

§29. Large Amplitude Langmuir and Ion-Acoustic Waves in a Relativistic Two-Fluid Plasma

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The purpose of this study is to show the 3-D pseudopotential for a relativistic two-fluid plasma, to exhibit the possibility of the existence of novel solutions of nonlinear Langmuir and ion-acoustic waves.

We consider an unmagnetized, collisionless relativistic two-fluid plasma consisting of the hot and isothermal electrons and ions. We assume the electron and ion flow velocities are relativistic and do not take into account kinetic effects.

a) *Relativistic Langmuir waves*

We derive the pseudopotential of the Langmuir waves and show the 3-D bird's eye view. By the consideration of the relativistic effect, we illustrate the existence region of large amplitude relativistic Langmuir waves in Fig.1. Large amplitude Langmuir waves can propagate in region A.

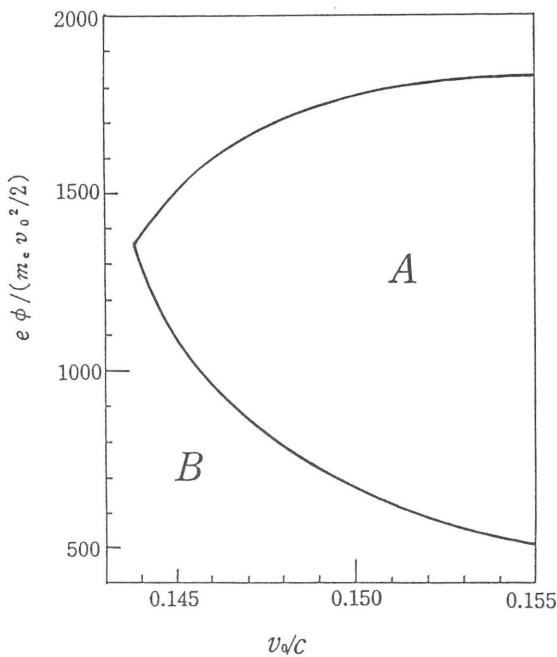


Fig.1. The existence region of large amplitude relativistic Langmuir waves

b) *Relativistic ion-acoustic waves*

In order to obtain pseudopotential for ion-acoustic waves, we show a bird's eye view of the pseudopotential in the range of $0.1 < \Phi < 0.8$ and $1.2 < M < 1.58$. Figure 2 shows the allowable region of nonlinear ion-acoustic waves depending on the potential Φ and the Mach number M . Ion-acoustic waves exist in region A.

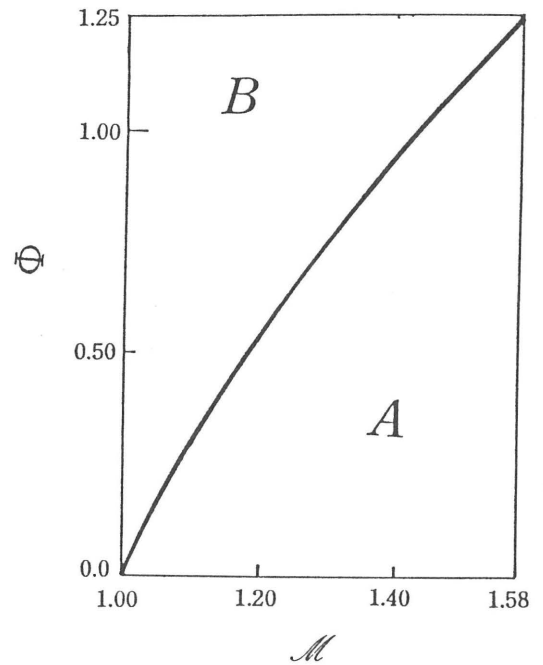


Fig.2. The existence region of large amplitude ion-acoustic waves.

Conclusion

The existence conditions for large amplitude relativistic Langmuir waves strongly depend on the relativistic factor v_0/c and the mass ratio m_i/m_e , where v_0 and c are the electron flow velocity and the light velocity. The existence region of large amplitude ion-acoustic waves sensitively depend on the Mach number rather than the relativistic effect. Therefore, this investigation predicts ¹ new findings on large amplitude relativistic Langmuir and ion-acoustic waves in plasmas.

References

1. Nejoh, Y., and Sanuki, H. Phys. Plasmas 1 (1994) (in press).