VERNOV, S. N.

"Interactions of primary cosmic-ray particles of different energies with nuclei in the atmosphere," a paper submitted at the XLI International Conference on Elementary Particles, 12-18 June 1955, Pisa, Italy.

VERNOV, S. N.

6

1RM

2761
A STUDY OF NUCLEON INTERACTION WITH LIGHT
NUCLEI AT THE ENERGY RANGE OF $10^8 \div 10^{12}$ ev. S. N.
Vernov, N. L. Grigorov, G. T. Zatsepin, and A. E.

Chudakov, Lebedev Inst. of Physics, Invest. Akad. Nauk
S.S.R.

Russian)
    Studies of various components of cosmic rays at differ-
ent stratosphere levels revealed the basic characteristics
of interaction processes of nucleons with light nuclei at
various energies. Diagrams and tabulations are presented.
12 references. (R.V.J.)

(3)

PM

VERNOV, S. N., GINZBURG, V. L., KURNOSOVA, L. V., ROZORIONOV, L. A., and FRADKIN, M.

"Study of the Primary Cosmic Radiation by Using Artificial Satellites of the Earth," a paper presented at the 8th International Astronautical Congress, 6-12 Oct 1957, Barcelona.

VERNOV, S·N·

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PHASE I BOOK EXPLOITATION

Vtoroy sovetskiy iskusstvennyy sputnik Zemli; materialy, opublikovannyye v gazete "Pravda" (The Second Soviet Artificial Earth Satellite; Material Published in "Pravda") Moscow, Izd-vo "Pravda", 1957. 47 p. 100,000 copies printed.

PURPOSE: The booklet was written to give the public information on the second artificial earth satellite.

COVERAGE: The book consists of a number of articles on the second sputnik originally published in the Moscow newspaper "Pravda". Basic information on orbit, structure, equipment, performance, and utilization of the sputniks is given. All these data have been repeatedly published elsewhere; therefore, only a few figures are arbitrarily singled out here. The total weight of the scientific apparatus, test animal, and power supply sources of the second sputnik was 508.3 kg. The initial orbital velocity was about 8,000 m per second. The second sputnik circled

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The Second Soviet Artificial Earth Satellite   (Cont.)

the earth initially in 103.7 minutes. Its radio transmitters operated on frequencies of 40.002 and 20.005 megacycles, etc. The last article quotes admiring comments of American, British, French, and Chinese scientists, statesmen, and journalists. The book contains 8 figures.

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Investigations of the Magnetic Pole of the Earth With the Aid of the Sputniks, by S. Dolginov, N. Pushkov, Candidates of Physical and Mathematical Sciences ("Pravda", Oct. 22, 1957) 29

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The Second Soviet Artificial Earth Satellite   (Cont.)

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Around the Earth and Around the Sputniks, by G. Rassadin   46
("Pravda", Nov. 17, 1957)

AVAILABLE: Library of Congress

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53-'B-10/18

AUTHOR
TITLE

VERNOV, S.N., LOGACHEV, Yu.I., CHUDAKOV, A.E., SHAFER, Yu.G.
The Investigation of the Variations of Cosmic Radiation
(Issledovaniye variatsiy kosmicheskogo izlucheniya, Russian)

ABSTRACT

The present paper reports on the problem of the use of an artificial
satellite for the study of the variations of cosmic radiation. By means
of a comparatively simple apparatus consisting of a counter and ioniza-
tion chamber the following phenomena can be studied: a) the variations
of the primary cosmic radiation. b) the variations of the multiply char-
ged component of the primary cosmic radiation which consists of helium
nuclei and heavier atoms. c) the geomagnetic field at great distances
from the earth. d) the albedo of the earth for cosmic radiation. e) the
structure of currents emitted by the sun.

I. Possibilities offered by the artificial earth satellites for the in-
vestigation of the variations. The variations of the secondary cosmic
radiation differ essentially from the variations of the primary radiation.
It is just for that reason that the study of the variations of the pri-
mary radiation is desirable. The variations recorded at sea level are
usually much smaller than the variations of primary radiation. The mea-
surements obtained by means of rockets are very inaccurate because of
the short stay of the rockets in high altitudes, but artificial earth

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The Investigation of the Variations of Cosmic Radiation

satellites offer great possibilities in this respect. Simultaneous measurements by counters and ionization chambers make a comparison of the variation of intensity of the primary protons with the variation of the intensity of the heavier primary nuclei possible. The variations have to be determined in the various regions of the energy spectrum of cosmic radiation. This is only possible on satellites with suitably selected orbits. The measurements of the intensity above the polar regions are of special interest.

II. The various phenomena which can be studied by an apparatus fixed in the satellite. The authors here consider the case that the satellite flies over the poles and is half of the time in the earth's shadow. Further, the measurement data can be transmitted during the entire time of the satellite's existence. The experimental material thus obtained on one single day by far surpasses the hitherto existing material this field. By a comparison of the material obtained from various revolutions and on various days the variations of intensity of the cosmic radiation can be concluded. If the data for the intensity and for the ionization power of cosmic radion over the entire surface of the globe is available, interesting conclusions concerning the following phenomena may be drawn:

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The Investigation of the Variations of Cosmic Radiation

1.) the alteration of intensity in time (great irregularities of in-
tensity in connection with eruptions of the solar chromosphere, reduc-
tion of intensity during magnetic storms, the variation (one and a half
hour variation)) connected with the revolution of the satellite round
the earth, the variations of intensity of the heavy nuclei of primary
cosmic radiation, the long-time periodic variations, the experimental
verification of the conncetion between primary and secondary variations.
2.) the earthmagnetic field and the interplanetary magnetic field.
3.) the alteration of the earth's albedo for cosnic radiation. 4.) the
search for electrons and photon in the primary cosmic radiation.

III. The apparatus for the study of the variations of cosmic radiation
outside the earth's atmosphere can determine these variations by mea-
suring the variations of the ionization or the variations of particles
passing through a counter. The influence of a possible revolution of
the satellite is pointed out, but this variation can at least partially
be compensated by fixing two counters to the satellite. For the radio-
technical equipment semiconductor triodes and tiratrones with a cold
cathode are used. The following elements of the apparatus are discussed
more in details: a) the counters of the charged particles, and b) the

Card 3/4

53-1±-1C/18

The Investigation of the Variations of Cosmic Radiation
counting method by means of semicondcutor triodes. (5 illustrations)

ASSOCIATION   Not given
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AVAILABLE   Library of Congress

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$\mathcal{VLRNOV, SN}$

53-1a-9/18

- AUTHOR   VERNOV, S.N., GINZBURG, V.L., KURNOSOVA, L.V., RAZOREKOV, L.A.,
            FRADKIN, M.I.

TITLE   The Investigation of the Composition of Primary Cosmic Radiation
            (Issledovaniye sostava pervichnogo kosmicheskogo izlucheniya. Russian)

PERIODICAL Uspekhi Fiz. Nauk, 1957, Vol 63, Nr 1a, pp 131 - Nr 1b ; p 148 (U.S.S.R.)

ABSTRACT   According to the data available at present, cosmic radiation consists
            of protons, α-particles and, to a far less extent, of heavy nuclei.
            The distribution of the nuclei with $Z > 2$ has as yet not been investi-
            gated sufficiently well and also other problems are still to be solved.
            Rockets are not suited for such measurements because their time of flight
            outside the atmosphere is too short. By means of artificial earth satel-
            lites, however, the necessary statistical material for the investigation
            of rarely occurring heavy nuclei can be obtained. One of the most im-
            portant problems concerns the numerical ratio between the currents of
            the light nuclei Li, Be, B and the nuclei C, N, O, F. By experimental
            determination of this ratio the various theories concerning the creation
            of cosmic radiation can be confirmed or rejected, If the particles of
            the cosmic radiation in the clouds of the supernovae are accelerated,
            a value $\geq 0,1$ is obtained for the ratio (Li, Be, B) / (C, N, O, F). In
            the case of this theory the ratio can also be somewhat higher, but never
            lower than 0,1. The data at present obtained for this ratio contradict
            each other. The problem whether or not nuclei with $Z > 30$ exist in cos-

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53-1a-9/18

The Investigation of the Composition of Primary Cosmic Radiation

mic radiation can also be solved by means of artificial earth satellites.
The existence of such nuclei in cosmic radiation would, on account of
its large interaction cross section and the short range in the inter-
stellar space, indicate an exceptionally large amount of heavy elements
existing in the sources of cosmic radiation.

The experimental data on the composition of primary radiation.
The results of the experiments carried out in 1952 - 1953 have already
been published in form of a collection of articles. The respective re-
sults obtained within the last years have been compiled in two tables.
The importance of the geographical location of the place of observation
in the case of equal geomagnetic latitude is pointed out. From the point
of view of determining the energy spectrum of the various nuclear groups
in primary cosmic radiation, with the help of artificial earth satelli-
tes afford great possibilities, because in this way the intensity of
the fluxes of the particles with various energies (even at different
widths) can be determined by means of the same devices. This, naturally,
will considerably increase the reliability of the data obtained con-
cerning the energy spectrum of the primary nuclei. One of the most in-
teresting problems of primary cosmic radiation is the determination of

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The Investigation of the Composition of Primary Cosmic Radiation

the amount of the nuclei of the group Li, Be, B.   53-1a-9/18

The experimental method for the study of the charge spectrum of nuclei in primary cosmic radiation. Such methods are of advantage as do not discriminate the particles with respect to their charge and mass. The use of particle counters in the case of which, on the occasion of the passage of a particle, the produced pulse depends upon the charge of the particle, forms part of this method. The application of such devices to an artificial earth satellite is, besides, of advantage in-so-far as the measured data can be telegraphed to the earth. The disadvantages of methods which are based upon the ionization of a medium by rapidly charged particles, are enumerated. The CHEREKOV counter is free from such disadvantages. The conditions to be fulfilled when measuring by this method, are enumerated. The apparatus is disdussed on the basis of a drawing. During the time of observation of one week about 1000 nuclei with $Z \geqslant 6$ cm, 7000 α-particles and a corresponding number of Li-, Be- and B-nuclei can be registered. For the experiments it is intended to register the differential spectrum of the nuclei with respect to Z in the interval from the α-particle up to oxygen. Such a method is realizeable only if the device is able to solve every peak belonging to the various values of Z. The use of artificial satellites offers new possi-

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The Investigation of the Composition of Primary Cosmic Radiation   53-12-9/13

bilities for the investigation of the primary cosmic radiation: viz.
measuring of the primary proton flux, explaining of the part played by
the "albedo" of the atmosphere of the earth, the determination of the
lower limit of the electron-positron components, the study of the inter-
action of the primary particles with matter and the variations with re-
spect to time of intensity. (With 7 illustrations and 4 tables).

