Problem Sheet 10

Open Quantum Systems WS18-19

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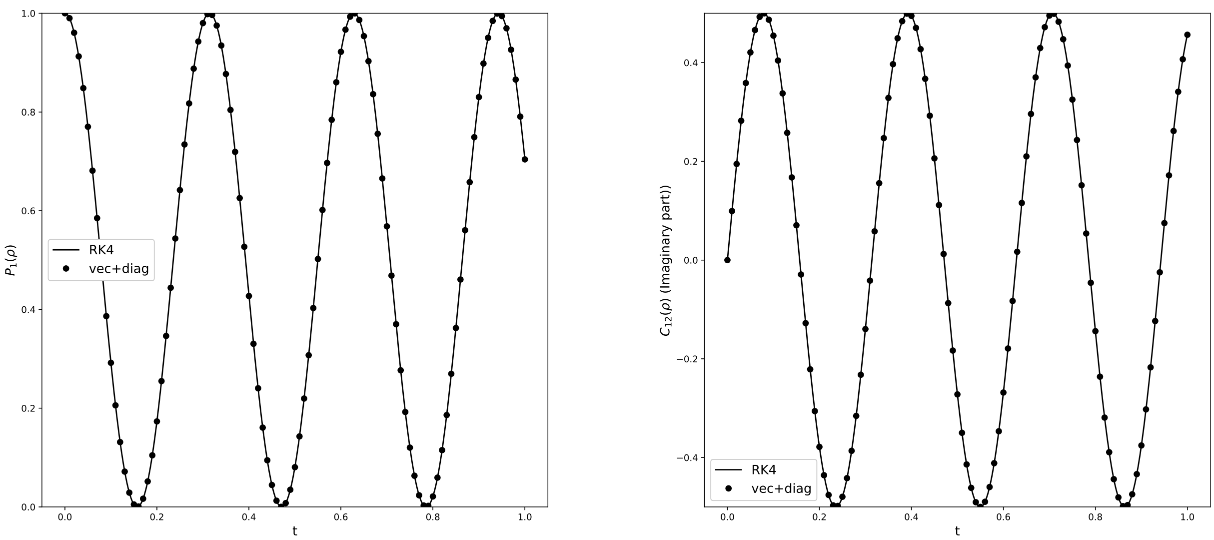
Code available here: https://github.com/iyanmv/OQS_ws18-19.

Exercise 22

For this exercise I tried both Runge-Kutta and vectorialization methods. Code can be checked and executed in the mentioned repo as well as in a printed at the end. Here I only present a summary of the plots and results.

A Runge-Kutta written by me was used for the first method and `linalg.eig` function from NumPy was used for the other one.

a) Population for the first site, $P_1(t)$, and inter-site coherence, $C_{12}(t)$ were computed for the case with $J = 10$ and $\gamma = 0$ (without disipator term) from $t = 0$ to $t = 1$. See Figure 1.

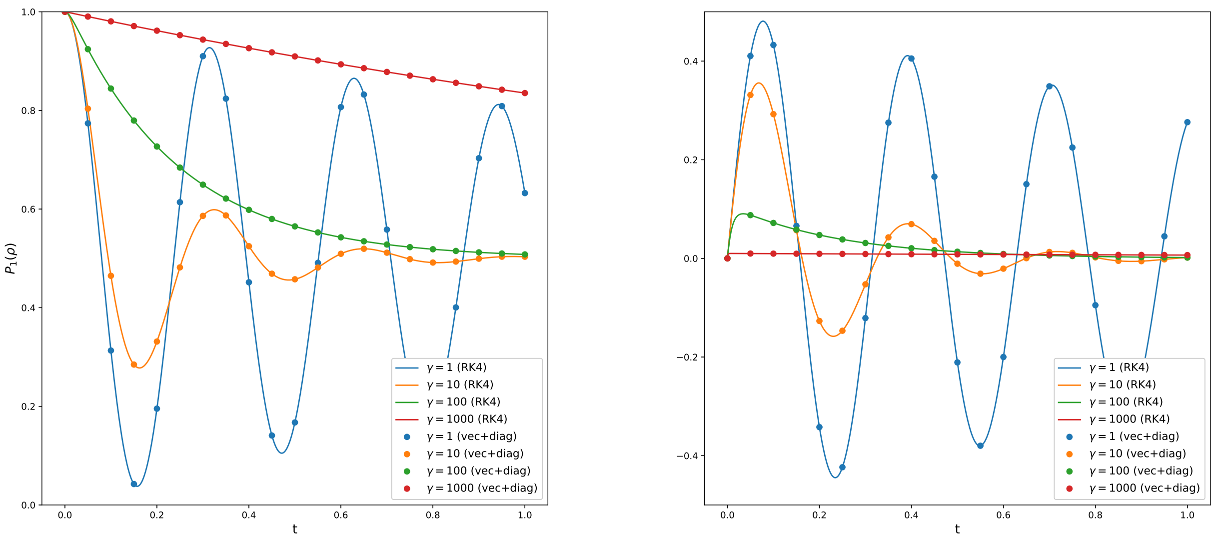


(a) (b)

Figure 1: Population and inter-site coherence obtained from $t = 0$ to $t = 1$ with both methods.

b) With the same $J = 10$, population and inter-site coherence were now computed with the noise term for different values of γ. See Figure 2.

Simplification) Same quantities were computed again with the simplified Hamiltonian and Markovian noise, exploiting the fact that the number of excitations within the system do not change. Same results were obtained and in the notebook are also shown.



