

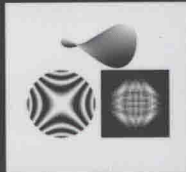
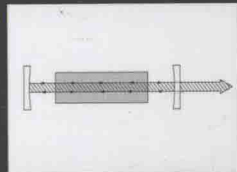
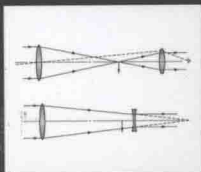
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HANDBOOK OF OPTICS

Volume II

*Design, Fabrication, and Testing; Sources
and Detectors; Radiometry and Photometry*



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Michael Bass

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Casimer M. DeCusatis
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HANDBOOK OF OPTICS

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COVER ILLUSTRATIONS

Left: Telescope such as used by Galileo to discover lunar craters and Jupiter's moons. The basic design is still used in opera and sports glasses. See Chap. 1.

Middle: Simplified schematic of a laser showing the gain medium which amplifies the light, and the resonator which defines the light's direction and spatial distribution. The third critical part, the source to excite the gain medium, is not shown. See Chap. 16.

Right: Zernike circle polynomial representing balanced astigmatism with a standard deviation of one wave illustrated as an isometric plot on the top, interferogram on the left, and point-spread function on the right. See Chap. 11.

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BRIEF CONTENTS OF ALL VOLUMES

VOLUME I. GEOMETRICAL AND PHYSICAL OPTICS, POLARIZED LIGHT, COMPONENT AND INSTRUMENTS

PART 1. GEOMETRICAL OPTICS

Chapter 1. General Principles of Geometrical Optics *Douglas S. Goodman*

PART 2. PHYSICAL OPTICS

Chapter 2. Interference *John E. Greivenkamp*

Chapter 3. Diffraction *Arvind S. Marathay and John F. McCalmont*

Chapter 4. Transfer Function Techniques *Glenn D. Boreman*

Chapter 5. Coherence Theory *William H. Carter*

Chapter 6. Coherence Theory: Tools and Applications *Gisele Bennett, William T. Rhodes, and J. Christopher James*

Chapter 7. Scattering by Particles *Craig F. Bohren*

Chapter 8. Surface Scattering *Eugene L. Church and Peter Z. Takacs*

Chapter 9. Volume Scattering in Random Media *Aristide Dogariu and Jeremy Ellis*

Chapter 10. Optical Spectroscopy and Spectroscopic Lineshapes *Brian Henderson*

Chapter 11. Analog Optical Signal and Image Processing *Joseph W. Goodman*

PART 3. POLARIZED LIGHT

Chapter 12. Polarization *Jean M. Bennett*

Chapter 13. Polarizers *Jean M. Bennett*

Chapter 14. Mueller Matrices *Russell A. Chipman*

Chapter 15. Polarimetry *Russell A. Chipman*

Chapter 16. Ellipsometry *Rasheed M. A. Azzam*

PART 4. COMPONENTS

Chapter 17. Lenses *R. Barry Johnson*

Chapter 18. Afocal Systems *William B. Wetherell*

Chapter 19. Nondispersive Prisms *William L. Wolfe*

Chapter 20. Dispersive Prisms and Gratings *George J. Zisis*

Chapter 21. Integrated Optics *Thomas L. Koch, Frederick J. Leonberger, and Paul G. Suchoski*

Chapter 22. Miniature and Micro-Optics *Tom D. Milster and Tomasz S. Tkaczyk*

Chapter 23. Binary Optics *Michael W. Farn and Wilfrid B. Veldkamp*

Chapter 24. Gradient Index Optics *Duncan T. Moore*

PART 5. INSTRUMENTS

Chapter 25. Cameras *Norman Goldberg*

Chapter 26. Solid-State Cameras *Gerald C. Holst*

Chapter 27. Camera Lenses *Ellis Betensky, Melvin H. Kreitzer, and Jacob Moskovich*

Chapter 28. Microscopes *Rudolf Oldenbourg and Michael Shribak*

Chapter 29. Reflective and Catadioptric Objectives *Lloyd Jones*

- Chapter 30. Scanners *Leo Beiser and R. Barry Johnson*
Chapter 31. Optical Spectrometers *Brian Henderson*
Chapter 32. Interferometers *Parameswaran Hariharan*
Chapter 33. Holography and Holographic Instruments *Lloyd Huff*
Chapter 34. Xerographic Systems *Howard Stark*
Chapter 35. Principles of Optical Disk Data Storage *Masud Mansuripur*

