P144-030 **Room: 304** **Time: May 17 12:00-12:15**

Application of VLBI technique for lunar exploration

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VLBI (very long baseline interferometry) technique is anticipated to be applied for precise positioning of an orbiter or a lander in lunar and planetary explorations. VLBI measures a difference in an arrival time of a signal transmitted from a radio source to two ground stations. The differential VLBI (DVLBI) measurement consists of the differenced delay between two radio sources (orbiter-orbiter or orbiter-quasar). The differential delays give plane-of-sky position differences of two radio sources in contrast to conventional 2-way Doppler measurements that give line-of-sight position information. The combination of VLBI with Doppler can be used for gravity field estimation of the Moon and planets, and for determining their rotations through the precise positioning of orbiters or landers. This presentation shows the recent results of the VLBI mission of Japanese lunar exploring program KAGUYA (SELENE) and the application of VLBI technique for next lunar and Mars landing missions.

In KAGUYA, VRAD (the differential VLBI RADio sources) mission is carried out to improve the accuracy of the lunar gravity field. Two VLBI radio sources are loaded on two sub-satellites called Rstar and Vstar. These on-board radio sources transmit four carrier wave signals and same beam VLBI observations of the two sub-satellites are demonstrated. Same beam VLBI contributes a great deal to cancel out the tropospheric and ionospheric delays which are major error sources of VLBI and to determine the absolute value of the cycle ambiguity by using the multi frequency VLBI method. As a result, the differential phase delay of the X-band signal is estimated within an error of below one pico-second (Kikuchi et al., 2009). This accuracy is more than one order of magnitude smaller than recent VLBI results. The preliminary results for the orbit determination of the sub-satellites show a decrease of the orbit error from a few hundred of meters to around 10 meters when the differential phase delay data are added to the conventional range and Doppler data. Although VLBI data are not processed in a routine basis, the low degree coefficients of the lunar gravity field model shows some improvement in a preliminary result of including about 4 months (Jan, March, April and May 2008) of same-beam VLBI data (Matsumoto et al., 2009).

We also planned to apply VLBI technique for next lunar and planetary missions. Inverse VLBI observations are proposed for a lunar landing mission (SELENE-2) and a Mars landing mission. The purpose of these observations is to investigate the internal structures through the estimation of the rotation changes of the Moon and Mars those are the precession, nutation and polar motion. We use multi-landers and measure the difference of the distances between landers and a ground station in order to estimate the rotation of the Moon and Mars. The inverse VLBI can also be applied for the gravimetry of the Moon and Mars with same beam VLBI technique. These VLBI techniques are expected to contribute the understanding of the internal structure and leading the origin and thermal evolution of the Moon and planets.

Reference

Kikuchi et al., Radio Science, 2009
Matsumoto et al., This conference, 2009