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Orthomodular structures as quantum logics. Transl. from the Slovak. (English)

Zbl 0743.03039

Fundamental Theories of Physics. 44. Dordrecht etc., Bratislava: Kluwer Academic Publishers, Veda. xxvi, 212 p. (1991).

The book under review is a translation from the Slovak original. It completes the literature on quantum logics and is based mainly on the original results of the authors and their collaborators in Prague and Bratislava.

The historical interlude introduces us into the beginning of quantum mechanics explicating such notions as quantum and Heisenberg's uncertainty principle. Then, proceeding from Birkhoff and von Neumann to Mackey, they show how quantum logic theory was born.

The book consists of seven chapters. In the first one, the subject of the book, quantum logic, is introduced. Since the main difference between classical mechanics and quantum mechanics is that the first one produces a Boolean σ-algebra model of events and the second one does not, in general, for measurement of quantum mechanical observables, it is important to know whether a subset of events has classical character, i.e., to find conditions when a given subset lies in a Boolean subalgebra.

The second chapter deals with states on logics. The authors presents a variant of the Loomis-Sikorski theorem. The state space of a product logic is presented, and important properties of states, e.g., Jauch-Piron states, are studied. The third part has physical character, and it deals with the superposition principle.

Observables and calculus of observables are studied in the fourth chapter. For measurement of quantum mechanical observables, a joint distribution is important. While in the classical case there are no problems, the quantum logical model provides unexpected complications. The fifth part deals with these problems. It is shown that the commutator plays a crucial role. The solution to these problems is then applied to the uncertainty principle. Besides the Gudder-type joint distribution, an Urbanik-type joint distribution for sum logic is introduced, and their mutual connection is explained for Hilbert space quantum logic.

The last part is devoted to generalization of probability theory to quantum logics. The familiar results, like convergence of observables, limit theorems, processes, random measures, are studied.

Every chapter contains a lot of exercises and explicating comments.The appendix presents more details on Hilbert space quantum logics, and the elementary proof of the Gleason theorem due to Cooke, Keane and Moran is included. Compared with the Slovak original, there is an extended list of references, and the contents of the book was slightly changed. The book ends with a subject index; an index of symbols is missing.

Reviewer: A.Dvurečenskij (Bratislava)

MSC:

03G12	Quantum logic
81P10	Logical foundations of quantum mechanics; quantum logic (quantum-theoretic aspects)
03-02	Research exposition (monographs, survey articles) pertaining to mathematical logic and foundations
81-02	Research exposition (monographs, survey articles) pertaining to quantum theory
06C15	Complemented lattices, orthocomplemented lattices and posets

Keywords:

quantum mechanics; quantum logic; states on logics; state space; measurement of quantum mechanical observables; joint distribution; uncertainty principle; generalization of probability theory to quantum logics; Gleason theorem