Lunar geodetic missions in SELENE (2005-2006) and SELENE2. H. Araki, K. Matsumoto, K. Heki, H. Hanada, and N. Kawano. National Astronomical Observatory, Mizusawa, Iwate, 023-4501 (email arakih@miz.nao.ac.jp).

Introduction: Selenological and Engineering Explorer (SELENE) is to be launched in 2005 from Japan with the nominal mission period of one year. The main orbiter, with a circular/polar orbit as high as 100 km, is equipped with various instruments including a laser altimeter (LALT). Two sub-satellites, with higher orbits, have very long baseline interferometry (VLBI) radio transmitters for three-dimensional tracking (VRAD), and Doppler signal relay equipments to enable direct farside gravimetry by high-low satellite-to-satellite radio tracking (RSAT). Details of the SELENE-B and SELENE2, two follow-on projects of SELENE, have not been determined yet, and we are proposing a polar telescope/PZT type optical telescope for accurate in-situ lunar orientation measurements (ILOM).

SELENE: SELENE, to be launched in 2005 summer using an H-IIA launch vehicle, has three missions related to lunar geodesy, namely LALT for laser altimetry and RSAT/VRAD for lunar gravimetry:

Laser Altimetry. LALT, a laser range instrument [1], is one of fourteen instruments aboard the SELENE lunar orbiter. Its scientific objectives are, determination of global lunar figure, construction of precise topographic data base of the entire lunar surface including the polar region (much better accuracy/coverage than the Clementine LIDAR). The proto-type model of LALT, assembled in December 2000, passed various environmental tests, and its design refinement and manufacture of the flight model will be completed by the end of June 2003.

Two characteristics of lunar global figure, that is, the centers of mass/figure offset of about 2km, and triaxiality with elongation approximately toward the Earth, are the keys to clarify lunar origin, tidal evolution, and internal structure. In addition to this, selenocentric height determinations would also contribute to the refinement of the selenodetic control point network. Information on smaller scale topographic features, combined with lunar gravity data, is important in constraining lithospheric thickness, and lunar thermal evolution. Precise and accurate topographic mapping of the lunar polar region will have a crucial significance for the lunar ice deposit investigation.

Lunar Gravimetry. The lunar gravity field is one of the keys to research the lunar origin. Its lowest degree/order components will constrain the size and/or density of the core together with lunar libration data. Combining higher degree/order gravity coefficients with altimeter data provides information on lunar tectonics and thermal history. In spite of past lunar explorations, gravity field of the farside has never been measured directly. This situation will be overcome by employing a free-flying satellite (RSAT) that relays Doppler signals from the main orbiter on the lunar farside [2]. The data will mainly contribute to the improvement in the high-degree gravity coefficients, but an order of magnitude improvement in the low-degree gravity coefficients is also anticipated. Three-dimensional tracking of the two free-flying satellites with differential VLBI will improve the gravity field determination [3] especially near the lunar limb where line-of-sight gravity components do not provide much information on the mass distribution.

SELENE2: Luni-solar tidal torques for the Earth with an inclined spin axis let the axis change its direction with various periods (forced nutation). The motion of surface fluids such as ocean and atmosphere excites the Earth's free polar motion (Chandler wobble). Amplitudes and phases of these variations provide valuable information on the Earth's interior. Likewise, the Moon has physical (free and forced) libration, and their measurements are important to know the physical status of lunar core and lower mantle. In the lunar exploration project after the SELENE, soft landing onto the lunar surface is planned. We are proposing the ILOM project [4], a lunar polar lander equipped with an optical telescope with diameter of 20 cm and focal length of 2 m. It is designed to enable accurate measurement of lunar rotational variation by analyzing the star trajectories associated with the lunar spin. This will greatly improve our knowledge of the lunar physical libration obtained by past lunar laser ranging (LLR) observations [5], and provide important information on the lunar interior.

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