VOLUME II. DESIGN, FABRICATION, AND TESTING; SOURCES AND DETECTORS; RADIOMETRY AND PHOTOMETRY

PART 1. DESIGN

- Chapter 1. Techniques of First-Order Layout *Warren J. Smith*
Chapter 2. Aberration Curves in Lens Design *Donald C. O'Shea and Michael E. Harrigan*
Chapter 3. Optical Design Software *Douglas C. Sinclair*
Chapter 4. Optical Specifications *Robert R. Shannon*
Chapter 5. Tolerancing Techniques *Robert R. Shannon*
Chapter 6. Mounting Optical Components *Paul R. Yoder, Jr.*
Chapter 7. Control of Stray Light *Robert P. Breault*
Chapter 8. Thermal Compensation Techniques *Philip J. Rogers and Michael Roberts*

PART 2. FABRICATION

- Chapter 9. Optical Fabrication *Michael P. Mandina*
Chapter 10. Fabrication of Optics by Diamond Turning *Richard L. Rhorer and Chris J. Evans*

PART 3. TESTING

- Chapter 11. Orthonormal Polynomials in Wavefront Analysis *Virendra N. Mahajan*
Chapter 12. Optical Metrology *Zacarias Malacara and Daniel Malacara-Hernández*
Chapter 13. Optical Testing *Daniel Malacara-Hernández*
Chapter 14. Use of Computer-Generated Holograms in Optical Testing *Katherine Creath and James C. Wyant*

PART 4. SOURCES

- Chapter 15. Artificial Sources *Anthony LaRocca*
Chapter 16. Lasers *William T. Silfvast*
Chapter 17. Light-Emitting Diodes *Roland H. Haitz, M. George Craford, and Robert H. Weissman*
Chapter 18. High-Brightness Visible LEDs *Winston V. Schoenfeld*
Chapter 19. Semiconductor Lasers *Pamela L. Derry, Luis Figueroa, and Chi-shain Hong*
Chapter 20. Ultrashort Optical Sources and Applications *Jean-Claude Diels and Ladan Arissian*
Chapter 21. Attosecond Optics *Zenghu Chang*
Chapter 22. Laser Stabilization *John L. Hall, Matthew S. Taubman, and Jun Ye*
Chapter 23. Quantum Theory of the Laser *János A. Bergou, Berthold-Georg Englert, Melvin Lax, Marian O. Scully, Herbert Walther, and M. Suhail Zubairy*

PART 5. DETECTORS

- Chapter 24. Photodetectors *Paul R. Norton*
Chapter 25. Photodetection *Abhay M. Joshi and Gregory H. Olsen*
Chapter 26. High-Speed Photodetectors *John E. Bowers and Yih G. Wey*
Chapter 27. Signal Detection and Analysis *John R. Willison*
Chapter 28. Thermal Detectors *William L. Wolfe and Paul W. Kruse*

PART 6. IMAGING DETECTORS

- Chapter 29. Photographic Films *Joseph H. Altman*
Chapter 30. Photographic Materials *John D. Baloga*

- Chapter 31. Image Tube Intensified Electronic Imaging *C. Bruce Johnson and Larry D. Owen*
 Chapter 32. Visible Array Detectors *Timothy J. Tredwell*
 Chapter 33. Infrared Detector Arrays *Lester J. Kozlowski and Walter F. Kosonocky*

PART 7. RADIOMETRY AND PHOTOMETRY

- Chapter 34. Radiometry and Photometry *Edward F. Zalewski*
 Chapter 35. Measurement of Transmission, Absorption, Emission, and Reflection *James M. Palmer*
 Chapter 36. Radiometry and Photometry: Units and Conversions *James M. Palmer*
 Chapter 37. Radiometry and Photometry for Vision Optics *Yoshi Ohno*
 Chapter 38. Spectroradiometry *Carolyn J. Sher DeCusatis*
 Chapter 39. Nonimaging Optics: Concentration and Illumination *William Cassarly*
 Chapter 40. Lighting and Applications *Anurag Gupta and R. John Koshel*

