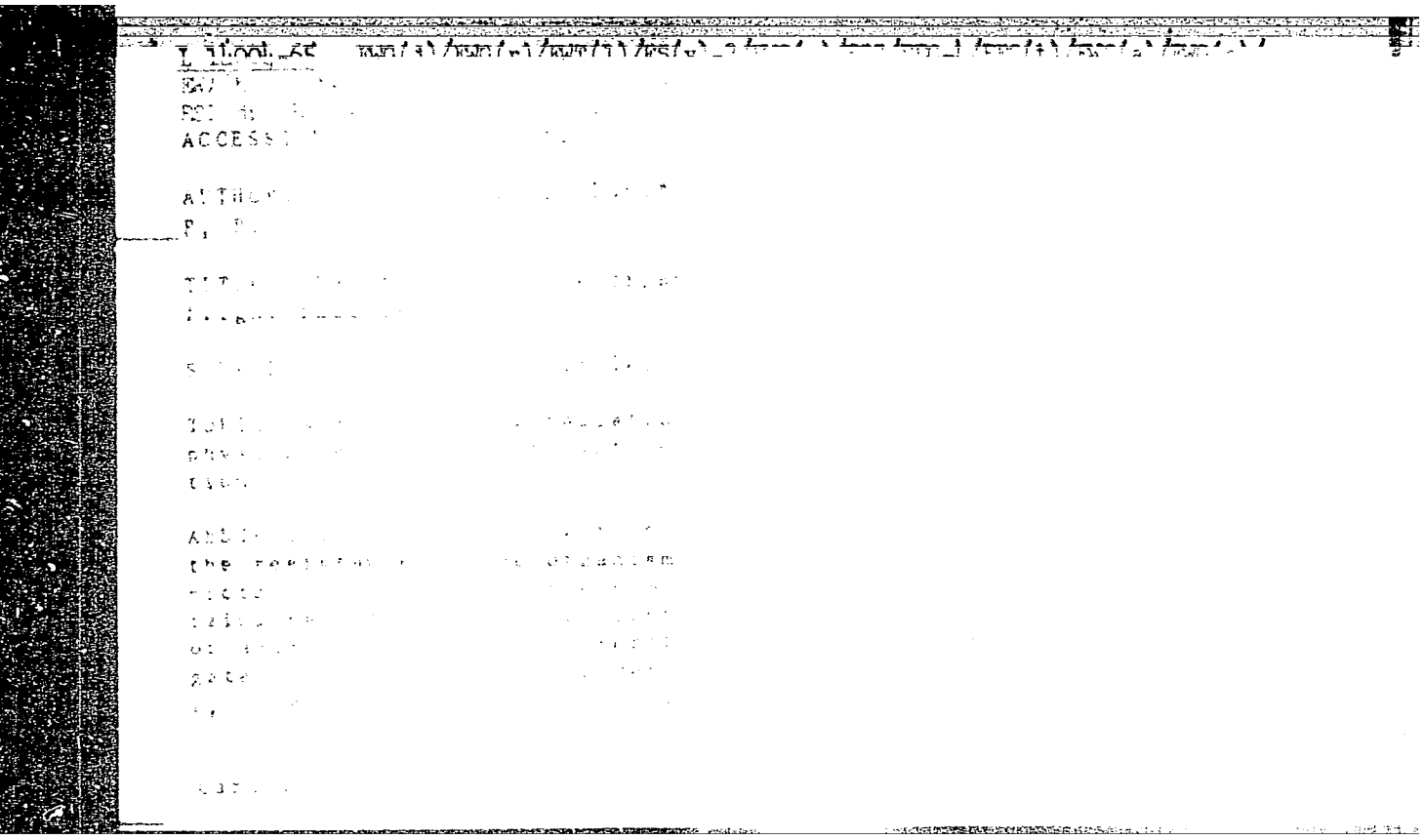
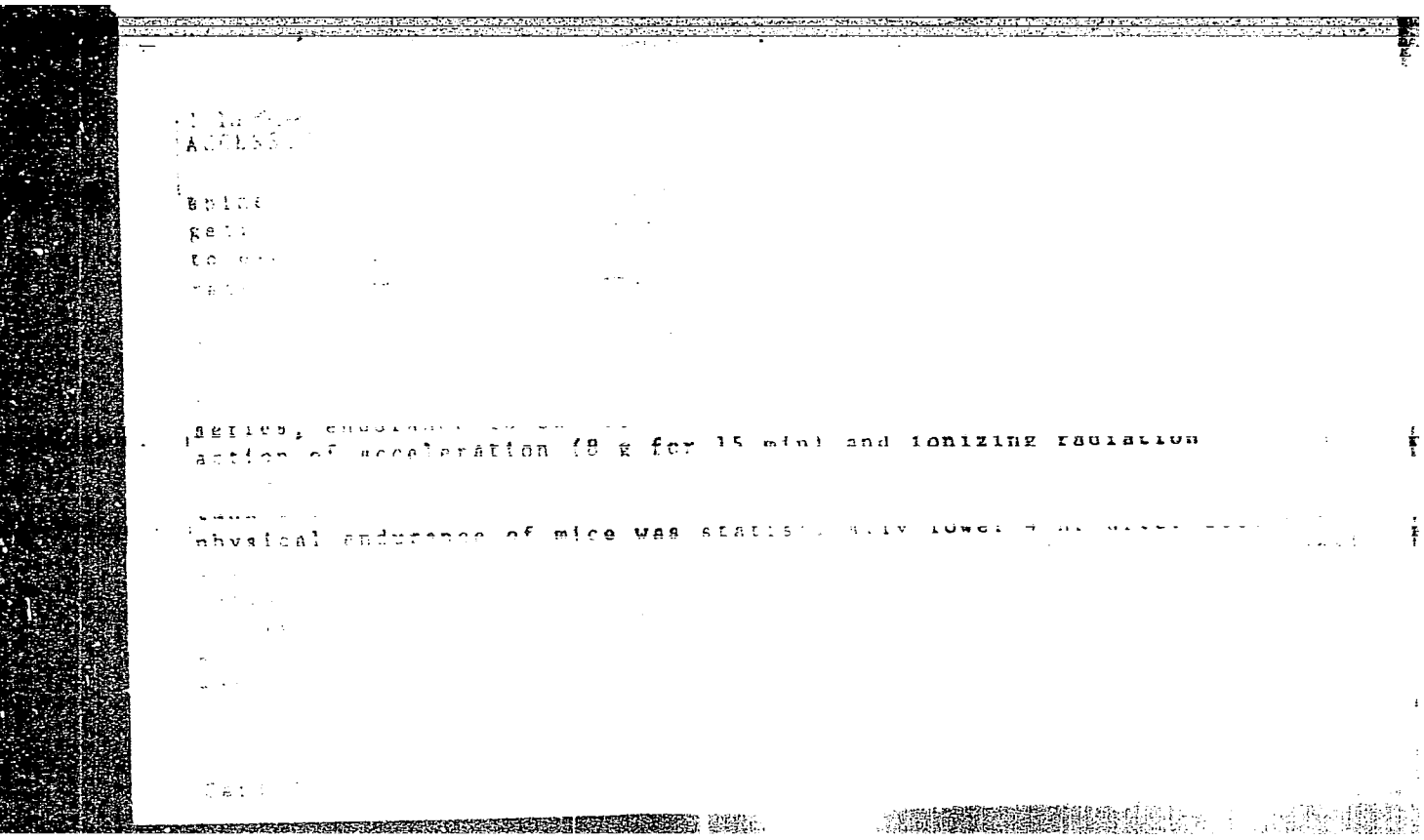
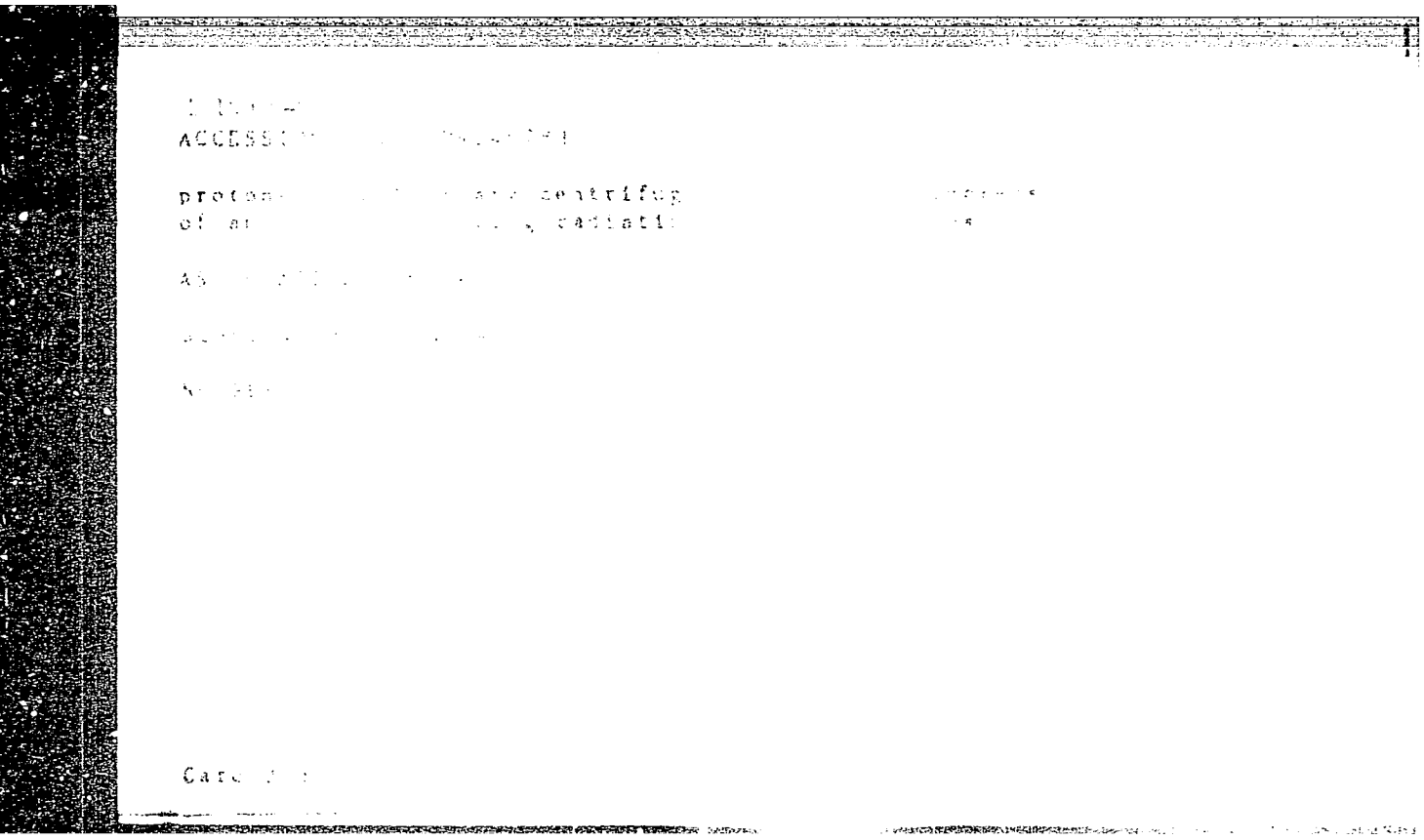
L 32445-65
ACCESSION NR: AT5003263

autologous bone marrow cells, and







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L 2[illegible]-65 EWT(l)/EWG(r)/EWA(l)/EWA(v)-2/EWG(v)/EWG(a)/EWG(c) Pe-5 DD/RD

ACCESSION NR: AP5003095 S/0216/65/000/001/0003/0009

AUTHOR: Parin, V. V.; Antipov, V. V.; Raushenbakh, M. O.; Saksonov, P. P.; Shashkov, V. S.; Chernov, G. A.

