2nd Conference on Localized Excitations in Nonlinear Complex Systems

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Universidad de Sevilla
(*Nonlinear Physics Group*)

Presentation

During the last two decades, an impressive volume of theoretical and experimental work has been devoted to the existence, stability and dynamics of localized excitations. Such coherent structures have been identified as critical components of numerous continuous and discrete dynamical systems and, depending on the context (and their particular form), they may be referred to as solitons, instantons, kinks, breathers, or quodons, among many others. We nowadays think of such localized nonlinear excitations as being ubiquitous in nature due to their experimental realization in many diverse systems including, but not limited to, optical fibers and waveguide arrays, photonic crystals, Bose-Einstein condensates, molecular crystals, quasi-one-dimensional solids, Josephson-junctions and arrays thereof, layered silicates, micromechanical cantilever arrays, uranium crystals, pendulum arrays, water waves, electrical transmission lines, ferromagnetic and antiferromagnetic materials, granular crystals and so on. Additionally, they are also conjectured to play an important role in denaturation transitions and bubble formation in DNA, protein folding, atom ejection and defect migration in crystals, low-temperature reconstructive transformations, and many others.
The study of nonlinear localized excitations is a long-standing challenge for research in basic and applied science, as well as engineering, due to their importance in understanding and predicting phenomena arising in nonlinear and complex systems, but also due to their potential for the development and "design" of novel applications.
The LENCOS Conferences were born in 2009 with the aim of becoming in a reference forum where experimental and theoretical physicists, chemists, biologists, and applied mathematicians, working in the broad field of nonlinear localized modes, can interchange ideas and promote the research in this multi-faceted and diverse thematic area.

About the organizers

The meeting is organized the Nonlinear Physics Group (Grupo de Física No Lineal) of the University of Sevilla. This research group has organized recently some events on the some subject such as Moving Breathers in Nonlinear Lattices (2003), Macroscopic Effects of Nonlinear Excitations (2004), New Horizons in Stochastic Complexity and Nonlinear excitations: theory and experiments (2005) apart from the first edition of the LENCOS Conference (2009).

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Quasi-one-dimensional Bose-Einstein condensates in nonlinear lattices
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Collaborator: **Boris Malomed**

We consider the three-dimensional (3D) mean-field model for the Bose-Einstein condensate (BEC), with a 1D nonlinear lattice (NL), which periodically changes the sign of the nonlinearity along the axial direction, and the harmonic-oscillator trapping potential applied in the transverse plane. The lattice can be created as an optical or magnetic one, by means of available experimental techniques. The objective is to identify stable 3D solitons supported by the setting. Two methods are developed for this purpose: The variational approximation, formulated in the framework of the 3D Gross-Pitaevskii equation, and the 1D nonpolynomial Schrodinger equation (NPSE) in the axial direction, which allows one to predict the collapse in the framework of the 1D description. Results are summarized in the form of a stability region for the solitons in the plane of the NL strength and wavenumber. Both methods produce a similar form of the stability region. Unlike their counterparts supported by the NL in the 1D model with the cubic nonlinearity, kicked solitons of the NPSE cannot be set in motion, but the kick may help to stabilize them against the collapse, by causing the solitons to shed excess norm. A dynamical effect specific to the NL is found in the form of freely propagating small-amplitude wave packets emitted by perturbed solitons.

Spatiotemporal dynamics in a ring of coupled pendula: analogy with bubbles
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Many systems in nature, like drops, bubbles or some macromolecules present circular or spherical symmetry. Under the influence of some external force, such objects often develop surface patterns whose properties are greatly influenced by the underlying geometry. However, differently from the planar case, patterns in curved geometries have been much less explored. Despite the complexity of the particular physical problems, the basic dynamical features are often captured by simple models of coupled oscillators. Here we present a theoretical and experimental study of the spatial instabilities of circular ring of coupled pendula parametrically driven by a vertical harmonic force. Normal oscillation modes (breathing, dipole, quadrupole) and localized patterns of different types (breathers and kinks) are predicted and observed. The analogy between the considered discrete mechanical system and a gas bubble cavitating under the action of an acoustic field is established. On the basis of this analogy, the oscillation patterns and localized modes observed experimentally in acoustically driven bubbles are interpreted and discussed.