2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Study of Ion Acoustic Wave in Inhomogeneous Magnetic Field of Multi-cusp Plasma Device

Meenakshee Sharma[1], A. D. Patel[1], N.Ramasubramanian[1], Y. C. Saxena[1]
[1] Institute for Plasma Research, HBNI, Gandhinagar
e-mail: meenakshee.26@gmail.com

Plasma can support various wave motion. Both high frequency ($\omega \geq \omega_{pe}$) and low frequency ($\omega \leq \omega_{pi}$), electromagnetic to electrostatic waves can propagate in Plasma. Tonk and Langmuir[1] first described ion acoustic waves in 1929 and provide a dispersion relation for IAW. The first clear observation of propagating IAW was made in a Q-machine by Wong et al., with $T_e = T_i$ in presence of collisionless damping[2]. Later Limpeacher and Mackenzie[3] used the multi-dipole magnetic field for plasma confinement and gave an advantage of IAW study in large uniform, quiescent and unmagnetized plasma. Ion acoustic waves are being used as a diagnostic tool in plasma based on frequency, wavelength and phase velocity. In many cases it served as diagnostics, in determining the electron temperature, plasma density. In two-ion-species plasmas it provide a measure of the relative concentration of ion species. In non-uniform plasmas it provide the information of drift velocity.

It is well known that in a magnetic field plasma waves can be neither purely longitudinal nor transverse unless they propagate along the field.

Electrostatic ion waves in a magnetic field have been theoretically investigated first by Stepanov[4] who has predicted the existence of two modes, which we call fast and slow modes, above and below the ion cyclotron frequency. The fast mode expected above the ion cyclotron motion and is usually referred to as the electrostatic ion cyclotron wave especially when the wave propagates across the magnetic field. However, if the wave frequency is much higher than the cyclotron frequency but much lower than the ion plasma frequency, the ion acoustic wave can be recovered irrespective of the propagation angle. The slow mode expected below $\omega_{ci} \cos\theta$ is essentially the ion acoustic wave propagating along the magnetic field if the wave frequency is not close to $\omega_{ci} cos\theta$[4].

Multi-line cusp geometry has been used to confine the Argon plasma in Multi-cusp Plasma Device (MPD)[5]. This geometry has the centre of radius of curvature outside the confined plasma, that gives magneto-hydrodynamic stability and the plasma produced is very quiescent. In MPD six electromagnets on the circumference of the device, have been used for the cusp magnetic field production. The experimental study of the ion acoustic wave interaction with plasma when it propagates through inhomogeneous magnetic field of MPD, will be presented in this paper.

References

1. Tonks L and Langmuir I, Phys. Rev. **33**, 195 (1929).
2. Wong A Y, D'Angelo N and Motely R W, Phys. Rev. Lett. **9**, 415 (1962).
3. R. Limpaecher, K. R. Mackenzie, Rev. Sci. Instrum. **44**, 726 (1973).
4. K. N. Stepanov, Sov. Phys. JETP **8**, 808 (1959).
5. A. D. Patel, M. Sharma, N. Ramasubramanian, R. Ganesh, P. K. Chattopadhyay, Rev. Sci. Instrum. **89**, 043510 (2018).