USS. -T. Nazarny

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

ST-LPS-RAD-10 549

MEASUREMENTS OF MOON'S RADIATION FLUXES IN THE INFRARED AND IN THE VISIBLE REGIONS OF THE SPECTRUM ON THE AMS "LUNA-10"

by

A. I. Lebedinskiy
A. A. Lozhnikov
V. I. Tulupov

(USSR)

23 DECEMBER 1966

ST - LPS - RAD - 10 549

MEASUREMENTS OF MOON'S RADIATION FLUXES IN THE INFRARED AND IN THE VISIBLE REGIONS OF THE SPECTRUM ON THE AMS "LUNA-10"

Kosmicheskiye Issledovaniya
Tom 4, vyp. 6, 838-841,
Izdatel'stvo "NAUKA", 1966

by A. I. Lebedinskiy
A. A. Lozhnikov
V. I. Tulupov

SUMMARY

Measurements of integral radiation flux of the Moon in the infrared have been carried out on the artificial satellite of the Moon "LUNA-10". The instrumentation consisted of radiation receivers constituting flat plates of 15 30 mm dimensions disposed in series. One of the receivers was covered with enamel, absorbing well the infrared radiation (85– 95 percent) and reflecting 70 to 75 percent of visible light. The other receiver was covered with gold foil. Obtained simultaneously, the data of both receivers allow the determination of the thermal radiation flux of the Moon.

*
* *

The temperature of the lunar surface varies within broad limits, descending to —150° during the lunar night and rising to +120° in the middle of the lunar day. As any heated body, the Moon emits a flux of thermal radiation, of which the magnitude is dependent on the temperature and the emitting capability of the lunar surface. The intensity maximum of such a radiation is located in the far infrared region of the spectrum, 7 — 20μ. Concomittantly the Moon reflects the solar radiation incident upon its surface, of which the maximum is in the visible part of the spectrum.

The device consisted of two radiation receivers constituting flat plates of 15 by 30 mm dimensions, disposed in series. In order to reduce the thermal flux from satellite's board to a minimum the receivers were fastened on a thermally insulated foundation, which in its turn was fastened to satellite's board with the aid of four titanium supports. The scheme of the device is shown in Fig.1.

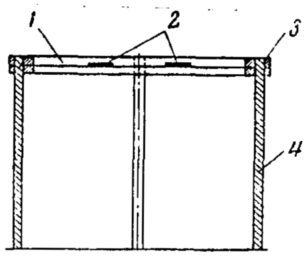
---

* IZEMERENIYA POTOKOV IZLUCHENIYA LUNY V INFRAKRASNOY I VIDIMOY OBLASTYAKH SPEKTRA NA CPUTNIKE "LUNA-10".

The receivers were switched onto a circuit measuring their resistance. The latter varied as the receiver was heated by the incident radiation, which was fixed by the station's apparatus and transmitted to Earth.

One of the receivers (A) is covered with enamel which absorbs well the infrared (85 to 95 percent) and reflects 70 to 75 percent of the visible radiation.

The other receiver (B) is covered by gold foil. As is well known, the latter reflects 97 to 99 percent of infrared radiation and absorbs well the visible radiation. Both the direct and the Moon surface-reflected radiation of the Sun (infrared fluxes) could hit the receiver. The one covered with gold foil was heated by the visible radiation, whereas that covered with enamel was heated by both the solar as well as the Moon's proper thermal radiation. The data of both receivers, obtained simultaneously, allowed the determination of the thermal radiation of the Moon. AMS LUNA-10 was spinning around its axis with a period smaller than the device's thermal inertia, and this is why the fluxes measured constituted the average as a result of rotation.



.Board of the satellite

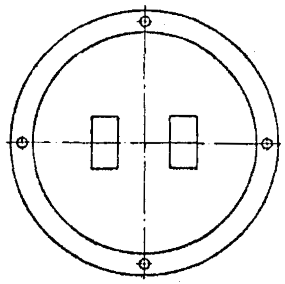


Fig.1. Apparatus

1) thermal insulator;
2) receivers; 3) grip ring;
4) support

Expounded in the present paper are the results of measurements. As to the discussion of the latter it will be the object of a separate paper.

