§23. Large Amplitude Ion-acoustic Waves in a Plasma with an Electron Beam

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Observations confirm the facts that stationary nonlinear ion-acoustic waves are usually formed when an electron beam is injected into a plasma. In the actual siruations, electron beam component are frequently observed in the region of space where ion-acoustic waves exist. We make an attempt to theoretically investigate the existence of large amplitude ion-acoustic waves under the influence of an electron beam in a plasma consisting of warm ions and hot isothermal electrons.

We apply the fluid equations for ions and beam electrons and use the Poisson's equation, and thereby the pseudopotential is derived. The oscillatory solution of large amplitude ion-acoustic waves exist when the following conditions are satisfied: (i) The pseudopotential has a minimum value at the origin. (ii) Nonlinear ion-acoustic waves exist only if the pseudopotential >0 at the maximum electrostatic potential. We show a bird's eye view of the pseudopotential when the electron beam temperature to free electron temperature=0.4, in Fig.1.

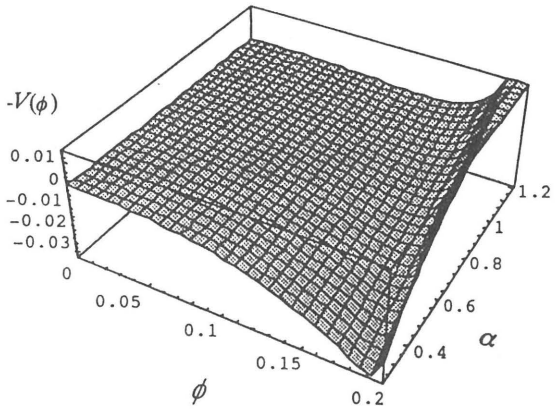

Fig.1

We illustrate the existence region of large amplitude ion-acoustic waves depending on the ratio of concentration of the electron beam density to the background electron density α in Fig.2-(a), (b) and (c), for the case of ν=0.2, 0.3 and 0.4, respectively, where ν is the ratio of the electron beam temperature to free electron temperature. Large amplitude ion-acoustic waves propagate in the lower region of the curves but do not exist in the other region.

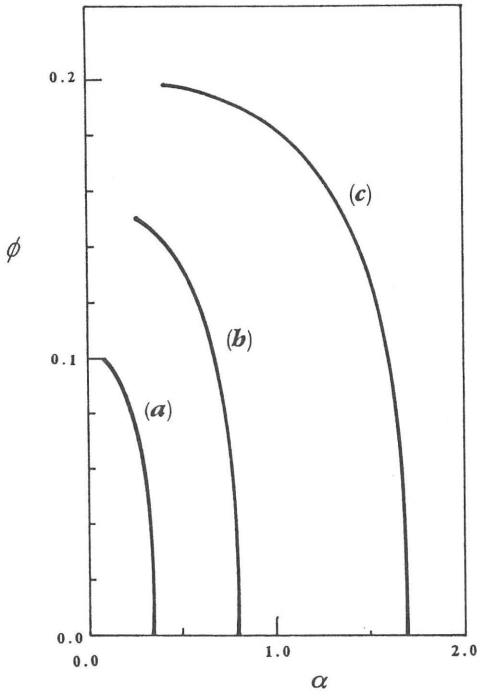

Fig.2

The results are summarized as follows[1),2)]: The conditions of existence for large amplitude ion-acoustic waves sensitively depend on the density, beam temperature and also the ratio of the bulk ion temperature to the electron temperature. The allowable range of the concentration of the electron density becomes wider as the beam temperature decreases. The electrostatic potential-beam density plane where large amplitude ion waves exist spread as the beam temperature increases.

References

1) Nejoh, Y. and Sanuki, H., Phys. Plasmas **2**, (1995) 4122 .

2) Nejoh, Y., J. Plasma Phys. **55**, (1996) (in press) .