TITLE: Changes in the concentration of serotonin in the blood of animals caused by the effects of ionizing radiation and the dynamic factors of space flight

SOURCE: AN SSSR. Izvestiya. Seriya biologicheskaya, no. 1, 1965, 3-9

TOPIC TAGS: blood serotonin level, ionizing radiation effect, x ray, vibration, vibration effect, combined factors effect, mouse, rat, guinea pig, dog, monkey, acceleration, weightlessness

ABSTRACT: Experiments were performed in order to test the effects of space flight in orbital spaceships and of ionizing radiation and vibration under laboratory conditions on the concentration of serotonin in the blood of animals. The biological method described by Erspamer and Vane was used to determine the concentration of serotonin in the blood. This method is based on the ability of serotonin to cause contraction of the smooth intestinal muscles of a rat. Monkeys, dogs, guinea pigs, rats, and mice were subjected to lethal doses of gamma rays (Co^{60}) in the radiation experiments. In dogs, monkeys, and guinea pigs, the disruption in the serotonin

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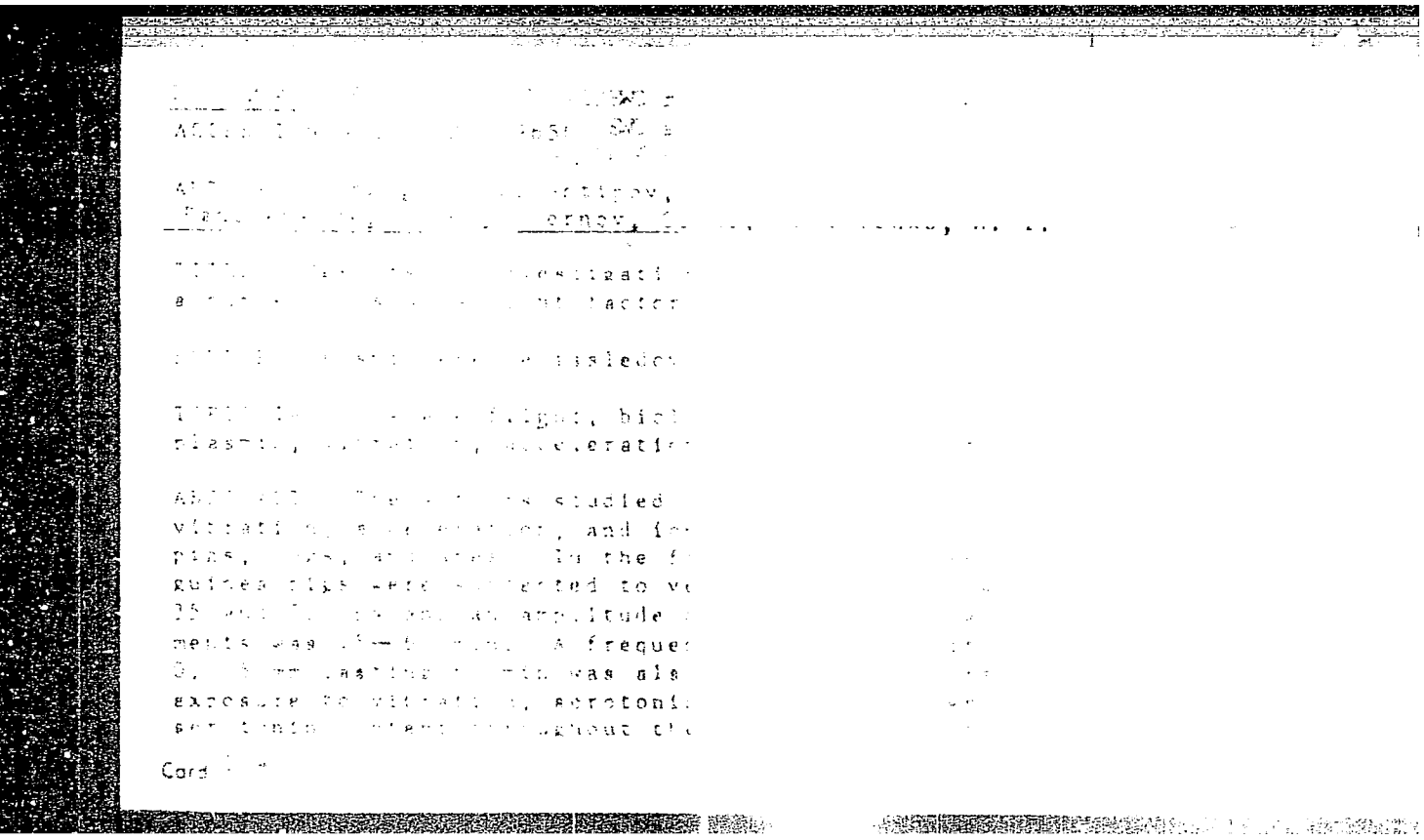
L 27408-65
ACCESSION NR: AP5003895

level of the blood was very marked and was in direct relation to the severity of the radiation sickness, while in rats and mice the drop in the concentration of serotonin was less marked and did not depend on the extent of radiation injury. The first group of animals developed a sharply defined hemorrhagic syndrome during the course of radiation sickness while the second group (rats and mice) did not evidence hemorrhagic symptoms. The chief reason for the drop in the serotonin level of the blood during radiation sickness is the disruption of the formation of serotonin in the digestive tract. The concentration of serotonin in the blood of mice and dogs carried on the fourth and fifth orbital spaceships dropped 8—10 times in mice and 3.5—10 times in dogs, on the first or second day after return, in comparison with the control level (0.12—0.2 μg/ml). After 10 days the serotonin level of these animals returned to normal. During the period of 80—240 days after space flight, the serotonin level in dogs remained normal. Mice and guinea pigs subjected to vibration (frequency: 35 and 70 cps, amplitude: 0.4 mm), for fifteen minutes also showed a drop in the serotonin level of the blood during the first two days, with a subsequent return to normal. The authors conclude that vibration is one of the factors responsible for a drop in the concentration of serotonin in the blood during space flight. Orig. art. has: 4 tables. [BH]

ASSOCIATION: none

Card 2/3



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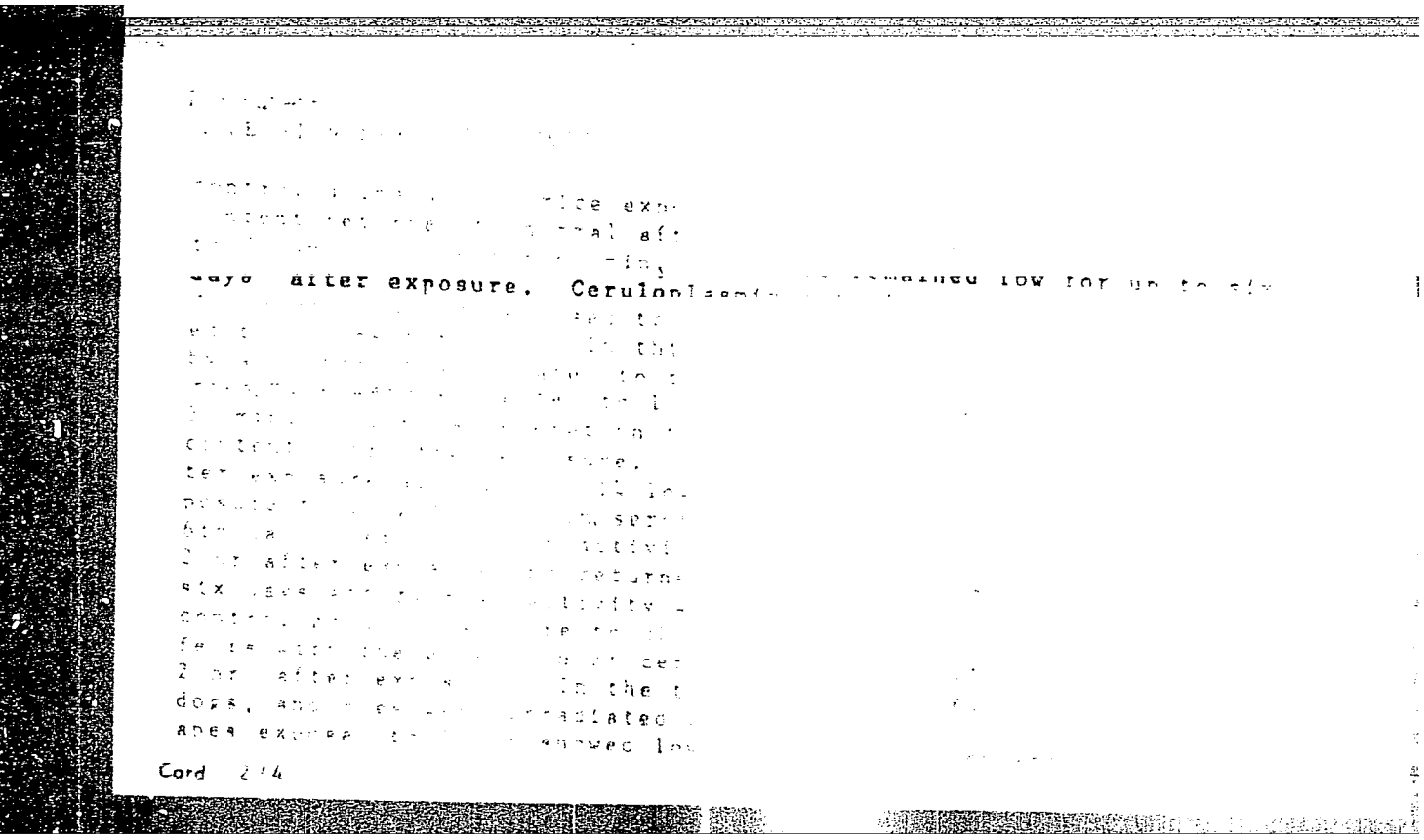
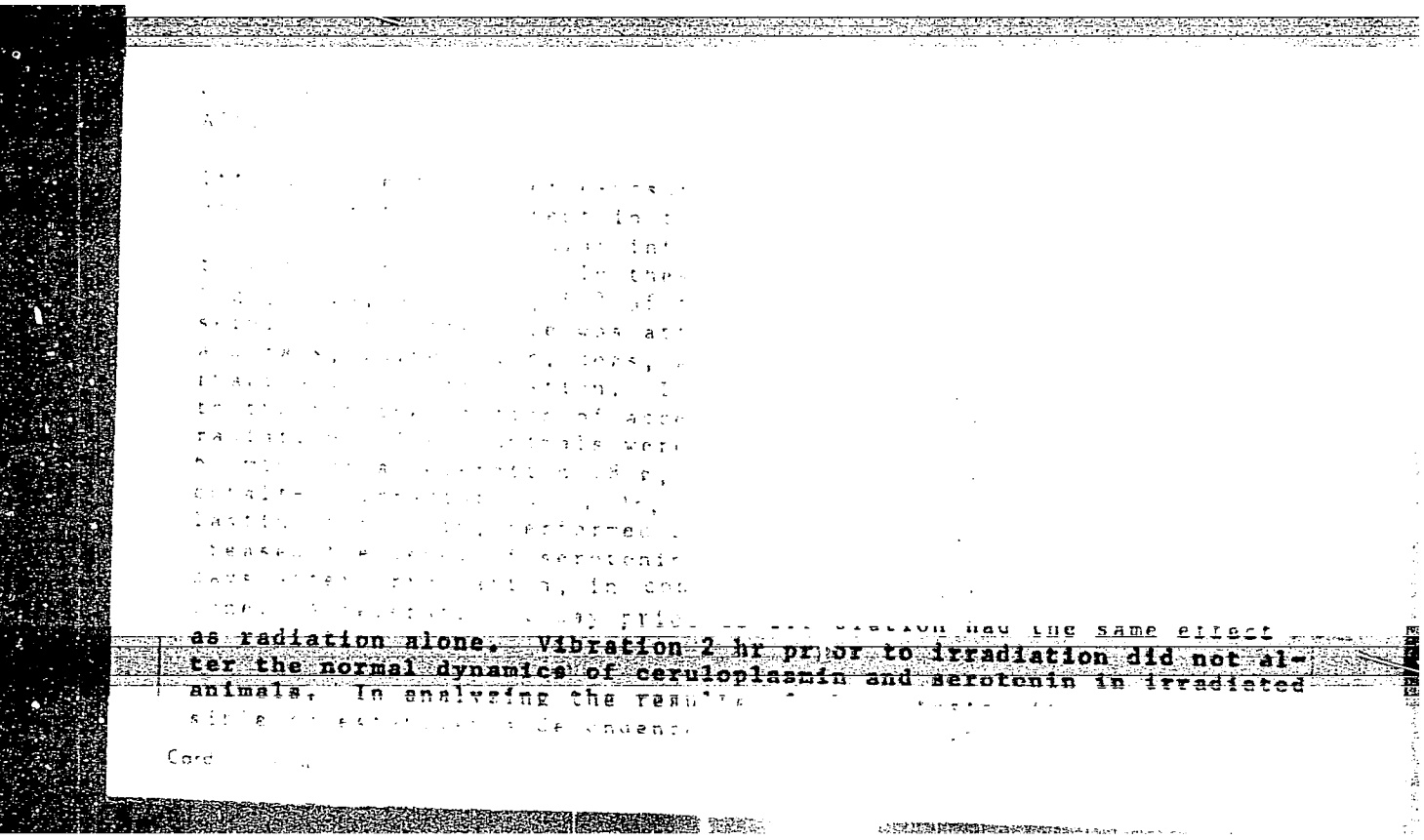


days after exposure. Ceruloplasmin

Card 2/4



as radiation alone. Vibration 2 hr prior to irradiation did not alter the normal dynamics of ceruloplasmin and serotonin in irradiated animals. In analyzing the results

