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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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Review Result

"Drift-Cyclotron Loss-Cone Instability in 3D Simulations of a Sloshing-Ion Simple Mirror" by Aaron Tran *et al*.

The paper provides a thorough examination of the DCLC instability in simple mirror plasmas. It is a comprehensive work that spans over 40 pages and presents spectral analysis in the wave-number-frequency space to investigate DCLC. The paper also explores topics such as ion velocity distribution, diffusion in velocity space, and confinement effects. The use of the Hybrid model in the simulation allows the authors to avoid the influence of terms involving 1/n by incorporating a density floor. This approach is a common numerical strategy in many simulations using the Hybrid model, and it is understandable within the context of the study. Furthermore, the authors do a commendable job of explaining the limitations and validity of their results, which is beneficial for readers' understanding.

The discussion is extensive and well-detailed. While the explanation of the apparent contradictions between Figure 9 and Figure 10 would benefit from direct evidence, it is reasonable to expect that future research may provide this evidence. Although mirror-based fusion does not involve closed magnetic flux structures, and thus challenges remain in this approach, the study represents a significant contribution to the development of the physics of open magnetic field-line regions. Therefore, the contribution of this paper is notable. The paper presents original and innovative content, and I fully recommend its publication in *Qeios*.

Minor Revisions Required for Publication:

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1. **Figure 1**: The figure is referenced on page 3, but the explanation of the term "t_{bounce}" is provided only on page 9. Typically, definitions should be introduced when the term first appears in the text. If this is not possible, a note should be added indicating that the definition will follow later in the paper.
2. **Figure 1 Panels (a), (e), and (i)**: The vertical axis in these panels is labeled as " r." However, in cylindrical coordinates, "r" typically starts at 0, making this labeling inappropriate. The vertical axis should perhaps be labeled as either "x" or "y" in Cartesian coordinates.
3. **Page 8, Mid-Section**: The paper states, "The diamagnetic field is updated in CQL3D-m every 1ms." This may be a typo, and it is likely that "1 u(micro)s" should be reconsidered or clarified.
4. **Figure 10**: It is understood that hot ions trace a toroidal orbit around the device axis. However, it is unclear why there is a peak in density at $r = 0$. There may be a misunderstanding on the part of the reviewer, but it seems that the distribution of hot ions should resemble the distribution of n_{cool} in Figure 10(a). If necessary, the authors should provide further clarification in the main text.
5. **Conclusion**: The conclusion outlines certain computational models that should be incorporated. A potential issue arises with the use of Equation (2.1) to determine the electric field when the density starts to decrease. The authors may want to consider incorporating a model that includes the effects of neutral particles, transitioning from the plasma region to the vacuum region, as part of a transitional region model.

Declarations

Potential competing interests: No potential competing interests to declare.

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