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Peer Review

Review of: "Drift-Cyclotron Loss-Cone Instability in 3D Simulations of a Sloshing-Ion Simple Mirror"

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The paper is devoted to the theoretical analysis and numerical modeling of the drift cyclotron instability in the open magnetic trap WHAM. According to the authors, this microinstability may cause an increase in plasma losses in the upcoming experiments on plasma confinement in this trap to the gas-dynamic level. The work shows qualitatively how the known method of stabilizing this instability by adding a population of cold ions to the plasma can work under the conditions of the WHAM experiment and is undoubtedly of great interest to the plasma community involved in fusion research on open magnetic traps. To improve the article and increase the reliability of the results obtained, the following proposals can be formulated:

1. The applicability range of the simplified model for electrons remains unclear, since fast ions formed during neutral injection have much larger (than electrons) gyroradii, which allows them to create an excess positive charge and a transverse potential jump at the plasma periphery. If the plasma has poor electrical contact with the wall, this jump can reach Ti/e values, leading to the transverse confinement of ions by the electric field and the generation of an equilibrium current solely due to the ExB-drift of electrons. It would be good to check the reliability of the simplified model using Ohm's law by comparing it with fully kinetic PIC simulations (at least with a reduced ion mass).
2. It would also be interesting to show a map of the angle-averaged radial electric field, which is subtracted from Figure 1d (or the corresponding radial potential profile). How large is the transverse potential jump compared to Ti/e? For example, the ambipolar potential drop of 5Te/e with the chosen parameters already becomes of the order of Ti/e. If these are comparable values, then in the expression for the azimuthal drift velocity of ions (3.1) it is necessary to take into

 doi.org/10.32388/ZG16WC

account not only the ion pressure gradient but also the electric force. Instead of the theoretical prediction for the ion drift velocity (3.1), it is possible to use its value directly measured in the PIC model (for example, by dividing the ion current density by the plasma density), which will allow us to assess the adequacy of the theory and, possibly, improve the agreement between the phase velocities of drift oscillations and the particle drift velocity in Figure 6.

3. The authors state that the addition of cold (1 keV) plasma to the periphery stabilizes the drift cyclotron instability. As evidence, they provide graphs (Fig. 10) in which the losses of fast particles decrease with increasing density of the cold component. To prove that this result is really associated with the suppression of drift oscillations and is not a consequence of, for example, a change in the longitudinal profile of the electric potential, it is necessary to show how the amplitude of oscillations of the azimuthal electric field changes with increasing density of the cold plasma (that is, to show the same maps of the field $E_\varphi(x,y)$ as in Fig. 1d).
4. When describing the initial conditions in the 3D PIC model, it is not said what electric field is set at the initial moment of time (is this the field calculated by the CQL3D-m code, or is the field calculated from Ohm's law based on the distribution of the initial plasma density and the current distribution that is formed in the PIC model?).
5. The numerical PIC model probably conserves energy poorly due to the introduction of super-resistivity. It would be nice to show how much of the system's energy is lost through dissipation by the end of the simulation.

Declarations

Potential competing interests: No potential competing interests to declare.

doi.org/10.32388/ZG16WC