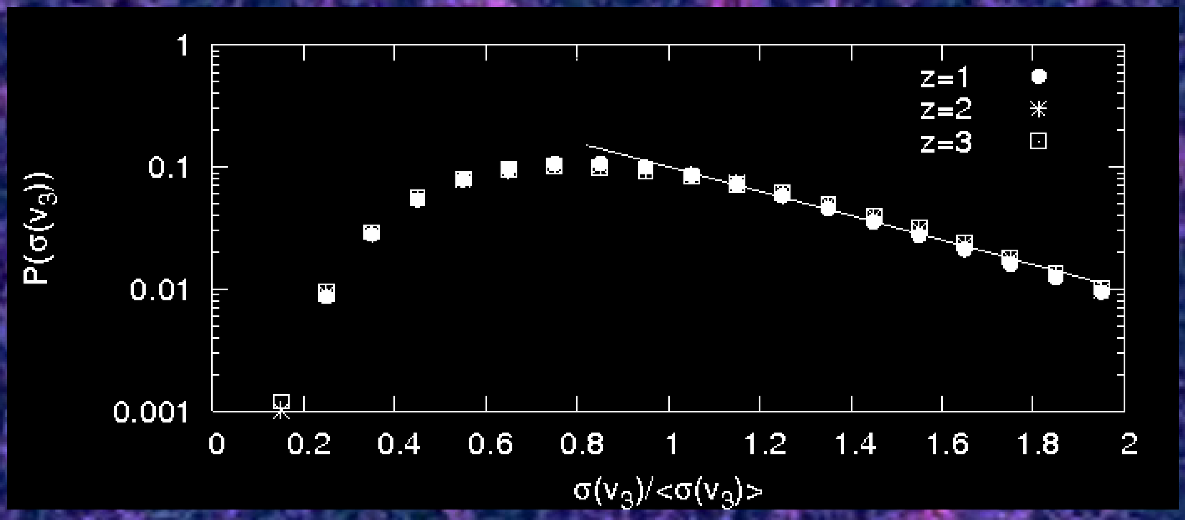
The mean Doppler parameter of absorbers is close to the temperature of the bacground hydrogen. However, from the PDF $P(x_b)$ it is clear that there is a significant ammount of absorbers with Doppler parameter higher and lower the background temperature.

