THE DYNAMICAL ENVIRONMENT FOR THE EXPLORATION OF PHOBOS

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Introduction. The Martian moon Phobos is of great interest for both planetary science and space exploration motivations, and has been the frequent target of space missions and remote observations. However, orbital dynamics in its vicinity are strongly perturbed relative to Keplerian motion, with its extreme environment extending to its surface as well. Thus, to plan and implement missions in the vicinity of and on Phobos will require these considerations be taken into account. We use the latest published models of the Phobos shape and dynamics to characterize its dynamical environment, both in close proximity orbit about the body and for motion across its surface. The results of this study have direct application to any orbital, landing or surface motion mission to this body.

Phobos Model. We use a recently published model of Phobos and its associated orbit and rotation state estimates to perform this study [1]. The salient features of this new model include an increased and more uniform surface resolution at an order of 100 m and a 45 degree and order expansion of the surface, enabling the computation of the surface curvature at any point. We also explore the accuracy of the Hill model for representing the Mars tidal effect on Phobos.

Orbital Environment. The Phobos orbital envionment will be characterized using previously developed methodologies focusing on periodic orbits and their stability [2]. Periodic orbit families about its two libration points are computed and found to be highly unstable with a significant influence on close proximity dynamics (Fig. 1). However, retrograde periodic orbits are stable down to the Phobos surface (Fig. 2).

Surface Environment. A comprehensive analysis of motion on the surface of Phobos is performed, including the computation of the newly defined concept of the "lift-off speed" that places limits on motion to remain on the surface (Fig. 3) [3]. Deployment trajectories to the surface utilizing the dynamical structure about Phobos are also explored [4].

References.

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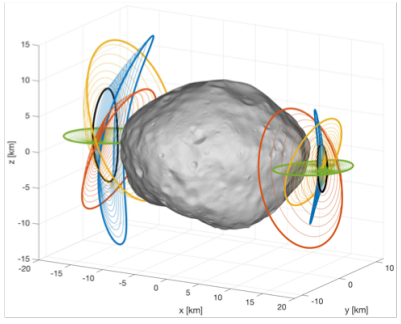

Figure 1: Unstable periodic orbits about Phobos

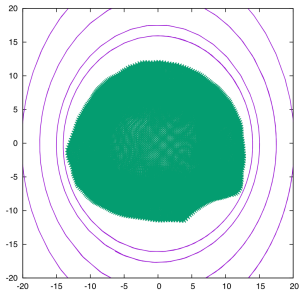

Figure 2: Stable retrograde orbits about Phobos.

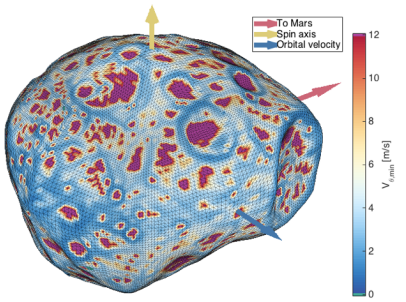

Figure 3: Minimum speeds for achieving orbital liftoff on the surface of Phobos.