GEOPHYSICAL CONSTRAINTS ON THE COMPOSITION AND STRUCTURE OF THE MARTIAN INTERIOR

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Important geophysical constraints on the bulk composition and interior structure of Mars are provided by the knowledge of its mean density ρ and polar moment-of-inertia (MoI) factor C/MR_p^2. Whereas the former can be calculated from the planet's mass M and radius R_p and has been known relatively well for a long time, the polar moment of inertia C has been derived only recently from a combined analysis of Mars Global Surveyor tracking and Mars Pathfinder and Viking Lander range and Doppler data [1]. A re-analyis of the data resulted in the most recent value of C/MR_p^2 = 0.3650 ±0.0012 [1], a significantly lower value than the most often used value of C/MR_p^2 = 0.3662 ±0.0017 [2]. The improved value is consistent with the model of a hydrostatic planet with non-hydrostatic contributions to the MoI factor entirely related to the axisymmetric distribution of topographic loads about Tharsis [3].

Most recent Martian interior structure models are based on the planet's polar moment-of-inertia C although the mean moment of inertia I is required for constructing spherically symmetric models of planetary interiors. Using the improved value of $C/M_pR_p^2$ recently obtained from a combined re-analysis of the entire set of radio science data collected during the last three decades and accounting for the rotationally and topographically induced shape of the planet's gravitational field [e.g., 4], we find a mean moment-of-inertia factor of $I/M_pR_p^2$ = 0.3635 ± 0.0012. The new lower value suggests a core radius several tens of kilometers larger if other parameters like core density, crust density, and crust thickness are fixed. It further implies that the Martian crust is several tens of kilometers thicker than previously thought if crust and mantle densities and core size are given. Moreover, the Martian mantle may be less dense, about several tens of kg m^{-3}, with a smaller iron content than previously thought if crust thickness and core size are specified. The mantle density of Mars is relatively well determined by the planet's MoI factor if crust thickness and density are specified [5].

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