Science targets by investigation of the internal structure of Mars

Kei Kurita[1]; Hideaki Miyamoto Discussion Group for the Lander of MELOS Mars Exploration Mission[2]

[1] ERI,Univ. of Tokyo; [2] -

Geophysical and geodetic observations by seismometers, magnetotelluric instruments and radio science techniquea are proposed for the Japanese next Mars mission, MELOS. Although the main and direct target is to understand the internal structure of Mars these observations are deeply linked with other subjects. The aim of this presentation is to clarify this linked structure and to show the important role of the geophysical and geodetic observations in Mars science.

Constraints for the evolution of the core: Mars is known to have a strong magnetic field at early stage, which ceased within several hundreds millions. Generation and cessation of the magnetic field, hence dynamo activity in the core is one of the grand problems in martian science. Size and present state of the core constrain the thermal evolution. To determine core size is also to constrain the role of the mantle as the heat source and heat-extraction ability, which dominate thermal state of the core. To drive thermal convection in the core the mantle should work as an efficient heat extractor while the size of Mars suggests it may work as a heater because of abundance of heat-generating elements and the size of mantle. Seismic structure and conductivity structure in the mantle can constrain the role of mantle.

Constraints for the evolution of the mantle: The size of martian mantle is about a half of the Earth's mantle, which means the lower mantle is missing. This is a very contrasting feature as for the mantle dynamics. The recent estimates for the mantle structure based on the average density and the moment inertia ratio still can not resolve the existence of post-spinel transition at the base of the mantle, which is suspected to control mantle dynamics. To determine the size of core also gives an answer to this problem.

Constraints for the interaction between atmosphere and solid Mars: The martian rotation system is also known to be unstable. This fragile system makes Mars quite unique object: variability of the spin axis causes strong perturbation of solar flux on the martian climate system and development of polar caps is expected to stabilize/destabilize the spin system. To characterize this and to quantify the coupling between atmosphere and solid Mars radio science techniques are applicable by developing several radio sources on the martian surface.

Excitation problem: In both seismological and geomagnetic researches there exists one problem to be clarified, an excitation source problem. As for the seismology, under the constraints of limited number of seismometers and limited time span for the observation detection of free oscillation is a practical way to conduct. But until now we do not have any solid evidence for the marsquake activity. The lack of the present-day plate tectonics suggests quite low activity(frequency and magnitude) compared with the Earth. Instead strong atmospheric disturbances could be a source for the excitation of free oscillations. Among such disturbances mountain Lee waves and slope wind are considered to be an effective source because they have a power near the surface. As for the geomagnetic research passive MT measurement is one of practical way to determine conductivity structure. Since this relies on the inductive current observation depends on the external perturbations of the magnetic field. The absence of the intrinsic magnetic field, which is different from the Earth, suggests low activity in the excitation. Both in seismology and geomagnetism collaborations with the atmospheric science and space plasma science are deadly needed. This will bring about new scientific subjects, which should be by-products during the course of this mission.