

GETEMME – A Mission to Explore the Martian Satellites and the Limits of Solar System Physics

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Abstract

We propose a mission to Mars and its two satellites Phobos and Deimos, as part of the ESA COSMIC VISION program. A spacecraft shall deploy retroreflectors on each moon. From Martian equatorial orbit, the spacecraft will carry out laser ranging measurements, which will be analyzed for dynamics of the Martian satellite system and fundamental physics.

1. Introduction

GETEMME (Gravity, Einstein's Theory, and Exploration of the Martian Moons' Environment) is an interplanetary mission to Mars and its two satellites Phobos and Deimos consisting of one spacecraft with four embedded landers. The Spacecraft will be launched in July, 2020 and transfer to Mars using an electric propulsion system. After 700 days of flight GETEMME will rendezvous first with Deimos, then with Phobos. During these two rendezvous phases two passive landers will be deployed on each moon. The spacecraft will finally proceed to a circular near-equatorial Mars orbit to carry out science operations for a nominal one Martian year mission.

2. Mission objectives

The S/C shall deploy passive Laser retro-reflectors on Phobos and Deimos (Fig. 1) and carry out a comprehensive mapping of the two satellites. In the second stage of the mission, the spacecraft will be transferred into a near-equatorial circular 1500-km Mars orbit, to carry out routine Laser range measurements to the reflector targets

An onboard accelerometer will ensure highly accurate spacecraft orbit determination. The inversion of all range and accelerometer data will allow us to determine or improve very much on a host of dynamic parameters of the Martian satellite system. From the complex motion and rotation of Phobos and Deimos we will obtain clues on internal structures and the origins of the satellites. Also, novel data on the time-varying gravity field of Mars due to climate variations will be obtained. Measurements by GETEMME will firmly embed Mars and its satellites into the Solar System reference frame. Finally, ranging measurements will be essential to improve on several parameters in fundamental physics, such as the Post-Newtonian parameter β as well as time-rate changes of the gravitational constant and the Lense-Thirring effect.

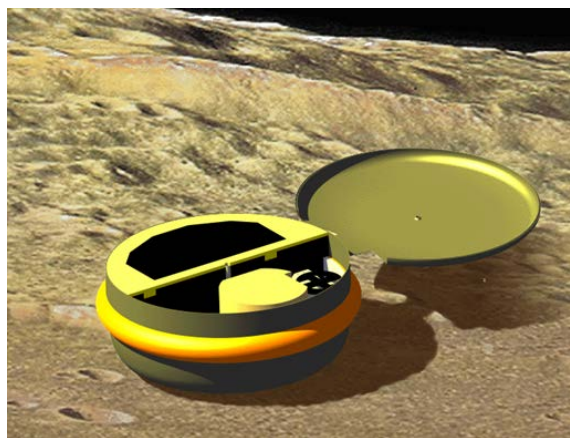


Fig. 1: Example of a small-bodies lander, following the Netlander principal design, including opening / uprightening technique (courtesy: DLR Braunschweig)

3. Payload

A Laser transmitter and a Laser receiver are central payload elements to the science objectives of GETEMME. The landed modules will carry one retro-reflector each which reflects the incoming laser back towards the spacecraft. The orbiter will also carry a multispectral camera, which will be used for a full characterization of the satellites at high resolution, multiple phase angles, and color. In addition, the orbiter will carry an accelerometer, which is intended to measure non-gravitational forces acting upon the spacecraft and help in the orbit determination of the spacecraft (see Table 1).

Table 1: Payload overview

Retroreflectors		4 passive landers with retroreflectors Heritage: CHAMP, GRACE, GOCE; 150 x 150 x 100 mm ³ ; Mass: 20 kg
Laser Ranging		Range measurements to Phobos, Deimos, Earth Heritage: Bepi Colombo Laser Altimeter; 1,000 x 550 x 450 mm ³ ; Mass: 15.5 kg
Accelerometer		Ultrasensitive accelerometers Heritage: CHAMP, GRACE, GOCE; 340 x 340 x 200 mm ³ ; Mass: 3.5 kg
Camera		Imaging Science Heritage: ROKVISS, SRC@MEX, DAWN camera; 700 x 420 x 450 mm ³ ; Mass: 5.6 kg
Spectrometer		Spectro-photometry: 400–2900 nm Heritage: CRISM Imaging Spectrometer; 310 x 430 x 510 mm ³ ; Mass: 14 kg

4. Spacecraft key issues

A Soyus-Fregat will bring the S/C into an Earth orbit. For the transfer to the outer Martian moon an electrical propulsion system will be used. The baseline S/C configuration adopts a cubical spacecraft bus of 1 m x 1 m x 1 m with a total launch mass of 1600 kg. A solar generator of 32 m² is generating about 2600 W of electric power. A high-gain RF antenna is foreseen for X-band communication during operation in Mars orbit.

Spacecraft specifications:

- Dimension: 1 m x 1 m x 1 m
- Total launch mass: 1600 kg
- Dry mass: 1190 kg
- Payload mass: 120 kg
- Solar array: 32 m²
- Propulsion: Solar-electric
- Propellant mass: 410 kg

References

[1] J. Oberst, V. Lainey, C. Le Poncin-Lafitte and the GETEMME proposal team; *GETEMME - A Mission to Explore the Martian Satellites and the Fundamentals of Solar System Physics*; submitted Apr. 2011