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Studies of existence and stability of circularly polarized few-cycle solitons beyond the slowly-varying envelope approximation

Submitted by Hervé Leblond on Mon, 12/15/2014 - 12:27

Titre	Studies of existence and stability of circularly polarized few-cycle solitons beyond the slowly-varying envelope approximation
Type de publication	Chapitre
Type	Ouvrage scientifique
Année	2013
Langue	Anglais
Pagination	247-275
Titre de l'ouvrage	Spontaneous Symmetry Breaking, Self-Trapping, and Josephson Oscillations
Auteur	Leblond, Hervé [1], Mihalache, Dumitru [2], Triki, Houria [3]
Editeur scientifique	Malomed, Boris A [4]
Editeur	Springer
Ville	Berlin Heidelberg
Mots-clés	Photonics [5], Progress Optical Sci. [6]
Résumé en anglais	In this chapter, we provide an overview of recent studies of theoretical models which adequately describe the temporal dynamics of circularly polarized few-cycle optical solitons in both long-wave- and short-wave approximation regimes, beyond the framework of slowly varying envelope approximation. In the long-wave-approximation regime, i.e., when the frequency of the transition is far above the characteristic wave frequency, by using the multiscale analysis (reductive perturbation method), we show that propagation of circularly polarized (vectorial) few-cycle pulses, is described by the nonintegrable complex modified Korteweg–de Vries equation. In the short-wave-approximation regime, i.e., when the frequency of the transition is far below the characteristic wave frequency, by using the multiscale analysis, we derive from the Maxwell-Bloch equations the governing nonlinear evolution equations for the two polarization components of the electric field, in the first order of the perturbation approach. In this latter case we show that propagation of circularly-polarized few-optical-cycle solitons is described by a system of coupled nonlinear evolution equations, which reduces, for the particular case of scalar solitons, to the completely integrable sine-Gordon equation describing the dynamics of linearly polarized few-cycle pulses in the short-wave-approximation regime. It is seen that, from the slowly varying envelope approximation down to a few cycles, circularly polarized solitons are very robust, according to rotation symmetry and conservation of the angular momentum. However, in the sub-cycle regime, they become unstable, showing a spontaneous breaking of the rotation symmetry.
URL de la notice	http://okina.univ-angers.fr/publications/ua6436 [7]
DOI	10.1007/10091_2012_28 [8]

Lien vers le document	http://link.springer.com/chapter/10.1007/10091_2012_28 [9]

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