This monograph provides concise and clear coverage of modern ray theory without the need of complicated mathematics. Comprehensive coverage is given to wave problems in engineering physics, considering rays and caustics as physical objects.

Written with the student of Physics and Engineering in mind, this textbook shows how to solve the typical examination questions. It also includes the solutions of many real and difficult problems encountered by the practicing Physicists and Engineers, and is illustrated with diagrams from the MATHLAB software.

This work is devoted to the analysis of high frequency solutions to the equations of nonlinear elasticity in a half-space. The authors consider surface waves (or more precisely, Rayleigh waves) arising in the general class of isotropic hyperelastic models, which includes in particular the Saint Venant-Kirchhoff system. Work has been done by a number of authors since the 1980s on the formulation and well-posedness of a nonlinear evolution equation whose (exact) solution gives the leading term of an approximate Rayleigh wave solution to the underlying elasticity equations. This evolution equation, which is referred to as “the amplitude equation”, is an integrodifferential equation of nonlocal Burgers type. The authors begin by reviewing and providing some extensions of the theory of the amplitude equation. The remainder of the paper is devoted to a rigorous proof in 2D that exact, highly oscillatory, Rayleigh wave solutions w to the nonlinear elasticity equations exist on a fixed time interval independent of the wavelength ε, and that the approximate Rayleigh wave solution provided by the analysis of the amplitude equation is indeed close in a precise sense to w on a time interval independent of ε. This paper focuses mainly on the case of Rayleigh waves that are pulses, which have profiles with continuous Fourier spectrum, but the authors’ method applies equally well to the case of wavetrains, whose Fourier spectrum is discrete.

This book introduces graduate students and researchers in mathematics and the sciences to the multifaceted subject of the equations of hyperbolic type, which are used, in particular, to describe propagation of waves at finite speed. Among the topics carefully presented in the book are nonlinear...
geometric optics, the asymptotic analysis of short wavelength solutions, and nonlinear interaction of such waves. Studied in detail are the damping of waves, resonance, dispersive decay, and solutions to the compressible Euler equations with dense oscillations created by resonant interactions. Many fundamental results are presented for the first time in a textbook format. In addition to dense oscillations, these include the treatment of precise speed of propagation and the existence and stability questions for the three wave interaction equations. One of the strengths of this book is its careful motivation of ideas and proofs, showing how they evolve from related, simpler cases. This makes the book quite useful to both researchers and graduate students interested in hyperbolic partial differential equations. Numerous exercises encourage active participation of the reader. The author is a professor of mathematics at the University of Michigan. A recognized expert in partial differential equations, he has made important contributions to the transformation of three areas of hyperbolic partial differential equations: nonlinear microlocal analysis, the control of waves, and nonlinear geometric optics.

The theory of the scattering of light by small particles is very important in a wide range of applications in atmospheric physics and atmospheric optics, ocean optics, remote sensing, astronomy and astrophysics and biological optics. This book summarises current knowledge of the optical properties of single small particles and natural light scattering media such as snow, clouds, foam aerosols etc. The book considers both single and multiple light scattering regimes, together with light scattering and radiative transfer in close-packed media. The third edition incorporates new findings in the area of light scattering media optics in an updated version of the text.

An ideal textbook for advanced undergraduate courses in geometrical optics; includes worked examples and exercises.

Solutions to the 25th & 26th International Young Physicists' Tournament provides original, quantitative solutions in fulfilling seemingly impossible tasks. The book expands on the solutions required by the problems. Many of the articles include modification, extension to existing models in references, or derivation and computation based on fundamental physics, and are not confined to the models and methods in present literatures. The International Young Physicists' Tournament (IYPT) is one of the most prestigious international physics contests among high school students. This book is based on the solutions of 2012 and 2013 IYPT problems. The young authors provide quantitative solutions to practical problems in everyday life, such as the 2013 problem "Bouncing ball" that shows "how the nature of the collision changes if the ball contains liquid", "Colored plastic" (2013 problem 6) and "Helmholtz carousel" (2013 problem 12) etc. This book is intended as a college-level solutions guide to the challenging open-ended problems. It is a good reference book for undergraduates, advanced high-school students, physics educators and the curious public interested in the intriguing phenomenon encountered in daily life.

