The First Accurate Global Gravity and Topography of the MOON by KAGUYA(SELENE) and Implication for Lunar Basin Evolution

SHO SASAKI[1], YOSHIAKI ISHIHARA[1], HIROSHI ARAKI, HIROTOMO NODA, HIDEO HANADA[1], KOJI MATSUMOTO[1], SANDER GOOSSENS[1], FUYUHIKO KIKUCHI[1], TAKAHIRO IWATA[2] and NORIYUKI NAMIKI[3]

[1]*National Astronomical Observatory of, Japan*
[2]*ISAS/JAXA, Japan*
[3]*Chiba Institute of Technology, Japan*

KAGUYA(SELENE) was launched on September 14th, 2007. It had been observing the Moon by June 11th, 2009. KAGUYA had two subsatellites (OKINA and OUNA) for gravity measurements and laser altimeters for topography measurement.

Previous lunar gravity models are in lack of direct observations of the farside gravity. Synchronous rotation of the Moon with its orbit inhibits a direct link between a ground tracking station and a lunar-orbiting spacecraft over the farside. Using 4-way Doppler tracking with relay satellite OKINA, KAGUYA obtained the first precise gravity field of the lunar far-side [1]. Multi-frequency differential VLBI observation using subsatellites OKINA and OUNA improved the accuracy of gravity, through precise determination of OKINA's orbit. Current gravity field model SGM100h has much less error on the farside in comparison with previous models.

Laser altimeter (LALT) on board KAGUYA obtained the first precise global topography of the Moon with range accuracy of 5 m [2]. Range data exceeded 20 million by the end of the mission. In the polar regions where laser altimeter on board CLEMENTINE did not observe, LALT clarified topographic features including permanently shadowed areas. Distribution of solar illumination rates was also estimated at elevated areas [3]. The amplitude of the power spectrum of topography spherical harmonics is larger than that of the previous model at L>30 [2]. We have a better correlation between spherical harmonics coefficients of gravity and those of topography than the previous model [1].

Gravity signatures of far-side impact basins are mostly explained by topography except for the central high. Extended density anomalies such as "mascons" are not observed in the farside, suggesting the nearside/farside difference of subsurface thermal condition. Farside interior would have cooled faster than the nearside. With topography data, we estimate Bouguer anomaly and the crustal thickness variation of the Moon [4]. The region with the thinnest crust is Mare Moscoviense. Bouguer anomaly does not change largely both within South Pole-Aitken basin and within far-side highland terrain. This would imply rather smooth crust-mantle boundary there.

Keywords: KAGUYA, gravity, topography, farside, crustal thickness, basin

References: [1] Namiki, N. et al.(2009) Science 323, 900, [2] Araki, H. et al. (2009) Science 323, 892. [3] Noda et al. (2008) GRL, 35, doi:10.1029/2008GL035692 [4] Ishihara, Y. et al.(2009) GRL, 36, L19202, doi:10.1029/2009GL039708.