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Mars deep internal structure determination using Phobos tide measurement strategy with the SEIS/InSight experiment

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The Insight NASA Discovery mission, led by the Jet Propulsion Laboratory, will deploy in 2018 a very broadband seismometer on the Mars surface, SEIS (Seismic Experiment for Interior Structure). It is a hybrid 3-axes instrument, which encloses 3 very broadband oblique sensors and 3 short period sensors. The sensor assembly and its wind and thermal shield will by deployed on the Mars surface from the Phoenix-like spacecraft by a robotic arm (IDS). The acquisition system will be hosted in the spacecraft warm electronics box, and connected to the deployed sensor assembly by a tether. The SEIS experiment is provided by CNES, the French Space Agency that makes the coordination of a wide consortium including IPGP of Paris, ETH of Zürich, the Jet Propulsion Laboratory of Pasadena, MPS of Göttingen, Imperial College of London, and ISAE from Toulouse.

One of the mission goals is to determine the deep internal structure of Mars in order to improve our models on the formation and evolution of telluric planets. In particular, the SEIS experiment aims at assessing the state (solid or liquid) of the planet core together with its size. This will be possible using the Phobos tide, a solid tide on Mars induced by one of its natural satellite, Phobos. As it orbits the planet, Phobos creates a small displacement of the Martian surface which will be measured to determine the absolute amplitude of one of the tide main harmonics which depends on Mars internal structure through the gravimetric factor $\gamma 2$ (a combination of the gravitational and displacement Love numbers) at a frequency range around 50 μHz. Since Phobos orbital properties are already well-known, comparing these measurements with existing proposed models of Mars allows us to refine the previous estimations of the Mars core state and diameter. Reliable assessment of the core state will be possible if the Phobos tide absolute amplitude is measured with a precision of 2.5 10-11 m/s2 at 50μHz, making noise determination and calibration a critical point of our study. As a consequence, undesirable effects such as displacement due to the solar tide, thermal expansion, atmospheric noise due to the wind, pressure displacements and internal instrumental noise to name a few, have to be accurately modeled and corrected. A particular processing of the atmospheric and thermal contamination has also been studied on experimental data.