This IMA Volume in Mathematics and its Applications GEOMETRIC METHODS IN INVERSE PROBLEMS AND PDE CONTROL contains a selection of articles presented at 2001 IMA Summer Program with the same title. We would like to thank Christopher B. Croke (University of Pennsylvania), Irena Lasiecka (University of Virginia), Gunther Uhlmann (University of Washington), and Michael S. Vogelius (Rutgers University) for their excellent work as organizers of the two-week summer workshop and for editing the volume. We also take this opportunity to thank the National Science Foundation for their support of the IMA. Series Editors Douglas N. Arnold, Director of the IMA, Fadil Santosa, Deputy Director of the IMA v PREFACE This volume contains a selected number of articles based on lectures delivered at the IMA 2001 Summer Program on "Geometric Methods in Inverse Problems and PDE Control." The focus of this program was some common techniques used in the study of inverse coefficient problems and control problems for partial differential equations, with particular emphasis on their strong relation to fundamental problems of geometry. Inverse coefficient problems for partial differential equations arise in many application areas, for instance in medical imaging, nondestructive testing, and geological prospecting. Control problems involving partial differential equations may arise...
from the need to optimize a given performance criterion, e. g. , to dampen out undesirable vibrations of a structure, or more generally, to obtain a prescribed behaviour of the dynamics.

This text provides all the basic information needed to research, develop, and design beam shaping systems. It includes sections on: diffraction theory, geometrical optics, shaping element design, beam profile measurement technology with applications and techniques for lossless beam shaping.

Electromagnetic Scintillation describes the phase and amplitude fluctuations imposed on signals that travel through the atmosphere. The volumes that make up Electromagnetic Scintillation will provide a modern reference and comprehensive tutorial, treating both optical and microwave propagation and integrating measurements and predictions at each step of the development. This first volume deals with phase and angle-of-arrival measurement errors, accurately described by geometrical optics. It will be followed by a further volume examining weak scattering. In this book, measured properties of tropospheric and ionospheric irregularities are reviewed first. Electromagnetic fluctuations induced by these irregularities are then estimated for a wide range of applications. The book will be of interest to those working in the resolution of astronomical interferometers and large single-aperture telescopes, as well as synthetic aperture radars and laser pointing/tracking systems. It is also directly relevant to those working in laser metrology, GPS location accuracy, and terrestrial and satellite communications.

There is a need for high gain antennas which are capable of rapid scanning and multibeam operations. The report presents a study of double-spherical Cassegrain reflector to ascertain whether this antenna is practical for these purposes. The aperture blocking, the spread of the field, and the phase and amplitude distributions are examined using geometric optical technique. There is no single optimum condition, but it is shown that a proper combination of the subreflector and main reflector sizes and the position of the feed can indeed produce a promising antenna. (Author).

This volume contains the proceedings of two conferences on Inverse Problems and Applications, held in 2012, to celebrate the work of Gunther Uhlmann. The first conference was held at the University of California, Irvine, from June 18-22, 2012, and the second was held at Zhejiang University, Hangzhou, China, from September 17-21, 2012. The topics covered include inverse problems in medical imaging, scattering theory, geometry and image processing, and the mathematical theory of cloaking, as well as methods related to inverse problems.

A concise, yet deep introduction to geometrical optics, developing the practical skills and research techniques routinely used in modern laboratories. Suitable for both students and self-learners, this accessible text teaches readers how to build their own optical laboratory, and design and perform optical experiments.

Near the Horizon starts out by considering several optical phenomena that can occur when the sun is near the horizon. One can sometimes see objects that are actually below the horizon. Sometimes there seems to be a dark strip in the middle of the solar disk. These are a result of the way that the atmosphere affects the geometry of light rays. Broer starts his book with the Fermat principle (rays of light take least-time paths) and deduces from it laws for refraction and reflection; by expressing these as conservation laws, he can handle both the case of inhomogeneous layers of air and the case of continuous variation in the refraction index. A surprising application is the brachistochrone problem, in which the path of fastest descent is determined by studying how a light ray would behave in a “flat earth” atmosphere whose refraction index is determined by the gravitational potential. This leads to a very interesting chapter on the cycloid and its properties. The final chapters move from the elementary theory to a more sophisticated version in which the Fermat Principle leads to a Riemannian metric whose geodesics are the paths of light rays. This gives us an optics which is geometric in a new sense, and serves as a nice demonstration of the physical applicability of Riemannian geometry.
Geometric Optics Problems With Solutions

