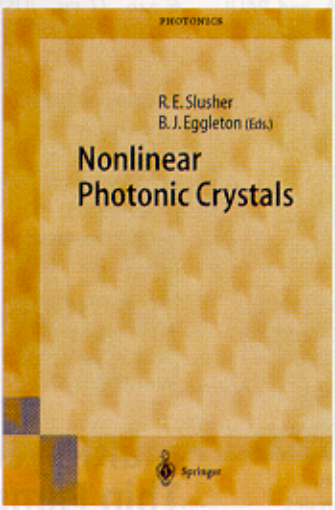
A light read

While *linear* photonic crystals continue to offer up new surprises, Richart E. Slusher and Benjamin J. Eggleton have leapt ahead to present an excellent collection of articles on *nonlinear* photonic crystals, says **Eli Yablonovitch**.

In the world of linear photonic crystals, significant breakthroughs are currently being made in photonic crystal fibers and the development of thin film, two-dimensional nano-optical cavities with Q-factors approaching 10^5. There are now many approaches toward nano-scopic, three-dimensional fabrication. Photonic crystals in the biological world are being rigorously tested, with theory being compared against the observed properties of biophysical pigments. Indeed, the field has grown so broad that it is now all but impossible to cover it in one volume. Hence, a need for specialization, as in this well-edited collection, *Nonlinear Photonic Crystals*, which ponders the nonlinear optical properties of photonic crystals.

Of course, nonlinear optics is much more difficult than linear optics, and so most of the effort is concentrated on the more tractable one-dimensional periodic structures rather than two- and three-dimensional photonic crystals. (With the passage of time, the nomenclature of the photonic crystal concept, which was originally intended only for two- and three-dimensional periodic structures, is now being employed for one-dimensional structures.) Indeed, there is already more than enough richness and complexity in the nonlinear optics of one-dimensional structures.



Slusher and Eggleton have persuaded the world's leading experts to contribute significant original articles and chapters to this book. Among the interesting effects represented here are soliton-like pulse propagation; polarization instability; gap solitons, particularly as driven by Raman-type nonlinearities; slow light; and self-induced transparency. Many of these effects had precursors in early work on optical bistability in cavities. In addition, there are chapters on frequency mixing and conversion, and the parametric instability that leads to optical squeezing.

Among the more practical forms of one-dimensional periodic optical structures is the weak induced fiber grating inside a single mode optical fiber. This experimental system has become a laboratory for interesting nonlinear optical effects like modulational instability, gap solitons, and, indeed, fully optical logic gates. In this respect, there is an undercurrent in this volume: a desire to replace transistor logic with all-optical logic. Historically, such a program has not gone well, since photon nonlinearities are weak but electron interactions, as in transistors, are strong. The central dogma of electrical engineering has been photons for telecommunications and electrons for logic and storage. Such assessments do not overshadow the value of this volume, since the nonlinear science of photonic structures has its own intellectual allure.

The closing chapters of the book are among the most fascinating. There is a section on chalcogenide glasses (glasses based on S, Se, and Te rather than oxides). These amazingly flexible materials are perpetually underestimated in terms of their practical potential. Photonic crystal fibers are covered in one chapter, but they deserve a whole volume in their own right. Distributed feedback lasers, a pioneering and important implementation of one-dimensional periodicity, are reviewed. Transverse optical solitons in beam propagation are also explored here. There is only one chapter on thin film, two-dimensional photonic crystals, where self-trapping of light is investigated. Finally, there is an amazing chapter on Bose-condensed matter waves, which are analogous to electromagnetic waves and can form band gaps in optically induced periodic potentials.

Richart E. Slusher and Benjamin J. Eggleton (eds.)
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This volume is an excellent accomplishment, bringing together many authors in a common and consistent theme in a rapidly developing new field. The publishers must take responsibility for one objection, however. In adapting graphics from so many sources, some figures are not reproduced as attractively as this book deserves.

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