BOOK REVIEW

“Light—Volume I—Waves, Photons, Atoms”

H. HAKEN

North Holland Publishing Co., New York 1981,
354 pp, US \$ 34 (Rs. 350 approx.)

In the conventional teaching of quantum mechanics the approach taken is to set up first the entire mathematical formalism as it applies to non-relativistic massive particles, while the quantisation of the electromagnetic field is taken up only later. This is also the historical sequence in which a mathematically satisfactory theory actually developed, notwithstanding the fact that the existence of the quantum of action was first revealed through the properties of radiation. In the volume under review this conventional approach is reversed. The emphasis is on the physical quantum nature of light, while quantum mechanics of matter is developed only to the extent necessary to go on with its interactions with photons.

The present volume is one of a set of three, the others (under preparation) being devoted to the laser and to non-linear optics. The author begins with a quick historical survey of developments in our understanding of the nature of light, and then discusses in turn the wave-particle duality for light and for matter. He then covers the so-called semiclassical region wherein quantised matter is subjected to external classical radiation. Then comes the quantisation of the Maxwell field, followed by a discussion of the various aspects of the interaction of quantised matter and radiation fields. The last two chapters discuss respectively the quantum theory of coherence, and dissipation and fluctuation in quantum optics.

The book is distinguished by an exceptionally clear and easy writing style, making it particularly excellent as a basis for self-study. It is self contained and explains all the important physical ideas and

mathematical step with great patience. For someone who has already studied quantum mechanics this book would be very easy going, indeed one almost feels impatient at times (such as when the author explains how the sine function can be expressed in terms of exponentials!). The physical nature of spontaneous emission, the quantum mechanics of two-level systems whether they be idealised atoms or spins, the development of the Born series and diagrammatic methods, damping and line width and many more topics are beautifully explained and derived. The book is full of useful exercises where one can learn many of the mathematical tricks of quantum mechanics.

The discussion of coherence is detailed enough for one to appreciate that when one makes measurements based on photon absorption (or stimulated emission) one must deal with the normal ordered (or antinormal ordered) quantum coherence functions. The chapter on dissipation and fluctuation discusses in some detail first the classical description and then the quantum version. It brings out clearly and need to have a quantum mechanical heat bath.

To sum up, a host of important physical concepts and insights are presented via the simplest possible example in a way that makes this book excellent both to teach from at quite an elementary level, or to learn from for oneself. One outstanding omission is the discovery of the Bose statistics, which by any account should have found its rightful place in the first chapter. The Indian price is rather high making it accessible essentially only to libraries. In spite of that, one looks forward eagerly to the subsequent volumes of this trilogy.

N. Mukunda

*Center for Theoretical Studies,
Indian Institute of Science,
Bangalore 560 012,*