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Nonlinear Structures Formation Under Saturation of Modified Explosive Instability

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Formation of coherent long-lived large-scale structures is often considered [1] to be one of the main reason of transition in the regime of improved confinement in tokamaks (L-H transition). In the present work we examined the possibility of self stabilization of explosive instability and showed that coherent localized structures of soliton-like type can appear. As an example, we considered the interaction of ion temperature gradient driven modes (η_i - mode) in tokamaks near the boundary of marginal instability [2]. These modes are expected to explain many features of tokamak confinement. Density $n(r)$ and temperature $T(r)$ profiles in plasma of tokamaks often nearly satisfy conditions for marginal stability of strong reactive unstable modes such as η_i-mode [3]. Below the linear stability boundary there still exists rather high level of turbulence, so called "subcritical turbulence." In [4] the nonlinear explosive instability due to interaction between modes with positive and negative energy was proposed as the driving mechanism for the turbulence.

We have shown that in the process of nonlinear interaction two different η_i-modes are "merging" and, interacting with other modes, are forming two solitons, corresponding of the each mode. One could say therefore, that the double nature of the mode of "zero" energy manifests itself in the process of two solitons formation.

It has been shown that the system has also solutions of the form of nonlinear periodic waves. Hence, the modified explosive instability can be stabilized by means of the formation of spatial coherent structures.

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