ASSOCIATION
PRESENTED BY   Not given
SUBMITTED
AVAILABLE
                      Library of Congress
Card 4/4

AUTHORS: Vernov, S. N., Corresponding Member,   SOV/20-120-6-18/59
            Academy of Sciences, USSR, Grigorov, N. L., Logachev, Yu. I.
            Chudakov, A. Ye.

TITLE: Measurement of Cosmic Radiation by the Sputnik (Izmereniye kos-
            micheskogo izlucheniya na iskusstvennom sputnike zemli)

ABSTRACT: The results discussed in this paper were obtained by
            equipment incorporated in the second earth   satellite. In
            order to be able to record the variations of the intensity of
            the cosmic radiation in a reliable manner two similar counters
            for charged particles (with a length of 100 mm and a diameter
            of 18 mm) was mounted in the sputnik. Both devices contained
            counters operating on the basis of semi-conductor triodes. The
            power consumption of the whole apparatus was 0,15 Watts. The
            batteries permitted   continuous operation for 200 hours. The
            relative increase of the intensity with   altitude was com-
            puted from the ratio of the intensity of cosmic radiation on the
            "inverse loops" (passage from the North to the South, at an
            altitude of 350 - 700 km) and the intensity on the "direct loops"

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Measurement of Cosmic Radiation by the Sputnik   SOV/2o-12o-6-18/59

(passage from the South to the North at an altitude of 225 - 240 km) measured at the same geographical points. This variation can be caused by at least three effects: 1) An increase of intensity due to a reduction of the shielding by the earth. 2) A reduction of the intensity by the weakening of the earth's magnetic field 3) By a variation in the albedo of the cosmic radiation. The dependence of the intensity upon the altitude can be explained by the first two effects. From the data obtained by the measurements of many loops the lines of equal intensity of cosmic radiation (isocosmic lines) are obtained. Such isocosmic lines are presented for three different counting rates. The experimental points above all fit upon the geographical parallels. The line of the minimum intensity of cosmic radiation (the "cosmic equator") does not coincide with the geomagnetic equator. According to the evidence obtained the intensity of the cosmic radiation sometimes increased considerably. During this the intensity fluctuated very much. There are 4 figures and 3 references, 1 of which is Soviet.

SUBMITTED: May 4, 1958
Card 2/3

21(7)

AUTHORS:

Vernov, S. N., Corresponding Member,
Academy of Sciences, USSR, Tulinov, V. F., Charakhch'yan,
A. N.

SOV/20-122-5-11/56

TITLE: The 27-Day Variations of the Intensity of Cosmic
Radiations in the Stratosphere (27-dnevnyye variatsii
intensivnosti kosmicheskikh luchey v stratosfere)

ABSTRACT: The authors carried out a long series of measurements
of the intensity of cosmic radiation in the strato-
sphere by means of spherical probes. These
measurements form part of the program of the Inter-
national Geophysical Year; they were duly begun
on July 1, 1957 at two geomagnetic latitudes: 1)
near Moscow ($\lambda = 51°$, station Dolgoprudnaya, Nauchnaya
stantsiya Fizicheskogo instituta AN SSSR)(Scientific
Station of the Physics Institute AS USSR) and 2)
near Murmansk ($\lambda = 64°$, station Loparskaya, Severnaya

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The 27-Day Variations of the Intensity of Cosmic   SOV/20-122-5-11/56
Radiations in the Stratosphere

Nauchnaya Stantsiya AN SSSR (Northern Scientific
Station AS USSR)). The present paper gives some
results obtained by measurements carried out at
the latitude of 51° from July 1, 1957 to February 1, 1958,
and at the latitude of 64° from July 1, 1957 to
October 1, 1957. These measurements were carried out
by means of the radiometeorograph RK-1, which
contained a thin-walled self-quenched counter of the
type STS-6. The pulses of this counter were trans-
mitted by means of a radio-transmitter. A short
report is made on the measurements of the height
and on the gauging of the counters. The authors
describe the results relating to the maximum of the
intensity curve in the pressure interval of   50-90
g/cm^2. These results, which are shown by a diagram,
seem to indicate a periodicity in the variations
of the intensity of cosmic radiation in the strato-
sphere, viz. for both of the aforementioned latitudes.
In the stratosphere the amplitude of the wave is
Card 2/4   from 5 to 10 times as great as the amplitude of the

The 27-Day Variations of the Intensity of Cosmic   SOV/20-122-5-11/56
Radiations in the Stratosphere

wave on sea level. Therefore the variations investigated
are to a great extent caused by the primary cosmic particles
of low energies. According to the data available for
magnetic storms there is not in every case a connection
between the variation of the intensity of cosmic
radiation and the existence of magnetic storms.   A
semiperiod of the aforementioned variations lasted
14.3 ± 1 days. Next, a procedure for the more exact
determination of this period is discussed. The authors
thank P.N.Ageshin, V.V.Bayarevich, A.G.Bednyakov,
V.A.Gladyshev, A.N.Istratova, A.F.Krasotkin, Yu.N.
Komarov, F.Kh.Mochakov, I.K.Marshanov, and G.V. Chur-
banova for preparing the apparatus and for carrying out
the experiments; they further thank Ye.S.Glokova. L.I.
Dorman, and A.Ye.Chudakov for their discuss ng the
results obtained .. There are 3 figures and 5 refer-
ences, 2 of which are Soviet.

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The 27-Day Variations of the Intensity of Cosmic   SOV/20-122-5-11/56
Radiations in the Stratosphere

ASSOCIATION: Fizicheskiy institut im. P.N.Lebedeva Akademii nauk SSSR
              (Physics Institute imeni P.N.Lebedev of the Academy
              of Sciences USSR)

SUBMITTED: May 24, 1958

Card 4/4

VERKOV, S.N.; VAKULOV, P.V.; GORCHAKOV, Ye.V.; LOGACHEV, Yu.I.;
CHUDAKOV, A.Ye.

Studying the soft component of cosmic rays beyond the atmosphere
limit. Isk.sput.Zem. no.2:61-69 '58.   (MIRA 12:5)
            (Cosmic rays) (Artificial satellites)

VERNOV, S. N.

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VERNOV   S N.

29(0)   PHASE I BOOK EXPLOITATION   SOV/1658

Akademiya nauk SSSR

Iskusstvennyye sputniki zemli, vyp. 1: Rezul'taty nauchnykh issledovaniy, prove-
    dennykh po programe MGG pri pomoshchi pervogo i vtorogo iskusstvennykh
    sputnikov zemli (Artificial Earth Satellites, Nr 1: Results of Scientific
    Studies Carried Out in Accordance With the IGY Program by Means of the First
    and Second Artificial Earth Satellites) Moscow, Izd-vo AN SSSR, 1958. 95 p.
    3,500 copies printed. [Microfilm and Zerox Copy]

Resp. Ed.: L.V. Kurnosova; Ed. of Publishing House: D.M. Alekseyev; Tech. Ed.:
    T.V. Polyakova.

PURPOSE: This collection of articles is the first in a series to be published
    regularly and is intended to disseminate to the scientific community data col-
    lected in investigations performed by means of artificial earth satellites.

COVERAGE:This collection includes papers covering scientific data obtained from
    the first and second Soviet artificial earth satellites. Among the areas
    reported on are measurements of cosmic radiation, atmospheric density, electron

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Artificial Earth Satellites (Cont.)   SOV/1658

concentration in the ionosphere, and biological studies of an animal occupant
of a satellite. Papers on the motions and perturbations of satellite orbits
and optical and Doppler methods of satellite tracking are also included. Cover-
age of the individual articles is given in the Table of Contents.

TABLE OF CONTENTS:

    This paper was first published in Doklady Akademii Nauk USSR Vol. 120,
    Nr 6, 1958, pp. 1231-1233. The paper presents preliminary results of
    measurements of cosmic-ray intensity obtained with instruments installed
    in Sputnik II. The close agreement of data from two separate instruments
    indicates the validity of these results. A brief description of the
    instruments and their operational characteristic are given. Since
    the ascending and decending segment of the orbit occurred at consider-
    ably different altitudes, it was possible to determine the relative

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Artificial Earth Satellites (Cont.)   SOV/1658

variation of cosmic-ray intensity as a function of altitude for the same
geographic points. The intensity was found to increase considerably between
225 and 700 km, the highest altitude achieved by the satellite. This vari-
ation is attributed to three causes: a) decreased screening by the earth,
b) reduction in the magnetic field of the earth permitting penetration of
lower-energy particles, and c) change in the albedo of cosmic radiation.   5
There are 3 references, 1 of which is Soviet, 1 English, 1 a trans-
lation from English.

Lidov, M.L. Determination of the Density of the Atmosphere From the
Observed Decelerations of the First Artificial Satellites   9
This paper presents equations relating the elements of a satellite orbit
to atmospheric density. The analytical procedures used in reducing
observed data on the evolution of the satellite orbit are given includ-
ing an evaluation of the approximations used in obtaining solutions to
the equations involved. It was assumed that in the range of altitudes
considered (228-368 km) the variation of density with altitude could be
approximated by the exponential function $\rho = \rho_\pi e^{-\frac{z - z_\pi}{H}}$

where ρ is the density at altitude z, ρ_π is the density at the
perigee altitude z$_\pi$, and H is the altitude of the homogeneous
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VERNOV, S. N. and CHUDAKOV, A.,

"Cosmic Ray and Photon Measurements from Satellites," paper presented at 10th
General Assembly, Int'l Astronomical Union, Moscow, Aug 1958.

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A005/A001

AUTHORS: Blokh, Ya. L., Vernov, S. N., Dorman, L. I., Dubrovin, M. M.