Geometrical Theory of Diffraction for Electromagnetic Waves

This volume is a compilation of carefully selected questions at the PhD qualifying exam level, including many actual questions from Columbia University, University of Chicago, MIT, State University of New York at Buffalo, Princeton University, University of Wisconsin and the University of California at Berkeley over a twenty-year period. Topics covered in this book include geometrical optics, quantum optics, and wave optics. This latest edition has been updated with more problems and solutions, bringing the total to over 200 problems. The original problems have been modernized, and outdated questions removed, placing emphasis on those that rely on calculations. The problems range from fundamental to advanced in a wide range of topics on optics, easily enhancing the student's knowledge through workable exercises. Simple-to-solve problems play a useful role as a first check of the student's level of knowledge whereas difficult problems will challenge the student's capacity on finding the solutions.

Until recently, there was no effective method for describing waves in weakly anisotropic inhomogeneous media. The method of quasi-isotropic approximation (QIA) of geometrical optics was developed to overcome this problem. The QIA approach bridges the gap between geometrical optics of isotropic media (Rytov method) and that of anisotropic media (Courant-Lax approach), thus providing a complete picture of the geometrical optics of inhomogeneous media. The book explores recent developments in QIA and describes the application of the theory to different branches of wave physics, from plasma physics, quantum physics and ionospheric radio wave propagation to acoustics, optics and astrophysics. The authors present some modifications and generalisations of QIA equations, and look at electromagnetic waves and optical and acoustic effects in weakly anisotropic media, as well as geometrical optics of 3D inhomogeneous media. The book closes with some quantum mechanical analogies. This is an up-to-the-minute exposition of the latest developments in an important new area, written by authors of outstanding international reputation. A rich source of both theoretical methods and practical applications, this book covers a wide range of problems of general physical significance and will be of interest to those working in optics, acoustics, electrical engineering, radio engineering and wave propagation through plasma.

Inverse problem theory is one of the most important directions of modern mathematics. In this monograph, for the most part, inverse coefficient problems are explored, for example Helmholtz equations. The coefficient of these equations need to be recovered by certain known information on the solutions of these equations. In this book, the basic method for studying multidimensional inverse problems is the small parameter method (the asymptotic method). Such methods are widely used for investigation of direct problems.

Summarizes current knowledge of the optical properties of single small particles and light scattering media (e.g. snow, clouds, foam, aerosols) crucial to diverse applications in atmospheric physics, atmospheric optics, ocean optics, remote sensing, astronomy, astrophysics, and biological optics. The main focus of Kokhanovsky (physics, Academy of Sciences, Minsk, Belarus) is on modern approximate analytical solutions for single and multiple light scattering problems, but he does not ignore theory (namely, scattering theory and radioactive transfer theory). Includes appendices on refractive indices; exact solutions of light-scattering problems for uniform, two-layered and optically active spherical particles; special functions; light-scattering codes on the Internet; and phase functions. Annotation copyrighted by Book News, Inc., Portland, OR

This book contains fourteen research papers which are expanded versions of conferences given at a meeting held in September 1996 in Cortona, Italy. The topics include blowup questions for quasilinear equations in two dimensions, time decay of waves in LP, uniqueness results for systems of conservation laws in one dimension, concentration effects for critical nonlinear wave equations, diffraction of nonlinear waves, propagation of singularities in scattering theory, caustics for semi-linear oscillations. Other
topics linked to microlocal analysis are Sobolev embedding theorems in Weyl-Hormander calculus, local solvability for pseudodifferential equations, hypoellipticity for highly degenerate operators. The book also contains a result on uniqueness for the Cauchy problem under partial analyticity assumptions and an article on the regularity of solutions for characteristic initial-boundary value problems. On each topic listed above, one will find new results as well as a description of the state of the art. Various methods related to nonlinear geometrical optics are a transversal theme of several articles. Pseudodifferential techniques are used to tackle classical PDE problems like Cauchy uniqueness. We are pleased to thank the speakers for their contributions to the meeting: Serge Alinhac, Mike Beals, Alberto Bressan, Jean-Yves Chemin, Christophe Cheverry, Daniele Del Santo, Nils Dencker, Patrick Gerard, Lars Hormander, John Hunter, Richard Melrose, Guy Metivier, Yoshinori Morimoto, and Tatsuo Nishitani. The meeting was made possible in part by the financial support of a European commission program, "Human capital and mobility CHRX-CT94-044."