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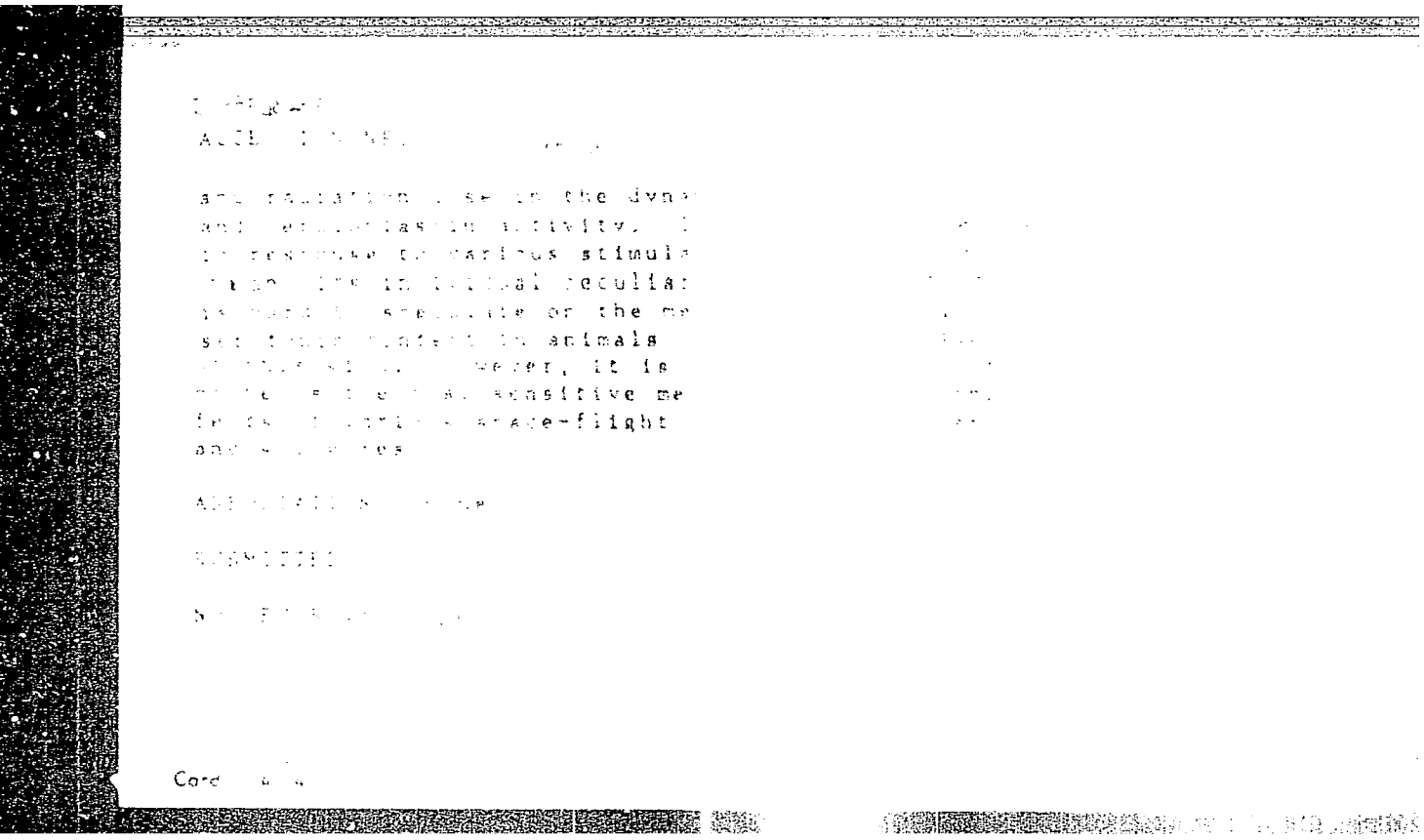


NESTERENKO, A.I.; CHERNOV, G.A.; MUKHAMEDZYANOVA, G.S.; RYNEYSKAYA, V.A.

Activity of ceruloplasmin in leukemic children. Probl. gematol. i perel. krovi no.6:27-30 '65. (MIRA 18:11)

1. TSentral'nyy ordena Lenina institut gematologii i perelivaniya krovi (dir. - dotsent A.Ye.Kiselev) Ministerstva zdravookhraneniya SSSR i Institut pediatrii (dir. - dotsent M.Ya.Studenikin) AMN SSSR, Moskva.

CHERNOV, G. G. and KOMAROV, N. S.

Vzaimozameniaemost' v sel'skokhoziaistvennom mashinostroenii. Moskva, Mashgiz, 1949. 166 p. illus.

DLC: TJ1480.K6

Interchangeability in agricultural machine building.

SO: Manufacturing and Mechanical Engineering in the Soviet Union, Library of Congress, 1953.

CHERNOV, G.G.

"Investigation of the Selection of Fit During Repair of Agriculture Machine Sliding Friction Bearings, Operating Under Conditions of Semi-liquid Friction." Theses for degree of Cand. Technical Sci. Sub 24 Nov 50, Moscow Inst for the Mechanization and Electrification of Agriculture imeni V.M.Molotov.

Summary 71, 4 Sep 52, Dissertations Presented for Degrees in Science and Engineering in Moscow in 1950. From Vechernyaya Moskva. Jan-Dec 1950.

CHERNOV, G.G.

Lock washer designed by I.F.Egorov. Sel'khozmashina no.6: 29-30 Je '55. (MLRA 8:8)

1. Vsesoyuznyy Nauchno-issledovatel'skiy institut sel'skokhozyaystvennogo mashinostroyeniya.
(Washers (Mechanics))

CHERNOV, G.G., kandidat tekhnicheskikh nauk.

Surface finish of cold-drawn shafts and axles in contact with roller bushings of bearings in farm machinery. Sel'khozmashina no.3:29-31 Mr '57. (MLRA 10:5)

(Bearings (Machinery))
(Surfaces (Technology))

CHERNOV, G.G.

Use of cold-drawn steel journals with sintered iron bushings.
Sel'khozmashina no.4:29-30 Ap '57. (MLRA 10:4)

1. Vsesoyuznyy nauchno-issledovatel'skiy institut sel'skokhozyaystvennogo mashinostroyeniya.
(Bearings(Machinery))

CHERNOV, G. G.

AUTHOR: Chernov, G.G., Engineer 28-58-1-20/34

TITLE: Tolerances and Fits of Key Connections (O dopuskakh i posadkakh shponochnykh soyedineniy)

PERIODICAL: Standartizatsiya, 1958, # 1, pp 50-51 (USSR)

ABSTRACT: The article presents a critical consideration of the "GOST 7227-54"-standard for fits and tolerances of prismatic and segment key connections. The large variety of standard tolerances creates difficulties in the production of keys, and keys produced with different tolerances have to be marked. Rules for measuring the key-seat dimensions on shafts are also criticized.

The author suggests a reduced system of tolerances, in which different degrees of connection tightness would be achieved by a different location of the tolerance fields for keyseats as well as change in the size of these tolerance fields. In this way, one of the 6 connection classes of the "GOST 7227-54" could be cancelled.

There is 1 figure and 2 tables.

AVAILABLE: Library of Congress

Card 1/1

VOLKOV, Yu.I., inzh.; GAFANOVICH, A.A., kand.tekhn.nauk; GLADKOV, N.G., kand.sel'skokhoz.nauk; GORKUSHA, A.Ye., agr.; ZHITNEV, N.F., inzh.; ZANIN, A.V., kand.tekhn.nauk; ZAUSHITSYN, V.Ye., kand.tekhn.nauk; ZVOLINSKIY, N.P.; ZEL'TSERMAN, I.M., kand.tekhn.nauk; KAIPOV, A.N., kand.tekhn.nauk; KASPAROVA, S.A., kand.sel'skokhoz.nauk; KOLOTUSHKINA, A.P., kand.ekon.nauk; KRUGLYAKOV, A.M., inzh.; KURNIKOV, I.I., inzh.; LAVRENT'YEV, L.N., inzh.; LEBEDEV, B.M., kand.tekhn.nauk; LEVITIN, Yu.I., inzh.; MAKHLIN, Ye.A., inzh.; NIKOLAYEV, G.S., inzh.; POLESHCHENKO, P.V., kand.tekhn.nauk; POLUNOCHEV, I.M., agr.; P'YANKOV, I.P., kand.sel'skokhoz.nauk; RABINOVICH, I.P., kand.tekhn.nauk; SOKOLOV, A.F., kand.sel'skokhoz.nauk; STISHKOVSKIY, A.A., inzh.; TURBIN, B.G., kand.tekhn.nauk; CHABAN, I.V., inzh.; CHAPKEVICH, A.A., kand.tekhn.nauk; CHERNOV, G.G., kand.tekhn.nauk; SHMELEV, B.M., kand. tekhn.nauk; KRASNICHENKO, A.V., inzh., red.; KLETSKIN, M.I., inzh., red.; MOLYUKOV, G.A., inzh., red.; BLAGOSKLONOVA, N.Yu., inzh., red.; UVAROVA, A.F., tekhn.red.

[Reference book for the designer of agricultural machinery in two volumes] Spravochnik konstruktora sel'skokhozialstvennykh mashin v dvukh tomakh. Moskva, Gos.nauchno-tekhn.izd-vo mashinostroit. lit-ry. Vol.1. 1960. 655 p. (MIRA 13:11)
(Agricultural machinery--Design and construction)

CHERNOV, G.G.

Key joints in agricultural machinery. Trakt.i sel'khozmash.
30 no.10:28-29 O '60. (MIRA 13:9)
(Couplings) (Agricultural machinery)

CHERNOV, G.G.

Using tolerances concerning the system of holes in agricultural machinery. Trakt. i sel'khozmash. 31 no. 5:35-36 My '61. (MIRA 14:5)

1. Vsesoyuznyy nauchno-issledovatel'skiy institut sel'skokhozyaystvennogo mashinostroyeniya.
(Tolerance (Engineering)) (Agricultural machinery)

POLESHCHENKO, P.V.; CHERNOV, G.G.; IVANOV, A.I., kand. tekhn. nauk, retsenzent; ZHURAVLEVA, M.N., red. izd-va; UVAROVA, A.F., tekhn. red.