TITLE: Preliminary Results of an Investigation of the Underground Variations
             of Cosmic Rays

PERIODICAL: V sb.: Variatsii kosmich. luchey pod zemley, na urovne morya i v
             stratosfere. No. 1, Moscow, AN SSSR, 1959, pp. 37-47

TEXT: The variations of the cosmic ray intensity are investigated on the
basis of data obtained from a counter telescope of triple coincidences, which was
located under the earth's surface at the depth of 40 m of water equivalent. By
the simple-correlation method the value of the barometric coefficient $\beta = (0.021 \pm
0.008)$ %/mb was obtained. The diurnal variation of the underground intensity
amounts to about 0.05%. By averaging the data it is shown that the average effect
at the depth of 40 m of water equivalent amounts to 0.3% during 11 events of
decreases of the Forbush type. The investigation of the disturbed diurnal varia-
tions in the cosmic ray intensity was also carried out.   N. K.
Translator's note: This is the full translation of the original Russian abstract.

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21(6)

AUTHORS: Vernov, S. N., Corresponding Member,   SOV/20-124-5-17/62
AS USSR, Grigorov, N. L., Ivanenko, I. P., Lebedinskiy,
A. I., Murzin, V. S., Chudakov, A. Ye.

TITLE: A Possible Mechanism of the Production of "Terrestrial
Corpuscular Radiation" Under the Action of Cosmic Rays
(Vozmozhnyy mekhanizm sozdaniya "zemnogo korpuskulyarnogo
izlucheniya" pod deystviyem kosmicheskikh luchey)

ABSTRACT: By "terrestrial corpuscular radiation" the authors mean
the fluxes of particles moving in the terrestrial magnetic
field along closed orbits. According to the authors'
opinion, the following radiation production mechanism
deserves the most attention: Under the action of cosmic
radiation, the earth, like any other celestial body,
becomes a neutron source. The neutrons traverse the
magnetic field without being disturbed as uncharged
particles and attain great distances from the earth.
The charged particles originating from neutron decay move
in the magnetic field along the lines of force. The particle
Card 1/4   in the course of time reaches the region of high geomagnetic

A Possible Mechanism of the Production of "Terrestrial   SOV/20-124-5-17/62
Corpuscular Radiation" Under the Action of Cosmic Rays

latitudes, where fieldstrength increases considerably
with increasing latitude. In this region the velocity
vector of the particle will, as the particle approaches
the earth, turn so long with respect to the vector $\vec{H}$,
until at the latitude λ_{max} the angle between the
velocity of the particle and the vector $\vec{H}$ becomes equal
to $90°$. At this point the particle returns and begins
to move in the rear direction along the same magnetic
line of force. If conditions are favourable, the decay
products of the neutrons may perform 10^8 and more
oscillations between the northern and the southern
turning point. Therefore, the intensity of the flux of
these particles increases by the same amount. Experimental
data indicate the existence of such a radiation. The
present paper carries out a closer investigation in order
to find out by what factors the intensity of these rays
is determined. Calculation is followed step by step. The
authors calculate the intensity of the "terrestrial

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A Possible Mechanism of the Production of "Terrestrial   SOV/20-124-5-17/62
Corpuscular Radiation" Under the Action of Cosmic Rays

corpuscular radiation" for various heights and latitudes;
the results obtained by these calculations are shown by
a diagram. They lead to the following conclusions:
Although the number of neutrons decaying in the earth is
very small, they may cause intensive cosmic radiation. The
experimentally determined intensity is by ∼ 100 times
lower near the equator than calculated intensity. According
to experimental data there is no terrestrial corpuscular
radiation in geomagnetic latitudes above 40°, but in the

present paper $j(\lambda = 40°) \sim j(\lambda = 0°)$ is obtained. This

means non-agreement by more than 10^5 times the amount. In
order to reestablish agreement with the experiment, it is
useful to assume an additional flux of particles from
"magnetic traps", which are particularly strong in large
latitudes. This may be due to the existence of electric
fields. This assumption also appears to be confirmed by
the data concerning the considerable increase of
perturbations of the terrestrial magnetic field with
increasing latitude. With increasing latitude, the
interdictions imposed upon energy by Stoermer's theory
are being disobeyed to an ever-increasing extent. The

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A Possible Mechanism of the Production of "Terrestrial   SOV/20-124-5-17/62
Corpuscular Radiation" Under the Action of Cosmic Rays

mechanism discussed in the present paper must apply
also in the neighborhood of astrophysical objects having
a magnetic field. Therefore, the investigation of this
radiation in the neighborhood of planets may be a means
of observing weak magnetic fields. The authors thank
D. V. Skobel'tsyn for his advice and M. S. Rabinovich
for discussions. There are 2 figures and 7 Soviet references.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet im. M. V.
Lomonosova (Moscow State University imeni M. V.
Lomonosov)

SUBMITTED: November 21, 1958

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SOV/20-125-2-16/64

24(7),24(8)
AUTHORS:

Vernov, S.N., Corresponding Member, AS USSR,
Chudakov, A.Ye., Vakulov,P.V., Logachev, Yu.I.

TITLE: Investigation of   Terrestrial Corpuscular Radiation and of
Cosmic Rays During the Flight of a Cosmic Rocket (Izucheniye
zemnogo korpuskulyarnogo izlucheniya i kosmicheskikh luchey pri
polete kosmicheskoy rakety)

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 125, Nr 2, pp 304 - 307 (USSR)

ABSTRACT: The rocket launched on January 2, 1959 in the direction of the
moon had apparatus for recording cosmic- and terrestrial corpuscular
radiation on board. By the latter the authors mean the fluxes of
fast charged particles in great altitudes, for which the terrestrial
magnetic field is a so-called "magnetic trap". The particles were
recorded by 2 Geiger-counters and 2 scintillation-counters. The
first apparatus, with scintillation counter, was a constructive
further-development of the device which the authors had built into
the third Soviet Sputnik. A cylindrical sodium-iodide crystal
served as a detector. The authors, above all, described the results
obtained by the preliminary evaluation of the data ascertained in
altitudes of from 8000 to 150000 km (from the center of the earth).
A schematical drawing shows the trajectory of the rocket with

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Investigation of   Terrestrial Corpuscular   SOV/20-125-2-16/64
Radiation and of   Cosmic Rays During the Flight of a Cosmic Rocket

respect to the terrestrial magnetic field. The intensity maximum
is ~26000 km from the center of the earth. At a distance of 55000 km
the intensity of terrestrial corpuscular radiation becomes practically
equal to zero, and the remaining ionization in this distance is
entirely due to cosmic radiation. According to the authors' opinion
the particles oscillate along the lines of force symmetrically to
the equatorial plane. The increase of intensity along a given line
of force in the transition from low to high altitudes serves as an
experimental proof for this assumption. The particle flux is directed
not only towards one side, and, in any case, the predominant part
of the particles undergoes complete reflection when approaching
the earth, and is therefore subjected to oscillations from one
hemisphere to the other. The trajectory of the rocket nowhere
intersects the so-called internal zone. . Actually, the apparatus
built into the cosmic rocket in no range of their trajectory
record particles of high energy which are characteristic of the
inner zone. On the other hand, the composition of radiation is very
similar to that observed by means of the third Sputnik in polar
Card 2/3   regions. Next, the composition of radiation in the outer zone with

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Radiation and of   Cosmic Rays During the Flight of a Cosmic Rocket

high intensity is dealt with. In the center of the outer zone,
where particle density is the greatest, the effective energy of
electrons is minimal. In conclusion, cosmic radiation is dealt
with. Beginning with a distance of 66000 km, the intensity of
all components remains constant. The strict constants of all
components at distances of from 66000 to 150000 km indicates
the existence of a radiation upon which the terrestrial magnetic
field exercises no influence. Therefore, either the terrestrial
magnetic field vanishes at a distance of 10 earth-radii, or
there are no particles with momenta of

$1.5.10^8$ to 4.10^7 ev/c in interplanetary space. The energy-flux
of the photons is very low and contributes partly nothing to
ionization. There are 2 figures and 4 Soviet references.

SUBMITTED: February 25, 1959

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VERNOV, S.

PHASE I BOOK EXPLOITATION   SOV/4890

Pravda

Besprimernyy nauchnyy podvig; materialy gazety "Pravda" o trekh sovetskikh
    kosmicheskikh raketakh (Unparalleled Scientific Achievement: Materials From
    "Pravda" on 3 Soviet Cosmic Rockets) Moscow, Gos. izd-vo fiziko-matematicheskoy
    lit-ry, 1959. 202 p. 50,000 copies printed.

PURPOSE: This book is intended for the general reader.

COVERAGE: The book contains articles from "Pravda", announcing the launching of
    three Soviet cosmic rockets on 2 January, 12 September, and 4 October 1959.
    Articles which describe details and observations of the flights of the rockets
    are included and are illustrated by diagrams and photographs. The book contains
    nontechnical contributions by several Soviet scientists. No personalities are
    mentioned. There are no references.

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THIRD SOVIET COSMIC ROCKET

AVAILABLE: Library of Congress (TL796.5.R8P66)

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31519
S/627/60/002/000/001/027
D299/D304

3.2410 (1559, 2205, 2705, 2805)

AUTHORS: Vernov, S. N., Khristiansen, G. B., Abrosimov, A. T.,
Goryunov, N. N., Dmitriyev, V. A., Kulikov, G. B.,
Nechin, Yu. A., Sokolov, S. P. (deceased), Solov'yeva,
V. I., Solov'yev, K. I., Strugals'kiy, Z. S., and
Khrenov, B. A.

