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Introduction

The objective of the complete book series is to impart the most important knowledge necessary for the understanding of and successful practical work in the area of optical design and simulation. The six volumes are devoted to the following subjects:

1. Fundamentals of Technical Optics
2. Physical Image Formation
3. Aberration Theory and Correction of Optical Systems
4. Survey of Optical Instruments
5. Metrology of Optical Components and Systems
6. Advanced Physical Optics

The first two volumes contain the basics necessary for the understanding of optical design. Volumes 3 and 4 will contain aberration theory, its application in optical design and the implementation of its principles in various system layouts. Volumes 5 and 6 will be supplementary, including sections devoted to the metrology used for the evaluation of simulation results as well as other side issues related to a greater extent to physical optics.

The first volume presents an introduction to geometrical optics. This includes paraxial imaging, ray tracing as an important tool for numerical calculation, and the description of optical systems as well as the treatment of material issues, light sources, sensors and photometry. Furthermore, color theory, special components, gratings and prisms are also treated. For the sake of clarity a separate section is devoted to each of the subjects: wave optics, aberrations, and metrology, which will be considered in detail in Volumes 2, 3, and 5, respectively.

The second volume is devoted to the physical description of optical imaging. Starting from the wave equation, diffraction theory is developed with special emphasis on aspects related to numerical simulations. After a presentation of the interference and coherence theory, the physical theory of image formation is then developed and, besides classical Fourier optics, extensions for partially coherent illumination and three-dimensional image formation are also discussed. This volume is completed by the presentation of polarization and its effect and consideration in image formation systems.

The third volume contains first an explanation of the aberration theory required for the understanding of optical systems. Based on this, diverse evaluation criteria

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for the characterization of optical systems is introduced. The accurate correction of aberrations and the methodical design and optimization of optical systems are the central topics of this volume. Practical problems which play a role in the implementation and realization of the design results and which are within the tasks of an optical designer will be included in the later chapters. These comprise on the one hand the tolerancing of optical systems, and on the other hand the principles of integration and assembling of complete optical systems. After a brief overview of the presently commercially available software for optical design, an introduction to the program OPTALIX is given. This program will be included as free software in the third volume for the practical implementation and testing of aberration representations and the principles of optical design.

The fourth volume represents a compendium of different system types of optical instruments with methodical presentations and explanations. The most important layouts and their principle of operation will be explained. In order to make the application and implementation possible and relatively simple for the reader, an extensive data collection for the program OPTALIX is enclosed in Volume 3, which can be used for immediate reconstruction of the numerous examples of optical systems.

The fifth volume describes the alternatives and approaches that can be used in practice for the measurement and testing of optical components and systems. The result of an optical design including the starting approach, the final layout, the optimization, and its realization, is always given as a computer output. The construction of any operating hardware always requires the assessment of its functionality and correct implementation as well as the fabrication of real components on the basis of the results of the model. In this spirit, the fifth volume provides the application in practice, which is closely related to the optical design by means of the evaluation criteria and the operational principles.

The sixth and, for the time being, last volume of the series will treat and present some specific issues which cannot be easily integrated into the logic and sequence of presentation in the first five volumes. These issues include topics of physical optics such as lasers, fibers, holography, optical layers, diffractive components, scattering, thermal problems, statistical optics, confocal methods, short pulse laser systems, special microscopic image formation techniques, adaptive optics, etc. None of these belong to the subject of classical optical design but all of them are becoming increasingly important for the understanding of an optical system as a whole.

This book is directed to readers who are becoming acquainted with professional practice and who are dealing increasingly with problems related to the layout and novel aspects of the optical design. The basic understanding of optical systems is becoming more and more important in many areas. Hence, this book would be useful also for university level studies or for further professional education. A didactically perfect and mathematically rigorous presentation has not been, however, my primary intention. Instead I have always attempted to find a compromise between the correct theory and a compact presentation related to practice. There will always be some disagreement, depending on the topic and the author. However, I have throughout tried to pay special attention to the pragmatic practical implementation and understanding of the interrelationships.

Although the reader is presumed to possess some basic knowledge of mathematics and physics the introductory character of the first two volumes should provide an understanding of the following volumes without the need for additional information.

The choice of the special topics in Volume 6 is certainly somewhat arbitrary and the boundary with some related areas such as photonics, laser physics, the theory of optical communication, digital image processing, etc. is not very clear or logical. This is only an attempt to offer some supplementary topics, which often appear, from a practical point of view, to be important for optical design.

I quite intentionally omitted to include in this book the aspects related to the mechanical construction and manufacturing technology of optical components. These issues very often depend on the specific tradition, experience and equipment of the manufacturer, which therefore makes an objective and neutral presentation difficult.