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Simulations of BAO reconstruction with a quasar Lyman-alpha survey

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The imprint of Baryonic Acoustic Oscillations (BAO) on the matter power spectrum can be constrained using the neutral hydrogen density in the intergalactic medium as a tracer of the matter density. One of the goals of the Baryon Oscillation Spectroscopic Survey (BOSS) of the Sloan Digital Sky Survey (SDSS-III) is to derive the Hubble expansion rate and the angular scale from the BAO signal in the IGM. To this aim, the Lyman-alpha forest of 10^5 quasars will be observed in the redshift range 2.2<z<3.5 and over 10,000 deg^2. We simulated the BOSS QSO survey to estimate the statistical accuracy on the BAO scale determination provided by such a large scale survey. In particular, we discuss the effect of the poorly constrained estimate of the unabsorbed intrinsic quasar spectrum. The volume of current N-body simulations being too small for such studies, we resorted to Gaussian random field (GRF) simulations. We validated the use of GRFs by comparing the output of GRF simulations with that of the Horizon N-body simulation with the same initial conditions. Realistic mock samples of QSO Lyman-\alpha forest were generated; their power spectrum was computed and fitted to obtain the BAO scale. The rms of the results for 100 different simulations provides an estimate of the statistical error expected from the BOSS survey. We confirm the results from Fisher matrix estimate. In the absence of error on the unabsorbed quasar spectrum, the BOSS quasar survey should measure the BAO scale with an error of the order of 2.3%, or the transverse and radial BAO scales separately with errors of the order of 6.8% and 3.9%, respectively. The significance of the BAO detection is assessed by an average \Delta\chi^2=17 but for individual realizations \Delta\chi^2 ranges from 2 t o 35. The error on the unabsorbed quasar spectrum increases the error on the BAO scale by 10 to 20% and results in a sub percent bias.

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