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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 range rate 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.

We are planning to improve lunar gravity field model by four-way Doppler measurements and differential VLBI observations using three orbiters of the SELENE (Selenological and Engineering Explorer) mission. SELENE is a Japanese lunar probe which will be launched by H-IIA launch vehicle in 2007. The spacecraft of SELENE is composed of the Main Orbiter, and two small free-flyer subsatellites: the Relay Satellite (Rstar) and the VLBI Radio Satellite (Vstar).

By using a high-low satellite-to-satellite tracking (four-way Doppler) capability between Rstar and the Main Orbiter, SELENE will provide the first global gravity data set of the Moon including the far-side. We will receive radio signals from artificial radio sources both on board Rstar and Vstar at multiple 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 for anticipated accuracy of lunar grav-

ity field recovery. The simulation accounts for realistic limitations for data acquisition such as possible visibility timings for 4-way link, battery resource restrictions of the small subsatellites, the antenna time sharing plan of ground stations, and so on. 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 those of 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.