Mathematics and Guided Waves in Liquid Crystals

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Nematic liquid crystals form an ideal medium for the study of nonlinear, optical guided waves, such as solitary waves, these being termed "nematicons" in nematic liquid crystals. The huge nonlinearity of nematic liquid crystals means that nonlinear effects can be observed over distances of millimetres. In addition nematic liquid crystals are "nonlocal" media, which means that the response of the liquid crystal extends far beyond the waist of the optical beam. Finally nematicons are two space dimensional waves. The facts that nematicons are nonlocal, 2+1 dimensional, nonlinear guided waves presents a number of mathematical challenges. This is particularly so as the standard mathematical methods for solitary wave equations, such as inverse scattering, are not easily extended to more than one space dimension. The basic physical properties of nematic liquid crystals, the governing equations and the mathematical background needed to study the propagation of nematicons will be discussed. Examples will be drawn from the propagation of single nematicons and the interaction of nematicons of different colours (wavelengths). Possible future research directions will finally be discussed.