

# Lattice dynamics

## From fundamental research to practical applications

**Johan Tidholm**



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# Introduction To Lattice Dynamics

**Gyaneshwar P. Srivastava**



## **Introduction To Lattice Dynamics:**

**Introduction to Lattice Dynamics** Martin T. Dove,1993-10-21 The vibrations of atoms inside crystals lattice dynamics is basic to many fields of study in the solid state and mineral sciences This book provides a self contained text that introduces the subject from a basic level and then takes the reader through applications of the theory **An Introduction to Lattice Dynamics** Ajoy K. Ghatak,L. S. Kothari,1972 **An Introduction to Lattice Dynamics** Ajoy K. Ghatak,1972 *An Introduction to Lattice Dynamics [by] A.K. Ghatak [and] L.S. Kothari* Ajoy K. Ghatak,1972 **The Lattice Dynamics and Statics of Alkali Halide Crystals** J. R. Hardy,2012-12-06 Lattice dynamics is a classic part of solid state physics and the alkali halide crystals are classic materials Nearly every new technique in many body theory has first been applied to lattice dynamical problems and much of our present understanding of the physics of real crystals has its origins in pioneering work both experimental and theoretical carried out between 1920 and 1950 on alkali halide systems The object of the present text is to present a unified coverage of that part of physics where these two areas overlap and to extend this coverage somewhat in order to include not merely the dynamical behavior of alkali halides but also their static behavior Specifically we discuss the manner in which these materials respond to the presence of point imperfections The rationale for this extension is simple mechanics includes both dynamics and statics and a text which discusses the former should also discuss the latter Two other unifying themes are also present the data presented are largely the result of our long collaboration in this area and the work is a partial history of the impact of digital computers on lattice dynamics an impact which parallels their impact on the whole of solid state physics Since this work is largely an account of model calculations we have stressed the use of the simplest possible model at each level of sophistication and its uniform application to the crystals discussed **Quantum Mechanics** Ajoy Ghatak,S. Lokanathan,2004-03-31 An understanding of quantum mechanics is vital to all students of physics chemistry and electrical engineering but requires a lot of mathematical concepts the details of which are given with great clarity in this book Various concepts have been derived from first principles so it can also be used for self study The chapters on the JWKB approximation time independent perturbation theory and effects of magnetic field stand out for their clarity and easy to understand mathematics Two complete chapters on the linear harmonic oscillator provide a very detailed discussion of one of the most fundamental problems in quantum mechanics Operator algebra is used to show the ease with which one can calculate the harmonic oscillator wave functions and study the evolution of the coherent state Similarly three chapters on angular momentum give a detailed account of this important problem Perhaps the most attractive feature of the book is the excellent balance between theory and applications and the large number of applications in such diverse areas as astrophysics nuclear physics atomic and molecular spectroscopy solid state physics and quantum well structures *Lattice Dynamics* R. F. Wallis,2013-09-03 Lattice Dynamics covers the proceedings of the 1963 International Conference on Lattice Dynamics held at the Niels Bohr Institute of the University of Copenhagen on August 5-9

This book is composed of seven parts that focus on a better fundamental understanding of the interactions between atoms in solids and their role in lattice dynamics. The major topics covered include phonon dispersion curves, anharmonic effects, optical and dielectric effects, influence of defects on lattice vibrations, elasticity and developments. Papers on the study of vibrational spectra by infrared absorption, X-ray and neutron scattering, and the electron tunneling effects, as well as papers on the influence of defects and on a variety of other problems in lattice dynamics, are included. This book will prove useful to applied physicists and researchers in the field and related fields of lattice dynamics.

*The Physics of Phonons* Gyaneshwar P. Srivastava, 2019-07-16

There have been few books devoted to the study of phonons, a major area of condensed matter physics. *The Physics of Phonons* is a comprehensive theoretical discussion of the most important topics, including some topics not previously presented in book form. Although primarily theoretical in approach, the author refers to experimental results wherever possible, ensuring an ideal book for both experimental and theoretical researchers. The author begins with an introduction to crystal symmetry and continues with a discussion of lattice dynamics in the harmonic approximation, including the traditional phenomenological approach and the more recent *ab initio* approach, detailed for the first time in this book. A discussion of anharmonicity is followed by the theory of lattice thermal conductivity, presented at a level far beyond that available in any other book. The chapter on phonon interactions is likewise more comprehensive than any similar discussion elsewhere. The sections on phonons in superlattices, impure and mixed crystals, quasicrystals, phonon spectroscopy, Kapitza resistance, and quantum evaporation also contain material appearing in book form for the first time. The book is complemented by numerous diagrams that aid understanding and is comprehensively referenced for further study. With its unprecedented wide coverage of the field, *The Physics of Phonons* will be indispensable to all postgraduates, advanced undergraduates, and researchers working on condensed matter physics.

