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The mass of Phobos

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Abstract

The Mars-Express spacecraft with its Radio-Science Experiment MaRS has performed two flybys at the Martian moon Phobos. The first one at a distance of 460 km on 23rd March 2006 and the second one at a distance of 275 km on 17th July 2008. Both flybys were analysed in order to estimate the mass of Phobos.

The orbit of the spacecraft was determined based on a very precise force model including all significant gravitational and non-gravitational forces. The resulting Doppler effect was determined in a relativistic treatment.

The tracking data received at the ground station were calibrated for the Earth ionosphere and troposphere and subsequently filtered in order to reduce the signal to noise ratio of the measured data. Applying a least square solution technique by comparing the predicted and calibrated tracking data the mass of Phobos could be estimated .

Both close flybys yield new accurate values for the mass of Phobos. The resulting density gives meaningful new constraints on the corresponding range of the body's porosity, providing a basis for interpretation of the internal structure of Phobos. Different scenarios for the origin of Phobos are discussed in terms of the precise mass estimate of Phobos.