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ION-CYCLOTRON PLASMA OSCILLATIONS IN A LONG DIAMAGNETIC TRAP *)

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One of the advantages of linear axisymmetric systems is the fundamental possibility of operating in regimes where the pressure of the confined plasma is comparable to the pressure of the magnetic field of the trap. In the limiting case, when the plasma pressure is equal to the magnetic field pressure (so-called diamagnetic confinement regime), the magnetic field is completely displaced from the region occupied by the plasma and a so-called diamagnetic bubble is formed [1]. Theoretical estimates show the fundamental possibility of a significant (at least by an order of magnitude) increase in the lifetime of particles upon transition to the diamagnetic confinement mode [1, 2]. Currently, experiments with diamagnetic plasma confinement are planned at the CAT device at the BINP SB RAS [3], plasma confinement with extremely high pressure is being studied at the C2-W device of Tri Alpha Energy. It should be noted experiment on the formation of a population of fast ions with high relative pressure at the 2XIIB device [4] and experiments on confining plasma with high pressure in cusps [5].

Currently, there is no systematic data on kinetic instabilities and anomalous transport in the diamagnetic regime. Oscillations with a frequency on the order of the cyclotron frequency of ions (identified as drift cyclotron loss cone instability) were observed at the 2XIIB device. These oscillations led to anomalous transport of fast ions and limited plasma pressure. Instabilities associated with electron drift in the transition layer were observed in cusps; these instabilities led to broadening of the layer and limited the plasma lifetime [5-7]. The stability of oscillations in a long trap with a thin layer of fast ions was theoretically studied in [8].

The mechanisms of excitation of kinetic instabilities in an axisymmetric diamagnetic trap filled with cold target plasma are discussed in this report; the diamagnetic current in the bubble is maintained by a population of fast ions. The longitudinal inhomogeneity of the plasma is neglected and the perturbation of the electric field can be found in the form $\mathbf{E}_0 e^{ikz+im\theta-i\omega t}$. The perturbation of the ion distribution function is found from the perturbed Vlasov equation, for the solution of which the expansion of the perturbed quantities into a Fourier series in phases of radial and azimuthal oscillations is used. This approach makes it possible to take into account the complicated picture of unperturbed motion of ions.

Oscillations with m=0 (axisymmetric waves, corresponding to Geodetic acoustic modes observed at the GDT device) and m=1 (corresponding to the Alfvén ion-cyclotron instability in open traps) are considered. The dependences of frequencies and increments on plasma parameters are discussed, and change of the characteristics of instabilities during the transition from plasma with moderate pressure to diamagnetic confinement is considered.

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