Importance of Solar X-ray Calibrator with Standard Sample for Lunar X-ray Spectrometry

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Quantitative major elemental composition (especially Mg, Al, and Si) of lunar and planetary surface is the most crucial data for surface rock type identification and the key information of investigating evolution process of those bodies. Remote sensing method is useful for mapping the surface globally. X-ray fluorescence spectrometry is most powerful, especially for the three elements when the solar activity is sufficiently high. Gamma-ray spectrometry is considered difficult to determine those three elements quantitatively enough as proven in the past missions, due to low effectiveness of gamma-ray excitation as well as severe contamination from cosmic-ray excited gamma-rays at spacecraft body .

X-ray spectrometry in the Kaguya, Chang'E-1, and Chandrayaan-1 lunar orbiter missions could have completed the global maps of Mg/Si and Al/Si composition ratio of the Moon, but all of them failed due to instrumental troubles and historically deemed solar activity in a century. This is the lost information among the key points to investigate the origin and evolution of the Moon.

In Chandrayaan-1, C1XS (=Chandrayaan-1 X-ray Spectrometer) observed X-ray spectra at some limited areas, but elemental composition differs from individual method of analysis. One of the problems is insufficient concurrent monitoring of solar X-rays. Direct solar X-ray monitor data exists but the fundamental defect is the accuracy of total efficiency of X-ray detection device: thickness of X-ray window, efficiency of detector, and dependency of onboard analysis. Solar X-ray numerical model is another point of problem. Use of fundamental parameter method for elemental analysis also causes expansion of uncertainty.

One solution is compared elemental analysis by the solar X-ray calibrator with a standard sample method used in Hayabusa and Kaguya. Hayabusa is a Japanese asteroid explorer for demonstrating technology of sample return from near-earth asteroid. Compared analysis is the most useful and established technique in the laboratory. This method applied in space use is also considered the best way to compensate those problems mentioned above, although the individual detectors must be used for X-ray observation and concurrent solar X-ray calibrator. In this paper, method and the result of solar X-ray calibrator is described and the merit is discussed.