lating Jewish family. He was raised and educated there in the same somewhat restricted yet obviously very special milieu that also produced Leo Szilard, Edward Teller and Eugene Wigner. All four eventually migrated to America and remained close friends for the rest of their lives. After attending universities in Hungary and Switzerland and working for a while in Europe, von Neumann moved to Princeton, New Jersey in 1930. There he remained, first at the university and later at the Institute for Advanced Study. He died in 1957 at the age of 53, bitterly aware that he had been cut down while he still had much to do.

Von Neumann's earliest work was in pure mathematics, where like most authentic geniuses he showed considerable precocity, producing his first significant work while still a teenager. As he matured he gradually expanded his interests, first to theoretical physics, then to computation and computers, economics and game theory and finally, to national security affairs, including strategic theory and practice.

His prowess as a mathematician was legendary, and his contributions to basic mathematics and theoretical physics were too fundamental and too diverse to be adequately summarized here. Suffice it to say that smart people who knew Johnny commonly said he was the smartest person they had known.

His work in computers included the invention and practical development of the "von Neumann architecture," still the basis of all modern designs. He also supervised the construction, at the Institute for Advanced Study, of one of the first modern digital computers. He worked closely with other pioneer computer developers, including Nicholas Metropolis and James Richardson at Los Alamos and J. Presper Eckert and John W. Mauchly, the producers of the first large commercially available digital computer, the Univac. In the realm of applications, he focused on using computers to understand and predict the weather.

With Oscar Morgenstern he created the new science of game theory which he then applied to such things as economics and the kind of formal strategic analysis pioneered at the Rand Corporation, where he served as a frequent consultant.

In 1943 von Neumann joined the Manhattan Project (Teller, Szilard and Wigner had all joined earlier). He made crucial direct contributions to bomb design, and in an advisory capacity he assisted many others in making their particular contributions. After the war ended, he continued to participate in the work at Los Alamos, particularly that related to the hydrogen bomb.

As the cold war intensified, Johnny expanded his advisory activities to include nuclear delivery systems and strategic policy. As an adviser to several elements of the Defense Department, he played an especially critical part during the 1950s in determining both the requirements for and the nature of America's strategic weapons. In 1955 he departed for the first time from his customary role of adviser and joined the Atomic Energy Commission as one of its five full-time commissioners. In both these roles he was for a time by far the most influential scientist of all those engaged in such matters, and the programs and policies that he helped to initiate and guide continued to form the backbone of America's strategic posture throughout the cold war.

Macrae's book covers, fairly and fully, all this ground from Johnny's origins through his multifaceted career to his untimely death. It is the best yet on this very special man, and it will likely remain so for some time.

HERBERT F. YORK
University of California, San Diego

The Physics of Waves

Howard Georgi
Prentice-Hall, Englewood Cliffs, N. J., 1993. 422 pp. $43.00 hc ISBN 0-13-665621-8

In reading this book I was reminded of a saying of Goethe: "Mathematicians are a kind of Frenchmen: When you talk to them, they translate it into their own language, and right away it is something different." I cannot help feeling that the same may be true of theoretical physicists! Howard Georgi, a distinguished member of this community, takes the traditional undergraduate subject of vibrations and waves and brings to it a decidedly nontraditional approach. In the preface to *The Physics of Waves*, he identifies three underlying principles that characterize many different kinds of wave phenomena: linearity, translation invariance and local interactions. He then proceeds to build up the subject in these terms.

When one looks beyond the unfamiliar terminology, one finds that Georgi's book has much in common with existing books on the subject. Georgi states that he was chiefly influenced by two well-known texts—

Waves (*Berkeley Physics Course, Vol. 3,* McGraw-Hill, New York, 1968) by Frank S. Crawford, Jr., and *Optics* (Addison-Wesley, Reading, Mass., 1987) by Eugene Hecht and Alfred Zajac—and that he sought to steer a middle course between them. I do not think, however, that this description is quite accurate. Crawford's and Hecht and Zajac's texts are replete with phenomenology, reinforced (especially the latter) by numerous vivid illustrations and photographs. Georgi, by contrast, emphasizes the powerful mathematical formalisms that underlie the wide variety of wave motions, and he pays relatively little attention to their individual properties. Detailed descriptions and quantitative data regarding wave phenomena are few and far between.

The result, to me at least, is a rather formidable treatment of the subject. I question whether it will be particularly appealing or accessible to students who are not fairly sophisticated mathematically. The austerity of the text is reinforced by the actual appearance of the book. The whole thing, including the figures, was apparently composed at the computer keyboard, and the result is unfortunately rather colorless (metaphorically speaking) and full of attenuated line drawings.

