THE LIGHT CURVES OF THEORETICAL ASTEROIDS' MODELS

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ABSTRACT. On the basis of modeling of asteroids form is calculate the set of light curves for five laws of reflection.

Key words: Asteroid model, Light curve

In the problem of determining parameters of asteroids' rotation from photometric data, a necessity arises to interpret the observed asteroids' light curve variation in form, the extrema light "shift" relative to a linear ephemeris and other similar phenomena taking place due to geometric observational conditions, the phase angle etc.

In the given work we shall consider some ellipsoids light curve characteristics obtained by dividing surfaces into element ones (N=1200) with the known area and orientation.

As a law of model surface light reflection the law of Lommel-Seeliger (LS) has been used:

$$dI = \frac{\cos i \, \cos \varepsilon}{\cos i + \cos \varepsilon} dS \; ;$$

as well as that of Lambert (L):

$$dI = \cos i \, \cos \varepsilon \, dS ;$$

theoretical Akimov's law (AT) (Akimov at al.,1992):

$$dI = \cos\left(\frac{\pi}{\pi - \alpha}\right) \cos\left[\frac{\pi}{\pi - \alpha}\left(\lambda - \frac{\alpha}{2}\right)\right];$$

empiric Akimov's law:

$$dI = \cos^P \varphi \, [\cos^P (\lambda - \frac{\alpha}{2}) - \sin^P \frac{\alpha}{2}]$$

at two values of the parameter P=1.1 (A1) and P=1.3 (A2).

To simplify the examination of the geometry influence of both the illumination and observation on the light curve form we restrict ourselves to a model – a rotational ellipsoid in form – with axes 1:2 in a ratio. Let us consider a system of coordinates related to the model centre (Fig.1).

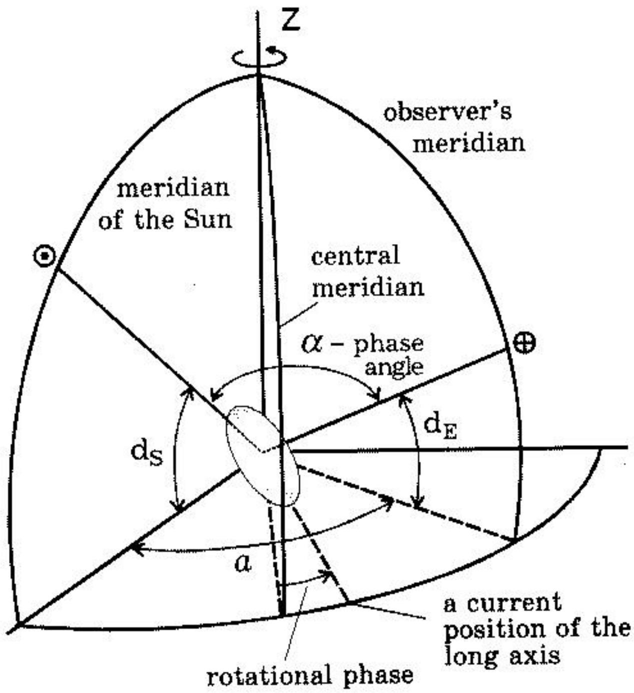

Figure 1: Geometry of the illumination and observation of asteroid model.

The light curves are nearly always asymmetric except for the cases when $d_E = \pm d_S$ or a = 0. At $d_S > 0$ for any law of reflection, minimum light is observed at phase of rotation equal to $-a/2$, that is when longitudinal ellipsoid axis crosses the illuminant meridian.

In Fig.2 is shown a course of the minimum light shift from the central meridian for five laws of reflection. When the Sun and the observer are on opposite sides from the rotation equator of model, the light is mainly determined by the body form.

At $d_S < 30^\circ$ maximum difference in the minimum state is observed in the region of $40^\circ \le d_E \le 80^\circ$ and amounts to 10° in phase whereas at $d_E = \pm\pi/2$ the phase of minimum is equal to $-a/2$ for all the laws considered. At $d_S > 30^\circ$ such a minimum state is always observed only for the Lambert's law. The laws LS, A1 and with some reserves A2 and AT in case $d_E = \pi/2$ result in the minimum phase equal to $\pi/2 - a/2$

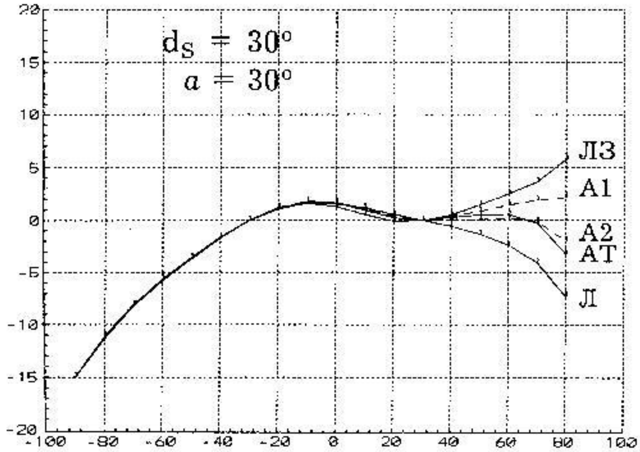

Figure 2: Shifts of the light minimum phase for five reflection laws.

