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Laboratory modeling of pulsed regimes of electron cyclotron instabilities in a mirror confined plasma produced by ECR discharge

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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 investigation of the cyclotron instabilities similar to the ones which take place in space plasmas. Three regimes of the cyclotron instability are studied. The first regime is related to quasi-periodic pulsed precipitation of energetic electrons from the trap, accompanied by microwave bursts at frequencies below the electron gyrofrequency in the center of the trap, has been detected. The study of the microwave plasma emission and the energetic electrons precipitated from the trap shows that the precipitation is related to the excitation of whistlers propagating nearly parallel to the trap axis. The observed instability has much in common with phenomena in space magnetic traps, such as radiation belts of magnetized planets and solar coronal loops. In the second regime we have detected and investigated quasi-periodic series of pulsed energetic electron precipitations in the decaying plasma of a pulsed ECR discharge in a mirror axisymmetric magnetic trap. The observed particle ejections from the trap are interpreted as the result of resonant interaction between energetic electrons and a slow extraordinary wave propagating in the rarefied plasma across the external magnetic field. We have been able to explain the generation mechanism of the sequences of pulsed precipitations at the nonlinear instability growth phase in terms of a cyclotron maser model in which the instability threshold is exceeded through a reduction in electromagnetic energy losses characteristic of the plasma decay. In the third regime we have studied the cyclotron instability of rarefied plasma in the mirror magnetic trap under the adiabatic compression of magnetic field.