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Radar Sounder Observations of Phobos

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Introduction

Since 2004, Mars Express has been orbiting around Mars. Due to its elliptical orbit, the Mars Express spacecraft provides MARSIS a unique opportunity to observe Phobos from a relatively close distance of a few hundred kilometres. The Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) is a 1.3-5.5 MHz subsurface sounder that has been probing Mars to a depth ~3.7 km from orbit. Although originally MARSIS was not designed to probe Phobos, we have been able to use this radar sounder to investigate it at decametre wavelengths for the first time.

Radar Observation of Phobos

The first MARSIS opportunity to observe Phobos was on November 4th, 2005. MARSIS came within 215 km of the Phobos surface. During this flyby, MARSIS collected data over a period of ~5 minutes from a distance of 460 km to 215 km and then out to 430 km. A total of 45 frames were collected with raw echoes stored in instrument on-board memory. During this flyby a total of ~16000 raw echoes were collected. In spite of the relatively small size of Phobos and large wavelength of the radar, we observed signal to noise ratio (SNR) of ~25 dB. This sensitivity was adequate to resolve features that could not be explained using the high-resolution shape models that are available today [1]. Subsequent Phobos flybys brought MARSIS to within 100 km of the Phobos. Since Phobos observation was not part of the instrument design requirements, it was necessary to stop radar operations below a range of 180 km.

Relevance to Future Asteroid Missions

Recently, Near-Earth asteroids or comets have been considered as important exploration targets since they provide clues to the evolution of the Solar System. The techniques exercised by MARSIS during the measurement of Phobos are very relevant to the type of data that one would expect to get from a radar orbiting around an asteroid. However, unlike the current Phobos flybys where the range is more than 100 km, an asteroid or comet mission would enjoy a much higher sensitivity, as distance could be reduced to 5-10 km. A factor of 10 in range can increase the SNR by approximately 30 dB or higher.

References

[1] Gaskell, R. (2007) private communication.

[2] Safaeinili, A. et al. (2007) *First International Conference on the Exploration of Phobos and Deimos,* LPI Contribution No. 1377, p.34

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