## §19. V-shaped dc Potential Structure Caused by Current-Driven Electrostatic Ion-Cyclotron Instability

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Formation of electric field along magnetic field lines is as yet a puzzling and challenging problem for generating accelerated charged particles in a space plasma. In particular, many space observations support the theory that auroral electrons are accelerated by a parallel electric field above the ionosphere. Current-driven kinetic instabilities such as ion acoustic and electrostatic ion-cyclotron instabilities have been paid much attentions as such candidates. It is well known that double layers are created by an ion acoustic instability for a relatively high electron stream. On the other hand, analysis says that electrostatic ion-cyclotron waves become unstable for a smaller electron stream in an isothermal plasma and in fact that are frequently observed by satellite observations. Furthermore, it is reported that a V-shaped potential structure and electrostatic ion cyclotron wave are simultaneously present above the auroral ionosphere. Although many laboratory experiments and numerical simulations concerned with a V-shaped potential structure or an ion-cyclotron instability have been performed, no one succeeded in demonstrating that current-driven electrostatic ion-cyclotron instability creates a V-shaped potential structure.

With these situation in mind, we have investigated deveolpment of a current-driven electrostatic ion-cyclotron instability and resulting dc potential structure by means of a sophistcated particle simulation model where fresh particles are injected from the boundaries at each time step avoiding unphysical accumulation of charged particles in front of the boundaries.

As current-driven electrostatic ion-cyclotron instability grows, dc potential structure appears. Figure 1 shows that the gray scale contour plot of potential profile together with the potential profiles along the magnetic field lines at $y/\lambda_{De} =$ 64 and across the magnetic field lines at $x/\lambda_{De} =$ 320, 370, and 430. These are averaged over the period of oscillation of the electrostatic ion cyclotron wave. The potential gradually rises up from $x/\lambda_{De} \simeq 300$ to the downstream boundary along the magnetic field lines. The total potential difference reaches about $e\Delta\phi/T_e \simeq 0.02$. The positive dc potential difference along magnetic field lines is generated by anomalous resistivity caused by the ion-cyclotron instability. In the $y$ direction the potential profile has a small well. This may be caused by the ion transport from the high stream region to the low stream region or the difference of ion perpendicular heating across the magnetic field lines. Thus, one can certainly recognized a V-shaped dc potential structure in the downstream region.

We have succeeded in the first time a two dimensional particle simulation which demonstrates that the V-shaped dc potential structure is created by the current-driven electrostatic ion-cyclotron instability.

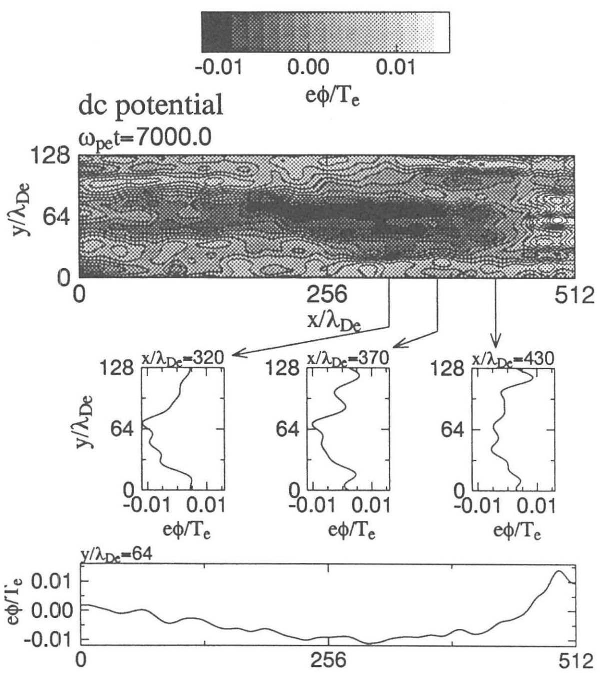


Fig. 1. Gray scale contour plot of the dc potential profile together with the $x$ direction profile at $y/\lambda_{De} = 64$ and the $y$ direction profiles at $x/\lambda_{De} = 320$, 370, and 430 at $\omega_{pe}t = 7000$