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Author: Dr. Claudio Bruno
United Technology Research Center (UTRC), United States

COMBINED NUCLEAR THERMAL AND ELECTRIC PROPULSION FOR MARS MISSION

Abstract

Manned interplanetary missions will be constrained by the need to limit crew radiation dose to a fraction of 1 Sievert. Recent data indicate a round trip Hohmann trajectory to Mars may result in a dose close to 1 Sievert, not accounting for that received on Mars. This has suggested faster missions, in practice enabled only by nuclear propulsion.

The dicotomy between Nuclear Thermal Rockets (NTR), providing substantial thrust but Isp limited 900 s, and Nuclear Electric Propulsion (NEP), providing Isp in the range 1000 to 10,000 s but at a very low thrust, may be resolved by combining the two propulsion strategies. In a 2013 IAF paper by Bruno and Dujarric one of these authors (C. Bruno) analyzed a notional round trip Earth-Mars mission by solving analytically the equation of motion by assuming fixed distance segments, each using either NEP or NTR. In this paper we assume a different strategy consisting in a fast NTR segment to quickly reach Earth escape speed, followed by mass-saving acceleration using a NEP ion thruster. The solution is still analytical, enabling to efficiently vary and observe the impact of the main mission parameters

Preliminary results were obtained by varying Earth-Mars distance, Isp of electric thrusters and initial spacecraft mass within ranges feasible with current or near-term technology. These results already indicate that the combined NTR+NEP strategy may result in a conjunction Earth-Mars mission time of order a few weeks, with reasonable values of spacecraft mass, thrust and Isp. Although far from being optimal, this exercise suggests that appropriately combining the two propulsion modes may become a workable solution to the mass and time problems posed by safe manned Mars missions.