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# The internal structure of Phobos and hints to its origin derived from Mars Express Radio Science observations

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## Abstract

Two different hypotheses for the origin of the Martian moon Phobos are still under discussion:

- asteroid capture by Mars or
- in situ formation.

The mass and the second order coefficient $C_{20}$ of the gravity field of Phobos were used to estimate geophysical parameters like density, porosity and possible water ice content. The capturing scenario cannot finally be denied but interpretation of the parameters tends to an in situ formation of Phobos.

## Introduction

The elliptical polar orbit of Mars Express allows close flybys at the Mars moon Phobos, the first close flybys since the flybys of Viking and Phobos twenty years ago.

In order to carry out a mass determination with the Radio Science Experiment MaRS, Mars Express performed three close flybys at Phobos: in 2006 at 460 km, in 2008 at 275 km and in 2010 at 77 km. The recorded data of the flyby in 2008 yielded an mass solution of $GM_{Ph} = (0.7127 \pm 0.0021) \times 10^{-3}$ $km^3/sec^2$ at an uncertainty of 0.3 %. It was found that Phobos has a porosity of 30 ± 5 %, i.e. it contains large voids [1].

The second order coefficient $C_{20}$ of the gravity field of Phobos was derived from the flyby in 2010, but because of the still large distance of 77 km at a large relative error (the planned closest approach distance was 62 km relative to the center of Phobos).

The $C_{20}$ value for different models of the interior of Phobos with varying water ice content and porosity are compared with the derived value from the close flyby. The results are consistent with large voids inside Phobos and an inhomogeneous density distribution. The water ice content Phobos is limited by the $C_{20}$ value.

The existence of the Stickney crater on Phobos supports the conclusion that Phobos contains large voids throughout its interior [2]. The grooves found on Phobos [3] are also consistent with such an internal structure.

## Summary and Conclusions

Many scenarios of the formation and origin of Phobos have been proposed:

- asteroid capture by Mars [4],
- formation in orbit from a debris disk of a formerly larger body destroyed by gravitational gradient forces near Mars [5] ,
- or by re-accretion of impact debris blasted into Mars orbit [6].

The high porosity, the inhomogeneous density distribution and the limited water ice content have consequences for the various hypotheses on the origin of Phobos [7], [8]. The results from the Mars Express Radio Science experiment are more consistent with the formation by re-accretion in orbit from an existing Martian debris disk than with the assumption that Phobos is a captured asteroid.

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# References


[1] Andert, T. P. et al. (2010), *GRL*, 37.

[2] Richardson, D. C. (2002), in Asteroids III, 501-515

[3] Murray, J. B. et al. (2006), LPSC, 37, 2195.

[4] Burns, J. A. (1992), in Mars, pp. 1283–1301.

[5] Singer, S. F. (2007), LPI Contrib., 1377, p. 36.

[6] Craddock, R. A. (1994), LPI Contrib., 1147, 293–294

[7] Rosenblatt et al. (2010), EPSC2010-65

[8] Rosenblatt et al., this session, EPSC-DPS, 2011