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Book Review

Relativistic Quantum Fields, *C. Nash,* Academic Press, London–New York, 1978, 223 pp., $31.00.

Quantum field theory has made a vigorous comeback in particle physics over the last decade. Many powerful techniques have been developed for practical calculations, and any new book which sheds some light on this bewildering variety is a welcome addition to the literature. The present book by C. Nash from the School of Mathematics of the University of Dublin addresses itself to some of these calculational techniques, in particular to the dimensional regularization and the renormalization group methods.

The first chapter, which accounts for almost a third of the book, begins with the basic ideas of renormalization, exemplified by the Φ^4 theory and quantum electrodynamics (QED). Next, functional differentiation and integration are developed, both for Bose and Fermi fields; for the latter there is a short introduction to functionals on a Grassmann algebra. It is then shown in some detail how the functional integral technique gives rise to the perturbation series of Feynman diagrams. Such functional methods have become increasingly popular in recent years as most problems in quantum field theory may easily be formulated in this language. Chapters II and III deal with the dimensional regularization of the Φ^4 theory and QED, illustrated for single- and multiple-loop diagrams. This method, where Feynman integrals are considered as functions of the dimension D of space-time by analytic continuation in D, has turned out to be a powerful tool in handling infinities (of which there are plenty in present models). In fact, dimensional regularization was essential for the proof of the renormalizability of non-Abelian gauge theories. These chapters also contain a comparison with the conventional method of an ultraviolet cutoff, Weinberg's theorem about the convergence properties of an arbitrary Feynman graph, and enough sample calculations to see dimensional regularization at work. The shortcomings of this method are fortunately limited to a few special situations of which the triangle anomaly is mentioned. In Chapter IV the gauge properties of QED are discussed in some detail, as are the infrared divergencies and their resolution, using the formalism of coherent states. Chapter V is devoted to the asymptotic behavior of scattering amplitudes, concentrating almost entirely

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on renormalization group methods (the short-distance expansion of Wilson being briefly mentioned). Within the context of gauge theories such methods have yielded an explanation of the scaling effects observed in deep inelastic scattering. (Application and extension of the concept of renormalization group to critical phenomena have led to a complete understanding of second-order phase transitions in statistical mechanics, perhaps the best illustration of the power of renormalization group ideas.) Beginning with the Gell-Mann–Low equations of QED, the Callan–Symanzik renormalization group equations are then derived in considerable detail for the Φ^4 theory. In the later parts of this chapter are shorter discussions of infrared and ultraviolet stability, asymptotic freedom, Yang–Mills fields, and the 't Hooft–Weinberg equations.

This is clearly not a book for beginners, a familiarity with at least the earlier chapters of the books by Bjorken–Drell or Schweber being assumed. Researchers who want to become acquainted with some of the current techniques of relativistic quantum field theory should be interested in this well-produced book. It concentrates perhaps too much on purely mathematical manipulations; not a single cross section is computed and there is a corresponding lack of physical motivation. The book contains no problems which might help the novice to overcome his or her initial bewilderment, and, apart from the last chapter, there is also a certain want of references. (For example, Chapter III on the dimensional regularization of QED has a mere four references, including one to an unpublished CERN report which might not always be easily available.) Among the references not included are the Proceedings of the 28th Session of Les Houches (*Methods in Field Theory*, R. Balian and J. Zinn-Justin, Eds., North-Holland, 1976), which we strongly recommend as a remedy against the shortcomings mentioned above.

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