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ELECTRIC PROPULSION FOR INTERPLANETARY MISSIONS IN THE SOLAR SYSTEM: TRADE STUDIES AND POTENTIAL APPLICATIONS.

Abstract

Interplanetary missions have become more important over the last ten years. It is necessary to answer many scientific questions concerning planetary objects in the solar system by performing in-situ experiments and observations. At the same time, those missions can be used as engineering tests for further development, with the ultimate goal of sending humans into deep space. Since the beginning of space exploration, chemical thrusters have taken the leading role for all types of propulsion systems. Getting into the orbit of another planet requires high V capabilities and chemical thrusters cannot provide them in some cases. Electric propulsion systems appear as some of the best alternatives due to their high specific impulse. In this paper, the physical properties of all the different types of electric propulsion are explained and the most suitable concepts for interplanetary missions are identified. The main advantages and drawbacks are outlined and potential approaches for considerably improving their capabilities are addressed. Hypothetical new power sources and engineering challenges are faced, basing on current technology and further developments. A trade-off study in electric propulsion systems is presented with the aim of designing satellite exploration missions and manned missions. Two case studies are developed, one robotic mission to Europa and one human mission to Mars by using a nuclear-electric propulsion system. For this purpose, a preliminary trajectory analysis is carried out to study the feasibility and potential applications for this technology. Constant thrust trajectories and all mission characteristics such as payload mass and trip time are explained and presented for both cases.