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BOOKS

The Foundational Aspects of Quantum Mechanics Made Accessible to Everyman (or Everyphysicist)

Conceptual Foundations of Quantum Physics: An Overview from Modern Perspectives

Dipankar Home
Plenum, New York, 1997. 386 pp. $115.00 hc ISBN 0-306-45660-5

Reviewed by James T. Cushing

Dipankar Home has for many years been actively involved in research on foundational issues in quantum mechanics. As the title of his book indicates, he has written an overview of an aspect of modern physics that until fairly recently has been too little appreciated by the physics community as a whole. Today, however, both philosophers of physics and practicing theoretical and experimental physicists are at least receptive to research on the foundational aspects of our most successful scientific theory to date: quantum mechanics.

Conceptual Foundations of Quantum Physics represents a novel attempt at introducing this growing corpus of work to a wider audience of scientists. Although the author is concerned with basic conceptual matters, he keeps the discussion anchored in quantitative physical phenomena and empirical implications. Results previously published by Home and his coworkers are heavily represented in the technical topics covered. Still, Home does discuss most of the central problems in the foundations of quantum theory.

In presenting the standard conundrums associated with the measurement problem, the classical limit of quantum mechanics, quantum nonlocality, complementarity, decoherence and causality in quantum theory, Home continually returns to a central theme: attempts to choose among various versions or interpretations of quantum mechanics (for example, the standard or Copenhagen formulation, the statistical interpretation, David Bohm's theory and spontaneous reduction models). One of the strengths of his approach is that it keeps in focus the empirical and conceptual importance of the ontology (essentially, the story or picture of the furniture of the world) that goes with the equations and calculational rules that occupy much of the time and energy of a professional physicist.

This monograph assumes that one has a solid background in the theory and mathematics of quantum mechanics. So the intended reader is really the professional physicist who is not already an expert in this field and wants an introduction both to some of the major outstanding theoretical and conceptual problems in quantum theory and to related proposed experiments. For such a person, Home provides what could be a stimulus for further reading in this important area of research.

Even though the level of presentation of the physics is at times quite detailed and technically advanced, there are also excursions into certain historical and philosophical matters. However, the latter consist mainly of brief selected quotations (from Albert Einstein, Niels Bohr, Werner Heisenberg and the like), rather than conceptual analyses such as those one would find in the professional literature of the history and philosophy of science.

Although Home does present several points of view, along with their strengths and weaknesses, overall he comes down, it seems to me, in favor of David Bohm's formulation of quantum mechanics. The basic reason is that this theory, while being empirically equivalent to the standard version, provides an objective (observer-independent) reality based on an ontology of entities and properties actually existing at all times. Related to this, in section 5.6, one finds a clear illustration of a major conceptual difference between the views of Louis de Broglie and Bohm on an important aspect of such an objective ontology underlying quantum phenomena.

Let me put my own gloss on this point: One often sees the expression "the de Broglie–Bohm theory" in the foundations literature. This is good, in that it does at least indirectly refer to the fact that as early as 1927, de Broglie, in his pilot-wave theory, did have in its essentials the theory that Bohm would (apparently independently) discover in 1952. However, this attempt to apportion priority equitably can obfuscate an important central debate: locality versus nonlocality in quantum theory.

The de Broglie–Bohm theory is inherently nonlocal (although its nonlocality produces no empirical conflict with the special theory of relativity), but de Broglie's first love, as it were, his theory of the double solution, is basically a local theory (with waves in physical three-dimensional space only, as opposed to the multidimensional configuration space of Bohm). The resurrections after 1952 of de Broglie's ideas, to which de Broglie himself contributed, were firmly rooted in this "local" approach (in spite of Bell's subsequent theorem and apparent empirical difficulties).

Hopefully, Home's book will contribute to increased interest, among scientists, in the meaning and implications of quantum theory.

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Time's Arrows and Quantum Measurement

Lawrence S. Schulman
Cambridge U.P., New York, 1997. 346 pp. $90.00 hc ($25.95 pb) ISBN 0-521-56122-1 hc (0-521-56775-0 pb)

Time's Arrows Today: Recent Physical and Philosophical Work on the Direction of Time

Edited by Steven F. Savitt
Cambridge U. P., New York, 1997. 330 pp. $24.95 pb ISBN 0-521-59945-8

The two books being reviewed here are part of a steady (or quasi-periodic) stream of books and articles having