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Author: Mrs. Monica Salunkhe
University of Alabama in Huntsville, United States

Dr. Gabe Xu
University of Alabama in Huntsville, United States
Dr. Dale Thomas
University of Alabama in Huntsville, United States

PRELIMINARY LOW THRUST DIRECT TRAJECTORY DESIGN USING NUCLEAR ELECTRIC PROPULSION SYSTEM FOR RENDEZVOUS MISSIONS TO JUPITER

Abstract

Nuclear propulsion can be one of the most sustainable space propulsion technologies we currently have. Considering the source of thrust, nuclear propulsion can be categorized into two types - Nuclear Electric Propulsion (NEP) and Nuclear Thermal Propulsion (NTP). This paper presents a preliminary low thrust trajectory design analysis for a direct rendezvous mission to Jupiter using a megawatt-class (MW-class) NEP system. NEP converts the heat released by the nuclear fission reactor to electricity which is used by the electric propulsion thrusters to ionize the gas propellant. The acceleration of the ionized propellant produces thrust. The NEP system provides high specific impulse and low thrust with constant acceleration which helps in achieving high velocities over time. The initial parking orbit of the spacecraft in this study is a circular orbit at a nuclear safe altitude of 2000 km from Earth. This analysis considers two approaches - a direct trajectory from the parking orbit to Jupiter and a transfer from the parking orbit to GEO followed by a direct trajectory to Jupiter. A comparison is drawn between the two approaches regarding the trip time and required delta V. The results of the analysis are further compared to the results of a direct rendezvous mission to Jupiter using NTP. The payload mass used for the NEP mission is the same as that used in the NTP mission for a fair comparison.