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# Review Of "Liquid Crystals: Fundamentals" By S. Singh

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# Liquid Crystals: Fundamentals

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to such now familiar areas in nonlinear dynamics as resonance overlap and period-doubling. It is interesting to have a pioneer's view.

The book is not quite "my view of the field" though, more like "interesting topics I have worked on." There is one clear theme: Completely regular and completely chaotic systems are both exceptional; most systems show a mixture of order and chaos. That is, it is typical to see neighboring trajectories diverge exponentially (the hallmark of chaos) in some parts of phase space but not in others. Moreover, the ordered and chaotic regions of phase space may be embedded within each other in incredibly complicated ways. Apart from that theme, however, the book does not have much in the way of general principles. The author tends to write in great detail about what most interests him, and then hurry through several other topics. In particular, astronomical problems other than in galactic dynamics make up only the last 5% of the book. On a smaller scale (the book is scale-invariant in this respect!), Lindstedt's perturbation method is disposed of in two sentences at the end of the periodic-orbits section. Because of its style and structure, *Order and Chaos in Dynamical Astronomy* is unlikely to work as a textbook, but it makes a useful reference for researchers in and around the field.

The book's biggest liability is probably the publisher. Springer has supplied a good cover and binding but not bothered with even basic copyediting or good-quality reproduction in figures, and the price tag will lose many potential readers.

Still, if you can afford it, there is plenty of interesting and useful information in the book. My favorite part was a discussion of the spectra of stretching numbers in chapter 2: I was always puzzled as to why Lyapunov exponents of chaotic orbits take so long to converge, and now I understand.

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## Liquid Crystals: Fundamentals

Shri Singh
*World Scientific, River Edge, N.J., 2002. $98.00 (531 pp.)*
*ISBN 981-02-4250-6*

Liquid crystals are a state of matter sharing properties that are usually associated with both solids and liquids. Their study belongs to the wider field of soft condensed matter physics, an area growing in importance because of the new physics being discovered and the possibility of various technological applications being developed. The publication of an up-to-date book stressing the theoretical foundations of liquid crystals is therefore timely and significant.

Shri Singh's *Liquid Crystals: Fundamentals* is comprehensive and current. The book has a strong theoretical emphasis throughout but also includes descriptive discussions when appropriate. Its extensive set of references serves as a roadmap through the literature and allows the reader to follow developments in the field over time—right up to the present. The intended audience, graduate students and researchers, will find the book to be a high-quality introduction to liquid crystals.

Singh is an accomplished theoretical physicist who has used statistical theories to advance the understanding of soft condensed matter physics. He is also extremely knowledgeable about the field of liquid crystals in general, and his varied, in-depth expertise contributes to the effectiveness of the book. The author introduces topics by first offering helpful background information for those unfamiliar with the field, but readers will still need a good deal of knowledge to understand most of the theoretical discussions.

The level of Singh's book compares with that of *The Physics of Liquid Crystals* (Oxford U. Press, 1993) by Pierre-Gilles de Gennes and Jacques Prost and *Liquid Crystals* (Cambridge U. Press, 1992) by Sivaramakrishna Chandrasekhar. Its style, however, is most similar to that of *Thermotropic Liquid Crystals: Fundamentals* (Springer-Verlag, 1988) by Gerrit Vertogen and Wim H. de Jeu. But Singh's book differs from that of Vertogen and de Jeu because it explores not only thermotropic but also polymeric and lyotropic liquid crystals.

The early chapters introduce readers to the classification schemes and physical properties of liquid crystals. Those chapters serve as an excellent starting point, but readers will find that advanced terms and ideas are sometimes used with little explanation. The discussion of microscopic and macroscopic order parameters and the description of the many anisotropic properties are especially well done.

The strongest chapters, on the statistical mechanics, elastostatics, and dynamics of the nematic phase of thermotropic liquid crystals, clearly demonstrate the author's expertise in

those areas. An extensive discussion of phase transitions and what researchers have learned through computations and simulations appears in the chapter on the smectic phase of thermotropic liquid crystals. Discotic (thermotropic liquid crystals formed by disk-shaped molecules), polymer, and lyotropic liquid crystals are covered in shorter chapters containing much less theory. Those chapters resemble what has been written in other texts on liquid crystals.

Singh's chapter on chiral liquid crystals effectively combines a discussion of the properties of chiral nematics and chiral smectics with theoretical insights. The author makes this chapter special by including a detailed description of the theory of the blue phases, an overview of theoretical work on ferroelectric phases, and a discussion on twist-grain boundary phases—topics rarely found in books on liquid crystals. In the final chapter, which covers defects and textures, Singh shares his own perspectives by tying together typical phenomena with unifying theoretical ideas.

From beginning to end, *Liquid Crystals: Fundamentals* gives readers a thorough look at a state of matter that continues to attract attention within the field of soft condensed matter physics. It emphasizes theory, offers a broad exploration of topics, and includes many recent developments. The combination makes Singh's book unique and worthy of attention.

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