Mémoire

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Master Thesis: Erratum

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Chapter 1

Open quantum systems

In the first paragraph of the chapter, the book *Quantum Optics* corresponding to the 36^{th} source is not correctly referenced and the sentence should read " Scully and Zubairy's book *Quantum Optics*[36]".

1.1 Density operator formalism

1.1.1 Why ket vectors formalism is insufficient

On page 8, the argument of the relative phase factor is about α (and not α^*) and β. The same error occurs on page 9 where the argument refers to β and not β^*. Furthermore, the word "phase" was forgotten in the expression "relative phase factor" (which in the text is simply "relative factor" and thus does not make much sense).

1.2 Dynamics of Markovian open quantum systems and steady state definition

1.2.1 The Markovian approximation and the GKSL master equation

On page 17, in the "Gorini-Kossakowski-Sudarshan-Lindblad master equation" box. The convention used for the dissipator is a bit inconsistent throughout the thesis. Here we used the convention

$$\mathcal{D}(\cdot) = \sum_{j=1}^{N_S^2-1} \gamma_j \left(L_j \cdot L_j^\dagger - \frac{1}{2}\left\{ L_j^\dagger L_j, \rho \right\} \right),$$

while in some other places in this master's thesis, we used the convention

$$\mathcal{D}(\cdot) = \sum_{j=1}^{N_S^2-1} \gamma_j \left(2L_j \cdot L_j^\dagger - \left\{ L_j^\dagger L_j, \rho \right\} \right).$$

We advise the reader to be careful that in the text, for Markovian systems, the first convention is used, while for non-Markovian systems, the latter convention is used.

1.3 Finding the steady state of a simple open quantum system

The equations (1.60a) and (1.60b) are plotted in Fig. 1.4 and not Fig. 1.3. The latter corresponds to the equations (1.59a) and (1.59b). Furthermore, on the corresponding plots, the values of h_0 and γ are never equal to 0, as this would not make much sense physically. The closer they go to 0 is actually 0.01.

1.4 Dynamics of non-Markovian open quantum systems

1.4.1 Markovian embedding

There should not be a pre-factor of $1/\pi$ in equation (1.68).

1.4.2 The HEOM method

We should add that the pseudo-modes development made in the previous subsection is also valid for this subsection.

There is a typing mistake for the expression (1.79d), it should be

$$C \equiv \mathbb{1} \otimes L^* - L^\dagger \otimes \mathbb{1},$$

and not

$$C \equiv \mathbb{1} \otimes L - L^\dagger \otimes \mathbb{1}.$$

Chapter 2

Quantum information and computation

2.1 Quantum Fourier Transform

In the first paragraph, the sentence regarding the exponential advantage should read: "The former performs with an exponential advantage compared to the *latter*" (and not former).

2.2 Quantum Phase Estimation

2.2.1 Circuit and detailed description

On page 50, although it is not incorrect, the decomposition $|x\rangle = |x_{t-1}\rangle \otimes |x_{t-2}\rangle \otimes \cdots \otimes |x_0\rangle$ does not follow the convention introduced earlier, and the indices should be reversed in order to be consistent.

On the same page, we apply the controlled-U gates on the state (2.28) and not (2.29) as written in the text.

On page 51, although the inequality $x \leq \pi \sin(x)$ for $x \leq \pi/2$ is technically correct, the inequality used in the calculations is actually $2x \leq \pi \sin(x)$ for $x \leq \pi/2$. The same mistake occurs in the 4^{th} footnote in the "Complexity analysis" subsection of the RS algorithm section in the third chapter.

Chapter 3

Quantum computation for open quantum systems

3.1 Ramusat and Savona (RS) algorithm

3.1.1 Measurement stage

Although it does not change the calculations, we should mention that the vectorized identity matrix also introduces a normalization factor in the expression $\mathrm{Tr}[\rho_{ss} O]$.

3.2 Adapting the RS algorithm to non-Markovian systems using the HEOM method: the RS HEOM algorithm

3.2.1 Quantum phase estimation stage

On page 76, the equation (3.43b) should read

$$c_j = \frac{1}{\sqrt{2}} \left\langle \eta_j | 1 \otimes \mathbf{0}_{N_1} \otimes \mathbf{0}_{2N_0} \right\rangle .$$

The pre-factor $1/\sqrt{2}$ is missing in the master's thesis.

3.2.2 Complexity analysis

The factor $1/\epsilon_m^2$ was forgotten in the scaling, and equation (3.53) should read

$$\#_{\text{gates}} = \mathcal{O}\left(\frac{(N+1)^k}{(t_0 g)^{1+1/p} \, \epsilon_p^{1/2+1/2p} \, \epsilon_\tau^{1/p} \, \epsilon_m^2} \right).$$

3.3 Applications of the RS HEOM algorithm

3.3.1 RS VS RS HEOM algorithm: two-mode open quantum Rabi model

On page 89, between the gray boxes, we should use the index j and not k. Since the latter refers to the continuum of modes of the bath, while the former refers to the pseudo-modes.