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Lambeck first describes how the Earth's gravity field can be interpreted in terms of both deep and shallow structure. There is then a fairly full discussion of crustal movements, including plate tectonics, glacial rebound and deformation along plate boundaries. In view of its importance in the seismic cycle, the last of these is treated somewhat too briefly. The book closes with a discussion of Earth tides and Earth rotation—and an amazingly wide-ranging bibliography.

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Elements of Quantum Optics

Pierre Meystre and
Murray Sargent III
Springer-Verlag, New York,
1990. 484 pp. \$44.50 hc
ISBN 0-387-52160-7

This is a well-written and useful book containing a broad coverage of the basic elements of quantum optics. It was a pleasure to read. The stated aim of the authors is to "present a variety of theoretical tools, so that after completion of the course students should be able to understand specialized research literature and to produce original research of their own." I believe that the student who seriously studies this text will achieve the goal set by its authors.

The second stated purpose of the book is to serve as a reference for a number of topics in quantum optics for which information cannot be found except in the original literature or in specialized monographs. On this count also the book is a success. There are indeed many topics in this combination text and reference that cannot be found elsewhere between hard covers, particularly those topics for which the authors are the acknowledged experts.

What does the book actually contain? Here I must admit that I have never understood exactly what the term "quantum optics" should include. A purist might say the term describes that branch of physics in which the quantum nature of the optical field plays an essential role. By this interpretation, only about one third of the book deals with quantum optics proper. (The quantized field is introduced on page 312, and its properties are developed thereafter.)

But, in fact, quantum optics is much broader than this narrow definition would suggest. There is no clear dividing line between quantum optics,

laser physics, quantum electronics, atomic physics, quantum electrodynamics, spectroscopy, nonlinear optics and so on. Accordingly the author of a text on quantum optics must draw the line for himself, and different authors would undoubtedly draw the line in different places. In my view the selection of topics made by Pierre Meystre and Murray Sargent gives a balanced picture of the field.

The topics covered by *Elements of Quantum Optics* include: nonlinear optics, laser theory, optical bistability, nonlinear spectroscopy, cavity quantum electrodynamics, resonance fluorescence, squeezed states and coherent transients. Topics some readers might like to have seen covered but that are not present include: the theory of resonance radiation pressure (the manipulation of atomic trajectories by light), super-radiance, quantum jumps and descriptions of experiments.

Both authors have long been major players in quantum optics and are eminently qualified to write a text on this subject. The book brings together seemingly unrelated topics, such as four-wave mixing, optical instabilities and resonance fluorescence, and displays the close connections among them through a cogent unified presentation. During the short time the book has been in my hands, I have found it to be a useful reference in my own research and have recommended it to a number of colleagues. All in all the book makes an important contribution to the literature of the field and deserves a place in the library of every serious student of quantum optics.

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Particle Physics and Cosmology

P. D. B. Collins, A. D. Martin
and E. J. Squires
Wiley, New York, 1989. 496 pp.
\$59.95 hc ISBN 0-471-60088-1

Particle Physics and Cosmology by P. D. B. Collins, A. D. Martin and E. J. Squires is successful in reaching very ambitious goals. From the title, I expected a book that would focus on the new interdisciplinary field of research often known as "particle physics and cosmology" that applies many of the ideas arising from particle physics to the study of the early universe. The synthesis of the two fields has been extremely fruitful in generating ideas for understanding the origins of our universe and in providing a laboratory for particle

physics experiments—the (presumably hot) early universe, of which we still have some traces today. Instead, for 400 out of the 500 pages, the book is largely a textbook in particle physics, albeit those aspects of particle physics that are most relevant to cosmology; the last 100 pages address topics in studies of the early universe and in astrophysics.

The bulk of the book, which deals with particle physics, is very well written and will be particularly useful for students and researchers in cosmology who wish to have an introduction to the basic ideas of particle physics of the last two decades. The book is extremely ambitious in attempting to explain in a self-contained fashion many of the recent directions of research in particle physics and, remarkably, succeeds. The part of the book that deals explicitly with cosmology and astrophysics is more sketchy; many topics are discussed at a rapid pace, sometimes without much detail. On the whole, however, the book is excellent, the writing very clear and the subject matter exciting.

