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The Signatures of Large-scale Temperature Fluctuations in the Lyman-alpha Forest

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It appears inevitable that reionization processes would have produced large-scale temperature fluctuations in the intergalactic medium. Using toy temperature models and detailed heating histories in cosmological simulations of HeII reionization, we study the consequences of inhomogeneous heating for the Ly-alpha forest. The impact of temperature fluctuations in physically well-motivated models can be surprisingly subtle. In fact, we show that temperature fluctuations at the level predicted by our reionization simulations do not give rise to detectable signatures in the types of statistics that have been employed previously. However, because of the aliasing of small-scale density power to larger scale modes in the line-of-sight Ly-alpha forest power spectrum, earlier analyses were not sensitive to 3D modes with >~ 30 comoving Mpc wavelengths -- scales where temperature fluctuations are likely to be relatively largest. The ongoing Baryon Oscillation Spectroscopic Survey (BOSS) aims to measure the 3D power spectrum of the Ly-alpha forest, P_F, from a large sample of quasars in order to avoid this aliasing. We find that physically motivated temperature models can alter P_F at an order unity level at k <~ 0.1 comoving Mpc^{-1}, a magnitude that should be easily detectable with BOSS. Fluctuations in the intensity of the ultraviolet background can also alter P_F significantly. These signatures will make it possible for BOSS to study the thermal impact of HeII reionization at 2 < z < 3 and to constrain models for the sources of the ionizing background. Future spectroscopic surveys could extend this measurement to even higher redshifts, potentially detecting the thermal imprint of hydrogen reionization.

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