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3RD GENERATION ELECTRIC PROPULSION DRIVE

Abstract

Low-temperature ($T_{\perp}/T_{\parallel} \ll 1$) plasmas (LTP) have rarely been considered for space propulsion because the plasma is usually thermally ionized. If LTP can be produced in a correlated quantum system, however, then long-range forces can produce highly collimated, super-Alfvénic plasma beams ideal for propulsion without parasitic entropic energy losses due to stochastic transport. If we regard electrostatic ion drives as 1st generation electric propulsion (EP) and neutral MHD plasma (ExB) drives as 2nd generation EP, then this LTP is a 3rd generation (kinetic theory) non-MHD plasma EP drive that differs from the 1st and 2nd generation through the use of field-aligned potentials or “plasma electrodes.” For a variety of space missions, high-speed plasma beams could deliver combined thrust and Isp levels unheard of in 1st and 2nd generation EP drives through the production of high-DC-voltage fields that are coherently (non-thermally) generated.

The LTP produced in the inhomogeneous, strong dipole field of a superconducting magnet provides both a “cold” magnetic field with low Alfvénic heating and highly controllable electric and magnetic field. The long correlation length of the Cooper pairs in the magnet, combined with the long correlation length of the plasma, permit the entire system to be considered a macroscopic quantum system (MQS). Modulation of either the plasma or the magnet will cause near instantaneous modulation of the other. Then injection of anisotropic plasma into the MQS will generate increased magnetic flux (inductive energy) in the magnet while increasing the quadrupolar charge separation (capacitive energy) in the plasma, which we liken to a metastable, higher energy state of the MQS. At some limiting energy, when the vacuum breaks down in an arc discharge, or the magnet is quenched, this energy is released in a strong jet of field aligned plasma, which we liken to a pulsed laser. If the anisotropic plasma injection is large enough, the “plasma laser” can be made continuous, converting electrical energy into a collimated beam of high speed plasma. Therefore this coherent beam of particles can be controlled to provide a 3rd generation electric propulsion drive, 3EPD.