



Formation of Double Layer in Two-Dimensional Current Carrying Plasma

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Localized unipolar electric fields, which is known as electric double layers have been observed in upward and downward regions of the auroral zone [1, 2]. However, recent *in-situ* observations have shown that electric double layers are not limited to the auroral acceleration region but exist in various regions of the Earth's magnetosphere as well [3, 4]. The previous one-dimensional Vlasov simulation study has demonstrated the formation of a double layer in a current-carrying plasma with a strong density depression [5]. However, multi-dimensional kinetic simulations on the formation of a double layer in a current-carrying plasma have not been performed over twenty years due to both computational resources and computational techniques.

In the present study, the current-carrying plasma model by Newman *et al.* [5] is first extended to two dimensions, by means of a state-of-art particle-in-cell simulation. The present two-dimensional particle-in-cell simulations have confirmed formation of a double layer in a two-dimensional current-carrying plasma with a density depression for $|\omega_{ce}|/\omega_{pe} = 0.1 - 1.0$. However, the lifetime of the double layer becomes shorter with a larger ambient magnetic field. Inside a cavity region of the double layer, electrostatic and electromagnetic waves propagating in the direction quasi-perpendicular to the ambient magnetic field are enhanced stronger with a larger ambient magnetic field, which collapse the double layer. The numerical frequency-wavenumber spectrum indicates the excitation of ion acoustic and lower-hybrid waves.

References

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