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Phononic Crystals. By Vincent Laude. De Gruyter, 2015. Pp. XII+427. Price (hardcover) Euro 139.95, USD 196.00, GBP 104.99. ISBN 978-3-11-030265-3.

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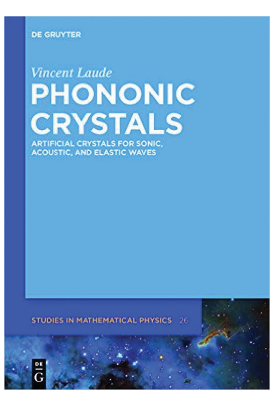
The monograph *Phononic Crystals* by Vincent Laude has appeared recently. It is very timely and describes the physical and mathematical basics for structures with periodic acoustic impedances. I start the review of this excellent monograph with comments concerning the term ‘phononic crystals’. The 21st century has been marked by the rapid development of nanotechnologies and nanoengineering. Various types of periodic structures have been designed, fabricated and used. These structures, artificially made by humans using advanced bottom-up or top-down fabrication methods of nanotechnologies, are often named by a quantum term depending on the physical nature of the quanta and the area of their applications. For elastic waves, in quantum terms phonons, the artificial structures with periodic distribution of the acoustic impedance are known as ‘phononic crystals’ in analogy with ‘photonic crystals’ for electromagnetic waves (*i.e.* photons). The essential feature of phononic crystals is the existence of a ‘phononic band gap’, which does not allow the propagation of elastic waves with the frequency falling into this gap. Actually, this remarkable property of artificial periodic structures for sound was known and used for many years before the term ‘phononic crystals’ was introduced at the end of the 20th century. Perhaps, for low-frequency sound, it would be more reasonable to call these structures ‘sonic’ or ‘acoustic’ crystals, but the name is unimportant when we are considering the physical background and equations describing the behavior of elastic waves in objects with periodic acoustic impedance.

This unique book by Vincent Laude is the first monograph that is concerned exclusively with phononic crystals, and it summarizes the theoretical development in this wide and nowadays popular field. In the book the reader will find various theoretical, analytical and numerical approaches for describing the properties of phononic crystals. The author accompanies the text and mathematical equations by experimental figures, and corresponding references, which make the book extremely useful not only for researchers interested in the theory of phononic crystals but also for experimentalists. The book will be useful for scientists in solid state physics at all levels interested in topics ranging from basic one-dimensional elastic equations and simple analytical solutions up to complex algorithms of numerical calculations for two- and three-dimensional periodic structures. The book is also appropriate for postgraduate students who are working on their projects and dissertations and early career researchers who are just entering the topic in their experimental or theoretical activity. Advanced readers will find many useful sections describing various types of phononic crystals and related phenomena.



The book consists of three parts occupying around 400 pages. The first part describes the case of scalar waves in periodic media. For clarity, the author uses in this case the terms ‘acoustic’ waves and ‘sonic’ crystals. The first sections give the theoretical basics for scalar waves and Bloch’s theorem and show the formation of band gaps. These well known topics, described in various textbooks on solid state physics, are combined together in a very compact and clear way, opening the gate to the field of phononic crystals for beginners. Using the example of one-dimensional periodic structures the author shows how to obtain analytical solutions, giving a clear feeling for the parameters that define the acoustic properties of an object. Turning to two- and three-dimensional cases, the author points to the complexity of the problem and the necessity of using numerical methods which become the main theoretical instruments in the next parts of the monograph. Using straightforward examples the author demonstrates the main properties of scalar acoustic waves, like reflection, refraction, scattering and local resonances. In part I the reader can find essential information on various levels from basic up to complex cases for scalar waves. This part also includes the fundamentals of the main methods for numerical modeling of sonic crystals. Some of them are widely used nowadays within commercial software packages (*e.g.* finite element modeling). Strictly speaking, the descriptions in part I for sonic crystals and scalar (*i.e.* 'acoustic' in the author's terminology) waves are valid only for objects based on fluids. However, the major properties of phononic crystals, like band gap and nonlinear dispersion, together with the modeling methods, already become clear for the researcher interested in the basic properties of phononic crystals.

Part II describes the general approach where it is necessary to consider the vector origin of mechanical waves. The author gives these the more general name 'elastic waves', and the corresponding periodic structures for these waves are called 'phononic crystals', in contrast to the sonic crystals introduced for scalar (acoustic) waves. In this part, the basic equations, which include polarization of the waves and anisotropy in the solid elements of phononic crystals, are considered. Special consideration is given to elastic waves in piezoelectric media. This topic is important for applications, owing to the possible conversion of high-frequency elastic waves to microwave radiation and *vice versa*. There are separate sections concerning plate and surface waves. Many examples of two-dimesional phononic crystals, their dispersion curves and methods for their calculation together with experimental figures and references are presented in this part.

Part III is concerned with a number of specific topics: The coupling of acoustic (*i.e.* scalar) and elastic waves in various phononic crystals is described. The objects are solid inclusions in fluids, solid (*e.g.* nylon) rods in water, air holes in two-dimensional phononic crystals and others. A separate chapter concerns evanescent waves in sonic and phononic crystals. There is a chapter describing practical phononic devices, like mirrors and waveguides. Particular attention is given to surface phononic crystals and phononic fibers. The last chapter is aimed at explaining the spatial and temporal dispersion of elastic waves and related phenomena (*e.g.* negative refraction, phonon tunneling). The conclusions are supported by figures from experimental work and corresponding references.

In summary, I find the monograph by Vincent Laude to be outstanding and extremely useful for researchers working in the field of phononics at all levels. It is attractive to exploit phononic crystals for hypersonic waves with nanometre wavelength and correspondingly with frequencies lying in the sub-terahertz and terahertz range. In practice it is very difficult to fabricate two- and three-dimensional phononic crystals for such elastic waves, and only a few experiments have been performed during the past decade. Most of the examples given in the book are related to work performed in traditional acoustic and ultrasonic frequency ranges, but all the approaches and background may be fully extended to a smaller scale and used for the design and analysis of phononic crystals with nanometre periods and high frequencies.