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

ST-ID-IM-10696

EXPERIMENTAL DATA AS EVIDENCE AGAINST THE HYPOTHESIS ON THE EARTH'S DUST CLOUD

by

B.P. Konstantinov
M.M. Bredov
E.P. Mazets

(USSR)

28 MARCH 1968

EXPERIMENTAL DATA AS EVIDENCE AGAINST THE HYPOTHESIS ON THE EARTH'S DUST CLOUD*

Dokl. A.N.SSSR
Geofizika
Tom 174, No.3, pp 580-582
Izdatel'stvo "NAUKA", 1967

By
B.P. Konstantinov
M.M. Bredov
E.P. Mazets

SUMMARY

This paper rejects the hypothesis of the existence of a dust cloud around the Earth on the basis of measurements of collision frequencies with micrometeorites in outer space, corroborating this further by showing the accord with the measurement data of puncture frequency.

*

* *

It has been asserted in numerous original and review papers devoted to the description and interpretation of experiments on collisions with micrometeorites in outer space that there exists a so called "dust cloud" [3]. This stems from direct measurements on rockets satellites and spacecrafts, completed in the course of a number of years at different geocentrical distances [12]. However, publications appeared in 1966, in which the reliability of such an assertion, was put to doubt.

The most essential part of experimental data having led to representations on concentration of interplanetary dust around the Earth was obtained with the help of piezoelectric collision sensors. Certain fundamental types of earlier applied piezoelectric sensors were studied in [4] and it was established that inner noises, generated under the effect of temperature variations, constituted their common shortcoming. In conditions close to real, the noise level was found to be so high that all the experimental data obtained earlier with the aid of piezoelectric collision sensors, cannot, in the author's opinion, be considered as satisfactory and be taken into account.

The doubts about the validity of measured values of dust particles' flows were expressed also in the theoretical context.

---

* Eksperimental'nyye dannyye svidetel'stvuyushchiye protiv gipotezy o pylevom oblake zemli.

Possible formation mechanisms of Earth's dust belt by way of capture of interplanetary dust particles were examined in a series of works [5] and it was shown that none of these mechanisms is however little effective.

Measurements of collision frequencies with micrometeorites in the 260-650 km altitude range, were completed by us aboard AES "Kosmos-135" placed in orbit on 12 December 1966; piezoelectric sensors, analogous in principle to those used by other methods for the same objective, were utilized in our experiments. However, basing ourselves upon the results of preliminary laboratory tests, having shown that as temperature regions vary, the sensors themselves and the construction parts may serve as sources of false signals, we undertook a series of special measures for the lowering of the interference level, as well as for improving the apparatus' noiseproof feature.

Two identical devices were installed aboard the satellite. Each one of them has two sensors including the piezoceramic element and a preamplifier. A high frequency signal component is utilized for the amplification in the 96-104 kc/sec band. With the view of suppression of noises of electromagnetic character the amplified signals from two sensors are fed to the collision circuit and, an additional selection on signal duration is introduced. The signal's amplitude is registered by a 10-channel amplitude analyzer with logarithmic scale and dynamic band $\sim$ 100.

The sensors of the first device are installed on a special extension panel well acoustically isolated from the frame of the satellite. The total area of the panel is 0.48 m^2. The sensors of the second device were placed directly on the frame. The sensitized surface constituted $\sim$ 1 m^2.

The apparatus' response was set up at such a level that during temperature tests of the sensors and of the assembled panel, false signals could not be observed, while the level of electrical and mechanical noises due to the apparatus was substantially below the treshold.

When preparing the experiment it was assumed that the comparitive data of the two devices allow the estimate of the possible contribution of noises of thermal origin, arising in the satellite construction parts, and will be useful during the projection of further experiments.

The continuity of each device during operation time in flight is checked by means of a rigorous periodical imparting of a calibration impact in the sensitized surface, whereupon the corresponding verification signal must pass into a specific amplitude analyzer's channel.

The laboratory calibration of devices' sensitivity was conducted by dropping tests of calibrated balls with weight from 50 to 2000 μg. The treshold response for the transmitted pulse of the first device constituted $6 \cdot 10^{-3}$ dyne/sec, and that of the second – $7 \cdot 10^{-3}$ dyne/sec. In the assumption that the mean velocity at collision is 30 km/sec. and the signal is proportional to particle impulse, the device must register micrometeors with mass $> 2 \cdot 10^{-9}$g.

Starting from data of literature on the dependence of collision frequency with micrometeorites in the near-ground space on the minimum registered mass [1] one may assume that, as an average, each device must register more than 100 collisions per 24 hours. However, the results obtained by us differ radically from these estimates based upon the results of previous investigations.

