EPSC Abstracts
Vol. 5, EPSC2010-750, 2010
European Planetary Science Congress 2010

Asteroids more accessible than the Moon

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Abstract

Searching for accessible NEAs gained a renewed interest after the recent announcement of the NASA strategic plans, which focus on NEAs as potential targets for extraterrestrial mining and human exploration. Within this framework a general approach to find asteroids more accessible than the Moon has been developed and applied to the whole NEA population. Potential targets are analysed in view of their interest for science and exploration.

1. Introduction

The dynamical variety of the Near-Earth Asteroid (NEA) population translates into widely different requirements in terms of accessibility for a space mission. Objects on high eccentricity, high inclination orbits can be more challenging for rendezvous than sending an orbiter around Jupiter or Saturn. On the other hand there do exist asteroids on almost circular 1 AU orbital paths very close to that of the Earth.

The accessibility of the Near Earth Asteroid population can be investigated by means of some basic celestial mechanics and astrodynamics. In particular, the H-plot analysis [1] exploits Hohmann-like transfer trajectories in order to display the accessibility of the NEA population as a whole, as well as for focussing on potential targets (i.e. scientifically interesting objects associated with technically feasible mission profiles) [2].

In order to allow meaningful comparisons with the lunar case, which represents a basic reference for human spaceflight, an extension of the H-plot method is presented, which encompasses hyperbolic escape from a parking orbit around the Earth.

2. The method

In its original formulation the H-plot method relies on the so-called "massless planet approximation", i.e. the spacecraft is assumed to move initially on the same orbit as the Earth but without being subjected to the Earth attraction. This dynamical model is clearly unable to include the Moon as one of the target bodies, thus needing a different approach.

If an Earth escape trajectory from an initially circular low-altitude Earth orbit (LEO) is taken into account it is possible to include in the model elliptic lunar transfers as well as hyperbolic escape into interplanetary space. This allows to give a Hohmann-like estimate of the accessibility of NEAs against that of the Moon [3].

3. Conclusions

The possibility of extending the H-plot analysis to include the lunar case can be used to demonstrate the existence of asteroids which are in principle more accessible than the Moon. Although the actual feasibility of a mission toward these objects depends upon the timing (e.g. launch windows computation), nevertheless the method allows us to quickly identify within the growing NEA population, targets deserving further attention, both for scientific and mission analysis studies.

References

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