Influence of low-frequency oscillations on ions dynamic in an helical mirror [[1]](#footnote-1)\*)

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Chernoshtanov I.S.

Budker institute of nuclear physics SB RAS, Russia, Novosibirsk, I.S.Chernoshtanov@inp.nsk.su

Helical mirrors proposed in [1] can be used to suppression of longitudinal losses from mirror machines. The idea is to rotate around axis of plasma (due to radial electric field) contained in helical magnetic field. Combination of the rotation with helical structure leads to appearance of a longitudinal force acting on the plasma. The helical mirrors can be used both for active control of longitudinal plasma losses from mirror machines and for plasma acceleration. Magneto-hydrodynamic model [2] predicts that efficiency of the loss suppression increases exponentially with length of the helical mirror. Magnitude of the magnetic field is modulated with a period equal to helical pitch; transfer of momentum between transit ions and ions trapped between the maxima of the magnetic field plays important role in the helical confinement.

Suppression of plasma flow through helical mirror has been experimentally demonstrated at SMOLa device in regimes with dense plasma [3]. In these regimes the ion mean free path is comparable to the helical pitch and momentum transfer can be provided by usual Coulomb collisions. In the same time, in recent experiments with a rarefied plasma (when ion mean free path exceeds significantly the helical pitch) degradation of plasma flow suppression is not observed [4]. Oscillations with frequency of the order of several tens of kilohertz are observed in these experiments; these oscillations may drive anomalous scattering of ions [4].

Influence of low-frequency oscillations on ions dynamic in a helical mirror is investigated numerically and analytically in this report. The oscillations are standing waves localized in the helical mirror, the wavelength is of the order of the mirror length. Plasma electrostatic potential is assumed to increases quadratically; electric drift results in plasma rotation with nearly constant frequency. If phase velocity of the oscillations is of the order of velocity of helical mirrors in the rotating frame of reference then these oscillations can effectively take energy from trapped ions. From the other hand, these oscillations can influences on longitudinal velocity of transit ions if the velocity of mirrors is similar to thermal velocity of these ions. Dependence of rate of ions flying through the helical mirror on magnitude of helical magnetic field and radial electric field, structure of the oscillations and frequency of Coulomb collisions are discussed.

References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Mu/ru/AS-Chernoshtanov.docx) [↑](#footnote-ref-1)