During the first 140 hours of operation, the pickups placed on the panel failed to register a single event. Over the following 120 hours, 35 events were recorded; however, the distribution of 24 of them is periodical in time. The sequence period of these events is linked with a precision to 4% with the revolution period of the satellite around the Earth, while the very moments of their appearance are tied to portions of panel's temperature regime variation similar to one another. It is quite obvious that the given signals can not be connected with micrometeorite impacts and are the result of registration of some interferences having occurred in the system, most likely of "cracks" of thermal origin. Let us note that the accuracy of both devices during the entire operation time is corroborated by the results of automatic checkups conducted regularly.

Of all registered signals only the one having passed through the most sensitive channel, failed to fit the above indicated periodicity and may be considered with a certain probability as being the result of collision.

The pickups (sensors) of the second device, installed directly on satellite's frame, registered 205 signals for 150 hours of operation. The distribution of these signals in time is essentially irregular: 75% of events are observed in a period from 1200 to 2200 hours satellite's local time, while the highest counting rate is observed in the region of satellite entry into the Earth's shadow. The amplitude distribution of pulses has a substantially steeper spectrum than that expected of collisions with micrometeorites. Thus, the amplitude of only one signal exceeds the value, corresponding to the pulse value $5.3 \cdot 10^{-2}$ dyne/sec. One may reliably assert that sensors registered mainly noises of thermal origin arising in the satellite and that it is practically impossible to separate from them the scarce signals corresponding to collisions.

It seems to us that this conclusion may to a greater degree be related to the earlier-conducted experiments, in which no special measures were taken for the protection from such kind of interferences.

Quantitatively, the data obtained by us may be characterized by Table 1.

TABLE I

Device	Exposure	Sensitivity dyne/sec	Collision frequency N, $m^{-2}.sec^{-1}$		
			inc.noise background	without background	computed by lit. data
No.1 sensor in plane	$4,4\cdot10^5$	$6\cdot10^{-3}$	$1,6\cdot10^{-4}$	$4,6\cdot10^{-6}$	$6,2\cdot10^{-3}$
No.2 Sensor	$5,4\cdot10^5$	$7\cdot10^{-3}$	$7,6\cdot10^{-4}$	—	$4,7\cdot10^{-3}$
on frame	$5,4\cdot10^5$	$5,3.10^{-2}$	$3,6\cdot10^{-6}$	—	$1,6\cdot10^{-4}$

The experimental values of N, compiled in Table 1 are multiplied by a factor of 2, so as to take account of shielding by the Earth. It may be seen from Table 1 that our data depart by more than 10^3 times from the results obtained earlier by other methods with the rise of piezoelectric detectors. Even the values of N, computed in the assumption that all registered signals correspond to collisions with micrometeorites, are by 1 to 2 values lower than the estimates according to data of literature.

It is important to note that the estimate $N < 4.6\cdot10^{-6}$ particle m^2-sec obtained by us and corresponding to one possible collision registered by sensors of the first device, agrees well with the data on the frequency of punctures of their shells of gas-filled cells, of wire nets and their condensors obtained on satellites "Explorer-16", "Explorer-23" and "Pegas-I and -2" [6-8]. This eliminates the requirement of artificial explanations of data discrepancies on punctures and collisions [6-8].

From the above, the following conclusions can be derived.

The application of sensors for collision with micrometeorites based upon the registration of mechanical oscullations, requires a number of careful precautions so as to protect the system from interferences of acoustic, thermal and electrical origin.

Starting from the results obtained by us and taking into account the results of laboratory investigations of earlier applied piezoelectric sensors [4], one may assume that in the experiments described in literature the level of interferences is excessively high, so that the values brought out of collision frequency are strongly overrated and do not correspond to reality.

Thus, the existence of a dust cloud around the earth can not be considered as established. Moreover, data of our measurements of collision frequency, in accord with the measurement data of puncture frequency, are much rather evidence of its absence.

Physico-Technical Institute
in the name of A.F. Ioffe
Ac. of Sc., of USSR.

Manuscript received
27 Feb. 1967

* * * THE END * * *

R E F E R E N C E S

[1] W.M. Alexander, O.E. Berg et al., Space Res., III, North-Holland, Amsterdam 1963, p.891
[2] T.N. Nazarova, ... Cosmic Invest., 4, No.6, 900 (1966)
[3] F.L. Whipple, ... Nature, 189, 127 (1961)
[4] C. Nilsson, ... Science, 153, 1242 (1966)
[5] I.I. Shapiro, D.A. Lautman, G. Colombo, J. Geophys. Res., 71, No.23, 5695 (1966)
[6] C.T. D'Aiutolo,.... Space Research, IV, North-Holland, Amsterdam 1964, p.858
[7] R.G. Newswald, ... Space Aeronautics, 45, No.5, 76 (1966)
[8] I.F. Vedder, ... Space Sci., Rev., 6, No.3, 365 (1966)

CONTRACT No.NAS-5-12487
Volt Technical Corp.,
1145 19th Street, N.W.
Washington, D.C. 20036
Telephone: 223-6700 (X 36)

Translated by
Dr. Andre L. Brichant
27 March, 1968

ALB/lf