



## The mass of Phobos from the Mars Express close flybys

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### Abstract

The mass of Phobos has been determined in the past from close spacecraft flybys and from secular changes in spacecraft orbital elements. The first mass values from the close Viking and Phobos-2 flybys were, however, inconsistent. Later, indirectly derived mass values from secular orbit changes of Mars Global Surveyor and Mars Odyssey returned mass values with extremely small errors which do not agree within their error bars.

Mars Express, in a highly elliptical orbit, is the first spacecraft since Phobos-2 able to perform close flybys at Phobos. Four datasets, close flybys in 2006 at 470 km, 2008 at 270 km, 2010 at 77 km, and orbital tracking data from 2006 to 2008 have been used by two subgroups of the MEX radio science team MaRS to derive four mass values with two different software packages and philosophies. These values are consistent and considered to be the most precise mass values for Phobos. The 2010 flyby at 77 km returned a value for  $J_2$  constraining the internal structure.