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Solitons and Coherent Structures in Bose-Einstein Condensates

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The Fermi-Pasta-Ulam (FPU) model was formulated fifty years ago in an attempt to explain heat conduction in non-metallic lattices and develop "experimental" (computational) methods for research on nonlinear dynamical systems. Further studies of the FPU problem ten years later led to the first analytical description of solitons, which occur ubiquitously in diverse physical situations ranging from water waves to plasmas, optical fibers, and more. More recently, the study of solitons and coherent structures in Bose-Einstein condensates (BECs) has come to the forefront of experimental and theoretical efforts, drawing attention from both atomic and nonlinear physicists. In this talk, I will discuss localized (soliton) and spatially extended solutions of the Gross-Pitaevskii (GP) equation describing the macroscopic behavior of BECs near zero temperature. As a key example, I will discuss BECs loaded into deep, spatially periodic optical potentials, which effectively splits the condensate into a chain of linearly-interacting, nonlinear droplets, the dynamics of which is characterized by nonlinear lattice models. This talk will highlight some of the dynamical structures in BECs reminiscent of the discoveries that originated from the FPU model.