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LyAl-Net: A high-efficiency Lyman-α forest simulation with neural network

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The inference of cosmological quantities needs accurate and large cosmological simulations. Yet, the computational time takes millions of CPU hours for a modest coverage in cosmological scales ($(100Mpc/h)^3$). This ML method could have a decisive impact on the results derived from QSO surveys, e.g., SDSS3/4 data, which has a resolution power of $R = 1500$ and $R = 2000$. But it could be critical for upcoming surveys like WEAVE-QSO with $R = 20000$ in high-res mode. We used the Horizon-NoAGN simulation to train the U-Net, to predict the neutral hydrogen physical properties; density, temperature, and velocities. The flux derived from the predictions is nearly identical to the original flux from simulation with $R \approx 30000$. More generally, the computation of individual fields from the dark matter density agrees well with regular physical regimes of the cosmological field. This approach provides fast and robust numerical simulations, not only for the Lyman-α forest but also a tool for other applications.

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