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Author: Mr. Julien Vaudolon
CNRS, France, jvaudolon@hotmail.fr

EXPERIMENTAL STUDY OF ACCELERATION PROCESSES IN HALL EFFECT THRUSTERS

Abstract

Chemical spacecraft propulsion systems create thrust by thermodynamically expanding heated propellant gas through a nozzle. Chemical propulsion allows generation of a large thrust level. As a direct consequence, it is possible for the spacecraft to quickly reach a high speed. However, the fast propellant consumption becomes a drawback for long-distance missions since either very large tanks are needed or the firing phase will be very short. The stability of the chemical propellant during a long time period is also a critical issue. Besides, many desirable future space missions require velocity increments that are an order of magnitude, or more, higher than this. For missions that require a high velocity increment (such as orbit transfer, de-orbit manoeuvre and interplanetary journeys), an alternative method of propulsion having a higher specific impulse or exhaust gas velocity can be achieved using electric propulsion (EP). The Gridded Ion Engine (GIE) and the Hall Effect Thruster (HET) are presently two EP propulsion devices mature enough with a long flight heritage to be envisaged as a solid option for main spacecraft propulsion in the case of outer planet exploration and science missions. Although GIE devices are able to attain very high specific impulse exceeding 4000 s at moderate applied power with xenon as a propellant, the ion current flowing through the grid assembly is limited by the Child-Langmuir principle, meaning a restricted thrust level. In other words, a large thrust can only be achieved with a very large grid area, which generates technological constraints and issues. The high thrust-to-power ratio (3 to 4 times as big as GIEs), the efficiency and the lifetime of HETs give this technology a serious advantage for primary propulsion of space probes during interplanetary journeys (as demonstrated by the successful SMART-1 Moon flyby mission of the European Space Agency).