EPSC Abstracts,
Vol. 4, EPSC2009-490-1, 2009
European Planetary Science Congress,

Computer simulation of star transition across the prime meridian for the future observations by the Lunar polar telescope in the Japanese project ILOM

N. Petrova (1,2), H. Hanada (3) and **M. Akutina** (1)

(1) Kazan State University, Kazan, Russia, (2) Kazan State Power Engineering University, Kazan, Russia, (3) National Astronomical Observatory of Japan, Mizusawa, Japan (nk_petrova@mail.ru)

Abstract

In the frame of the second stage of the Japanese space mission SELENE II [1] the placing of the telescope on the Lunar surface is planned, which is supposed to provide accuracy of 1 ms of arc for position detection of the star position on the CCD array. In situ Lunar Orientation Measurement (ILOM) [1] is an experiment to measure the Lunar physical librations in situ on the Moon with a small telescope which tracks stars. Conditions of observations and parameters of the telescope will allow determining parameters of the Lunar physical libration with the accuracy, which was inaccessible nor from the groundbased observations, nor from Lunar Laser ranging.

Presented report describes the first step of the theoretical providing of the observations by the Lunar polar telescope - simulating of process of receiving "observed" selenographical polar distance of a star and "observed" time of its transition of the prime lunar meridian.

Preparing of the list of stars for the future observations

The latest design of the telescope has an aperture of 10cm and it can detect about 25 stars brighter than stellar magnitude m = 11 with a sufficient signal to noise relation by 40 seconds of integration. The field of view of the telescope is 1^o and it is assumed the telescope will be placed directly to one of the Lunar rotation poles. According to these parameters we selected stars with coordinates in the vicinity of 0.5^o of the precession motion of the Lunar poles, which are being moved around the northern (Fig. 1) and southern poles of the ecliptic on a mean distance $I \approx 1^o32'$. Stars were taken from various stellar catalogues, such as the UCAC2-BSS, Hipparcos, Tycho and FK6. Stellar coordinates α_o, δ_0 were reduced from ICRF system to the ecliptical one λ, β at epoch of observation JD2013. Precession motion of the world pole, aberration and proper motion of the stars were taken into account for this reduction. As a result the selected stars form the ring with width of 1^o (Fig.2).

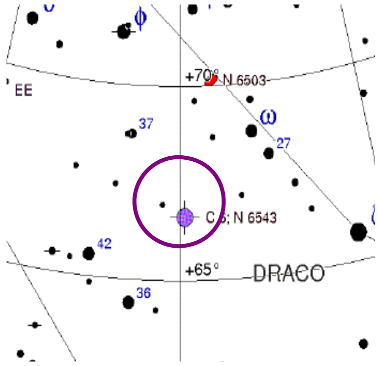

Fig.1 Precession motion of the northern Lunar pole (the map shows objects brighter than m = 7).

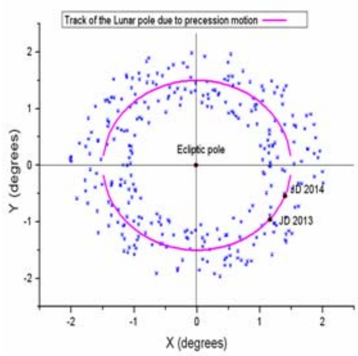

Fig. 2 Stars in a vicinity of 1 degree of the northern Lunar spin during 18.6 years

Reduction ecliptical stellar coordinates to the selenography system

Principal axes of inertia (dynamical system of coordinates – DSC) were taken as a frame for selenography system coordinates [2], [3]. Reduction of the ecliptical coordinates to the

EPSC Abstracts,
Vol. 4, EPSC2009-490-1, 2009
European Planetary Science Congress,

selenography one (δ, φ) were done using the matrixes $\prod_i(a)$ of rotation on the angle *a* relatively axis *i* :

$$\begin{pmatrix}\cos\delta\cos\varphi\\ \cos\delta\sin\varphi\\ \sin\delta\end{pmatrix}=\prod_z(\varphi+180^\circ)\prod_x(-\Theta)\prod_z(\Psi)\begin{pmatrix}\cos\beta\cos\lambda\\ \cos\beta\sin\lambda\\ \sin\beta\end{pmatrix}$$

here (x, y, z) – axes of the main inertia, (φ, Θ, Ψ) – Eulerian angles (Fig. 3), describing rotation of the Moon relatively ecliptical frame. They are determined by the libration angles: $\Theta(t)=I+\rho(t)$, $\varphi(t)=F+\tau(t)$, $\Psi(t)=\Omega+\sigma(t)$, where ρ(t), τ(t), σ(t) are calculated by the tables of analytical libration theory [4] for the dynamical model LP100 [5].

