

# Absorption And Scattering Of Light By Small Particles

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**Clouds in a Glass of Beer** Craig F. Bohren 2013-04-09 Liberally sprinkled with humor, these lessons will fascinate beginning physics students and other readers with chapters titled "On a Clear Day You Can't See Forever" and "Physics on a Manure Heap."

**Multiple Light Scattering** H Van de Hulst 2012-12-02 Multiple Light Scattering: Tables, Formulas, and Applications, Volume 1 serves to give concise and handy information related to multiple scattering theory in such a way that the reader would not have to rely on extensive literature on the subject. The book is divided into two parts. Part I: General Theory covers the basic concepts, terms, and notations related to multiple scattering theory; exponential integrals and related functions; reciprocity and detailed balance; different related methods; and homogenous atmospheres with arbitrary phase function and single-scattering albedo. Part II: Isotropic Scattering discusses related concepts such as solutions using the Milne operator; semi-infinite atmospheres; the H-functions; and finite slabs. The text is recommended for practitioners in optics, atmospheric physics, astronomy, and other fields that need a reference book in the subject of multiple light scattering.

**Electromagnetic Scattering by Particles and Particle Groups** Michael I. Mishchenko 2014-04-24 A self-contained, accessible introduction to the basic concepts, formalism and recent advances in electromagnetic scattering, for researchers and graduate students.

**Particle Size Measurements** Henk G. Merkus 2009-01-07 This book focuses on the practical aspects of particle size measurement: a major difference with existing books, which have a more theoretical approach. Of course, the emphasis still lies on the measurement techniques. For optimum application, their theoretical background is accompanied by quantitative quality aspects, limitations and problem identification. In addition the book covers the phenomena of sampling and dispersion of powders, either of which may be dominant in the overall analysis error. Moreover, there are chapters on the general aspects of quality for particle size analysis, quality management, reference materials and written standards, in- and on-line measurement, definitions and multilingual terminology, and on the statistics required for adequate interpretation of results. Importantly, a relation is made to product performance, both during processing as well as in final application. In view of its set-up, this book is well suited to support particle size measurement courses.

**Light Scattering by Nonspherical Particles** Michael I. Mishchenko 1999-09-22 There is hardly a field of science or engineering that does not have some interest in light scattering by small particles. For example, this subject is important to climatology because the energy budget for the Earth's atmosphere is strongly affected by scattering of solar radiation by cloud and aerosol particles, and the whole discipline of remote sensing relies largely on analyzing the parameters of radiation scattered by aerosols, clouds, and precipitation. The scattering of light by spherical particles can be easily computed using the conventional Mie theory. However, most small solid particles encountered in natural and laboratory conditions have nonspherical shapes. Examples are soot and mineral aerosols, cirrus cloud particles, snow and frost crystals, ocean hydrosols, interplanetary and cometary dust grains, and microorganisms. It is now well known that scattering properties of nonspherical particles can differ dramatically from those of "equivalent" (e.g., equal-volume or equal-surface-area) spheres. Therefore, the ability to accurately compute or measure light scattering by nonspherical particles in order to clearly understand the effects of particle nonsphericity on light scattering is very important. The rapid improvement of computers and experimental techniques over the past 20 years and the development of efficient numerical approaches have resulted in major advances in this field which have not been systematically summarized. Because of the universal importance of electromagnetic scattering by nonspherical particles, papers on different aspects of this subject are scattered over dozens of diverse research and engineering journals. Often experts in one discipline

(e.g., biology) are unaware of potentially useful results obtained in another discipline (e.g., antennas and propagation). This leads to an inefficient use of the accumulated knowledge and unnecessary redundancy in research activities. This book offers the first systematic and unified discussion of light scattering by nonspherical particles and its practical applications and represents the state-of-the-art of this important research field. Individual chapters are written by leading experts in respective areas and cover three major disciplines: theoretical and numerical techniques, laboratory measurements, and practical applications. An overview chapter provides a concise general introduction to the subject of nonspherical scattering and should be especially useful to beginners and those interested in fast practical applications. The audience for this book will include graduate students, scientists, and engineers working on specific aspects of electromagnetic scattering by small particles and its applications in remote sensing, geophysics, astrophysics, biomedical optics, and optical engineering. The first systematic and comprehensive treatment of electromagnetic scattering by nonspherical particles and its applications Individual chapters are written by leading experts in respective areas Includes a survey of all the relevant literature scattered over dozens of basic and applied research journals Consistent use of unified definitions and notation makes the book a coherent volume An overview chapter provides a concise general introduction to the subject of light scattering by nonspherical particles Theoretical chapters describe specific easy-to-use computer codes publicly available on the World Wide Web Extensively illustrated with over 200 figures, 4 in color

