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Contour optimisation for the sign problem with an efficient evaluation of the Jacobian

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In previous work, with Francis Bursa, we considered the approach of addressing the sign problem using simple contour deformations. As a toy model for examining the approach we used the one-dimensional Bose gas with chemical potential. The contour deformations that were considered are local and they lead to simple forms of the Jacobian that can be simulated fast.

However, the periodic boundary conditions complicated the form of the Jacobian and lead either to an increase of the complexity of the simulation time or to a reduction of the effectiveness of the approach. Naturally, this problem is especially significant for $d > 1$, in which case it was effectively impossible to go beyond some given value of the chemical potential using a fast algorithm.

Now, a modification of the previous approach is presented that does not suffer from this problem, while retaining efficient complexity of the algorithm. While for small values of the chemical potential the new approach can be somewhat less effective than the previous ones, it remains effective in reducing the sign problem also for larger values of the chemical potential. We consider ansätze within the new approach and examine its effectiveness in reducing the sign problem.

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