The book begins with the “standard model” of particle physics. After an introduction to the basic particles and forces, the reader is led through discussions of gauge theories, renormalization and strong interaction symmetries to the $SU(2) \times U(1)$ model for the electroweak interactions. These first four chapters are clear and self-contained. The fifth chapter discusses anomalies and the axial $U(1)$ and θ problems. This chapter puts together all the pieces for those readers who have most of the background, but leaves out many steps. Perhaps this chapter will have to be supplemented by other books, for example Claude Itzykson and Jean-Bernard Zuber's *Quantum Field Theory* (McGraw-Hill, New York, 1980) for a discussion of Pauli-Villars regularization, or R. Rajaraman's *Solitons and Instantons* (North-Holland, New York, 1982) for a discussion of instantons and relevant path integrals.

Subsequent chapters discuss tests of the standard model and then move to theoretical work beyond the standard model: grand unified theories, technicolor, composite models, supersymmetry, higher-dimensional theories and string theory. These theories attempt to address problems unanswered by the standard model; as yet none has found experimental verification. All of these approaches have led to new ideas in cosmology.

Chapter 10 on supersymmetry is an excellent introduction to the subject. It has sections on supersymmetry

algebra, the construction of supersymmetric field theories (for example, the Wess–Zumino model), superpotentials and spontaneous breaking of supersymmetry. The entire chapter is written at a level that makes it clear to the nonexpert, to anyone comfortable with the standard model. In the section on supersymmetry phenomenology, the discussion of the photino as possibly the lightest supersymmetric particle—and therefore a dark matter candidate—is a bit glib in that there is a mass matrix of neutralinos, and it is not clear which particle to extract as the relevant light supersymmetric particle candidate (for example, higgsino or linear combination of photino and higgsino).

Chapters 15–18 cover topics in cosmology. Here the discussion is more cursory than suggested by the title of the book. The microwave background, for example, is covered in less than a page, and galaxy formation is briefly discussed in the context of inflation. The sections on nucleosynthesis and baryogenesis are also short, but they do cover the most important aspects of the subject. As the index is very good, it is easy to find the sections on these and other topics. The concept of redshift is never used. I think it would have been helpful if the authors had more frequently used

the concept of Ω , the ratio of the energy density of the universe to the critical density needed to close the universe. For example they never directly state the bound arising from primordial nucleosynthesis on Ω_b , the amount of baryonic matter. In addition, in the discussion of the allowed masses of baryonic dark matter, a plot of Ω versus particle mass would have been pedagogically useful.

In these chapters, too, the emphasis is on particle physics aspects of cosmology; for example, the six pages on higher-dimensional cosmologies are excellent. There could have been more discussion of axion cosmology (the book covers it in one paragraph) and of dark matter detection (a device made of superconducting granules is the only detector mentioned, even though it is one of many proposed detector types). These topics are, however, carefully discussed in other books and review articles.

My major objection is that some statements are presented as being more established than they really are or, without a discussion of subtleties, give the wrong impression. In some cases these statements depend crucially on assumptions that are still controversial; in other cases research done since the book was written has

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changed some of the conclusions. For example, the discussions of brown dwarfs, inhomogeneous nucleosynthesis, limits on neutrino lifetimes from supernova 1987A, monopole bounds, biased galaxy formation and axion cosmology are incomplete and possibly misleading. In the discussion of the "slowly rolling regime" of the inflationary universe, the subtleties in the required conditions for over-

damping are glossed over. If there were references given for these statements, the reader could then look them up to obtain more details. More references would have been extremely helpful, particularly in those areas where research is ongoing. Other than this level of detail, these sections are good, as is the rest of the book.

In summary, it is a pleasure to read such a lucid presentation of many

important particle physics developments, particularly those relevant to the study of cosmology.

KATHERINE FREESE
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