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Book Review: Quantum and Statistical Field Theory

Quantum and Statistical Field Theory. Michell Le Bellac, Clarendon Press, Oxford, 1991.

It is inaccurate to simply label someone a physicist these days. It is much more precise to call someone, for example, a solid state spectroscopist or a string field theorist. Legend has it that the late Lev Landau was the last Mohegan who was able to understand all of the practically unbounded fields which for some reason still share the common name physics (together with chemical physics, biophysics, geophysics, etc.). It is sometimes the case that one learns much from related fields of physics. The classical example of this is, of course, Ken Wilson, who "visited" the field of solid state physics, applied the renormalization group technique to phase transitions, got his Nobel prize, and then returned to his original background in field theory. Unfortunately, not everybody is able to do the same with a similar degree of success, but to try to visit neighboring territory is always a great temptation, sometimes crowned with great rewards.

The book under review invites the reader to follow the Wilson strategy by giving a statistical mechanics course for field theory physicists, and vice versa.

The book is composed of four parts:

Part I contains an introduction to critical phenomena, including both the Landau–Ginzburg mean field theory and the Wilson renormalization group procedure. The XY model and ε-expansion are considered in detail.

Part II covers perturbation expansions in statistical physics, especially methods based on Feynman diagrams, the normalization procedure, and an analyses of the Callan–Symanzik equation.

Part III contains the quantum theory of spinless particles, including path integrals, second quantization, Green's functions, and the S-matrix.

Part IV covers the Dirac equation, quantum electrodynamics, and non-Abelian gauge theories (theory of electroweak interaction and quantum chromodynamics).

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Although the first two parts are devoted to statistical mechanics and the last two to field theory, the formal developments in both share common roots. For readers familiar with one of these subjects it is not hard to gain a clear picture of the other one. Even for beginners the book constitutes a very useful introduction to two fields which at first glance look far apart but are, in fact, deeply related.

This book has a number of pedagogical assets:

1. All mathematics is done in detail. It does not contain such familiar sentences as, "it can be easily shown," which means that the appropriate calculations are too long and/or too complicated to be included in a text.
2. There is a very convenient division into chapters, paragraphs, sections, and subsections, with preliminary guide to their content and precise instructions for further reading.
3. The book contains 130 problems which are clearly formulated and many of them contain references to complete solutions.
4. The most useful formulas are marked in the text, and all formulas are clearly written and seem to be carefully checked.

There are other books on the same subject: D. Amit, *Field Theory, the Renormalization Group and Critical Phenomena* (World Scientific, Singapore, 1984); G. Parisi, *Statistical Field Theory* (Addison-Wesley, New York, 1988); C. Itzykson and J. M. Drouffe, *Statistical Field Theory* (Cambridge University Press, Cambridge, 1989); J. Zinn-Justin, *Quantum Field Theory and Critical Phenomena* (Oxford University Press, Oxford, 1989); and many reviews.

However, the book under review is written on a much more accessible level than those mentioned above and is intended for a reader generally unacquainted with these topics, although some general knowledge of statistical and quantum mechanics is assumed. Good undergraduates, graduate students, teachers at different levels, and curious scientists are among the potential readers of this very interesting book.

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