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A Calculation of Higher Order Taylor Expansion Coefficients

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The long term goal of our current project is to provide a high-order Taylor expansion of the grand canonical partition function of QCD, at non vanishing chemical potential.
For our study we use (2+1)-flavor of highly improved staggered quarks
(HISQ) with physical light and strange quark masses.
In order to achieve that goal, we are further advancing the numerical
tools that allow for the calculation of up to tenth-order Taylor-expansion coefficients: in particular, we are improving the current measurement and sampling strategies.
Concerning the measurement, we are developing a way to apply deflation as variance reduction tool to the operators that appear in the coefficients of the expansion of the pressure. In particular, we are focusing on the quark number density operator (D_1), that is the main building block in the calculation of the expansion coefficients in the linear-μ framework. The spectrum of this operator is complex so, in order to evaluate a sufficient number of eigenvalues and eigenvectors to apply the deflation method, we are currently implementing an eigensolver algorithm for non-hermitian operators. Through this algorithm we want to calculate the smallest eigenvalues of D_1^{-1}, that correspond to the largest of D_1. Increasing the order of the coefficients, the smallest eigenvalues of D_1 will become more and more negligible, so once we have a sufficient number of large eigenvalues of the quark number density we will able to estimate coefficients to arbitrary order, at least in principle.
We also discuss the calculation of unbiased estimators for higher
moments of the trace of the quark-density operator.

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