



Lectures on Light: Nonlinear and Quantum Optics using the Density Matrix

Stephen Rand

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This book attempts to bridge in one step the enormous gap between introductory quantum mechanics and the research front of modern optics and scientific fields that make use of light. Hence, while it is suitable as a reference for the specialist in quantum optics, it will also be useful to the non-specialists from other disciplines who need to understand light and its uses in research. With a unique approach it introduces a single analytic tool, namely the density matrix, to analyze complex optical phenomena encountered in traditional as well as cross-disciplinary research. It moves swiftly in a tight sequence from elementary to sophisticated topics in quantum optics, including laser tweezers, laser cooling, coherent population transfer, optical magnetism, electromagnetically-induced transparency, squeezed light, and cavity quantum electrodynamics. A systematic approach is used that starts with the simplest systems - stationary two-level atoms - then introduces atomic motion, adds more energy levels, and moves on to discuss first-, second-, and third-order coherence effects that are the basis for analyzing new optical phenomena in incompletely characterized systems.

Unconventional examples and original problems are used to engage even seasoned researchers in exploring a mathematical methodology with which they can tackle virtually any new problem involving light. An extensive bibliography makes connections with mathematical techniques and subject areas which can extend the benefit readers gain from each section.

To identify techniques and ideas that are universal enough to be applied across the bewildering landscape of research on intersecting boundaries of emerging modern disciplines is a great challenge. This book offers selected insights on quantum dynamics and quantum theory of light for exactly this purpose.

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