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Ion acceleration in electrodeless plasma thrusters TREVOR LAFLEUR, LPP Ecole Polytechnique, and Centre National d'Etudes Spatiale (CNES), FELIX CANNAT, Mars-Space, JULIEN JARRIGE, PAUL-QUENTIN ELIAS, DENIS PACKAN, ONERA-The French Aerospace Lab — Since electrodeless plasma thrusters do not use biased electrodes or grids to accelerate ions, it is unclear what determines the magnitude of the "accelerating voltage" and hence what the ion beam energy is. In this work a combined theoretical/experimental study of the relationship between the electron temperature and the ion energy was performed to provide such an answer. Experimental measurements show that the ion energy and electron temperature are strongly correlated, and demonstrate that the driving force for the plasma expansion in magnetic nozzles is the electron pressure: in complete analogy to chemical rockets with physical nozzles. Because there are no electrodes or applied voltages, the plasma that exits the thruster must be current-free, and we show that this establishes a strong criterion that determines the maximum accelerating potential that self-forms in the plasma. This maximum accelerating potential (which is between about 4-6 times the electron temperature) is similar to that which develops for a floating sheath, and depends on the electron velocity distribution function. Based on plasma loss considerations inside the thruster cavity, and the drop-off of the ionization cross section for large electron energies in most gases, we predict a theoretical maximum achievable ion beam energy of about 400 eV for argon and xenon propellants.

Trevor Lafleur
LPP Ecole Polytechnique, and Centre National d'Etudes Spatiale (CNES)

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