Preserve the Non-Stationary Long-Term Dynamics via Selected Dual Basis Sets

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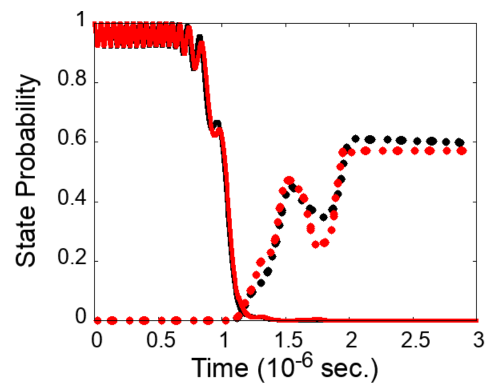
Without using complete basis set of constructing wavefunction, we combine a static and moving basis set and then the non-stationary long-term dynamics can still be preserved. Motivated by recent experiment, the quantum dynamics of coupled-qubit chains is studied [1]. The definition of the moving basis set, coupled-coherent state (CCS)[2], is redefined to avoid numerical instability, and then the corresponding equation-of-motion is derived. During the propagation, the wavefunction is projected to an optimised static basis set. Comparing with the complete basis set, above method uses one-third size in a seven-qubit system and reproduces two physical observables, state probability and domain-wall density, and detail numerical examples demonstrate the utility of this method.

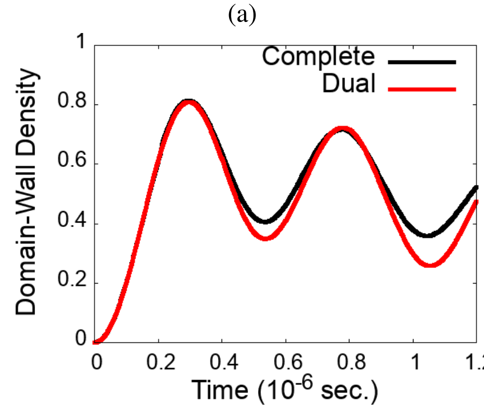
Index Terms: moving basis, quantum dynamics, coupled-qubit chain

[1] Bernien, H. et al, "Probing many-body dynamics on a 51-atom quantum simulator", Nature, 551, 579–584.

[2] Shalashilin, D. and Child, M. S., "The phase space CCS approach to quantum and semiclassical molecular dynamics for high-dimensional systems", Chem. Phys., 304, 103–120.



(a)



(b)

Figure 1: Comparing the result of complete basis set (128 basis) in black line and dual bases (34 basis) in red line with both (a) state probability and (b) domain-wall density. In (a), solid line is the ground state ($|0000000\rangle$) probability, and dot line is the probability of the target ordered state ($|1010101\rangle$).