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Author: Mr. Julian Rothenbuchner
The Netherlands, julian@teamtumbleweed.eu

Mrs. On Mikulskyt
The Netherlands, one@teamtumbleweed.eu
Dr. Bart Root
TU Delft, The Netherlands, B.C.Root@tudelft.nl

MARTIAN INTERIOR INVESTIGATION USING DISTRIBUTED GEODETIC SENSOR NETWORK IN THE THARSIS REGION OF MARS

Abstract

Mars can provide unique insights into the mechanisms of planetary formation, thereby offering valuable clues to the early history of Earth and other rocky bodies. Currently, the internal structure of Mars is investigated using the instruments of the INSIGHT lander, offering clues to its internal structure and formation. However, many questions remain unanswered, such as the existence and strength of convective mantle plumes. One major limitation of current experiments is that they provide measurements from only one point on the Martian surface. We propose a network of combined radiobeacon and laser retroreflector instruments to be deployed to the Tharsis Region on Mars using a swarm of wind-driven Mars Rovers. The mission itself is discussed further in abstract number 72458. After being deployed on Mars, the instruments will be spread to cover significant portions of the Martian surface such as the Tharsis region. They take advantage of already-existing ranging capabilities on orbital spacecraft used on legacy surface missions and can provide geodetic data over long periods up to several decades. The Tharsis region on Mars is uniquely suited to provide insights into the interior structure of Mars by investigating volcanic and tectonic activity. Gathering geodetic data and measuring potential ground deformation will offer vital clues on the mechanisms supporting the region. Moreover, it is possible to measure tidal deformations, providing more exact constraints on the Love number j_2 which can in turn give further insight into the size of the planetary core and mantle properties. Moreover, the proposed network augments gravimetry of Mars through tracking orbiters. The radio beacon network also allows for the precise determination of Martian rotation, precession and nutation to gain insights into polar ice cap evolution and Martian interior structure. We have also identified numerous secondary applications for this network, namely long-term atmospheric studies using optical sensing. Using proven instruments and methods, it is possible to make measurements of the optical density and absorption characteristics of the atmosphere using the retroreflector. The same instrument can also be used in fundamental science, validating aspects of general relativity. Lastly, the technical feasibility of the instrument is evaluated: while there is a laser retroreflector with flight heritage fitting the requirements, creating a radio beacon and transmitter that is sufficiently light will require further development. Here, the adaptation of CubeSat hardware is a promising avenue. A complementary orbiter architecture is investigated in the abstract number 71894 submitted by F. Abel.