Optics & Laser Technology

Book Reviews

Introduction to the Optical Transfer Function

C.S. Williams and O.A. Becklund
Wiley Interscience, 1989, ISBN 0-471-94770-9, pp xi + 412, £33.35

This book covers the underlying principles, the definition, use and measurement of the Optical Transfer Function (OTF). The emphasis throughout is placed on the use of the OTF in optical system design, restricted to the optical components (that is, excluding the sampling of the system output by detectors).

The book is divided into ten chapters and three appendices. The first chapter consists of a brief history of the subject and is followed by a chapter each devoted to definitions and to notational conventions. These foundation chapters are followed by a treatment of the contribution to the total wavefront aberration function made by spherical aberration, coma and astigmatism. The role of the OTF as a transfer function in a linear system is described in Chapter 5. Chapter 6 considers the procedure followed in lens design, describing the difficulty in specifying the performance of a lens system by a simple measure like resolution alone. Consideration is given to the role of the Modulation Transfer Function (MTF) and Phase Transfer Function (PTF) in the image appearance.

In Chapter 7 the use of figures of merit related to Strehl ratios is examined and methods of balancing aberrations to achieve merit figures are considered. Chapter 8 is devoted to measurement of system performance by use of grating responses, edge and slit images and interferometric techniques. Chapter 9 is concerned with analytic prediction of the OTF of systems subject to defocus error and astigmatism. The final chapter is concerned with numerical methods for deducing the OTF from estimates of the system wavefront error. Finally, the three appendices are concerned with a review of some case history results, simple Fourier transform and convolution theory and scalar wave theory.

The book contains many illustrations, mostly of high quality although some show signs of desk top publishing. Consideration is specifically restricted to the optical regime and effects like contrast reversal were not considered in applications such as high resolution electron microscopy, where they are quite important. On the first page the authors note '... there is evidence that a traditional dependence on geometrical optics and ray tracing for design and analysis has delayed acceptance of the OTF'. The dominant role of the MTF in this book, rather than the full OTF, illustrates the difficulty. Even in the final chapter the evaluation of the OTF from '. . . initial data in the form of optical path differences observed in laboratory measurements *or calculated from ray trace data*' is considered (my italics). This field suffers from the use of many synonyms and the authors use and explain a wide range of these, occasionally to the detriment of an easy-to-read text.

In summary, a book likely to be very useful to those interested in actually using the OTF, but not one for browsing at leisure. Likely to be a useful addition to the libraries of any organization interested in optical system design.

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Photorefractive Materials and their Applications II — Survey of Applications

Edited by P. Gunter and J.-P. Huignard
Springer-Verlag, 1989, ISBN 3-540-19202-6, pp viii + 367, DM 124

The book is a collection of eight survey papers written by twenty-two of the leading experts in the field of photorefractive materials and non-linear optical phenomena, recruited from five different countries. In the introduction, the editors embark upon the task of focusing on the application of the physical phenomena manifested by and associated with the non-linear behaviour of the various photorefractive crystals.

The topics covered by the book include image storage, information processing and non-linear wave mixing. Furthermore, the authors present, amongst other things, experimental results on parametric amplification, spatial light modulators, phase distortion compensation and wavefront restoration. Several outstanding results illustrate not only the possible application but also the limitations imposed by the material parameters of the crystal used in the experiment.

In the second chapter 'Application, Oscillation and Light-Induced Scattering in Photorefractive Crystals' S.G. Odulov and M.S. Soskin survey the subject of optical amplification of coherent light in photorefractive materials. The authors start off with the principles of light amplification due to the dynamic interaction between beams inside the photorefractive crystal. It is demonstrated that this dynamic hologram recorded in a non-linear medium can be utilized to develop a novel holographic amplifier, based on diffraction and light induced change in the refractive index.