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SPACE EXPLORATION SYMPOSIUM (A3)
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SOLAR POLAR OBSERVATION MISSION AND ITS ORBIT DESIGN

Abstract

n recent years the sun observation is increasingly developed, but the example of observing the solar pole is still only of Ulysses launched in 1990. In addition to not only knowing the behavior of the solar pole but also the three dimensional observation of the solar system, the solar pole observation mission is very successful if it is realized. In reality, however, observation of the solar pole has not developed and one reason is the difficulty of escaping from the ecliptic plane. In the case of solar polar observation, it is desirable that the satellite should take a trajectory perpendicular to the ecliptic plane, but too large deltaV for propulsion is required to achieve such a trajectory. So Ulysses made the inclination angle large by Jupiter swing-by. After that Ulysses took the ballistic trajectory so the orbit was very large and the moment of sun observation in one round was quite limited. Therefore, by repeating the Earth swing-by after Jupiter swing-by, a method called E2I conversion which raises the inclination angle while reducing the orbit is invented. In this method, by repeating Earth swingby a plurality of times, the trajectory can be reduced ballistically and the tilt angle can be increased. Finally, the orbit length radius is less than 1AU and the inclination angle is about 90 degrees, and an ideal trajectory for solar polar observation is achieved. However, there is a problem that the flight time of the entire mission will be extended to 25 years due to the relation of the meeting cycle and the effect of the Earth gravity. Therefore, in this research, we propose to reduce the mission period drastically by using a low thrust continuous propulsion typified by electric propulsion. Previous studies have not attempted to combine E2I conversion and optimized trajectory by continuous thrust. In this research, propulsion is used only in the direction to change the orbital period within the same orbital plane. This proves that the degree of freedom is given to the Earth association cycle and the flight time required for input to the short period high tilt angle orbit can be dramatically shortened. The thrust constraint such as the thrust upper limit changes the number of necessary earth swing by and the flight time also changes greatly.Thereby the relation of thrust constraint, total deltaV, shortening time of total flight time becomes clear, The feasibility of this is also shown.