[Tolerances and dimensional chains in agricultural machines] Dopuski i razmernye tsepi v sel'skokhoziaistvennykh mashinakh; spravochnoe posobie. Moskva, Mashgiz, 1963. 254 p. (MIRA 16:6)

(Agricultural machinery--Desing and construction)

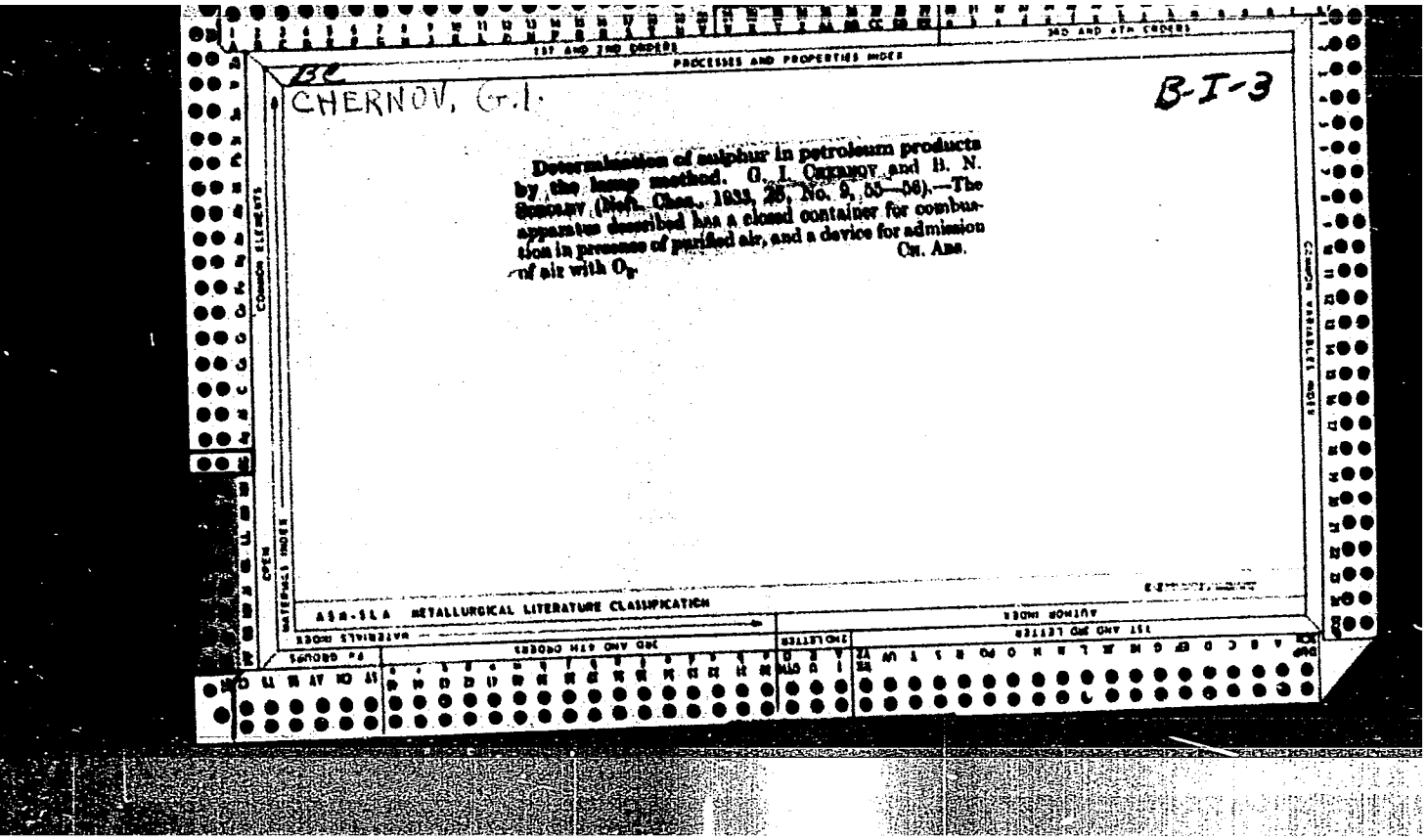
CHERNOV, G.G.; MUGERMAN, L.I.

Installing electric protection simultaneously with construction of the line. Stroi. truboprov. 8 no.1:16-17 Ja '63. (MIRA 16:5)

1. Nachal'nik proizvodstvenno-tekhnicheskogo otdeleniya stroitel'nogo uchastka No.14 tresta po stroitel'stvu gazoprovodov Glavnefteprovodstroya Ministerstva stroitel'stva predpriyatiy neftyanoy promyshlennosti SSSR, Podol'sk.
(Electrolytic corrosion) (Gas, Natural--Pipelines)

CHERNOV, Georgiy Gavrilovich; BLOKHIN, N.N., red.; ANDREYEVA, L.S., tekhn. red.

[Safety measures in the operation of agricultural machinery] Tekhnika bezopasnosti pri rabote na sel'skokhoziaistvennykh mashinakh. Izd.2., ispr. i dop. Moskva, Izd-vo VTsSPS Profizdat, 1961. 159 p. (MIRA 15:4)
(Agricultural machinery--Safety measures)



KRIVOSHEYEV, V.N., inzh.; POLSTYANOY, V.A., inzh.; CHERNOV, G.I., inzh.
LAZNEVOY, V.S., inzh.

Adopting machines for calcining limestone in the sintering process.
Stal' 21 no. 4:293-296 Ap '61. (MIRA 14:4)

1. Makeyevskiy metallurgicheskiy zavod.
(Ore dressing) (Limestone)

S/133/62/000/007/006/014
A054/A127

AUTHORS: Smirnov, Yu.D.; Chernov, G.I.

TITLE: At the Chelyabinskiy nauchno-issledovatel'skiy institut metallurgii (Chelyabinsk Scientific Research Institute of Metallurgy)

PERIODICAL: Stal', no. 7, 1962, 620

TEXT: In cooperation with the Magnitogorskiy metallurgicheskiy kombinat (Magnitogorsk Metallurgical Combine) a technology for semi-killed steel has been developed, in which reduction is effected only by silicon added in the furnace or the ladle. High-quality 7-ton ingots of Ст . 3пс (St.3ps) steel can be produced by this technology. As to chemical composition, the new grade is similar to killed steel; the surface of rolled sections is satisfactory and requires less finishing than the Ст .3сп (St.3sp) killed steel. The yield of serviceable product for rolled sections increased by 9%, the production costs were cut by 2.55 rubles/ton. In rolled sections with diameters under 30 mm the strength and ductility are in accordance with ГОСТ 380-60 (GOST 380-60) for killed steel, at sub-zero temperatures and after mechanical aging, however, the notch toughness values are not equal to those of killed steel. Therefore, the new

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At the Chelyabinskiy ....

steel grade can replace the St.3sp grade only for rolled sections up to 30 mm, not requiring high notch toughness at -20°C, and after aging. The possibility of replacing Ст .3 кп (St.3kp) steel by semi-killed steel in the production of the Chusovskiy metallurgicheskiy zavod (Chusovoy Metallurgical Plant) was also investigated. When castings were made in bottle-shaped ingot molds, the yield of serviceable rolled sections was raised by 2%, due to reduced head crop.

Card 2/2

KANFER, D.F., inzh.; CHERNOV, G.I., inzh.; TOPOL', N.F., inzh.; ALFEROV, K.S., inzh.; YEVDOKIMOV, N.A., inzh.

Research at the Makeyevka Metallurgical Plant. Stal' 23 no.2:116,130-131,156 F '63. (MIRA 16:2)
(Makeyevka—Metallurgical research)

CHERNOV, Grigoriy Iosifovich; SMIRNOV, Yuriy Dmitriyevich; SVET, Ye.B., red.; KUZNETSOVA, O.Ya., tekhn.red.

[Production of semikilled steel] Proizvodstvo poluspokoinoi stali. Cheliabinsk, Cheliabinskoe knizhnoe izd-vo, 1963. 59 p. (MIRA 17:3)

ROSTEMBERSKIY, A.V.; KANFER, V.D.; SOLDATKIN, A.I., kand.tekhn.nauk; KUMANI, B.G.; CHERNOV, G.I.; LOZNEVOY, V.S.; ZAPOROZHETS, N.P.

Increasing the productivity of sintering plants and improving the quality of the sinter. Met. i gornorud. prom. no. 2:20-22 Mr-Ap '64. (MIRA 17:9)

SEN'KO, G.Ye.; ONOPRIYENKO, V.P.; TSARITSYN, A.N.; MOZGOVOY, V.M.; CHERNOV, G.I.; KONAREVA, N.V.

Analysis of blast furnace performance with the automatic control of the blast in the air tuyeres. Stal' 25 no.7:590-593 Jl '65. (MIRA 18:7)

1. Ukrainskiy nauchno-issledovatel'skiy institut metallov i Makeyevskiy metallurgicheskiy zavod.

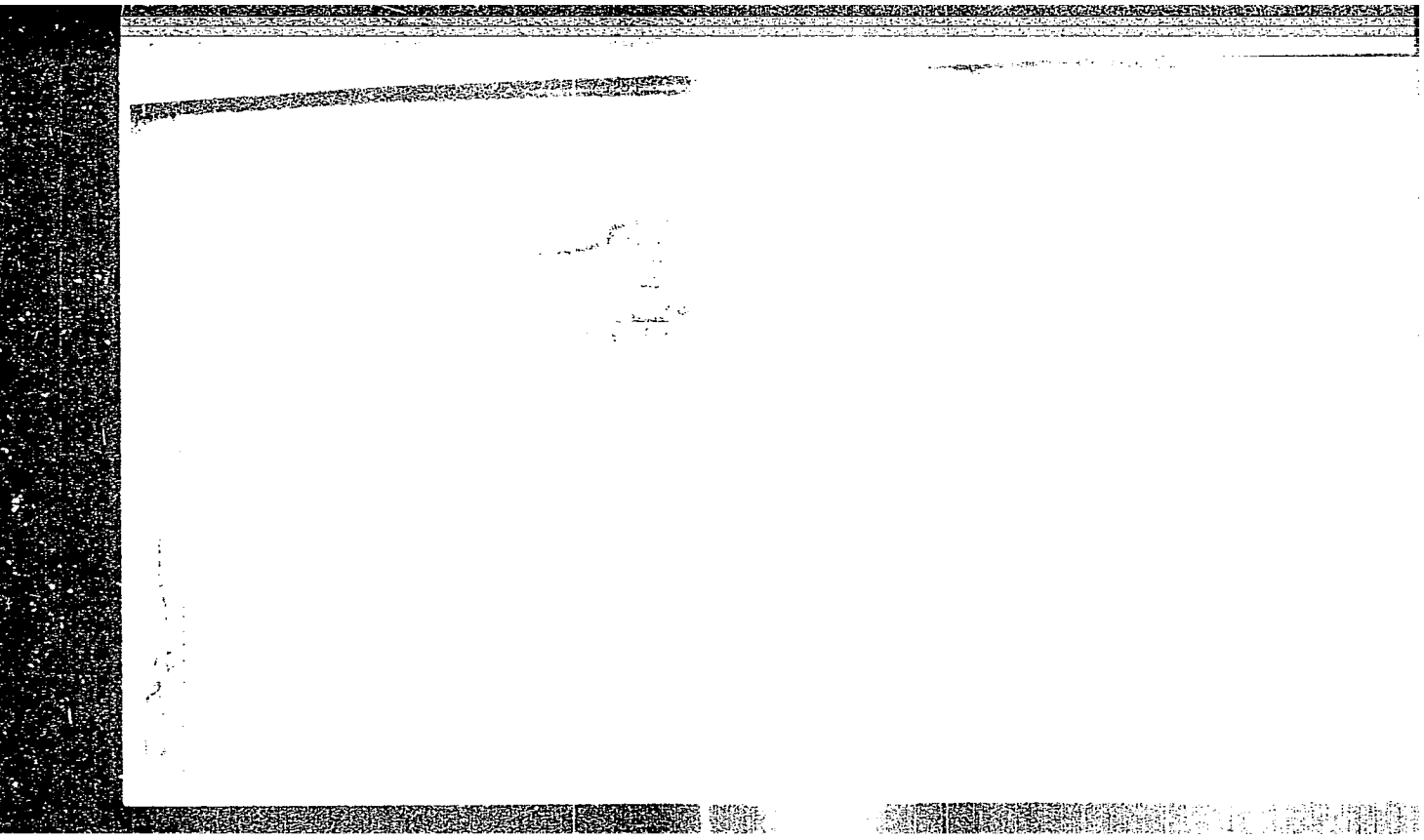
CHERNOV, G.I.; YEVDOKIMOV, N.A.; MUSERSKIY, Ye.V.; SEREZHKIN, B.I.; NIKOLAYEVA, M.R.

Operation of a blast furnace with automatic control of the blast distribution through the tuyeres. Metallurg 10 no.6: 8-10 Je '65. (MIRA 18:6)

CHERNOV, G.I.; POPOV, R.V.

Manufacturing water and gas pipes from cut strips in continuous furnace-welding units. Biul.tekh.-ekon.inform.Gos.nauch.-issl.inst. nauch.i tekh.inform. 18 no.4:3-5 Ap '65.

