

# Preface

The second edition is an enlarged and updated version of the book I completed in Canberra in June 1986. There are six new chapters, *Uniaxial anisotropy*, *Ellipsometry*, *Periodically stratified media*, *Neutron and X-ray reflection*, *Acoustic waves* and *Chiral isotropic media*. A first edition chapter has been split into two, dealing with *Pulses* and *Finite beams* separately. The chapters on matrix methods and on numerical methods have been combined into one. The former appendix is now the chapter *Particle waves*, preceding that on neutron and X-ray reflection. The second edition contains 20 chapters, some with their own appendices, compared with 13 chapters and one appendix in the first edition.

The aim remains the same: to present the theory of reflection and transmission of waves from and through (mainly) planar stratifications in a simple and physical way, from first principles. By that I mean from the Maxwell or Schrödinger equations, for instance. As a theorist, I have naturally favoured exact results and have emphasized universal conservation and invariance properties. However, many particular cases are made explicit in graphs and formulae. That's where the theory connects with reality (as revealed by experiment), and where one gets a physical feel for the meaning of the formulae. Applied topics do appear: two examples are the important phenomenon of attenuated total reflection in Chap. 10, and the reflectivity of multilayer dielectric mirrors in Chaps. 12 and 13.

I have tried to maintain a logical progression throughout, rather than a historical one. Nevertheless, due credit is given to the pioneers of the subject of wave reflection. Rayleigh (John William Strutt, 3rd Baron Rayleigh, 1842–1919) features prominently, as may be expected given the influence of his work, especially of his *Theory of sound*. Even so, some of his reflection papers seem to have been forgotten and his results keep being rediscovered, often in inferior form. The Rayleigh (or weak reflection) approximation is an example, and appears frequently throughout the book.

Rayleigh was of privileged birth and made the most of the consequent opportunities. Not so privileged was George Green (1793–1841), the baker's and later miller's son. He was almost entirely self-taught, having just one year of formal

schooling as a child, between the ages of 8 and 9, and becoming a Cambridge undergraduate when nearly 40. Green's functions form the basis of the perturbation theories for long waves in Chap. 3 and for short waves in Chap. 6. No surprise there. But who talks of the Liouville–Green wavefunctions, or who has heard of Green's angle? The former are the high-frequency waveforms dating back to 1837. Green's angle, as I have called it in Sect. 1.4, is the acoustic analogue of the Brewster angle, at which one polarization has zero reflectance from a sharp interface.

Rayleigh's use of  $k$  for wavenumber has become the standard, and I have built on that to maintain a consistent notation throughout the book, as far as possible. The normal and tangential components of the wavevector  $\mathbf{k}$  are always labelled  $q$  and  $K$ ; the latter is special in being an invariant for waves in plane-stratified media, with the laws of reflection and transmission consequent from that invariance. Greek letters are used (not exclusively, but in preference) for dimensionless quantities.

The book is written for scientists and engineers whose work involves wave reflection or transmission. Most of the chapters are in the language of electromagnetic theory, but many of the electromagnetic results can be applied to particle waves, specifically to those satisfying the Schrödinger equation. The mathematical connection between electromagnetic  $s$  (or TE) waves and quantum particle waves is established in Chap. 1. The main results for  $s$  waves are translated into quantum mechanical language in the Chap. 15. There is also a close analogy between acoustic waves and electromagnetic  $p$  (or TM) waves, as shown in Sect. 1.4, and in detail in Chap. 17. Thus the book, though primarily intended for researchers working in optics, microwaves or in neutron or X-ray optics, will be of use to physicists, chemists and electrical engineers studying reflection and transmission of particles at potential barriers, and also to those working in acoustics, oceanography and seismology.

Chapter 1 is recommended for all readers: it introduces reflection phenomena, defines the notation and previews (in Sect. 1.6) the contents of the rest of the book. The reader can then go to any other chapter in the book, all of which are intended to be sufficiently self-contained so that only occasional reference to other parts of the book is needed.

The first edition was written at the Department of Applied Mathematics of the Australian National University, Canberra. In the Preface I had the pleasure of thanking two Australians, Barry Ninham and Colin Pask. The second edition was written in New Zealand, but I again have pleasure of thanking two Australians, this time Tony Klein and Andrew Wildes, for their suggestions and comments on the new chapter on X-ray and neutron reflection.

Wellington

John Lekner

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Lekner, J.

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