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DEVELOPMENT ACTIVITIES OF AN INERTIAL ELECTROSTATIC CONFINEMENT DEVICE FOR SPACE APPLICATIONS

Abstract

This publication gives a status and further outlook of the inertial electrostatic confinement (IEC) research at the Institute of Space Systems (IRS). Theoretical and conceptual studies about nuclear fusion plasma concepts have been conducted for several years. For future space missions that are supposed to lead us farer than to the low earth orbit, high efficiency propulsion and energy sources are needed. One of the most promising concepts is the fusion technology. But the best technologies in terms of fusion power on earth (e.g. ITER) need huge, massive structures for power supply, magnets or capacitors and lasers. Earlier studies have described IEC fusion concepts to provide a high-power density fusion propulsion system capable of deep space missions. Moreover considering a short- or middle term program an application as IEC ion thruster concept is interesting too. A typical IEC device consists of two spherical, concentric grids placed in a vacuum chamber. The inner grid is biased with a highly negative voltage and the outer grid is grounded. A glow discharge is created between these grids and the generated ions get accelerated into the grid center and fuse with other ions occasionally. With the beginning of 2010 a project has been set up in order to build such an IEC test stand in the IRS Laboratory to broaden the understanding and knowledge of plasma confinement and plasma beam extraction, first in a non-fusion regime. Especially the feasibility of an application for space propulsion will be examined within this project. The planed milestones as well as some preliminary results of this project will be presented: Firstly, the following experimental work packages will be completed. A first test setup consisting of a spherical two-grid system will be assembled and operated in a glow discharge mode. The used propellant is Argon. Discharge characteristics and operational conditions of this device will be shown and discussed. Moreover different operation modes could be observed. Secondly, with a theoretical approach space charge effects on the ion current through the grids will be studied. From the conventional gridded ion thruster theory it is known that at higher pressures the Langmuir-Child effect is driving the limits for the maximum ion current going through the grids. This also applies for an IEC device. A theoretical analysis for the existing grid construction will be done in order to estimate the maximum flowing ion current.