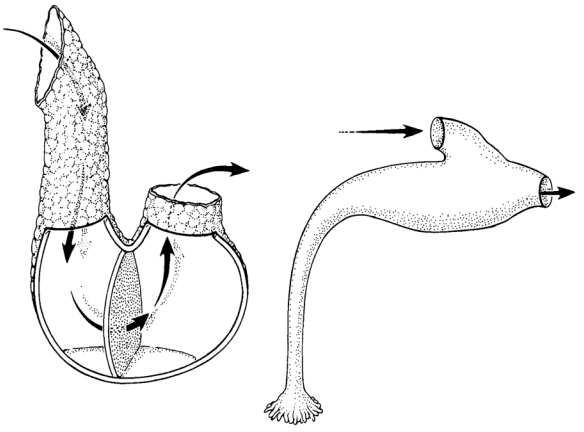

ADAPTATIONS of life forms to fluid flow. At left: Marine macroalgae that reconfigure in flow. Below (left): The case and catch-net of the larval caddis fly *Macronema*. Below (right): The in-current and excurrent siphons of the ascidian *Styela montereyensis*. From *Life in Moving Fluids*.

and baseballs, the physics of flight and the mechanics of pumping systems, for example.

Many fascinating biological issues are addressed. We learn, for example, that the eyes of most fish are located at a point on the body where the pressure does not vary with swimming speed, that there are about three billion capillaries in parallel in the human body, that sponges (using flagella) pump fluid equivalent to their own volume every five seconds, that simple momentum and energy considerations limit (but do not preclude) the use of jet propulsion by animals, and that trees reduce their drag coefficients by changing shape at high wind velocities.

The author is a fan of simple but elegant measurements, and he shows how elementary flow-visualization schemes, inexpensive instruments and Reynolds scaling ideas can be used to study the flows in and around organisms (or other objects). The functioning of simple instruments such as Pitot tubes is clearly explained. The book is a healthy counterpoint to the assumption that sophisticated instrumentation is needed to study flows.

Vogel encourages speculation, and he considers questions that have not been fully resolved. For example, has the temperature dependence of the viscosity of water led to evolutionary adaptations in some organisms? Do any organisms use polymers to reduce drag? The reader is engaged in trying to understand why organisms have developed in particular ways. The author makes a compelling case that adaptation to fluid flow is a common feature of biological design. It is clear that many phenomena in this field remain to be explored.

Life in Moving Fluids is beautifully produced. The referencing and indexing are abundant, line drawings are simple yet carefully designed, and the entire appearance is aesthetically pleasing. Some topics are intentionally excluded, but these decisions seem sensible and are clearly stated. Even those who know little about fluid dynamics will find that the book contains everything they need to know to begin thinking about biological situations. *Life in Moving Fluids* belongs in any physics library and many of our personal libraries as well.

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Electro-Optic Effects in Liquid Crystal Materials

L. M. Blinov and V. G. Chigrinov
Springer-Verlag, New York, 1994. 464 pp. $129.00 hc
ISBN 0-387-94030-8

This book is a new and improved version of Lev Mikhaylovich Blinov's earlier *Electro-Optical and Magneto-Optical Properties of Liquid Crystal* (Wiley, 1993). With its good introduction to liquid-crystal materials and description of the elementary properties of liquid crystals, it is a good starting point for beginners in the field. Those familiar with the subject may also benefit, because of the extensive citation of the original literature. In this new book, the authors have covered most of the new electro-optic effects that have been discovered since the publication of the previous version.

The authors assume little and take readers through introductory chapters that expose them to various types of liquid crystals, including the recently discovered twist-grain boundary phase. A description is given of typical properties of this and other phases of liquid crystals and how they change with modification of the chemical structure of the molecules that constitute them. The book also describes techniques for measuring the relevant parameters often used to optimize the electro-optic effects. Surface properties, which play an important role in the behavior of confined liquids crystals, are also discussed in some detail.