We shall introduce the following denotations. The angle with summit at the center of the Moon O and sides passing through the subsolar point C and the subsatellite point P will be denoted by γ(Fig.2). For the determination of the angle γ one must know the longitude α of the subsatellite point counted from the longitude of the subsolar point taken for zero, and the latitude β, counted from the lunar equator (Л is the station LUNA-10).

At the beginning of April 1966 the latitude of the subsolar point was $\sim 1°$, diminishing to 0° by the middle of May. Under the condition that the angle α be significantly greater than these quantities, the angle γ is determined from formula

$$\cos\gamma = \cos\alpha \cos\beta .$$

For angles $\gamma < 90°$ the satellite is located above the sunlit side of the Moon, for $\gamma > 90°$ it is above the night side, $\gamma = 0°$ corresponding to terminator.

Graphs of receivers' A and B temperatures for three communication sessions are represented in Fig.3.

Temperature readings from the receivers on the satellite were taken down every two minutes. As may be seen from the graphs, the temperatures of the receiver A were negative and those of the receiver B -- positive. During the 8th session the satellite passed from the night to the daytime side, and during the 49th session it passed from the daytime to the nighttime side; during the 31st session the satellite was located on the daytime side of the Moon. It may be seen from these graphs that during passage to the daytime side the temperatures of both receivers rise, and when passing to the nightside, they fall.

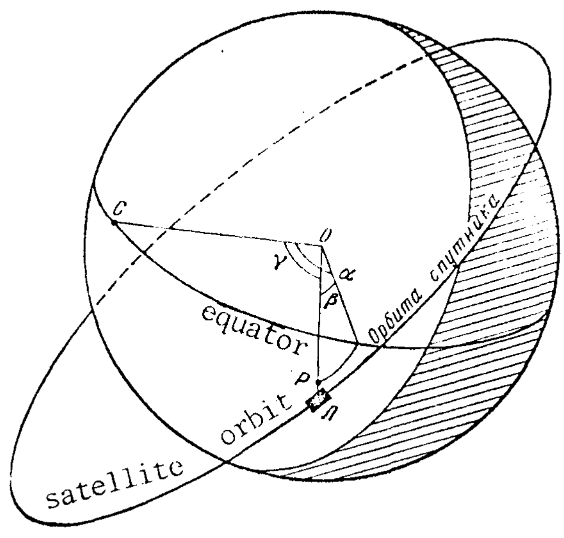


Fig.2. Sketch illustrating the construction of the angle γ.

It should be noted that during the passage of the subsatellite point through the terminator to the night side, the satellite was still illuminated by the Sun for some time, and this is why the temperatures of the receivers did not drop so sharply. Analogously, the satellite was sunlit during long time prior to intersecting the morning terminator. In this case the range of temperature variations of receiver A is larger than that of receiver B. The set of the satellite in the shadow rejected by the Moon takes place at the angle $\gamma = 123°$ for the altitude h = 350 km above the Moon's surface. For greater heights this angle increases, reaching 140° at h = 1000 km. The satellite was illuminated by the Sun for an overwhelming number of sessions.

The temperature of the receivers is plotted in Fig.4 as a function of the angle γ. To that effect data of 44 lunar sessions were utilized.

During the short 5 to 10 minute sessions temperature readings in the middle of the session were taken down, during those of up to 20-minute duration, they were taken at the beginning and at the end of the sessions and for those of up to 40-minute duration they were taken down at the beginning, in the middle and at the end of the session. During such prolonged sessions as the one represented in Fig.3, the 8th session, the temperatures utilized corresponded to four uniformly distributed moment of time of the session. The angles γ in the abscissa axis decrease at the beginning during the motion from left to right, then increase again. This corresponds to the cases when the satellite passes from the night to the daytime side (passing through the terminator at $\gamma = 90°$), and then again drifts from the daytime to the night time side (to the left is the "rise" of the satellite on the daytime side of the Moon, to the right is its "setting").

A temperature increase in the receivers can be clearly seen on the graphs on the daytime side of the Moon. Because of thermal inertia of the receivers, their temperatures at intersection of the morning terminator by the satellite ($\gamma = 90°$ to the left) is lower than on the evening terminator ($\gamma = 90°$ to the right).

