

Exam “Foundations of Quantum Mechanics”
29 January 2013, 09.00-12.00 AM.

Please write your name and registration number on every sheet!

1. Classical mechanics and quantum mechanics represent the states of physical systems, and physical quantities, in different ways. Explain these differences, paying attention to the mathematical structure of the respective state spaces. Why does the non-classical structure of the quantum mechanical state space and the way quantum mechanical quantities are represented in it give rise to interpretation problems?
 2. Suppose that an object system C (a cat) enters into an interaction with a radioactive atom that activates a deadly device if it decays.
 - a. Describe this process with the Schrödinger equation.
 - b. Explain why and how the final state of this interaction gives rise to an interpretational problem.
 - c. In what way is this problem solved by the standard postulates of quantum mechanics?
 - d. Discuss the pros and cons of this “standard solution”.
 3. In the 1950’s Bohm proposed a hidden variable theory.
 - a. Discuss the general ideas of this hidden variable theory. What are the hidden variables?
 - b. A hidden variable theory should reproduce the predictions made by standard quantum mechanics. Does Bohm’s theory comply with this requirement? Discuss an example.
 4. Einstein’s hopes for a local hidden variables theory have foundered on no-go theorems.
 - a. Describe Einstein’s (EPR) argument for the existence of hidden variables and explain the role played by locality in this argument.
 - a. Explain how the Kochen and Specker no-go theorem is relevant to the EPR situation. How does the Kochen and Specker result relate to locality?
 5.
 - a. Explain the difference between pure and mixed states in mathematical terms.
 - b. A given mixed state may be proper or improper; explain the difference.
 - c. Suppose we are studying a physical system experimentally and determine that it is in a mixed state W . What should we do in order to find out whether this state is proper or improper?
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