TITLE: General description of the setup used for studying ex-
tensive air showers and the provisional results ob-
tained

SOURCE: International Conference on Cosmic Radiation. Moscow,
1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kas-
kadnyye protesessy, 5-16

TEXT: A complex experimental setup was installed at Moscow State
University, consisting of a simultaneously operating physical appa-
ratus plus the corresponding radiotechnical equipment and photo-
graphical recording devices. The setup incorporates over 5000 Gei-
ger-Müller counters (forming a hodoscope), about 150 ionization

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General description of the setup...

chambers and a large diffusion chamber. The setup is designed for a comprehensive and simultaneous investigation of all the basic components (electrons and photons, nuclear-active particles and μ-mesons) of extensive air showers at sea level. The setup was designed in 2 different configurations: the first at the end of 1957, and the second at the beginning of 1959. Below, only the results obtained by means of the first setup are considered. The setup was located in a special building and in 10 mobile laboratories. The showers were registered by the system of hodoscoped counters. Part of the counters were shielded (those for detecting the nuclearactive particles and the μ-mesons) and the other counters were not shielded. The ionization chambers served to determine the lateral distribution of the electron-photon component and of the nuclearactive component. The microstructure of the electron component was studied by means of the diffusion chamber. Special measures were taken to ensure continuous and prolonged operation of the setup. The main units of the setup were automatically controlled, in particular the supply units and the photography system. The operation of the setup (as a whole) was controlled (triggered) by a selection system; in parti-

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General description of the setup ...

cular, the showers were selected in accordance with the density of the electron flow and of the μ-mesons. The setup was in operation for about 2500 hours, yielding a large amount of experimental data which are still being processed. The probability theory (Baye's theorem) was used for determining the (x,y)-axes and the number of particles N of the shower; in addition the distribution function f(r) as well as other distribution functions were determined (r denoting distance). The values of x, y and N were found by means of a special electronic simulator. The density distribution of electrons and mesons was determined by means of formula

$$W(\rho) = \prod_i \left[1 - \exp(-\rho\sigma_i)\right]^{m_i} \cdot \exp\left[-\rho\sigma_i(n_i - m_i)\right]$$

where m_i is the number of counters which operate over an area σ_i, and n_i – the overall number of such counters. The energy E of the electron-photon component was determined by means of ionization

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General description of the setup ...

chambers, shielded with lead (up to 6 cm thick). A very comprehen-
sive picture of the particles and energies was obtained for showers
whose axes fell within the system of 128 cubic detection chambers.
The setup permits observing the central part of an atmospheric
shower, whereby its several layers are simultaneously observed;
this corresponds to the individual observation of the electron-
photon, nuclearactive and μ-meson components. The processed mate-
rial already yielded a fairly detailed picture of the structure of
extensive air showers at sea level. Thus, the lateral distribution
of particle flow in the individual showers was ascertained. It was
found that the lateral distribution varies (in the 1 to 25 m range)
from shower to shower; the average distribution is, in the range of
5 cm to 100 m, as follows:

$$\rho(r) = \left\{ \frac{K_1 N}{r^{0,6}} \quad K_1 = 3,3 \cdot 10^{-3}, \ 0,05 < r < 0,3 \text{ m} \right.$$

(cont'd)

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General description of the setup ...

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$$\left. \frac{K_2 N}{r} \cdot e^{-\frac{r}{60}} \right., \quad K_2 = 2 \cdot 10^{-3}, \quad 0,3 \langle r \langle 100 \text{ m}$$

The lateral distribution of the electron-photon components also fluctuates from shower to shower. At distances smaller than 1.5 m, these fluctuations are particularly sharp. The nuclearactive components also exhibits considerable energy fluctuations. The fluctuations in the high-energy μ-mesons were not yet analyzed. The energy of the electron-photon component E_{eph} was calculated for a shower with number of particles equal to $(2.7\pm0.2) \cdot N\beta$, where β is the critical energy for air (72 Mev). The above value was obtained with an accuracy of appr. 30%. It was found that the energy of the nuclearactive component $E_n \simeq (0.5 \text{ to } 1.0)E_{eph}$. This value is, however, subject to considerable fluctuations and the experimental data are as yet insufficient to determine the contribution of the

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General description of the setup...

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nuclearactive component in showers. In addition, the above-mentioned fluctuations severely delimit the choice of a theoretical model for the development of showers. Particular attention was devoted to the structure of the shower in the immediate vicinity of its axis, where the particles of highest (for the particular shower) energy should be concentrated. This led to the discovery of a new effect: Groups of particles (from 4 to 20) travel in narrow beams (not exceeding 8 cm in diameter) in the neighborhood of the axis (or along the axis itself), whereby their lateral distribution shows that the beams are not due to Poisson fluctuations. The new effect can be explained as follows: Either the beam is the core of a "young" electron-photon shower which originates from a high-energy π^0-mesor at a certain distance from the apparatus, or the beam consists of μ-mesons. These two possibilities are discussed. The observed irregularity in the lateral distribution of μ-mesons in the vicinity of the shower axis might be related to the new effect. There are 6 figures and 2 tables.

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General description of the setup ...   D299/D304

ASSOCIATION: Nauchno-issledovatl'skiy institut yadernoy fiziki
              MGU, Moskva (Scientific Research Institute of Nucle-
              ar Physics Moscow State University, Moscow)

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31526
S/627/60/002/000/008/027
D299/D305

3, 2410 (1559, 2205, 1705)

AUTHORS: Vernov, S. N., Goryunov, N. N., Dmitriyev, V. A., Kulikov, G. V., Nechin, Yu. A., Solov"yeva, V. I., Strugal'skiy, Z.S., and Khristiansen, G. B.

TITLE: Study of lateral-distribution function of charged particles and of the energy density of the electron-photon component of extensive air showers

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protsessy, 117-122

TEXT: The data obtained by means of the diffusion chamber and the hodoscoped counters permit determining the particle distribution in the neighborhood of the shower axis as well as at large distances from it. These data can be used for determining the number of particles and the position of the axis to an accuracy of approximately 1 m by means of the hodoscoped counters, and to an accuracy of several centimeters if the axis lies within the limits of the diffu-

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Study of lateral-distribution ...

sion chamber. The electron-photon component at large distances from the axis was studied by means of large ionization chambers, shielded with lead. During 1000 hours of operation, 28 cases were recorded of the axis (of showers with number of particles $N \geqslant 10^5$) passing through the core detector. All these showers were investigated in detail with respect to distribution and energy of particles. The cases most favorable for analysis are those, in which the shower axis lies in the diffusion chamber. In all, 7 such cases were recorded. For each of these showers, the lateral-distribution function of particle density was constructed for distances ranging from 5 cm to 1 m from the shower axis. It was found that the form of the distribution function varied from shower to shower in the core region. In that region, a peculiar feature of particle distribution was observed, namely a narrow beam (4 cm in diameter) of particles, consisting of a large number (4 to 15) of particles with collinear tracks. From data obtained by means of the hodoscoped counters and knowing the position of the shower axis, it is possible to construct the distribution function of charged particles up to a distance of r = 25 m. from the axis, for each individual

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shower. Then the experimental distribution functions were compared with the theoretical functions of Nishimura and Kamata. The results of the comparison are shown in a table. A difference was noted in the form of the distribution of the energy flux of the electron-photon component in the individual shower at a distance of $r \sim 1$ m, and at large distances from the axis; this is due to local fluctuations in the form of the energy distribution in the core. In each of the investigated showers, the energy flux of the electron-photon component was found within a radius of 25 m; it turned out that the electron-photon component energy-flux was stronger (on the average) in showers with small s, than in showers with large s (s being the "age parameter"). The system of counters permitted recording showers with number of particles $N = 10^4$ to 10^7. The data yielded by the diffusion chamber were used for constructing the distribution function for distances $r < 1$ m from the shower axis. The conclusion was reached that the form of the electron-photon energy distribution-function does not depend on the number of particles in the shower. Therefore, all the data were referred to a shower with same N, and the average energy-density distribu-

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tion constructed. Approximating this distribution by a power law of type r^{-n}, one obtains for the exponent n the following values (as a function of the distance r from the axis):

$$n = 1,2 \pm 0,2, \qquad 0,1 < r < 1 \text{ m}$$

$$n = 1,5 \pm 0,2, \qquad 1 < r < 10 \text{ m}$$

$$n = 2,0 \pm 0,3, \qquad 10 < r < 60 \text{ m}$$

$$n = 2,6 \pm 0,2, \qquad 60 < r < 1000 \text{ m}$$

Further, the mean energy per electron was obtained from experimental and theoretical values (based on the cascade shower theory) of the mean energy as a function of r showed a discrepancy which can be removed by taking into account the effect of nuclear scattering. The experimental values permit calculating the energy of the

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Study of the lateral-distribution ...   D299/D305

electron-photon component, viz. E_{eph} = 2.5 βN, where β denotes the mean energy loss per unit of depth t. There are 2 figures, 1 table and 6 references: 5 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: J. Nishimura, K. Kamata. Suppl. Theor. Phys., no. 6, 1958.

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31527
S/627/60/002/000/009/027
D299/D305

3,2410(1559, 2705, 2805)

AUTHORS: Vernov, S. N., Goryunov, N. N., Dmitriyev, V. A., Ku-
            likov, G. V., Nechin, Yu. A., and Khristiansen, G. B.

TITLE: Study of high-energy nuclearactive component of exten-
            sive air showers at sea level

SOURCE: International Conference on Cosmic Radiation. Moscow,
            1959, Trudy. v. 2. Shirokiye atmosfernyye livni i kas-
            kadnyye protsessy, 123-131

TEXT: The high-energy nuclearactive component was studied by the
apparatus of Moscow State University. The nuclearactive component
was detected and measured by means of hodoscoped counters and ioni-
zation chambers. The processed hodoscope data permitted determining
the total number of particles N and the distance R_i of the shower
axis from the ionization chambers. Part of the data were processed
by the electronic computer of Moscow State University; thereby the
number of particles was determined to an accuracy of approximately

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Study of high-energy ...

20%, and the position of the axis to within 0.25 m, provided it fell inside the area of a detector of 4 m^2. The joint processing of the data of the hodoscope and ionization chambers yielded the mean energy of the nuclearactive component of showers of various number of particles, the energy spectra of the nuclearactive particles in the central part of the shower, the lateral distribution of the energy flux carried by the nuclearactive component in the central part of the shower and the lateral distribution of the nuclearactive particles. Showers, whose axes were at a distance of less than 10 m from the detector of nuclearactive particles, were selected for further study. These showers were divided into 4 groups according to number of particles; over 1000 such showers were investigated. The integral spectra of nuclearactive particles of energies $E_{na} \leqslant 10^{12}$ ev. were obtained for the 4 groups. The integral spectra of nuclearactive particles, averaged over the showers of all the groups, can be approximated by an exponential function with exponent $\gamma = -1.0 \pm 0.2$. For showers with large N (group 4), the value of γ shows a decreasing tendency. The space distribution of the energy flux near the

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Study of high-energy ...

axis can be approximated by an exponential function with exponent
$n = -1.5 \pm 0.2$. A typical correlation was established between the
electron-photon and the nuclearactive components of cores of the in-
dividual showers, namely showers with an electron-photon component
of an energy much higher than the average, have (as a rule) a nu-
clearactive component of lesser energy. The converse was also ob-
served. The measurements gave direct evidence of the presence of nu-
clearactive particles of high-energy ($\sim 10^{12}$ ev.) in showers at sea
level, and of the considerable importance of the nuclearactive com-
ponent in the energy balance of the shower. The nuclearactive com-
ponent in the central part of the shower carries an energy which is
(on the average) almost as large as the entire energy of the elec-
tron-photon component at the level of observation. The presence of
considerable energy in the nuclearactive component affects the ab-
sorption of particles in the shower. The development of individual
showers can differ considerably, as the magnitude of the energy of
the nuclearactive component differs considerably in the individual
showers. The main contribution to the energy flux carried by the nu-

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clearactive component within a circle of given radius is made by
high-energy particles, whose lateral distribution is such that, on
the average, all the particles with energy $>10^{12}$ ev. are contained
in a circle of radius $r = 1$ m. The distribution of the energy flux
carried by the nuclearactive component showed that this flux is
fairly widely distributed. Further, the transverse momentum im-
parted to the particles (during their generation), was estimated.
The nuclearactive component of showers with $N = 10^4$ to 10^6 at sea
level carries an energy of 0.5 to 1.0 of the total energy, carried
by the electron-photon component. As a result of the energy fluctu-
ations of the nuclearactive component in the individual showers, the
development of the showers fluctuates, too. The distribution of the
energy flux of the nuclearactive component over a region of $1 < r < 20$ m
near the axis is described by the law $r^{-2 \pm 0.25}$; such a distribution
should affect the characteristics of the soft component. There are
4 figures, 1 table and 10 references: 9 Soviet-bloc and 1 non-So-
viet-bloc. The reference to the English-language publication reads
as follows: J. Nishimura, K. Kamanta.Suppl. Prog.Phys.,no.6, 1958.

