Status report of RSAT experiment of KAGUYA: Global gravity field of the Moon

Noriyuki Namiki[1]; Takahiro Iwata[2]; Koji Matsumoto[3]; Hideo Hanada[3]; Hirotomo Noda[3]; Mina Ogawa[4]; Nobuyuki Kawano[3]; KAZUYOSHI ASARI[5]; Seiitsu Tsuruta[6]; Sander Goossens[3]; qinghui Liu[7]; Fuyuhiko Kikuchi[8]; Yoshiaki Ishihara[3]; Toshiaki Ishikawa[3]; Sho Sasaki[3]; Masao Hirota[4]; Chiaki Aoshima[9]; Seiji Sugita[10]; Kosuke Kurosawa[10]; Masanori Yokoyama[11]; mizuho matsumura[12]; Shunichi Kamata[13]; Naohiro Kubo[14]

[1] Earth and Planetary Sciences, Kyushu Univ.; [2] ISAS/JAXA; [3] RISE, NAOJ; [4] JAXA; [5] National Astronomical Observatory,Mizusawa; [6] RISE,NAOJ; [7] NAOJ; [8] none; [9] Fujitsu; [10] Dept. of Complexity Sci. & Eng., Univ. of Tokyo; [11] Earth and Planetary Sciences, Univ. Tokyo; [12] Erath and Planetary sci ,Tokyo Univ; [13] Earth and Planetary Sci., Univ. of Tokyo; [14] Earth and Planetary Sciences,Kyushu Univ

The gravity field is a basic and significant data set for the study of the internal structure and the evolution of planetary bodies. High-resolution gravity models have been used for studies of structure and tectonics of the Moon. Current lunar gravity field models, however, include large uncertainties on the far side of the Moon. This is because synchronous rotation of the Moon inhibits a direct link between a ground tracking station and a spacecraft over the far side. This problem of the lunar gravity model remains unresolved until global coverage of gravimetry observation is completed.

In order to track a spacecraft over the lunar far side, we developed a satellite-to-satellite Doppler tracking sub-system (**RSAT**) on **KAGUYA** (SELENE). Main function of RSAT is to relay Doppler tracking signals between the main orbiter (MAIN) over the far side and ground-based antenna. We call this tracking system four-way Doppler measurement. **RSAT** realizes the first direct observation of the gravity field over the far side of the moon, and enables global gravity anomaly mapping of the Moon.

Rstar was released from MAIN successfully at 0:36 a.m. on October 9 (Universal Time). Rstar was then inserted into an elliptic orbit with altitude ranging from 120 to 2395 km, inclination of 90.1 degree, and a period of 4 hours and 5 minutes with respect to the Moon. The very first Doppler data were collected in the initial check out, and processed by *Matsumoto et al.* First four-way Doppler data over the far side of the Moon were obtained between 19:27 and 20:20 on November 5, between 23:17 on November 5 and 0:12 on November 6, and between 3:06 and 4:09 on November 6. Over the near side, variation of the residuals between Doppler data and model prediction is smaller than 5 mm/s. In contrast, variation over the far side is as large as 30 mm/s. We infer that the latter variation is a true signal of unresolved gravity anomaly on the far side, because these variations of residuals reveal a good correlation when plotted along a ground track of MAIN. The variation of residuals further indicates the possibility that the lunar gravity anomaly map on the far side is changed on the order of several tens mgal.

The nominal mission period of **KAGUYA** and the collection of four-way Doppler measurements continue until October 2008. In the meantime, chances for the four way Doppler measurements are limited, as particular geometry among the two satellites and the ground station must be satisfied. Besides, the small size of Rstar limits electric power supply from solar array panels, and therefore time for four-way measurements. From December 2, 2007 to early January 2008, Rstar is fully lit by the Sun and we are operating Rstar to obtain as much four-way Doppler data as possible.

We plan to release our first lunar gravity model in March when sufficient amount of Doppler data are accumulated. Our first lunar gravity model may be limited to degree lower than 60, and adopt tracking data of not only **KAGUYA** but also Lunar Prospector, Clementine, Apollo, and so on. After the first release, the lunar gravity model will be updated every three months by incorporating new tracking data.