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Identifying QCD transition in a hybrid model with deep learning

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A deep convolutional neural network (CNN) is constructed and trained in supervision to identify the QCD transition from the averaged final-state pion spectra ρ(pT,φ) in simulations of heavy-ion collisions with a hybrid model (iEBE-VISHNU), which couples (2+1)-D relativistic viscous hydrodynamics to a hadronic cascade "afterburner" (UrQMD). Hidden correlations in ρ(pT,φ) are captured by the neural network, which serves as an effective "EoS-meter" in distinguishing the nature of the QCD transition. The EoS-meter is robust against many simulation inputs, such as the collision energy, fluctuating initial conditions, equilibration time, shear viscosity and switching criterion. Thus the EoS-meter provides a powerful tool as the direct connection of heavy-ion collision observables with the bulk properties of QCD.

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