Seminar

Institute for Plasma Research

Title: Experimental study of plasma in electronmagnetohydrodynamic regime

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Date : 14th August, 2018 (Tuesday)
Time : 10.30 AM
Venue : Seminar Hall, IPR

Abstract :

Whistlers are ubiquitous in naturally occurring plasmas; the most common observations are during lightning discharges occurring in D and E regions of the ionosphere. The frequency of these waves lies typically in the Very Low Frequency (VLF) regime with earth's magnetic field providing the guiding field. Other situations also arise where whistlers are observed in nature, have a wide range of perturbation scale lengths and are excited spontaneously. However, excitation of whistlers in the laboratory requires a controlled environment. Many experiments have been carried out in the past with the waves showing three dimensional force free topologies. While most of the experimental works have focused on large spatial scale lengths of the perturbations, typically >> de (electron skin depth), theoretical and computational works have been able to predict and explain processes in regimes over a much wider range unexplored by experiments. Some of the works have also predicted structures in the form of vortices propagating uninhibited in the surrounding plasma. In the present work, whistler waves with perpendicular spatial scale lengths ≤ de have been excited in the lab and detailed topology unraveled. The experiments were conducted in a new device specifically built for the purpose [1]. The device can produce a low temperature (Te 2 – 4 eV) quiescent plasma over a wide range of density ne ~ 1010 – 1012 cm-3 over a large uniform region. The region within 100 – 200 ~s in the afterglow was identified for wave experiments. It was found that the whistler waves were elongated in the propagation direction parallel to the external magnetic field, with the extent in perpendicular direction limited to skin depth [2]. It was also found that the waves showed feeble resonance cone at angle µ 10o but no obliqueness. This was in contrast to results obtained in earlier experiments that showed highly oblique propagation. The results are attributed to electron inertia effects and explained using an improvised physical model showing how the secondary induction phenomena do not manifest within the spatial scale lengths characteristic to this regime and thus give rise to such modes. The work was extended to a regime where antenna field significantly modified the external field and results revealed the interplay between electron inertia and Larmor radius effects. The radial spread was no longer restricted to skin depth as was the case with the linear regime. This is also explained with the help of a modified physical model taking into account the changing background magnetic field and net guiding field [3].

References:

1. A new linear plasma device for the study of plasma waves in the electron magnetohydrodynamics regime. Garima Joshi, G. Ravi and S. Mukherjee, Pramana J. Phys. 90:79, (2018).
2. Observations of elongated whistler waves in the inertial regime. Garima Joshi, G. Ravi and S. Mukherjee, Phys. Plasmas 24, 122110 (2017).
3. Whistler wave propagation and interplay between electron inertia and Larmour radius effects. Garima Joshi, G. Ravi and S. Mukherjee (under communication)