Referee Report

An Introduction to Markovian Open Quantum Systems

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The referees wish to congratulate the author on such a beautifully crafted and concise introduction to QOS. We appreciate the effort and vision of the author in keeping it brief and to the point. We found the manuscript almost error-free. What follows is a list of suggestions and possible corrections. The author is encouraged to consider them, while feeling free to follow them or not.

Comments

- p.2 top line, perhaps one could mention other applications such as quantum thermodynamics
- p.2 second paragraph, while citing [2,7,13-15] perhaps one can cite [28] too.
- **Sentence:** "A density matrix describes our incomplete knowledge of a quantum state." (Sec. 2, p. 3)

  Comment: Perhaps not true entirely, since a density matrix can also be associated to a pure state.
- p.4 Consider citing the work on entanglement negativity by Plenio [Phys. Rev. Lett. 95, 090503 (2005)] along with that on negativity [17].
- **Sentence:** "An extreme example is $\rho \propto 1$, for which $\rho_A \propto 1_A$ and S is maximum even though A and B are not entangled" (Sec. 2, p. 4)
  Comment: Maybe a couple more lines explaining this would be useful.
- p.5 Different symbols are used for the identity in this and other pages, including I and $\hat{1}$. It is unclear to the reader whether the choice carries any connotation. If not, it may help to use a single symbol throughout the text.
- p.5 The choice of notation for the matrix elements of rho, $\rho_{(i,j),(i',j')}$ is somewhat cumbersome, though clear.
- **Sentence:** "This is achieved by setting all but one Kraus operators proportional to $\sqrt{dt}$." (Sec. 3, p. 6)
  Comment: It would be useful to write a sentence about why any other choice of Kraus operators (in terms of proportionality to $\sqrt{dt}$) gives an equivalent / incompatible description. This could even be a simple exercise for the reader.
- p.7, in-text eq above (14) replace 1 by $\hat{1}$ or I in the definition of $\hat{K}_0$.
- **Sentence:** "$\hat{H}$ is an arbitrary Hermitian operator." (Sec. 3, p. 7)
  Comment: It is not clear why $\hat{H}$ has to be Hermitian.
- p.8, after (16), how a bout a citation when introducing the Kossakowski matrix?
- **Sentence:** Eqns. 23, 24 (Sec. 3, p. 9)
  Comment: Useful to explicitly remind the reader that $\langle \hat{O} \rangle = \mathrm{Tr}(\rho \hat{O})$.

- p.9 Does (15) motivate the introduction of the adjoint of the dissipator?
- **Sentence:** Eqn. 26 (Sec. 3, p. 9)
  Comment: Please mention the meaning of the term $\langle \sigma_{x,y,z} \rangle$ that occurs in the density matrix.
- p.10 Q6 calls to mind a theorem by Lidar Shabani and Alicki on the conditions for purity decreasing dynamics, for which the map being unital is a sufficient condition

  https://doi.org/10.1016/j.chemphys.2005.06.038
- p.10, is there a typo in (32)? Using (31) it appears that the first H in the RHS of (32) should be $I \otimes H_{\text{eff}}^T$ instead of $I \otimes H_{\text{eff}}^*$ Note also that the definition of H_{eff} only appears after (33), and could have provided earlier on to ease readability.
- p.11 In 3.3.7, we believe the author is trying to simplify the flow of the exposition in an accessible way. Perhaps the first sentence is not that accurate, as in general the diagonalization of the Liouvillian brings a Jordan block form. We have in mind the exposition at the level of the review by Advances in Physics 69, 3 (2020)
- **Sentence:** "but $(L\hat{\rho})^\dagger \neq \hat{\rho}L^\dagger$ or $\hat{\rho}^\dagger L^\dagger$." (Sec. 3, p. 11)
  Comment: Useful to specify that this is because L is a superoperator and not an operator.
- p.13 Fluctuating Hamiltonians have a long history. One could cite, e.g., the book by van Kampen at the beginning of Sec 4.1
- p. 15, Eq. (53). It may be worth emphasizing whether this equation is exact or involves a perturbative expansion in the coupling. Compare this with the perturbative equation in Budini PHYSICAL REVIEW A, VOLUME 64, 052110 (2001)
- **Sentence:** "This is called a stochastic Schrödinger equation (SSE), and the resulting pure-state trajectories are called Monte-Carlo wave functions [47]." (Sec. 4, p. 19)
  Comment: The classic review by Zoller may be mentioned here: `https://arxiv.org/pdf/quant-ph/9702030`.
- **Sentence:** Eqn. 90. (Sec. 4, p. 13)
  Comment: Should be $\tilde{H}_{SR}$.
- p.28, well, a colon after $\langle \chi | \chi \rangle$?
- **Sentence:** "odd single-particle eigenfunctions". (Sec. 5.4, p. 35)
  Comment: Please specify what is meant by odd or even in this context.
- p.46, perhaps the citations in Sec 7 are somewhat idiosyncratic, but that is hard to avoid given the terseness of the closing paragraph.