

this nature may be, however, a direct result of fluctuations in year-class strength, and of changing climatic conditions; both factors may mask the adverse effects of pollution.

Several of the essays are concerned with technical subjects. R. W. Blacker's discussion of recent advances in otolith studies is an important contribution to the methods of study and interpretation of otoliths for age determination (a 'traditional' fisheries' tool). By contrast, Alan Jamieson and C. E. Purdom present new techniques in fisheries research with essays on the study of genetic tags for marine fish stocks, and genetic variation in fish. The volume also contains a contribution on the design of research vessels by Geoffrey C. Trout, as important a study as any attempted at Lowestoft (and as one who has sailed on FRV *Cirolana*—the newest of the fleet of research vessels—I can vouch for the excellence of the product.

The quality of production of this book is excellent, although the photographic illustrations do not reproduce well. The editing is even and unobtrusive and must have represented a formidable task for the editor. Altogether this is an admirable and fitting volume in honour of Michael Graham.

Alwyne Wheeler

Liquid crystals

The Physics of Liquid Crystals. By P. G. de Gennes. (The International Series of Monographs on Physics.) Pp. xi+333. (Clarendon: Oxford; Oxford University Press: London, June 1974.) £11.50.

THIS is the first modern book to survey and discuss the physical properties of liquid crystals. Liquid crystals combine some of the properties of the crystalline and of the isotropic liquid phases; they have received considerable attention during the last 10 years. The re-discovery of electro-optical effects, which are used in liquid crystal display devices, has led to a revival of basic research on the physical and chemical properties of liquid crystals, both theoretically and experimentally. Their study is complicated because it involves various physical and chemical disciplines, making it almost impossible to cover all the aspects in one book. Although the main physical topics are discussed or at least mentioned in this book, the main emphasis is on hydrostatic and hydrodynamic properties which, in principle, also determine the optical properties.

In Chapter 1 there is a short introduction to the nature of the different liquid crystalline phases and of the constituent molecules. The following four

chapters, the major part of the book, deal with the nematic liquid crystalline phase which is characterised by long range, orientational ordering of the constituent, rod-like molecules.

Chapter 2 deals with long and short range order. Different order parameters are introduced and linked to measurable quantities, such as nuclear magnetic resonance spectra, the anisotropy of magnetic susceptibility, and so on. Some theories of orientational ordering are reviewed briefly. Finally, short range order effects near the transition from the isotropic to the nematic phase are discussed. The static, elastic distortions in a nematic single liquid crystal are treated in Chapter 3. There, a hydrostatic theory based on a continuum description is introduced and discussed thoroughly, and the role of boundary effects and boundary conditions is made clear. Various applications of the theory, and some instructive problems are given. Most are concerned with deformations induced by external magnetic and electric fields for different boundary conditions. Close attention is also given to the strong natural light scattering, which is analysed in terms of spontaneous orientation fluctuations.

Chapter 4 describes distortions that are not continuous but which involve singular points or lines. These defects, where the orientation varies discontinuously, are called disclinations. In connection with disclinations different textures are discussed.

An understanding of the coupling between orientation and flow is essential to any consideration of hydrodynamic properties. That problem, and the different approaches to it, are discussed thoroughly in Chapter 5. Again various applications and experimental situations are described, including classical flow experiments, flow induced by external fields, inelastic light scattering, dynamic scattering, and so on.

The cholesteric liquid crystalline phase, essentially a helically distorted nematic phase, is also discussed. Because of the helical structure this phase has rather peculiar optical properties which are discussed in a rather formal way. The hydrostatic and hydrodynamic theories of the nematic phase are extended to a discussion of the cholesteric phase. The static distortion of the helical structure by external fields, flow properties, the analogue of dynamical scattering and other typical phenomena are considered and some typical defects and textures are also described.

The last chapter is devoted to smectic liquid crystals. In addition to the orientational ordering they have a layer structure. First, a classification and description of the different smectic phases is given, and then attention is restricted

to the A and C-phases. In the discussion of the static and dynamic properties the role of the layer structure is clearly displayed. Again, attention is given to distortions induced by external fields and mechanical forces, to light scattering, the propagation of acoustic waves and flow properties. The chapter ends with a description of phase transitions and precritical phenomena.

Though various experimental methods and experiments are mentioned or briefly described, the main emphasis is on the theoretical aspects. The approach to these aspects, which is purely phenomenological, is based on the fundamental hydrostatic and hydrodynamic equations. The study of chapters 3 and 5, which form the central part of the book, is therefore necessary before the chapters on the cholesteric and smectic phases can be understood. One may regret that little or no attention has been given to molecular theories and considerations, as these have been quite successful and instructive. Some of the discussions are rather formal and general, whereas others are more concise, but the material is nevertheless presented in a clear and systematic way.

This is a most valuable book which gives a comprehensive though not easy introduction to many aspects of the liquid crystalline phases.

W. J. A. Goossens

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