ChatGPT Summary Overview

Prompt: “Can you write me a summary as a numbered list of questions with the different topics for the following short exam protocols in Quantum Optics:”

Here is a summary of the different topics and questions asked in the short exam protocols in Quantum Optics:

1. Jaynes-Cummings model:

- Deriving the JC Hamiltonian from the minimal coupling Hamiltonian.

- Questions about the LWA and the eigenstates of JC.

- Differences between JC and Tavis-Cummings models.

- How to differentiate whether there is one or many atoms in the cavity by analyzing the leakage.

- How an atom in the dark superposition state can decay and how this depends on the distance between the atoms.

2. Ion trapping:

- Why the dipole approximation is still valid and what are the relevant physical quantities.

3. Rabi oscillations and collapse and revival:

- What happens if we increase the photons in the cavity and how it affects the revival and collapse time.

- Why we have antibunching in dressed states and why we don't have it when we only have a cavity (without emitter).

4. Spontaneous Emission:

- Questions about the Markov Born Reservoir approximation in both Wigner Weisskopf and density matrices cases.

- OBEs in steady state and why you don't see Rabi oscillations there.

- Rabi oscillations in G2.

5. Coupling laser to center of mass motion:

- Different ways to couple a laser to the center of mass motion and collective motion of matter.

- Deriving the JC Hamiltonian from the minimal coupling Hamiltonian and explaining all assumptions & approximations.

- Can you couple to the center of mass motion of an atom or what other term you need.

6. Photon-photon interactions:

- Under which conditions we can have Rabi oscillations between ground state and |-, 1> state of JC model driving a cavity in the photon blockade regime.

7. Master equation and HBT experiment:

- Writing a master equation for a system involving a cavity that can lose photons through a 2-photon process to a reservoir.

- What would be the output in an HBT setup.

- What would be the effect of Gamma1 in the HBT experiment.

8. HOM interference:

- Can we have HOM interference between the photons emitted by two such cavities?

- Questions about the hom interferometer and the shape of photon pulses.

Prompt: “Could you rewrite this as a non-personal list of numbered questions? These are messages from students who all took an oral exam in quantum optics in their masters programme:”

Sure, here is a non-personal list of numbered questions based on the messages from the students who took an oral exam in quantum optics in their masters programme:

1. Did the examiner allow the students to choose a topic?

2. What were the questions asked about the Jaynes-Cummings Hamiltonian from the minimal coupling Hamiltonian?

3. What is the LWA?

4. What did the examiner ask about the eigenstates of JC?

5. What is the Purcell regime?

6. What are the relevant parameters of the Purcell regime?

7. How does the spectrum of JC change in the Purcell regime?

8. How does the Purcell regime affect the correlation function?

9. Why is the dipole approximation still valid in ion trapping and what are the relevant physical quantities?

10. What did the examiner ask about Rabi oscillations and collapse and revival?

11. What is important to know about each regime in quantum optics?

12. Does the examiner give hints when students are stuck?

13. What did the examiner ask about Tavis-Cummings, and what are the differences between JC and TC?

14. How can we differentiate whether there is one or many atoms in the cavity by analyzing the leakage?

15. What did the examiner ask about two atoms in the dark superpos state and how does this depend on the distance between the atoms?

16. What did the examiner ask about dressed states, why we have antibunching and why we don't have it when we only have a cavity (without emitter)?

17. What did the examiner ask about Spontaneous Emission and density matrices, and what is the approximation in both cases?

18. What did the examiner ask about OBEs in steady state and why you don't see Rabi oscillations there?

19. What did the examiner ask about different ways to couple a laser to the center of mass motion and collective motion of matter?

20. How can the JC Hamiltonian be derived from the minimal coupling Hamiltonian and what are the assumptions and approximations?

21. Can the JC Hamiltonian be used to couple to the center of mass motion of an atom or what other term is needed?

22. What did the examiner ask about cavity optomechanics and if the mirror should be heavy or not have a large coupling rate?

23. What is the exercise the examiner gave the students?

24. What did the examiner ask about the terms in the master equation and how this affects the results in the HBT experiment?

25. What is the effect of Gamma1 in the HBT experiment?

26. Under which conditions can we have Rabi oscillations between ground state and |-, 1> state of JC model driving a cavity in the photon blockade regime?

27. What did the examiner ask about hom interferometer and everything about it?

28. What did the students talk about regarding bell basis and the shape of photon pulses?

Prompt: “Could you rewrite this as a non-personal list of numbered questions? If it is about the examiner otr the mode of conduct of the exam, summarize it at the end of your answer and leave it out of the rewritten questions. These are messages from students who all took an oral exam in quantum optics in their masters programme:”

Here is a non-personal list of the questions/topics the students were asked during their oral exam in quantum optics:

1. How do we arrive at the Jaynes-Cummings Hamiltonian from the minimal coupling Hamiltonian?

2. What are the assumptions of the Jaynes-Cummings model and why is it important?

3. What are the eigenstates of the Jaynes-Cummings model?

4. What is the Purcell regime, what are the relevant parameters, and how does it affect the correlation function and the spectrum of the Jaynes-Cummings model?

5. Why is the dipole approximation still valid in ion trapping and what are the relevant physical quantities?

6. What are Rabi oscillations and collapse and revival?

7. How does increasing the number of photons in the cavity affect the collapse and revival time?

8. What are Tavis-Cummings and how are they different from Jaynes-Cummings models?

9. How can we differentiate whether there is one or many atoms in the cavity by analyzing the leakage?

10. What is the large cooperativity and why is it important in the Purcell regime?

11. How do two atoms in the dark superposition state decay and how does it depend on the distance between the atoms?

12. What are dressed states and why do we have antibunching with them?

13. Why don’t we have antibunching when we only have a cavity (without emitter)?

14. What are different ways to couple a laser to the center of mass motion and collective motion of matter?

15. How can we derive the Jaynes-Cummings Hamiltonian from the minimal coupling Hamiltonian and explain all assumptions and approximations?

16. What is the effect of Gamma1 in the HBT experiment and how does it affect the results?

17. Under which conditions can we have Rabi oscillations between the ground state and |-, 1> state of JC model driving a cavity in the photon blockade regime?

18. Write a master equation for a system with a cavity that can lose photons through a two-photon process to a reservoir.

19. What would be the output in a Hanbury-Brown and Twiss setup for this system?

20. Can we have Hong-Ou-Mandel interference between the photons emitted by two such cavities?

It is important to note that the examiner did not provide many hints when students got stuck and that it is crucial to know the assumptions and approximations of each regime.