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Analysis of observing conditions for Phobos from satelliltes in quasi-orbits

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Abstract

In this paper we study satellites in Phobos's quasi-orbits. We estimated the lifetime of quasi-satellites under the influence of various perturbing forces. We also study Phobos observing conditions and possible surface mapping strategies.

1. Introduction

The Solar system hosts large numbers of small planetary satellites of great interest to scientists. However exploration of such bodies requires complex mission scenarios because the satellites typically move close to the primary and their own gravity fields are too faint to support Kepler-type orbits for the spacecraft. To address this problem we consider quasi-orbits, in which the spacecraft moves in an orbit very similar to that of the satellite, but at slightly different eccentricity and inclination. From the satellite, the spacecraft appears like being in orbital motion. This type of mission scenario is studied for a spacecraft moving near Phobos.

This paper we study the dynamics and life times of Phobos's quasi-orbits, and we investigate lighting- and observing conditions for mapping.

2. Method

Orbit integration were performed by the explicit Adams–Bashforth method as described in [3]. Perturbations invoked by the Mars gravity field for degree and order up to 30x30, third body attraction (Sun, 7 planets and Moon) and gravitational influence of a Phobos (up to 6 orders) were taken into account. Ephemeridees of third bodies are obtained by use of kernels SPICE [1].

Initial conditions for quasi-satellite were specified by entering variations in eccentricity and an inclination with respect to the Phobos orbit. Parameters of Phobos orbit have been obtained by means of the HORIZONS system [2].

At the fig. 1 we can see the unperturbed quasi-orbit trajectory around Phobos in the IAU_Phobos coordinate system of 10 days interval. The inclination of this orbit is the same as that of Phobos, and eccentricity is slightly larger 0.0349 (versus 0.0149 in case of Phobos).

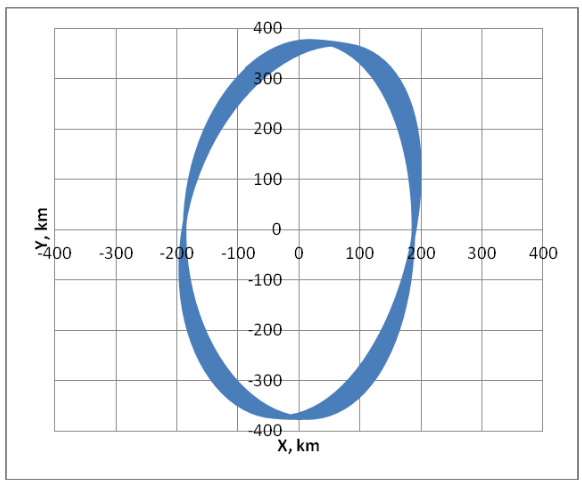

Figure 1: Unperturbed trajectory of quasi-satellite in XY plane (Phobos equatorial plane).

A drift of the spacecraft trajectory with respect to Phobos owing to perturbing forces is shown in fig. 2.

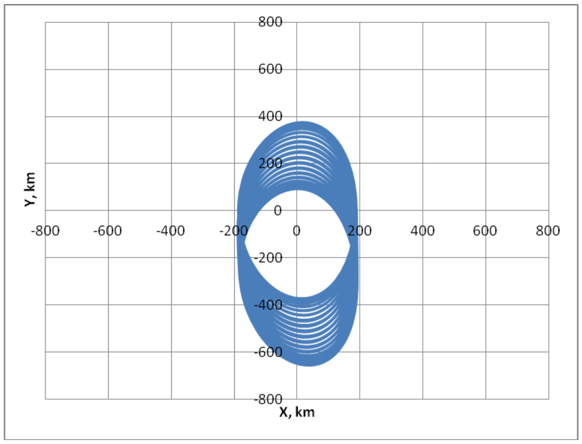

Figure 2: Perturbed trajectory of quasi-satellite in XY plane (Phobos equatorial plane).

Fig. 3 presents the perturbed quasi-satellite trajectory in the body-centred body-fixed IAU_Phobos coordinate system

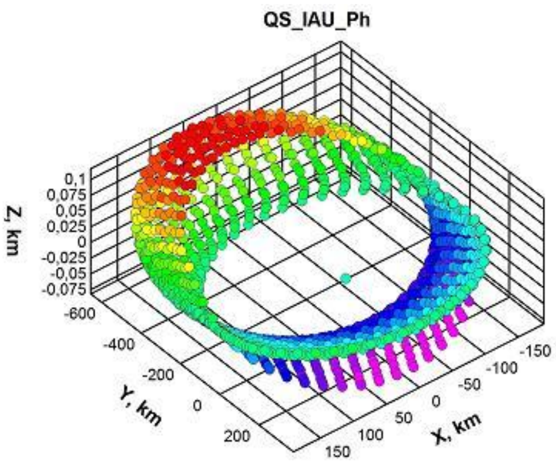

Figure 3: Perturbed trajectory of the quasi-satellite in 3D. The green point in the center is Phobos.

In case that inclination is increased by 2°, the XY projection does not change, but the 3D image looks differently and is presented (fig. 4).

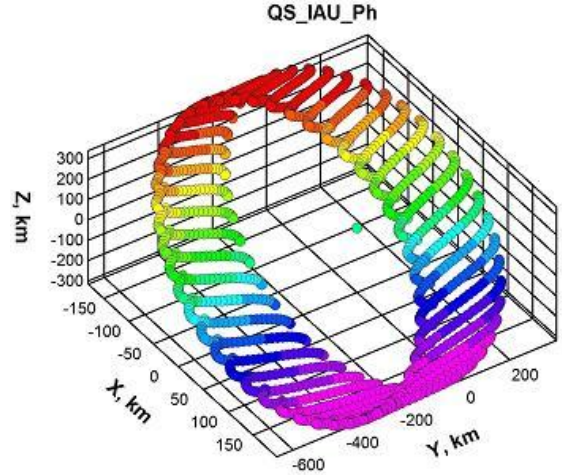

Figure 4: Perturbed trajectory of quasi-satellite in 3D with inclination slightly larger than Phobos.

4. Summary and Conclusions

In this paper were studied satellite motion near Phobos in quasi-orbits, and dependence of the orbit characteristics from eccentricity and inclination. At the conference, we will present illumination and observing conditions.

Acknowledgements

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References

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