REVIEW

Book Review of Quantum Processes, Systems and Information by Benjamin Schumacher & Michael Westmoreland

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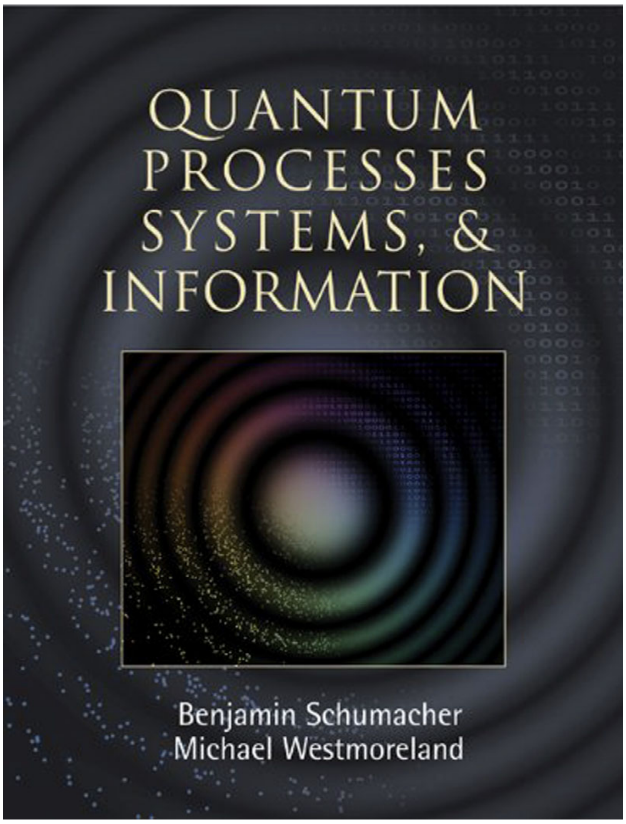

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Quantum Processes, Systems and Information is a textbook aimed at advanced undergraduate students that brings together more traditional quantum mechanics topics and quantum information theory. The book is novel both in this focus and its presentation of the material. The first five chapters discuss the basics of quantum theory using three isomorphic two-level systems: a photon in a Mach–Zehnder interferometer, a spin ½ particle and a two-level atom. These chapters also develop basic quantum information concepts such as the entropy of a message, interpreting unitary time evolution in terms of information capacity and the difference between distinct and distinguishable states in terms of the basic decoding and distinguishability theorems. The text then continues (chapters 6–9) with two-particle states, including entanglement, hidden variables, the no-cloning theorem, density operators and open systems. The transition to continuous systems, the starting point for many quantum mechanics textbooks, is made only in chapter 10, and the following chapters include standard wave mechanics found in many texts. The final three chapters revert the focus back to quantum information processing.

While mathematically rigorous (Hilbert space is introduced in chapter 3 and tensor products in chapter 6), the book has an excellent balance between the mathematical description and a careful treatment of conceptual and interpretive themes often neglected in quantum mechanics textbooks. For example, the discussion of the projection rule in chapter 4 includes its limitations when an absorbing measurement makes successive measurements impossible. Chapter 10 includes a section "how not to think about ψ" that discusses differences between the quantum wave function, a classical physical field and a classical probability distribution. The text includes occasional links to experiments, showing how the theory has been experimentally confirmed and applied.

The text is interspersed with short exercises, questions to the reader that probe basic understanding, as well as more involved end-of-chapter problems. The in-text exercises are very useful checkpoints for understanding and can motivate students to read the text more carefully. Students may however have wished for solutions to exercises and problems and worked examples in the text.

In summary, this is an excellent textbook that stands out in terms of its balanced focus on both information theory and more traditional wave mechanics, its balanced focus on mathematical rigour and conceptual and interpretive themes, the clarity of the text, organization of the material, and the numerous in-text exercises.