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MODELING THE PHENOMENON OF NONLOCAL HEAT TRANSPORT BY CREATING ELECTRON TEMPERATURE AND DENSITY DISTURBANCES IN THE LHD HELIOTRON *)

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One of the methods for studying the transverse transfer of heat and particle is the disturbance creation of plasma parameters and further disturbance propagation observation. The propagation of the disturbance of the electron temperature T_e and density n_e in magnetic traps can have a diffusion nature, the behavior of these parameters in this case corresponds to the diffusion equations (thermal conductivity). However, in specific cases, it turns out that the disturbance propagation does not obey diffusion: when the electron temperature at the periphery decreases, the temperature in the center increases [1]. This manifestation is called non-local heat transport (NLT). At the moment, there are no generally accepted explanations for the NLT phenomena of heat, physical models explaining this phenomenon, only results. The existing reasons for the phenomenological description of NLT are realized within two approaches. The first approach involves calculating the coefficient of heat conductivity evolution $\chi(r,t)$ from the electron heat balance equation based on the evolution data $T_e(r,t)$ and $n_e(r,t)$ under the assumption of no plasma movement [2, 3]. The second approach involves calculating evolution of the plasma velocity $v(r,t)$ under the assumption that $\chi(r)$ remains constant in time [4,5].

The report demonstrates the results of applying both approaches to experimental data on the evolution of the electron temperature $T_e(r,t)$ and density $n_e(r,t)$ after injection of polystyrene macroparticles into the LHD heliotron plasma. An analysis of the levels of disturbance occurrence during the transition from the diffusion to NLT nature of the propagation of the disturbance T_e is carried out. It is shown that this may indicate in favor of using method that uses plasma motion to describe distributions propagation.

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References

[1]. V.D. Pustovitov, Plasma Phys. Control. Fusion 54, 124036 (2012).
[1]. N. Tamura et al., Nucl. Fusion 47, 449 (2007).
[2]. S. Inagaki et al., Plasma Phys. Control. Fusion 52, 075002 (2010).
[3]. V.Yu. Sergeev et al., Plasma and Fusion Research 14, 3402121 (2019).
[4]. В.Д. Пустовитов, Избранные вопросы физики плазмы и ее применения, вып. 1 (2017).

*) abstracts of this report in Russian