# Introduction to surface and superlattice excitations

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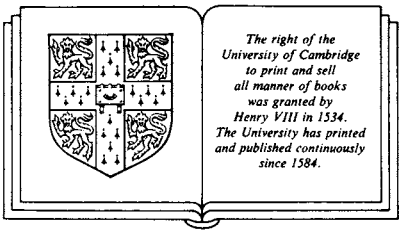


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# Preface

The past twenty years have seen a great expansion in the study of surface properties. One part of this activity has been concerned with the various acoustic, magnetic and optic modes that propagate at the surface of a solid or liquid. These modes have a great deal in common, for example, they are often characterised by an amplitude that decays as an exponential (or sometimes a sum of exponentials) with distance from the surface. The generality of the concepts is well known to research groups working on surface modes, and most of them have made contributions across the board. However, although a number of excellent advanced monographs and review articles have appeared, there is no introduction to the field. The present work is designed to fill this gap.

Our intention is to provide an introductory text for someone starting research on surface modes or extending their range from one type of surface mode to another. It is hoped in addition that much of the material will be useful for advanced undergraduate teaching. In keeping with this pedagogical character, we have provided problems at the end of each chapter, and the lists of references are extensive, although we do not claim that they are comprehensive.

The experimental techniques employed for the study of surface modes are described, some in Chapter 1, and the more specialised techniques at the appropriate points in later chapters. The experimental data that are shown have been selected to clarify the discussion and not with any intention, for example, of always showing the latest available results.

The theoretical description of surface modes can be given at two levels. First, homogeneous equations of motion can be solved for a dispersion equation (frequency versus wavevector) and related properties such as variation of amplitude with distance from the surface; this level is adequate for understanding most of this book. Second, inhomogeneous equations

can be solved to find Green functions by means of linear response theory. This method is harder, but it gives more complete information, including, for example, thermal fluctuation spectra and scattering cross sections. For those who are interested, we have given the basic formalism in the Appendix, and details of a Green function calculation are given just once, in Chapter 2.

Somewhere in the middle of the gestation period of this book the authors got involved in the worldwide effort on superlattices. A system with a large number of interfaces is an obvious generalisation of a system with one or two interfaces, so naturally many ideas about surface modes carry over for superlattices. We have therefore included a chapter on this topic.

The book is primarily concerned with acoustic, magnetic and optic properties, mainly because they are closely related, but also because that is where the bulk of our own experience lies. This means that some topics, although substantial, are dealt with only briefly. In particular, electronic properties do not feature largely, since to do more than we have would have required a lengthy digression into electron-band theory. Likewise, the discussion of liquid surfaces is restricted in scope.

Our indebtedness to a large number of friends and collaborators will be clear from the book. It has been our privilege for the last ten years or more to be part of the theoretical surfaces group at Essex, and to develop many ideas with the help of Professor Rodney Loudon, Dr Mohamed Babiker and Dr Stephen Smith. Our graduate students, now established in their own careers, include John Nkoma, Enaldo Sarmento, Karsono bin Dasuki, Latiff bin Awang, Eudenilson Albuquerque, Fernando Oliveira, Bob Moul, Demosthenes Kontos, Marcilio Oliveros, Arnobio dos Santos, Aurino Ribeiro Filho, Nilesh Raj, Nic Constantinou, Roger Philp, Monkami Masale, Hossein Heidarpour and Heidar Khosravi. We are grateful to all of them. People elsewhere who have contributed to our understanding include the surfaces groups in Irvine, California; Natal, Brazil; Exeter, England, and Royal Holloway and Bedford New College, England. Their work features in many parts of the book.

Finally, we should like to express our thanks to two people. Simon Capelin, the commissioning editor, has given us unfailing encouragement and allowed us a free hand over content. Carol Snape has typed the book with an accuracy which is no less amazing because we have become accustomed to it.

Mike Cottam
David Tilley
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