Book Reviews

Optics and Information Theory—Francis T. S. Yu. New York: Wiley-Interscience, 1976, $15.75. *Reviewed by Edward C. Posner*.

This book attempts to fill a gap in undergraduate engineering and physics education by surveying information theory and then relating it to optical communication. Unfortunately, the book suffers from severe defects which render it useless or worse. The defects can be classified into three types: incorrectness, triviality, and irrelevance. These will be treated in turn.

Incorrect statements abound, many of them severe. The first appears on p. 10. The author purports to prove that the conditional entropy of B given A is equal to or less than the entropy of B. This is true. He "proves" it by quoting the result that the probability of b given a is at most the probability of b, where a and b are fundamental events. The probability of getting a head on a flip of a fair coin is $\frac{1}{2}$. The probability of getting a head on a fair coin given that the outcome *is* a head is 1, which is *not* equal to or less than $\frac{1}{2}$. Other errors of varying degrees occur, including incorrect heuristic explanations of optical phenomena.

Defects of triviality center around, among other things, the key relevance of information theory to optics. This is in signal design and coding for optical communication systems. However, Shannon's coding theorem is hinted at but not even stated. The student would have no idea how information theory is to be used, since the key piece is left out. The text is in this way more of a philosophy text on some of the foundations of information theory, with the real meaning never explained. None of the significant contributions of signal processing to image enhancement are discussed so that the reader can figure out how the images were enhanced or how to explore the true ultimate enhancement limits. No part of the theory or technology is covered in enough detail that anything can be learned.

The final deficit is irrelevance. The "triple mutual information" is defined but not used (there are no known uses, and the term is invented for the book). More important, the different chapters are not related to each other. For example, the chapter on Maxwell's Demon is not used (nor could it have been used) to elucidate questions in later chapters relating for example to accuracy and reliability in observations. Such a chapter is out of place in this book. The text does not start from basic laws and build up a feeling for the technological and physical possibilities, but rather remains at the anecdotal level throughout.

This book cannot be recommended. To learn about information theory as related to optics the best approach for someone who knows optics is to learn information theory from a text devoted to the subject, for example, the first half of McEliece's book [1] and then relate it to optics by the use of Helstrom's book [2]. A more elementary book than [2] which combines information theory and optics in a satisfactory way is yet to be written.

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References

[1] R. J. McEliece, *The Theory of Information and Coding*. Reading, MA: Addison-Wesley, 1977.
[2] C. W. Helstrom, *Quantum Detection and Estimation*. New York: Academic, 1976.

Qualitative Methods in Quantum Theory—A. B. Migdal, vol. 48, *Frontiers in Physics* series. New York: Benjamin, 1977 (translated from 1975 Russian edition by Anthony J. Leggett). *Reviewed by Ralph H. Bartram*.

It is usual for textbooks on quantum theory to stress formal developments and their applications to idealized problems which can be solved exactly. This volume is devoted instead to those qualitative aspects and "physical insights" which theoretical physicists use to discern the essential features of real problems. Prof. Migdal, a distinguished Soviet theorist, has compiled and classified qualitative methods abstracted from many sources, including his own publications. The level of presentation, though somewhat uneven, is appropriate to a graduate student in physics who has completed introductory courses in quantum mechanics and electrodynamics, and whose mathematical preparation includes complex variables, since contour integration is exploited extensively.

The book is divided into six chapters, of which the first three comprise a revision of an earlier work, *Approximation Methods in Quantum Mechanics* by A. B. Migdal and V. P. Krainov (New York: Benjamin, 1969). The first chapter, on dimensional and "model" approximations, begins with procedures such as the method of steepest descents for estimating the values of mathematical expressions, and results are collected for subsequent reference. It concludes with the use of dimensional arguments and simplified models to estimate a variety of quantities in atomic physics including scattering cross sections, lifetimes of excited states, the Lamb shift, and the multiple scattering and energy loss by ionization of fast charged particles in a medium. No single method is presented in this chapter; rather, a style of approach is taught by example. The second chapter deals with perturbation theory, including small, sudden and adiabatic perturbations. Among the diverse applications discussed are nuclear scattering, ionization in β-decay, and the Born–Oppenheimer approximation in molecular physics. The quasiclassical approximation, which is the topic of Chapter 3, exemplifies the efficacy of qualitative methods. Its status as the leading term of an asymptotic series is established, together with criteria for the validity of matching conditions. The utility of the approximation is demonstrated for a variety of problems in one and three dimensions, including barrier penetration and the Thomas–Fermi model.

The remainder of the book is concerned with qualitative

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