Mathematical model of magnetic tornado in solar plasma [[1]](#footnote-1)\*)

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As a rule, a magnetic tornado is considered as vortex high-speed flows of a gas conducting electric current in an electromagnetic field. Such flows have been repeatedly observed in solar plasma [1]. There is reason to believe [2] that magnetic tornadoes originating in the solar chromosphere form a channel for transporting energy from the lower layers of the Sun to the solar corona and are the cause of its anomalous heating, the appearance of sunspots and the generation of the solar wind.

It is shown in the report that magnetic tornadoes can theoretically be realized as a special type of stationary axisymmetric plasma flows in a magnetic field with a radially parabolic pressure distribution, generalizing the viscous incompressible fluid flows known from the hydrodynamics of T. Karman, caused by the rotation of a flat infinite disk. The indicated flows are exact solutions of the classical MHD equations of H. Alfven and are found by solving some boundary value problems on the half-line for the magnetic tornado equations derived by the authors [3], to which the classical MHD equations are reduced on the indicated flows. The complexification of magnetic tornado equations and similarity transformations allow us to reduce them to a nonlinear system of two equations of heat conduction with respect to complex “temperatures” and thereby reduce the dimension of the problem.

Let us consider two classes of solutions of magnetic tornado equations containing tornado-type plasma flows, the study of which is reduced to solving the tornado equations [4] in atmospheric air and allows us to study the mutual influence of plasma and magnetic field dynamics leading to the appearance of a magnetic tornado. A numerical stabilization method finding stationary solutions of the tornado equations is considered [4].

The study of these two classes of flows provides, on the one hand, a theoretical proof of the existence of observed magnetic tornadoes in solar plasma, and, on the other hand, allows one to discover a number of important regularities in the interaction of a magnetic field with a tornado. The reliability of the results obtained is the same as for the equations of classical MHD, the applicability of which to the analysis of phenomena in solar plasma is generally accepted.

References

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