(a) **(b)**

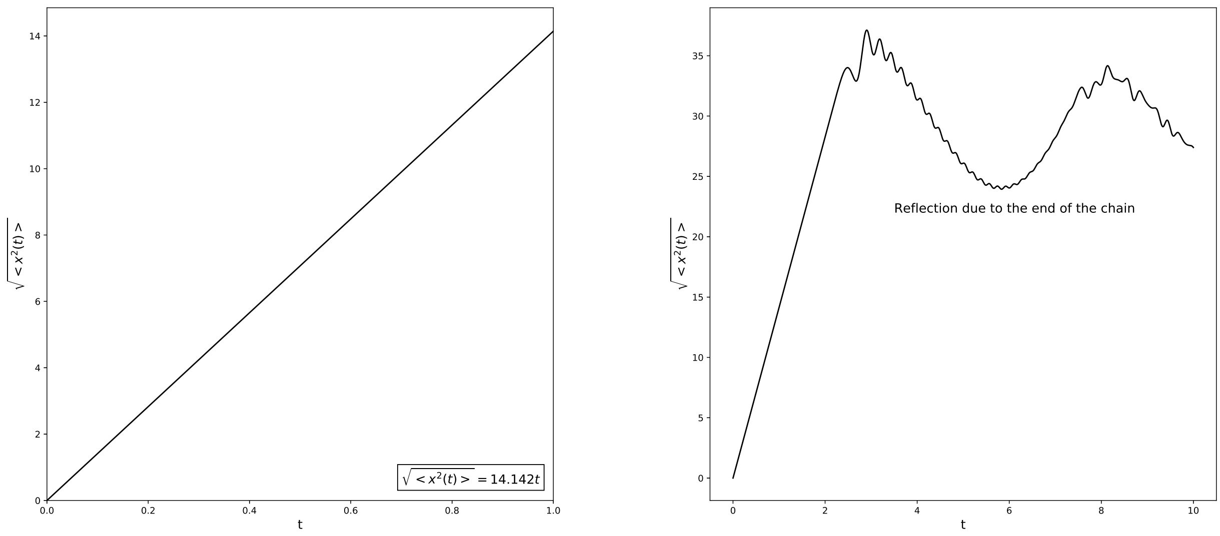
Figure 2: Population and inter-site coherence obtained from $t = 0$ to $t = 1$ with both methods for $\gamma = \{1, 10, 100, 100\}$.

Exercise 23

The simplified Hamiltonian and Markovian noise expressions were used for this exercise but now considering 101 sites instead of just two.

a) Mean square displacement from the initial site was computed from $t = 0$ to $t = 1$. A linear relation with time was found, and a simple linear regression was done to compute the slope. See Figure 3.

b) Mean square displacement is now computed with the Markovian noise term for $\gamma = \{1, 10, 100, 1000\}$. The classical behaviour starts to appear for larger values of γ. See Figure 4.



(a) **(b)**

Figure 3: Mean square displacement from the initial site with $J = 10$ and $\gamma = 0$. In 3a linearity of this quantity with respect time is shown from $t = 0$ to $t = 1$. In 3b, reflection at the boundaries of the chain is shown for larger times.

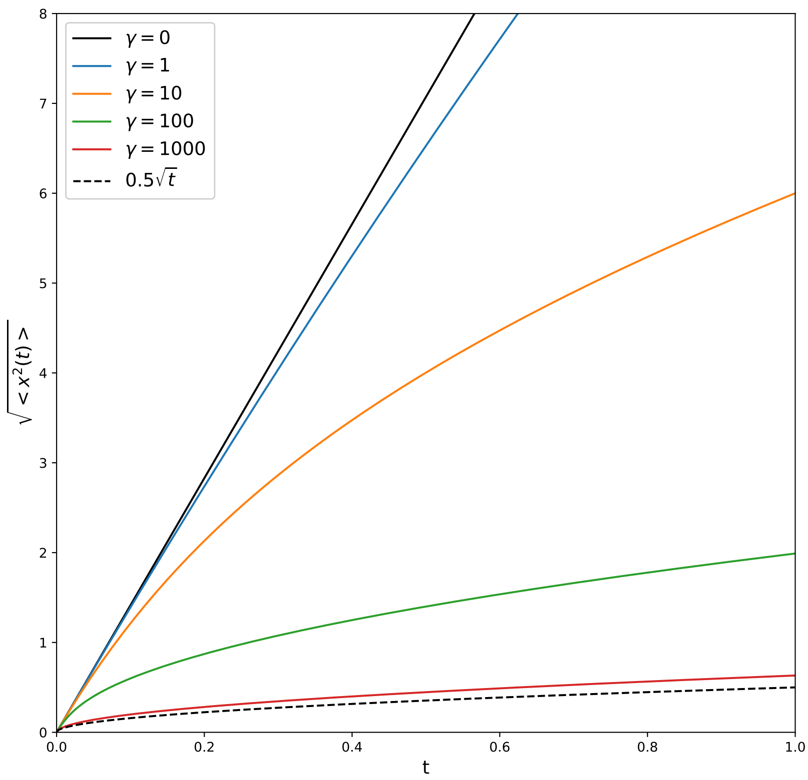


Figure 4: Mean square displacement from the initial site from $t = 0$ and $t = 1$ for different values of γ. In solid black, 3 is plotted again. In dash black, a curve proportional to $\sqrt{t}$ to serve as a reference of the classical behaviour for the simulations.