Abstract *(paper not available)*

Electron Thermodynamics in the Magnetized Expansion of a Rarefied Plume

Jaume Navarro Cavalle, Sara Correyero, Jaume Navarro Cavalle, Eduardo Ahedo

Universidad Carlos III Madrid (Spain)

Within the group of emergent technologies for Electric Propulsion, most of them present common characteristics, such as the use of magnetic nozzles (MN) to guide and expand the plasma. Among them we find, the helicon plasma thruster (HPT), the electron cyclotron resonance thruster (ECRT) or the Variable Specific Impulse Magnetoplasma Rocket (VASIMR). The study of electron thermodynamics at the plasma plume area is crucial to determine propulsive performances. But not limited to this issue, it is also important to assess the properties of the plasma impinging SC surfaces, for example the electron temperature, or electric potential space evolution. Nowadays, most models employ isothermal or polytrophic laws for the evolution of the electron temperature throughout the plume expansion. However, this is not always justifiable in rarefied plasmas and thus could lead to unrealistic results. For instance, an isothermal assumption, which is justifiable only if the distribution remains close to Maxwellian, drives inconsistencies far downstream, since it leads to unbounded electric potential fall and plasma acceleration. In [1] and [2] the authors developed a paraxial steady-state kinetic model of a quasineutral collisionless magnetized plasma, in order to determine consistently the axial evolution of the electric potential and the electron and ion distribution functions, and their associated properties such as the electron and ion temperatures and electric potential fall. All this analysis was carried out assuming that electrons and ions were Maxwellian far upstream, say at the plasma source exit. In the work presented here, the study is extended along three lines. First, results will be presented for a plasma where two different electron populations, that is thermal and suprathermal ones, coexist at the source, a case that has reported interest in some experimental works in helicon sources [3]. Secondly, an anisotropic electron population, with the perpendicular temperature much higher than the parallel one, will be considered within the source, a case especially interesting for the ECR thruster [4]. Finally, the asymptotic approaches at the far field of the expansion will be given by the cases analyzed in Ref [1] and the parametric analysis of [2] will be extended to derive fluid models based on isothermal – polytropic combinations that could fit the response of the main plasma properties, and can be used in simpler (e.g. fluid-type) plasma expansion models. References [1] M.Martinez-Sanchez, J.Navarro-Cavallé, and E.Ahedo, “Electron cooling and finite potential drop in a magnetized plasma expansion”, Physics of Plasmas 22, 053501 (2015). [2] J.Navarro-Cavallé, S.Correyero and E.Ahedo, “Collisionless electron cooling on magnetized plasma expansions: advances on modelling”, 34th International Electric Propulsion Conference, IEPC-117 (2015).[3] West, M. D., Charles, C., & Boswell, R. W. (2008). Testing a helicon double layer thruster immersed in a space-simulation chamber. Journal of Propulsion and Power, 24(1), 134-141. [4] Cannat, F., Lafleur, T., Jarrige, J., Chabert, P., Elias, P. Q., & Packan, D. “Optimization of a coaxial electron cyclotron resonance plasma thruster with an analytical model”, Physics of Plasmas 22(5), 053503 (2015).

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