## **The Scattering of Light and Other Electromagnetic Radiation**

**Milton Kerker** 2013-10-22 The Scattering of Light and Other Electromagnetic Radiation discusses the theory of electromagnetic scattering and describes some practical applications. The book reviews electromagnetic waves, optics, the interrelationships of main physical quantities and the physical concepts of optics, including Maxwell's equations, polarization, geometrical optics, interference, and diffraction. The text explains the Rayleigh<sup>2</sup> theory of scattering by small dielectric spheres, the Bessel functions, and the Legendre functions. The author also explains how the scattering functions for a homogenous sphere change depending on different physical parameters such as the optical size, the complex refractive index, and the angle of observation. The author addresses the assignment of a complex dielectric constant and a corresponding refractive index to plasma when an alternating electrical field is applied that will make the plasma exhibit conductivity and polarization. In a liquid, the author points out that the intensity of scattering is one or two orders of magnitude less than that found in a gaseous system; he explains that the molecules are no longer acting as incoherent nor as randomly located scatterers. This book can be useful for physicists, chemists, biochemists, and engineers whose work includes research utilizing light scattering in the study of certain gases, pure liquids, molecular solutions, macromolecules, polymers, and glass.

## **Absorption & Scattering of Light by Small Particles** CF. Bohren 1983

**An Introduction to Atmospheric Radiation** K. N. Liou 2002-05-13 Fundamentals of radiation for atmospheric applications -- Solar radiation at the top of the atmosphere -- Absorption and scattering of solar radiation in the atmosphere -- Thermal infrared radiation transfer in the atmosphere -- Light scattering by atmospheric particulates -- Principles of radiative transfer in planetary atmospheres -- Application of radiative transfer principles to remote sensing -- Radiation and climate.

## **Theoretical Investigation of the Absorption and Scattering of Small Particles** N. L. Krascella 1965

**Noble and Precious Metals** Mohindar Seehra 2018-07-04 The use of copper, silver, gold and platinum in jewelry as a measure of wealth is well known. This book contains 19 chapters written by international authors on other uses and applications of noble and precious metals (copper, silver, gold, platinum, palladium, iridium, osmium, rhodium, ruthenium, and

rhodium). The topics covered include surface-enhanced Raman scattering, quantum dots, synthesis and properties of nanostructures, and its applications in the diverse fields such as high-tech engineering, nanotechnology, catalysis, and biomedical applications. The basis for these applications is their high-free electron concentrations combined with high-temperature stability and corrosion resistance and methods developed for synthesizing nanostructures. Recent developments in all these areas with up-to-date references are emphasized.

**Electromagnetic Scattering** Piergiorgio Uslenghi 2012-12-02

Electromagnetic Scattering is a collection of studies that aims to discuss methods, state of the art, applications, and future research in electromagnetic scattering. The book covers topics related to the subject, which includes low-frequency electromagnetic scattering; the uniform asymptotic theory of electromagnetic edge diffraction; analyses of problems involving high frequency diffraction and imperfect half planes; and multiple scattering of waves by periodic and random distribution. Also covered in this book are topics such as theories of scattering from wire grid and mesh structures; the electromagnetic inverse problem; computational methods for transmission of waves; and developments in the use of complex singularities in the electromagnetic theory. Engineers and physicists who are interested in the study, developments, and applications of electromagnetic scattering will find the text informative and helpful.

**Optical Measurements** Franz Mayinger 2013-03-14 Increasing possibilities of computer-aided data processing have caused a new revival of optical techniques in many areas of mechanical and chemical engineering.

