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Particle simulations of solitary waves in the auroral region

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We perform two-dimensional electrostatic particle simulations of electron beam instabilities using parameters characteristic of the auroral region, and find formation of one- and two-dimensional electrostatic solitary waves (ESW).
In these simulations, cold electron beams excite two-dimensional potentials, and warm beams excite one-dimensional potentials.
Two-dimensional potentials, however, are diffused and disapper by ions.
On the other hand, one-dimensional potentials are modulated with the ion gyroradius in the perpendicular direction, leading to formation of two-dimensional structures.

We perform two-dimensional electrostatic particle simulations of electron beam instabilities using parameters characteristic of the auroral region. Counter-streaming electron beams interact strongly to form large electrostatic potentials trapping the beam electrons.The potentials coalesce with each other to form electrostatic solitary waves (ESW) which have been observed by recent spacecraft in various regions of the magnetosphere.
The nonlinear trapping of the electron beams leads to formation of electron holes in the velocity phase space.
We study two cases with different thermal velocity of the electron beams,i.e., cold and warm electron beams.
In the case of cold beams, we find two-dimensional potentials are formed under a relatively strong magnetic field corresponding to the electron cyclotron frequency equal to the electron plasma frequency.
These two-dimensional potentials, however, are diffused by ions, and disapper with the time scale of the plasma oscillation period of ions.
On the other hand, in the case of warm beams, one-dimensinoal potentials elongated in the direction perpendicular to the magnetic field at the saturation phase of the beam instability.As time gose on, these one-dimensional potentials are modulated with the ion gyroradius in the perpendicular direction, leading to formation of two-dimsntional structures which are stable for more than 26 plasma oscillation periods of ions.