Like Crawford, Georgi approaches waves through an analysis of the normal modes of discrete oscillating systems containing from one to N similar oscillators. About a third of Georgi's book is devoted to this topic before the transition is made to standing waves in a continuous medium and then, rather abruptly, to traveling waves. The last third of the book is about waves in two and three dimensions. The discussion of water waves in this section, though brief, is an elegant application of the general principles developed earlier. The treatment of diffraction theory, with the free use of Fourier analysis and convolutions, is also very nice. In sharp contrast to Hecht's book, however, conventional optics (that is, the physics of visible light) receives little attention, and I found myself craving some actual pictures of interference patterns.

Accompanying the text are two disks of software designed to illustrate vibration and wave phenomena through animation. The concept is good, and the execution must have involved a great deal of work; but few of the demonstrations, in my opinion, provide much additional insight, and some I found confusing. (Prospective users should be aware that the programs are on high-density disks, which

are not usable on all computers.)

In his preface, Georgi mentions that the book is based on a course he has taught at Harvard University for 15 years. Clearly, then, it has been successful in this context, and if an instructor desires to have a text that discusses waves from the standpoint of a modern field theorist (including even an appendix about Goldstone bosons!), this book may well meet his or her needs.

ANTHONY P. FRENCH
Massachusetts Institute of Technology

Liquid Crystals

S. Chandrasekhar
Cambridge U. P., New York, 1992. Second edition. 460 pp. $100.00 hc ISBN 0-521-41747-3 $39.95 pb ISBN 0-521-42741-X

When the first edition of Sivaramakrishna Chandrasekhar's highly acclaimed book appeared a decade and a half ago, liquid crystals were still something of a curiosity. Physicists were discovering phases and phenomena that are now commonplace, and were beginning to recognize the universal properties relating liquid crystals to other physical systems such as superfluids. On the industrial side, the twisted nematic cell, patented in 1972, had just found its way into wristwatches and calculators. Nevertheless, prophets of doom from time to time opined that the field had been exhausted and little was left to accomplish.

Cut to the present. Attendance at the biennial International Liquid Crystal Conference has quadrupled, and it's easy to spend more time at topical meetings than in one's office. The annual worldwide market for flat-panel liquid crystal displays now exceeds $3.5 billion, and is expanding so rapidly that it is expected to surpass the market for cathode-ray tubes within five years. The field of liquid crystals was recognized with Pierre-Gilles de Gennes' 1991 Nobel Prize in Physics, and researchers are *still* discovering new phases and phenomena at an ever-increasing rate. "Antiferroelectricity," "nonlinear optics," "pattern formation," "blue phase," "boojum," "discotic," and "twisted grain boundary" are among the many terms that have been added to the liquid crystal lexicon since the publication of the first edition of *Liquid Crystals* in 1977. These are certainly interesting times.

In this milieu Chandrasekhar, a renowned leader in liquid crystal research and a cofounder of the International Liquid Crystal Society, has updated and revised his book. His new edition includes several topics that were first emerging in the late 1970s, as well as phenomena discovered in the intervening years.

Perhaps the most significant revision is the addition of a chapter on discotic liquid crystals, a field developed in large part by the author. The traditional liquid crystalline molecule is approximately rod-shaped, giving rise to many of the phases and physical characteristics we normally associate with liquid crystals. Disk-shaped molecules also display a variety of mesogenic phases. As with rod-shaped molecules, the symmetry axis of these planar molecules may exhibit long-range orientational order. In fact, for molecules with sufficient biaxial character, one may even encounter a biaxial nematic phase. At lower temperatures a variety of columnar phases may obtain, in which the disk-shaped molecules stack in columns that themselves are ordered. These phases, which exhibit fascinating and potentially advantageous optical and mechanical properties, have not been observed with rod-shaped molecules.

Another new topic that Chandrasekhar weaves into this new edition is blue phases, which occur in chiral systems near the cholesteric–isotropic phase transition. These phases exhibit complex helical structures in three dimensions and have rather striking macroscopic optical properties. During the past 15 plus years, considerable effort has also been spent understanding the many new smectic A phases. In addition to the traditional smectic A phase (these days called the smectic A_1 phase), we now have smectic A_2, A_d and $\tilde{A}$ phases, and most recently a chiral version of the smectic A ("twisted grain boundary") phase. Chandrasekhar deals rather nicely with these issues. The second edition also discusses ferroelectric liquid crystals and touches on other contemporary topics such as the hexatic phase and smectic layering at a free surface.

It's difficult in a book of this sort, however, to cover all topics to everyone's satisfaction. In the first edition Chandrasekhar eschewed lyotropic liquid crystals, as they were not well understood at the time; although our understanding has greatly improved, the new edition treats lyotropics only in other contexts, such as biaxiality. Interfacial behavior is a vast and vital area of research, as it addresses both fundamental and practical issues, but it receives only a smattering of attention in the book. Other important areas that receive scant or no coverage include nonlinear optics,