Quantum error mitigation by hierarchy-informed sampling: chiral dynamics in the Schwinger model

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The phase diagram of QCD at finite densities remains numerically inaccessible by classical computations. Quantum computers, with their potential for exponential speedup, could overcome this challenge. However, their current physical implementations are affected by quantum noise. In this contribution, I will introduce a novel quantum error mitigation technique based on an extended qubits BBGKY-like hierarchy. This mitigation scheme is applicable to any spin-chain quantum simulation, that is, whose Hamiltonian can be time-dependent and can encode arbitrary interactions among spins. The core idea of our method is to draw connected BBGKY equations from the hierarchy and use them to constrain a random sampling of possible mitigations. Our results indicate that the mitigation scheme, applied to simulations of the chiral magnetic effect (CME) in the (1+1)-Schwinger model, systematically (fig. 1) and progressively (fig. 2) improves the quality of the noisy measurements, as a larger selected portion of the BBGKY hierarchy constraints the mitigation.

Figures

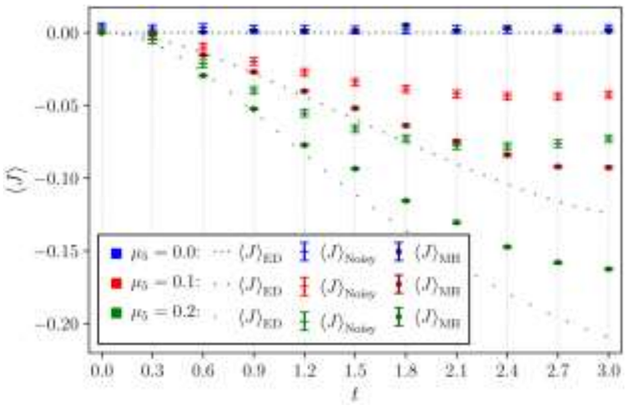

Figure 1: Systematic improvement of CME simulations performed in different Schwinger model chiral imbalance regimes.

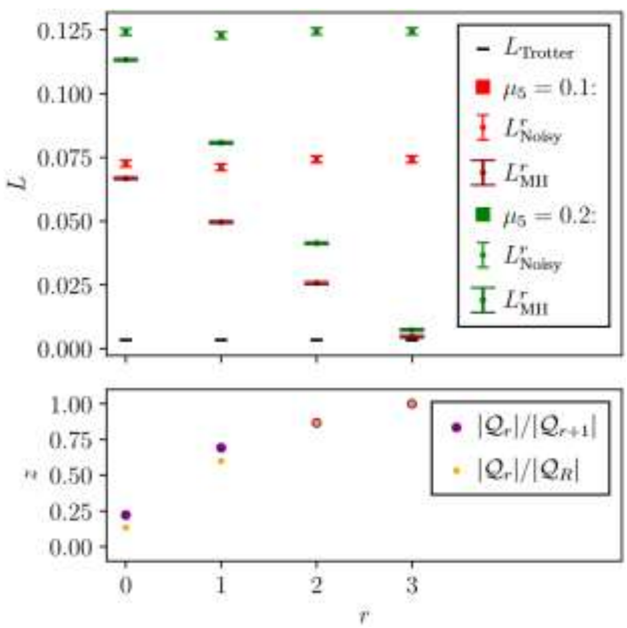

Figure 2: Progressive improvement of the mitigation capability. The error L decreases as the amount z of constraining BBGKY equations is increased.