2D AND 3D SIMULATIONS OF NEUTRAL PARTICLE FLUXES FROM PLASMA RECORDED BY NEUTRAL PARTICLE ANALYZER AT THE L-2M STELLARATOR [[1]](#footnote-1)\*)

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At the L-2M stellarator, the neutral particle analyzer (NPA) diagnostics is being upgraded, which measures the fluxes of neutral particles from plasma. For correct interpretation of energy spectra of plasma neutrals measured by NPA, it is necessary to know the radial profiles of the concentration of neutrals and the neutral fluxes from plasma. These parameters can be obtained by simulating the processes of penetration into the plasma of neutrals flying from the vacuum chamber wall.

When simulating the penetration of neutrals into plasma, the simple flat-layered model is most often used, in which one-dimensional distribution functions of neutrals and ions in the velocity space are used [1]. Such simulations using one spatial coordinate and one-dimensional velocity distribution function are called the 2D simulations. When using the flat-layered model, it is assumed that after collision, the charge-exchange neutrals move only along one direction: forward or backward. Obviously, this picture is far from reality. After charge-exchange event, the ions can move in any direction with equal probability.

The charge-exchange processes can be more adequately described using the model, in which after charge-exchange event, the velocity distribution of neutrals is assumed to be two-dimensional, and the one-dimensional cylindrical model is used to describe the plasma. We call such simulations the 3D simulations. The authors are aware of only a small number of studies, in which such 3D simulations are performed, for example, in [2]. Apparently, this is due to the fact that in 3D simulations, the calculations become much more complicated, although they provide for more accurate modeling of the experimental data on the flux of charge-exchange atoms.

In this work, 2D simulations of neutral particle fluxes were performed. The results of these simulations suggest that in the L-2M stellarator, at the mean density of hydrogen plasma exceeding 8×1019 particles per cubic meter, it becomes necessary to take into account the contribution of recombination to the formation of the radial distribution of neutrals. At such densities, the number of neutrals, arising in the paraxial plasma regions as a result of radiative recombination, exceeds the number of neutrals formed as a result of charge-exchange events.

In this work, the 3D simulations of neutral particle fluxes were also performed for the same plasma parameters. Comparison of the results of 2D and 3D simulations showed that in 3D simulations, the concentration obtained of charge-exchange neutrals near the axis of the plasma column is 3.5 times lower than that obtained in 2D simulations. The results of more accurate 3D simulations suggest that the contribution of recombination should be taken into account even at average plasma densities of the order of 6.5×1019 particles per cubic meter.

The simulation results obtained will be used to interpret the experimental data of the NPA diagnostics at the L-2M stellarator. At the moment, the NPA diagnostics is ready for operation: the necessary calibrations of the channel energy widths and channel amplifiers-discriminators have been performed.

References

1. Yu.N. Dnestrovskij and D.P. Kostomarov, *Mathematical Simulations of Plasma* (Nauka, Moscow, 1993), p. 236.
2. A.B. Izvozchikov and M.I. Petrov, Sov. J. Plasma Phys. **2**, 117 (1976).

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