Quantum Information and Computing

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Optimal control transport of trapped ions

Transport of trapped ions is a key tool in trapped ion experiments. The task of moving one ion from A to B in the trap can be split into a series of interconnected optimization problems.

Reference: *Optimal control transport of neutral atoms in optical tweezers at finite temperature*, https://doi.org/10.1103/PhysRevResearch.6.033282

1. Reproduce the optimal control transport task discussed in the paper for the case of trapped ions. Formulate the problem as the 1D transport of one particle in a harmonic potential (rather than gaussian) and find a trajectory with minimal excitation using realistic trap parameters. You can use the python package referenced in the paper https://pypi.org/project/quocs-lib/
   Bonus: transport two ions, use two control parameters (position and trap frequency), and minimize the excitation of both the COM and STR mode.
2. Implement the transport in a realistic ion trap. Build an electrostatic model for a surface electrode trap, and find the voltage waveforms that reproduce the optimal control trajectory. I suggest using the python package *pytrans* https://pypi.org/project/pytrans/ (and related examples)

By the due date please submit the presentation and the code. The final presentation will be 20 minutes long and you have to present the problem, methods and results. A final question on the program of the Quantum Information and Computing course will conclude the exam.

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