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High thrust-over-power collisional Hall thruster

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The possibility of realizing a high thrust-over-power collisional Hall thruster will be discussed.

A major figure of merit in propulsion in general and in electric propulsion in particular, is the thrust per unit of deposited power, the ratio of thrust over power. We have recently demonstrated experimentally and theoretically [1-5] that for a fixed deposited power in the ions, the momentum delivered by the electric field is larger if the accelerated ions collide with neutrals during the acceleration. The higher thrust for given power is achieved for a collisional plasma at the expense of a lower thrust per unit mass flow rate, reflecting what is true in general, that the lower the flow velocity (and the specific impulse) is, the higher the thrust for a given power. This is the usual trade-off between having a large specific impulse and a large thrust. Broadening the range of jet velocities and thrust levels is desirable since there are different propulsion requirements for different space missions. Operation in the collisional regime therefore can be advantageous for certain space missions.

I will review our experimental results that show the increase of thrust-over-power due to collisions. The increase is found to be proportional to the square root of the number of collisions. The configuration used was of a crossed electric and magnetic fields, as in the Hall thruster, so that the source of the thrust is the magnetic pressure. Tailoring the magnetic field profile in order to modify the electric field will be examined.

Sources of inefficiency will be discussed. The electron cross-field transport is increased as the gas pressure in the acceleration channel is increased. As a result, the current utilization is reduced. The energy utilization is reduced as the spread in energy of ions and neutrals is increased by ion-neutral collisions.

Momentum delivery to neutrals on the few eV level should be examined for other industrial applications in addition to electric propulsion.

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