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Some preliminary estimates of the possibility of determining the Lunar physical libration in the project ILOM

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A brief description of targets and problems of the future Japanese project ILOM (In situ Lunar Orientation Measurement), which is planned to be realized as one of kinds of observations of lunar rotation at the second stage of SELENE-2 mission, is given in the report. One of the important elements of the project is placing of a small optical telescope on the lunar surface with the purpose to detect the lunar physical libration with high accuracy 0.001 arc sec. Computer simulation of the future observation is being done with the purpose of their optimization: effective placement of measuring system on the lunar surface and formation of scheduling of observations for monitoring the physical libration of the Moon. The results of the first stage of the simulation are presented in the paper. At this stage the tracks for the selected stars are constructed and analyzed, their sensitivity to the internal characteristics of the lunar body, in the first place, to the selenopotential coefficients, is tested.

Analyses of simulated stellar tracks observable from the lunar surface (in a polar zone) revealed a difference from daily parallels of stars in comparison with ground based observations. During one ”lunar day” equal to 27.3 terrestrial days, a star moves along a spiral. In dependence on the longitude of the star, these spi-rals can be untwisted or twisted. In the latter case a star can describe a loop in the sky of the Moon during the observation period. The reason of such unusual astrometry phenomenon is combination of the slow rotation of the Moon as compared with the Earth and the fast precession motion of the lunar pole (in comparison with precession motion of a terrestrial pole).

Due to physical libration the shifts of all tracks will be observed towards direction opposite the Earth. The tracks are sensitive to gravity model of the Moon and are different even for the most accurate modern gravity field models LP150Q and SGM100h.

In the current report we present formulation of the inverse problem of the lunar libration and the application of gradient method for solution of this problem. It is shown that longitudinal libration can not be revealed from observations of polar stars. It is shown, that measuring inaccuracy E in selenographic coordinates x and y causes the inaccuracy in libration angles less than sqrt(2)∗E. Residuals in comparing libration angles of inclination (rho) and node (I∗sigma) calculated for two kinds of lunar body model (deformable and rigid Moon) are analyzed. FFT applied on the residuals spectra reveals several periodical components which are sensitive to the Love number k2 Identification of the components with origin harmonics in analytical series of libration is carried out, what can be useful for the future spectral analyses.

References:

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