Nonlinear optics is a rapidly developing field of modern physics. Nonlinear optical phenomena such as self-focusing, self-phase modulation, soliton formation and propagation, higher harmonic generation, different types of stimulated light scattering, and four-wave mixing have attracted interest from the fundamental point of view of the investigation of light/matter interaction, and as a basis for applications in contemporary optical communications and optical signal processing. Nonlinear Optics - Novel Results in Theory and Applications contains novel results concerning the mathematical methods of nonlinear optical phenomena analysis, soliton formation and propagation in optical fibers, and peculiarities of nonlinear optical phenomena in micro- and nanostructures. The book may be interesting for researchers and engineers interested in nonlinear optics, lasers, and optical communications.

Principles of Optical Fiber Measurements focuses on the optical fiber systems, which are being added to the telephone networks of various countries around the world. This book explores the significance of optical fiber systems in the increasing variety of fiber-related products on the market. Comprised of seven chapters, this book starts with an overview of the fiber fabrication process with emphasis on the method of measurements to reduce fiber loss in the field of optical communication. This text then examines the special methods to measure extremely low dispersion in single-mode fibers. Other chapters consider the measurement requirements of commercial fiber manufacturers to allow them to specify their products as well as for fiber users to verify that they get what they expect. The final chapter deals with the various measurement methods for determining the V value of fibers as well as the geometrical dimensions of fibers and preforms. This book is a valuable resource for specialists and readers who desire a better understanding of fiber specifications.

Modern Geometrical Optics, although it covers matrix methods, emphasizes y-nu ray tracing methods, which are used most commonly by optical engineers and are easier to adapt to third-order optics and y-??? diagrams. Moving by logical degrees from fundamental principles to advanced optical analysis and design methods, this book bridges the gap between the optical theory taught in introductory physics texts and advanced books on lens design. Providing the background material needed to understand advanced material, it covers important topics such as field of view, stops, pupils and windows, exact ray tracing, image quality, and optimization of the image. Important features of Modern Geometrical Optics include: * Examples of all important techniques presented * Extensive problem sets in each chapter * Optical analysis and design software * Chapters covering y-??? diagrams, optimization, and lens design This book is both a primer for professionals called upon to design optical systems and an ideal text for courses in modern geometrical optics. Companion Software Special lens design and analysis software capable of solving all problems presented in the book is available via Wiley's FTP site. This software also serves as an introduction to the use of commercial lens design software. Appendix C is a user's manual for the software.
Applied mathematics is a central connecting link between scientific observations and their theoretical interpretation. Nonlinear analysis has surely contributed major developments which nowadays shape the face of applied mathematics. At the beginning of the millennium, all sciences are expanding at increased speed. Technological, ecological, economical and medical problem solving is a central issue of every modern society. Mathematical models help to expose fundamental structures hidden in these problems and serve as unifying tools to deepen our understanding. What are the new challenges applied mathematics has to face with the increased diversity of scientific problems? In which direction should the classical tools of nonlinear analysis be developed further? How do new available technologies influence the development of the field? How can problems be solved which have been beyond reach in former times? It is the aim of this book to explore new developments in the field by way of discussion of selected topics from nonlinear analysis.

Optical imaging starts with geometrical optics, and ray tracing lies at its forefront. This book starts with Fermat's principle and derives the three laws of geometrical optics from it. After discussing imaging by refracting and reflecting systems, paraxial ray tracing is used to determine the size of imaging elements and obscuration in mirror systems. Stops, pupils, radiometry, and optical instruments are also discussed. The chromatic and monochromatic aberrations are addressed in detail, followed by spot sizes and spot diagrams of aberrated images of point objects. Each chapter ends with a summary and a set of problems. The book ends with an epilogue that summarizes the imaging process and outlines the next steps within and beyond geometrical optics.


