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Laboratory studies of kinetic instabilities under double plasma resonance condition in a mirror-confined non-equilibrium plasma

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Plasma instabilities in magnetic traps on the Sun are the sources of powerful broadband radio emission (the so-called type IV bursts) 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.

With the use of non-equilibrium mirror-confined plasma produced by the electron cyclotron resonance (ECR) discharge we provide the possibility to study plasma instabilities under double plasma resonance condition in the laboratory. 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.

Possible manifestations of double plasma resonance effect are not rare in astrophysical plasmas. The phenomenon of zebra pattern is observed not only on the Sun, but in the decametric radiation of the Jupiter, kilometric radiation of the Earth and even in the radio emissions of pulsars. Thus, verification of the effect of double plasma resonance in a laboratory plasma experiments is a very relevant task.