

On the attenuation of reflected echoes of Lunar Radar Sounder onboard Kaguya

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The successful Japanese Moon probe, KAGUYA, was equipped with a variety of state-of-the-art scientific instruments including the Lunar Radar Sounder (LRS; Ono et al., 2010). LRS is a frequency modulated continuous wave (FMCW) radar with carrier frequencies from 4 to 6 MHz, and succeeded in observing distribution of reflectors beneath almost all the Moon's surface (Ono et al., 2009). Pommerol et al. (2010) further pointed out that the presence of the reflectors in lunar maria is negatively correlated with abundance of TiO₂ because of its high electrical conductivity.

Loss tangent is defined as a ratio of the conduction to displacement current within an electric medium and hence an indicator of high electrical conductivity. If loss tangent is small enough, the permittivity and the electrical conductivity of the Moon's surface can be determined at the same time by comparing the reflected echo of LRS with its source pulse. Namely, by estimating the complex ratio of the received signal to the transmitted pulse, the dielectric constant can be known from the phase difference while the electrical conductivity can be derived by the observed amplitude attenuation and the permittivity obtained from the phase difference.

However, determination of the complex ratios is not straightforward because the reflected echoes are the product of a pulse compression technique and thus needs deconvolution to restore the true amplitude and phase of the echoes. Preliminary analysis of the LRS waveform data collected at the end of the fast down-link (21.3 Gbps) mode [Jun. - Sep. 2008] showed that quality of the data is sufficient enough to perform necessary deconvolution. This implies that LRS can also be used as a ground penetrating radar.

In this presentation, the principle and the method for estimating the permittivity and electrical conductivity are first described in addition to the data used. Interpretation of the derived complex ratios and its spatial distribution on the Moon's surface is finally discussed and summarized.

REFERENCES

Ono, T. et al., Lunar Radar Sounder Observations of Subsurface Layers Under the Nearside Maria of the Moon, *Science*, 323, 909-912 doi:10.1126/science.1165988, 2009.

Ono, T. et al., The Lunar Radar Sounder (LRS) onboard the KAGUYA (SELENE) spacecraft, *Space Sci. Rev.*, 154, 145-192, doi:10.1007/s11214-010-9673-8, 2010.

Pommerol, A. et al., Detectability of subsurface interfaces in lunar maria by the LRS/SELENE sounding radar: Influence of mineralogical composition, *Geophys. Res. Lett.*, 37, L03201, doi:10.1029/2009GL041681, 2010.

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