Orbital lifetime of Rstar (OKINA)

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Japanese lunar exploration KAGUYA (SELENE) has one large main orbiter (KAGUYA) and two small spin-stabilized sub-satellites, Rstar (OKINA) and Vstar (OUNA). The two sub-satellites have installed elliptic polar orbits. Perilune and apolune heights of Vstar are 100 km and 800 km, and those of Rstar are 100 km and 2400 km respectively. Since these two satellites are free flyer, their orbital lifetime simply depend the gravity (lunar, planets and the Sun) and solar radiation pressure.

After the deployment of two sub-satellites, we started to estimation for their lifetime. Estimation is carried out following procedure.

(1) Orbital propagation from each predict file using GEODYN II.

– Force modeling on the satellites consisted of the LP100K as a priori gravity filed.

– The DE403 ephemeris was adopted for the computation of third-body perturbations, as well as the definition of the lunar librations and coordinate system.

– Solar radiation pressure was modeled as a cannonball model.

(2) Compare the spherical height of the spacecraft with lunar topography model (ULCN2005 lunar global topographic model).

– When the spherical height of the orbit of spacecraft became lower than elevation of the lunar topographic model, we decide spacecraft is collided with lunar surface.

Our analysis proved that the orbital lifetime of Vstar is enough for nominal and extend mission. On the other hand, we found limited orbital lifetime of Rstar. The estimated crash date is Feb. 12, 2009 (3 month after the nominal mission) and crash location is deep far side. For validation of our estimation, we tested other lunar gravity models (ex. LP75G, LP150Q, etc...). For any gravity model, we obtained almost same result. This result shows that the crash location is controlled by low degree term of the gravity field. For more accurate estimation, we need more precise lunar gravity model (especially far side) and more precise and detail topography model. As of Feb. 2008, LALT team starts to build new lunar topography model. That is much precise and detail topography model than previous ones. RSAT/VRAD team also starts to build new gravity model using 4way Doppler data (far side tracking data). In meeting, we will report the updated result based on new gravity and topography models.