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<<准晶数学的弹性理论及应用>>

图书基本信息

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前言

This monograph is devoted to the development of a mathematical theory of elasticit: of quasicrystals and its applications. Some results on elastodynamics and plasticitl of quasicrystals are also included to document preliminary advances in recent yearsThe first quasierystal was observed in 1982 and reported in November 1984. A that time several physical and mathematical theories for quasicrystal study alreadl existed. Soon after the discovery, the theory of elasticity of quasicrystals was pu forward. Based on Landau-Anderson symmetry-breaking, a new elementary exci ration - the phason - was introduced in addition to the well known phonon. The phason concept was suggested in the 1960's in incommensurate phase theory. Groul theory and discrete geometry e.g. the Penrose tiling provide further explanation to quasierystals and their elasticity from the standpoint of algebra and geometry The phonon and phason elementary excitations form the basis of the theory of elas ticity of this new solid phase. Many theoretical （condensed matter） physicists have spent a great deal of effort on constructing the fundamental physical framework othe theory of elasticity of quasicrystals. Applications of group theory and groul representation theory further enhance the physical basis of the description. On the, basis of the physical framework and by extending the methodology of mathematica physics and classical elasticity, the mathematical theory of elasticity of quasierystal, has been developed. Recent studies on the elasto-/hydro-dynamics and the plastic. ity of quasierystals have made preliminary but significant progress. As regards the dynamics, there are various viewpoints in the quasierystal community, which the unusual characteristics of phason dynamics. Yet the effect of the phason de. grees of freedom on plastic deformation is not well understood, and the basic plastic properties of the material are virtually unknown. Because of many unsolved critica issues, the study of quasicrystals has attracted many researchers. The contex of the last few chapters in this book is a probe of the fascinating research area.

内容概要

This inter-disciplinary work covering the continuum mechanics of novel materials, condensed matter phyics and partial differential equations discusses the mathematical theory of elasticity of quasicrystals (a new condensed matter) and its applications by setting up new partial differential equations of higher order and their solutions under complicated boundary value and initial value conditions. The new theories developed here dramatically simplify the solving of complicated elasticity equation systems. Large numbers of complicated equations involving elasticity are reduced to a single or a few partial differential equations of higher order. Systematical and direct methods of mathematical physics and complex variable functions are developed to solve the equations under appropriate boundary value and initial value conditions, and many exact analytical solutions are constructed.

书籍目录

章节摘录

插图：In general, the course of crystallography does not contain the contents given in this section. Because the discussion here is dependent on quasicrystals, especially with the elasticity of quasicrystals, we have to introduce some of the simplest relevant arguments.In 1900, Planck put forward the quantum theory. Soon after Einstein developed the theory and explained the photo-electric effect, which leads to the photon concept. Einstein also studied the specific heat c~ of crystals by using the Planck quantum theory. There are some unsatisfactory points in the work of Einstein although his formula explained the phenomenon of c~ = 0 at T = 0, where T denotes the absolute temperature. To improve Einstein's work, Debye[3] and Born et al. [4,5] applied the quantum theory to study the specific heat arising from lattice vibration in 1912 and 1913 respectively, and got a great success. The theoretical prediction is in excellent agreement to the experimental results, at least for the atom crystals. The propagation of the lattice vibration is called the lattice wave. Under thelong-wavelength approximation, the lattice vibration can be seen as continuum elastic vibration, i.e., the lattice wave can be approximately seen as the continuum elastic wave. The motion is a mechanical motion, but Debye and Born assumed that the energy can be quantized based on Planck's hypothesis. With the elastic wave approximation and quantization, Debye and Born successfully explained the specific heat of crystals at low temperature, and the theoretical prediction is consistent with the experimental results in all range of temperature, at least for the atomic crystals. The quanta of the elastic vibration, or the smallest unit of energy of the elastic wave is named phonon, because the elastic wave is one of acoustic waves. Unlike photon, the phonon is not an elementary particle, but in the sense of quantization, the phonon presents natural similarity to that of photon and other elementary particles, thus can be named quasi-particle. The concept created by Debye and Born opened the study on lattice dynamics, an important branch of solid state physics. Yet according to the view point at present, the Debye and Born theory on solid belongs to a phenomenological theory, though they used the classical quantum theory.

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