by starting out with the quantization of the electromagnetic field. But as early as the first chapter, Walls and Milburn discuss such novel topics of current research as the properties of squeezed states and the phase operator. Whereas the classic textbooks on quantum optics, such as *Elements of Quantum Optics* by Pierre Meystre and Murray Sargent (Springer, 1991), and *Laser Physics* by Murray Sargent III, Marlan 0. Scully and Willis Lamb Jr. (Addison Wesley, 1987), devote most of their attention to semiclassical quantum optics, *Quantum Optics* is dedicated entirely to the study of the interaction of matter with quantized light.

After a review of the coherence properties and representations of the electromagnetic field, *Quantum Optics* discusses areas to which the Walls school has made substantial contributions. There is a detailed explanation of the generation of squeezed light by a parametric oscillator and by second harmonic, as well as twin beam generations. The authors also present the quantum theory of resonance fluorescence, Bell's inequalities in quantum optics, quantum nondemolition measurements and decoherence in the measurement process. The book concludes with an introduction to the most current field, atom optics, in which the wave nature of the center-of-mass motion of atoms allows for atom interferometers and manifests itself in the diffraction and focusing of atoms from a standing light field. Experimental results accompany the theoretical discussions of these topics in all chapters.

Quantum Optics is written by two leading experts, and it includes topics from the cutting edge of this field. It therefore is at a very advanced level. The book should be recommended reading for graduate-level courses, and it will serve as an extremely valuable reference book for any theoretical or experimental researcher in quantum optics.

There are some draw-backs, however. For instance, in various chapters the equations have become mixed up. Often the reader is referred back to an equation that has nothing to do with the question at hand. Moreover, the notation sometimes changes within a chapter. For example, in chapter 10 the subscripts on the Pauli spin matrices become superscripts in another subsection. Although these are minor details, one should be aware of them so as not to become confused. These minor faults could easily be fixed in a second edition, and they do not detract from the overall goal of the book, which is to provide the reader with an up-to-date and thorough representation of modern quantum optics. In this it succeeds, and I am convinced that *Quantum Optics* will become a standard reference book and will play an important role in the teaching of this field.

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The Observational Foundations of Physics

Alan Cook
Cambridge U. P., New York, 1994. 164 pp. $39.95 hc
ISBN 0-521-45450-6

Alan Cook is a physicist of distinction who has played an important part in developing the present high level of precision measurements and standards. In *The Observational Foundations of Physics* he attempts "to unravel some ways in which the practice of physics determines the form and contents of physics and physical theory" and to ascertain "how far and in what ways the formal structure of theoretical physics is determined by the observations it is possible to make of nature." He also asks why mathematics is successful in describing and predicting the results of observations. These are important and difficult questions. Their discussion involves concepts and arguments that are hard to make precise, so their acceptance necessarily involves subjective factors.

I must confess that I find much of the book's reasoning unconvincing. This may be my fault, not that of the book, but the arguments do contain a large number of errors in physics. Space allows me to quote only a few examples. The author argues, for instance, that in many cases physical phenomena and their mathematical description are representations of a symmetry group, and he cites the structures of molecules and crystals, for which he declares, "the relative positions of all particles are known from the space group." In fact, this is true only for Bravais lattices. If it were generally true, crystallographers would be wasting their time.

Then, in discussing the resonance condition involved in the determination of the frequency standard, this relationship is said to demonstrate that the wave function of any stationary atomic state has an exponential time dependence. The argument proves, in fact, only that the *ratio* between the wave functions of any two states varies exponentially in time. The author further states, correctly, that information about distant events can be obtained only through electromagnetic signals, but he implies that this always involves observations of time.

It is implied that we know the distance of planets, stars and galaxies from the time it takes for light from them to reach us. In fact, we can determine this time only in the case of the Moon, where a reflector has been placed to get light signals there and back. For more distant objects we have to use the ancient method of triangulation, which cannot be carried out with the same incredible accuracy as frequency measurements. And in the course of a rather obscure discussion of chaotic systems, the author claims that the soluble equation $dx/dt = ax(1-bx)$ leads to chaotic behavior.

In spite of the many surprising errors, *The Observational Foundations of Physics* presents an interesting challenge, and experienced readers will be stimulated to decide whether to accept the author's picture or to create their own. Here, as elsewhere in science, it is often more important to ask the right questions than to put forward answers.

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Lectures in Particle Physics

Dan Green
World Scientific, River Edge, N.J. 1994. 475 pp. $48.00 pb
ISBN 981-02-1683-1

Richard P. Feynman begins his book *Theory of Fundamental Processes* with the statement "These lectures will cover all of Physics." In his book *Lectures in Particle Physics*, Dan Green has attempted the more modest task of providing the student of particle physics with the basic information on this field. Each of the book's four sections is derived from a series of lectures on specific topics in particle physics. Green indicates in his preface that his original intent was to explain the entries in the "particle data book," which he claims summarizes the accumulated wisdom of our field. This material constitutes the book's first section. The second and third sections introduce two particular issues at the frontiers of particle physics: *CP* violation in B physics and the explorations inherent in collider physics at the highest mass scales. Lastly, Green points out in the preface that particle physics has recently allied itself with cosmology in the exploration of the origins of the universe, and therefore some knowledge of general relativity is necessary for a well-rounded education; this material constitutes the fourth section of this book.

Unfortunately, it is not really clear for whom this book is intended. The list of four topics is too disjointed, and each topic too narrowly focused, to provide the student in an introductory course with a broad overview of particle physics. On the other hand, each section is sufficiently short that the expert would most likely not turn to this book as a reference.

Despite the absence of an obvious clientele, *Lectures in Particle Physics* has a number of positive features that would make it most suitable as a supplemental text in an introductory (or even advanced) course in particle physics. For example, the development of the constituent quark model in the first section is clear and concise, and all the ingredients that contribute to the construction of an effective quark and gluon potential are well motivated by physical considerations. Inevitably, such a topical approach slights some important subjects. The OZI (Okubo–Zweig–Iizuki) rule is mentioned, but just barely, and there is little on the QCD prediction of gluonic bound states, or glueballs. In fact, there is surprisingly little on quantum chromodynamics and strong interactions in general. The processes of quark and gluon fragmentation and hadronization, which are essential for understanding jets in e^+e^- collisions—at the Z^0 resonance with the CERN LEP collider and the SLAC linear collider, for example—and jets in hadronic collisions—at the Fermilab $\bar{p}p$ collider—are dealt with only minimally.

The section on B physics includes an excellent summary of both the origin and present knowledge of the CKM (Cabibbo–Kobayashi–Maskawa) matrix. This is a field in which recent progress has been great, and some of the quoted experimental results have been superceded by more precise measurements.

Another feature of this book, which again makes it suitable only as a supplemental text for a course in particle physics, is the complete absence of problems or exercises. It may be possible for some people to learn particle physics solely by reading a text and not actively solving problems themselves, but those people are surely a small minority of physics students.

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