Finite Element and Boundary Element Applications in Quantum Mechanics

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Book review

Finite Element and Boundary Element Applications in Quantum Mechanics
L Ramdas Ram-Mohan
Oxford: Oxford University Press (2002)
624 pp £26.50 (paperback)
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Although this book is one of the Oxford Texts in Applied and Engineering Mathematics, we may think of it as a physics book.

It explains how to solve the problem of quantum mechanics using the finite element method (FEM) and the boundary element method (BEM). Many examples analysing actual problems are also shown. As for the ratio of the number of pages of FEM and BEM, the former occupies about 80%. This is, however, reasonable reflecting the flexibility of FEM.

Although many explanations of FEM and BEM exist, most are written using special mathematical expressions and numerical computation fields. However, this book is written in the 'language of physicists' throughout. I think that it is very readable and easy to understand for physicists.

In the derivation of FEM and the argument on calculation accuracy, the action integral and a variation principle are used consistently. In the numerical computation of matrices, such as simultaneous equations and eigen value problems, a description of important points is also fully given. Moreover, the practical problems which become important in the electron device design field and the condensed matter physics field are dealt with as example computations, so that this book is very practical and applicable.

It is characteristic and interesting that FEM is applied to solve the Schrödinger and Poisson equations consistently, and to the solution of the Ginzburg–Landau equation in superconductivity. BEM is applied to treat electric field enhancements due to surface plasmon excitations at metallic surfaces. A number of references are cited at the end of all the chapters, and this is very helpful.

The description of quantum mechanics is also made appropriately and the actual application of quantum mechanics in condensed matter physics can also be surveyed. In the appendices, the mathematical foundation, such as numerical quadrature formulae and Green's functions, is conveniently described.

I recommend this book to those who need to solve Schrödinger equations, especially within a system of complicated shape.

Tsuyoshi Ueta
Institute of Media and Information Technology, Chiba University, 1–33 Yayoi-cho, Inage-ku, Chiba, 263-8522, Japan

