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ANOMALOUS TRANSPORT PARAMETERS FOR EDGE PLASMA WITH LITHIUM IMPURITY IN THE T-15MD TOKAMAK *)

Stepanenko A.A.

National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), aastepanenko@mephi.ru

Controlling the matter and energy flows coming from the hot core to the plasma-facing elements of the tokamak is one of the key issues that must be addressed to create a thermonuclear reactor. Among the possible approaches to mitigating the thermal loads coming onto the tokamak walls, the use of renewable liquid metal coatings, in particular lithium and tin, is currently proposed [1, 2].

Recently, the T-15MD tokamak was commissioned at the Kurchatov Institute [3]. The research program at the facility includes, among other things, the development of first wall technologies, including the use of liquid lithium. Simulations of the T-15MD edge plasma transport [4] show that the liquid metal coating can effectively reduce the thermal loads on the tokamak walls. In high-power operational regimes, however, evaporation and sputtering of the coating can lead to unacceptably high concentrations of impurity particles at the periphery of the plasma column.

Another physical mechanism affecting the heat and particle fluxes to the tokamak reactor wall is the edge plasma turbulence [5]. The parameters of the anomalous transport are determined by a wide range of the facility's characteristics, such as the discharge power, plasma concentration and temperature, magnetic field geometry, the presence of impurities, and other factors. A common approach to describing the anomalous transport is the use of two-fluid plasma-dynamic models, which consider the collective dynamics of the main plasma ions and electrons, and describe the transport of impurities in the passive scalar approximation. At the same time, the estimates [6] show that the presence of impurities in non-trace quantities, such as during the erosion of a liquid-metal lithium wall [4], can affect the turbulence parameters, which should be taken into account when analyzing transport at the periphery of the facility.

The paper presents the results of modeling the parameters of anomalous transport of edge plasma with the lithium impurity in the T-15MD tokamak. Drift-reduced two-dimensional equations of electrostatic transport of plasma with the lithium impurity are obtained for modeling turbulent dynamics of matter at the periphery of the setup. Using the BOUT++ library [7], calculations of spatial and temporal spectra of fluctuations of plasma density, temperature and potential are performed, depending on the concentration and localization of the impurity. Distributions of anomalous heat and particle fluxes outside the separatrix are obtained. Averaged self-consistent profiles of plasma density and temperature, established taking into account turbulence, are found, and the parameter λ_q is determined.

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