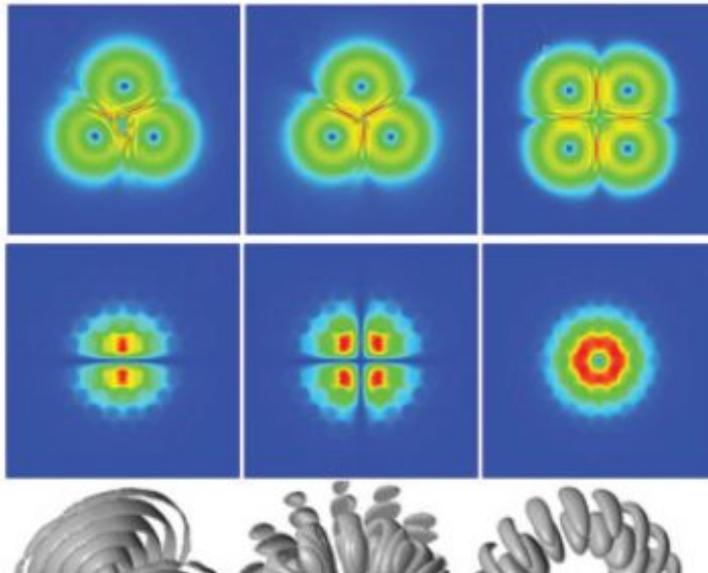

OLGA BOROVKOVA

Advisor: Lluís Torner

Yaroslav Kartashov



PhD Thesis Defense **OLGA BOROVKOVA** 'Soliton Generation and Control in Engineered Materials'

OLGA BOROVKOVA

October 11, 2013

Friday October 11, 11:00. ICFO Auditorium

OLGA BOROVKOVA

NONLINEAR OPTICAL PHENOMENA

ICFO-The Institute of Photonic Sciences, SPAIN

Optical solitons provide unique opportunities for the control of light-by-light. Today, the field of soliton formation in natural materials is mature, as the main properties of the possible soliton states are well understood. In particular, optical solitons have been observed experimentally in a variety of materials and physical settings, including media with cubic, quadratic, photorefractive, saturable, nonlocal and thermal nonlinearities.

New opportunities for soliton generation, stability and control may become accessible in complex engineered, artificial materials, whose properties can be modified at will by, e.g., modulations of the material parameters or the application gain and absorption landscapes. In this way one may construct different types of linear and nonlinear optical lattices by transverse shallow modulations of the linear refractive index and the nonlinearity coefficient or complex amplifying structures in dissipative nonlinear media. The exploration of the existence, stability and dynamical properties of conservative and dissipative solitons in settings with spatially inhomogeneous linear refractive index, nonlinearity, gain or absorption, is the subject of this PhD Thesis.

We address stable conservative fundamental and multipole solitons in complex engineered materials with an inhomogeneous linear refractive index and nonlinearity. We show that stable two-dimensional solitons may exist in nonlinear lattices with transversally alternating domains with cubic and saturable nonlinearities. We consider multicomponent solitons in engineered materials, where one field component feels the modulation of the refractive index or nonlinearity while the other component propagates as in a uniform nonlinear medium. We study whether the cross-phase-modulation between two components allows the stabilization of the whole soliton state.

Media with defocusing nonlinearity growing rapidly from the center to the periphery is another example of a complex engineered material. We study such systems and, in contrast to the common belief, we have found that stable bright solitons do exist when defocusing nonlinearity grows towards the periphery rapidly enough. We consider different nonlinearity landscapes and analyze the types of soliton solution available in each case.

Nonlinear materials with complex spatial distributions of gain and losses also provide important opportunities for the generation of stable one- and multidimensional fundamental, multipole, and vortex solitons. We study one-dimensional solitons in focusing and defocusing nonlinear dissipative materials with single- and double-well absorption landscapes. In two-dimensional geometries, stable vortex solitons and complexes of vortices could be observed. We not only address stationary vortex structures, but also steadily rotating vortex

solitons with azimuthally modulated intensity distributions in radially symmetric gain landscapes.

Finally, we study the possibility of forming stable topological light bullets in focusing nonlinear media with inhomogeneous gain landscapes and uniform two-photon absorption.

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Thesis Advisor: Prof. Lluís Torner

Thesis Co-advisor: Dr. Yaroslav Kartashov

