Reversed currents in current sheets: causes and effects [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2021.48.1.106

Frank A.G., Satunin S.N.

Prokhorov General Physics Institute of the Russian Academy of Sciences, Moscow, Russia, annfrank@fpl.gpi.ru

One of the most interesting problems related to the dynamics of current sheets consists in a possibility of appearing oppositely directed electric currents, as it was predicted by S.I. Syrovatskii [1] and was revealed experimentally at the late stage of the current sheet evolution [2,3]. Along with an appearance of reversed currents there were observed a decrease of the current density and an increase of the thickness of the current sheets’ peripheral regions. At the same time the questions about a connection between these phenomena and about a nature of reversed currents remained still unsolved.

In this report we discuss dynamic processes in current sheets, which are produced by the motion of directed plasma flows in a magnetic field and excitation of inductive electric fields. This approach allowed us explaining the causes of reversed currents’ occurrence, the peculiarities of their evolution and the effect of their appearance. Our discussion is based on the results obtained with the CS-3D device (GPI RAS) [4,5].

It was observed that reversed currents can appear in a wide range of experimental conditions, specifically when a current sheet was formed in plasmas with ions of various masses, but a time moment for origination of reversed currents and their values are different.

We have shown that inductive electric fields are non-uniform along the current sheet width due to the non-uniform character of both plasma velocities and the normal magnetic field component [6]. Near side edges of the sheet electric fields are maximal and can exceed the absolute value of the initial electric field, which gave rise to the current sheet formation. This conclusion correlates with experimental results, which demonstrate that reversed currents arise namely near the sheet edges. The time moment of reversed current appearance depends on the plasma acceleration time, which increases for plasma with heavy ions.

There is good reason to believe that relatively rapid decreasing of current density and increasing of transverse sizes of a current sheet away from its central region are produced by excitation of reversed current inside the whole sheet, not only near the edges. Reversed currents of smaller values could not be registered directly, but gave indirect evidence.

At the sheet regions containing reversed currents we have registered for the first time the Hall currents of opposite directions as compared with the Hall currents at the early stage of the sheet evolution. We believe that the directions of the forces, which accelerate the ions, should also become opposite, and this effect may result in braking plasma flows.

This work was carried out under State Assignment № 0024-2018-0045.

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