**Interstitial Intermetallic Alloys** F.

Grandjean, G.J. Long, K.H.J. Buschow, 2012-12-06

It is well known that the density of molecular hydrogen can be increased by compression and/or cooling, the ultimate limit in density being that of liquid hydrogen. It is less well known that hydrogen densities of twice that of liquid hydrogen can be obtained by intercalating hydrogen gas into metals. The explanation of this unusual paradox is that the absorption of molecular hydrogen, which in TiFe and LaNi<sub>5</sub> is reversible and occurs at ambient temperature and pressure, involves the formation of hydrogen atoms at the surface of a metal. The adsorbed hydrogen atom then donates its electron to the metal conduction band and migrates into the metal as the much smaller proton. These protons are easily accommodated in interstitial sites in the metal lattice, and the resulting metal hydrides can be thought of as compounds formed by the reaction of hydrogen with metals, alloys, and intermetallic compounds. The practical applications of metal hydrides span a wide range of technologies, a range which may be subdivided on the basis of the hydride property on which the application is based. The capacity of the metal hydrides for hydrogen absorption is the basis for batteries, as well as for hydrogen storage, gettering, and purification. The temperature-pressure characteristics of metal hydrides are the basis for

hydrogen compressors sensors and actuators The latent heat of the hydride formation is the basis for heat storage heat pumps and refrigerators      *Ultrasonic Spectroscopy* Robert G. Leisure, 2017-06-09 Elasticity Acoustic waves in solids Experimental methods Elastic constants Ultrasonic loss      **Introduction to Surface and Superlattice Excitations** Michael G. Cottam, David R. Tilley, 1989-04-06 Cottam and Tilley provide an introduction to the properties of wave like excitations associated with surfaces and interfaces The emphasis is on acoustic optic and magnetic excitations and apart from one section on liquid surfaces the text concentrates on solids The important topic of superlattices is also discussed in which the different kinds of excitation are considered from a unified point of view Throughout the book the authors are careful to relate theory and experiment and all of the most important experimental techniques are described The theoretical treatment assumes only a knowledge of undergraduate physics except for Green function methods that are used in a few sections these methods are developed in an appendix The book also contains extensive references to enable the reader to consult the research and review literature and problems are provided in each of the main chapters to allow the reader to develop topics presented in the text      Treatise on Geophysics, Volume 2 G David Price, 2010-04-20 Treatise on Geophysics Mineral Physics Volume 2 provides a comprehensive review of the current state of understanding of mineral physics Each chapter demonstrates the significant progress that has been made in the understanding of the physics and chemistry of minerals and also highlights a number of issues which are still outstanding or that need further work to resolve current contradictions The book first reviews the current status of our understanding of the nature of the deep Earth These include the seismic properties of rocks and minerals problems of the lower mantle and the core mantle boundary and the state of knowledge on mantle chemistry and the nature and evolution of the core The discussions then turn to the theory underlying high pressure high temperature physics and the major experimental methods being developed to probe this parameter space The remaining chapters explain the specific techniques for measuring elastic and acoustic properties electronic and magnetic properties and rheological properties the nature and origin of anisotropy in the Earth the properties of melt and the magnetic and electrical properties of mantle phases Self contained volume starts with an overview of the subject then explores each topic with in depth detail Extensive reference lists and cross references with other volumes to facilitate further research Full color figures and tables support the text and aid in understanding Content suited for both the expert and non expert

Microscopic Properties and Processes in Minerals Charles Richard Arthur Catlow, 1999-10-31 One of the major developments in Earth Sciences in general and mineralogy in particular has been the growth of our understanding of the microscopic behaviour of the complex materials that make up the Earth This has been made possible by advances in our ability to probe minerals at the atomic level over a large range of pressure and temperature conditions New experimental techniques include the use of scanning probe microscopies to investigate mineral surfaces as well as the use of neutron scattering nuclear spectroscopies and synchrotron radiation to investigate the bonding and structure of minerals In addition

there have been major developments in computational methods so that it is now possible to calculate the electronic structure of many rock forming materials The aim of this volume is to give a coherent survey of the latest developments in experimental and theoretical approaches to the study of microscopic properties and processes in minerals Chapters in the book cover a number of key themes in the mineral sciences such as the behaviour of minerals at extremes of pressure and temperature ordering in complex silicates mechanisms of water incorporation in mantle phases the importance of reactions occurring at the mineral surface and the ability of computational methods to provide useful qualitative information on the bulk and surface properties of minerals The background to several experimental techniques is covered in some detail with examples of relevance to the issues cited above

