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A FIRST STEP TOWARDS INTERSTELLAR FUSION PROPULSION

Abstract

60 years of spaceflight lead to incredible explorations' feat, which teased the curiosity of humanity to discover the unknown of the Universe. This inherent desire has been fulfilled with missions that went far and beyond, allowing humans to leave the Solar System. Nevertheless, reaching other stars seems to be far from the present era considering the limits of the current technologies.

This paper focuses on nuclear fusion processes, reactions in which two or more atomic nuclei combine to form one or more different atomic nuclei and subatomic particles. When this process is exothermic, a quantity of energy envied by all the current propulsion systems is released, energy that can be exploited for interstellar missions' purposes. Although fascinating, the nuclear power development is stalled by technological implications derived by the abundance of energy generated.

The Inertial Electrostatic Confinement (IEC) is a method to obtain nuclear fusion reactions by means of strong electrical fields confining plasma. Two concentric spherical electrodes apply enough voltage to ionize the gas in between them and accelerate the obtained ions to the center of the system. Eventually, collisions ion-ion occur and the kinetic energy gained with the acceleration permit the fusion of the two nuclei. By manipulating the electrical field applied between the two electrodes and the geometry of these, plasma can be ejected, such as the common electrostatic propulsion systems.

This paper appreciates the physics of an IEC by manufacturing and testing a small-scale plasma confining propulsion system and conceivably applying it to a 6U CubeSat. Moreover, this paper describes the framework of a physical model that simulates the behavior of the IEC and evaluates its propulsion performances in terms of specific impulse. The in-laboratory experiments and the mathematical model aim to obtain a first stage of an electrical propulsion system working with the IEC principle, and to explore the increase in the specific impulse by invoking nuclear reactions. Hence this research represents the first non-nuclear step for obtaining an innovative electrical propulsion system, along as a first step towards nuclear fusion, the sole technology to allow interstellar exploration. The work has been carried out at NASA Ames Research Center, in the Technological and Educational Nanosatellite department leaded by Marcus Murbach, Principal Investigator at the Space Technology division.