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Identifying the nature of the QCD transition in relativistic collision of heavy nuclei with deep learning

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Using deep neural network, the nature of the QCD transition can be identified from only the final-state pion spectra from hybrid model simulations of heavy-ion collisions. Within this hybrid model, a viscous hydrodynamic model is coupled to a hadronic cascade "after-burner". Two different types of equations of state (EoS) of the medium are used in the hydrodynamic evolution. The resulting spectra are used as the input data to train the neural network to distinguish EoS. Different scenarios for the input data are studied and compared in a systematic way. A clear hierarchy is observed in the prediction accuracy when using the event-by-event, cascade-coarse-grained and event-fine-averaged spectra as input for the network, which are about 80\%, 90\% and 99\%, respectively. Thus the high-level correlations of pion spectra learned by a carefully-trained neural network can serve as an effective "EoS-meter" to distinguish the nature of the QCD transition even in a simulation scenario which is close to the experiments.

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