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INTRODUCTION AND PERFORMANCE ANALYSIS OF THE SOLAR WIND ION FOCUSING THRUSTER (SWIFT)

Abstract

Several studies were conducted in the 1960's and 70's concerning the applications of interplanetary ramjets. These studies proposed using some type of magnetic or electrostatic technique to collect ions from the solar wind and feed them into a pulsed fusion reactor to generate thrust. We propose here a new technique that avoids many of the drawbacks of previous concepts. Consider a series of wires arranged as a cone with the large open end facing the sun. If the wires are highly positively charged and not farther apart than the solar wind plasma Debye length, then the protons in the solar wind will be repelled by the wires and cannot escape the cone. If nothing else was done, then the whole structure would be pushed along like a variant of an electric sail; however, if the focused, higher density plasma in the base of the cone is connected to an ion acceleration stage, then the protons can be accelerated out the small end of the cone at much higher velocities than they had when they entered the cone. This proton beam could then be directed in any desired direction to propel the spacecraft. We call this concept a Solar Wind Ion Focusing Thruster or "SWIFT". This paper summarizes the high-level feasibility of such a system, including the forces generated, power needed for creating the electric field and accelerating the protons, effects of cone size on mission performance, and mission applications. Preliminary work shows that a SWIFT powered craft with a cone diameter of 1 km could generate thrust on the order of 2 mN at 1 AU, which is competitive with other propellantless systems (e.g. solar sails). Additionally, exhaust velocity would be 1000 km/s since the main component of the accelerated material is hydrogen, 130 times lighter than the xenon often used in ion thrusters, and even better methods of ion acceleration should be possible with a SWIFT system since the plasma is already ionized when collected, eliminating a large source of energy consumption in traditional ion drives. Finally, a SWIFT system would have a major advantage over solar sails in that the thrust could be easily directed along any desired vector without a loss in magnitude, as opposed to sails which need to be angled to change the thrust vector, sacrificing some of the available thrust.