Optical methods have a long tradition in heat and mass transfer and in fluid dynamics. Global experimental information is not sufficient for developing constitutive equations to describe complicated phenomena in fluid dynamics or in transfer processes by a computer program.

Furthermore, a detailed insight with high local and temporal resolution into the thermo- and fluid dynamic situations is necessary. Sets of equations for computer program in thermo dynamics and fluid dynamics usually consist of two types of formulations: a first one derived from the conservation laws for mass, energy and momentum, and a second one mathematically modelling transport processes like laminar or turbulent diffusion. For reliably predicting the heat transfer, for example, the velocity and temperature field in the boundary layer must be known, or a physically realistic and widely valid correlation describing the turbulence must be available. For a better understanding of combustion processes it is necessary to know the local concentration and temperature just ahead of the flame and in the ignition zone.

**Aerosol Optics** Alexander A. Kokhanovsky 2008-03-18 This new text offers experienced students a comprehensive review of available techniques for the remote sensing of aerosols. These small particles influence both atmospheric visibility and the thermodynamics of the atmosphere. They are also of great importance in any consideration of climate change problems. Aerosols may also be responsible for the loss of harvests, human health problems and ecological disasters. Thus, this detailed study of aerosol properties on a global scale could not be more timely.

**Light Scattering by Small Particles** H. C. van de Hulst 2012-06-08

Comprehensive treatment of light-scattering properties of small, independent particles, including a full range of useful approximation methods for researchers in chemistry, meteorology, and astronomy. 46 tables. 59 graphs. 44 illustrations.

**In Vivo Optical Imaging of Brain Function, Second Edition** Ron D.

Frostig 2009-05-06 These are exciting times for the field of optical imaging of brain function. Rapid developments in theory and technology continue to considerably advance understanding of brain function. Reflecting changes in the field during the past five years, the second edition of In Vivo Optical Imaging of Brain Function describes state-of-the-art techniques and their applications for the growing field of functional imaging in the live brain using optical imaging techniques. New in the Second Edition: Voltage-sensitive dyes imaging in awake behaving animals Imaging based on genetically encoded probes Imaging of mitochondrial auto-fluorescence as a tool for cortical mapping Using pH-sensitive dyes for functional mapping Modulated imaging Calcium imaging of neuronal activity using 2-photon microscopy Fourier approach to optical imaging Fully updated chapters from the first edition Leading Authorities Explore the Latest Techniques Updated to reflect continuous development in this emerging research area, this new edition, as with the original, reaches across disciplines to review a variety of non-invasive optical techniques used to study activity in the living brain. Leading authorities from such diverse areas as biophysics, neuroscience, and cognitive science present a host of perspectives that range from a single neuron to

large assemblies of millions of neurons, captured at various temporal and spatial resolutions. Introducing techniques that were not available just a few years ago, the authors describe the theory, setup, analytical methods, and examples that highlight the advantages of each particular method.

**Encyclopedia of Color Science and Technology** Ronnier Luo

2021-01-14 The Encyclopedia of Color Science and Technology provides an authoritative single source for understanding and applying the concepts of color to all fields of science and technology, including artistic and historical aspects of color. Many topics are discussed in this timely reference, including an introduction to the science of color, and entries on the physics, chemistry and perception of color. Color is described as it relates to optical phenomena of color and continues on through colorants and materials used to modulate color and also to human vision of color. The measurement of color is provided as is colorimetry, color spaces, color difference metrics, color appearance models, color order systems and cognitive color. Other topics discussed include industrial color, color imaging, capturing color, displaying color and printing color. Descriptions of color encodings, color management, processing color and applications relating to color synthesis for computer graphics are included in this work. The Encyclopedia also delves into color as it applies to other domains such as art and design - ie - color design, color harmony, color palettes, color and accessibility, researching color deficiency, and color and data visualization. There is also information on color in art conservation, color and architecture, color and education, color and culture, and an overview of the history of color and comments on the future of color. This unique work will extend the influence of color to a much wider audience than has been possible to date.

