POSITIONS OF THE BASIC PHOTOMETRIC MERIDIANS OF THE SPHERICAL PLANET UNDER VARIOUS CONDITIONS OF ILLUMINATION OF ITS VISIBLE DISC. V. V. Mikhalchuk, Odessa national maritime academy, Ukraine, 65029, Odessa, Didrikhsona str., 8, e-mail: vmihalchuk@mail.ru

Introduction: At photometrical observations of the surface of planets of the Solar system and their natural satellites there is a problem of determination of positions of features of the local albedo on images of their visible discs. For terrestrial planets which shape can be counted as a first approximation spherical, this problem becomes complicated influence of a phase when the phase angle Φ is distinct from zero. The phase of the planet is considered in an orthographic approximation. At ground-based and near-earth observations the planet's visible disc is observed in the orthographic projection.

For determination of the position of features of an albedo on an illuminated part of the visible planetary disc and for photometric measurings the basic photometric points located on equator of intensity have a major value. Through each of these points and two points of orthographic horns it is possible to conduct the photometric meridians accordant to them.

To solution of the considered problem within the indicated approximations the contributions [1,2] are devoted, in which the position of any point observed on the illuminated part of the visible disc of the spherical planet, is determined with the help of the photometric coordinate system connected with equator of intensity.

In contributions [3-8] for determination of planetocentric coordinates of features of an albedo the auxiliary coordinate system, which also can be applied for photometric observations, is entered. She as well as and photometric system, is nonrotational and connected with equator of intensity, but differs from he by select of the prime photometric meridian and the direction of the measure of longitudes.

Thus, there is a necessity in the engaging of the auxiliary coordinate system for determination of positions of the indicated basic photometric points and the photometric meridians accordant to them. The purpose of the present contribution is research of dependence of their position from conditions of illumination of the visible disc of the spherical planet.

The basic photometric points and the basic photometric meridians of an illuminated part of the visible disc of the spherical planet: Let's consider the visible disc of the spherical planet illuminated by the Sun under the arbitrary phase angle Φ (fig. 1). Let O – geometric center of the planetary disc (the subterral point), E – the subsolar point (the pole of illumination), points A and B – orthographic horns of the disc. The basic points of diameter of intensity: C – center of the illuminated part of the visible planetary disc, L – the pole of phase, F – the point of the least illumination of the disc, T – the visible center of orthographic terminator, M – the mirror point.

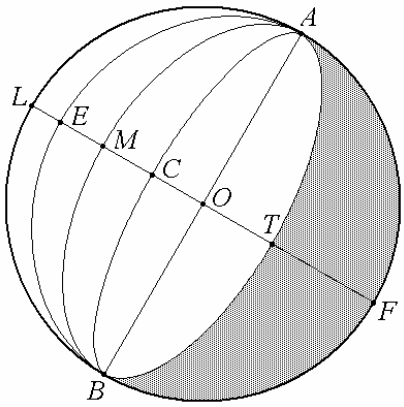

Fig. 1. The basic points of an illuminated part of the visible disc of the spherical planet.

The nonrotating auxiliary spherical coordinate system was applied to determination of a position of any point of an illuminated part of the visible disc of the spherical planet on its surface in a method [3] (λ,φ_0) in which the latitude φ_0 is measured from equator of intensity to northern orthographic horn A of the planet, and the longitude λ is measured from mean meridian ACB westward of the planet.

Owing to effect of the phase the center of an illuminated part of the visible planetary disc is shifted relative to center of its geometric disc on angle γ, which is termed the phase shift of center of the planetary disc that is determined from equation

$$\sin\gamma = \pm\sin^2\frac{\Phi}{2}. \qquad (1)$$

The select of the sign in equation (1) is carried out by following rule [3]: the upper sign concerns to the case, when $\sin(P-Q)>0$, and the lower sign – when $\sin(P-Q)<0$, where P is the position angle of the planet's rotation axis and Q is the position angle of the point of the least illumination intensity of its visible disc on the geocentric celestial sphere [9]. This rule of signs is spread and further, to all subsequent equations.