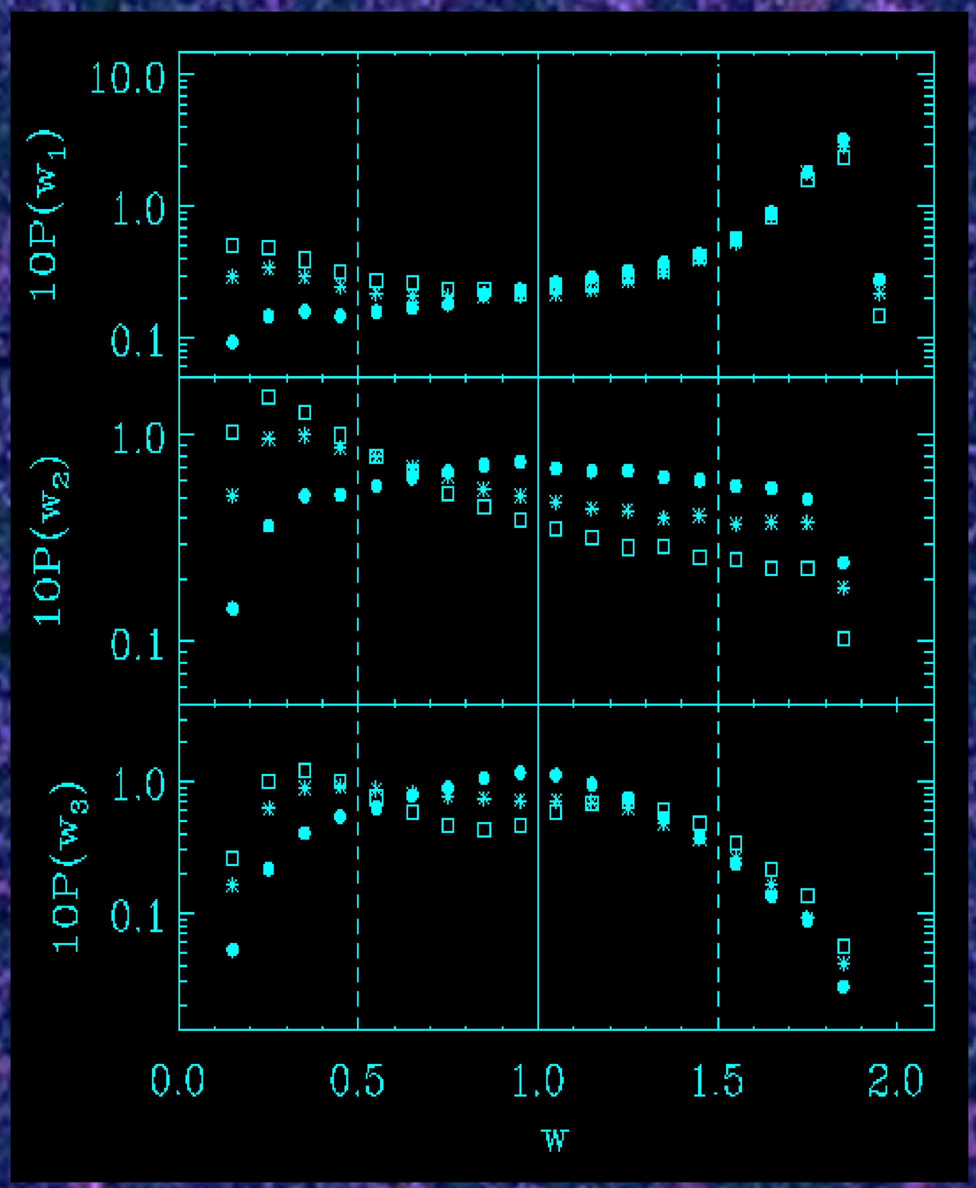
The Numerical Simulation

We investigate the formation and evolution of the DM LSS within the concordance cosmological model. We use three simulations, the first one was performed with the ART code within a box of $L_{box}=150h^{-1}$ Mpc, it has 256^3 particles (Wojtak et al., 2005). Two others was performed with GADGET2 code within the MareNostrum Universe project (Gottlöber, Yepes 2007) and have $L_{box}=500\ h^{-1}$ Mpc and 1024^3 particles and $L_{box}=50\ h^{-1}$ Mpc, 512^3 particles. The MareNostrum simulation DM distribution is used as a background picture for this poster.

From the DM distribution within the simulation we select a set of low massive (not multiconnected) clouds using the Minimal Spanning Tree technique with the threshold overdensity, $\delta=\rho/\langle\rho\rangle$, slightly above 1. Then for each cloud we calculate their main properties: richness (mass), three comoving principle sizes defined through the inertia tensor, velocity dispersions along each principle axis of a cloud.

As an example, the PDFs of the velocity dispersion along the shortest axis, $\sigma(v_3)$, of clouds at z=1, 2 & 3 (points, stars & squares) is at the figure to the right. The weak evolution of this and others PDFs shows the self similar character of the DM LSS evolution.





On the picture we present the ratio of projected velocity and velocity dispersion along the largest, w_1, middle, w_2, and the shortest, w_3, principle axes of clouds. They are plotted for the redshifts z=1, 2 & 3 (points, stars & squares). For a cloud with relaxed matter distribution and random velocities of particles we can expect that $|w_k-1|<<1$. In contrast, for regular expansion or contraction $|w_k-1|\sim 1$ seems to be more probable. In the case $w_k > 1$ and $w_k < 1$ correspond to the domination of the expansion and compression along k^{th} axis.

The picture demonstrates the domination of the retained expansion and moderate degree of relaxation along the largest axis of the clouds. This effect can be responsible for the presence of objects with temperature different from the background one.

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