VOLUME III. VISION AND VISION OPTICS

- Chapter 1. Optics of the Eye *Neil Charman*
 Chapter 2. Visual Performance *Wilson S. Geisler and Martin S. Banks*
 Chapter 3. Psychophysical Methods *Denis G. Pelli and Bart Farell*
 Chapter 4. Visual Acuity and Hyperacuity *Gerald Westheimer*
 Chapter 5. Optical Generation of the Visual Stimulus *Stephen A. Burns and Robert H. Webb*
 Chapter 6. The Maxwellian View with an Addendum on Apodization *Gerald Westheimer*
 Chapter 7. Ocular Radiation Hazards *David H. Sliney*
 Chapter 8. Biological Waveguides *Vasudevan Lakshminarayanan and Jay M. Enoch*
 Chapter 9. The Problem of Correction for the Stiles-Crawford Effect of the First Kind in Radiometry and Photometry, a Solution *Jay M. Enoch and Vasudevan Lakshminarayanan*
 Chapter 10. Colorimetry *David H. Brainard and Andrew Stockman*
 Chapter 11. Color Vision Mechanisms *Andrew Stockman and David H. Brainard*
 Chapter 12. Assessment of Refraction and Refractive Errors and Their Influence on Optical Design *B. Ralph Chou*
 Chapter 13. Binocular Vision Factors That Influence Optical Design *Clifton Schor*
 Chapter 14. Optics and Vision of the Aging Eye *John S. Werner, Brooke E. Scheffrin, and Arthur Bradley*
 Chapter 15. Adaptive Optics in Retinal Microscopy and Vision *Donald T. Miller and Austin Roorda*
 Chapter 16. Refractive Surgery, Correction of Vision, PRK and LASIK *L. Diaz-Santana and Harilaos Giniis*
 Chapter 17. Three-Dimensional Confocal Microscopy of the Living Human Cornea *Barry R. Masters*
 Chapter 18. Diagnostic Use of Optical Coherence Tomography in the Eye *Johannes F. de Boer*
 Chapter 19. Gradient Index Optics in the Eye *Barbara K. Pierscionek*
 Chapter 20. Optics of Contact Lenses *Edward S. Bennett*
 Chapter 21. Intraocular Lenses *Jim Schwiegerling*
 Chapter 22. Displays for Vision Research *William Cowan*
 Chapter 23. Vision Problems at Computers *Jeffrey Anshel and James E. Sheedy*
 Chapter 24. Human Vision and Electronic Imaging *Bernice E. Rogowitz, Thrasyvoulos N. Pappas, and Jan P. Allebach*
 Chapter 25. Visual Factors Associated with Head-Mounted Displays *Brian H. Tsou and Martin Shenker*

VOLUME IV. OPTICAL PROPERTIES OF MATERIALS, NONLINEAR OPTICS, QUANTUM OPTICS

PART 1. PROPERTIES

- Chapter 1. Optical Properties of Water *Curtis D. Mobley*
 Chapter 2. Properties of Crystals and Glasses *William J. Tropf, Michael E. Thomas, and Eric W. Rogala*
 Chapter 3. Polymeric Optics *John D. Lytle*
 Chapter 4. Properties of Metals *Roger A. Paquin*

- Chapter 5. Optical Properties of Semiconductors *David G. Seiler, Stefan Zollner, Alain C. Diebold, and Paul M. Amirtharaj*
- Chapter 6. Characterization and Use of Black Surfaces for Optical Systems *Stephen M. Pompea and Robert P. Breault*
- Chapter 7. Optical Properties of Films and Coatings *Jerzy A. Dobrowolski*
- Chapter 8. Fundamental Optical Properties of Solids *Alan Miller*
- Chapter 9. Photonic Bandgap Materials *Pierre R. Villeneuve*

