A simulation study for anticipated accuracy of lunar gravity field model by SELENE tracking data

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Study of the lunar gravity field plays an important role in understanding the structure and evolution of the Moon. Although many have studied the lunar gravity field in the past, the existing models are mostly based on Earth-based 2-way range and Doppler observations. Due to the synchronous rotation of the Moon, it always turns the same face toward the Earth, which results in large gravity errors on the far-side due to the lack of tracking data so far obtained.

In the upcoming Japanese lunar mission SELENE, to be launched in 2007, we propose new observation techniques to overcome this problem of lunar gravity field recovery. SELENE consists of a main lunar orbiter in a 100 km altitude circular orbit and two small satellites (Rstar and Vstar) in 100-2400 km and 100-800 km altitude elliptical orbits, respectively. By using a high-low satellite-to-satellite tracking (4-way Doppler) capability between Rstar and the main orbiter, SELENE will provide the first truly global gravity data set of the Moon. We will also receive radio signals from artificial radio sources both on board Rstar and Vstar at 8 VLBI ground stations. Differential VLBI observations of these two small satellites, combined with conventional 2-way Doppler observations, will contribute to precise orbit determination of these satellites. The precise orbit of Rstar is in particular of importance to serve as a reference for 4-way Doppler observations.

We will report results of numerical simulations which account for realistic limitations for data acquisition such as possible visibility timings for 4-way link, battery resource restrictions of the small satellites, and the antenna time sharing plan of ground stations. The expected outcome includes; (1) the error on the far-side will dramatically be reduced, (2) many gravity coefficients will be determined by observation which were so far determined by a priori constraint, and (3) the lunar gravity coefficients below degree around 30 will be improved to the accuracy of one order of magnitude better than LP100J, which is one of the current state-of-the-art lunar gravity field model. Such a lunar gravity field model will improve the constraints on the structure and constitution of the Moon.