WAVE EXCITATION UNDER DOUBLE PLASMA RESONANCE CONDITION IN A MIRROR-CONFINED PLASMA

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Study of kinetic instabilities of non-equilibrium plasma produced in an open magnetic trap by powerful microwave radiation under electron cyclotron resonance (ECR) conditions is of fundamental interest including prospects to simulate physical processes in the magnetospheres of the Earth and other planets, in the solar corona. Heating under the ECR conditions allows to create two component plasma which is typical for the inner magnetosphere of the Earth. Plasma contains cold dense component with an isotropic velocity distribution, and less dense component of hot electrons with anisotropic distribution function (with a predominance of the transversal to the magnetic field momentum as compared to the longitudinal one). In such plasma different types of kinetic instabilities may occur as a result of resonant interaction of hot electrons and plasma waves. For example, plasma instabilities in magnetic traps are the sources of powerful broadband radio emission which is interpreted as the excitation of plasma waves by fast electrons in the upper hybrid resonance frequency followed by transformation in electromagnetic waves. In the case of double plasma resonance condition when the frequency of the upper hybrid resonance coincides with one of the electron gyrofrequency harmonics the instability increment of plasma waves is greatly increased. This leads to the appearance of bright narrow-band radio emission near the harmonics of the electron gyrofrequency – the so-called zebra patterns. It should be noted that the possible manifestations of double plasma resonance effect are not rare in astrophysical plasmas. The phenomenon of zebra pattern is observed in kilometric radiation of the Earth, in electromagnetic emission of the Sun, in the decametric radiation of the Jupiter and even in the radio emissions of pulsars. In connection with the above, verification of theoretical and numerical models of instabilities under double plasma resonance in a laboratory plasma experiments is a very relevant task.

With the use of non-equilibrium mirror-confined plasma produced by the ECR discharge we provide the possibility to study plasma instabilities under double plasma resonance condition in the laboratory [1]. In the experiment such conditions are fulfilled just after ECR heating switch-off, i.e. in the very beginning of a dense plasma decay phase. The observed instability is accompanied by a pulse-periodic generation of a powerful electromagnetic radiation at a frequency close to the upper hybrid resonance frequency and a second harmonic of the electron gyrofrequency, and synchronous precipitations of fast electrons from the trap ends. It is shown that the observed instability is due to the excitation of plasma waves at a double plasma resonance in decaying plasma of the ECR discharge [2]. Also a pulse-periodic regime of the observed instability is discussed.

References

[1] M. Viktorov, D. Mansfeld and S. Golubev // EPL. 2015. V.109, No.6. P.65002.
[2] M.E. Viktorov et al. // Radiophysics and Quantum Electronics. 2015. V.57, No.12. P.849.