Many-Body Problems and Quantum Field Theory: An Introduction

Philippe A. Martin
and François Rothen (translated from French by Steven Goldfarb)
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Many-Body Problems and Quantum Field Theory: An Introduction came out of a graduate course that presented a unified treatment of condensed-matter, nuclear, and particle theory. The course emphasized the similarities, sometimes even the identity, of the methods used in those fields—a wonderful idea, because students are often led to believe that the fields are disparate and never meet. Naturally, the authors could not present all three subjects in detail in one introductory course. Hence the authors omitted many specialized topics and emphasized the common ground. They demanded three elementary courses as prior knowledge: quantum mechanics, classical electromagnetism, and statistical mechanics.

Does the book succeed in its unification? To a large extent, yes. It is refreshing to see modern physics presented so broadly at such an advanced level, and for that reason alone the book is worthwhile. Will all students acquire the firm foundation in general theoretical methods that the authors are trying to impart? It depends. Both authors, Philippe A. Martin and François Rothen, are condensed matter physicists, and the book is weighted slightly to that side. After three introductory chapters, four chapters deal with condensed matter, two with particles, and one with nuclei. The best-written chapters are on particles and I enjoyed those chapters most. If you are a specialist in one of the other two subjects and want to learn something about particle physics, you may share my experience. Of course, the book omits many basics of particle physics, so it is not the book to study to become a particle specialist.

The nuclear physics chapter fails, I think. The idea of emphasizing the application of Bardeen-Cooper-Schrieffer (BCS) theory to nuclei is excellent, but the chapter also contains much misinformation about nuclei. Nuclear theory is subtle and I wish that, before writing this chapter, Martin and Rothen had studied Aage Bohr and Ben Mottelson's marvelous two-volume work, *Nuclear Structure* (World Scientific, 1998), which treats nuclei with due accuracy.

Chapter 1 also does not work. It is supposed to be a review, but in fact it is a hodge-podge of simple topics. It is either too long or too short. For each topic, students who have seen it before will not learn much, and students who have not seen it will find the treatment too fast and not detailed enough.

In the other chapters, Martin and Rothen are at their best when they explain in words the physical reasons for a particular phenomenon. For example, the phenomenology of superconductivity, the deep reasons why BCS needed a paired variational wavefunction, the superfluidity of liquid helium, the long theoretical reach of the gauge principle, and the Higgs phenomenon, are all described in ways I found exciting. But the authors are at their worst when they give long algebraic derivations, in which they plod through equation after equation with unnecessary definitions, confusing notations, and badly articulated connections. Such a presentation is not a good example for students! Luckily, the physical discussions usually outweigh the algebraic manipulations.

The translation is dreadful. In many cases, French is translated literally without regard to meaning. Two instances occur repeatedly. One is reference to the "force" of the interaction between two particles, instead of to the "strength" of the interaction. The other is the frequent and incorrect use of "has been" instead of "was." The two French forms, "a été" and "fut," have identical meanings; but the English counterparts do not. More generally, the translator often uses words and constructions that are strange, inappropriate, or syntactically incorrect. An example among hundreds: "One may suggest that, together with London, a relation such as (5.15) reveals a quantum origin" (p. 167). Every page has instances of misconstructions that physicists are warned against in all the style manuals: dangling participles, misplaced modifiers, and use of the equal sign from an equation in place of an English verb. For instance, ". . . it will be assumed that this force is attractive without bothering to determine its exact value" (p. 175). The translator also made major TeX errors in some of the equations.

In summary, the book has undeniable virtues and serious flaws. A book of this type could become a classic; in its present form, this one will not. Nonetheless, it can still be useful to many people, especially condensed

matter physicists looking for a treatment of theoretical particle physics integrated with what they already know.

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