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Book Reviews

Mathematical Theory of Elementary Particles. Eds., R. Goodman and I. Segal. The MIT Press, Cambridge, Mass. (1966). 188 pp. $6.00.

This compact volume contains the proceedings of a conference bearing the title of the book, held at Endicott House, Dedham, Mass., September 12-15, 1965. The conference was aimed at bringing about an exchange of ideas between pure mathematicians and physicists, mainly axiomatic field theorists.

The title is a misnomer, for there are neither "theories" nor "elementary particles" in this book. It is perhaps justified by the fact that if everyone at the conference solved all the problems they wanted to solve, then maybe one can catch a glimpse of some "mathematical theory of elementary particles." This is not meant to be disparaging, but to set the proper perspective, for when mathematicians try to understand what physicists are doing (and probably vice versa) the hardest thing to come by is the proper perspective. The content of this book actually shows that this conference was both worthwhile and interesting.

Twelve of the thirteen contributions are by physicists. The sole mathematical contribution is an article on "Quantization and Dispersion for Nonlinear Relativistic Equations" by I. Segal. To a physicist, the article is a rigorous treatment of classical scattering in a relativistic ϕ^4 theory, with emphasis on the asymptotic condition.

An excellent summary of the present status of axiomatic field theory is given by A. S. Wightman, who reviewed recent work on inequivalent representations of commutation relations and solvable models. The former includes a discussion of current commutators, which has "the exhilarating feature that it seems to have something directly to do with the real world." Wightman ends on the optimistic note that it may be within one's reach to prove the existence of a field theory with dynamical content.

S. Coleman presented a discussion on the impossibility of constructing certain relativistic extensions of symmetry groups that have been relatively successful in classifying states of elementary particles at rest. This is the only paper that mentions elementary particles.

M. Froissart gave a brief but clear summary of the application of algebraic topology to the study of singularities of Feynman diagrams. This technique has not been found helpful so far, but Froissart's summary is an excellent introduction for those who wish to look into the subject.

All the remaining contributions deal with formal field theory. They include O. W. Greenberg, on statistics other than Bose or Fermi; A. Jaffe, on existence of cutoff ϕ^4 theory; G. Kallen, on holomorphy envelopes; E. Nelson, on two-dimensional ϕ^4 theory; D. Ruelle, on axiomatics; R. F. Streater, on Goldstone's theorem; K. Symanzik, on Euclidean quantum field theory; J. Tarski, on Green's functions; and A. Visconti, on renormalized propagators.

This is an excellent book for those interested in field theory who wish to have a bird's-eye view of the main activities in this field in the past year.

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About the Reviewer: Kerson Huang is Professor of Physics at the Massachusetts Institute of Technology. He has worked on the many-body problem and is the author of a graduate textbook on Statistical Mechanics. His current research interest lies in high energy physics, especially the interactions of strongly interacting particles.

Unified Theory of Nuclear Models and Forces. By G. E. Brown. John Wiley and Sons, Publisher (1967). 252 pp.

Nuclear structure theory attempts to explain the properties of atomic nuclei by describing them as collections of protons and neutrons (nucleons). We know this to be an oversimplification. The nucleons interact with each other by exchanging other elementary particles, whose degrees of freedom should be included in a complete dynamical theory. It is hopefully assumed that nuclear properties at low energies, below the pion rest mass of 135 MeV, can be understood in terms of the degrees of freedom of the nucleons alone. The effect of the neglected particles is simulated by allowing the nucleons to interact through a potential that correctly describes the properties of the two-nucleon system. This potential is very complicated, and so, even though we have retained only the nucleon degrees of freedom, we are still left with a very intractable many-body problem. In spite of the complexity of this mathematical problem, the nuclei themselves exhibit many simple regularities. Thus, it has been tempting for the nuclear theorist to invent simple models that exhibit these simple regularities. This approach has been very successful. The models have correlated a great amount of experimental data, and have often guided new and fruitful experimental programs. However, nuclei in different regions of the periodic table exhibit different sorts of regularities. Thus, nuclear structure theorists work with the independent particle model near closed-shell nuclei, with the rotational model far from closed shells, and with the vibrational model in between. All the while, they have recognized the unsatisfactory nature of this situation, and have sought to derive these models from a more fundamental theory, preferably from the original Schrödinger equation with realistic two-body forces.

G. E. Brown has been an active nuclear theorist for almost 20 years. He has stressed the need repeatedly to