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BOOK REVIEW

Walter Langel

Condensed matter physics. Crystals, liquids, liquid crystals, and polymers

Strobl, Gert 2004, X, 381 p. 169 illus., Softcover, ISBN: 3-540-00353-3, 39,95 €

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Even though exciting new fields open up in bio- and polymer physics, few textbooks so far cover soft matter adequately. In this sense, Strobl follows a very modern approach for undergraduate teaching by trying a unified treatment of "condensed matter" properties. This is a tribute to the increasing importance of life sciences and modern materials sciences, which do no more focus on simple structures such as perfect crystals, but handle a continuous spectrum of pure liquids, solutions, liquid crystals, amorphous rubbers and glasses, nanocrystals, and finally perfect solids.

This approach is very consequently applied throughout all five parts of the book. The first one discusses the structural properties of matter. Fundamentals of crystal physics are the starting point, and major parts of the chapter are related to the description of pair correlations as needed for liquids and to the orientational order of liquid crystals. In addition to this, the relations between chemical structure and conformation of polymers are demonstrated. Polymers are also a very important example for amorphous phases, the glass and crystallization transitions being discussed at this example. The very contiguous approach of this book also includes the physical background of scattering experiments for structure determination on both solids and liquids.

Part two, "Moduli, Viscosities, Susceptibilities", gives a common treatment for the response of condensed systems to mechanical, electrical and magnetic stress. Thus, viscosity is not introduced the traditional way as a transport phenomenon, but in context with the elastic properties of soft matter. Specific concepts of viscosity for liquid crystals and polymers are added, going far beyond the standard Newton liquid. The dependences of mechanical and electrical response on the frequency are treated by common schemes, even though they have very different practical implications. An important aspect of the frequency dependence of mechanical response is its huge temperature shift in glasses. The dielectric susceptibility is discussed for understanding interactions of electromagnetic radiation with matter in a wide frequency range from RF to UV, and a nice derivation of the Clausius Mosotti equation is given. The interaction of mechanical and electrical properties is demonstrated at the example of the piezo effect. In chapter 2.4, common aspects of susceptibilities are discussed which are the meaning of real and imaginary part for energy dissipation and the Kramers Kronig relation between both.

Chapter 2.3 on magnetic fields is clearly oriented towards the basic physics of electron spin and nuclear magnetic resonances (ESR and NMR). These two techniques both have high practical relevance and make use of elaborate theoretical overhead. Having in mind the general concept of the book, I miss some more explicitness concerning the actual applications. The physics of the line shape, including quadrupole broadening and magic angle spinning would have been a very interesting link between the basics of magnetism and the general materials sciences background of the book.

Several examples of second order or so-called critical phase transitions are of great practical relevance. The author aligns ferroelectricity, ferromagnetism, nematic transitions in liquid crystals and phase separations in binary polymer melts in the third part of his text. With the exception of the polymers, all these systems are treated starting from the Landau expansion of the Gibbs free energy, the parameters of this expansion depending on the respective internal molecular fields. For phase separations, the Flory-Huggins theory is introduced, from which the difference between nucleation and spinodal mechanisms may be derived. These thermodynamic approaches are complemented by treating critical scattering and demonstrating the differences in structure formation after nucleation and spinodal phase separation.

The large fourth part is devoted to charges and currents in matter and discusses in depth the typical topics of solid state physics starting with metallic conduction by electrons in the classic and in the Fermi gas approximations. This

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includes the frequency dependence of the conductivity and especially electrons in periodic fields and band structures. Electron hole conduction and p–n junctions are essential for understanding semiconductors. Two further chapters on conduction electrons in magnetic fields and on superconductivity conclude this series. Focus is on basic physics topics such as Cooper pairs and others, and no mention is made, e.g. of high temperature superconductivity. The last chapter of this part features fundamentals of electrochemistry such as the ionic conduction in electrolytes covering typical concepts of electrochemistry such as Gibbs reaction energy, Nernst equation and Debye Hückel model.

