Flute-like kinetic instabilities in a mirror trap with skewed neutral beam injection

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The Drift-Cyclotron-Loss-Cone (DCLC) instability arises in mirror traps due to non-equilibrium distribution function of ions (existence of loss cone in velocity distribution) and transversal plasma non-uniformity [1]. Excitation of the DCLC instability results in generation of flute-like perturbations of plasma potential with frequency similar to the ions cyclotron frequency and propagating in azimuth direction. Such oscillations drive collisionless scattering of ions and can provoke anomalous losses from the trap. Filling of loss cone at low energies by warm isotropic ions is effective method of stabilization of the DCLC instability. But Double-Humped (DH) instability can arises if temperature of warm ions is too low [2]. The DH instability is driven by velocity difference of anisotropic and warm ions; mechanism of the DH instability excitation is similar to the mechanism of the two-stream instability.

Conditions of excitation of the DCLC and DH instabilities in a mirror trap with skew neutral beam injection in warm target plasma are considered in the present report. The skew neutral beam injection results in formation of population of fast anisotropic “sloshing” ions which are confined in adiabatic regime. In such a system the flute-like kinetic instabilities can arise in the turning points of fast ions, where the density of fast ions is maximal and the density of warm ions is reduced because of displacement by ambipolar potential. It should be noted that the DCLC instability excitation in the turning point of fast ions was observed experimentally at the TMX-U device [3].

Conditions of excitation of the DCLC and DH instabilities in the turning points of fast ions are investigated at plasma parameters corresponding parameters of the GDT device [4] and projected GDT-based source of thermonuclear neutrons [5]. The frequency spectrum and spatial distribution of unstable fluctuations are investigated also what is important for identification of experimentally observed instabilities.

References

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