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Fast complex dynamics emulators using deep generative models

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Cosmological simulations of galaxy formation are inexorably limited by the availability of finite computational resources. Drawing from recent advances in deep generative modelling techniques, we present two physical engines, motivated by our understanding of physics and knowledge of fundamental symmetries, to emulate the complex dynamics and currently unresolved physics involved in galaxy formation. First, we design a (Wasserstein) generative adversarial network for mapping approximate dark matter simulations to 3D halo fields, thereby obviating the need for full N-body simulations and halo finding algorithms (arXiv:1903.10524). We subsequently extend our existing framework to emulate high-resolution cosmological simulations from low-resolution ones (arXiv:2001.05519) . These halo painting and super-resolution emulators pave the way to detailed and high-resolution analyses of next-generation galaxy surveys via Bayesian forward modelling techniques.

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