

Introduction to the Foundations of Quantum Mechanics and Applications

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- 1. Quantum formalism, examples for application of quantum formalism, assumption of completeness of the quantum formalism.
- 2. Hidden variables; limitations on maps between noncommutative and commutative structures: von Neumann's theorem, Gleason's theorem, the paradox of Kochen and Specker.
- 3. Entanglement in many-particle quantum mechanics; tensor product of Hilbert spaces, of vectors, of operators, of orthonormal bases.
- 4. Bell's inequality; the paradox of Einstein, Podolsky and Rosen (EPR); Bell's proof of quantum non-locality.
- 5. Density matrix and mixed quantum state; reduced density matrix, decoherence and the measurement problem.
- 6. Bohmian mechanics, examples; probability and the law of large numbers.
- 7. The spontaneous collapse model of Ghirardi-Rimini-Weber (GRW)
- 8. Introduction to Quantum Information.
- 9. Quantum computers.
- 10. Entanglement as a computational resource.