

Observed bulk properties of the Mars moon Phobos

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Abstract

The mass of the Mars moon Phobos has been determined by spacecraft close flybys, by solving for the Martian gravity field and by the analysis of secular orbit perturbations. The absolute value and accuracy is sensitive on the actuality of the Phobos ephemeris, the accuracy of the spacecraft orbit, other perturbing forces acting on the spacecraft and the resolution of the Martian gravity field besides the measurement accuracy of the radio tracking data. The mass value and its error improved from spacecraft mission to mission or from the modern analysis of “old” tracking data but none of these values can claim to be the final truth. The mass value seems to settle within the range of $GM_{Ph} = (7.11 \pm 0.09) \cdot 10^{-4} \text{ km}^3 \text{ s}^{-2}$ (3σ) which covers almost all mass values from close flybys and “distant” encounters. Using the volume value determined from MEX HRSC imaging, the bulk density is $(1873 \pm 31) \text{ kg/m}^3$, a low value which suggests that Phobos is either highly porous, is composed partially of light material or both. In view of theories of the Phobos’ origin, one possibility is that Phobos is not a captured asteroid but accreted from a debris disk in Mars orbit as a second generation solar system object.

