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A NUMERICAL MODEL OF A NONSTATIONARY PLASMA IN AN AXIALLY SYMMETRIC OPEN TRAP MIDAS-1D2V *)

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Up to now, a number of models have been developed to simulate the parameters of the GDT device. The main approach was to divide the ions into two parts: "warm ions" with a high collision frequency and a distribution function close to Maxwellian, and "fast ions" formed by capturing of injected neutral beams. The focus was on fast ions, their distribution function was evaluated analytically [1], or calculated using numerical codes [2,3]. At the same time, the parameters of warm ions were estimated by simplified models. Another approach involves the numerical calculation of all plasma parameters based only on electrodynamics and some simplification for paired Coulomb collisions. This option is implemented in the form of a particle-in-cell kinetic code [4], and the complexity of its application is associated with high requirements for computational resources.

Within the framework of this work, a numerical model is proposed to calculate the evolution of the ion distribution function in an axially symmetric open trap (Mirror Ion Distribution with Axial Symmetry — MIDAS). To simplify the model, the following assumptions are made. Firstly, without taking into account collisions, the magnetic moment μ and the total energy E of the ions are preserved in the approach of a collisionless motion. The distribution on the Larmor rotation phase is considered homogeneous. For this reason, the phase space is parameterized by two variables — E and μ. Secondly, the model is constructed for plasma inside a single power tube with a uniform distribution over its cross section. Therefore, the usual space is parameterized by a single coordinate along the axis of the system. As a result, the distribution function depends on time, one spatial and two phase coordinates (which is often abbreviated as 1D2V). Thirdly, the Rosenbluth potentials were calculated using angle-averaged ion distributions. And fourthly, the Maxwellian distribution of electrons with the same temperature in the entire power tube was assumed, and the magnetic field distortions were calculated in the paraxial approximation.

A preliminary verification of the code was carried out: the results of calculations performed in extreme cases of long and short mean free pathes demonstrate good agreement with theoretical models.

References

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