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31533
S/627/60/002/000/016/027
D299/D304

3.2410 (1265, 2705, 2805)

AUTHORS: Vernov, S. N., Tulupov, V. I., Khrenov, B. A., and
             Khristiansen, G. B.

TITLE: Investigating high-energy μ-meson component of exten-
             sive air showers

SOURCE: International Conference on Cosmic Radiation. Moscow,
             1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kas-
             kadnyye protsessy, 169-180

TEXT: The selection of μ-mesons of various energies was carried
out by recording them at various depths of the absorber. The pecu-
liar feature of the experiments consisted in the need to select
showers, whose axes pass at various distances from the meson det-
ectors, so as to study the space distribution of the meson flow.
Thereby, the distance between the underground detectors and the
shower axis recorded at the surface, may largely depend on the in-
clination of the shower axis. The apparatus made it possible to
determine the mean density of meson flow with treshold energies

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E_μ equal to 0.4, 5, and 10 Bev, at distances of 100, 25, and below 25 m, for showers of various number of particles. The detectors with a large sensitive area permitted observing the peculiarities of meson distribution in the various showers. The apparatus was in operation for approximately 2000 hours. The energy spectra of the μ-mesons and their lateral distribution for distances of 3 - 100 m from the shower axis were obtained. It was found that for showers with $N = 2 \cdot 10^5$, the lateral distribution of μ-mesons with $E_\mu \geqslant 10$ Bev has an exponent $n \leqslant 1$ for distances up to 100 m. This means that μ-mesons of such energies are mainly found outside a circle of radius $r = 100$ m. Further, the irregularities of meson-distribution at a depth of 40 m were studied in individual showers by means of meson detectors of total area 3.1 m^2. Irregularly distributed meson-groups were observed. In all, 17 such groups were recorded in 14 showers, during 800 hours of operation of the detectors. The pertinent experimental results are listed in tables. It was found that the meson groups appear in showers which do not differ from "aver-

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age" showers with respect to the total meson-flow. The distance be-
tween the meson group and the shower axis did not exceed 3 m for
showers with $N = 2 \cdot 10^5$. A comprehensive knowledge of the high-ener-
gy meson component was obtained, in particular with respect to me-
son flow in the vicinity of the shower axis, where the energy of
the μ-mesons exceeds 10 Bev. By comparing the number of mesons at
mountain altitude and at sea level, the conclusion is reached that
μ-mesons with $E_\mu > 10$ Bev. are effectively generated at high altitudes
(above 3800 m), acquiring a sufficiently large transverse momentum.
The character of the lateral distribution of μ-mesons near the
shower axis is determined by the character of meson generation ac-
cording to altitude. Computations were carried out of meson distri-
bution near the axis ($r \leqslant 25m$), with $E_\mu > 10$ Bev, for 2 models of ex-
tensive shower development. Further, various interpretations are
proposed for the appearance of μ-meson groups in the vicinity of
the shower axis. The angular distribution of π-mesons in nuclear
interactions has a substantial effect on the lateral distribution
of μ-mesons with $E_\mu > 10$ Bev. The majority of μ-mesons of such ener-

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gies are generated at altitudes of 6 - 8 km above sea level. The dependence of the number of μ-mesons with $E_\mu \gg 10$ Bev. on the number of particles in the shower, in the circle $r = 25$ m, is expressed by $N^{0.6 \pm 0.1}$ (for the range $N = 10^4$ to $5 \cdot 10^5$). The meson distribution (with $E_\mu \gg 10$ Bev.) in showers with $N = 2 \cdot 10^5$ is expressed by $\rho_\mu = K/r^n$, $n = 0.8 + 0.2$, for distances of 3 to 10 m from the shower axis. There are 6 figures, 6 tables and 10 references: 8 Soviet-bloc and 2 non-Soviet-bloc. The references to the English-language publications read as follows: B. Edwards, J. Losty, D. H. Perkins, P. Pinkau, J. Reynolds. Phil. Mag., 3, 237, 1958; A. Ueda, N. Ogita. Progr. Theor. Phys., 18, 269, 1957.

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21(7)
AUTHORS: Vernov, S. N., Goryunov, N. N., Zatsepin, G. T., Kulikov, G.V.,
             Nechin, Yu. A., Strugal'skiy, Z. S., Khristiansen, G. B.

TITLE: Investigation of the Core of Extensive Atmospheric Showers
             (Issledovaniye stvola shirokogo atmosfernogo livnya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959,
             Vol 36, Nr 3, pp 669-681 (USSR)

ABSTRACT: The group of research scientists followed a suggestion made
             by D. V. Skobel'tsyn to investigate the passage of extensive
             atmospheric showers through matter simultaneously in different
             depths; in this connection an investigation of the shower
             core was carried out. Figure 1 shows a block scheme of the
             experimental arrangement used, which furnished data concerning
             the electron-photon and the nuclear-active components of the
             shower core. The experimental system consisted essentially
             of a diffusion chamber (0.64 m^2), 124 ionization chambers in
             hodoscope-connection, special filters and 672 Geiger-Mueller
             (Geyger, Myuller) hodoscope counters of different sizes. The
Card 1/4   method, which is described as new, is described in detail,

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Investigation of the Core of Extensive Atmospheric Showers

and the possibilities it offers are discussed. The entire device remained in operation for 1300 hours and recorded more than 10,000 passages of extensive air showers. Within 1,000 hours 28 passages of shower cores with a shower particle number of $N > 10^5$ through the first row of ionization chambers were recorded. Figure 4 shows a photograph of the diffusion chamber for such a passage and the corresponding pulse oscillogram of 64 ionization chambers. The article gives numerous individual data concerning different showers as e.g. the ionization distribution in the 64 ionization chambers of the first and second row respectively for $N = 5.10^5$, $1.3.10^5$ and $N \approx 10^5$ with a spatial distribution of energy flux $\sim 1/r^3$ (Fig 6). Figure 8 shows the same, expressed by the number of relativistic particles passing through the ionization chambers of the first and second row for $N = 10^4$ and 2.10^4 and an energy flux $\sim 1/r^2$ and $\sim 1/r$. Figures 6 and 8 show the particle flux distribution in the diffusion chamber for $N = 2.10^6$ and $3.5.10^4$ respectively. In extensive air

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Investigation of the Core of Extensive Atmospheric Showers

showers with $N > 10^5$ it was observed in the shower core
($r < 1m$) that the total energy of nuclear-active particles
is of the order of the energy of the electron-photon com-
ponent at the same distance from the axis; for individual
showers, however, the ratio of these energies showed different
values. The energy current density of the electron-photon
component shows an increase of up to $r = 20 \div 30$ cm from
the shower axis; the course of energy flux density in depen-
dence on r cannot be represented by a general formula. It
fluctuates between $\sim 1/r$ and $\sim 1/r^3$. The energy fluxes of
electron-photon and nuclear-active components of the shower
core show considerable fluctuations (up to 10 times). The
authors finally thank Academician D. V. Skobel'tsyn for his
help and interest, V. V. Borisoglebskiy for his collaboration,
Professor N. A. Dobrotin for his help and discussions, and
further also a group of collaborators of the MGU: A. T.
Abrosimov, S. S. Glagolevskiy, B. V. Subbotin, A. D. Yerlykin,
A. B. Kamnev, E. N. Sosnov for their help in carrying out
experiments. There are 8 figures, 2 tables, and 12 references,
11 of which are Soviet.

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SO7/56-36-3-4/71

Investigation of the Core of Extensive Atmospheric Showers

ASSOCIATION: Moskovskiy gosudarstvennyy universitet
(Moscow State University)
Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR
(Physics Institute imeni P. N. Lebedev of the Academy of
Sciences, USSR)

SUBMITTED: July 21, 1958

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SOV/56-36-4-2/70

21(1)

AUTHORS: Vernov, S. N., Babetskiy, Ya. S., Goryunov, N. N., Kulikov, G. V., Nechin, Yu. A., Strugal'skiy, Z. S., Khristiansen, G. B.

