

Investigation of lunar interior volatile from the state of the core and the lower mantle: SELENE-2 VLBI-LLR proposals

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Existence of volatiles in lunar deeper interior should change lunar evolution scenario of hot origin: from the giant impact through the magma ocean. Liquid metallic core would be caused by significant amount of sulfur to lower core melting temperature, whereas low-viscosity lower mantle would suggest the presence of water.

The effect of lunar tidal deformation can be detected by gravity change, through degree 2 potential Love number, k_2 , which could constrain the state of the core and viscosity of the lower mantle of the Moon. We propose VLBI radio (VRAD) sources both on the lander and the orbiter of SELENE-2. Using same-beam (or two-beam) multi-frequency VLBI, we can measure low-order gravity changes, and estimate k_2 with uncertainty below 1% through precise orbit determination of the orbiter of relatively higher altitude (> a few 100km). When the core radius is 350 km, k_2 value changes by about 5% between liquid and solid cores. And if the core size is constrained by SELENE-2 seismometer, contributions of lower mantle and core on k_2 would be separated.

Dissipations of lunar librations also depend on core and lower mantle states. We also propose a Lunar Laser Ranging (LLR) reflector on SELENE-2 lander. With pre-existing reflectors, latitudinal component of lunar libration and its dissipation will be measured. Among LLR parameters, k_2 and core oblateness are coupled. Once k_2 is determined, we can determine core oblateness, which would also constrain core and lower mantle states.

Keywords: origin and evolution of the moon, lunar lower mantle, lunar core, tidal love number, lunar rotation, lunar volatiles