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Experimental constraints on the size of Martian liquid core

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Internal structure of Mars has been reported based on high-pressure mineralogical study at the mantle condition (e.g., Kamaya et al., 1993 ; Bertka and Fei 1998). Information of density of iron alloy at the Martian core condition strongly constraints the core size. In previous studies, the size of the Martian core has been estimated from density of solid iron-alloys. However, precise determinations of the moment of inertia and solar tidal deformation by Mars Global Surveyor mission indicated that the present-day Martian metallic core is not completely solid. Hence, density of liquid Fe-alloy is indispensable to estimate the Martian internal structure. Here we report the results of experimental study on the density of liquid Fe-Ni-S alloy at high pressures and estimate the internal structure of Mars.

The density of solid / liquid Fe-Ni-S was measured by X-ray absorption method combined with X-ray micro-tomography technique at high pressure and temperature. The density measurements were carried out up to 6.7 GPa and 1357 K using the tomography press at BL20B2 beamline, SPring-8.

Density of liquid Fe-Ni-S increases from 5.3 to 6.5 g/cm^3 with pressure (0.3 to 5.9 GPa). Isothermal bulk modulus (K_T) is estimated to be 25 GPa by fitting the density data to Vinet equation of state, assuming that its pressure derivative (K') is 4.

Based on the obtained density of liquid Fe-Ni-S and mantle mineralogy data (Bertka and Fei, 1998), we made the models of the internal structure of Mars that satisfy its mass and the observed moment of inertia. Radius of the Martian liquid core is ranged from 1600 to 1700 km with the crust size of 25-100 km. This suggests that there is no Mg-perovskite layer at the base of Martian mantle if Mars has a liquid core of Fe-Ni-S.

Keywords: Mars, liquid coreMars, Fe-Ni-S density, tomography, perovskite