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Lunar Surface Heat Flow Measurement in SELENE-2 Mission

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We are planning to operate a Heat Flow Probe system in the SELENE-2 mission. It measures temperature and thermal conductivities at several depths in the lunar subsurface layer to determine the heat flow with around 10% accuracy. The potential drilling/sensing instrument is the HP^3 (Heat flow and Physical Properties Package) developed by DLR, Germany. The HP^3 is an instrument originally designed for the Exo-Mars mission by ESA. We are planning to achieve long-term observations including lunar nighttime by loading the HP^3 into the Japanese survival system to be deployed on the Moon.

The heat flow measurement in planetary surface layer is a method to directly estimate an amount of the interior heat generation. In case of the Moon, the only internal heat source would be radioisotopes, whose bulk quantity and distribution are essential for determining lunar origin and its thermal history. In fact, pioneering in-situ measurements were conducted in the Apollo 15 and 17 missions. However, past studies have obtained the heat flow values only with large uncertainties due to the heterogeneous subsurface structure around the landing sites, regolith disruptions during the drilling process for inserting the probes, and possibly a secular drift of insolation durations. A high accuracy and reliable measurement of the heat flow is mandatory for precise discussions of the lunar geological issues.

The lunar subsurface layer has also recorded solar irradiance variation in past a few hundred years as temperature profile. History of solar irradiance is essential for constructing and validating climate models and future climate projections. For example, small temperature disturbances within several meters depth reveal the total solar flux during the low solar activity period in AD 1600-1700 when observational data are not available.

Keywords: heat flow, lunar exploration, SELENE-2