PART 2. NONLINEAR OPTICS

- Chapter 10. Nonlinear Optics *Chung L. Tang*
- Chapter 11. Coherent Optical Transients *Paul R. Berman and D. G. Steel*
- Chapter 12. Photorefractive Materials and Devices *Mark Cronin-Golomb and Marvin Klein*
- Chapter 13. Optical Limiting *David J. Hagan*
- Chapter 14. Electromagnetically Induced Transparency *Jonathan P. Marangos and Thomas Halfmann*
- Chapter 15. Stimulated Raman and Brillouin Scattering *John Reintjes and M. Bashkansky*
- Chapter 16. Third-Order Optical Nonlinearities *Mansoor Sheik-Bahae and Michael P. Hasselbeck*
- Chapter 17. Continuous-Wave Optical Parametric Oscillators *M. Ebrahim-Zadeh*
- Chapter 18. Nonlinear Optical Processes for Ultrashort Pulse Generation *Uwe Siegner and Ursula Keller*
- Chapter 19. Laser-Induced Damage to Optical Materials *Marion J. Soileau*

PART 3. QUANTUM AND MOLECULAR OPTICS

- Chapter 20. Laser Cooling and Trapping of Atoms *Harold J. Metcalf and Peter van der Straten*
- Chapter 21. Strong Field Physics *Todd Ditmire*
- Chapter 22. Slow Light Propagation in Atomic and Photonic Media *Jacob B. Khurgin*
- Chapter 23. Quantum Entanglement in Optical Interferometry *Hwang Lee, Christoph F. Wildfeuer, Sean D. Huver, and Jonathan P. Dowling*

VOLUME V. ATMOSPHERIC OPTICS, MODULATORS, FIBER OPTICS, X-RAY AND NEUTRON OPTICS

PART 1. MEASUREMENTS

- Chapter 1. Scatterometers *John C. Stover*
- Chapter 2. Spectroscopic Measurements *Brian Henderson*

PART 2. ATMOSPHERIC OPTICS

- Chapter 3. Atmospheric Optics *Dennis K. Killinger, James H. Churnside, and Laurence S. Rothman*
- Chapter 4. Imaging through Atmospheric Turbulence *Virendra N. Mahajan and Guang-ming Dai*
- Chapter 5. Adaptive Optics *Robert Q. Fugate*

PART 3. MODULATORS

- Chapter 6. Acousto-Optic Devices *I-Cheng Chang*
- Chapter 7. Electro-Optic Modulators *Georgianne M. Purvinis and Theresa A. Maldonado*
- Chapter 8. Liquid Crystals *Sebastian Gauza and Shin-Tson Wu*

PART 4. FIBER OPTICS

- Chapter 9. Optical Fiber Communication Technology and System Overview *Ira Jacobs*
- Chapter 10. Nonlinear Effects in Optical Fibers *John A. Buck*
- Chapter 11. Photonic Crystal Fibers *Philip St. J. Russell and G. J. Pearce*
- Chapter 12. Infrared Fibers *James A. Harrington*
- Chapter 13. Sources, Modulators, and Detectors for Fiber Optic Communication Systems *Elsa Garmire*
- Chapter 14. Optical Fiber Amplifiers *John A. Buck*
- Chapter 15. Fiber Optic Communication Links (Telecom, Datacom, and Analog) *Casimer DeCusatis and Guifang Li*

- Chapter 16. Fiber-Based Couplers *Daniel Nolan*
 Chapter 17. Fiber Bragg Gratings *Kenneth O. Hill*
 Chapter 18. Micro-Optics-Based Components for Networking *Joseph C. Palais*
 Chapter 19. Semiconductor Optical Amplifiers *Jay M. Wiesenfeld and Leo H. Spiekman*
 Chapter 20. Optical Time-Division Multiplexed Communication Networks *Peter J. Delfyett*
 Chapter 21. WDM Fiber-Optic Communication Networks *Alan E. Willner, Changyuan Yu, Zhongqi Pan, and Yong Xie*
 Chapter 22. Solitons in Optical Fiber Communication Systems *Pavel V. Mamyshev*
 Chapter 23. Fiber-Optic Communication Standards *Casimer DeCusatis*
 Chapter 24. Optical Fiber Sensors *Richard O. Claus, Ignacio Matias, and Francisco Arregui*
 Chapter 25. High-Power Fiber Lasers and Amplifiers *Timothy S. McComb, Martin C. Richardson, and Michael Bass*