(MIRA 18:6)



APPROVED FOR RELEASE: 06/12/2000 CIA-RDP86-00513R000308530006-6"

CHERNOV, G.K., inzhener.

Utilizing waste nitrogen in producing protective atmospheres.
Kislorod 10 no.2:36 '57. (MLRA 10:9)
(Nitrogen) (Protective atmospheres)

CHERNOV, G.K., inzhener.

Vibration tube performance. TSement 23 no.3:25-26 My-Je '57.
(MLRA 10:7)

1. Gidroenergoprom.
(Conveying machinery)

CHERNOV, G.K., inzh.

[redacted] safe systems of feeding gas to burners. Bezop. truda v prom. 2 no.11: 17 N '58. (MIRA 11:11)
(Gas burners)

CHERNOV, G.K.

Technical decisions concerning the conversion of the Novocherkask Electric Locomotive Plant to gas fuel. Gas.prom. 4 no.10:34-37 O '59. (MIRA 13:2)
(Novocherkask--Electric locomotives)
(Gas as fuel)

KUKOZ, F.I., kand.tekhn.nauk; CHERNOV, G.K., inzh.; SKALOZUBOV, M.F., kand. tekhn.nauk

Magnetic treatment of aquous solutions. Prom. energ. 20 no.2:34-36 '65. (MIRA 18:4)

CHERNOV GRIGORIY L.

MEL'NICHUK, Petr Alekseyevich; CHERNOV, Grigoriy L'vovich; SHMERLING, Klara Grigor'yevna; LYUDSKOV, B.P., redaktor; MEDRISH, D.M., tekhnicheskiy redaktor.

[Organization and equipment of the food trade; a manual for schools of Soviet commerce] Organizatsiia i tekhnika torgovli prodovol'stvennymi tovarami; uchebnoe posobie dlia tekhnikumov sovetskoi torgovli. Moskva, Gos.izd-vo torg.lit-ry, 1957. 311 p. (MIRA 10:11)

(Food industry)

AUTHORS: Estulin, I. V., Chernov, G. M., Pastukhova, Z. V. SOV/56-35-1-9/59

TITLE: On the Mo^{99}-Decay Scheme (O skheme raspada Mo^{99})

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 1, pp 71 - 77 (USSR)

ABSTRACT: In a number of earlier papers the decay scheme of Tc^{99} was already investigated at excitation energies of 140 and 142 keV (Refs 1-3), 180 and 922 keV (Refs 5-7), and β-transitions of Mo^{99} (Refs 1,5,8). In the present paper the authors deal with the investigation of the angular correlations of the 742 - 180 keV-γ-quanta which are emitted at the decay of Mo^{99}. The decay scheme is given in figure 1(levels: 922, (780), (509), 180, 142, 140 keV). Figure 2 is a schematic representation of the measuring arrangement used. It consists essentially of two luminescence counters with stilb crystals of 20 mm thickness and a photomultiplier FEU -19; the coincidence had a resolving power of $\tau = 3.10^{-8}$sec. The luminescence crystals were housed in lead containers of 3 mm thickness. Control

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tests were carried out with a Cs^{137} source. Before the window of the lead containers there were lead filters of 1 mm thickness. Results for the transitions 922-180-0 keV (a_2 = coefficient of angular correlation, $W(\theta)$ = correlation function):

		$W(\theta)/W(\pi/2)$:	90°	140°	165°
3/2(D)5/2(Q)9/2	a_2= -0,0714		1,00	0,95	0,91
3/2(Q)7/2(D)9/2	-0,0716		1,00	0,94	0,90
7/2(D)7/2(D)9/2	-0,0667		1,00	0,94	0,91
5/2(Q)9/2(D)9/2	-0,119		1,00	0,90	0,84
5/2(D)7/2(M1+E2)9/2	-0,17 < a_2 < +0,32				
experiment	-0,07 ± 0,015		1,00	0,93±0,02	
				0,92± 0,02	

For δ^2, i.e.the ratio of the emission intensities E2:M1 it holds that

$(1+\delta^2)a_2 = 0{,}050+0{,}097\delta^2+ 0{,}486\delta$. The chemical separation of Tc^{99m} showed that the β-transition in Mo^{99} with E_β=1,23 MeV leads to an isomeric equilibrium in Tc^{99} and (7±1)% of the 140 keV intensity is not connected with the isomeric transition. In conclusion the authors thank I.S.Shapiro

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for discussing results. There are 5 figures, 1 table, and 17 references, 5 of which are Soviet.

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

SUBMITTED: February 27, 1958

CHERNOV, G.M.

S/166/60/000/03/03/011
C111/C222

AUTHORS: Azimov, S.A., Corresponding Member of the AS Uz SSR, Chernov, G.M., and Chudakov, V.M.

TITLE: On the Investigation of the Angular Distribution of Shower Particles in Nuclear Interactions 79

PERIODICAL: Izvestiya Akademii nauk Uzbekskoy SSR, Seriya fiziko-matematicheskikh nauk, 1960, No. 3, pp. 16 - 23

TEXT: The authors join the results of (Ref. 1,2,3). Let $c\beta_c$ be the velocity of the system of the mass center, $c\beta^*$ be the velocity of the particle in this reference system, let $m = \frac{\beta_c}{\beta^*}$. The paper contains a theoretical investigation of the angular distribution of the shower particles for different $m \neq 1$. It is assumed that there exists a reference system with a symmetrical angular distribution of the shower particles with respect to the angle $\theta^* = \frac{\pi}{2}$ (S - system). The system of the laboratory is called L - system. VB

Card 1/2

On the Investigation of the Angular Distribution of Shower Particles in Nuclear Interactions

S/166/60/000/03/03/011
C111/C222

It is stated that the deviation of the number m from the value 1 for not too large energies leads to an appearant asymmetry of the angular distribution with respect to the angle $\frac{\pi}{2}$ in an arbitrary reference system. At the other hand, here the anisotropy of the angular distribution in the S-system and the mean value $\overline{m}$ can be estimated if the weak dependence of the characteristics of the angular distribution of m in the domain of small angles θ in the L - system is used. Different methods for the estimation of $\overline{m}$ have to lead to the same results and simultaneously show whether $\overline{m} > 1$ or $\overline{m} < 1$. In the contrary case it can be concluded that there does not exist a reference system with an angular distribution symmetrical with respect to $\frac{\pi}{2}$. There are 5 figures and 7 references: 6 Soviet and 1 American.

ASSOCIATION: Fiziko-Tekhnicheskiy institut AN Uz SSR (Physical-Technical Institute AS Uz SSR)

SUBMITTED: February 2, 1960

Card 2/2

VB

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S/048/60/024/009/009/015
B013/B063

24.6720

AUTHORS: Surkov, Yu. A., Chernov, G. M., Lavrukhina, A. K., Khromchenko, Z. V.

TITLE: Investigation of Neutron-deficient Osmium Isotopes

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1960, Vol. 24, No. 9, pp. 1119-1123

TEXT: The present paper gives the results of an investigation of neutron-deficient osmium isotopes on the synchrocyclotron of OIYaI (Joint Institute of Nuclear Research). The osmium isotopes were produced by bombarding ~0.2 g of gold with 660-Mev protons for 1 — 2 hours. The purity of the separated elements was radiochemically checked. A 100-channel scintillation gamma spectrometer and β- and γ-counters were used to analyze the beta and gamma emission of the nuclear reaction products. Fig. 1 shows the gamma spectrum of the osmium isotopes obtained. The authors identified Os^{182}, Os^{183}, Os^{183*}, and Os^{185} which had a half-life of at least 10 hours. In addition, the spectrum showed an intense line, E_γ = 230 kev, which had

Investigation of Neutron-deficient Osmium Isotopes

a half-life of ~2.7 hours. Control experiments indicated the existence of a new osmium isotope having a half-life of three hours. This was confirmed by the study of the daughter osmium (Figs. 3 and 4) and the daughter rhenium (Fig. 5). This neutron-deficient isotope is assumed to be Os^{181} and has a half-life 2.7 hours. By capture of the orbital electron it is converted into Re^{181}. 230-kev gamma quanta are emitted during this conversion. Fig. 2 shows the descending curve of the activity sum of Os, which was measured by an end-window counter. It confirms the correctness of the identification of the isotopes. As there are now only few data available on neutron-deficient Ir, Os, and Re isotopes, the conclusions drawn from the results obtained require further confirmation. The agreement of these results with experiments recently carried out with protons of 10 - 80 Mev (Ref. 1) indicates that the above-mentioned identification is correct. The results further indicate the existence of the isotope Ir^{183} which is formed by the decay of the two isomers Os^{183} and Os^{183}. Furthermore, a 23-min activity of osmium (E_γ = 170 kev) was observed during the experiments. However, the 23-min isotope may well be an isomer

83676

Investigation of Neutron-deficient Osmium Isotopes

S/048/60/024/009/009/015
B003/B063

of some unidentified osmium isotope. The authors thank V. I. Baranov for his interest in this work. There are 6 figures and 2 references: 1 Soviet and 1 Canadian.

Card 3/3

CHERNOV, G.M., inzh.

New automatic mixer. Stroi.i dor.mashinostr. no.7:17 Jl '59.
(MIRA 12:11)

(Concrete mixers)

20622
S/063/60/005/005/011/021
A051/A029

55500

AUTHORS: Baranov, V.I., Professor, Sankov, Yu.A., Chernov, G.M., Yakovlev, Yu.V.

TITLE: Radioactivation Analysis of Pure Materials and Prospects of Its Development

PERIODICAL: Zhurnal Vsesoyuznogo Khimicheskogo Obshchestva im. D.I. Mendeleyeva, 1960, No. 5, Vol. 5, pp. 570-573

TEXT: The radioactivation analysis method is used for the determination of pure materials in the semiconductor and reactor-building industries. It is highly sensitive, depending on the magnitude of the flux of bombarding particles and the cross-section of the activation of a given element, i.e., its specificity: there is no necessity for a quantitative separation of the traces of the elements, no correction for the control test (Ref. 7-10). In the more recent application of the method gamma-spectroscopy is used (Ref. 13-15) which reduces the number of chemical separations of the analyzed

Radioactivation Analysis of Pure Materials and Prospects of Its Development

samples. By applying gamma spectroscopy, a continuous check of the accuracy and purity of the chemical operations can be carried out, contrary to the usual calculation of the β-activity. A study of the spectrum obtained leads to an estimation of the qualitative purity of the separated sample according to the energies of the characteristic gamma-rays. The amount of admixture present in the sample is determined from the areas of the spectra sections corresponding to the activated isotope of this admixture. The measurement of the area of the photopeak is done by approximation of the photopeak contour of the Gaussian error curve. If the sample under investigation does not emit gamma-rays, or if its half-life is so slight that it completely decays by the time the measurements are made, then the gamma-scintillation spectrometer introduces new possibilities for coping with this problem. Reference is made to a number of publications dedicated to the application of gamma-spectroscopy (Ref. 16-19). The authors of this article conducted a radioactivation analysis of admixtures in materials used in the semiconductor-manufacturing industry and list the obtained results. Ad-

Radioactivation Analysis of Pure Materials and Prospects of Its Development

mixture detection in silicon was carried out using a 50-channel scintillation spectrometer. A 40 x 40 mm NaJ(Tl) crystal served as the emission detector and the ФЭУ-С(FEU-S) photomultiplier was used. The detector was surrounded by a lead shield. The impulses from the photomultiplier reached the 50-channel amplitude analyzer through the linear amplifier and discriminator. The analyzer is based on the principle of transformation of the pulses in time, combined with the memory device on an ordinary electrostatic cathode-ray tube. Recording of the signals on the analyzer tube renders it possible to obtain the spectrum image on a linear scale with an unlimited channel capacity. The resolution of the gamma-spectrometer measured by Cs^{137} is 9%. The estimated Zn content was $1 \cdot 10^{-2}$%, arsenic $1.2 \cdot 10^{-1}$%, copper and gallium $2\text{-}3 \cdot 10^{-1}$%. Fig.1 shows the gamma-spectrum of the activated silicon sample. Further work was carried out on the same gamma-spectrometer without chemical processing of the sample being analyzed for determining admixtures of Mn, Zn, Cu, As and Sb in several samples of thallium metal. A weighed batch (about 0.5 g) of the sample and standards in the form of microquantities of

