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Phobos Geodesy and Cartography

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We are involved in an in-depth study of the irregularly-shaped moon Phobos. Our studies include the tracking of Phobos' orbital motion, as well as the modelling of its shape and physical parameters based on recently obtained high resolution images of the Super Resolution Channel (SRC) and the High Resolution Stereo Camera (HRSC) onboard the European Mars Express spacecraft.

During the course of our studies we have made Phobos positional measurements using fly-by images of Phobos and observations of Phobos' shadow on the Martian surface.
While results of the latter analysis show large scatter, we find consistent and systematic offsets to the orbit models, indicating that Phobos is ahead of its predicted position by approximately 2km.

For modelling of the irregular shape of Phobos, a new global control point network was established. The 665 object point coordinates with respect to the Phobos body-fixed coordinate frame were determined through observations in 53 SRC and 16 Viking Orbiter images. Coordinates of the object points were computed by means of a least-squares bundle block adjustment. The overall accuracy of coordinates was estimated to be in the order of ±17 m.
A global digital terrain model (DTM), based on stereo images of the HRSC and Viking Orbiter images, was computed and used to ortho-rectify SRC and Viking images. Based on the ortho-rectified images an accurate map of Phobos was produced.

Using the control point coordinates, coefficients of the surface spherical harmonic function were determined. This analytical expression was used to re-estimate the volume, bulk density, and the moments of inertia tensor. A volume of 5685 km³ and a bulk density of 1.85 g/cm³ were determined, in good agreement with previous estimates of these values.
The moments of inertia were computed assuming a homogeneous mass distribution within Phobos. These can be put in relation with the forced libration amplitude. The modeled forced libration amplitude agrees well with the observed value within error limits.