PART 5. X-RAY AND NEUTRON OPTICS

Subpart 5.1. Introduction and Applications

- Chapter 26. An Introduction to X-Ray and Neutron Optics *Carolyn A. MacDonald*
 Chapter 27. Coherent X-Ray Optics and Microscopy *Qun Shen*
 Chapter 28. Requirements for X-Ray diffraction *Scott T. Misture*
 Chapter 29. Requirements for X-Ray Fluorescence *George J. Havrilla*
 Chapter 30. Requirements for X-Ray Spectroscopy *Dirk Lützenkirchen-Hecht and Ronald Frahm*
 Chapter 31. Requirements for Medical Imaging and X-Ray Inspection *Douglas Pfeiffer*
 Chapter 32. Requirements for Nuclear Medicine *Lars R. Furenlid*
 Chapter 33. Requirements for X-Ray Astronomy *Scott O. Rohrbach*
 Chapter 34. Extreme Ultraviolet Lithography *Franco Cerrina and Fan Jiang*
 Chapter 35. Ray Tracing of X-Ray Optical Systems *Franco Cerrina and M. Sanchez del Rio*
 Chapter 36. X-Ray Properties of Materials *Eric M. Gullikson*

Subpart 5.2. Refractive and Interference Optics

- Chapter 37. Refractive X-Ray Lenses *Bruno Lengeler and Christian G. Schroer*
 Chapter 38. Gratings and Monochromators in the VUV and Soft X-Ray Spectral Region *Malcolm R. Howells*
 Chapter 39. Crystal Monochromators and Bent Crystals *Peter Siddons*
 Chapter 40. Zone Plates *Alan Michette*
 Chapter 41. Multilayers *Eberhard Spiller*
 Chapter 42. Nanofocusing of Hard X-Rays with Multilayer Laue Lenses *Albert T. Macrander, Hanfei Yan, Hyon Chol Kang, Jörg Maser, Chian Liu, Ray Conley, and G. Brian Stephenson*
 Chapter 43. Polarizing Crystal Optics *Qun Shen*

Subpart 5.3. Reflective Optics

- Chapter 44. Reflective Optics *James Harvey*
 Chapter 45. Aberrations for Grazing Incidence Optics *Timo T. Saha*
 Chapter 46. X-Ray Mirror Metrology *Peter Z. Takacs*
 Chapter 47. Astronomical X-Ray Optics *Marshall K. Joy and Brian D. Ramsey*
 Chapter 48. Multifoil X-Ray Optics *Ladislav Pina*
 Chapter 49. Pore Optics *Marco Beijersbergen*
 Chapter 50. Adaptive X-Ray Optics *Ali Khounsary*
 Chapter 51. The Schwarzschild Objective *Franco Cerrina*
 Chapter 52. Single Capillaries *Donald H. Bilderback and Sterling W. Cornaby*
 Chapter 53. Polycapillary X-Ray Optics *Carolyn MacDonald and Walter M. Gibson*

Subpart 5.4. X-Ray Sources

- Chapter 54. X-Ray Tube Sources *Susanne M. Lee and Carolyn MacDonald*
 Chapter 55. Synchrotron Sources *Steven L. Hulbert and Gwyn P. Williams*
 Chapter 56. Laser Generated Plasmas *Alan Michette*

- Chapter 57. Pinch Plasma Sources *Victor Kantsyrev*
Chapter 58. X-Ray Lasers *Greg Tallents*
Chapter 59. Inverse Compton X-Ray Sources *Frank Carroll*

Subpart 5.5. X-Ray Detectors

- Chapter 60. Introduction to X-Ray Detectors *Walter M. Gibson and Peter Siddons*
Chapter 61. Advances in Imaging Detectors *Aaron Couture*
Chapter 62. X-Ray Spectral Detection and Imaging *Eric Lifshin*

Subpart 5.6. Neutron Optics and Applications

- Chapter 63. Neutron Optics *David Mildner*
Chapter 64. Grazing-Incidence Neutron Optics *Mikhail Gubarev and Brian Ramsey*

EDITORS' PREFACE

The third edition of the *Handbook of Optics* is designed to pull together the dramatic developments in both the basic and applied aspects of the field while retaining the archival, reference book value of a handbook. This means that it is much more extensive than either the first edition, published in 1978, or the second edition, with Volumes I and II appearing in 1995 and Volumes III and IV in 2001. To cover the greatly expanded field of optics, the *Handbook* now appears in five volumes. Over 100 authors or author teams have contributed to this work.

