Nonlinear charge dynamics effects in a Hall thruster device

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Plasma thrusters have been identified as a promising technology for primary propulsion in deep-space scientific missions. Among different types of plasma propulsion devices, Hall effect thrusters stand out by its current state of the art [1]. Most of the basic analyses of particle dynamics on Hall thrusters are based on models that consider a one dimensional flow that lead to integrable charge dynamics. In practice, however, the dynamics is fully three dimensional, allowing for the onset of more complex dynamical behavior [2]. In this paper, we investigate the charge dynamics in a simplified three dimensional model for the Hall thruster which presents chaotic behavior. A detailed discussion on the validity of the model is presented. It is shown that electron chaotic dynamics is intimately connected with an increased background gas ionization probability and plasma formation, which is of utmost importance for the device operation [3]. It is also shown that despite the chaotic dynamics, charge confinement can be preserved with a proper choice of the electromagnetic field profile.

References

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