TITLE: On the Structure of the Core and the Central Regions of Extensive Atmospheric Showers at Sea Level (O strukture stvola i tsentral'-nykh oblastey shirokikh atmosfernykh livney na urovne morya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 4, pp 976-984 (USSR)

ABSTRACT: The object of the present paper was an experimental investigation of the spatial distribution of the energy flux of the electron-photon and the nuclear-active component in the core and the central regions of extensive air showers; the present paper is a continuation of an article published in the preceding issue of this periodical (Ref 1), in which the method and the experimental arrangement were already described. Figure 1 is a schematical representation of the chamber system with the distribution of hodoscope counters. The counters were located in groups of 12 and 24 in containers. The ionization chambers had a total area of 4 m^2. In the course of the 1800 hours during which the apparatus was in operation, about 18000

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On the Structure of the Core and the Central Regions of Extensive Atmospheric Showers at Sea Level

showers were recorded, with particle numbers of between 10^3 and 10^6, and axes which were at a distance of up to 30 m from the system of ionization chambers. From the manifold material obtained by these investigations the spatial distribution obtained for individual showers or groups of showers (classification according to particle number N) are analyzed. For spatial particle flux density it holds that $\varrho(r) \approx 2.10^{-3} N/r$ for $r < 10$ m, for the energy flux density: $\varrho_E(r) \sim r^{-n}$. For shower groups of different sizes (ΔN from $1.0.10^5 - 5.0.10^5$ up to $5.10^3 - 5.10^5$) table 1 shows how many of the total of 82 investigated showers correspond to certain n-values (from < 0.8 to $3.2 - 3.4$). Figure 2 (a,b) shows the spatial distribution of the energy flux of electron-photon and nuclear-active components of two different shower groups, figure 3 shows the energy spectrum of the nuclear-active component in the shower cores, and figure 4 shows the distribution of the absolute values of the energy flux of the electron-photon component in a circle with the radius 1.5 m round the axis of a shower with $\overline{N} = 10^5$ particles. The diagram is characteristic of the strong oscillations ob-

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On the Structure of the Core and the Central Regions of Extensive Atmospheric Showers at Sea Level

SOV/56-36-4-2/70

served. Figure 5 finally shows the spatial energy flux distribution within the range of from 0.1 to 30 m; the measured values (in a semilogarithmic diagram) are practically on a steeply declining straight line. Thus, the following is obtained for the electron-photon component:

$$Q_{e-ph} \sim 1/r^{1.35} \quad \text{at} \quad 0.1 \text{ m} < r < 2.0 \text{ m}$$
$$Q_{e-ph} \sim 1/r^2 \quad \text{at} \quad 2.0 \text{ m} < r < 30 \text{ m}$$

and for the nuclear-active component: $Q_{n-a} \sim 1/r^2$ at $0.2\text{m} < r < 30\text{m}$.

Figure 6 again shows the spatial distribution of the absolute values of energy flux in a distance of 10 m from the shower core; like within the range of the core itself, oscillations are considerable. The authors finally thank G. T.Zatsepin and I. P. Ivanenko for advice and discussions. There are 6 figures, 3 tables, and 3 Soviet references.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute for Nuclear Physics of Moscow State University)

Card 3/4

21(0)

AUTHORS: Vernov, S. N., Gorchakov, Ye. V.,   SOV/56-36-4-39/70
             Ivanenko, I. P., Khristiansen, G. B.

ABSTRACT: Already Guzhavin, Guzhavina and Zatsepin (Ref 1) calculated
             the height dependence of high-energy nuclear-active
             particles and the number of high-energy μ-mesons at sea
             level, as well as the height-dependence of the nuclear-
             active and of the soft component of extensive air showers.
             The elementary act was calculated according to Landau
             (Ref 2) and Vernov (Ref 3). For all energies the collision
             cross sections were calculated, and for the free path in
             air the value $\lambda_0 = 65 \div 70$ g/cm^2 was obtained. The results

Card 1/3   of calculations depend in a high degree on λ_0; however,

On the Development of the Nuclear- Active Components   SOV/56-36-4-39/70
in Extensive Atmospheric Showers

λ_0 is at energies of $\gtrsim 10^{10}$ ev not known from experiments.
Therefore, the authors of this paper calculated different
characteristics for the nuclear-active (n.a.) component of
extensive air showers (e.a.sh.), in which λ_0 is determined
by the type of the elementary act and the experimental range
of the absorption of n.a. particles ($E \sim 10^{12}$ ev). By making
simple assumptions concerning the nature of the elementary
act the spectrum of the n.a. particles in e. a. sh. was
computed, and likewise the ranges for the absorption of n.a.
particles and the energy fluxes in the showers. Also the
probability for the observation of one or two high-energy
n.a. particles in a given altitude is estimated. The main
aim of this paper was to find characteristics of the
e. a. sh. for various parameters of the elementary act
and λ_0 , which are sensitive to the nature of interation.

It was found that besides the e.a.sh. characteristics,
which depend only weakly on the nature of the elementary
particle, there exist also such as are highly dependent.
An exact experimental investigation of the latter may lead
Card 2/3   to important results concerning the elementary act.

On the Development of the Nuclear- Active Components in SOV/56-36-4-39/70
Extensive Atmospheric Showers

There are 2 figures and 11 references, 9 of which are Soviet.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute of Nuclear Physics of Moscow State University)

SUBMITTED: October 16, 1958

Card 3/3

VERNOV, S. N.

"Radiation Studies in Outer Space"
S. N. Vernov, A. E. Chadakov

The present paper contains the results of measurements carried out on Sputnik IIand Sputnik III (Soviet artificial earth satellites) and the Soviet cosmic rocket.
I. Measurements of the number of charged particles by means of two gas-discharge counters on Sputnik II showed the following: (1)
1. In the eastern hemisphere (latitudes 30° - 60°) up to 700 km. altitude the increase in the number of particles with altitude is slight and is determined by the diminishing geometric shadow of the earth and the decreasing lower limit of energy of cosmic-ray particles.
2. At latitudes above 60°, cases were observed of a considerable increase in intensity. The biggest increase (exceeding 50%) was observed on November 7, 1957 between 4 hr. 36 min. and 4 hr. 49 min. Moscow Time.
The absence of any increase in cosmic-ray intensity at the earth's surface at the same time shows that this phenomenon must be due to low-energy particles.

report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959.

VERNOV S. N.

"The composition of Terrestrial Corpuscular Radiation and possible Mechanisms of its origin"
    S. N. Vernov, A. E. Chudakov, A. I. Lebedinsky, I. P. Ivanenko

    Investigations conducted during the flights of the Soviet earth satellites and the cosmic rocket have yielded the following data on the composition of "terrestrial corpuscular radiation", that is, particles revolving about the earth:
    1. In the outer zone (1), the overwhelming majority of particles are electrons of energy 20 to 100 kev. If we represent the energy spectrum of these electrons in the reigion of maximum radiation in the form: $N (E) 1/E$, then   5. Extrapolation of such a soft spectrum into the region of lower energies shows that at $E=5$ to 10 kev, the total density of electron energy would exceed the energy density of the magnetic field $H^2 /. 8$. For this reason, the electron spectrum in the region of low energies (several kilovalts) should either have a maximum or at least should be small at least in this region. The number of electrons of relatively high energies $(5 \times 10^6$ ev) is negligibly small as compared with the number of electrons in the 20-100 Kev range. The overall energy released in the crystal of the scintillation counter from photons due to the bremsstrahlung of electrons is from two to three orders of magnitude in excess of the energy released by all high energy particles that produce an energy release in the crystal of over 4.5×10^6 ev per particle. The total energy of all electrons in the outer zone is approximately equal to the energy released in aurorae during somewhat over one week.

    report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959

VERNOV, S. N.

"MEASUREMENT OF COSMIC RAY VARIATION IN THE STRATOSPHERE"
S. N. Vernov, B. E. Samosudov, V. F. Tulinov, A. N. Charakhchian and T. N.
Charakhchian

Beginning with July 1, 1957 (when the IGY programme began) regular measurements
have been made of cosmic ray intensity in the stratosphere at geomagnetic latitudes
of 51°N and 64°N, while since March 1958 similar measurements have been taken also
at geomagnetic latitude of 41°N. The measurements are made with a single G-M counter.
During this period 840 stratosphere observations were made.
    1. The data gathered have helped to establish the existence of a 27-day variation
of cosmic rays in the stratosphere. The shape of the averaged wave is close to
sinusoidal while the period is 27 or 28 days. The wave amplitude, however, changes
more than 5-fold in the observed intervals. The obtained values for the amplitude
of the 27-day variation in the stratosphere are 8 to 10-fold that of similar data
on the Earth.
    2. The existence in the stratosphere of long periodical variations of cosmic
rays of extra-terrestrial origin has been discovered.
    3. Values have been obtained for the cosmic ray latitude effect between latitudes
of 64°N, 51°N and 41°N. It has been ascertained that the latitude effect between
64°n and 51°N undergoes substantial changes with time. The latitude effect between
these latitudes in the maximum of the intensity curve amounts on the average to several
per cent, and goes up abruptly with increase in altitude of observation reaching
15-20% at an altitude of approximately 30 km. Several cases of abnormal increase in
cosmic ray intensity in the stratosphere at the latitude of 64°N have been discovered.

Vernov, S. N.   (continued)

cosmic ray intensity in the stratosphere at the latitude of 64°N have been discovered.
    4. A correlation between 27-day variations of cosmic retiation and the floccula
on the Sun, and a correlation between the long period cosmic ray variation and Sun
spots has been established.

Report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959

VERNOV S.

Pravda, Moscow.

Vtoroy Sovetskiy kosmicheskiy korabl'; materialy, opublikovannyye v gazete "Pravda" (The Second Soviet Cosmic Ship; Materials Published in the Newspaper "Pravda") Moscow, 1960. 198 p. 50,000 copies printed.

Resp. for this Publication: V. Reut and V. Salmov; Tech. Ed.: V. Yagodkina.

PURPOSE: This book is intended for the general reader.

COVERAGE: The book is a compilation of articles which appeared in the newspaper Pravda after the launching, orbiting, and recovery of the capsule of the Soviet 4,600 kg spaceship on August 19, 1960. The articles give some details of scientific research undertaken in this flight in the fields of biology, cytology, genetics, cosmic radiation, solar radiation, ultraviolet radiation, and radiation levels. A description and three photos of the capsule are given. No personalities are mentioned. There are no references.

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VERNOV, S.N.; CHUDAKOV, A.Ye.; VAKULOV,P.V.; LOGACHEV, Yu.I.; Nikolayev, A.G.
Associate Member, Academy of Science, USSR.

"Radiation Measurements During the Flight of the Second Soviet
Space Rocket."

report presented at the First Intl Space Symposium, Nice, France, Jan 1960.
National Academy of Sciences of the USSR, MOscow.'

VERNOV, S.N. and CHUDAKOV, A.Ye.

"Terrestial Corpuscular Radiation and Cosmic Rays."

report presented at the 1st Intl Space Symposium, Nice, France, January, 1960.
Academy of Sciences, Moscow, USSR.

VERNOV, S. N.

   "The Exploration of Outer Space."

report presented at the XI International Astronautical Congress, Stockholm, Sweden, 15-20 August 1960

VERNOV, S. N.

pp. 2,3

SOV/4413

PHASE I BOOK EXPLOITATION

International Cosmic Ray Conference. Moscow, 1959.

Proceedings. v. III. Moscow, 1960. 253 p. Errata slip inserted. No. of
copies printed not given.

