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Superregular solitonic solutions: a novel scenario for the nonlinear stage of modulation instability.

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The superregular solitonic solutions, recently discovered by Vladimir E. Zakharov and Andrey A. Gelash [1], is an important scenario of modulation instability in the frame of the one-dimensional focusing Nonlinear Schrödinger Equation (NLSE). This 2N-solitonic solutions describes the evolution of a broad class of an initial plane wave (a condensate) small localized perturbations. Recently we have generalized the theory to the degenerate case [2]. Here we discuss the possibility of their experimental observation. We present the most appropriate solution parameters for hydrodynamics and optics.

However, the self-consistent theory of modulation instability should describes the evolution of arbitrary initial condensate perturbations. In the second part of this work we present the next step toward the full theory. The famous Peregrine soliton [3] is an another example of the NLSE solutions which describes a very special but important nonlinear scenario of modulation instability. Nowadays multi-solitonic generalizations are known [4,5]. These rational solutions describe waves of extremely high amplitude - the so-called "freak waves". They appear from small localized perturbations, reach at least three condensate amplitude and then vanish. Physically there are always additional noise exists. Its solitonic spectrum part is described by superregular solutions.

We construct N-solitonic solution on the Peregrine background by using the dressing method. It is a very useful tool allows to study nonlinear interactions of the Peregrine soliton with Kuznetsov soliton, Akhmediev breather, superregular solutions or any other N-solitonic solution without applying of the L'Hopital rule for each solution (the L'Hopital rule applies only once to construct the dressing). In conclusion we demonstrate and discuss an explicit scenario of superregular and rational solutions simultaneous development.

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