INTERIOR OF MARS FROM GEODESY. T. Van Hoolst[1], V. Dehant[1], W. Folkner[2], S. Asmar[2], A. Rivoldini[1], and B. Banerdt[2], [1]Royal Observatory of Belgium (3 avenue Circulaire, B1180 Brussels, Belgium, t.vanhoolst@oma.be and v.dehant@oma.be), [2]Jet Propulsion Laboratory (william.m.folkner@jpl.nasa.gov, sami.w.asmar@jpl.nasa.gov, and william.b.banerdt@jpl.nasa.gov).

Introduction: Within the INSIGHT mission, the radioscience experiment RISE (Rotation and Interior Structure Experiment) aims at obtaining the rotation and interior structure of Mars. It does not use an instrument stricto sensus but uses the spacecraft X-band communication system.

RISE will determine Mars' length-of-day variations, precession (long-term changes in the orientation), and nutations (periodic changes in the orientation). From the rotation and orientation observations the angular momentum of the atmosphere and the moments of inertia of the whole planet and of the core will be estimated and used to constrain the interior structure of Mars.

Ojectives: The Doppler effect on a radio signal between the Earth and a lander on Mars is related to the variations of the rotation and orientation of the planet Mars. When measured for a time longer than the seasonal timescale, Doppler observations can provide values for the moment of inertia of the whole planet and of the core. The moments of inertia constrain the core size and density, mantle mineralogy, crust density and thickness, and temperature. The size of the core has major consequences for internal dynamics and planetary evolution. For example, with a large core, a perovskite-bearing lower mantle is unlikely due to insufficient pressure at the base of the mantle. The endothermic phase transition spinel-perovskite has a strong effect on mantle convection. The size and composition of the core are also important in the history of the magnetic dynamo, which in turn has important consequences for the retention of the atmosphere and the possible habitability of the surface early in Mars' history.

Current Constraints: The only "direct" observations of the interior are those of the gravity field and polar moment of inertia from spacecraft radio tracking [1,2,3]. Those observations are the main constraints for interior models. Geochemical studies argue for relative enrichment of *Fe* in the Martian mantle with respect to the Earth's, and relative enrichment of *S* in its iron core, with the amounts of enrichment depending on the initial composition and differentiation history of the planet. The measured tidal effect on the orbits of MGS and ODY suggests that the core is at least partially liquid [2,4] and, together with the moment of inertia constraint, that the radius of the core is 1794 ± 195 km (at 3 σ) [5].

Principles of the measurements: Precision tracking of the Martian surface is performed through radio links between ground stations on the Earth and the lander on the surface of Mars. The experiment uses the X-band communications transponder to obtain two-way Doppler and ranging measurements from the radio link. These Doppler measurements over a long period of time can be used to obtain Mars' rotation behavior (precession, nutations, and length-of-day variations). More specifically, measuring the relative position of the lander on the surface of Mars with respect to the terrestrial ground stations allows reconstructing Mars' time varying orientation and rotation in space.

Precession and nutations: The RISE investigation infers interior structure from its effect on variations in the orientation of Mars with respect to inertial space. The precession and nutation of Mars result from the interaction of the interior mass distribution with the gravity of the Sun. RISE provides improved estimates of these motions by analyzing the radio link with the spacecraft. Precession measurements improve the determination of the moment of inertia of the whole planet and thus the radius of the core. A precise measurement of variations in the orientation of Mars' spin axis also enables an independent (and more precise) determination of the size of the core via the core resonance in the nutation amplitudes. The amplification of this resonance depends on the size, moment of inertia, and flattening of the core. For a large core, the amplification can be very large, ensuring the detection of the free core nutation and determination of the core moment of inertia [6-8].

A large inner core can also have an effect on the nutations that could be measured by radio tracking. Due to the existence of another resonance (the free inner core nutation), there would be amplification in the prograde band of the nutation frequencies. The main effect on nutation would be the cancellation of the largest prograde semi-annual liquid core nutation [9-12]. Failure to detect the amplification of the semi-annual nutation with radioscience in its more precise configuration, together with the confirmation of a liquid outer core from the retrograde nutation band and from the k_2 tidal Love number, could then be interpreted as strong evidence for a large solid inner core.

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