An Introduction to Nonlinear Optics

Robert A. Fisher
R. A. Fisher Associates
bob@rafisher.com

AN INTRODUCTION TO NONLINEAR OPTICS draws from many different nonlinear optical phenomena to elucidate the basic components of the subject.

The Introduction will develop the general topic via the Maxwell equations and the "reduced" or "Slowly-Varying Envelope Approximation (SVEA)". Expansions for the nonlinear susceptibility will be described, and specific third order effects will be introduced. Each idea is explained in clear and simple terms with an emphasis on underlying physical principles and with a minimum of mathematics.

Next, specific nonlinear optical effects will be studied in detail to illustrate specific points.

Phase matching conditions will be introduced in our discussion of Second Harmonic Generation. Here Type I and Type II phase matching will be presented for uniaxial doubling crystals.

To become conversant with the slowly-varying envelope approximation, the Optical Kerr Effect will be discussed. Here the basic Kerr nonlinearity will be described, along with its relationship to spontaneous depolarized Rayleigh wing scattering, stimulated Rayleigh wing scattering, weak-wave retardation, and self-focusing. Furthermore, plane-wave Kerr propagation effects such as self-phase modulation, and dispersive self-phase modulation optical solitons will all be described.

The concept of stimulated nonlinear scattering is introduced in Stimulated Brillouin Scattering. The electrostrictive nonlinearity is described, and both stimulated and spontaneous aspects are reviewed, including the SBS gain coefficient, the concept of threshold, and polarization issues.