Dissipative State Preparation and the Dissipative Quantum Eigensolver

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For any local Hamiltonian H, I construct a local CPT map and stopping condition which converges to the ground state subspace of H. Like any ground state preparation algorithm, this algorithm necessarily has exponential run-time in general (otherwise BQP=QMA), even for gapped, frustration-free Hamiltonians (otherwise BQP is in NP). However, this dissipative quantum eigensolver has a number of interesting characteristics, which give advantages over previous ground state preparation algorithms.
- The entire algorithm consists simply of iterating the same set of local measurements repeatedly.
- The expected overlap with the ground state subspace increases monotonically with the length of time this process is allowed to run.
- It converges to the ground state subspace unconditionally, without any assumptions on or prior information about the Hamiltonian.
- The algorithm does not require any variational optimisation over parameters.
- It is often able to find the ground state in low circuit depth in practice.
- It has a simple implementation on certain types of quantum hardware, in particular photonic quantum computers.
- The process is immune to errors in the initial state.
- It is inherently error- and noise-resilient, i.e. to errors during execution of the algorithm and also to faulty implementation of the algorithm itself, without incurring any computational overhead: the overlap of the output with the ground state subspace degrades smoothly with the error rate, independent of the algorithm's run-time.
I give rigorous proofs of the above claims, and benchmark the algorithm on some concrete examples numerically.