Fundamentals of Photonics A complete, thoroughly updated, full-color third edition Fundamentals of Photonics, Third Edition is a self-contained and up-to-date introductory-level textbook that thoroughly surveys this rapidly expanding area of engineering and applied physics. Featuring a blend of theory and applications, coverage includes detailed accounts of the primary theories of light, including ray optics, wave optics, electromagnetic optics, and photon optics, as well as the interaction of light and matter. Presented at increasing levels of complexity, preliminary sections build toward more advanced topics, such as Fourier optics and holography, photonic-crystal optics, guided-wave and fiber optics, LEDs and lasers, acousto-optic and electro-optic devices, nonlinear optical devices, ultrafast optics, optical interconnects and switches, and optical fiber communications. The third edition features an entirely new chapter on the optics of metals and plasmonic devices. Each chapter contains highlighted equations, exercises, problems, summaries, and selected reading lists. Examples of real systems are included to emphasize the concepts governing applications of current interest. Each of the twenty-four chapters of the second edition has been thoroughly updated.

This collection of exercises, compiled for talented high school students, encourages creativity and a deeper understanding of ideas when solving physics problems.

University Physics is designed for the two- or three-semester calculus-based physics course. The text has been developed to meet the scope and sequence of most university physics courses and provides a foundation for a career in mathematics, science, or engineering. The book provides an important opportunity for students to learn the core concepts of physics and understand how those concepts apply to their lives and to the world around them. Due to the comprehensive nature of the material, we are offering the book in three volumes for flexibility and efficiency. Coverage and Scope Our University Physics textbook adheres to the scope and sequence of most two- and three-semester physics courses.
nationwide. We have worked to make physics interesting and accessible to students while maintaining the mathematical rigor inherent in the subject. With this objective in mind, the content of this textbook has been developed and arranged to provide a logical progression from fundamental to more advanced concepts, building upon what students have already learned and emphasizing connections between topics and between theory and applications. The goal of each section is to enable students not just to recognize concepts, but to work with them in ways that will be useful in later courses and future careers. The organization and pedagogical features were developed and vetted with feedback from science educators dedicated to the project. VOLUME III Unit 1: Optics Chapter 1: The Nature of Light Chapter 2: Geometric Optics and Image Formation Chapter 3: Interference Chapter 4: Diffraction Unit 2: Modern Physics Chapter 5: Relativity Chapter 6: Photons and Matter Waves Chapter 7: Quantum Mechanics Chapter 8: Atomic Structure Chapter 9: Condensed Matter Physics Chapter 10: Nuclear Physics Chapter 11: Particle Physics and Cosmology

This IMA Volume in Mathematics and its Applications MULTIDIMENSIONAL HYPERBOLIC PROBLEMS AND COMPUTATIONS is based on the proceedings of a workshop which was an integral part of the 1988-89 IMA program on NONLINEAR WAVES. We are grateful to the Scientific Committee: James Glimm, Daniel Joseph, Barbara Keyfitz, Andrew Majda, Alan Newell, Peter Olver, David Sattinger and David Schaeffer for planning and implementing an exciting and stimulating year-long program. We especially thank the Workshop Organizers, Andrew Majda and James Glimm, for bringing together many of the major figures in a variety of research fields connected with multidimensional hyperbolic problems. Avner Friedman Willard Miller PREFACE A primary goal of the IMA workshop on Multidimensional Hyperbolic Problems and Computations from April 3-14, 1989 was to emphasize the interdisciplinary nature of contemporary research in this field involving the combination of ideas from the theory of nonlinear partial differential equations, asymptotic methods, numerical computation, and experiments. The twenty-six papers in this volume span a wide cross-section of this research including some papers on the kinetic theory of gases and vortex sheets for incompressible flow in addition to many papers on systems of hyperbolic conservation laws. This volume includes several papers on asymptotic methods such as nonlinear geometric optics, a number of articles applying numerical algorithms such as higher order Godunov methods and front tracking to physical problems along with comparison to experimental data, and also several interesting papers on the rigorous mathematical theory of shock waves.