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Radioactivation Analysis of Pure Materials and Prospects of Its Development

salts of the elements being determined were placed into quartzite containers previously processed with hot aqua regia and then rinsed with water, alcohol and ether. The containers were wrapped in aluminum foil, placed into aluminum cases and irradiated in a neutron flux of about 10^{13} neutr. per $cm^2 \cdot sec$ for 24-28 hours. After a chemical purification from impurities, primarily Na, the standards and samples were measured in the gamma-spectrometer. In analyzing thallium on the gamma-spectrometer a difficulty arises: although Tl^{204} formed in the reactor is a β-emitter with a transition to the main level, about 30% of its decay is due to K-captures. Thus a characteristic X-ray emission with an energy of about 75 Kev occurs, which renders the analysis difficult for small quantities of admixtures. Fig. 2 shows the spectra of two investigated samples of thallium. The decay curve of the photopeak of As+Sb showed that it is mainly due to As^{76} ($T_{1/2}$ = 26 hours). Table 1 shows the result of the determination of Mn, Cu, Zn, Sb and As admixtures in the thallium sample. The quantitative analysis of the admixtures was carried out by comparing the areas or the photopeak heights of the

Radioactivation Analysis of Pure Materials and Prospects of Its Development

sample being analyzed and the standards relative to one moment of time. Correction for the geometry was not introduced, since the samples and standards were measured under similar conditions. The admixture content (in %) was estimated after calculating the absolute mass of the admixture. Table 2 gives the results of the analysis of several samples of graphite, also carried out on the gamma-spectrometer without chemical separation. In discussing the future prospects of developing the radioactivation method of analysis the authors point out some of the difficulties in applying it. The main difficulty is given as being the fact that most substances when activated with neutrons become gamma-emitters themselves. Germanium is given as an example. Another difficulty lies in the processing of the gamma-spectrum obtained in the spectrometer due to the occurring compton electrons which give a continuous distribution of the pulses on the spectrum. A third difficulty is the detection of admixtures with a small yield, giving photopeaks which are weak in their intensity. The authors further state that one of the main problems which lie ahead in this connection is the development of

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Radioactivation Analysis of Pure Materials and Prospects of Its Development

new effective methods of chemical purification of ultra-small quantities of admixtures from the basic component having gamma-activity. The chemical purification in this case must not take up too much time, since the decay of the short-living activity lowers the sensitivity of the activation analysis. By developing the described methods, gamma-spectroscopy will become applicable for analyzing materials, which, when activated, become intensive gamma-emitters themselves. It is further recommended to decrease the compton background by using more perfected spectroscopic apparatus. The authors have developed a one-channel double-crystal counting gamma-spectrometer with automatic recording of the spectra (Ref. 23). It is based on the principle of the simultaneous recording of the gamma-spectrum by two different crystals with subsequent counting of the obtained spectra in a corresponding difference scheme. A third aspect is the application of the double-crystal spectrometer for significantly increasing the sensitivity of the method without lessening the effectiveness and resolving power. The authors point out the necessity of developing an activation method for the analysis of short-lived

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Radioactivation Analysis of Pure Materials and Prospects of Its Development

isotopes. When investigating the admixtures of short-lived radioactivity, the activation analysis should be carried out near the reactor for this reason. The radio-chemical operations should be eliminated. Finally, the authors suggest that in order to detect certain elements by the activation method, it would be most feasible to use fast neutron fluxes. In the case of detecting Al and Mg admixtures, for example, the reaction on fast neutrons should be used: $Al^{27}(n,\alpha)Na^{24}$ and $Mg^{24}(n,p)Na^{24}$. The reaction on neutrons in the resonance energy field might also prove useful in this connection. A significant increase in the monochromatic neutron flux would then be necessary. The activation analysis method should be developed toward a constant minimum loss in its performance and toward increasing its productivity. Automation of measurements is suggested, as well as of the result processing, yielding a complete analytical chart of the sample. This can be facilitated by introducing into industry the activation method of analysis of elements by the computing technique. There are 3 figures, 2 tables and 23 references: 9 Soviet, 14 English.

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Radioactivation Analysis of Pure Materials and Prospects of Its Development

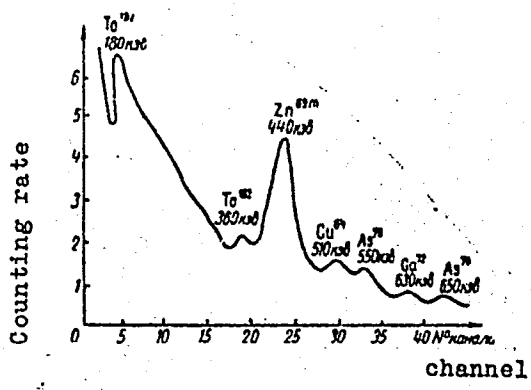

Figure 1: Gamma-spectrum of an activated sample of silicon.

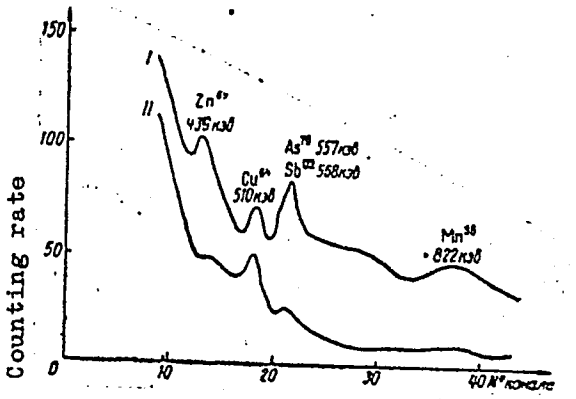

Figure 2: Gamma-spectrum of two activated samples of thallium

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Radioactivation Analysis of Pure Materials and Prospects of Its Development

Table 1: Results of analysis of highly-purified thallium

Sample No.	Admixtures being determined, in %				
	Mn	Cu	Zn	Sb	As
1	$2,9 \cdot 10^{-7}$	$3 \cdot 10^{-7}$	-	$\leq 4 \cdot 10^{-6}$	$2 \cdot 10^{-6}$
2	$1\ 3 \cdot 10^{-7}$	$1 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$\leq 9 \cdot 10^{-6}$	$5 \cdot 10^{-6}$
3	$< 4 \cdot 10^{-8}$	$1,8 \cdot 10^{-7}$	$1 \cdot 10^{-5}$	$\leq 2 \cdot 10^{-6}$	$1 \cdot 10^{6}$
4	$< 4 \cdot 10^{-8}$	$\leq 1 \cdot 10^{-7}$	-	$\leq 2 \cdot 10^{-6}$	$1 \cdot 10^{-6}$

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Radioactivation Analysis of Pure Materials and Prospects of Its Development

Table 2: Results of analysis of highly-purified graphite

Sample No.	Admixtures being determined, in %		
	Br	Au	W
1	$1,9 \cdot 10^{-4}$	none	none
2	$5 \cdot 10^{-4}$	$2,3 \cdot 10^{-8}$	none
3	$3,4 \cdot 10^{-4}$	$1,1 \cdot 10^{-7}$	$2 \cdot 10^{-5}$
4	none	none	$6, \cdot 10^{-4}$
5	$2,6 \cdot 10^{-4}$	none	$5 \cdot 10^{-5}$

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88424

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AUTHORS: Azimov, S. A., Teshabayev, K.T., Chernova, L. P., Chernov, G. M., Chudakov, V. M.

TITLE: Angular Distribution of Shower Particles in Nuclear Interactions Between Fast Nucleons and Heavy Nuclei of Photographic Emulsions

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 6(12), pp. 1534-1539

TEXT: The angular distributions of secondary particles were investigated in 70 interaction events of singly-charged or neutral cosmic particles with heavy photoemulsion nuclei. These showers were found during the evaluation of Ilford-G-5 plates, which had been exposed in the stratosphere in 1955, in the course of the Italian expedition. 55 of them had been caused by singly-charged, and 15 by neutral particles. The energies of the primary particles could be determined as amounting to 10^{10} - 10^{12} ev; the showers consisted of more than eight strongly ionizing particles. Symmetry investigations of the angular distributions led to the result that symmetry

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Angular Distribution of Shower Particles in Nuclear Interactions Between Fast Nucleons and Heavy Nuclei of Photographic Emulsions

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exists with respect to the angle $\pi/2$ in a system of reference, in which for half of all particles $\theta^* > \pi/2$ (s-system); the conversion of θ measured in the laboratory system is carried out according to the equation $\gamma_c \tan\theta = \tan(\theta^*/2)$, where γ_c is the Lorentz factor. γ_c is determined from $(\gamma_c)_1 = \operatorname{ctan}\theta_{1/2}$ and $\log(\gamma_c)_2 = \overline{-\log\tan\theta}$, $\gamma_c = \bar{\gamma}_c = \frac{1}{2}\left[(\gamma_c)_1 + (\gamma_c)_2\right]$.

Fig. 1 shows the angular distribution in the s-system for secondary shower particles, caused by charged particles a) for $\gamma_c < 3$ (31 showers of 55), and b) for $\gamma_c > 3$. Further, the dispersions for the angular distributions were investigated along with the interrelation between γ_c and the number of the relativistic tracks n_s. ($n_s \geq 5$). The mean anisotropy of the angular distribution of the particles in the c-system may quantitatively be characterized by:

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Angular Distribution of Shower Particles in Nuclear Interactions Between Fast Nucleons and Heavy Nuclei of Photographic Emulsions

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$$\sigma = \left[\sum_{i=1}^{N} \sum_{j=1}^{n_i} \left[\log \tan \theta_{ij} - \overline{(\log \tan \theta)_i} \right]^2 \Big/ \sum_{i=1}^{N} (n_i - 1) \right]^{1/2},$$

where n_i is the number of charged secondary particles in the i-th shower with $\theta < \pi/2$, N is the number of showers, σ is between 0.44 and 0.55. The authors thank G. B. Zhdanov for discussions. Zh. S. Takibayev is mentioned. There are 4 figures, 1 table, and 8 references: 5 Soviet, 2 US, and 1 Italian

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Uzbekskoy SSR (Institute of Physics and Technology of the Academy of Sciences of the Uzbekskaya SSR). Sredneaziatskiy gosudarstvennyy universitet ((Soviet) Central Asia State University)

SUBMITTED: June 27, 1960

Card 3/3

31067
S/166/61/000/006/008/010
B102/B138

24.6700 (also 1191)

AUTHORS: Azimov, S. A., Corresponding Member AS Uzbekskaya SSR, Nikishin, B. K., Chernova, L. P., Chernov, G. M., Chudakov, V. M.

TITLE: Investigation of the azimuthal angular distribution of shower particles

PERIODICAL: Akademiya nauk Uzbekskoy SSR. Izvestiya. Seriya fiziko-matematicheskikh nauk, no. 6, 1961, 65-76

TEXT: This is a continuation of previous studies, covering: investigation of the influence of energy and momentum conservation law on the azimuthal characteristics of secondary particles; study of azimuthal effects in the collision of singly charged cosmic particles with heavy emulsion nuclei ($n_h+n_g \geq 8$) and in pN collisions of 9-Bev primary particles; comparison between theory and experiment. The influence of momentum conservation was studied by evaluating experimental data on random stars imitating the 9-Bev pp collisions of statistical theory. The characteristic parameters of the azimuthal angular distributions were found to be below the values

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Investigation of the azimuthal ...

expected for isotropic. The effect of energy and momentum conservation decreases with increasing number of shower particles. Data from nuclear emulsions exposed to 9-Bev protons at the Ob"yedinennyy institut yadernykh issledovaniy (Joint Institute of Nuclear Research) were used to study the azimuthal effects in pN collisions. Most of the "jets" formed in the emulsion by single charged cosmic particles were pN collisions and displayed an azimuthal anisotropy of the secondary particles. The angular distribution was less disturbed by azimuthal effects than was isotropy. An azimuthal effect was found to be also present in collisions between singly charged cosmic particles and heavy emulsion nuclei ($n_h+n_g > 8$), but it was weaker than in "jets". This is due to the number of nucleons in the target nucleus. The azimuthal anisotropy of secondary particles is in contradiction with the hydrodynamic theory of "jet" formation but agrees with the results of the two-center model. Conservation of angular momentum has also to be taken into account. Some conclusions of the two-center model are discussed. Azimuthal anisotropy indicates the presence of high angular momentum of the excited centers, which can be assumed to be rotating spheres. There are 1 figure, 4 tables, and 21 references:

Card 2/3

Investigation of the azimuthal ...

