INVESTIGATION OF THE INTERACTION OF A HELIUM JET WITH A HIGH-TEMPERATURE PLASMA TOKAMAK [[1]](#footnote-1)\*)

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Spectroscopic diagnostics of the peripheral plasma of a tokamak based on neutral helium injection provide valuable information about distribution of electron temperature and density in the peripheral regions of the plasma derived from ratios of experimentally measured radiation intensities in the spectral lines of neutral helium [1]. It is important to understand the physical processes that occur during the interaction between neutral helium and high-temperature tokamak plasma because it would improve the quality of the obtained results and improve their interpretation. This report is devoted to the study of the distributions of neutral helium atoms in specific excited states that are realized in a real experiment.

Numerical simulation of the flow of neutral helium in the spectroscopic diagnostics injection system installed on the Globus-M2 tokamak was the first step towards obtaining distributions of excited helium atoms [2]. Also, calculations of the parameters of the Laval nozzle, which can optimize the specified injection system, were made. Numerical simulation of the neutral helium flow was performed using the CFD package of the ANSYS Fluent computing environment [3].

The report presents the results of numerical calculations of the distribution of helium atoms in the excited state 1s3s(3S), corresponding to the emission in the neutral helium line ((1s3s(3S) − 1s2p(3P0)). Using the scaling of the gas-dynamic expansion of gas from orifice into vacuum given in [4], the distribution of the density of injected helium atoms nHe in the tokamak chamber was estimated. The processes of ionization and charge exchange were considered. The electron temperature and density profiles were calculated with the SOLPS-ITER code [5]. From the known cross section for the excitation of the ground state of helium to the upper level of the 1s3s(3S) − 1s2p(3P0) transition, the spatial distribution of the radiation intensity in the corresponding line was estimated:

 I706(R, Z, φ) ~ nHe (R, Z, φ) ne (R, Z, φ) <σv> (Te (R, Z, φ)), (1)

where ne (R, Z, φ) is electron density, <σv> (Te (R, Z, φ) is averaged cross-section of excitation from ground state to 1s3s(3S).

The calculation results were compared with the experimental data obtained by spectroscopic diagnostics of peripheral plasma with helium injection at the Globus-M2 tokamak. A detailed analysis of the results and their discussion are given in the report.

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References

1. Zweben S.J. et al Rev Sci Instrum. 2017 Apr; 88(4):041101. doi: 10.1063/1.4981873. PMID: 28456269.
2. V. M. Timokhin et al JETP Letters, 116:5 (2022), 292–299.
3. ANSYS Fluent. 2022. – URL: <https://www.ansys.com/products/fluids/ansys-fluent> (10.10.2022)
4. V. G. Dulov and G. A. Luk’yanov, Gas Dynamics of the Outflow Processes (Nauka, Novosibirsk, 1984), formula (4.18), p. 81.
5. V.A. Rozhansky et al Nucl. Fusion 41 387 (2001).
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/AY-Korobko.docx) [↑](#footnote-ref-1)