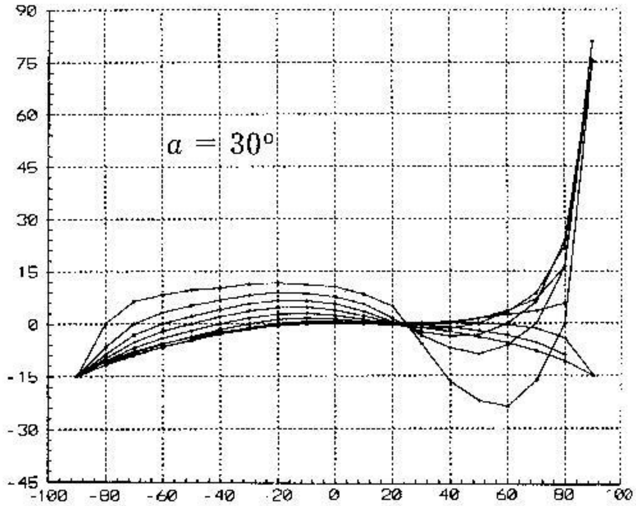

Figure 3: Shifts of the light minimum phase for LS-ellipsoid for set of Sun's aspect.

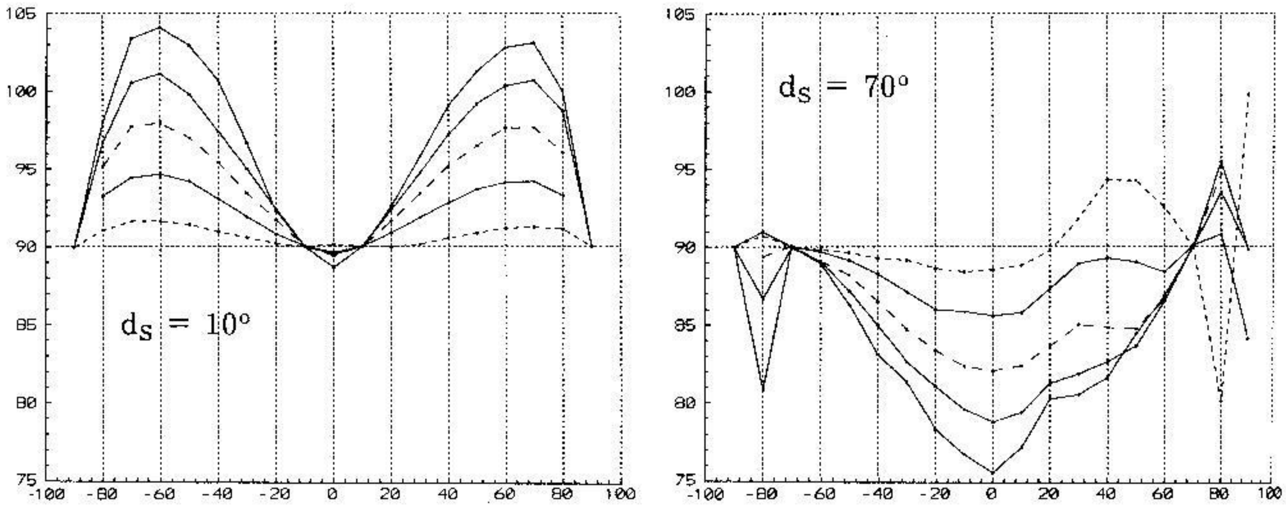

Figure 4: Asymmetry of light curves for LS-ellipsoid for set of Sun's aspect.

that is their light curves are in antiphase with Lambert's light curves and the minimum light phase is far from the region embraced between the Sun's and the observer's meridians.

In **Fig.3** are presented shifts of the minimum light phase for the Lommel-Seeliger ellipsoid depending upon the observer's aspect for $a = 30^{\circ}$ at different aspects of the Sun.

In **Fig.4** are given differences in the minimum and maximum shifts for the LS model. As is seen, a common character of the maximum phase shift is the same as that of the minimum. But the magnitude may differ, and as a result of this in the considered range of geometric conditions the assymetry of light curves (deviations of phases for maximum and minimum light from $\pi/2$) can be equal to $\pm 15^{\circ}$.

It should be noted that a varying sign of the light curve asymmetry is ignored in methods based upon phase angle bisectrix that may lead to essential problems in determining asteroids' rotation parameters. As to the choice of the most suitable light reflection law for asteroids' surface, the problem is likely to be solved in comparing light curves of models with circumpolar observations of asteroids or their rigowns physical analogues.

References

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