LUNAR PHASE CURVE AT VIS/NIR WAVELENGTH OBSERVED BY SELENE SPECTRAL PROFILER. Y. Yokota[1], T. Matsunaga[2], M. Ohtake[1], J. Haruyama[1], Y. Ogawa[2], R. Nakamura[3], C. Honda[1], T. Morota[1], K. Saiki[4], S. Kawabe[4], K. Nagasawa[4], K. Kitazato[5],and LISM Working Group, [1]ISAS/JSPEC/JAXA 3-1-1 Yoshinodai, Sagamihara, Kanagawa, Japan, (e-mail: yokota@planeta.sci.isas.jaxa.jp), [2]National Institute for Environmental Studies, Japan, [3]AIST, Japan, [4]Osaka Univ., [5]Kobe Univ.

Introduction: SELENE Spectral Profiler (SP) obtains Lunar Visible to NIR spectral data at spatial resolution of 500 m [1]. Since brightness of lunar surface depends on the viewing geometry, we have to correct these data to the values under certain standard observation geometry prior to the detailed analysis by an adequate phase curve.

Although many researchers had proposed photometric models and parameters of the moon (e.g., [2-6]), extensive study is still important in following aspects:

(1) Large incidence angle. High latitude regions are usually observed at large incidence angle. Accurate photometric parameters suites for such incidence angle range are required for precise analysis of those regions.

(2) Wavelength dependence. Clementine UVVIS data significantly contributed to the photometric studies [e.g. 2-5] at 5 bands ranging from 415nm to 1000nm. However, SP and other recent remote-sensing observations require much longer wavelength coverage.

(3) Geology dependence. Lunar phase curve also has a dependence on geological types such as the Highland and Mare [3, 5].

We report preliminary results of Disk-resolved lunar phase curve at highland in Vis/NIR wavelength range by SP data.

Data: SELENE main-orbiter has been settled into circular polar orbit with ~100 km altitude around the moon. SP accompanies three detectors (VIS: 513-1010 nm, NIR1: 884-1676 nm and NIR2: 1702-2588 nm) with spectral resolutions of 6-8 nm [7]. Because of the progress status of the calibration, VIS and NIR1 data are used in our current study.

Viewing Geometry and Region of the Observation. Line-of-sight of SP has been kept nadir pointing during one year nominal observation period, except some occasions of special operations. Thus, the emission angle e is nearly zero in usual SP observation, and the solar phase angle α is almost equal to the incidence angle i. Solar phase angle changes with latitude, and it becomes minimum value at the equator. Once in a half year, phase angle at the equator comes close to zero. The nearly zero phase angle observation (opposition surge observation) was performed on April 2, 2008, at longitude ~225E. This area corresponds to Lunar farside highland. Observation of 4 orbits (Revolution #2147-2150) in this occasion was used in this study. In order to increase data points in the range of moderate phase angle, each data file of the orbits was merged with a data file of an orbit observing neighbor area at one month later (Revolution #2481-2482). To avoid dark units in the SPA region, a southernmost limit to use the data in this study was set as latitude -25°N.

Method: Dark offset is subtracted from raw DN, and Preflight radiometric calibration coefficients are currently applied to obtain the radiance [W/m^2 um] [1, 7]. The radiance is converted to Radiance factor (RADF) by using solar irradiance ("newkur.dat" file of MODTRAN 4.0) and following equation:

$$\mathrm{RADF} = \pi * \mathrm{Radiance/Solar\_irradiance}.$$

Data selection. Brightness histogram in a narrow phase angle range does not always have a Gaussian distribution (Fig. 1). This trend is significant at large phase angle range, because of the variation of surface slope direction. For the purpose of selecting the lunar surface units which have moderate albedo and horizontal plane, we employed median data of 752.8 nm band DN in 1 degree width of phase angle.

Results: Phase curve of 753 nm band is shown in Fig.2. The plot was prepared by the same manner as Fig. 2 and 13 of [3]. RADF have been multiplied by the factor (cos i + cos e)/cos i to correct for variations in emission and incidence angle. The SP data and the Clementine model curve agree well in medium phase angle range (6°<α<65°). However, there are discrepancies in small phase angle range (α<6°) and in large phase angle range (α>65°).

Normalized phase curve (α<50°) is shown in Fig. 3 to compare with Clementine data of [5]. There is discrepancy in the small α range again. Fig 2 and 3 suggest that the smaller opposition surge than SP plot is reasonable for typical highland. Regional albedo variation around the equator of ~225E should be checked carefully at our next step.

Fig. 4 shows the relation between phase angle and color ratio. Selected 4 bands data were divided by 753 nm band data, and normalized at α=30°. There are two remarkable features: (1) the relation between α and color ratio clearly changes at α=65°, and (2) Phase reddening effect appears in the wavelength range 513-1550 nm, but in the wavelength range 1550-1676nm, the trend is different.

Further studies to explain those features by physically based model are required, and probability of regional material variation effect should be checked.

