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The kinetic features of ion dynamics in the closed magnetic configurations.

Andrey Malykhin (1,2), Elena Grigorenko (1), Helmi Malova (3,1)

(1) Space Research Institute of RAS, Moscow, Russian Federation (ANMAURDREG@gmail.com), (2) Moscow Institute of Physics and Technology (SU), Moscow, Russian Federation , (3) Skobeltsyn Institute of Nuclear Physics MSU, Moscow, Russian Federation

A lot of spacecraft observations showed that the closed magnetic configurations such as plasmoids and magnetic islands are often observed in the Earth magnetotail. The purpose of our study is to analyze the kinetic features of nonadiabatic ion dynamics in the current sheet (CS) inside a plasmoid and the efficiency of ion acceleration in such configurations. Trajectories of test ions of different masses (H+ O+) were studied in the prescribed magnetic configuration similar to the one observed by Cluster spacecraft (s/c). The magnetic configuration consists of a single stationary plasmoid in the tail side of a near-Earth magnetic X-line. Everywhere in the system there is the constant and uniform dawn-dusk electric field Ey $\sim$ 0.1 mV/m. Cold ion beams with the characteristics similar to the ones observed in the lobe were launched in the system. In the absence of electromagnetic fluctuations the plasmoid localization in the dawn-dusk direction imposes a limit on the ion energy gain in the course of ion nonadiabatic interaction with the plasmoid's CS (in the region of minimum |B| field). The ion dynamics and energy gain changed dramatically when we introduced the low-frequency electromagnetic fluctuations into the plasmoid. The spectra of the magnetic and electric field fluctuations were similar to the ones observed inside the plasmoids by Cluster spacecraft. Our analysis showed that in the presence of fluctuations the ion dynamics and energy gain are defined by the resonant interaction of ions with the wave harmonics. Ions can gain energy hundred times larger than their energy gain in the system without electromagnetic fluctuations.
The inclusion of a guide magnetic field (By) significantly affects the ion dynamics inside the plasmoid. The presence of a guide field generates the "north-south" asymmetry in the ejection of nonadiabatic ions from the CS. The effects of the "north-south" asymmetry in the spatial distribution of the nonadiabatic ions inside the plasmoid on the magnetic configuration of its CS are discussed.