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Theoretical study of formation of nonlinear localized electrostatic structures in space plasmas

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Some theoretical models of the formation of the electrostatic solitary structures and double layers are calculated analytically and numerically. Basing on the MHD system equations for multi-component plasma, composed of warm beams of ions and electrons the evolutionary equations for three-dimensional structures are derived. Taking into account the effects of the nonisothermal hot electrons or ions the evolutionary equations with mixed nonlinearity (the modified equations MKdV-ZK) are received. Mathematical methods for the solution of these nonlinear equations with different degree of nonlinearity are developed It has been shown that the nonlinearity of plasma plays a unique role. Effect of trapped particles and their interaction with the potential structures modifies significantly the parameters of the structure: velocity, the amplitude, width and can lead to the formation of the double-layers, to the spiky and explosive structures Also, it is shown, that in plasma with the beams of ions and electrons two types of structures can be formed: the solitary structures moving with the velocity comparable to local ion-acoustic velocity (IAS), and the solitary structures moving with the velocity comparable to electron thermal velocity, electron acoustic structures (EAS).

In the private case of the spherical symmetry, numerical analysis of coefficients of the evolutionary equation with different degree of nonlinearity allows to determine the characteristics of nonlinear electrostatic structures: waveforms of density and electric field, velocity, and the oblateness ratio of the structure $R = L_{perp}/L_{par}$ (where L_{par} and L_{perp} - field-aligned and perpendicular scales). Some examples of the numerical simulation of the electrostatic structures in the multi-component plasmas are presented for the various regions of the magnetosphere. This theoretical models is in good agree-

ment with experimental data obtained by satellites *FAST, POLAR and GEOTAIL*.