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1D GYROKINETIC CODE FOR MODELING THE DEVELOPMENT OF A PLASMA DISCHARGE IN AN OPEN TRAP *)

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The operation of a fusion facility such as open magnetic trap is impossible without creating an initial plasma with a density sufficient to capture the injected neutral beams. One of the most promising methods for igniting a plasma discharge in such systems is the ionization of a neutral gas by an electron beam. Unlike direct injection of plasma into a trap using a plasma gun, injection of an electron beam does not create problems with partial reflection of plasma from magnetic mirrors. In this case, plasma is successfully generated along the entire length of the facility.

Previously, at the GDT device located at Institute of Nuclear Physics SB RAS experiments on injection of an electron beam with a characteristic energy of 20-30 keV and a current of 5 -8 A into neutral gas have been carried out [1]. It was shown that a beam having a diameter of 1 cm in the central section of the setup is capable of creating plasma in the entire volume of the trap (50 cm in diameter). Recent attempts to explain this phenomenon by the rapid radial expansion of the plasma turbulence region, highly localized near the entrance magnetic mirror, with the subsequent transfer of energy from the beam relaxation region to cold electrons in other parts of the trap due to classical electron thermal conductivity, have not been successful. Because of the fact that the rapid energy losses to the cold wall greatly underestimated the electron temperature in the trap compared to the experimental value (20 eV) [2,3]. In reality, energy losses to the wall in a mirror trap turn out to be much lower due to the formation of an ambipolar potential jump in the expanders. However, in order to correctly describe the influence of this effect, as well as take into account the fact that the mean free path of electrons at measured temperatures is comparable to the size of the plug, it is necessary to go beyond the applicability of the hydrodynamic approach and study the kinetics of electrons at least within the framework of a simplified gyrokinetic model. To reproduce classical transfer processes in the presence of an ambipolar potential jump and without presence of restrictions on plasma temperature, the development of a 1D gyrokinetic Particle-In-Cell (PIC) code was started.

This paper presents a description of an energy-conserving 1D gyrokinetic code. To describe the longitudinal motion of particles under the influence of mirror and electric forces, this code uses the semi-implicit PIC model [4]. The transverse velocity changes in accordance with the magnetic moment conservation law. The presented physical tests confirm the correct operation of the code.

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