BOOK REVIEW

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Michael I. Mishchenko, Larry D. Travis, Andrew A. Lacis: *Scattering, Absorption, and Emission of Light by Small Particles*; 2002, XV + 445 p., 168 figures; hard-cover GBP 65.00; Cambridge University Press, Cambridge, United Kingdom, ISBN 0-521-78252-X.

This excellent book is bound to become the principal standard reference on scattering of electromagnetic radiation by small particles. It is not a university-course textbook but a thorough and up-to-date review of both theory and solution techniques. The theory starts with the Maxwell equations; the solution techniques include detailed computer code descriptions. The presentation is impeccable, with good illustrations, complete references (including useful "further reading" sections at the end of each chapter), thorough appendices, and a useful symbol specification list. The book is a must for researchers in planetary atmosphere, climate, and remote sensing research. It is likely to also find many readers in varied other technology and science endeavours.

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BOOK REVIEW

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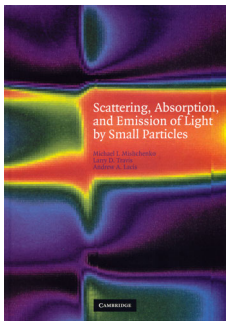
SCATTERING, ABSORPTION, AND EMISSION OF LIGHT BY SMALL PARTICLES

Michael I. Mishchenko, Larry D. Travis, and Andrew A. Lacis, 2002, 445 pp., $90.00, hardbound,
Cambridge University Press, ISBN 0-521-78252-X

Electromagnetic wave scattering by small particles is an interdisciplinary area of research with applications to fields ranging from biomedicine to climate research and remote sensing. The particles encountered in nature often deviate from the spherical and homogeneous model of the well-known Lorenz-Mie scattering theory. Recent technological advancements in observing systems, measuring techniques, and computers have enhanced our ability to observe and simulate physical systems. Along with the new applications, the need for accurate calculations of scattering, absorption, and emission properties of a wide range of irregular shapes and heterogeneous composition particles is prominent.

Mishchenko's book fills the need for an up-to-date and comprehensive description of theory, numerical methods, and practical applications on light scattering absorption and emis-

sion by small particles. The author does an excellent job of combining all the material into a coherent story. The book has the potential to serve as a reference book for researchers in a wide range of fields. The material is better organized than in previous works (e.g., Mishchenko et al. 2000), and provides an effective explanation of how the scattering and absorption properties behave in a much more general context than that provided by the Rayleigh theory (traditionally the realm of radar meteorologists). It puts universally accepted truths such as, "an oriented oblate spheroid produces positive ZDR because the horizontal axis is greater than the vertical one," into perspective, and thus, can effectively lead to new areas of applications.



The book is divided into three parts: I–Basic Theory; II–Overview of Methodologies; and III–Results (mainly simulations). Part I deals with the "basic theory of electromagnetic scattering, absorption, and emission." All necessary quantities (such as the Stokes parameters, scattering matrix, phase matrix, etc.) are introduced, and all the important relations (such as far-field scattering, reciprocity, etc.) are derived. The presentation is concise, clear, and self-contained. Unavoidably, there is overlapping with other books in the field. In particular, the choice of material follows closely that of Mishchenko et al. (2000) – for example, in chapter 1. In his previous work, however, the emphasis is on simply presenting the results, without giving details of the derivations, whereas here Mishchenko provides a more expanded and thorough presentation. Furthermore, much of the material has also been covered by Bohren and Huffman (1983) and van de Hulst (1957). Since these earlier treatments contained many new derivations and insights, they were more original than the present book. Nevertheless, this first section of the book is useful, mainly because it is well organized and because it describes accurately the present state-of-the-art in theoretical studies of electromagnetic wave scattering by nonspherical particles.

Part II deals with the "calculation and measurement of scattering and absorption characteristics of small particles." Most of it is devoted to the T-matrix method; the Lorenz-Mie theory is derived as a particular case of the T-matrix formulation. The material is an extended version of Mishchenko et al. (2000). Here, the derivations are described in greater detail and the presentation is much more self-contained. In particular, the following material has been added: 1) the procedure for computing the elements of the T-matrix is presented [following Tsang et al. (1985)]. 2) Mishchenko's T-matrix computer codes, which are also used by the meteorological community, are described in detail, including instructions on how to use them as well as illustrative examples. Other techniques using exact, approximate, and experimental methods, respectively, are discussed.

Part III presents many results (mainly from T-matrix simulations) for the scattering and absorption properties of a variety of particles. The authors devote one full chapter to spheres, which they use as exemplar small particles. The properties of particles of other shapes are then discussed relative to those of equal-surface spheres. The main question addressed is, how are deviations in the shape of a particle (with respect to a sphere) manifested in its scattering and absorption properties? Relative to previous treatments, the material on spheres overlaps partly with that of Bohren and Huffman (1983), whereas the material for nonspherical particles is, to a great extent, not available in other books. Overall, the chapter on nonspherical particles is the most important contribution of the book. The authors give reference results for a wide range of particle shapes (spheres, spheroids, finite cylinders, Chebyshev particles, polyhedral particles, ir-

regular particles, clusters of spheres, spheres with inclusions), several size parameters (from Rayleigh to geometric optics regime), and a number of scattering parameters (cross sections, angular scattering patterns, etc.). The presentation is clear and logically organized. First, results for monodisperse spheres are given. Next, the effects of averaging over size are discussed. Then, the effects of nonsphericity and of averaging over orientations are considered. Finally, the effects of averaging over shape are addressed. This final process is shown to transform the feature-full (e.g., rainbows, glories, etc.) angular scattering patterns of spheres to the featureless angular scattering patterns that are typically observed experimentally for naturally occurring collections of particles.

Mishchenko's book has a place in the related literature as a standard reference on light scattering by small particles. It may be a rather narrow story, but it is a full one. Theoreticians in particular will enjoy having the theoretical material (including the derivations), the information on computer codes, and the detailed numerical studies in the same volume. The book contains good illustrations and a plethora of detailed and complete references, including interesting "further reading" sections at the end of each chapter.

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