National Aeronautics and Space Administration
Goddard Space Flight Center
Contract No.NAS-5-12487

ST-OA-SA-10609

GEOMETRICAL MODEL OF CALCULATION OF PLANET REFLECTED SOLAR THERMAL FLUXES

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18 MAY 1967

ST – OA – LPS – 10609

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Kosmicheskiye Issledovaniya
Tom 5, v.2, 308-10,
Izdatel'stvo "NAUKA", 1967

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SUMMARY

The geometrical construction of this problem is based upon the assumption that the scattering of the radial flux proceeds according to the Lambert law, and that the scattered reflection factor is the same for all portions of planet's surface.

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*   *

A precise calculation of solar thermal fluxes reflected from the planet is beset with difficulties caused by the requirement of having concrete data on reflection properties of both the atmosphere and the planet's surface. However, if we assume, as was proposed in ref. [1], that

1) the scattering of radial flux takes place according to Lambert law,

2) the factor of scattered reflection is identical for all parts of planet's surface,

the solution of the problem is reduced to geometrical constructions. Then it is found to be possible to obtain final results which may also be useful for the estimate of the influence of geometrical factors on the magnitude of thermal fluxes, besides these rough technical computations.

The present note deals with certain results of calculations completed /to according/this scheme for a plate. Let us consider the initial model of calculation. Assume that the plane is arbitrarily oriented relative to the illuminated part of the planet, as is shown in Fig.1 (see next page). Then, substituting the surface of the planet by a sphere and utilizing the above assumptions, we may write for the thermal flux q

$$dq = \frac{PSA\cos\beta\cos\alpha\cos\Delta\, dS}{\pi\rho^2}. \qquad (1)$$

(*) GEOMETR..CHESKAYA MODEL RASCHETA OTRAZHENNYKH OT PLANETY SOLNECHNYKH TEPLOVYKH PO..OKOV

Here A is the albedo, P is the area of the plate, S is the solar constant; the remaining denotations are shown in Fig.1. The quantities ρ, β, α and Δ are easy to express in spherical coordinates; then the thermal flux's ratio to its maximum , equal to PSA, will be written in the following fashion:

$$\bar{q} \equiv \frac{q}{PSA} = \frac{1}{\pi} \int\limits_{\theta} \int\limits_{\varphi} \frac{\left(\cos\theta + \frac{h}{R}\cos\theta - 1\right)(\cos\theta_S \cos\theta + \sin\theta_S \sin\theta\cos\varphi)}{\left[1 + \left(1 + \frac{h}{R}\right)^2 - 2\left(1 + \frac{h}{R}\right)\cos\theta\right]^2} \times$$

$$\times \left[\cos\gamma\left(1 + \frac{h}{R} - \cos\theta\right) + \sin\gamma\sin\theta\cos(\varphi - \varphi_c)\right]\sin\theta\, d\varphi\, d\theta. \qquad (2)$$

