PLASMA transport time EVOLUTION at the high PRESSURE limit IN the OPEN AXISYMMETRIC TRAP

1,2Khristo M.S., 1,2Beklemishev A.D.

1Budker Institute of Nuclear Physics SB RAS, Novosibirsk, Russia  
2Novosibirsk State University, Novosibirsk, Russia, [khristo.mikhail@gmail.com](mailto:khristo.mikhail@gmail.com).

The diamagnetic confinement mode [1] should provide a significant increase in the plasma lifetime in the mirror trap. The feasibility of transition to this mode will be tested on the GDT and CAT experimental setups for the purpose of its further use in the design of the new generation trap GDMT [2]. The diamagnetic confinement corresponds to the high-pressure limit (β →1). In this mode, high-pressure plasma “bubble” with a relatively thin boundary is formed in the region of the minimum vacuum magnetic field. Inside the “bubble”, the magnetic field almost vanishes, which leads to a significant increase in the transverse transport. At the same time, the axial lifetime grows greatly due to the increase in the mirror ratio. The flow conservation condition allows us to estimate the boundary layer thickness and the total confinement time [1].

In previous works, the stationary MHD model, consisting of the Grad-Shafranov equilibrium equation and the transport equation describing transverse diffusion and gas-dynamic axial loss, was constructed. Stationary axisymmetric solutions corresponding to the diamagnetic confinement mode were found numerically.

This paper is devoted to the theoretical study of the nonstationary transport in an open axisymmetric trap in the diamagnetic confinement mode. We modified the stationary model and now it takes into account the dependence of plasma pressure on time. It was also assumed that the characteristic transport time significantly exceeds the force equilibrium time. This allows us to consider the plasma to be in equilibrium at each moment in time, using the Grad-Shafranov equation.

The numerical model of nonstationary plasma transport in the axisymmetric open trap was constructed. Numerical solutions corresponding to the diamagnetic confinement mode were found. The results of this work gives us a qualitative picture of the diamagnetic “bubble” formation process, and in the future, it might be used in the experimental data analysis.

References

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