The heart of the book contains a good description of the abundant electro-optic effects in nematic, cholesteric and smectic liquid crystals, particularly the ferroelectric liquid crystals. The relevant mathematical description of the director distortion in the presence of the field is clearly described, often with varying boundary conditions, including treatment of

weak anchoring at surfaces. The optical properties that result from the director distortion are also discussed, although detailed treatment of optical methods, such as the 4×4 matrix methods, is lacking. Some of the electro-optic effects described include the electrically controlled birefringence, the twist and super-twist effects, guest–host effects and the flexolectric effect in both nematics and cholesterics. The extensive literature citation is impressive, particularly of the less familiar Soviet references, which are noteworthy. I found the review of the modulated and nonuniform structures in nematic and cholesteric liquid crystals with and without external perturbations to be very interesting.

Toward the end, a chapter devoted to ferroelectric liquid crystals is a self-contained review of this subgroup of liquid crystals. As does the rest of the book, it describes the relevant properties and the ways in which they can be measured, as well as the various electro-optic effects, including the recently observed deformed helix ferroelectric effect.

The final chapter is devoted to common applications of liquid-crystal devices, such as displays, light valves, modulators, deflectors, logic elements and storage devices. On the whole the book is well written, with a clear, logical path from one topic to another. It is likely to be of value to researchers and students interested in liquid crystals, whether or not they have experience with them.

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Wolfgang Pauli: Scientific Correspondence with Bohr, Einstein, Heisenberg a. o.;Vol. III: 1940–1949

Edited by Karl von Meyenn
Springer-Verlag, New York, 1993. 1077 pp. $144.00 hc
ISBN 0-387-54911-0

Wolfgang Pauli is one of the major figures of the physics of this eventful century, not only for his own contributions but, like Niels Bohr, for the influence of his strong personality on other physicists. Fortunately, his trenchant, often acerbic, qualities are preserved in his many letters, which trace the whole course of the development of theoretical physics for almost four decades from 1919. This volume will be especially valuable to anyone interested in the development of elementary particle physics in the 1940s and responsive to Pauli's always witty and elegant style.

Born in Vienna in 1900, Pauli acquired a German passport as a result of Austria's *Anschluss* with Germany in 1937. After the outbreak of war in Europe, Pauli left his professorship in Zurich and spent the years 1940 to 1946 as a member of the Institute for Advanced Study in Princeton, New Jersey. Although baptized (his godfather being Ernst Mach) and raised as a Christian, as Pauli wrote in May 1940 to Frank Aydelotte, director of the institute at Princeton: "Actually I suppose I am after German law 75 per cent Jewish. This would mean that in the case of a German occupation of Switzerland I would be really menaced and treated as a Jew." Thus Pauli, who considered himself to be incorrigibly European, became a temporary American and wrote most of his letters in English.

This large book is an archive in itself: 732 pages of letters from the 1940s and 95 pages of letters from earlier years that were not included in the first two volumes of his correspondence. There is a 58-page introductory essay by the editor, a 74-page report by Pauli and Werner Heisenberg for the 1939 Solvay Conference (canceled due to war) with commentary by Manuel G. Doncel, and 163 pages of appendices, 10 in number. The introduction and comments are in German, as are about half of the letters; the remainder are mostly in English, with a few in Danish and French. Pauli's most frequent correspondents during this period were Bohr, J. Robert Oppenheimer, I. I. Rabi and Homi J. Bhabha, to all of whom Pauli wrote in English; in German, his main correspondents were his Swiss associates Markus Fierz and Josef Maria Jauch. The editorial amenities, especially the very extensive bibliography, make this book a pleasure to work with, although those without any knowledge of German will not get the full benefit of the excellent introduction and notes by editor Karl von Meyenn. Incidentally, it is mostly his effort over many years that has given us this extraordinarily rewarding historical treasure.

The letters do not deal only with physics, but that is their main thrust. The principal subject in the first half of the decade was meson theory, where Pauli's main constructive contributions were to his Zurich colleague Gregor Wentzel's strong coupling