learning of the Tower of Hanoi spatial puzzle (despite the fact that these patients cannot consciously recall having encountered the task before), the authors ascribe to the procedural memory system the capacity for "cognitive problem solving and sequential planning procedures"—processes that the reader might reasonably think would require the representational flexibility that the authors reserve for the declarative memory system, which is presumably defective in these amnesics.

Neurophysiologists may be disappointed to find that Cohen and Eichenbaum do not provide a quantitative or computational model of hippocampal function. Moreover, devotees of the brain electrical pattern known as hippocampal theta may feel that this area has been shortchanged. Also, an author index would have been helpful. Overall, however, this is a serious and interesting attempt to organize a substantial portion of the literature on the functional role of the hippocampal formation. Neuropsychologists and others interested in the brain and human cognition will want to make sure they put their declarative memory to work on the arguments put forward in this book.

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Promising Polymers

Liquid Crystalline Polymers. A. M. DONALD and A. H. WINDLE. Cambridge University Press, New York, 1992. xiv, 310 pp., illus. $100 or £55. Cambridge Solid State Science Series.

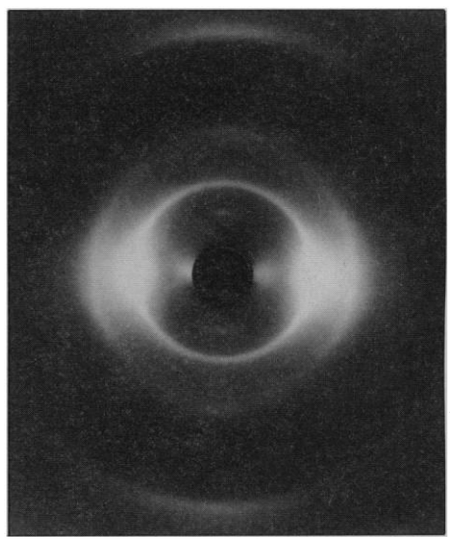
In the early 1970s physics Nobel laureate Pierre-Gilles de Gennes theorized on the diffusion of linear-chain macromolecules in condensed phases through "reptation." This motion was envisioned as the snakelike crawling of highly entangled flexible chains through imaginary tubes formed by surrounding macromolecules. Toward the middle of the same decade, Jerry Jackson and his colleagues at the Kingsport, Tennessee, laboratories of Eastman Kodak reported on the self-organization of linear-chain macromolecules into orientationally ordered liquid crystals. The polymer molecules that were found to form such nematic liquids had backbones stiffened by aromatic units and thus differed from those described as "flexible snakes." These polymers have rod- or board-shaped molecular segments that pack in parallel arrangement within domains that easily acquire dimensions in the range of microns. The discovery of liquid crystallinity in pure and synthetic polymers marked the beginning of a new chapter in polymer science and will most likely be regarded in the future as having had a profound impact on the development of the field. It also offered great potential for the production of new materials such as ultrastrong and durable fibers and films, the preparation of well-defined polymeric surfaces, and the development of new field-responsive polymeric materials for electrical, optical, or magnetic technologies.

Two decades after this important discovery, *Liquid Crystalline Polymers* offers the first opportunity for the scientific community to learn about some of the advances that have been made in the field, including the discovery three decades ago of the synthetic lyotropic systems, in which polymer solutions self-order into liquid crystals. This development led to formulation of the organic material known as Kevlar, which is used to make bulletproof vests and fibers that can have greater strength-to-density values than steel. Donald and Windle begin with a brief history of liquid crystals and liquid crystalline polymers. This chapter's closing statement identifying liquid crystallinity as a form of orientational self-assembly that can be controlled by external fields captures much of the essence of liquid crystallinity's importance for polymeric materials. This is in fact a good reason to have treated in greater depth the subject of electric, magnetic, and surface field alignment of liquid crystalline polymers. The possibility of aligning macromolecules in fields other than mechanical fields is, after all, a unique property of this type of polymer, and the book's omission of some of the key references and discoveries in this area is unfortunate. The introductory chapter is followed by an alphabetical glossary of terminology and concepts, covering both liquid crystals and polymer science. Such a feature is valuable in this era of interdisciplinary science; this chapter will be especially useful to those with limited knowledge of polymer science. The reader is referred to specialized books on liquid crystals for a more complete description of basic concepts such as the classification of the smectic phases.