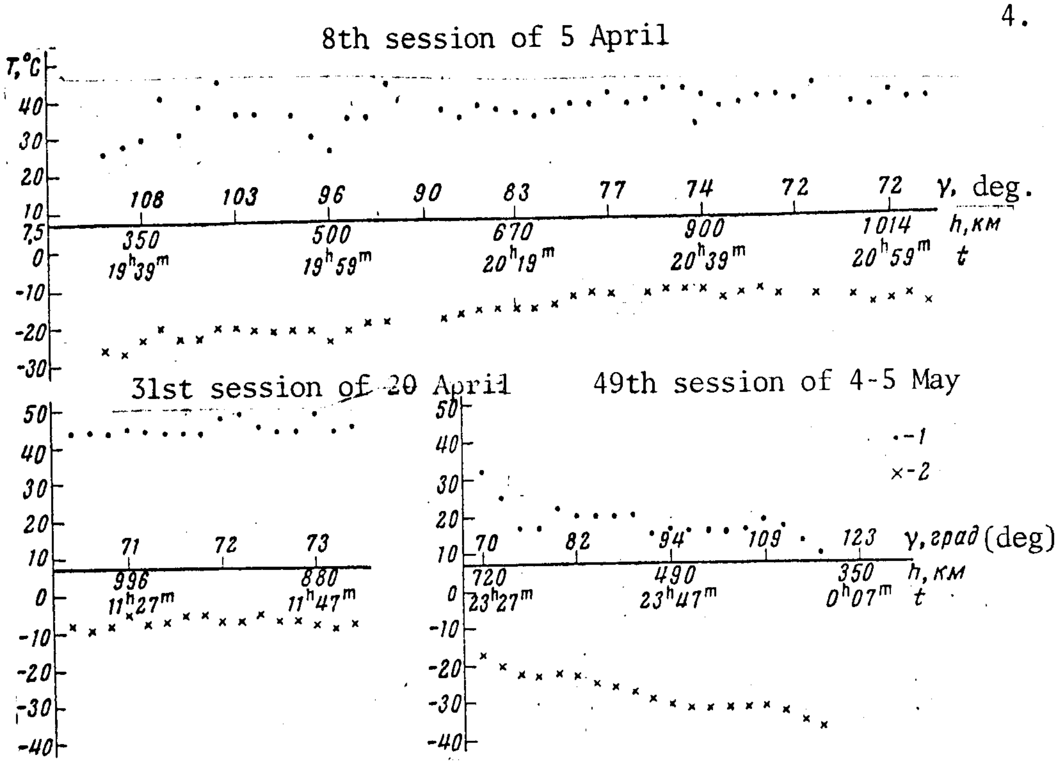


Fig.3. Readings of receivers A and B during the 8th, 31st and 49th sessions

1) receiver B covered with gold foil; 2) receiver A covered with enamel. The time is Moscow.

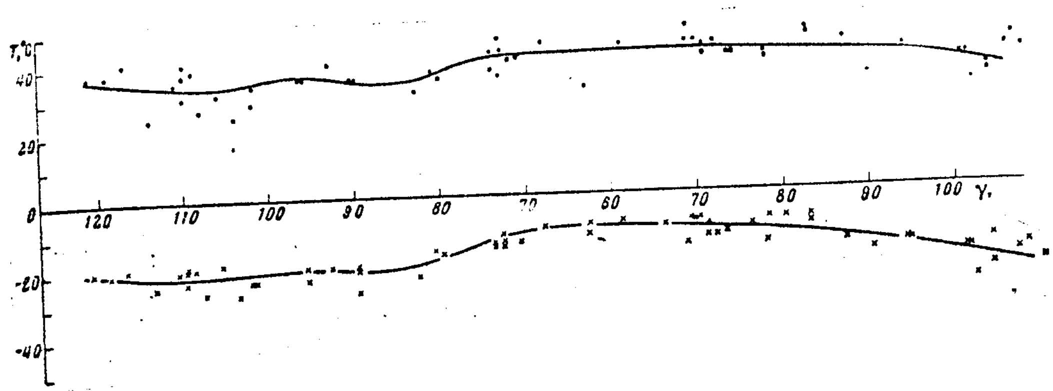


Fig.4. Receivers' temperature as a function of the angle γ.

The denotations here are the same as in the Fig.3.

The influence of thermal inertia on receiver temperature may be illustrated by graphs in Fig. 5 hereafter. Here receiver temperatures are plotted in the time scale for 79 sessions. The temperatures were taken down at the same moments of time as in the case of Fig.4. The points and the crosses without circles correspond to the right-hand part of Fig.4. The curves drawn through the median points were obtained by averaging the real readings over five-day intervals. The median points are not shown in the graphs. The solid curves are constructed by the points and crosses with circles, the dashed curves were done from points without circles. The dashed lines run everywhere above the solid ones, which may be explained by the thermal inertia of the receivers.

