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Nonlinear small-scale localized electrostatic structures and their impact on magnetospheric boundaries

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The formation of three-dimensional solitary electrostatic structures and double layers in the magnetospheric boundary plasma is investigated. Basing on the MHD system of equations for small finite- amplitude structures, the evolutionary equations of modified Korteweg-de Vries-Zakharov- Kuznetzov (*MKdV-ZK*) type are derived. The mathematical methods for the solution of these nonlinear equations with different degree of nonlinearity are developed. In the specific case of the spherical and cylindrical symmetry, their numerical solutions are found.

It is shown, that the presence of the trapped electrons (ions) in the localized potential plays the important role in the formation of compressive (rarefactive) solitary electrostatic structures and double layers. From the analysis of the nonlinear evolutionary equations the characteristics of solitary structures include waveforms of density and electric field, field-aligned velocity, and the oblateness ratio R = L_{perp}/L_{par} (where L_{par} and L_{perp} - field-aligned and perpendicular scales) is also determined.

We compare the theoretical predictions for the localized structures with the Interball-1 and Cluster data and discuss their role in the mass, energy and momentum transport and transformation in the magnetopause and boundary layers, including cusp, stagnation region and low latitude boundary layer. The localized double layers and charged current sheets occur to provide the means for nonlinear wave- particle interactions in the collisionless plasma. The latter could dominate in the high- β boundary layers, and regulate the particle penetration and energization in the MP current sheets. We discuss the double layers at thin current sheets driving the Hall current, which provides the

general field rotation at MP of an ion gyroradius scale. Also addressed are features of the smallest predicted structures versus that of ‘electron holes’.

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