Over the past two decades polymer scientists have concentrated on two distinct families of liquid crystalline polymers: main-chain and side-chain systems. In main-chain systems the elongated molecular segments that lead to liquid crystallinity are part of the polymeric backbone. In the architecture of side-chain systems, on the other hand, these rigid units are bonded to a flexible backbone through a spacer, forming comb polymers with self-ordering teeth. Donald and Windle treat main-chain systems in greater detail than side-chain systems and clearly convey our current understanding of factors that stabilize the liquid crystalline, as opposed to the isotropic, state of polymeric backbones. Especially well presented are the importance of the chain's persistence length and its directional attractive forces in the stability of polymeric liquid crystalline phases, and the molecular tools discovered by polymer chemists to depress the melting points and isotropization transitions of these materials. A table is presented that contains persistence-length data for various polymers, including some that are nonmesogenic—that is, that do not self-organize into liquid crystalline phases. The phase diagrams of lyotropic polymers—polymers that form liquid crystalline phases in solution beyond a critical concentration—are described in detail.

Theories that predict the physical behavior of liquid crystalline polymers of main-chain and side-chain architecture need further development. There have been many efforts over the past few years to address such issues as the effects of molar mass polydispersity, the semiflexibility of polymer chains, and the role of anisotropic attractive forces. Two important classical contributions are described in detail in the book: the steric lattice theory developed by Flory, relevant to main-chain systems, and the Maier-Saupe mean field theory of liquid crystals.

One chapter is devoted to polymeric analogs to the Friedelian classes of liquid crystals (nematic, cholesteric, and smectic). The macromolecular nature of mesogens or the attachment of mesogens to macromolecules introduces complications that make their classification in the Friede-



Transmission x-ray diffraction pattern of a liquid crystalline copolyester of intermediate molecular weight with a degree of polymerization of 25, cooled in a field of 1.2 T oriented vertically. [From *Liquid Crystalline Polymers*]

lian scheme a difficult task. For example, there are questions about the global versus the local nature of nematic order in polymeric liquid crystals, the role of nematic-isotropic fluctuations in polymeric nematics, and—most challenging of all—defining a smectic layer in a main-chain liquid crystalline polymer. The chapter deals with some but not all of these issues. With regard to smectic layers, an interesting question has been whether or not segregation by molar mass takes place in polydisperse materials. On this issue the authors point out that exact segregation of the ends of rigid chains into sharply defined layers is impossible. Obviously, many unknowns remain with regard to the nature of molecular organization in polymeric liquid crystals.

The blossoming of liquid crystalline polymer science over the last two decades has been much more than a simple extension of the well-established science of liquid crystals. Synthetic work has demonstrated that most of the covalent linkages used to build the periodic or aperiodic sequences of polymers are compatible with liquid crystallinity. Liquid crystalline polymers will therefore continue to gain importance in macromolecular science and in the development of polymer technology. This book will serve as an excellent guide to the subject for students of materials science, chemistry, and physics.

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Correction and Updating

In the heading of David Cassidy's review of *The Private Lives of Albert Einstein* (18 February, p. 997) the price of the book as sold by its British publisher, Faber and Faber, was given incorrectly; the correct price is £15.99. The book is also to be published in the United States by St. Martin's Press, New York, in April, at a price of $23.95.

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The Book of the Pearl. The History, Art, Science and Industry of the Queen of Gems. George Frederick Kunz and Charles Hugh Stevenson. Dover, New York, 1993. xx, 548 pp., illus. Paper, $17.95. Reprint, 1908 ed.

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Free for All? Lessons from the RAND Health Insurance Experiment. Joseph P. Newhouse and The Insurance Experiment Group. Harvard University Press, Cambridge, MA, 1994. xii, 489 pp., illus. $49.95. A RAND Study.

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