*Handbook of Elastic Properties of Solids, Liquids, and Gases, Four-Volume Set* Moises Levy, Henry Bass, Richard Stern, 2000-10-23 Sound waves propagate through galactic space through two dimensional solids through biological systems through normal and dense stars and through everything that surrounds us the earth the sea and the air We use sound to locate objects to identify objects to understand processes going on in nature to communicate and to entertain The elastic properties of materials determine the velocity of sound in them and tell us about their response to stresses something which is very important when we are trying to construct manufacture or create something with any material The Handbook of Elastic Properties of Materials will provide these characteristics for almost everything whose elastic properties has ever been measured or deduced in a concise and approachable manner Leading experts will explain the significance of the elastic properties as they relate to intrinsic microscopic behavior to manufacturing to construction or to diagnosis They will discuss the propagation of sound in newly discovered or created materials and in common materials which are being investigated with a fresh outlook The Handbook will provide the reader with the elastic properties of the common and mundane the novel and unique the immense and the microscopic and the exorbitantly dense and the ephemeral You will also find the measurement And theoretical techniques that have been developed and invented in order to extract these properties from a reluctant nature and recalcitrant systems Key Features Solids liquids and gases covered in one handbook Articles by experts describing insights developed over long and illustrious careers Properties of esoteric substances such as normal and dense stars superfluid helium three fullness two dimensional solids extraterrestrial substances gems and planetary atmospheres Properties of common materials such as food wood used for musical instruments paper cement and cork Modern dynamic elastic properties measurement techniques

*Solid State Physics*, 2014-05-14 Solid State Physics [Vibrational Properties of Solids](#) Gideon Gilat, 2012-12-02 Methods in Computational Physics Volume 15 Vibrational Properties of Solids explores the application of computational methods to delineate microscopic vibrational behavior This book is composed of nine chapters that further illustrate the utility of these methods to ordered lattices quantum solids impurity modes surface modes and amorphous solids The opening chapters present the basic theoretical models and their computational aspects for different solids of diverse chemical nature together with some

methods of automation and computation in the highly sophisticated experiments in inelastic scattering of neutrons These topics are followed by a discussion on how group theoretical methods treated by computers can yield the proper symmetry assignments of phonon eigenvalues and eigenstates Considerable chapters are devoted to the different applications of traditional lattice dynamics each having its own computational ramification Other chapters survey the properties of solids that mostly involve integrations over the Brillouin zone The last chapter concerns the dynamic or time dependent aspect of lattice dynamics namely the calculation of thermal and electric conductivities in some models of solids This book is of great benefit to geoscientists physicists and mathematicians

**Chemical Mössbauer Spectroscopy** R.H. Herber, 2012-12-06

The past twenty five years roughly the period from 1960 to 1985 have been by all measures among the most exciting and challenging times of our science The increasing sensitivity of chemical instrumentation the introduction of the routine use of computers for data reduction and of microprocessors for instrumental control the wide spread utilization of lasers and the disappearance of traditional disciplinary boundaries between scientific fields are but a few of the examples one could cite to support the introductory contention Almost all of these developments have had their impact on the development of Mossbauer Effect Spectroscopy into a technique par excellence for the elucidation of problems in all areas of chemistry and its associated sister sciences Indeed because this spectroscopy is based on fundamental phenomena in nuclear physics is described in terms of the theory of the solid state and structural chemistry is useful in the understanding of chemical reactivity and biological phenomena and can serve to supplement information developed by many other experimental techniques it has provided an unparalleled opportunity for the exchange of ideas among practitioners of a very wide variety of subfields of the physical and biological sciences The present collection of contributions is the direct result of such an interaction

Frustrated Materials and Ferroic Glasses Turab Lookman, Xiaobing Ren, 2018-11-01 This book provides a comprehensive introduction to ferroics and frustrated materials Ferroics comprise a range of materials classes with functionalities such as magnetism polarization and orbital degrees of freedom and strain Frustration due to geometrical constraints and disorder due to chemical and or structural inhomogeneities can lead to glassy behavior which has either been directly observed or inferred in a range of materials classes from model systems such as artificial spin ice shape memory alloys and ferroelectrics to electronically functional materials such as manganites Interesting and unusual properties are found to be associated with these glasses and have potential for novel applications Just as in prototypical spin glass and structural glasses the elements of frustration and disorder lead to non ergodicity history dependence frequency dependent relaxation behavior and the presence of inhomogeneous nano clusters or domains In addition there are new states of matter such as spin ice however it is still an open question as to whether these systems belong to the same family or universality class The purpose of this work is to collect in a single volume the range of materials systems with differing functionalities that show many of the common characteristics of geometrical frustration where interacting degrees of freedom do not fit in a

lattice or medium and glassy behavior is accompanied by additional presence of disorder The chapters are written by experts in their fields and span experiment and theory as well as simulations Frustrated Materials and Ferroic Glasses will be of interest to a wide range of readers in condensed matter physics and materials science

**Vibrational Spectroscopy of Solids** P. M. A. Sherwood, 1972-09-21 This 1972 monograph is devoted to the analysis and interpretation of the infrared and Raman spectra of solid compounds frequently used for their identification and characterization It was thought unsatisfactory to analyse such spectra by the theory applicable to gas phase samples though this was frequently done Furthermore the results obtained by far infrared and laser Raman spectrometers which detect the movement of atoms and or molecules as a whole had no gas phase analogy A separate approach to solid state vibrational spectra was therefore proposed within this volume Dr Sherwood describes the solid state physics of vibrational spectroscopy and extends it to the more complex structures of low symmetry He assumes an understanding of the infrared and Raman spectra of gases

**Physics of Solids** Mr. Rohit Manglik, 2024-06-24 Examines solid state physics including crystal structures electronic properties and thermal behavior with applications in materials science

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