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13 Soviet and 8 non-Soviet. The reference to the English-language publication reads as follows: W. L. Kraushaar, L. J. Marks, Phys. Rev. 93, 326, 1954.

ASSOCIATION: Fiziko-tekhnicheskiy institut AN UzSSR (Physico-technical Institute of AS Uzbekskaya SSR)

SUBMITTED: April 7, 1961

Card 3/3

ALIMARIN, I.P.; YAKOVLEV, Yu.V.; SHCHULEPNIKOV, M.N.; VLASOV, D.A.; CHERNOV, G.M.; SURKOV, Yu.A.

Radioactive determination of impurities in high purity thallium. Zhur.anal.khim. 16 no.2:213-216 Mr-Ap '61. (MIRA 14:5)

1. Vernadsky Institute of Geochemistry and Analytical Chemistry, Academy of Sciences U.S.S.R., Moscow.
(Thallium—Analysis)

S/048/62/026/001/013/018
B125/B102

AUTHORS: Malysheva, T. V., Moskaleva, L. P., Chernov, G. M., Filateva L. V.

TITLE: Study of neutron-deficient tantalum isotopes

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 26, no. 1, 1962, 125 - 126

TEXT: The authors studied the neutron-deficient tantalum isotopes that are formed in the spallation of gold by 660-Mev protons. 0.3 to 0.5 mg of metallic gold were irradiated for 30 - 60 min by the inner beam of the synchrocyclotron of the OIYaI and, after dissolution in aqua regia, extracted with ether. Tantalum was separated on an isotope carrier in the radiochemically pure form. Hafnium, the daughter, was separated from tantalum by 5 precipitations. The forming radioactive isotopes of tantalum and hafnium were identified from their γ-spectra by means of a scintillation γ-spectrometer with a 100-channel pulse analyzer (consisting of a ФЭУ-С (FEU-S)-photomultiplier with NaI crystal) and from the energy of β-radiation. Ta^{175} was observed in the spallation products of gold

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by measuring the activity in the hafnium specimens during three months. The decay curves indicate the existence of a component Hf^{175} with half life of 70 days. Three months after hafnium had been separated from tantalum 340- and 230-kev γ-lines of Hf^{175} (half life 10 ± 1hr) were observed. Hf^{173} with a half life of 24.5 hr detected in the daughter emits the 120- and 300-kev γ-lines. The tantalum activity consists of 4 main components with the half lives 1.2, 4, 12, and 53 hr. The existence of Ta^{173} in the spallation products of gold is confirmed by the half lives 4 and 12 hr. The papers (Ref. 4) published after the present experiments had been completed confirm the existence and the half life of the isotope Ta^{173} discovered by the author. There are 4 figures and 4 references: 1 Soviet and 3 non-Soviet. The three references to English-language publications read as follows: Ref. 1: Strominger D., Hollander J. M., Seaborg G. T., Revs. Mod. Phys., 30, 585, (1958); Ref. 2: Mihelich J. W., Harmatz B., Handley T. H., Phys. Rev., 114, 1082 (1959); Ref. 4: Faler K. T., Rasmussen J. O., Phys. Rev., 118, 265 (1960).

Card 2/3

ASSOCIATION: Institut geokhimii i analiticheskoy khimii im. V. I. Vernadskogo Akademii nauk SSSR (Institute of Geochemistry and Analytical Chemistry imeni V. I. Vernadskiy of the Academy of Sciences USSR)

V

S/166/62/000/004/006/010
B112/B186

AUTHORS: Azimov, S. A., Chernova, L. P., Chernov, G. M., Chudakov, V. M.

TITLE: The nature of the interaction between fast nucleons and heavy nuclei

PERIODICAL: Akademiya nauk Uzbekskoy SSR. Izvestiya. Seriya fiziko-matematicheskikh nauk, no. 4, 1962, 47 - 51

TEXT: The authors studied experimentally the angular distribution (S-system) of secondary particles in showers produced by charged particles. They observed growth properties of the anisotropy σ which are qualitatively inconsistent with theoretical representations of the interaction between a nucleon and the flight-path "tube" of nuclear matter. If, however, the model of peripheral interactions is applied to rearrangement collisions of fast nucleons with heavy nuclei the increase of anisotropy in the S-system can be explained as due to an increased number of nucleus-target nucleons participating in the collision, as well as to the formation of a great number of ionized particles and the appearance of humps in shower particles. There is 1 figure.

Card 1/2

The nature of the interaction...

ASSOCIATION: Fiziko-tekhnicheskiy institut AN UzSSR (Physico-technical Institute AS UzSSR)

SUBMITTED: April 25, 1961

Card 2/2

ABDUZHAMILOV, Sh.; AZIMOV, S.A.; CHERNOVA, L.P.; CHERNOV, G.M.; CHUDAKOV, V.M.

Azimuthal angular distribution of shower particles producted by cosmic ray particles in a photographic emulsion. Zhur. eksp. i teor. fiz. 45 no.3:407-414 S '63. (MIRA 16:10)

1. Institut yadernoy fiziki AN Uzbekskoy SSR.
(Photography, Particle track)
(Cosmic rays)

ACCESSION NR: AP4042364 S/0056/64/047/001/0024/0029

AUTHORS: Abduzhamilov, Sh.; Azimov, S. A.; Chernova, L. P.; Chernov, G. M.; Chudakov, V. M.

TITLE: Angular distributions of secondary particles in pN collisions at 24 BeV energy

SOURCE: Zh. eksper. i teor. fiz., v. 47, no. 1, 1964, 24-29

TOPIC TAGS: pion scattering, angular distribution, nucleon scattering, dispersion analysis, nuclear emulsion

ABSTRACT: The research was undertaken because asymmetric emission of particles was observed in nucleon-nucleon collisions at energies of several hundred BeV (V. V. Guseva et al., Izv. AN SSSR, Ser. fiz., v. 26, 549, 1962. N. A. Dobrotin et al., Nuclear physics v. 35, 152, 1962). The statistical method of dispersion analysis (the F test) is used to check the hypothesis of independent secondary-particle

emission angles in inelastic pN interactions involving primary protons of equal energy E and equal numbers n of charged secondary particles. The experimental values of F for pN interactions at 24 BeV and for 4--9 charged secondary particles conflict with this hypothesis and indicate nonuniformity of the angular distributions in the laboratory system. This nonuniformity cannot be accounted for by momentum conservation in knock-on collisions and is associated with the particle production mechanism in peripheral interactions. The efficiency of the F-test for determining nonuniform angular distribution in the laboratory system was checked by investigating the random stars obtained from a somewhat different model of NN interactions at 300 BeV, by obtaining the spectrum of meson cloud velocities in the center of mass system and the secondary-particle energy spectrum in the rest system of the meson cloud. An accelerated on-track scanning of plates bombarded with 24-BeV protons in the CERN accelerator has shown that for the stars observed in the emulsion the most values of F exceed unity, meaning that the emission angles of the secondary particles are not independent at least for some

ACCESSION NR: AP4042364

values of n. The nonuniformity of the angular distributions is similar to the asymmetric c.m.s. particle emission observed in NN collisions at ~10^{11} eV. The peripheral interactions at E-24 BeV remains dominant up to a multiplicity n = 9. "The authors are grateful to W. O. Lock for collaborating in the acquisition of the photographic plates exposed in the CERN accelerator." Orig. art. has: 2 figures and 19 formulas.

ASSOCIATION: Institut yadernoy fiziki Akademii nauk Uzbekskoy SSR (Institute of Nuclear Physics, Academy of Sciences, Uzbek SSR)

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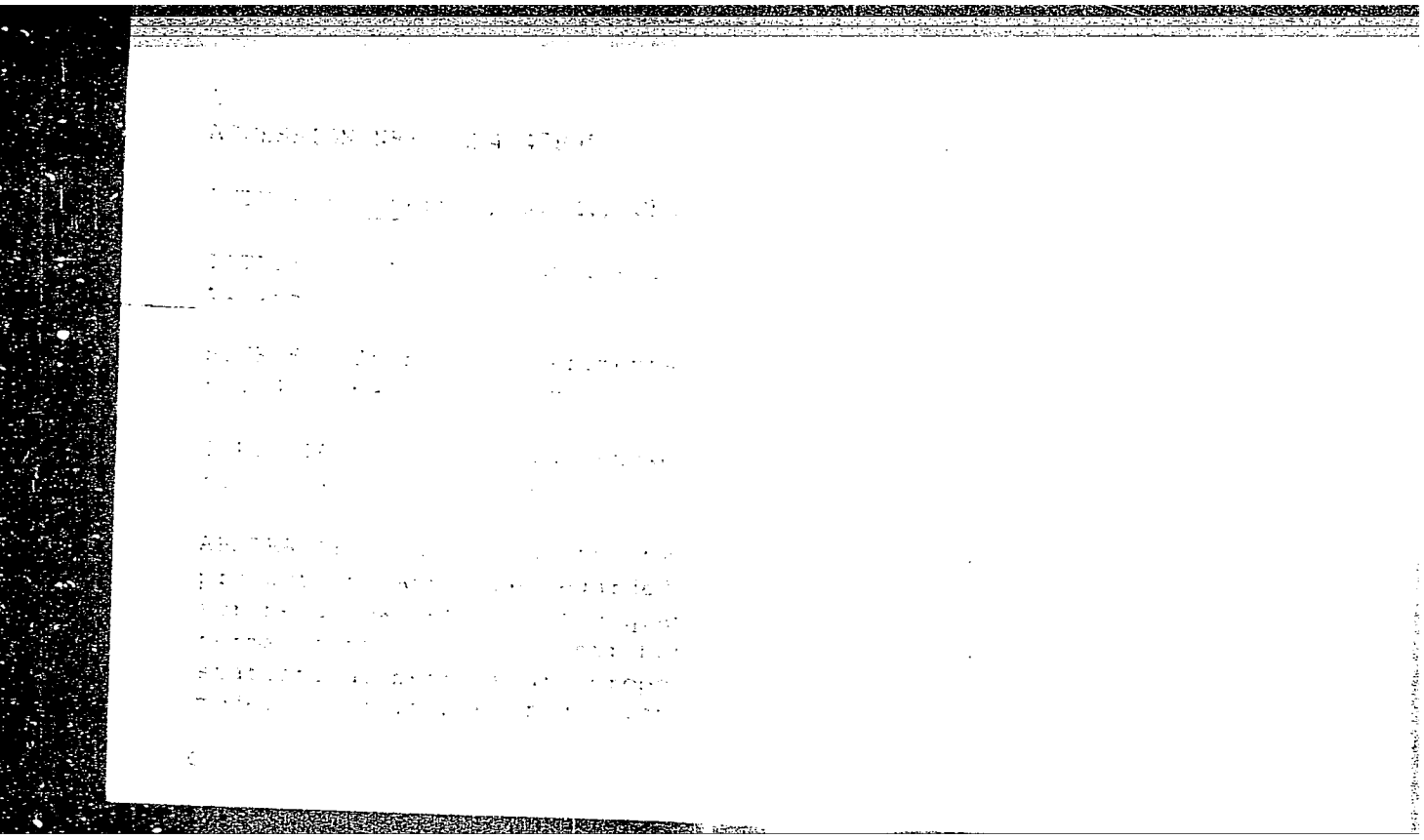

