E014-P003 Time: May 29 17:00-18:30

Simulation Study on Generation Mechanism of Electron/Ion hole in Space Plasmas

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We performed electrostatic particle simulations of Buneman instability, which is occurred when beams of electrons and ions have a relative drift velocity. Through the previous simulations, we found that generations of electron holes and ion holes depend on thermal velocities of electrons and ions. In the present study, we use the real ion/electron mass ratio. We study how increase of mass ratio effects on the nonlinear evolutions of the Buneman instability and generations of electron holes and ion holes.

Through recent spacecraft observations, we find that a variety of coherent potential structures exist along the magnetic field lines in various regions of the magnetosphere. We know that some of the coherent potential structures are electron holes and ion holes corresponding to positive solitary potentials and negative solitary potentials, respectively.

In order to find possible generation mechanisms of these potential structures, we performed one-dimensional electrostatic particle simulations with periodic boundaries. We set one electron beam and one ion beam with a relative drift velocity in the system. Under this condition, there occurs Buneman instability. We varied thermal velocities of electrons and ions, and found that nonlinear evolutions of the instability are very different depending on these parameters. The final states of the nonlinear evolutions are mainly classified into two potential structures. One is an electron hole, other one is an ion hole. It is also found that electron holes and ion holes coexist and interfere each other under some conditions.

In the previous simulations, the ion/electron mass ratio is set much smaller than the real mass ratio. In order to clarify whether this dependence of the thermal velocity is found with the real mass ratio, we use the real ion/electron mass. We study effects of different mass ratios on the nonlinear evolutions of the Buneman instability and the generations of electron holes and ion holes.