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Mapping Dark Matter to the Lyman-α Forest with Neural Networks

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We present a machine learning framework that uses neural networks to predict Lyman-α forest spectra from dark matter density fields. Trained on simulations with varying cosmological parameters, our network learns the complex, non-linear transformation from the underlying matter distribution and velocity fields to transmitted flux. We demonstrate that the network accurately reconstructs the Lyman-α absorption features along sightlines within the same simulation box and speculate that this approach can enable fast and accurate generation of Lyman-α spectra, offering a powerful tool for emulating large-scale structure observables and accelerating parameter inference in cosmology.

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