Magnetic reconnection plasma thruster

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We have recently introduced a new concept for rocket thrusters that exploit the mechanism behind solar flares, where magnetic energy is converted to kinetic energy through the process of magnetic reconnection. Inspired by the studies of fundamental processes in helicity injection experiments in NSTX, computer simulations (in both single and two-fluid extended MHD models) were used for the first time to demonstrate that a particular configuration of electric and magnetic fields can both create plasma and accelerate it by continuously producing plasmoids (plasma enclosed by magnetic fields that are detached from the externally applied fields) through spontaneous fast magnetic reconnection. Due to an Alfvenic outflow from the reconnection site, its thrust is proportional to the square of the magnetic field strength and does not ideally depend on the mass of the ion species of the plasma, giving flexibility in the choice of propellant gas [Journal of Plasma Physics, 86(6), 2020]. Our calculations of thrust and exhaust velocity are performed via state-of-the-art extended MHD simulations with a realistic coil configuration. Variable unidirectional high exhaust ion velocities, as well as quasi-steady large net thrust, are directly demonstrated in the simulations. These results support the fast reconnection base magnetic reconnection thruster (MRT) concept. New computational results, as well as our system design to build a plasmoid-mediated MRT will be presented. Operational thruster regimes based on magnetic reconnection phase diagram will also be discussed. This work has been supported by DOE at PPPL.