Manifestations of plasma self-organization in the l-2M stellarator in ecrh regime [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.093

Meshcheryakov A.I., Grishina I.A.

General Physics Institute of the Russian Academy of Sciences, Moscow, Russia, meshch@fpl.gpi.ru

Self-organization is a fundamental property of physical (and many other) systems, which manifests itself in ordering the parameters of these systems due to the action of internal factors, without specific external action. Plasma confined in toroidal magnetic traps is also subject to self-organization processes [1]. One of the manifestations of plasma self-organization in toroidal magnetic traps is the formation of canonical pressure profiles of the electron component.

In this work, we analyzed the plasma confinement in the L-2M stellarator during the ECR heating pulse and after it was switched off. The main phases of plasma energy confinement were identified and the main mechanisms for energy loss in these phases were determined. The effect of self-organization processes on plasma confinement is revealed, and it is shown, in which confinement phases this effect is decisive.

In the L-2M stellarator in the ECRH regime, four phases of energy confinement were distinguished during plasma heating and cooling. In phase *1*, the initial plasma heating occurs. Phase *2* is the quasi-stationary phase. In phase *3*, after the ECRH pulse is switched off, the plasma cools down in the absence of microwave radiation action. After the plasma edge cools down and plasma interaction with the wall is terminated, phase *4* of plasma confinement begins.

It has been experimentally ascertained that in phase *1*, the canonical pressure profiles of the plasma electron component do not form. Apparently, the mechanism for formation of these profiles is associated with the plasma-wall interaction, which is weak in phase *1* due to the presence of relatively cold plasma layer at the plasma edge. Phase *4* is similar in properties to phase *1*.

In phase *2*, after the cold periphery warms up, the plasma and the wall begin to actively exchange particle flows. The processes of self-organization tend to establish the canonical pressure profile, at which the energy loss from the plasma is minimal, and the external effect of microwave radiation tends to take the plasma out of the state with minimal losses. As a result, pressure profiles are established in the plasma that are close to the canonical one.

In phase *3*, after switching off the microwave heating, the plasma begins to freely relax in the absence of external action. In this phase, the canonical pressure profiles are established and for each of the states with certain plasma energy,the heat loss is minimal. It has been experimentally ascertained that as the plasma energy decreases, the total heat loss decreases in proportion to the cube of the plasma energy. In this phase, self-organization is decisive for the plasma confinement. For phase *3*, the scaling law for the energy lifetime is obtained, which is very close to the scaling law of the L-2M stellarator in the quasi-stationary phase. The authors believe that in phases *2* and *3*, the dependences of the energy lifetime on the parameters of plasma and facility (scaling laws) are determined by the processes of plasma self-organization.

References

1. Yu. N. Dnestrovskij, *Self-Organization of Plasma* (NRC Kurchatov Institute, Moscow, 2013).
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/AD-Meshcheryakov.docx) [↑](#footnote-ref-1)