Sponsoring Agency: International Union of Pure and Applied Physics. Cosmic
Ray Commission.

Ed.: S. I. Syrovatskiy, Editorial Board: G. B. Zhdanov (Ed.-in-Chief), I. P.
Ivanenko (Assistant Ed.-in-Chief), N. M. Gerasimova, A. I. Nikishov, V. I.
Zatsepin, B. A. Khrenov, L. I. Dorman, V. F. Tulinov, S. I. Syrovatskiy, V. M.
Fedorov, Yu. N. Vavilov, and A. T. Abrosimov.

PURPOSE: This book is intended for physicists, astronomers and other scientists
concerned with the earth's radiation belts and cosmic ray research.

COVERAGE: This is Volume 3 of a 4-volume work containing the proceedings of
the Moscow Cosmic Ray Conference held July 6-11, 1959. This volume contains
40 reports on the earth's radiation belts and primary cosmic radiation. The

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reports delivered by Soviet scientists are abstracted below. References
accompany individual reports.

TABLE OF CONTENTS:

I. THE EARTH'S RADIATION BELTS

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varied with increase in rocket distance from the Earth is
compared with the corpuscular radiation intensity values
obtained on the cosmic rocket and Pioneer III. The compari-
son shows that the observed changes in the Earth's magnetic
field are related to the outer corpuscular region, and that
they might be due to the superposition of the magnetic field
of the corpuscular zone on the magnetic field of the Earth.

7. Vernov, S.N., A.E. Chudakov, A.I. Lebedinsky (Lebedinskjy), and I. P.
   Ivanenko. Composition of the Earth's Corpuscular Radiation and   46-49
   Possible Mechanisms of Its Origination
      This paper presents data on the composition of the Earth's
      corpuscular radiation obtained by means of the Soviet sputniks
      and the cosmic rocket. The overwhelming majority of parti-
      cles in the external zone, limited by magnetic lines of force
      crossing the Earth's surface at geomagnetic latitudes of 55°
      and 65°, are electrons of 20-100 Kev. Protons of approximately
      100 Mev were discovered in the internal zone, limited by

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International Cosmic Ray Conference . Proceedings. v. III   SOV/4413

magnetic lines of force crossing the Earth's surface at geomagnetic latitudes of 30-40°. Among the possible mechanisms of origination of the Earth's corpuscular radiation is injection into the Earth's magnetic field of electrons and protons, produced by the decay of neutrons emitted by the Earth's atmosphere as a result of cosmic ray irradiation.

9. Krassovsky (Krasovskiy), V.I., I.S. Shklovsky (Shklovskiy), G. I. Galperin, and E.M. Svetlitsky (Svetlitskiy). On Fast Corpuscles of the Upper Atmosphere   59-63
   This paper presents experimental data on fast corpuscles of the upper atmosphere and gives a detailed description of the equipment used in the experiment.

11. Dorman, L.I. On the Problem of the Nature of Soft Radiation in the Upper Atmosphere   74-80
    This paper summarizes the available data on bursts of soft radiation in the atmosphere and investigates the nature of the bursts in relation to processes on the sun, in corpuscular streams, and in the interplanetary medium. It also investigates the nature of these bursts in relation to the properties of the Earth's belts of radiation.

12. Askar'yan G. A. On the Nature of the External Radiation Belt of the Earth   81-82

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~~29 (2), 29 (5)~~

67908

s/020/60/130/03/009/065
B014/B014

AUTHORS: Vernov, S. N., Corresponding
~~Member of the~~ AS USSR, Chudakov, A. Ye.,
Vakulov, P. V., Logachev, Yu. I., Nikolayev, A. G.

TITLE: Radiation Measurement During the Flight of the Second Cosmic
Rocket

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 130, Nr 3, pp 517 - 520
(USSR)

ABSTRACT: The equipment of the interplanetary rocket launched on
September 12, 1959 was designed for measuring the outer radia-
tion-belt of the Earth, for recording cosmic radiation on its
flight from the Earth to the Moon and a potential radiation
belt of the Moon. The individual parts of the apparatus, which
consisted of six gas-discharge and four scintillation counters,
are described in detail. Furthermore, this paper contains re-
sults of the first evaluation of data obtained for the range of
from 9,000 to 120,000 km away from the center of the Earth and
in the neighborhood of the Moon. Figure 1 illustrates the tra-
jectories of the first and second interplanetary rockets re-
ferred to the terrestrial magnetic field. Ionization measure-

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Radiation Measurement During the Flight of the
Second Cosmic Rocket .

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ments are also graphically represented in figure 1. It is noted that the shift of the ionization maximum between the two measurements was not caused by the slight difference of the trajectories of the two rockets. The radiation belt is most probably deformed by streams of solar corpuscles. This assumption seems to be confirmed by a comparison with the results of measurements performed by the American rocket Pioneer III. The energy-flux density of electrons of more than 5 Mev or of protons of more than 30 Mev is said to be

1 particle/cm^2.sec. Furthermore, a radiation was detected which consisted of electrons having an energy of the order of 10^6 ev, or of protons of an energy of about 10 Mev. The first possibility is considered to be more probable. This electron flux is said to be 5.10^5 particles/cm^2.sec. The existence of electron fluxes having an energy of between 20 and 50 kev (flux:

10^{10} particles/cm^2.sec), which had already been detected by the first intercontinental rocket, were proven again. Thus, two essential groups of particle fluxes were found: electrons

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Radiation Measurement During the Flight of the   S/020/60/130/03/009/065
Second Cosmic Rocket·   B014/B014

of about 20 kev and 10^6 ev electrons. The energy of the first group is close to the mean energy of the solar corpuscular radiation and allows to assume the existence of a thermodynamic equilibrium between protons and electrons on their penetration into the terrestrial magnetic field. It is pointed out that the electron momenta of the second group are close to the proton momenta of corpuscular radiation and to the momenta of the electrons arising from the decay of the reflected neutrons. The existence of a lunar radiation belt could not be proven. Constant radiation intensity was measured at a distance of 70,000 km from the Earth. There are 2 figures, 1 table, and 2 references, 1 of which is Soviet.

SUBMITTED: November 20, 1959

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89610

S/020/60/136/002/013/034
B019/B056

9.9130 (1041, 1046, 1060)

AUTHORS: Vernov, S. N., Corresponding Member of the AS USSR,
            Chudakov, A. Ye., Vakulov, P. V., Gorchakov, Ye. V.,
            Logachev, Yu. I., and Nikolayev, A. G.

TITLE: Radiation Measurements During the Flight of the Third Cosmic
           Rocket

TEXT: The third cosmic rocket launched on October 4, 1959 contained a
scintillation counter and three gas discharge counters. All gas discharge
counters had a wall strength of 50 mg/cm^2 steel sheets and were, in addi-
tion, surrounded by several shields. Counter I had a shield made from
3 mm lead + 1 mm aluminum with a counter window of 0.28 cm^2, which was
closed by a 0.2 mm thick aluminum sheet. Counter II had the same shield,
but without counter window, and counter III was in an aluminum container
made from 2.5 mm thick aluminum. The scintillation counter recorded the
ionization of the crystal (NaI) and the counting rate. Preliminary results
of evaluation of the instrument readings are given from the time from

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Radiation Measurements During the Flight of   S/020/60/136/002/013/034
the Third Cosmic Rocket   B019/B056

October 4, 1959, to October 18, 1959. The trajectory of the rocket was in
practical agreement with that of the first and second cosmic rocket. From
a comparison of the readings of the various counters, the authors conclude
that the intensities of the particles recorded by the instruments depend
on the absorption in the container walls. Measurements in the interplane-
tary space showed that the cosmic radiation on the boundary of the
terrestrial magnetic field is very strong; only individual small fluctua-
tions were recorded. Finally, the agreement existing between the recorded
intensities and those of a monitor are dealt with. From these considera-
tions the authors draw the conclusion that the weak variations in the
time from October 4 to October 18 are in connection with the variations of
the magnetic fields in the solar system and the interactions among the
latter are connected with cosmic radiations. There are 1 figure, 1 table,
and 3 Soviet references.

SUBMITTED: October 26, 1960

Card 2/2

VERNOV, S.N.; CHUDAKOV, A.Ye.; VAKULOV, P.V.; LOGACHEV, Yu.I.;
        NIKOLAYEV, A.G.

    Measurement of radiation during the flight of the second
cosmic rocket. Isk.sput.Zem. no.5:24-29 '60.
                              (MIRA 13:5)
    (Lunar probes) (Radiation--Measurement)

66010

3.9000
3.2000

AUTHORS: Vernov, S. N., Chudakov, A. Ye.   S/053/60/070/04/002/011
                                                           B006/B01:

TITLE: Investigations of Cosmic Rays and Terrestrial Corpuscular Radiation
         in the Flights of Rockets and Sputniks

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol 70, Nr 4, pp 585-619 (USSR)

TEXT: The present article offers a survey of methods and results obtained from
the investigation of corpuscular radiation in the space round the earth by means of
space rockets and artificial satellites. Chapter 1: equipment (scintillation counter,
gas counter, photomultiplier). Chapter 2: the outer zone of the terrestrial cor-
puscular radiation belt (position of this zone relative to the earth, investigation
of intensity fluctuations according to the ionization effect). Chapter 3: the inner
zone of the high intensity of terrestrial corpuscular radiation (position of the
inner zone relative to the earth, nature and energy of the particles in the inner
zone, constancy of intensity). Chapter 4: radiations outside the magnetic field of
the earth (Table). Chapter 5: analysis of data obtained and possible hypotheses
concerning the origin of terrestrial corpuscular radiation. Summarizingly, the fol-
lowing is stated: 1) The earth is surrounded by two spatially separate zones of
high-intensive radiation. 2) The outer zone extends in the equatorial plane from
about 20,000 to 60,000 km out from the earth center and is delimited by the lines
of force of the geomagnetic field. In geomagnetic latitudes of 55 - 70°, this zone

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Investigations of Cosmic Rays and Terrestrial
Corpuscular Radiation in the Flights of Rockets
and Sputniks

