Probability, statistical optics, and data testing

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B. R. Frieden. *Probability, Statistical Optics, and Data Testing.*—2nd ed.—Springer-Verlag, Berlin, a.o., 1991, 444 p. (Springer Series in Information Sciences. V.10)

Volume 10 of the Springer Series in Information Sciences is the second edition of the book by B. R. Frieden "Probability, Statistical Optics, and Data Testing." In the new edition of the book an additional chapter has appeared devoted to a discussion of the optimum methods of making statistical estimates. Also a number of examples and problems has been added with all being taken from the field of statistical optics.

This book by B. R. Frieden is devoted to an introduction to the methods of the theory of probability and mathematical statistics and their being brought to bear on the analysis of problems of statistical optics. Thus, two problems are being solved simultaneously—problems of statistical optics are discussed and mathematical methods suitable for their analysis are presented. In the interpretation of physical phenomena the simplest statistical models are being utilized in the text, but always references are given to the more modern methods. The book discusses problems associated with photon statistics, and also problems of describing random wave fields arising in the course of propagation of optical radiation in random media or upon reflection from inhomogeneous surfaces.

The book is divided into two parts. The first eight chapters of the book are devoted to a presentation of the basic concepts and methods of the theory of probability and their application to the description of statistical phenomena in optics. Definitions are given of the concepts of probability, conditional probability, noise, and quantity of information, and a discussion is given of their properties and application to the description of probabilistic phenomena in optics. Different examples are given of the laws of distribution of probability, and of the methods of calculating expectation values and moments. A discussion is given of the random walk method, the central limit theorem and the Fourier method. The properties of functions of random variables are illustrated using the example of transforming random fields in concrete optical systems (image in a lens, formation of speckle images, optical methods of transferring information through a turbulent atmosphere, and the Huygens principle for random fields). The methods of the theory of discrete random processes are illustrated using the example of the description of the processes of quantum fluctuations of light (shot noise, and the experiments of Hanbury-Brown and Twiss). A separate chapter of the book is devoted to a discussion of the Monte-Carlo method. The apparatus of the transfer function, the power spectrum and the autocorrelation function is used to analyze the resolution limits of speckle interferometry and the possibility of producing an optimum restoring filter, and also to present a number of aspects of optical transmission of information.

The second part of the book is devoted to a presentation of the fundamentals of mathematical statistics and an introduction to statistical methods. Methods are discussed for reconstruction of the distribution function using experimental data based on expansion in terms of orthogonal functions, utilizing the principle of maximum likelihood and the maximum entropy estimate. Different test procedures are introduced and illustrated such as the significance test, test on the mean, and the test on variance. The method of least squares is presented, and also methods based on utilization of *a priori* probability. The last chapter of the book is devoted to the theory of optimum methods of making estimates that refer to estimating both parameters and distribution laws.

The book contains a large number of problems and exercises, and this provides the possibility of using it as a basic textbook for a number of special courses on statistical optics. The book undoubtedly will attract considerable interest of specialists working in the field of statistical optics since it also presents methods which so far have not become widespread in physics literature.

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