Environment expansion for tensor networks

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I will present a general framework for incorporating degrees of freedom into a tensor network (i.e. bond expansion), with applications for DMRG, TDVP, and other algorithms. Our approach makes use of reduced rank singular value decompositions, such that all operations required for the bond expansion have computational complexity that is at most quadratic in the bond dimension D and linear in the local Hilbert space dimension d, so much cheaper than other components of DMRG that scale as D^3. *Post-expansion* is a successor to the single-site subspace-expansion (3S) algorithm[1] for models with long-range interactions, with better convergence properties and easier control. These algorithms perform better than 2-site or 3S DMRG in all known cases, and are especially useful for models where the local Hilbert space dimension is large, such as bosonic degrees of freedom.

[1] C. Hubig, I.P. McCulloch, U. Schollwöck and F.A. Wolf, Phys. Rev. B **91**, 155115 (2015)
[2] Ian P McCulloch and Jesse J Osborne, arXiv:2403.00562