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A Method to Calculate Conserved Currents and Fermionic Force for the Lanczos Approximation to the Overlap Dirac Operator

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The overlap Dirac operator at finite chemical potential can be efficiently computed with the two-sided Lanczos algorithm. Compared with other methods the Lanczos algorithm has the advantage that it takes into account information about the source vector when constructing an approximation to the overlap operator.
In order to study transport coefficients in terms of correlators of conserved currents or to calculate the fermionic force in Hybrid Monte-Carlo simulations with the Lanczos approximation to overlap, one needs to calculate the derivative of this approximate overlap operator over the gauge field. We found that a straightforward algorithmic differentiation approach leads to huge numerical errors and is not feasible even for small lattice sizes.
In this talk we argue that it is possible to simultaneously compute the action of the overlap operator and its derivative on a source vector. Using a matrix function identity, found by R. Mathias, we show that the calculation can be done without knowledge of the derivative of the Lanczos algorithm. To this end one has to apply the Lanczos algorithm to a block Toeplitz matrix of some special form, which acts on the linear space with two times larger dimension than the dimension of the original overlap operator. We present preliminary results and show that our method is numerically stable.

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