This book is the culmination of twenty-five years of teaching Geometrical Optics. The volume is organised such that the single spherical refracting surface is the basic optical element. Spherical mirrors are treated as special cases of refraction, with the same applicable equations. Thin lens equations follow as combinations of spherical refracting surfaces while the cardinal points of the thick lens make it equivalent to a thin lens. Ultimately, one set of vergence equations are applicable to all these elements. The chapters are devoted to in-depth treatments of stops, pupils and ports; magnifiers, microscopes, telescopes, and camera lenses; ophthalmic instruments; resolving power and MTF; trigonometric ray tracing; and chromatic and monochromatic aberrations. There are over 100 worked examples, 400 homework problems and 400 illustrations. First published in 1994 by Penumbra Publishing Co.

The material for these volumes has been selected from the past twenty years' examination questions for graduate students at University of California at Berkeley, Columbia University, the University of Chicago, MIT, State University of New York at Buffalo, Princeton University and University of Wisconsin.

Written as a tribute to the mathematician Carlo Pucci on the occasion of his 70th birthday, this is a collection of authoritative contributions from over 45 internationally acclaimed experts in the field of partial differential equations. Papers discuss a variety of topics such as problems where a partial differential equation is coupled with unfavourable boundary or initial conditions, and boundary value
problems for partial differential equations of elliptic type.

Introduction to Optics is now available in a re-issued edition from Cambridge University Press. Designed to offer a comprehensive and engaging introduction to intermediate and upper level undergraduate physics and engineering students, this text also allows instructors to select specialized content to suit individual curricular needs and goals. Specific features of the text, in terms of coverage beyond traditional areas, include extensive use of matrices in dealing with ray tracing, polarization, and multiple thin-film interference; three chapters devoted to lasers; a separate chapter on the optics of the eye; and individual chapters on holography, coherence, fiber optics, interferometry, Fourier optics, nonlinear optics, and Fresnel equations.

This volume presents the proceedings of a workshop on Inverse Problems and Applications and a special session on Inverse Boundary Problems and Applications. Inverse problems arise in practical situations, such as medical imaging, exploration geophysics, and non-destructive evaluation where measurements made in the exterior of a body are used to deduce properties of the hidden interior. A large class of inverse problems arise from a physical situation modeled by partial differential equations. The inverse problem is to determine some coefficients of the equation given some information about solutions. Analysis of such problems is a fertile area for interaction between pure and applied mathematics. This interplay is well represented in this volume where several theoretical and applied aspects of inverse problems are considered. The book includes articles on a broad range of inverse problems including the inverse conductivity problem, inverse problems for Maxwell's equations, time reversal mirrors, ultrasound using elastic pressure waves, inverse problems arising in the environment, inverse scattering for the three-body problem, and optical tomography. Also included are several articles on unique continuation and on the study of propagation of singularities for hyperbolic equations in anisotropic media. This volume is suitable for graduate students and research mathematicians interested in inverse problems and applications.

This workbook is designed to supplement optics textbooks and covers all the traditional topics of geometrical optics. Terms, equations, definitions, and concepts are discussed briefly and explained through a series of problems that are worked out in a step-by-step manner which simplifies the problem-solving process. Additional practice problems are provided at the end of each chapter. * - An indispensable tool when studying for the state and National Boards * - An ideal supplement to optics textbooks * - Covers the traditional topics of geometrical optics.

This book—unique in the literature—provides readers with the mathematical background needed to design many of the optical combinations that are used in astronomical telescopes and cameras. The results presented in the work were obtained by using a different approach to third-order aberration theory as well as the extensive use of the software package Mathematica®. Replete with workout examples and exercises, Geometric Optics is an excellent reference for advanced graduate students, researchers, and practitioners in applied mathematics, engineering, astronomy, and astronomical optics. The work may be used as a supplementary textbook for graduate-level courses in astronomical optics, optical design, optical engineering, programming with Mathematica, or geometric optics.

This book is the solution manual to the textbook "A Modern Course in University Physics". It contains solutions to all the problems in the aforementioned textbook. This solution manual is a good companion to the textbook. In this solution manual, we work out every problem carefully and in detail. With this solution manual used in conjunction with the textbook, the reader can understand and grasp the physics ideas more quickly and deeply. Some of the problems are not purely exercises; they contain extension of the materials covered in the textbook. Some of the problems contain problem-solving techniques that are not covered in the textbook. Request Inspection Copy