A view of light in the living world

The Optics of Life
A Biologist's Guide to Light in Nature

Sönke Johnsen
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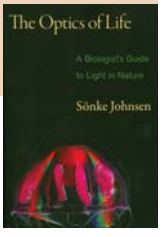

Reviewed by
Nicholas Roberts

Light is essential to life. The answers to questions about ecology, behavior, neuroscience, and evolution involve measuring and understanding some aspect of light, from the bright, colorful iridescence in a muster of peacocks to bioluminescence in deep-sea trenches. Classic textbooks such as *Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light* by Max Born and Emil Wolf (7th edition, Cambridge University Press, 1999) or *Optics* by Eugene Hecht (4th edition, Addison Wesley, 2001), which are mostly used by physicists and optical engineers, tend to focus away from such biological problems. And, in general, only physicists entering biological fields after exposure to such books have been able to use more mathematical tools in their research.

Duke University biophotonics researcher Sönke Johnsen is one such scientist. Yet, his book, *The Optics of Life: A Biologist's Guide to Light in Nature*, is written for readers who are not specialists in the field. Filled with anecdotes and original examples, *The Optics of Life* is well written and highly readable—and the latter is not often said about optics books. The book clearly states its intentions: to be an introductory text about absorbance, scattering, fluorescence, and other important processes; light-measuring techniques; and the quantum nature of light. It would help graduate students in any science major to develop a correct foundation for the important properties of light and associated measurement techniques. And although the book offers well-chosen biological examples, it appropriately holds back from trying to be a text on visual or behavioral ecology.

The Optics of Life is arranged in sections that are clearly and logically presented. After the initial chapter on scientific units, the main part of the text is split into chapters that address the most important optical processes. Each chapter has a common structure: an introduction to the underlying physics, followed by examples of how the optics has been relevant to different biological systems. The chapter on scattering with interference is a typical example: It describes the fundamental optics of constructive interference, explains how multilayer reflectors work, and then follows with interesting examples of mid-water reflective camouflage and work on reflective optics in animal eyes. Many examples in the book, including that one, have a visual-ecology bias, which is unsurprising given Johnsen's background. However, all the underlying electromagnetic principles described also apply to medical optics and bioimaging technologies.

One area that gets little mention from Johnsen is the phylogenetics of biological optical structures. However, such scant treatment reflects a dearth in the current research. In recent years, the number of papers documenting photonic mechanisms in butterflies and other insects, birds, and fish have increased substantially. Still, very few of those studies have attempted to deal with the evolution and development of the optics.

The final section of the book introduces techniques of measuring light—for example, making measurements of calibrated irradiance, radiance, reflectivity, and transmission. The introductions to those techniques and the associated appendices are extremely useful and should help many researchers to measure light better. One standout comment from the polarization chapter actually applies more generally: "Buying optical equipment is easy, but using it correctly in a biological setting is not."

Because of its emphasis on correctly approaching the way physical measurements should be made, *The Optics of Life* has something to offer anyone whose research directly or tangentially involves light. More than a biologist's guide to light in nature, this book is a guide for any scientist interested in optics and the world around us.

Nicholas Roberts is a physicist and sensory biologist in the school of biological sciences at the University of Bristol in the UK. He conducts research on polarization vision, biological structures that control light, and the visual systems of deep-sea animals.

War of the Worldviews
Science vs. Spirituality

Deepak Chopra and
Leonard Mlodinow
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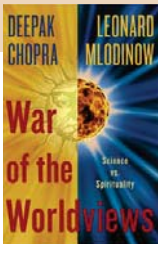

Deepak Chopra, a best-selling author of books on spirituality and health, is regarded by many scientists as a guru of pseudoscience. Leonard Mlodinow is a physicist, a screenwriter, and the author of popular science books, including *The Grand Design* coauthored with Stephen Hawking (and reviewed in PHYSICS TODAY, January 2011, page 58). Now Chopra and Mlodinow have collaborated on *War of the Worldviews: Science vs. Spirituality*.

The book gives each author the chance to speak to a wider audience than either could attract on his own. Each author responds to his counterpart's arguments and thereby forces the other to explain clearly to the reader what he thinks. That debate format engages the reader well: It allows the scientifically inclined skeptic to relax and read each Chopra chapter with an open mind, knowing that a critical analysis from Mlodinow will follow. The book will also expose some of Chopra's supporters to orthodox interpretations of science.

War of the Worldviews covers cosmology, life and evolution, the mind and brain, and God. Throughout, Chopra advocates his own brand of spirituality, a worldview in which the universe is an evolving consciousness. He states that "to arrive at DNA, life on Earth, and the human mind, the universe was self-aware and could understand what it was doing." He also suggests that by going deeply into your own awareness, you will find a special place where the consciousness of the universe will be "drawn