References: [1] Matsunaga T. et al. (2008) *GRL*, 35, L23201, doi:10.1029/2008GL035868. [2] McEwen A. S. et al. (1998) *LPS XXIX*, Abstract #1466. [3] Hillier J. K. et al. (1999) *Icarus*, 141, 205-225. [4] Kreslavsky M. A. et al. (2000) *JGR*., 105 E8, 20,281-20,295. [5] Yokota Y. et al. (2003) *LPS XXXIV*, Abstryct #1885. [6] Buratti et al. (2008) *LPS XXXIX*, Abstruct #1471. [7] Ogawa Y. et al. (2008) *LPS XXXIX,* Abstruct #2498.

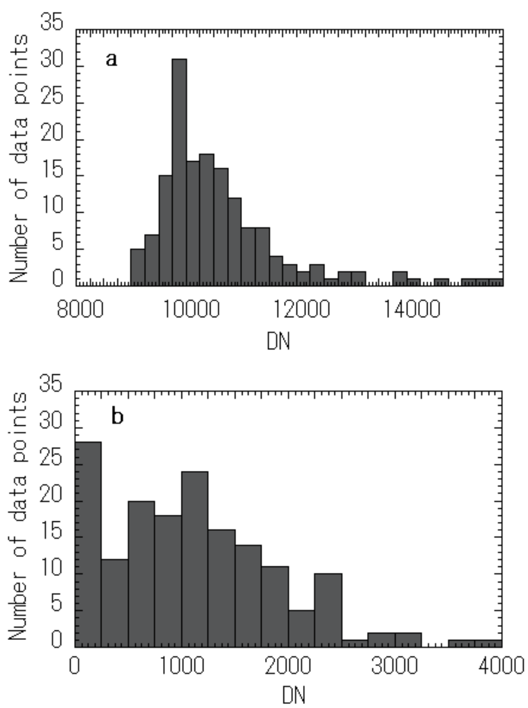

Fig. 1. Histograms of DN at 753 nm band. (a) Phase angle range from 20 to 21°. (b) Phase angle range from 85 to 86°.

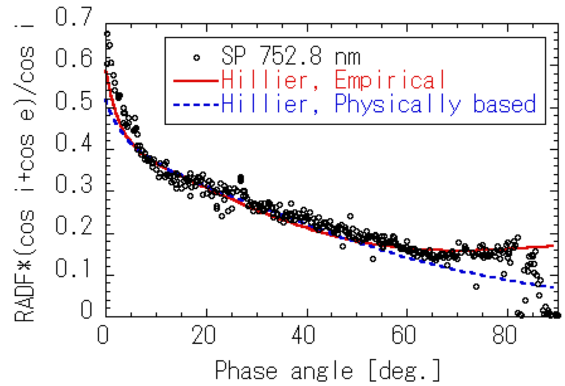

Fig. 2. Phase curves at ~750 nm band. Open circle: SP data. Solid line: Empirical fit for Clementine highland data by [3]. Dotted line: Physically based model curve by [3] (SHOE only).

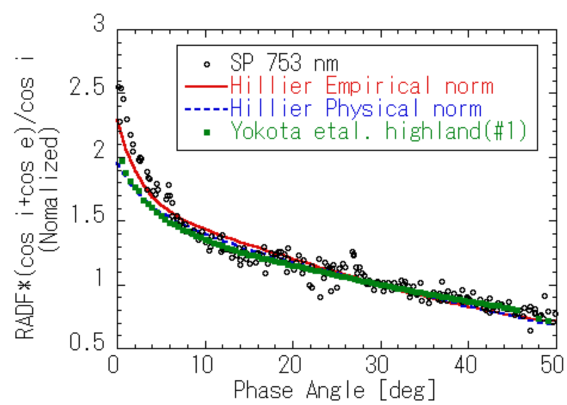

Fig. 3. Normalized phase curves (α<50°) at ~750 nm band.

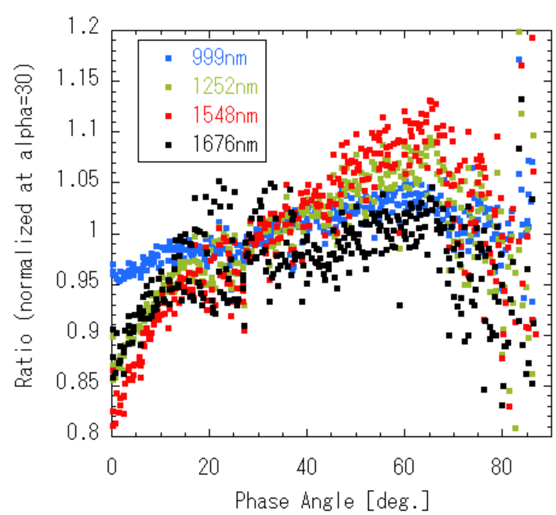

Fig. 4. Color ratio plot of SP data.