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Spatial structure of pulsed energetic-electron precipitation upon the cyclotron instability in a magnetic mirror trap

S. V. Golubev, A. G. Demekhov, D. A. Mansfeld, and A. V. Vodopyanov
Institute of Applied Physics, Nizhny Novgorod, Russia (gol@appl.sci-nnov.ru/Fax: +7 831 436 2061)

We present the results of experimental study of a pulsed regime of the cyclotron instability in a magnetic mirror trap, aimed at laboratory modeling of nonstationary processes in space cyclotron masers. The plasma in the trap comprises two electron populations one of which is denser and cooler ($\sim 10^{13}$ cm^{-3} and 300 eV) and the other one is a small energetic addition ($\sim 10^{10}$ cm^{-3} and 10 keV) with anisotropic velocity distribution. The instability manifests itself as series of quasi-periodic pulses of electromagnetic radiation at a frequency below the electron gyrofrequency and related precipitation of energetic electrons. The energy of precipitated electrons estimated by using Al filters of different thickness is about 8 keV which agrees with the energetic-electron temperature in the trap measured by their bremstrahlung radiation. The spatial profile of the energetic-electron precipitation was obtained by using a movable semiconductor detector (p-i-n diode). We found out that the spatial structure can be different depending on the plasma parameters and, in particular, can be strongly inhomogeneous. In our case, this structure is determined by the magnetic field in the trap. For the conditions of the strongest instability, the precipitation is almost zero at the trap axis and reachesa a maximum at some distance from the axis. As the magnetic field increases, the precipitation maximum is shifted to the axis and finally the precipitation profile monotonically decreasing from the axis is observed. At the same time, the radial distribution of the plasma in the trap remains monotonically decreasing for all regimes of the discharge. Estimates indicate the relation of the observed difference in the precipitation structure with the excitation of different transverse modes of the

wave field in the trap. Under the optimal conditions, the basic axially symmetric eigenmode having the zero transverse electric field on the axis is excited, while under other conditions the mode close to the TE_{01} mode of a circular waveguide grows faster. The observed phenomenon can have a similarity with the formation of spatial structure of pulsating auroral patches.