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FORMATION AND STABILITY OF MULTIDIMENSIONAL LOCALIZED STRUCTURES IN OPTICS AND BOSE-EINSTEIN CONDENSATE: RECENT STUDIES

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Abstract. *We give a brief overview of recent results in the area of both* (2+1)- *and* (3+1)-*dimensional localized structures in some selected models in optics and Bose-Einstein condensate. We concentrate on the existence and robustness of these multidimensional localized structures and on the possibility of observation of* (3+1)-*dimensional solitons ("light bullets") in optical settings.*

Keywords: spatiotemporal optical solitons, light bullets, vortex (spinning) solitons, optical lattices, Bose-Einstein condensates

1. Introduction

In the past two decades there has been an increasing interest in the theoretical and experimental study of shape-preserving confined structures of light, which overcome either dispersion (temporal solitons), or diffraction (spatial solitons) [1]-[4]. These temporal and spatial solitons are special cases of a larger class of nonlinear phenomena in which both temporal and spatial effects are coupled and occur simultaneously. The space-time coupling occurring when a pulsed optical beam propagates through a nonlinear medium leads to unique nonlinear effects, such as the spatiotemporal collapse in the case of anomalous group-velocity dispersion (GVD), pulse splitting if the GVD of the medium is normal, the formation of fully confined (in both transverse spatial dimensions) light pulses, i.e., the creation of spatiotemporal optical solitons [1], etc. The multidimensional localized structures have attracted a great deal of attention both in optics and in the field of atomic Bose-Einstein condensate (BEC).

In optics, the localized multidimensional structures are spatially confined on the order of wavelength. They represent the "particle-like" counterpart of the more common extended light structures. The optical media that might sustain such self-guiding structures should be nonlinear, i.e., their refractive index should depend on the light intensity. Different kinds of nonlinearities of optical materials such as absorptive, dispersive, second-order (quadratic), third-order (Kerr-like) can be used to prevent temporal dispersion/spatial diffraction of light beams or both of

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