**A Method for Computing Nonlinear Scattering and Absorption of Light by Small Arbitrarily Shaped Particles** Michael James Guthrie 1992

**Light Scattering Media Optics** Alex A. Kokhanovsky 2004-08-05 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.

**Springer Series in Light Scattering** Alexander Kokhanovsky 2021-10-28

The book aims to the description of recent progress in studies of light absorption and scattering in turbid media. In particular, light scattering/oceanic optics/snow optics research community will greatly benefit from the publication of this book.

**Optical Properties of the Atmosphere (Third Edition)** R. A. McClatchey

1972 A series of tables and charts is presented from which the atmospheric transmittance between any two points in the terrestrial atmosphere can be determined. This material is based on a set of five atmospheric models ranging from tropical to arctic and two aerosol models. A selected set of laser frequencies has been defined for which monochromatic transmittance values have been given. For low resolution transmittance prediction, a series of charts has been drawn providing the capability for predicting transmittance at a resolution of 20 wave-numbers. Separate sections are included on scattered solar radiation, infrared emission, refractive effects, and attenuation by cloud and fog. This third edition differs from the others in that the low resolution spectral curves for the uniformly mixed gases and in the short wavelength region for water vapor have been revised, providing some overall improvement in accuracy; and more importantly, an appendix has been added providing model data and equivalent sea level path data for the U.S. Standard Atmosphere, 1962.

**Aerosol Remote Sensing** Jacqueline Lenoble 2013-02-11 This book gives a much needed explanation of the basic physical principles of radiative transfer and remote sensing, and presents all the instruments and retrieval algorithms in a homogenous manner. The editors provide, for the first time, an easy path from theory to practical algorithms in one easily accessible volume, making the connection between theoretical radiative transfer and individual practical solutions to retrieve aerosol information from remote sensing, and providing the specifics and intercomparison of all current and historical retrieval methods.

**Leaf Optical Properties** Stéphane Jacquemoud 2019-09-05 Presents state-of-the-art research into leaf interactions with light, for scientists working in remote sensing, plant physiology, ecology and resource management.

**Absorption and Scattering of Light by Small Particles** Craig F.

Bohren 1983-04-15 Treating absorption and scattering in equal measure, this self-contained, interdisciplinary study examines and illustrates how small particles absorb and scatter light. The authors emphasize that any discussion of the optical behavior of small particles is inseparable from a full understanding of the optical behavior of the parent material-bulk matter. To divorce one concept from the other is to render any study on scattering theory seriously incomplete.

**Scattering, Absorption, and Emission of Light by Small Particles**

Michael I. Mishchenko 2002-06-06 A thorough and up-to-date treatment of electromagnetic scattering by small particles.

**Introduction to Planetary Photometry**

Michael K. Shepard 2017-04-27 Introducing planetary photometry as a quantitative remote sensing tool, this handbook demonstrates how reflected light can be measured and used to investigate the physical properties of bodies in our Solar System. The author explains how data gathered from telescopes and spacecraft are processed and used to infer properties such as the size, shape, albedo, and composition of celestial objects including planets, moons, asteroids, and comets. Beginning with an overview of the history and background theory of photometry, later chapters delve into the physical principles behind commonly used photometric models and the mechanics of observation, data reduction, and analysis. Real-world examples, problems, and case studies are included, all at an introductory level suitable for new graduate students, planetary scientists, amateur astronomers and researchers looking for an overview of this field.

**Light Scattering by Particles** Peter W. Barber 1990 This book presents the separation-of-variables and T-matrix methods of calculating the scattering of electromagnetic waves by particles. Analytical details and computer programs are provided for determining the scattering and absorption characteristics of the finite-thickness slab, infinite circular cylinder (normal incidence), general axisymmetric particle, and sphere. The computer programs are designed to generate data that is easy to graph and visualize, and test cases in the book illustrate the capabilities of the programs. The connection between the theory and the computer programs is reinforced by references in the computer programs to equations in the text. This cross-referencing will help the reader understand the computer programs, and, if necessary, modify them for other purposes.

**Multiple Scattering of Light by Particles** Michael I. Mishchenko 2006-04-27 Monograph on multiple scattering of light by small particles; resource for science professionals, engineers, and graduate students.

