BOOK REVIEW

The Physics of Liquid Crystals, Second Edition

by P G de Gennes and J Prost, International Series of Monographs on Physics No 83,published OUP (1993) ISBN 0 19 852024 7

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Liquid crystals have attracted physicists from the beginning of this century. However only in 1974 was the long-felt need for a major monograph on the physics of liquid crystals met by P G de Gennes. The first edition of The Physics of Liquid Crystals has served as an educational and unifying guide for the whole liquid crystal community, and the book helped to transform the field of liquid crystals into one of the cornerstones of 'soft matter' science.

Only twenty years ago many properties of liquid crystals seemed to be mysterious oddities, while now they are successfully used in display applications. What is more, they are willingly taken as starting points, reference systems and physical models for scientists working in such different fields as anisotropic superfluids, surfactant films or even cosmology.

Rapid development of the field and the transformation of liquid crystals into mainstream modern physics underlie the necessity for a new publication. The new version significantly extends the description of smectic phases, and introduces readers to the physics of columnar liquid crystals. As written in the Preface, this extension was made possible mainly by the efforts of J Prost, one of the pioneers and major contributors in the area of liquid crystals.

The second edition of The Physics of Liquid Crystals preserves and develops all the features that made the first edition a classic text. One of the book's many strengths is its two-level style of description. Mathematical theory and qualitative physical pictures are masterfully welded together. As a result the book is equally valuable for those who prefer physical ideas in their simplest form, and for those who appreciate the beauty of liquid crystals only through the language of correlation functions, renormalisation groups, fluxes and conjugate forces.

Chapter One gives an introduction to and general classification of liquid crystals, including both thermotropic and lyotropic phases. It shows how the spatial organisation of different building units leads to three basic mesomorphic classes: nematics, smectics and columnar phases. Symmetry classification is accompanied by a qualitative analysis of elastic properties and fluctuations. Step-by-step the authors sharpen the descriptions of liquid crystal phases, proceeding from intuitive molecular models to rigorous definitions in terms of long-range, quasi-long-range and short-range order.

Long-range orientational order in the nematic phase is described in Chapter Two. The authors discuss the scalar and tensor order parameters, and give a brief but comprehensive analysis of statistical theories and phenomenological Landau-de Gennes approach. New subsections deal with Monte Carlo computer calculations and the biaxial nematic phase.

Chapter Three is central for understanding the phenomenological theory of nematics. The authors start with Frank-Oseen elastic theory, and explain how to find equilibrium director distributions and balance of torques. They give an introduction to surface anchoring effects, and proceed to dielectric, diamagnetic and flexoelectric phenomena, finally concluding with the theory of director fluctuations and light scattering. This brisk survey conveys in less than 70 pages the breadth and excitement of the whole field.

Chapters Four to Six have not undergone significant change, apart from the description of blue phases within the framework of two complementary models. Chapters Seven to Ten contain detailed descriptions of a vast variety of smectic and columnar liquid crystals. Special emphasis on these one-and two-dimensionally ordered phases is exemplified by amazing results obtained recently: twist-grain boundary and hexatic phases, freely suspended films, ferroelectric smectics,

The authors have managed throughout to retain the spirit of parallel interpretation in terms of qualitative physical ideas and mathematical formulae. This approach makes many quite delicate problems accessible for a general audience. Examples include the description of thin free-standing smectic films, Kosterlitz-Thouless phase transitions, developable domains in columnar phases, hexatic bond ordering and the celebrated superconductivity analogy with the theoretical prediction of twist-grain boundary phases as its most exciting result.

The material of this book is of exceptional value to scientists. The major criticism concerns what the book does **not** contain. Some "little corners in the painting" are deliberately sacrificed: for all its universality *The Physics of Liquid Crystals* cannot cover everything, and there are a few features that might have deserved more attention. One of them is the divergence contributions to the elastic free energy functionals, known also as k_{13}(mixed splay and bend) and k_{24} (saddle-splay) terms in the theory of nematics and the k (saddle-splay) term in smectics. Deriving Frank-Oseen functionals, the authors note that divergence elastic terms may be discarded, since they can be transformed into surface energies (p100). Such a transformation, however, does not prove that the divergence energies are negligible in comparison with the usual "bulk" energies (both of them scale linearly with the system's size, whatever way of integration is chosen). Neither does it prove that the divergence energies can be taken into account by renormalising the interfacial (anchoring) energy. Another issue worthy of consideration is that of surface phenomena; the last decade has brought many interesting results in this area (e.g. subsurface orientational and translational ordering different from that in the bulk) that are not duly emphasised in books on liquid crystals.

Without a doubt, this book will remain an excellent guide for researchers and graduate students studying different "soft matter" systems. If "soft matter" science has a bright future, then it is definitely brought closer by *The Physics of Liquid Crystals*.

From the Secretary

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will affiliate to the ILCS. Furthermore, it is a policy of the Society to disseminate and encourage liquid crystal research especially in emerging countries in order to help them initiate new programmes and bring new ideas to liquid crystal science and applications.

In his latest Presidential message, Geoffrey Luckhurst emphasised that it is important that the Society continues to develop in response to the needs of its members. In fact the ILCS is enlarging its objectives, as has been reported in *Liquid Crystals Today*, and a review of its activities is to be undertaken to realise how these should develop further, There will be continual stimulus and challenge for members to respond to, and I feel the Society needs all their best efforts. In accepting the invitation to act as Secretary, I know I will have the fullest support from the President, and the past Secretary and present Editor of this Newsletter, David Dunmur. I am also urging the members of the Society to share with me their opinions and comments, so that the society can continue to meet their needs.

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