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Book Review

Foundations of Radiation Theory and Quantum Electrodynamics

Ed. by A. O. BARUT

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[pp. i–x + 220]

Editor of this book A. O. BARUT writes in the short preface that *origins of quantum theory can be found in the study of electromagnetic radiation and of interaction of electromagnetic field with matter*. Indeed, such problems are of fundamental importance for the whole modern physics. Despite the fact that these problems are studied by many physicists, and that approaches to the radiation theory have been formulated, it cannot be said that we have understood everything.

The development of entirely new fields of the physics and measurement techniques, such as quantum optics and laser physics, allows to investigate radiation phenomena in great number of physical experiments. That is why the subject of the book should be very interesting for every physicist.

Most of the contributions have been presented at the recent symposium on the Foundations of Radiation Theory and Quantum Electrodynamics. The symposium was held at the University of Colorado in Boulder in 1978. The idea of the editor and all the authors was to publish the original material in a book form. As a result we have received a volume of a much higher value than the conference proceedings. The book includes 18 contributions by different authors, which give various approaches to the problems of radiation theory and quantum electrodynamics, present the actual knowledge in the field and provide some reviews or syntheses.

The papers can be divided into two groups. First group deals with various approaches to radiation theory – quantum electrodynamics, random or stochastic electrodynamics, neoclassical or semiclassical theory. P. MILONNI reviews the old and new developments in the fundamental problem of spontaneous emission, role of vacuum field and radiation reaction; J. H. EBERLY presents a unified view of spontaneous emission in several theories of radiation: QED, random electrodynamics and nonclassical theory, showing the common features and differences in their predictions. All the theories are obtained from the same, formal Lagrangian. EBERLY pays his attention to interpretative frame, which in a sense is the only thing that differs these theories. The papers by M. SCULLY and E. T. JAYNES give a polemics on quantum beats phenomena and the consistency and interpretation problems of quantum electrodynamics and semiclassical theory. T. BOYER reviews the results of so-called random electrodynamics, based on the old Nerst idea of zero-point radiation. K. WÓDKIEWICZ in his contribution discusses resonance, fluorescence and spontaneous emission phenomena in terms of electromagnetic field correlation functions as tests of QED. Finally, the work of E. POWER deals with the canonical transformations in neoclassical theory.

Second group of contributions is connected with fundamental physical and mathematical questions and methods of quantum electrodynamics, L. DAVIDOVICH and H. M. NUSSENZWEIG discuss the problem of natural line shape with the help of soluble multilevel atomic model. The paper provides also a clear explanation of the

differences and similarities of the results obtained from minimal coupling and phenomenological interaction Hamiltonians. I. BIRULA–BIAŁYNICKI describes in his work the so-called phase representation of quantized electromagnetic field, this method is very useful while dealing with the problems involving large numbers of photons. The calculations of electron self-mass, g-factor, and radiation reaction force are given in the paper by D. SHARP and also in the paper by H. GROTCH and E. KAZES. First author presented non-perturbative approach. His results differ from those obtained by GROTCH and KAZES, who applied the perturbation theory.

Some fundamental physical problems of QED are discussed in the work by F. RORLICH: the problem of treating the Coulomb interactions of QED, infrared problem, classical limit problem and a closure problem of QED. The paper by A. O. BARUT is in fact connected with the closure problem of quantum electrodynamics. According to this author electromagnetic interactions have much richer and deeper structure than that given by the perturbation theory and the concepts and methods of QED should be generalized. As, for instance, all hadron states can be indetified with the magnetic resonance non-perturbative states of proton, electron and neutrino, thus quantum electrodynamics is in this sense a unified theory. K. A. MILTON describes macroscopic effects of QED with the help of source theory. Second paper by D. SHARP, concerning local gauge invariant formulation of QED, and that by D. LEITHER on new, finite, charge-field formulation of classical electrodynamics complete this wide presentation of our knowledge of quantum electrodynamics.

The last article is that by M. M. NIETO and L. M. SIMMONS. Their paper, through not directly connected with *QED and all that*, may be, however, useful in quantum optics or atomic physics. NIETO proposes some generalization of the notion of coherent states for an arbitrary atomic system.,

The book is a collection of separate articles in many respects, however, it resembles a monograph. It introduces to the modern radiation theory. Nearly all the articles are simple and deal with important fundamental questions. Therefore the book can be recommended for all the physicists. It obviously should be very interesting and useful for all those, who work in quantum electrodynamics and optics, especially in theory.

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