S/055/60/C70/04/0C2/9::
B006/3011

is observed at relatively low altitudes (500-1500 km). The intensity changes with time are considerable; in the flight of the first Russian cosmic rocket, the radiation maximum was recorded on January 1, 1959 at a distance of 26,000 km from the earth center on a line of force cutting the earth surface on the 63rd degree of latitude. In the flight of the second Russian cosmic rocket, this maximum was recorded at a distance of 17,000 km on the 59° line of force. 3) The particles occurring in this zone are electrons of two energy groups. The electrons of the first group have some ten kev. The maximum flux of electrons with energies greater than 20 kev amounts to $1C^9 cm^{-2} sec^{-1} steradian^{-1}$. Electrons of the second group have energies of the order of $10^6 ev$ and exhibit a maximum flux of $10^5 cm^{-2} sec^{-1} steradian^{-1}$. 4) The inner zone begins on the equatorial plane at an altitude of 600 km on the Western hemisphere and extends up to distances equalling the terrestrial radius; it is delimited by a line of force on 35° latitude. The radiation intensity in this zone remains constant within about 15% in one month. 5) The particles occurring in this zone are protons of about $10^8 ev$, their flux attains $10^2 cm^{-2} sec^{-1} steradian^{-1}$. On the edge of the zone in the geomagnetic interval of 35-40° latitude, a low-energy radiation (electrons of less than $10^6 ev$) is

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Investigations of Cosmic Rays and Terrestrial
Corpuscular Radiation in the Flights of Rockets
and Sputniks

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ascertained. 6) Between the two zones, in the interval of the geomagnetic latitudes
of 40-55°, there is a region in which no higher radiation intensity is detected.
Provided that measurements are accurate, it may be assumed that in this region, at
an altitude of 300-70C km, the flux of electrons with more than 1CO kev amounts to
less than one-thousandth of the flux at the boundary of the outer zone. The same
ratio compared with the one at the boundary of the inner zone holds for the flux
of protons with more than 10^8ev. 7) The particle radiation outside the magnetic
field of the earth consists of protons and other nuclei (flux 2 particles/cm^2.sec).
The photon flux in the interplanetary space is less than 0.1 photon/cm^2.sec
(hv $>$ 450 kev) and $<$ 3photons/cm^2.sec (hv $>$ 45 kev), respectively. 8) It is con-
cluded from a comparison of experimental data with theoretical considerations
that the high-energy protons are the result of a decay of neutrons emitted from the
earth atmosphere. The radiation intensity in the center of the inner zone at low
altitudes is determined by the ionization losses of the protons in the upper at-
mospheric layers. In geomagnetic latitudes of more than 30° and at larger altitudes
of the equatorial plane intensity drops more rapidly due to the incompleteness of
the magnetic trap. This incompleteness is independent of the particle energy, and
it is therefore improbable for it to be related with the nonconservation of the

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Investigations of Cosmic Rays and Terrestrial
Corpuscular Radiation in the Flights of Rockets
and Sputniks

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B006/B011

magnetic moment of the particles. Ye. V. Gorchakov, S. Sh. Dolginov, G. I. Goly-
shev, V. C. Kort, A. I. Lebedinskiy, and I. P. Ivanenko are mentioned. There are
18 figures, 1 table, and 17 references, 14 of which are Soviet.

Card 4/4

VERNOV, S.N., otv. red.; DORMAN, L.I., kand. fiz.-mat. nauk, otv.
red.; KURYKOVA, M.F., red.; GUS'KOVA, O.M., tekhn. red.

[Articles] Sbornik statei. Moskva, Izd-vo AN SSSR.
No.1.[Variations of cosmic rays below ground, at sea level,
and in the stratosphere] Variatsii kosmicheskikh luchei pod
zemlei, na urovne moria i v stratosfere. 1959. 56 p.
No.2.[Variations of cosmic rays and solar corpuscular streams]
Variatsii kosmicheskikh luchei i solnechnye korpuskuliarnye po-
toki. 1960. 143 p.
(MIRA 16:11)

1. Akademiya nauk SSSSR. Mezhduvedomstvennyy geofizicheskiy
komitet. VII razdel programmy MGG: Kosmicheskiye luchi. 2.Chlen-
korrespondent AN SSSR (for Vernov).

(Cosmic rays)

S/030/60/000/008/002/013
B021/B054

AUTHOR: Vernov, S. N., Corresponding Member of the Academy
              of Sciences USSR

TITLE: Cosmic Rays and Cosmic Space

PERIODICAL: Vestnik Akademii nauk SSSR, 1960, No. 8, pp. 10-26

TEXT: This is a report delivered by the author at the Plenary Meeting
of the Akademiya nauk SSSR (Academy of Sciences USSR) on June 10, 1960.
Experiments made by Academician D. V. Skobel'tsyn showed that cosmic
rays consist of high-energy particles. An investigation of these rays
permits two essential problems to be solved: first, the determination
of the properties of the cosmic space where they are formed, and second,
the use of cosmic rays for the bombardment of atomic nuclei. The author
in his report deals with the former problem, but he briefly mentions
experiments which showed the presence of particles of energies of up to a
billion billions of electron volts in cosmic rays. He also briefly
describes the plant of the Moskovskiy gosudarstvennyy universitet (MGU)
(Moscow State University)(Fig. 1) for the investigation of superhigh-

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Cosmic Rays and Cosmic Space

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energy particles, which was designed by the author together with
G. B. Khristiansen and G. T. Zatsepin. Fig. 2 shows the distribution of
particles in the diffusion chamber, Fig. 3 a schematic cross section of
the MGU plant. It may be assumed at present that superhigh-energy
particles are formed outside the boundaries of our galaxy. Further, the
author investigates the cosmic space in close vicinity of the earth.
Investigations by means of artificial satellites and space rockets showed
that the earth is surrounded by two radiation zones, the internal and
the external one, the intensity of their radiations being very high.
This circumstance has to be considered in the construction of space
ships. Fig. 4 shows diagrams of the measuring apparatus of earth
satellites. The investigations were made by the author together with
A. Ye. Chudakov, Yu. I. Logachev, P. V. Vakulov, Ye. V. Gorchakov, and
A. G. Nikolayev. An ФЭУ (FEU) photoelectric multiplier was used in the
scintillation counter. Fig. 5 shows the measurement results of the
second earth satellite on November 7, 1957. Fig. 6 shows a sample of
the recordings made by the instruments of the third earth satellite.
Fig. 7 shows the diagram of a large part of the northern hemisphere. The
projection of the flight path of a particle on the plane of the meridian

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is shown in Fig. 8. Investigations proved that radiation intensity increases with the distance from the earth along the line of force, and that the particles of the radiation zones in the magnetic field of the earth oscillate from one hemisphere into the other. Therefore, it may be assumed that the magnetic field of the earth represents a trap for the particles. The flight paths of the Soviet space rockets and the change in radiation intensity during the flight are shown in Figs. 9-12. N. V. Pushkov and Sh. Sh. Dolginov discovered anomalies of the magnetic field of the earth during the flight of the first Soviet space rocket. Fig. 13 shows a sample of the recordings of radio signals made by the third Soviet earth satellite. The measurements showed that electrons of relatively low energy are present in the external radiation zone of the earth, and particles of more than 10,000,000 ev in the internal zone. Fig. 14 shows a general picture of the distribution of radiation zones around the earth. As to the origin of the radiation zones of the earth, the hypothesis may be set up that the magnetic field of the earth represents a trap for the particles in which they may stay for a very long while. The origin of the external radiation zone of the earth is sought in the corpuscular radiations of the sun. The flight around the moon

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Cosmic Rays and Cosmic Space   S/030/60/000/008/002/013
                                                B021/B054

showed that the moon has no magnetic field. It is assumed that in the
cosmic space there are giant reservoirs of particles moving about, as
had been detected by A. N. Charakhch'yan by means of special radiosondes.
These experiments showed that the sun emits cosmic rays once a month, on
an average. During that time, their intensity is so high that man cannot
stay in the interplanetary space without protective equipment. As yet,
the explosion processes of the sun cannot be predicted. There are 14
figures.

Card 4/4

VERNOV, S.N.

    About the "corona" of the earth. Znan.sila 35 no.3:37-39 Mr
    '60.   (MIRA 13:6)

    1. Chlen-korrespondent AN SSSR.
         (Particles (Nuclear physics)   (Atmosphere, Upper)

VERNOV, S.N.; GORYUNOV, N.N.; DMITRIYEV, V.A.: KULIKOV,G.V.; NECHIN, Yu.A.;
KHRISTIANSEN, G.B.

Function of the spatial distribution of a flux of charged particles
in an individual extensive air shower. Zhur. eksp. i teor. fiz. 38
no.1:297-298 Jan '60.   (MIRA 14:9)

1. Institut yadernoy fiziki Moskovskogo gosudarstvennogo universi-
teta.
                        (Cosmic rays)

S/056/60/039/002/042/044
B006/B070

AUTHORS: Vernov, S. N., Ivanenko, I. P., Kulikov, G. V.,
              Khristiansen, G. B.

TITLE: The Nature of the Particle Beams in the Core of an Extensive
              Air Shower /9

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960,
              Vol. 39, No. 2(8), pp. 509 - 512

TEXT: In an earlier paper (Ref. 1) the authors communicated their
investigations of a shower core by means of diffusion chamber. They found
that narrow beams consisting of 4-15 particles appear, and the beam
trajectories are collinear. These particle beams are, either, cores of
electron-photon avalanches released from π^0-mesons, or groups of high-
energy muons. Which of these alternatives is correct, is now investigated.
In the present paper, the authors show that the latter is much more
probable. The first assumption is discussed in detail, and the experiment
and its results are analyzed from this stand-point. The observed number
of particles in the beam can only be released by primary particles whose

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The Nature of the Particle Beams in the Core   S/056/60/039/002/042/044
of an Extensive Air Shower   B006/B070

energy $E_o \geqslant 10^{12}$ ev. The energy spectrum of electrons and photons in the
avalanche at a depth of 2t-units had the following form (N - number of
particles released by particles with $E_o = 10^{12}$ ev):

E	10^8	10^9	10^{10}	10^{11}
$N_{el}(>E)$	5.5	4.0	2.5	0.5
$N_{phot}(>E)$	10	8.0	4.0	0.8

For their experiments, the authors used a plate of lead glass (type TФ-1
(TF-1)) with high lead content. This plate covered one half of the
diffusion chamber. 850 hours of measurement were made in the open chamber
and 440 hours in the closed one. The actual number of particles observed
in the showers is much smaller than that which would be expected if the
first assumption on the nature of the collinear beam were true. Experi-
ments performed with diffusion chamber, arranged above two rows of
ionization chambers, gave similar results. The second assumption, that
the observed beam consists of μ-mesons, is then briefly discussed. For

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