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BOOK REVIEW

Multiple Scattering: Interaction of Time-Harmonic Waves with N Obstacles. By P. A. MARTIN. Cambridge University Press, 2006. 450 pp. ISBN 0521 865549. £75.
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This is an impressive text that presents a catalogue of methods and techniques associated with the solution of a class of important problems emerging from the study of wave propagation in a range of physical applications. The focus is placed on the scalar-field theories of water waves and acoustics and the vector-field theories of electromagnetics and solid mechanics. Despite the fairly obvious connections, these topics are rarely considered in such detail alongside one another and books and research papers often only make casual references outside their immediate area of interest.

By choosing to focus on analytical, numerical and approximate solution techniques for single- and multiple-body scattering, rather than the specific application, the author is able to provide a platform for presenting a comprehensive account or a variety of modern solution techniques in the setting of each of the different wave theories.

Wave interaction between multiple obstacles can lead to many fascinating effects, especially when there exist large numbers of scatterers. Here a direct numerical assault becomes time-consuming and unwieldy. The key is often to be able to make as much analytical progress as possible to reduce eventual numerical effort and this is where the books heart really lies.

This book offers many different things. Treated as a handbook, many useful results can be readily accessed in modern and tangible notation, which may otherwise lurk in obscure texts (in fact, some results presented are new). There is also just enough detail to be able to follow through the derivations of the various results, something which has an intrinsic value. A vast number (over 1400) of references included in the book not only connect the methods presented to applications, but allow researchers specialising in one particular type of wave theory to access key contributions in other research disciplines. However, one would be missing a key element of this book if it were used soely for dipping into for references and results. The author has provided a perceptive and incisive insight into the techniques that are put before us. We are not bogged down unnecessarily with technical issues such as convergence, nor with implementation of numerical methods.

As one might expect, the author's own research interests run a thread through the book (for example, the emphasis on hypersingular integral equation methods), but any one-dimensionality is avoided by developing important related ideas in each of the main categories of wave theory.

In Chapter 1, the scope of the book is defined and the various wave equations introduced. Chapters 2 and 3 are devoted to 'addition theorems' in two and three dimensions and under different coordinate systems. These have intrinsic importance in multiple scattering, by providing a mapping from one local coordinate system to another. These chapters are the least easy to digest, being far removed from the application and dense in detailed analysis. The introduction of 'separation matrices'

is not only a useful notational device, but also exposes the underlying structure of the transformations. Multipole potentials for water wave problems are also introduced. Chapter 4 is related to the previous two chapters using the machinery therein to develop solutions based on separation methods (multipole methods) for single- and multiple-body problems. For scattering obstacles with non-simple geometric features, the use of boundary integral equations is inevitable, and chapters 5 and 6 are devoted to this, formulating equations for acoustics, electromagnetics, elasticity and water waves. Key issues associated with single-body scattering are addressed, for example the occurrence of irregular frequencies, which plague integral equations arising from nearly all applications of wave scattering. Fast multipole methods are described for multiple-body scattering before, in chapter 7, the powerful null-field and related T-matrix methods are described, allowing scattering properties of single scatterers in isolation to be constructed before being assembled into a multiple-scattering framework. Finally, in chapter 8, some approximation techniques for scatterers which are 'small' and/or widely-separated as well as large random arrangements of scatterers (homogenisation methods) are discussed, although there is no focus on localisation.

This book will appeal to applied mathematicians, physicists and engineers with an interest in applications involving the linear theory of wave scattering. In spite of the large quantity of detailed analysis that has been crammed into this book it is surprisingly compact, at only 437 pages, 80 of which are assigned to the comprehensive list of references. The widespread use of quotations within the text both provides a wonderful historical perspective on the development of the subject area and offers some welcome lighthearted relief from the analysis. I found this a book easy to dip in and out of at odd moments, as well as rewarding to the reader making a more serious investment of their time.

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