**Spectroscopy and Radiative Transfer of Planetary Atmospheres**

Kelly Chance 2017-03-16 Spectroscopy and radiative transfer are rapidly growing fields within atmospheric and planetary science with implications on various fields. Remote sensing and modeling atmospheric composition require detailed knowledge of how radiation and matter interact in planetary atmospheres. This book provides this fundamental knowledge to a depth that will leave a student with the background to become capable of performing quantitative research on atmospheres. The book is intended for graduate students or for advanced undergraduates. It spans across principles through applications, with sufficient background for students without prior experience in either spectroscopy or radiative transfer. Courses based on this book are intended to be accompanied by the development of increasing sophisticated atmospheric and spectroscopic modeling capability (ideally, the student develops a computer model for simulation of atmospheric spectra from microwave through ultraviolet).

**The Mie Theory** Wolfram Hergert 2012-06-30 This book presents in a concise way the Mie theory and its current applications. It begins with an overview of current theories, computational methods, experimental techniques, and applications of optics of small particles. There is also some biographic information on Gustav Mie, who published his famous paper on the colour of Gold colloids in 1908. The Mie solution for the light scattering of small spherical particles set the basis for more advanced scattering theories and today there are many methods to calculate light scattering and absorption for practically any shape and composition of particles. The optics of small particles is of interest in industrial, atmospheric, astronomic and other research. The book covers the latest developments in divers fields in scattering theory such as plasmon resonance, multiple scattering and optical force.

**Handbook of Optical Biomedical Diagnostics** Valeriï Viktorovich Tuchin 2016 This text begins by describing the basic principles and diagnostic applications of optical techniques based on detecting and processing the scattering, fluorescence, FT IR, and Raman spectroscopic signals from various tissues, with an emphasis on blood, epithelial tissues, and human skin. The second half of the volume discusses specific imaging

technologies, such as Doppler, laser speckle, optical coherence tomography (OCT), and fluorescence and photoacoustic imaging.

**Absorption and Scattering of Light by Small Particles**

Craig F. Bohren 1983 Absorption and Scattering of Light by Small Particles Treating absorption and scattering in equal measure, this self-contained, interdisciplinary study examines and illustrates how small particles absorb and scatter light. The authors emphasize that any discussion of the optical behavior of small particles is inseparable from a full understanding of the optical behavior of the parent material-bulk matter. To divorce one concept from the other is to render any study on scattering theory seriously incomplete. Special features and important topics covered in this book include: \* Classical theories of optical properties based on idealized models \* Measurements for three representative materials: magnesium oxide, aluminum, and water \* An extensive discussion of electromagnetic theory \* Numerous exact and approximate solutions to various scattering problems \* Examples and applications from physics, astrophysics, atmospheric physics, and biophysics \* Some 500 references emphasizing work done since Kerker's 1969 work on scattering theory \* Computer programs for calculating scattering by spheres, coated spheres, and infinite cylinders

**Dynamic Light Scattering** Bruce J. Berne 2013-07-24 Lasers play an increasingly important role in a variety of detection techniques, making inelastic light scattering a tool of growing value in the investigation of dynamic and structural problems in chemistry, biology, and physics. Until the initial publication of this work, however, no monograph treated the principles behind current developments in the field. This volume presents a comprehensive introduction to the principles underlying laser light scattering, focusing on the time dependence of fluctuations in fluid systems; it also serves as an introduction to the theory of time correlation functions, with chapters on projection operator techniques in statistical mechanics. The first half comprises most of the material necessary for an elementary understanding of the applications to the study of macromolecules, or comparable sized particles in fluids, and to the motility of microorganisms. The study of collective (or many particle) effects constitutes the second half, including more sophisticated treatments of macromolecules in solution and most of the applications of light scattering to the study of fluids containing small molecules. With its wide-ranging discussions of the many applications of light scattering, this text will be of interest to research chemists, physicists, biologists, medical and fluid mechanics researchers, engineers, and graduate students in these areas.

