Contribution ID: **4** Type: **not specified**

Diffusion Models as Stochastic Quantization in Lattice Field Theory

Thursday, 30 May 2024 10:15 (45 minutes)

In this work, we establish a direct connection between generative diffusion models (DMs) and stochastic quantization (SQ). The DM is realized by approximating the reversal of a stochastic process dictated by the Langevin equation, generating samples from a prior distribution to effectively mimic the target distribution. Using numerical simulations, we demonstrate that the DM can serve as a global sampler for generating quantum lattice field configurations in two-dimensional phi4 theory. We demonstrate that DMs can notably reduce autocorrelation times in the Markov chain, especially in the critical region where standard Markov Chain Monte-Carlo (MCMC) algorithms experience critical slowing down. The findings can potentially inspire further advancements in lattice field theory simulations,

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Session Classification: Talks