# Formation of a new type of WDL in the auroral acceleration region with up-flowing ions

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A series of one-dimensional electrostatic particle simulations was carried out to study the formation of a new type of Weak Double Layer (WDL) in the auroral particle acceleration region including magnetospheric hot electrons, background cold ions and ionospheric hot beam ions. We discovered the excitation of downward propagation slow ion acoustic waves, and the subsequent formation of type 1 WDLs from the nonlinear development of the slow ion acoustic waves. We also discovered the excitation of upward propagating fast ion acoustic waves, and the formation of type 2 WDLs as a result of the nonlinear development of these waves. This type 2 WDL is a newly discovered type of WDLs.

A series of one-dimensional electrostatic particle simulations was carried out to study the formation of a new type of Weak Double Layer (WDL) in the auroral particle acceleration region. In the system, we assumed magnetospheric hot electrons, background cold ions and ionospheric hot beam ions. We discovered the excitation of downward propagation slow ion acoustic waves, and the subsequent formation of type 1 WDLs from the nonlinear development of the slow ion acoustic waves.

These type 1 WDLs were categorized as ordinary WDLs able to be found in the system where no ionospheric hot beam ions are present. However, we also discovered the excitation of upward propagating fast ion acoustic waves, and the formation of type 2 WDLs as a result of the nonlinear development of these waves. This is a newly discovered type of WDLs.

In the real auroral particle acceleration region, the density of ionospheric hot beam ions is not negligible. Therefore, type 2 WDLs must also be formed and contribute toward accelerating both electrons and ions.

We further found that the type 2 WDLs can be
formed in a limited altitude range,
and that there is significant interaction between the type 1 and type 2 WDLs.