Volume I is devoted to the fundamentals, components, and instruments that make optics possible. Volume II contains chapters on design, fabrication, testing, sources of light, detection, and a new section devoted to radiometry and photometry. Volume III concerns vision optics only and is printed entirely in color. In Volume IV there are chapters on the optical properties of materials, nonlinear, quantum and molecular optics. Volume V has extensive sections on fiber optics and x ray and neutron optics, along with shorter sections on measurements, modulators, and atmospheric optical properties and turbulence. Several pages of color inserts are provided where appropriate to aid the reader. A purchaser of the print version of any volume of the *Handbook* will be able to download a digital version containing all of the material in that volume in PDF format to one computer (see download instructions on bound-in card). The combined index for all five volumes can be downloaded from www.HandbookofOpticsOnline.com.

It is possible by careful selection of what and how to present that the third edition of the *Handbook* could serve as a text for a comprehensive course in optics. In addition, students who take such a course would have the *Handbook* as a career-long reference.

Topics were selected by the editors so that the *Handbook* could be a desktop (bookshelf) general reference for the parts of optics that had matured enough to warrant archival presentation. New chapters were included on topics that had reached this stage since the second edition, and existing chapters from the second edition were updated where necessary to provide this compendium. In selecting subjects to include, we also had to select which subjects to leave out. The criteria we applied were: (1) was it a specific application of optics rather than a core science or technology and (2) was it a subject in which the role of optics was peripheral to the central issue addressed. Thus, such topics as medical optics, laser surgery, and laser materials processing were not included. While applications of optics are mentioned in the chapters there is no space in the *Handbook* to include separate chapters devoted to all of the myriad uses of optics in today's world. If we had, the third edition would be much longer than it is and much of it would soon be outdated. We designed the third edition of the *Handbook of Optics* so that it concentrates on the principles of optics that make applications possible.

Authors were asked to try to achieve the dual purpose of preparing a chapter that was a worthwhile reference for someone working in the field and that could be used as a starting point to become acquainted with that aspect of optics. They did that and we thank them for the outstanding results seen throughout the *Handbook*. We also thank Mr. Taisuke Soda of McGraw-Hill for his help in putting this complex project together and Mr. Alan Tourtlotte and Ms. Susannah Lehman of the Optical Society of America for logistical help that made this effort possible.

We dedicate the third edition of the *Handbook of Optics* to all of the OSA volunteers who, since OSA's founding in 1916, give their time and energy to promoting the generation, application, archiving, and worldwide dissemination of knowledge in optics and photonics.

Michael Bass, Editor-in-Chief
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Eric Van Stryland

PREFACE TO VOLUME II

Volume II of the *Handbook of Optics* is a continuation of Volume I. It starts with optical system design and covers first-order layout, aberration curves, design software, specifications and tolerances, component mounting, stray light control, and thermal compensation techniques. Optical fabrication and testing are discussed next. A new chapter on the use of orthonormal polynomials in optical design and testing has been added. Such a polynomial representing balanced astigmatism is illustrated on the cover. The section on sources includes different types of lasers, laser stabilization, laser theory, and a discussion of ultrashort laser sources. Light-emitting diodes including the new “high-brightness” LEDs are presented. Artificial sources of light for both the laboratory and field are described along with a discussion of light standards calibration. The section on detectors includes high-speed and thermal detectors along with an analysis of signal detection. Imaging using film, detector arrays, and image tubes is discussed. This volume ends with a section on radiometry and photometry. Two new chapters have been added in this area. One is on spectroradiometry and the other is on lighting and applications.

Every effort was made to contact all the authors of chapters in the second edition that would appear in this edition so that they could update their chapters. However, the authors of several chapters could not be located or were not available. Their chapters are reproduced without update. Every effort has been made to ensure that such chapters have been correctly reproduced.

There are many other chapters in this edition of the *Handbook* that could have been included in Volumes I and II. However, page limitations prevented that. For example, in Volume V there is a section on Atmospheric Optics. It consists of three chapters, one on transmission through the atmosphere, another on imaging through atmospheric turbulence, and a third on adaptive optics to overcome some of the deleterious effects of turbulence.

The chapters are generally aimed at the graduate students, though practicing scientists and engineers will find them equally suitable as references on the topics discussed. Each chapter has sufficient references for additional and/or further study.

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