introduced the boundary-layer approach. Prandtl showed that viscosity is only significant in a thin layer near a solid surface and that flow outside the layer can be treated as inviscid. He went on to study the formation of turbulent boundary layers and the criteria for boundary-layer separation. Wing theory, the understanding of lift and drag, and the development of the whole of modern aeronautics have depended on his ideas.

Despite its extensive treatment of the history of hydrodynamics, I have a personal disappointment with *Worlds of Flow*: It is a pity that the author chose to end the story with Prandtl, with only a passing reference to Geoffrey Taylor, a towering figure in British fluid mechanics whose life and contributions overlapped with Prandtl's. Nonetheless, by presenting in detail the interactions between many mathematicians and engineers, and by emphasizing the different styles characteristic of scientists in different countries, Darrigol has provided a fascinating insight into the development of hydrodynamics.

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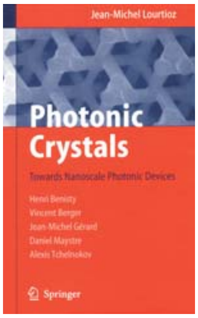
Photonic Crystals
Towards Nanoscale Photonic Devices

Jean-Michel Lourtioz, Henri Benisty, Vincent Berger, Jean-Michel Gérard, Daniel Maystre, and Alexis Tchelnokov (translated from French by Pierre-Noel Favennec)
Springer, New York, 2005. $99.00 (426 pp.). ISBN 3-540-24431-X

Photonic crystals are artificial periodic structures in which electromagnetic wave dispersion can be engineered and controlled, in analogy to the way the bands of electrons in semiconductor crystals are manipulated. The field involves the discovery and creation of those types of photonic crystals that have interesting properties, and a photonic bandgap is only one such property. Today, a whole array of photonic crystals illustrate one aspect or another of basic science, fulfill various practical aims, or occasionally provide physically based pigments in living things.

The study of photonic crystals spans solid-state physics, physical optics, crystallography, quantum optics, electromagnetic engineering, and even biology. The range and escalation of the field have led to the defeat of most researchers' attempts to provide a contemporary follow-up to the beautiful introductory monograph *Photonic Crystals: Molding the Flow of Light* (Princeton U. Press, 1995) by John D. Joannopoulos, Robert D. Meade, and Joshua N. Winn. In the past 10 years a large number of books have emerged, but the very breadth of the subject means that such volumes as *Photonic Crystals: Advances in Design, Fabrication, and Characterization* (Wiley-VCH, 2004), edited by Kurt Busch and coworkers; *Photonic Crystals: Physics, Fabrication and Applications* (Springer, 2004), edited by Kuon Inoue and Kazuo Ohtaka; and *Electromagnetic Theory and Applications for Photonic Crystals* (CRC Press, 2005), edited by Kiyotoshi Yasumoto, have usually consisted of collections of discrete articles written by individual authors and supervised by editors. Many worthy writers have been defeated in their attempts to create a single comprehensive text.

In *Photonic Crystals: Towards Nanoscale Photonic Devices*, Jean-Michel Lourtioz and his colleagues have come out with an impressive major volume that covers many of the main themes of photonic crystals, but it required the concerted effort of six coauthors. The English version, thanks to translator



Pierre-Noel Favennec, has been worth the wait. A uniform voice and consistent notation distinguish the book, making it useful as an introduction for students or as a handbook for practitioners who want to learn about photonic-crystal research outside their own specialty. The authors are the leading photonic-crystal researchers of France, and we are lucky that an English translation is now available.

The first chapter adapts Maxwell's equations to the periodic environment and introduces the major computational methods that are used to design and analyze photonic crystals. It is useful to see all the different approaches in one place and in a consistent notation, as that presentation helps researchers select the right computational method for a given situation. Meter-kilogram-second (MKS) units are used throughout the book; there seems to be no other choice, since antenna problems invariably lead to $\sqrt{\mu_o \backslash \varepsilon_o}$, the impedance of free space.

The book contains a lovely chapter giving a clear exposition of photonic quasicrystals; the quasicrystal concept emerges in full rigor since the photonic versions can be artificially engineered to any desired properties. Nonetheless, the existence of a complete photonic bandgap in quasicrystals is still much debated.

The book pays adequate attention to metallic periodic structures that lead to so-called left-handed electromagnetic properties, metamaterials, and the fertile area of plasmonics. Uniquely, the authors offer a full discussion of applications in microwave engineering. They also present complete coverage of two-dimensional, thin-dielectric-film photonic crystals that engineers are now applying toward commercial nanophotonic circuits employing thin silicon layers. Microcavities and single-photon light sources are treated as well, but it is difficult for the authors to keep up with fast-moving developments. The book covers Q-factors in the thousands, but $Q > 10^6$ has recently been achieved by Takashi Asano, Susumu Noda, and Bong-Shik Song.

The authors include a brief chapter on photonic crystal fibers, but complete volumes dedicated to that topic by other researchers have begun to appear, such as the text by Zolla and his colleagues and *Photonic Crystal Fibres* (Springer, 2003) by Anders Bjarklev, Jes Broeng, and Araceli Sanchez Bjarklev. Photonic crystals occur in the botanical and zoological worlds as physically based pigments, and yet biological photonic crystals are not mentioned in the book. They deserve a colorful volume of their own, showing what is known, for example, of peacock and parrot feathers.

Overall *Photonic Crystals* is an excellent book that can serve as an introductory text and a reference for graduate students and researchers.

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