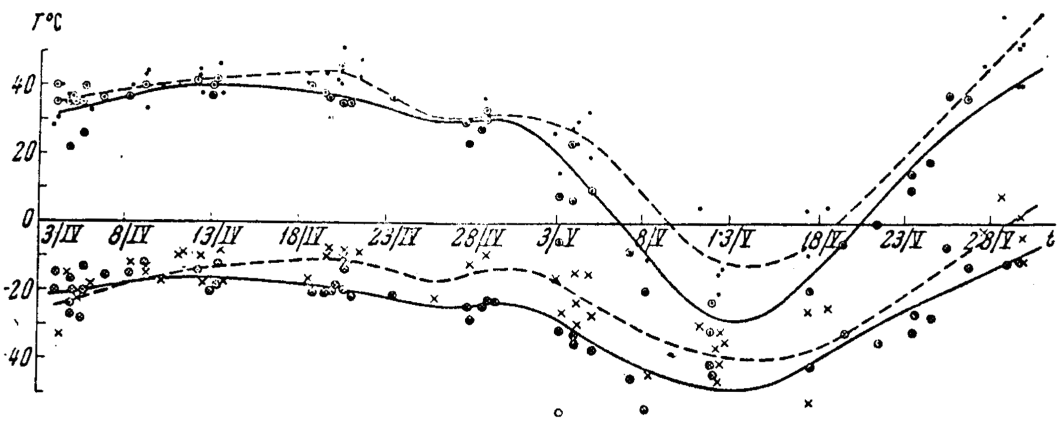


Fig.5. Receiver temperatures as a function of time

Beginning from 2 - 3 May and up to 13 May, the temperatures of both receivers decreased: that of receiver A by 22 degrees and that of receiver B by 50°, after which they began to rise again. Such a variation of temperature may be explained by the slow reorientation of the satellite relative to the Sun in such a way that the incidence angle of solar rays upon the receivers increase. Since receiver B, covered by gold fold, absorbs more visible light, such a reorientation has influenced the receiver B more than the receiver A.

In conclusion the authors wish to thank A. D. Levchenko and V. V. Vernigor for their assistance in conducting the experiment and participation in the processing of the data obtained.

***** THE END *****

Manuscript received on
22 August 1966

NO REFERENCES

Contract No.NAS-5-12487
VOLT TECHNICAL CORPORATION
Suite 601, 1145 19th st NW
WASHINGTON D.C. 20036
Tel: 223-670; 223-4930.

Translated by ANDRE L. BRICHANT

on 23 December 1966

DISTRIBUTION

GODDARD SPACE F.C.

100, 110, 400, 601		
610	MEREDITH	
611	McDONALD	6
612	HEPPNER	6
613	KUPPERIAN	8
614	WHITE	5
615	BAUER	6
640	HESS	
	O'KEEFE	
641	MEAD	
	CAMERON	
	MUSEN	
	BURLEY	
	READING RM	
620	SPENCER	
622	BANDEEN	
630	GT FOR SS	
730	STAMPFL	
252	LIBRARY	
256	FREAS	
LNH	VOLT	

NASA HQS

SS	NEWELL, NAUGLE	
SG	MITCHELL SMITH	
	GLASER	
	ROMAN	
	DUBIN	
	SCHARDT	
	GAUGLER	
SL	WILMARTH	
	BRYSON	
	MOLLOY	
	BRUNK	
	SCHERER	3
	FELLOWS	
	HIPSHER	
	HOROWITZ	
SM	FOSTER	
	GILL	
SA	BADGLEY	
RR	KURZWEG	
RTR	NEILL	
USS	NAGURNIY	
WX	SWEET	

OTHER CENTERS

A M E S R C

SONETT	3
LIB	

LANGLEY R C

116	KATZOFF
160	ADAMSON
235	SEATON
185	WEATHERWAX

J P L

T-1[illegible]	LPS	3
111-127	LAWSON	
183B-365	NEWBURN	
VIS LAB	WYCKOFF	

MIT

BARRETT

UNIV.MICH.

ARNOLD
HADDOCK

plus all permanent addressees