**Fundamentals of Atmospheric Radiation** Craig F. Bohren 2006-08-21 Meeting the need for teaching material suitable for students of atmospheric science and courses on atmospheric radiation, this textbook covers the fundamentals of emission, absorption, and scattering of electromagnetic radiation from ultraviolet to infrared and beyond. Much of the contents applies to planetary atmosphere, with graded discussions providing a thorough treatment of subjects, including single scattering by particles at different levels of complexity. The discussion of the simple multiple scattering theory introduces concepts in more advanced theories, such that the more complicated two-stream theory allows readers to progress beyond the pile-of-plates theory. The authors are physicists teaching at the largest meteorology department in the US at Penn State. The problems given in the text come from students, colleagues, and correspondents, and the figures designed especially for this book facilitate comprehension. Ideal for advanced undergraduate and graduate students of atmospheric science. \* Free solutions manual available for lecturers at [www.wiley-vch.de/supplements/](http://www.wiley-vch.de/supplements/)

**Light and Water** Curtis D. Mobley 1994 Light and Water offers an extensive treatment of radiative transfer theory in a format tailored to the specific needs of optical oceanography, emphasizing physical comprehension and practical application, rather than mathematical rigor alone. Mobley presents his unique framework for understanding and predicting underwater light fields with care and precision, developing concepts to facilitate understanding of mathematically dense material. Numerical techniques for solving various radiative transfer equations are explained in settings that are realistic approximations of nature. Extensive references and problem sets are provided. Light and Water interweaves two levels of discussion. The first, suitable for all oceanography graduate students, develops the basic theory and reviews the current literature on optical oceanography. The second, which will appeal to researchers in the field, develops numerical methods for solving radiative transfer equations. Throughout, the text emphasizes applications of radiative transfer theory to practical, relevant, and realistic problems.

**Scattering of Light in a Turbid Medium** K. S. Shifrin 1959

*Spectrophotometry & Spectrofluorimetry* C. L. Bashford 1987 Using this book biochemists can determine how spectrophotometry can contribute to laboratory analyses. Emphasis is placed on the capabilities and limitations of the instrument in use--how to select a machine, how to check if it is working satisfactorily, and what to do if it fails to produce the data expected.

Light Scattering by Particles: Computational Methods

**Optical-Thermal Response of Laser-Irradiated Tissue** Ashley J. Welch 2011-01-15 The second edition maintains the standard of excellence established in the first edition, while adjusting the content to reflect changes in tissue optics and medical applications since 1995. The material concerning light propagation now contains new chapters devoted to electromagnetic theory for coherent light. The material concerning thermal laser-tissue interactions contains a new chapter on pulse ablation of tissue. The medical applications section now includes several new chapters on Optical Coherent Tomography, acoustic imaging, molecular imaging, forensic optics and nerve stimulation. A detailed overview is provided of the optical and thermal response of tissue to laser irradiation along with diagnostic and therapeutic examples including fiber optics. Sufficient theory is included in the book so that it is suitable for a one or two semester graduate or for senior elective courses. Material covered includes (1) light propagation and diagnostic application; (2) the thermal response of tissue and therapeutic application; (3) denaturation; and (4)

ablation. The theory and applications provide researchers with sufficient detail that this volume will become the primary reference for laser-tissue interactions and medical applications.

Light Scattering by Ice Crystals Kuo-Nan Liou 2016-10-06 This volume outlines the fundamentals and applications of light scattering, absorption and polarization processes involving ice crystals.

**Absorption and Scattering of Light by Small Particles** Craig F. Bohren 2008-09-26 Absorption and Scattering of Light by Small Particles Treating absorption and scattering in equal measure, this self-contained, interdisciplinary study examines and illustrates how small particles absorb and scatter light. The authors emphasize that any discussion of the optical behavior of small particles is inseparable from a full understanding of the optical behavior of the parent material-bulk matter. To divorce one concept from the other is to render any study on scattering theory seriously incomplete. Special features and important topics covered in this book include: \* Classical theories of optical properties based on idealized models \* Measurements for three representative materials: magnesium oxide, aluminum, and water \* An extensive discussion of electromagnetic theory \* Numerous exact and approximate solutions to various scattering problems \* Examples and applications from physics, astrophysics, atmospheric physics, and biophysics \* Some 500 references emphasizing work done since Kerker's 1969 work on scattering theory \* Computer programs for calculating scattering by spheres, coated spheres, and infinite cylinders