

Two-dimensional particle simulations of electromagnetic emission from electrostatic solitary waves

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We present computer simulations of electrostatic solitary waves (ESW) observed by the GEOTAIL and other recent spacecraft in the Earth's magnetosphere. The previous electrostatic simulations in uniform periodic systems have demonstrated that ESW correspond to BGK solitary potentials generated through nonlinear evolution of the electron bump-on-tail instability. We found that there exists little enhancement of magnetic field around one-dimensional potentials, while two-dimensional potentials are accompanied by solitary structures of magnetic fields. The detailed analysis of the isolated electrostatic and electromagnetic structures will be presented. We will also discuss possible emission process of electromagnetic waves from the solitary potentials.

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The simulation system is two-dimensional taken in the x-y plane. In the present study, we inject a cold electron beam from the left boundary of the system into the homogeneous background plasma. The bump-on-tail instability develops into formation of a series of electrostatic potentials. These potentials coalesce with adjacent potentials and become isolated one-dimensional potentials. In the top part of the electron beam, there are purely one-dimensional potentials. On the other hand, in the generation region of the solitary potentials, two-dimensional potentials are formed through coupling process of solitary potentials with oblique modes.

In the present simulation of the bump-on-tail instability, magnetic fields B_x and B_y are enhanced. The current density is also enhanced in the z direction. We found a good correlation between J_z and perpendicular electric field E_y . We also found that there exists little enhancement of magnetic field around one-dimensional potentials, while two-dimensional potentials are accompanied by solitary structures of magnetic fields. The detailed analysis of the isolated electrostatic and electromagnetic structures will be presented. We will also discuss possible emission process of electromagnetic waves from the solitary potentials.