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GEODESIC ACOUSTIC MODES IN A HELICAL MAGNETIC MIRROR *)

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Helical magnetic mirrors [1] are a promising method for suppressing longitudinal plasma losses in linear magnetic traps. The helical mirror is a region with a uniform magnetic field, on which a magnetic field with helical symmetry is superimposed. Azimuthal rotation of plasma in crossed magnetic and electrostatic (arising from the ambipolar potential, or created by sectioned plasma absorbers) fields leads to the appearance of a longitudinal force, which slows down or accelerates the plasma flow. Theoretically, the longitudinal flow of collisional plasma (when the mean free path of ions is on the order of the pitch of the helical corrugation) should be suppressed exponentially with an increase in the length of the helical mirror [2].

Experiments at the SMOLa facility is demonstrated a significant (tens of times) suppression of the plasma flow not only in regimes with frequent collisions, but also in regimes with rarefied plasma, when the mean free path was an order of magnitude greater than the pitch of the helical corrugation [3]. In experiments with rarefied plasma, excitation of oscillations with a frequency of tens of kilohertz and a wide spectrum is observed; presumably, the anomalous scattering of ions by these oscillations replaces the Coulomb scattering [4].

A hypothesis that some of the observed oscillations are explained by the excitation of geodetic acoustic modes (GAMs) is discussed in this report. GAMs are electrostatic oscillations which are well known in toroidal traps [5, 6]. Within the framework of single-fluid MHD, low-amplitude electrostatic oscillations in plasma flowing through a magnetic field with helical symmetry are considered. The electrostatic potential is assumed to be constant on the magnetic surface $r \bullet A\theta + Az/k = \text{const}$, where $A\theta(r,\theta - k \bullet z)$ and $Az(r,\theta - k \bullet z)$ are the cylindrical components of the magnetic field vector potential, $k = 2\pi/h$ and h is the helical corrugation pitch. The unperturbed state is specified using solutions to the single-fluid MHD equations describing helically symmetric flows of magnetized plasma [7]. The dependence of the oscillation frequency on the azimuthal rotation velocity of the plasma, the plasma density, and the helical corrugation depth is found. The possibility of excitation of GAMs by interaction with ions trapped due to magnetic field corrugation is discussed.

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