In contribution [3], except the auxiliary longitude λ, is measured from the mean meridian, the longitude λ_0, is measured from the line of horns AB, which is passing through subterral point O, westward of the planet. These longitudes are connected between themselves by a equation $\lambda_0 = \lambda + \gamma$. As all considered basic photometric points of the visible planetary disc are located on equator of intensity for each of them the condition $\varphi_0 = 0$ satisfies, and the position of this point is determined only by the longitude. The longitudes of an auxiliary coordinate system of the basic

photometric meridians (fig. 1), which are described in [3,4,7] are listed in table 1.

Table 1. The longitudes of the basic photometric meridians

The point	The photometric meridian	λ	λ_0
O	*AOB*, subterral meridian	–γ	0
E	*AEB*, subsolar meridian	±Φ–γ	±Φ
C	*ACB*, mean meridian	0	γ
L	*ALB*, light orthographic limb	±90°–γ	±90°
T	*ATB*, orthographic terminator	±(Φ–90°)–γ	±(Φ–90°)
M	*AMB*, mirror meridian	±Φ/2–γ	±Φ/2

Points *C* and *M* always are on an illuminated part of the visible planetary disc, besides always *LC*=*CT* (fig. 1). Longitudes of points *E* and *T* always differ from each other precisely on 90°, therefore for $\Phi < 90°$ the equation is fulfilled $OE^2 + OT^2 = r^2$, where *r* – the visible radius of the planet.

The diagram of illumination of the planet: The graphs of dependence of the longitude λ from the phase angle for the various meridians passing through the basic points of the illuminated part of the visible planetary disc are submitted on fig. 2.

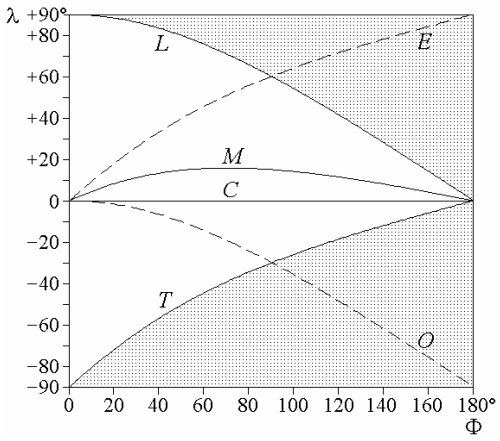

Fig. 2. The diagram of illumination of the planet in the coordinate system (λ, Φ).

The curves accordant to meridians of points *O*, *E*, *C*, *L*, *T* and *M*, are shown for the case when $\sin(P-Q) > 0$. The field of figure, which is restricted by curves *L* and *T*, corresponds to an illuminated part of the visible planetary disc. The curves *O* and *E* are outside the limits of this field for $\Phi > 90°$. The curves *C* and *M* completely lay in the field of figure, which is restricted by the curves *L* and *T*, i.e. on an illuminated part of the visible planetary disc. In the case if $\sin(P-Q) < 0$, the longitudes of the points of all curves change the sign on opposite. Thus, the system of the curves reduced on fig. 2, represents the diagram of illumination of the planet in the coordinate system (λ, Φ).

The curve *M*, as against all remaining curves having the monotonic dependence on the phase angle, has well noticeable extremum: the maximum for $\sin(P-Q) > 0$ and the minimum otherwise. It means, that the mirror point at the particular phase angle is as much as possible declined on the longitude λ to side of the light orthographic limb. It can be show that the value of this phase angle is $\Phi = 70°.53$. The value of the phase we shall find by means of the formula $k = \cos^2 \frac{\Phi}{2}$, it is equal: $k = \frac{2}{3}$. Then the extreme value of the longitude of the mirror point will be equal $\lambda = \pm 15°.79$. From formula (1) and table 1 follows, that for the given phase of the planet $\gamma = \pm 19°.47$, and $\lambda_0 = \pm 35°.26$ accordingly. The angular distance σ of the point located on diameter of intensity from geometric center of the planetary disc is calculated from the formula $\sigma = r \sin \lambda_0$. Therefore in the considered case the point *C* will be located on angular distance $\sigma = 0.333r$, and the point *M* – on angular distance $\sigma = 0.577r$ from geometric center of the planetary disc.

The examples of determination of coordinates of the basic points of an illuminated part of visible discs of Mercury, Venus and Mars for their physical ephemerides on 0^h UT January 8, 2004 [10] are considered. The longitudes of the basic photometric meridians of their visible planetary discs, computed by the formulas obtained in the given contribution, completely agree with the physical ephemerides of planets.

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