The final part is named microscopic dynamics. It starts with waves in crystals, discusses phonons and dispersion relations, and derives the specific heat from the vibrational structure. Further examples of wavelike motions in solids are spin waves in ferromagnets, which contribute to the specific heat according to Bloch's law. Localized electronic excitations in solids, so-called excitons, have much higher transition energies in the visible and may move in a crystal just like a material particle (chapter 5.1.3). Going from the crystal to soft matter, damping of vibrations has to be taken into account. In this atomic picture, diffusion is the extreme case of a fully damped motion. Chapter 5.2 refers both to the atomic picture of diffusion and to the transport equations introducing the time-dependent autocorrelation function and Fick's (first) law, respectively, giving a simple derivation for the Einstein relation at the end. The typical dynamics in liquid crystals consist of orientational fluctuations which are split into splay, twist and bend modes. Of great interest is also the distinction between reptation and Rouse models for mobile polymer chains in chapter 5.4. Chapter 5.5 finally extends the scattering experiments as introduced in part one to time- and energy-dependent light and neutron scattering.

As is intended by the author, the book distinguishes from similar volumes by putting emphasis on polymers and liquid crystals, and especially by combining elementary physics with modern and ambitious thematic. It is tried to treat phenomena with a similar underlying physics and mathematical overhead in the same context irrespective of the materials actually considered. This unconventional organization of the contents is useful in many places for understanding general physical concepts. To my opinion, there is only one major inconsistency: Putting the contents of part five to the very end of the book is not really sensible since most of it is directly related to part one at the beginning. This holds for phonons which belong to crystal physics, as well as the dynamics of liquid crystals, which refers to the splay, twist and bend modes introduced in chapter 2.1, and the reptation and Rouse models which should be introduced in the context of chapter 1.4. The separation of elastic (chapter 1.5) and time-dependent scattering experiments (chapter 5.5) is especially difficult to understand, since this distinction is artificial, especially for neutron and light scattering, and the underlying physical concepts are the same.

The text contains few errors and misprints apart of referring ambiguously to both divisions and subdivisions of the volume in the same way as "chapters". The caption of Fig. 3.19 is somewhat in disorder, in Fig. 4.39, the title of the *y*-axis contains the units of the conductivity, not of the molar conductivity, which is actually plotted, and in Eq. 5.268, a right-hand bracket is missing. More importantly, the list of only 51 references to 47 books and articles at the end is not really convincing for a volume covering such a wide field of different subjects.

"Condensed Matter Physics" is a clearly structured and well-written textbook which may certainly be recommended for undergraduate students not only in experimental physics but also in materials and engineering sciences. It preferably addresses to physicists rather than to chemists who might sometimes find the extent of mathematics prohibitive. Like many other good textbooks, it benefits of the great experience of the lecturer in presentation and, last but not least, of valuable exercises at the end of the parts with the corresponding solutions in the appendix.

Liquid crystals (LCs) represent a state of matter intermediate between crystalline solids, which are characterized by a regular periodic arrangement of atoms or molecules, and isotropic liquids, which lack any type of order. They exhibit varying degree of orientational and/or translational order in specific spatial directions.Â LC phases formed by surfactant solutions are known as lyotropic liquid crystals and their discussion is beyond the scope of this article. The simplest of the LC phases, the nematic (N) phase, is formed when the molecules are oriented, on average, parallel to a common direction represented by an apolar unit vector, n, referred to as the â€œdirector.â€ Hypercomplex Liquid Crystals. Exciton Condensation in Bilayer Quantum Hall Systems. Bird Flocks as Condensed Matter. Crossover from Bardeen-Cooper-Schrieffer to Bose-Einstein Condensation and the Unitary Fermi Gas. Crackling Noise in Disordered Materials.Â We first briefly recapitulate the basic physics of molecular liquid crystals. Next, we describe the behavior of colloidal liquid crystals, which combine desirable features of colloidal suspensions with those of classical liquid crystals. From here, we focus on how merging liquid crystals and cross-linked rubber leads to solid networks with surprising elastic properties. Then, we describe. 138 Dogic Sharma Zakhary. Phases Â· Phase transition Â· QCP. v. t. e. Condensed matter physics is the field of physics that deals with the macroscopic and microscopic physical properties of matter, especially the solid and liquid phases which arise from electromagnetic forces between atoms. More generally, the subject deals with "condensed" phases of matter: systems of many constituents with strong interactions between them. More exotic condensed phases include the superconducting phase exhibited by certain materials at low