Lattice Dynamics

The Physics of Phonons. J. A. REISSLAND. Wiley-Interscience, New York, 1973. xii, 320 pp., illus. $19.95.

The appearance of this book testifies to the continuing interest in lattice dynamics, one of the oldest branches of solid state physics. The first four of its eight chapters take the reader through such introductory material as the establishment of the Hamiltonian operator for the atomic motions in a crystal and in the harmonic approximation, the equations of motion that follow from it, its simplification in terms of normal coordinates, the solution of the equations of motion for the frequencies of the normal modes of vibration and the associated polarization vectors, Brillouin zones, interatomic potentials for different crystal types, the relation of elasticity theory to the long wavelength limit of lattice dynamics, the distribution function for normal mode frequencies, the quantization of lattice vibrations, and the thermodynamic properties of solids, including phenomenological treatments of thermal expansion and melting. The presentation of this material is clear, and the emphasis appears to be on the use of simple crystal models for the establishment of results rather than on obtaining results in the greatest generality.

The second half of the book is devoted to the study of the interaction of phonons with other phonons and with other elementary excitations in solids, such as infrared photons, x-rays and gamma-rays, neutrons, electrons, excitons, and magnons. These chapters present the perturbation theory for weakly anharmonic crystals and its application to the calculation of equilibrium properties such as the Helmholtz free energy and to the calculation of time-dependent properties through the Matsubara thermodynamic Green's function approach. Thermal expansion, the temperature dependence of the elastic constants, ultrasonic attenuation, thermal conductivity, dielectric properties, piezoelectricity, and ferroelectricity are discussed in a deliberately "thumbnail-sketch" fashion in order to illustrate the utility of the preceding theoretical methods in a variety of physical phenomena in which lattice dynamics plays a fundamental role, as well as to introduce the phenomena themselves.

A set of nine appendices presents a variety of specialized topics that bear on material presented in the text but are peripheral to it. Each chapter is fol-

lowed by a summary and a set of chapter notes that generally provide details of derivations in the text in addition to references.

There is no discussion of the use of symmetry and group theory in the solution of lattice dynamical problems, except for the role of lattice periodicity in the establishment of wave vector conservation laws. The majority of the material presented presupposes a perfect, infinitely extended crystal: There is almost no mention of the effects of defects on lattice vibrations. The discussion of the mean square displacement of an atom in section 4.8 is incorrect in its assumption that cross terms between different Cartesian components disappear, and does not apply even to cubic crystals, for which the expression given is too large by a factor of 3. Nevertheless, because of the range of topics it does cover, its extensive use of simple models and examples to make its points, and the general clarity of its presentation, the book is a useful addition to the literature of phonon physics.

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Harriot's Achievements

Thomas Harriot. Renaissance Scientist. JOHN W. SHIRLEY, Ed. Clarendon (Oxford University Press), New York, 1974. x, 182 pp., illus., + plates. $21.

There is probably no early European scientist so distinguished and yet so poorly known as Thomas Harriot. Harriot, who lived from 1560 to 1621, was roughly contemporary with Galileo and Kepler—and the available evidence suggests that his intellect was the equal of theirs. For example, Harriot appears to have been the first to discover the sine law of refraction (which eluded Kepler); he studied ballistic curves and proved them to be parabolic; he made telescopic observations of the moon within several weeks of Galileo's first telescopic observation of the heavens (without knowledge of Galileo's work), and his observations of sunspots were superior in some respects to Galileo's; he was one of the earliest proponents of Keplerian ellipses in all of Europe (by 1610); he belonged to a circle of philosophers instrumental in introducing the atomic philosophy into England as an alternative to Aristotelian natural philosophy; he made important

contributions to the early development of algebra and explored the characteristics of a binary number system; he studied the mathematics of navigation and suggested improvements in navigational practice; and, finally, he made important studies in the natural history and ethnography of North America, which he visited at least once.

Harriot spent most of his adult life in the employ of two patrons, Sir Walter Ralegh and Henry Percy, ninth Earl of Northumberland. He tutored Ralegh in mathematics and the art of navigation and participated in Ralegh's adventures in the New World. When Ralegh was committed to the Tower of London, Harriot became a member of the Earl of Northumberland's household, "an intellectual companion, and an associate free to follow his interest in mathematics and experimental sciences" (p. 26). Northumberland surrounded himself with scientific books and some of England's brightest intellects, and of the latter Harriot was clearly preeminent. Our ignorance of Harriot's achievements is largely the result of his failure to carry his researches through to completion and commit his findings to print. His only printed works are *A Briefe and True Report of the New Found Land of Virginia* (London, 1588) and his posthumous *Artis analyticae praxis, ad aequationes algebraicas nova . . . methodo resolvendas* (London, 1631). However, some 10,000 pages of his scientific manuscripts are extant, and these are beginning to yield their secrets to historians of science.

The volume under review, a collection of seven articles originally presented at a Thomas Harriot symposium in 1971, represents a cross section of current research. The articles and their authors are "Harriot's science, the intellectual background," by Edward Rosen; "Sir Walter Ralegh and Thomas Harriot," by John W. Shirley; "Thomas Harriot and the New World," by David B. Quinn; "Harriot's earlier work on mathematical navigation: theory and practice," by Jon V. Pepper; "Henry Stevens and the associates of Thomas Harriot," by R. C. H. Tanner; "Harriot, Hill, Warner and the new philosophy," by Jean Jacquot; and "Thomas Harriot and the first telescopic observations of sunspots," by John North. The articles are followed by a useful bibliography of Harriot's papers and printed literature dealing with his life and labors.

For the most part the articles are a specialized lot, and the reader should