Dispersive shocks and complexity of nonlinear waves

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Dispersive shock waves are ubiquitous phenomena originated by the regularization of wave breaking of nonlinear waves. Wave breaking, in turn, is characterized by the formation of singular and multivalued regions that, in dispersive media, act as precursors for the generation of periodic nonlinear wavetrains (i.e., cnoidal waves), whose dynamics defines the dispersive shock. In this talk I will review my activity in the field, discussing various theoretical approaches to the problem, including the Whitham theory of modulation and new statistical mechanics frameworks based on the thermodynamics of chaos. I will also discuss the implications of shock waves on the complexity of Soliton waves.

Destabilization of localized structures induced by delayed feedback

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We are interested in the stability of localized structures in a real Swift-Hohenberg equation subjected to a delayed feedback. We shall show that variation in the product of the delay time and the feedback strength leads to complex dynamical behavior of the system, including formation of oscillons, soliton rings, labyrinth patterns or moving structures. We provide a bifurcation analysis of the delayed system and derive a system of order parameter equations for the position of the localized structure as well as for its shape. In a special case, a normal form of the delay-induced drift-bifurcation is obtained, showing that spontaneous motion arises without change of shape.

The way to powerful single-cycle pulses: laser filaments and electron jets

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The unique conversion efficiency of laser radiation in supercontinuum is achieved in SF6 forming uniform over-octave 300-950 nm spectrum. The different parts of this supercontinuum within 440-800 nm were compressed down to 8 fs. With a single broadband compressor the sub-5 fs pulses were detected. The filamentary mechanism admits the scalability to higher pulse energies with the example of self-compression of 3.8 mJ pulses. Another new two-step approach for generation of attosecond hard X-rays is exploited. In the first stage, hot electrons are produced in a primary water target and accelerated in forward