

## The lunar impact flash observations among two nations and application of the results to future lunar seismic experiments

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The lunar impact flashes have been observed by ground telescopes (e.g., Suggs et al., 2008). Through lunar impact flash monitoring program in NASA since 2006, about 400 impact flashes could be detected during about 10 years. The magnitudes of many impact flashes can give information about frequent distribution of meteoroid impacts for the energies and/or masses in the Earth-Moon system assuming some luminous efficiencies (e.g., Ortiz et al., (2006), Suggs et al., (2014)). The impact location determined by the flash should be also useful for future lunar seismic experiments. In the NASA Apollo mission during 1969-1977, the seismic observations by a network consist of 4 seismic stations have continued. Through the seismic observation, about 1700 impact seismic events were detected and their travel time data were applied to determine the lunar crustal structure. However, we may be able to deploy only one or two seismic stations in future lunar seismic missions such as APPROACH, and it will be difficult to locate the seismic source using only travel time data. In that case, the impact flashes observed by the ground stations will be available to locate the impact seismic events, and we can obtain information about lunar interior structure even if we have only one seismic station data.

On the other hand, previous lunar impact flash observations have been performed separately at each ground station, and each observation of the Moon is limited in both time and space. In addition, ground observation can be prevented due to cloud weather. Therefore, we have planned lunar impact flash observations among two nations; Japan and France during same term. The observations at two separate stations in longitudinal direction can enlarge time and area of the flash monitoring. In this plan, we prepared some ground station in each country to ensure detection of the impact flashes and acquire redundancy against weather. We have a plan to improve the detection efficiency of the lunar impact flash and knowledge about the frequent distribution of meteoroid impacts by comparison and integration of the observational results in the two countries. Then, we will evaluate the expected number of impact seismic events detected in future seismic experiments using the new ground observational results, and study how accurate we can determine the lunar interior structure by the new travel time data.

Currently, in Japanese side, 4 ground stations have been constructed at the University of Electro-Communications, Nihon University, ISAS and NAOJ-Mizusawa-observatory. We observe the Moon during lunar phases between crescent and half moons at every month using various telescopes at visible, near-infrared and thermal infrared wavelengths. We could detect lunar impact flashes simultaneously at 3 ground stations during Geminids in December 2017. In this presentation, we will report current observational and analysis results from our observations and discuss application of the results to future lunar seismic experiments.

Keywords: Lunar impact flash, Ground observation, Impact seismic events, Lunar seismic experiment

