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Study of Numerical Methods for the Time-Dependent Gross-Pitaevskii Equation

Numerical methods for the solution of the one-dimensional time dependent Gross-Pitaevskii equation are investigated in the presence of a harmonic trapping potential. The respective schemes are compared by computing their efficiency and their accuracy. The methods under study include the Split-Operator methods (Kinetic and Potential split, Harmonic oscillator split) with three and seven exponentials, the Crank-Nicolson method and the Spectral Method. Optical lattices are later introduced by turning on a periodic potential, and the projection on the initial (stationary) state is computed to determine how well the different methods conserve the initial state. Finally, based on the accuracy and the computational efficiency, conclusions are derived on the suitability of each method for a given set of parameters.

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