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# Observations of pulsed regimes of electron cyclotron instabilities in a mirror confined plasma produced by ECR discharge: similarities and differences with space plasmas

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We demonstrate the use of a laboratory setup based on a magnetic mirror trap with plasma sustained by a gyrotron radiation under the electron cyclotron resonance (ECR) conditions for modeling the development of cyclotron instabilities similar to the ones which take place in space plasmas. During the gyrotron operation the plasma density is sufficiently high, with the electron plasma frequency exceeding the electron gyrofrequency. The electron distribution function formed in ECR discharge comprises two fractions, one of them being a small energetic addition to the other component which is much cooler and denser. Such conditions are typical, e.g., for the Earth's inner magnetosphere and can also be met in solar flaring loops and at other space objects. At this stage, we observe the excitation of whistler-mode waves which propagate nearly parallel to the magnetic field and cause precipitation of energetic electrons to the trap ends. The instability is observed as series of quasi-periodic pulses of electromagnetic radiation and related precipitation of energetic electrons, which can be explained by similar mechanisms as the quasi-periodic regimes of instabilities under natural conditions, e.g., in pulsating aurora. The spatial structure of the precipitation is reproducible from pulse to pulse, however, it depends on plasma parameters. This fact can be related to the discrete structure of the transverse modes of the electromagnetic wave field distribution formed inside the plasma cavity. Another regime of instability has been revealed in the same setup during the plasma decay after the ECR power switch-off, when the external source of a free energy is absent. The instability devel-

ops when the plasma density becomes low enough, so that the electron plasma frequency is much less than the electron gyrofrequency. Such conditions resemble those in auroral plasma cavities and similar systems, and in this case electromagnetic waves with quasi-perpendicular propagation direction are excited. It should be stressed that the instability in the decaying plasma also develops in the pulsed regime, i.e., in the form of quasi-periodic spikes of wave activity and related electron precipitation. This regime was first discovered in these laboratory experiments performed with the aim to simulate nonlinear wave-particle interactions in space plasmas. It was interpreted as a special regime of relaxation oscillations in the decaying plasma, in which a decrease in the wave energy losses provides repeated recovery of the instability conditions and thus serves as an effective source of free energy.