GLOBAL TOPOGRAPHY AND GRAVITY FIELDS OF THE MOON BY KAGUYA(SELENE).

S. Sasaki[1], H. Araki[1], H. Hanada[1], N. Namiki[2], T. Iwata[3], K.Asari[1], S. Goossens[1], Y. Ishihara[1], T. Ishikawa, N. Kawano[1], F. Kikuchi[1], Q. Liu[1], K. Matsumoto[1], H. Noda[1], S. Tazawa[1], S. Tsuruta[1], K. Kurosawa[4], S. Sugita[4], T. Takano[5], [1]National Astron. Obs., 2-12 Hoshigaoka, Mizusawa, Oshu, Iwate 023-0861 JAPAN (sho@miz.nao.ac.jp), [2]Kyushu Univ., 6-10-1 Hakozaki, Higashi-ku, Fukuoka 812-8581 JAPAN, [3]ISAS/JAXA, 3-1-1 Yoshinodai, Sagamihara 229-8510 JAPAN, [4]Univ. Tokyo, 5-1-5 Kashiwanoha, Kashiwa 277-8561, JAPAN, [5]Nihon Univ., 7-24-1 Narashinodai, Funabashi 274-8501, JAPAN

Introduction: The Japanese lunar explorer KAGUYA (SELENE) was launched successfully on September 14th, 2007. The aim of KAGUYA is to investigate important issues in the lunar science such as the interior structure, the near/far side dichotomy and the origin of the Moon [1]. Two small spin-stabilized subsatellites, Rstar (OKINA) and Vstar (OUNA) were deployed in October for gravity measurement. Rstar and Vstar are spin-stabilized satellites of an octagonal shape with diameter 0.99m and mass 45kg [2]. Three satellites take different polar orbits around the Moon. Also, a laser altimeter (LALT) is on board the main orbiter of KAGUYA.

Gravity measurements: Using RSAT (a satellite-to-satellite Doppler tracking sub-system) and VRAD (artificial radio sources for VLBI), we can track the three satellites by new methods: 4-way Doppler tracking between the main satellite and Rstar for the farside gravity and multi-frequency differential VLBI tracking of Rstar and Vstar. The global lunar gravity field with unprecedented accuracy can be obtained. The 4-way Doppler tracking for the farside gravity started on November 5th 2007 during initial check out phase if KAGUYA. First, we estimated residuals of observed Doppler data from a prediction based on LP100K lunar gravity model. Over the nearside, the variation of the residuals is smaller than 5 mm/s. In contrast, the variation over the far side is as large as 30 mm/s, becausefar-side gravity anomalies were not accurately mapped previously [3]. We also confirmed the validity and accuracy of the multi-frequency differential VLBI tracking of Rstar and Vstar using VERA and international VLBI network [4].

From more than 6 month observation of 2-way and 4-way Doppler tracking, precise gravity field (free-air gravity anomaly SGM90d) including most of farside was obtained [3]. Although nearside gravity of KAGUYA would agree basically with previous LP100K gravity, on the farside our gravity field shows significant improvement from the previous model. In our new gravity model, many circular signatures corresponding to impact structures are identified. Some of the circular gravity anomalies in the free-air gravity apparently disappear in Bouguer anomaly map. This change implies that surface topography is a dominant source of free-air gravity anomalies and large impact structures are supported by lithosphere; difference of thermal history between nearside and farside can be discussed. A possible cryptomare candidate (a circular gravity anomaly without topographic signature) was also found on the farside.

Topography measurements: The objectives of LALT are (1) determination of lunar global figure, (2) internal structure and surface processes, (3) exploration of the lunar pole regions, and (4) reduction of lunar occultation data [5]. LALT transmits laser pulses whose time width is about 20 nanoseconds and pulse interval is 1 second. The beam divergence is 0.4 mrad and beam spot size on lunar surface is typically 40m when main orbiter altitude is 100km. Range accuracy is ±5m. The range data are transformed to the topography of the moon with the aid of position and attitude data of the main orbiter. By early April, more than 7000000 footprint data were obtained. The footprint spacing is 1.5 km (along-track) and 1 - 15 km (cross-track) in the equator region.

In the polar regions where previous CLEMENTINE altimeter did not cover, many topographic features that were difficult to see on the imagery from spacecraft or ground based radar images are discovered. Solar illumination condition was calculated: the region whose solar illumination rate is higher than 90% is very limited. Lunar mean radius is 1737.15±0.01 km and the COM-COF offset is 1.94 km based on the spherical harmonic model STM359_grid-02 from LALT topography. The amplitude of the power spectrum of STM359_grid-02 is larger than that of the previous model at spherical harmonics degree L>30 [6].

From the gravity and topography data, we obtain the distribution of the crustal thickness on the Moon. We also estimate the correlation between gravity and topography and localized admittance values. Gravity and topography observation of KAGUYA will continue until early 2009.

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