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EXPLORING THE FEASIBILITY OF A POWER-GENERATING PULSED NUCLEAR MAGNETIC NOZZLE

Abstract

Crewed missions to Mars and robotic missions to the gas giant planets are challenging because of the current lengthy trip times (2 years to Mars, 20+ years to the gas giants) with current propulsion technology. These trips endanger astronauts due to the harmful effects of radiation and microgravity, and represent a significant fraction of a PI(Principal Investigators' lifespan for uncrewed gas giant missions. To make these trips safer and more reliable, trip times need to be reduced dramatically. Pulsed nuclear fusion propulsion systems promise to reduce these trip times down to 1-3 months for the Mars mission and 1-4 years for gas giant missions. However, widespread use of these systems is hampered by many technical factors, including efficient conversion of directed jet power for thrust and generation of input power for fusion reactor operation. To address both of these challenges, we propose using the novel power-generating magnetic nozzle; this nozzle uses high-strength magnetic fields for thrust generation and low-strength fields for power generation. Most approaches in the literature consider the effect of either the high-strength fields or the low-strength fields but, for this work, we would like to show their combined effect. To address this, we use two computational tools in tandem from prior work; the Smoothed Particle Fluid with Maxwell equation solver (SPFMax) and a plasma flux compression generator code. The former will determine the effect of the high-strength fields and the latter will determine the effect of the low-strength fields. Combined, they will show the effect on thrust, efficiency, and power generation. We expect to show that the inclusion of a power-generation system does not degrade thrust significantly; we also expect to determine best practices and non-dimensional scaling parameters that characterized design of these novel nozzles. This work will reduce the technical risk associated with these nozzles, hopefully allowing for their application in current concepts/programs, make interplanetary trips safer and more reliable, and allow humanity to venture out and explore the solar system.