

HYDROGEN-HELIUM IONIZATION PLASMA BALANCE IN THE INITIAL STAGE OF DISCHARGE IN MAGNETIC SYSTEM ^{*)}

Nagel N.N., Lisitsa V.S., Shurygin V.A.

NRC «Kurchatov institute», dementevanadegda@mail.ru

The problems of spectroscopic study of transient phases of plasma discharge of magnetic confinement systems, considered in the present work using the LHD stellarator data as an example, are associated with non-stationary behavior of helium admixture: determination of ionization-recombination fluxes, observations and calculations of high-intensity line emission, time evolution of hydrogen and helium densities as the main plasma components and its parameters [1].

For the conditions of [1], a kinetic model of quasi-stationary charge kinetics of helium was developed [2], it was shown that the atomic processes under consideration correspond to quasi-stationary evolution in time of the charge-radial distribution of helium in plasma (Fig. 1).

The relative concentration of neutral hydrogen $\xi_n(t) = n_H(t)/n_e(t)$ determines the rate of charge-exchange recombination of nuclei and helium ions. To determine it, the system of plasma quasi-neutrality equations is supplemented with equations for the intensity of hydrogen, helium, and helium ion lines.

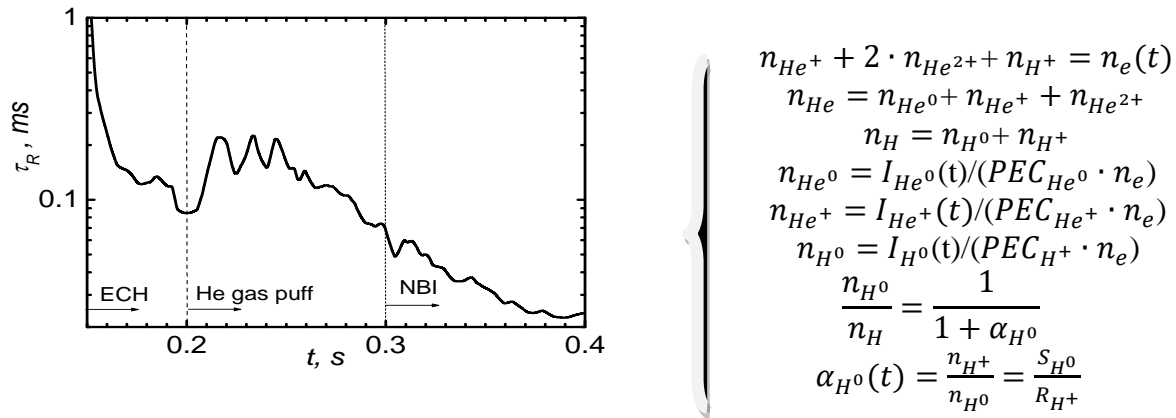


Fig. 1 - Relaxation time of the charge distribution of helium in the initial phase of discharge in LHD where n_{H^0} , n_{H^+} , n_{He^0} , n_{He^+} , $n_{He^{2+}}$ – concentration of H, He; S_{H^0} , R_{H^+} – rates of hydrogen ionization and recombination.

A self-consistent approach to solving a quasi-stationary system of equations, including spectroscopic experimental data and ionization balance, parametrically dependent on time, allows determining the kinetics of all plasma components.

The paper analyzes the ionization balance of hydrogen-helium plasma components and their time evolution in three phases of the initial stage of the discharge, calculates the rates of processes for the main recombination channels based on measurements of the intensities of the spectral lines of the plasma components, including charge-exchange recombination from excited states of hydrogen, in the initial stage of the plasma discharge.

References

- [1]. M. Goto, S. Morita, K. Sawada, T. Fujimoto, S. Yamamoto, J. Miyazawa, H. Yamada, K. Toi, 2003, Physics of Plasmas, Vol. 10, P. 1402-1410.
- [2]. N.N. Nagel, V.S. Lisitsa, V.A. Shurygin V.A., Analysis of unsteady charge state kinetics of helium in the startup phase of plasma discharge in LHD. – VANT. Thermonuclear fusion, 2024, v. 47, №. 3, p. 60–67.

^{*)} [abstracts of this report in Russian](#)