STUDY OF THE DYNAMICS OF HELIUM ATOMS IN CURRENT SHEET PLASMA BY SPECTROSCOPY METHODS [[1]](#footnote-1)\*)

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The dynamics of helium atoms in the plasma of current sheets formed in 2D and 3D magnetic configurations has been studied. The research was carried out by spectroscopy methods. Using the Doppler broadening of the He I 587.6 nm spectral line, the temperature and energy of the directed motion of helium atoms at different times were determined.

The current sheets were created in a highly inhomogeneous magnetic field with an X -type singular line during a discharge in helium using a CS-3D experimental setup. The magnetic field gradient in these experiments was h = 0.5 kG/cm, the initial helium pressure p = 320 mTorr, and the maximum electric current *J*z = 45 kA. To create a 3D magnetic configuration, a uniform magnetic field with induction *B*z = 2.9 kG was applied along the X-line; in 2D magnetic configurations *B*z = 0 [1].

Using a two-channel optical scheme, plasma radiation was collected from a central quasi-cylindrical region elongated along the direction of the current in the sheet (*z* axis) and along the width (the largest of the transverse dimensions) of the sheet (*x* axis), which made it possible to determine the temperature of helium atoms in the central region of the current sheet and the energy of directed motion of helium atoms, averaged along the sheet width. The profiles of the He I 587.6 nm line were recorded in one pulse of the experimental setup using a Nanogate 1UF programmable digital camera, which consists of an electro-optical converter with an image intensifier based on a microchannel plate and a radiation detector – CCD matrix. The duration of the strobe pulse of the camera was 0.8 µs, while the lifetime of the current sheet was about ~ 6 µs [2–5].

It was found that, during the formation of a current sheet in a 2D magnetic configuration, at certain times the He I 587.6 nm line broadenings measured along the *x* axis were ~ 7 times higher than the line broadenings measured in the *z*-direction. An analysis of the experimental data showed that this difference is due to the appearance in the current sheet of fast superthermal fluxes of helium atoms directed from the center of the sheet to its side edges (along the x axis). The energy of the directed motion of helium atoms during the evolution of the current sheet rapidly increases, reaching the value *W*x = 480 ± 120 eV, which is ~20 times higher than the temperature of helium atoms *T*a = 20 ± 2 eV at the same time moments.

The appearance of fast helium atoms in the plasma of the current sheet correlates with the generation of accelerated flows of helium ions [2–5] and is apparently associated with the resonant charge exchange of helium ions on helium atoms [6].

During the formation of the current sheet in the 3D magnetic configuration, the directed motion of fast helium atoms was not observed, just as the acceleration of helium ions in the 3D magnetic configuration was not observed earlier [2–5].

References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/FY-Kyrie.docx) [↑](#footnote-ref-1)