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Instantons from Lattice QCD using Gradient Flow in Pion Form Factors

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The instanton liquid model is believed to capture the main features of vacuum QCD dynamics. Recently, multiple predictions for hadron structure functions have been derived and compared with experimental measurements and lattice QCD calculations, showing general agreement. In order to explore the precision of the instanton liquid model, one has to compare its predictions with non-perturbative simulations in a regime dominated by instanton dynamics.

This has been performed for two gluon-sensitive observables: the gluon Green's function and the strong running coupling constant [1]. In this contribution, we propose to study a fermionic observable, the pion vector form factor, for which instanton liquid model predictions have been discussed in [1]. We use the Wilson flow to single out the dominant instanton contribution from lattice QCD gauge-field configurations. We describe the details of our numerical setup and present first preliminary results.

Interestingly, we find that at positive Wilson flow time the statistical signal for hadronic matrix elements, particularly at higher momentum transfer, is significantly improved. This suggests that Wilson flow may provide a useful way to access fermionic observables in a regime where instanton-dominated dynamics can be more clearly isolated.

Reference

[1] Wei-Yang Liu, Edward Shuryak, and Ismail Zahed, Phys. Rev. D 109, 074029 (2024). doi:10.1103/PhysRevD.109.074029

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