

Phys 637, I-Semester 2022/23, Tutorial 6 14.10.2022

We suggest to do “Stages” in the order below, feel free to change that as per your interests. Discuss first on your table within your team, then with neighboring tables.

Stage 1 (*Born-Markov Masterequation*)

- (i) What do we try to achieve when deriving a Masterequation? How does it help?
- (ii) Discuss in your own words what is the content of the Born and Markov approximations. Explain this once in terms of physics and then what is the consequence in terms of mathematics.
- (iii) Through which quantity does the environment enter the effective system evolution in the master-equation? Which information from the environment enters this quantity?

Stage 2 (*Lindblad Master equation*)

- (i) What is good about a Lindblad masterequation and not so good about its precursor, the Born-Markov masterequation?
- (ii) What is meant by a CPTP map?
- (iii) Describe the ingredients of a Lindblad equation and methods for its solution.

Stage 3 (*Dephasing*) Take a good look at example 27 (Lindblad equation for dephasing) of the lecture.

- (i) Make yourself comfortable with the solution (4.29) and how it was obtained.
- (ii) Find the initial state, some state in between and final state ($t \rightarrow \infty$) of the density matrix. Discuss the physical meaning of each of them.
- (iii) You can interpret the dynamics as the most basic form of decoherence of a q-bit for a quantum computer. If you just build a quantum computer, and want to test how good it is, how could you try to “measure” what we have just derived?

Stage 4 (*Revision and question generation*) The end of week6 marks an important central point of the lecture, where we have already covered the most essential results and the remainder could be called advanced (but nonetheless important) topics. For that reason let’s take a break to do the following

- (i) Make a list of what you consider the most important results or points raised in the lecture so far (about six to eight).
- (ii) Make a list of topics that you think you more or less understood (A), and a list of topics where you are rather confused (B) (on the whiteboard).

- (iii) Then walk around to take a look at other team's whiteboards. Exchange explanations wherever your (A) list contains an item on someone else's (B) list. At the end of the tutorial, click a picture of all the lists and send those to me later.

Stage 5 (*Derivation review*) If you have reached here before the end of the tutorial, please use the remaining time to review week6 derivations, make sure everyone in your team is on the same page.