

Temperature dependence of permittivity can help determine the amount of water ice in lunar and Martian regolith

*Makito Kobayashi¹, Hideaki Miyamoto¹, Tomohiro Takemura¹, Bernadett Pál²

1. University of Tokyo, 2. Konkoly Observatory, Research Centre for Astronomy and Earth Science, ELKH

The putative presence of water ice on the Moon now becomes an important exploration target from both the scientific and engineering perspective. Direct observation by drilling into the subsurface and measuring the nature of the volatiles, as proposed by the LUPEX mission, is the most accurate approach to determining the presence of ice. However, because such observations can only provide information at the drill sites, an additional approach would be required to extend the results to larger regions. We propose a new strategy to determine the subsurface water ice content on the subsurface based on our new findings of the temperature dependence of the permittivity. Importantly, the permittivity of the rock differently depends on the temperature compared to that of the water ice. We find that this difference can be useful in determining the amount of water ice in the regolith with a high accuracy of a few wt%. Direct measurements of the permittivity on the lunar surface may be possible by using the Ground Penetrating Radar observations onboard LUPEX, while a probe-like instrument based on the TDR method, would be also be useful. In particular, with some ingenuity, GPR can measure the subsurface permittivity within milli-seconds, allowing measurements of large regions during a mission and providing a distribution and abundance map of water ice. This strategy requires multiple measurements at different temperatures, so that repeated measurements of the permittivity in the same region will help elucidate the distribution and amount of water in the lunar and Martian subsurface.

Keywords: Moon, Permittivity, Water ice, Ground Penetrating Radar (GPR), Mars