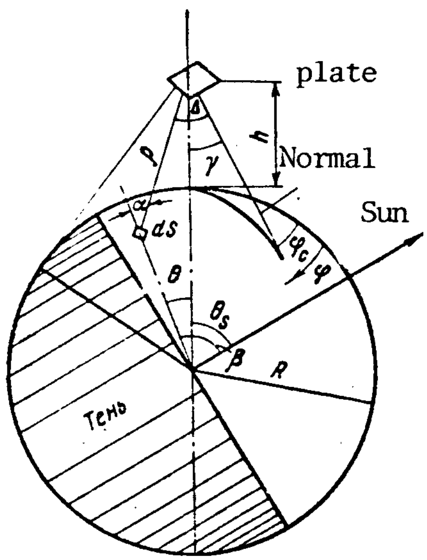

Fig.1

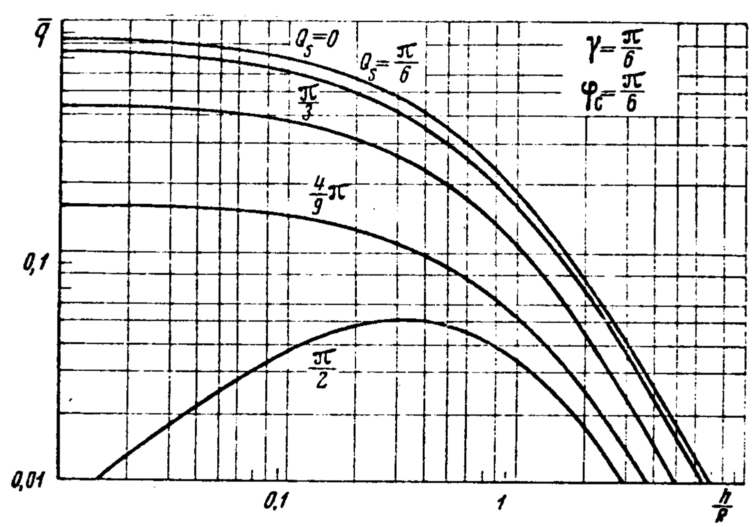

Fig.2

In formula (2) the integration is conducted over the surface of the illuminated part of the sphere that can be seen from the plate. Because of diversity of forms of intersections of the plane of the plate with the half-illuminated sphere and the complexity of the integrand, practical calculations were found to be advantageously performed with the aid of a computer, of which the program foresees the search for the expression for $\bar{q}$ by the given quantities θ_S, ϕ_C, γ and h/R, defining the plate's position relative to the planet and its calculation.

A typical example of such a calculation is shown in Fig.2. Attention is drawn by the quiet feeble dependence of thermal flux on the angle θ_S, when these angles are sufficiently small and the sharp decrease of $\bar{q}$ takes place as $\theta_S \rightarrow \pi/2$.The maximum value of q above the terminator line $(\theta_S = \pi/2)$ constitutes in all 0.052. This is why in cases when the body is over the shadowed side of the planet, the influence of reflected radial fluxes on it may apparently be always neglected by comparison with the intensity of direct solar light.

The characteristic appearance of maximum illumination for large angles θ_S is explained by the fact that the most strongly illuminated regions of the planet become visible as the height increases, and they are the main contributors to the quantity q.

It appears to be of interest to compare the thermal fluxes reflected from the sphere and the boundless plane for which the simple law of intensity distribution by the angle

$$q = q_0 \cos^2 \frac{\gamma}{2},$$

is valid. Here q_0 is the magnitude of thermal flux at $\gamma = 0$. Such a comparison for several values of h / R and $\theta_S = 0$, is presented in the Fig.3. For $\theta_S \neq 0$ the distribution of q by the angle γ depends also on the value of the angle ϕ_C.

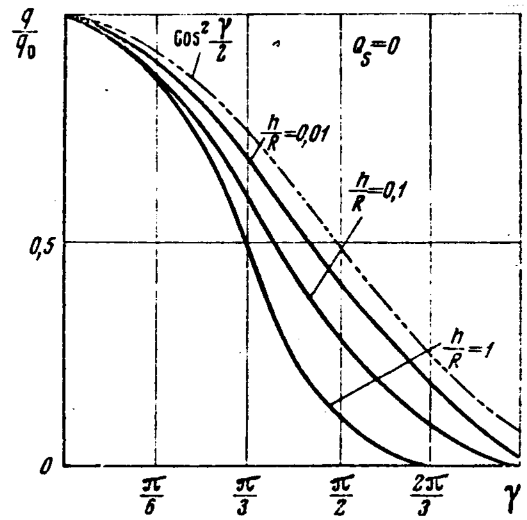

Fig.3

**** THE END ****

Manuscript received on 23 Sep.1966

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CONTRACT No.NAS-5-12487
VOLT TECHNICAL CORPORATION
1145 19th St.NW
WASHINGTON D.C. 20036.
Tel: 223-6700; 223-4930.

Translated by ANDRE L. BRICHANT

on 18 May 1967

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