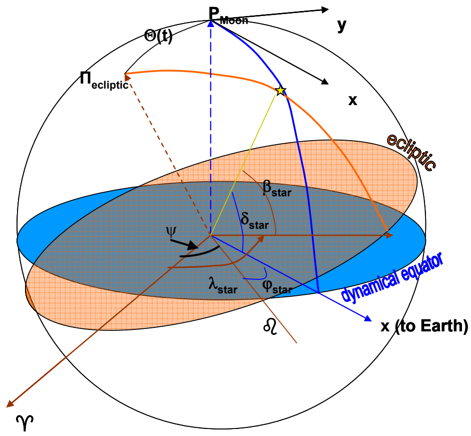

Fig. 3 Ecliptical and dynamical system of coordinates, selenography angles of a star

Results of simulating stellar tracks

The first step of simulating allows calculating x-coordinate of a star and the moment of its transition of the prime meridian (Fig. 4). It was discovered, that some of the stars show the winding spirals, but some of the stars show the unwinding spirals (Fig. 5). This phenomenon cannot be observed from the Earth surface. The reason of this behaviour of stellar tracks is explained by the character of the Lunar rotation: this is a combination of the fast (relatively to Earth) precession motion and slow "diurnal" rotation. Those stars, whose longitude is less than the longitude of the Lunar pole at the epoch of observation, will be approached to the Lunar pole, and then they will be removed away from centre of the telescope (Fig.6) – variation of polar distance.

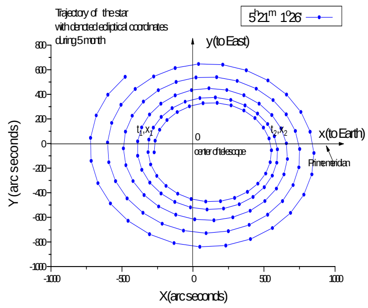

Fig. 4 Fixing of the moment of transition of the prime meridian

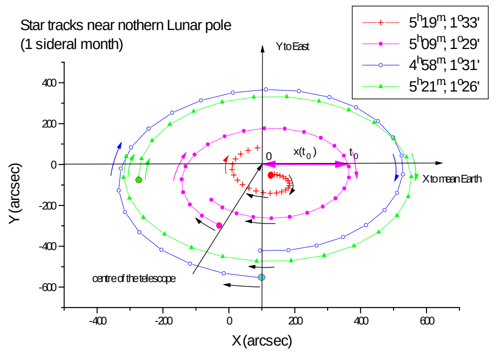

Fig.5 Twisted and untwisted spirals of stars with different ecliptical longitudes

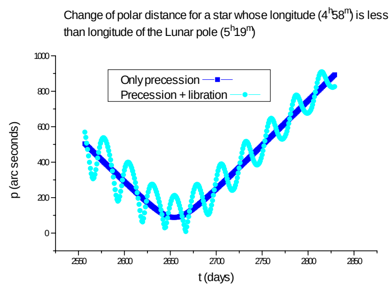

Fig. 6 Variation of polar distance of the star with $\lambda_{star} < \lambda_{pole}$

The research was supported by the Russian-Japanese grant RFFI-JSPS 09-02-92113-ЯФ_a, (2009-2010)

References

[1] Hanada H., S. Sasaki (1), F. Kikuchi et al.(2009), v. 11, EGU2009-8405
[2] Petrova N., Gusev A., Kawano N., Hanada H. (2008) *ASR*, v. 42, p. 1398 – 1404.
[3] Petrova, N., Gusev, A., Hanada, H.; Heki, K.; Kawano, N. v 3. EPSC2008-A-00231
[4] Petrova N. (1996) *Earth, Moon and Planets*, v. 73, No 1, p. 71-99.
[5] A. S. Konopliv, S. W. Asmar, E. Carranza et al. (2001), *Icarus* 150, 1–18