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EXPLORATION OF THE SOLAR SYSTEM AND BEYOND USING A THERMONUCLEAR FUSION DRIVE

Abstract

This study demonstrates that developing a nuclear fusion rocket engine based on a D - ^{3}He technology [1] will allow to travel in the Solar System and beyond with an ease never before attained and opens almost 'science fiction' possibilities to humankind. The Direct Nuclear Fusion Drive (DNFD) is the D - ^{3}He fueled, aneutronic, thermonuclear fusion propulsion system that is under development at Princeton University Plasma Physics Laboratory [1]. It is shown that DNFD is essential in human planetary exploration and constitutes a solution to the problem of exploring and colonizing the Solar System.

We consider and analyze the Earth – Mars mission using the DNFD. It is shown that one-way trips to Mars in slightly more than 100 days become possible, and journeys to the asteroid belt will take about 250 days [2].

We perform an analysis of realistic trajectories for a robotic mission to Saturn's largest moon, Titan, to demonstrate the great advantages of the thermonuclear fusion engine. The trajectories calculations and analysis for the Saturn's largest moon Titan for different profile missions are presented based on characteristics for a 2 MW class DNFD engine. This capability results in a total trip duration of 2.6 years for the thrust–coast–thrust profile and less than 2 years for the continuous thrust profile [3]. Using the same 2 MW class DNFD one can reach some trans-Neptunian object, such as the dwarf planets Makemake, Eris and Haumea in less than 10 years with a payload mass of at least of 1500 kg. Therefore, it would enable all kinds of missions, from scientific observation to in-situ operations [4]. We consider for each mission a thrust-coast-thrust profile. We present calculations to reach a vicinity at 125 AU for the study of the Sun magnetosphere, with interest on the influence of different acceleration phases.

Finally, we conclude that a spacecraft propelled by DNFD will open unprecedented possibilities to explore the Solar System border, in a limited amount of time and with a very high payload to propellant masses ratio.

References:
[1] S. A. Cohen, C. Swanson, et al., JBIS **72** (2019) 37–50.
[2] G. Genta, R. Ya. Kezerashvili, Acta Astronautica **173** (2020) 303–309.
[3] P. Aime, M. Gajeri, R. Ya. Kezerashvili, Acta Astronautica **178** (2021) 257–264.
[4] M. Gajeri, P. Aime, R. Ya. Kezerashvili, Acta Astronautica **180** (2021) 429–438.