LIGHT SCATTERING MEDIA OPTICS: PROBLEMS AND SOLUTIONS
2^{ND} EDITION

A. A. KOKHANOVSKY

Preface

The first Edition of this book was warmly welcomed by light scattering community. The main idea behind the preparing this second Edition of the book was to wide the range of solutions considered. More illustrations and physical discussions were added. However, the main idea of the book, namely – the presentation of main approximate solutions of light scattering media optics in the short, instructive, and user-friendly form, was preserved.

The author is grateful to Prof. Alan R. Jones (Imperial College, UK) , Prof. Teruyuki Nakajima (University of Tokyo, Japan), and Prof. Reiner Weichert (Technical University Clausthal, Germany) for many helpful discussions of ligh scattering problems and continuous support. Special thanks are to Prof. A. P. Ivanov and researches of the Light Scattering Media Optics Laboratory in Minsk (B. I. Stepanov Institute of Physics, Belarus), where I spent 20 years in studies of various aspects of light interaction with inhomogeneous media. I also acknowledge the support by INTAS grant 99/652.

Last, but not least, I would like to underline that this book had never be prepared without help and understanding of my family to whom I devote it

PREFACE TO THE FIRST EDITION

The main subject of this book is the interaction of light with disperse systems, defined as ensembles of small particles in a host medium, within the framework of the physical optics. In principle, particles can have arbitrary size, chemical composition, internal structure, shape, and concentration. The light field is characterised by the Stokes vector or the density matrix.

Generally speaking, there are two methods for handling the problem. The first one is to solve the Maxwell's equations for the system of N particles. This method can be used only for small numbers of particles N because of limits, imposed by modern computers. Another approach calls for the replacement of a disperse system by a continuous medium with some phenomenological propagation constants. The last method is of frequent use in physical sciences. For instance, the electrodynamics o continuos media is based on essentially the same approach. Namely, the system of oscillating charges is replaced by a continuous medium with *a priori* defined values o the specific conductivity, dielectri permitivity, and magnetic permeability. These quantities are calculated within the framework of the quantum mechanics.

In the case of disperse of systems, one should calculate propagation constants (e.g., extinction and scattering coefficients) in the framework of the classic electrodynamics of continuous media and consider the light propagation in the framework of the radiative transfer theory afterwards. Such a simplified approach is possible only if the wavelength of the incident radiation is much smaller than the extinction and scattering lengths, defined as the inverse values of the extinction and scattering coefficients. This often holds for the optical band of the electromagnetic spectrum.

Both the electrodynamics of continuous media and the radiative transfer theory can be considered as special branches of the mathematical physics with its own characteristic methods and techniques. For example, the main task of the famous book of S. Chandrasekhar (1950), devoted to radiative transfer problems, was to present the subject of the radiative transfer as a branch of the mathematical physics.

My objective here is completely different. Exact methods are out f scope of this book. The main subject is the introduction to the approximate methods of the light scattering media optics. This is important for the derivation of simple equations, which relate microphysical (the size, shape, concentration of particles, their optical constants) and optical (the intensity or Stokes vector of the reflected, internal or transmitted light) properties of disperse systems. But the main key reason for my approach is that any field of the theoretical physics is not completely developed i simple solutions of a general problem at some limiting cases are not presented. According to this intention, the book is divided into following five parts.

Main definitions are presented in the introductory Chapter I.

Chapter II is devoted to the scattering theory, based on the Maxwell's equations. The main task of this part is to present approximate methods and results for the calculation of propagation constants. The special cases of small and large, optically soft and hard particles are considered.

The subject of Chapter III is approximate results of the radiative transfer theory. Approximate formulae are presented for the small and large value of the optical thickness of a scattering layer, weak and strong absorption of light in a medium, isotropic and highl anisotropic scattering of light by particles.

Complex problems of close-packed media, where the use of the radiative transfer equation is in question, are touched upon in Chapter IV.

Chapter V is the outcome of Chapters II-IV. Here the simple approximate relationships derived are used for the solution of a number of applied problems. For the most part attention is given to geophysical applications. Indeed, approximate methods are most suitable to the solution of geophysical problems. The investigator in the laboratory can prepare a special light-scattering medium and describe its optica properties with exact theoretical methods. This is impossible in the case of natura media, which are characterized by an extremely complex structure. An exac knowledge of the microstructure parameters of such media (particle size distributions, chemical compositions of particles, their shapes and concentrations) i not available *a priori*. Moreover, these parameters rapidly change in space and time. Thus, we arrive at the important conclusion that, in the field of geooptics, result obtained by exact and approximate methods can have about the same accurac (as compared with measurements). This gives the book its special value for tackling atmospheric optics problems and provides a rationale for its inclusion in the Wiley-Praxis Series in Atmospheric Physics and Climatology. However, I do hope that thi Chapter and the book as a whole will be useful for engineers and scientists, who deal with applied light-scattering problems in different branches of modern physics, geophysics, biophysics, and chemical physics.

Finally, I thank Eleonora Zege, who taught me light scattering.

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