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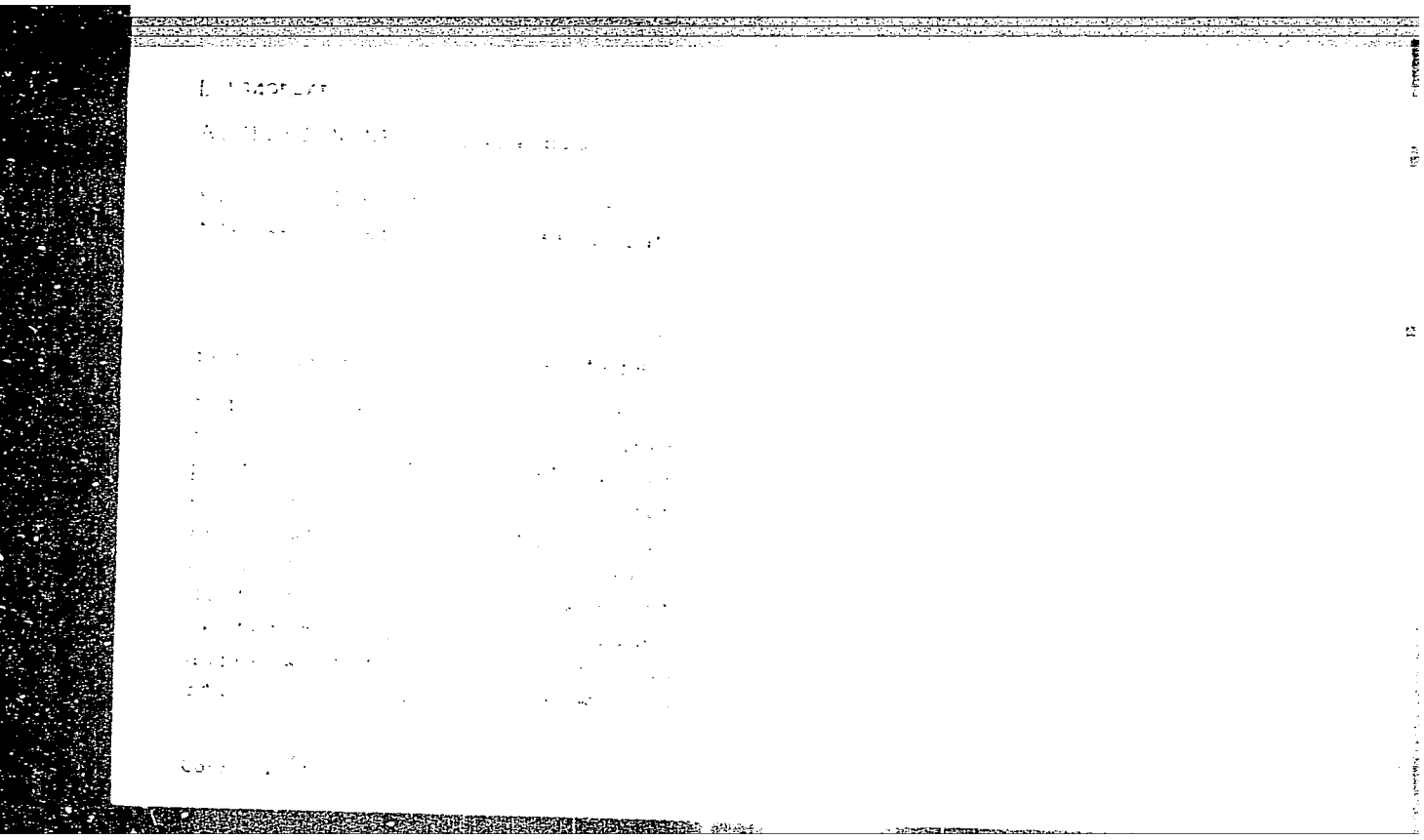

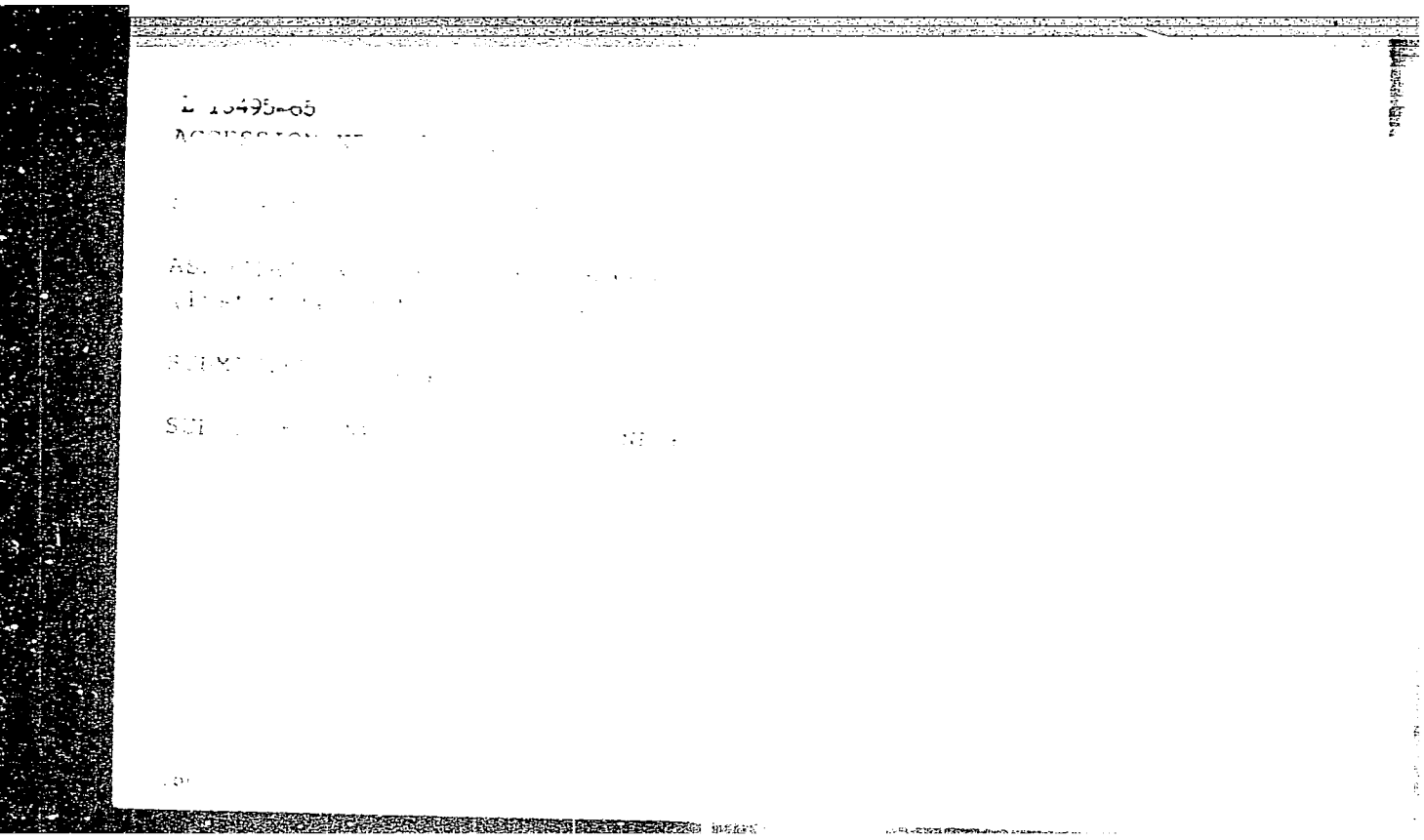

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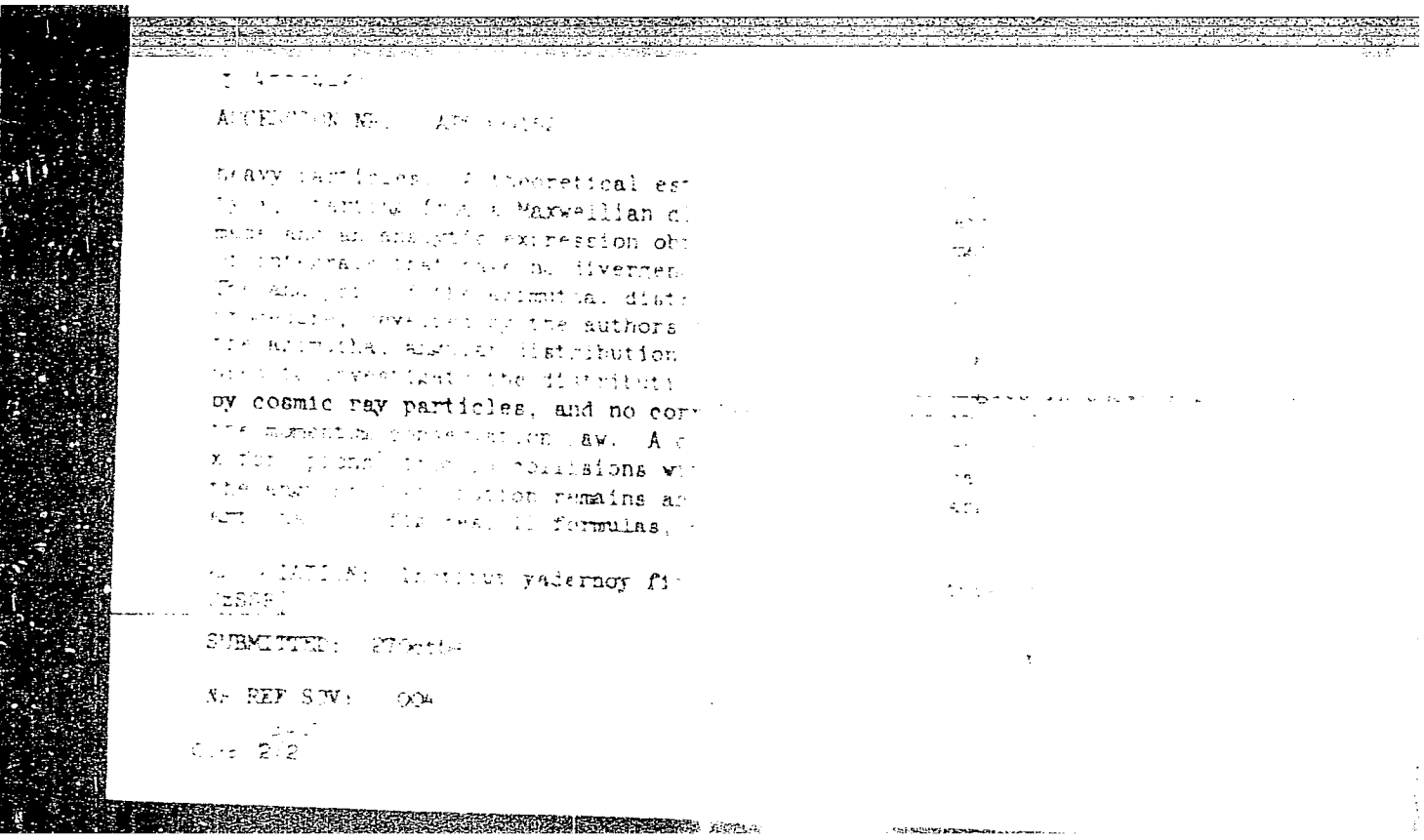

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Card 2/2

AKDUZHAMILOV, Sh.; BELEN'KIY, V.M.; CHERNOVA, L.P.; CHERNOV, G.M.

Angular distribution of shower particles in collisions of 24 Bev. protons with nucleons and nuclei of a photoemulsion. Izv. AN Uz. SSR. Ser. fiz.-mat. nauk 9 no.1:98-104 '65. (MIRA 18:6)

1. Institut yadernoy fiziki AN UzSSR.

L 45314-66 EWT(m)/T

ACC NR: AP6023083 (AN) SOURCE CODE: UR/0367/66/003/004/0657/0662

AUTHOR: Abduzhamilov, Sh.; Azimov, S. A.; Chernova, L. P.; Chernov, G. M.; Chudakov, V. M.

ORG: Institute of Nuclear Physics, Academy of Sciences, Uzbek SSR (Institut yadernoy fiziki akademii nauk uzbekskoy SSR)

TITLE: Coherent interaction of high-energy protons with complex nuclei

SOURCE: Yadernaya fizika, v. 3, no. 4, 1966, 657-662

TOPIC TAGS: proton, high energy protin, photoemulsion, nucleon, particle interaction, proton interaction, inelastic interaction

ABSTRACT: The authors use a method proposed in a previous work [Sh. Abduzhamilov, S. A. Azimov, L. P. Chernova, G. M. Chernov, V. M. Chudakov ZhETF, 47, 24, 1964] to find and analyze in detail the differences between the angular distributions of secondary particles in showers formed by high-energy protons and satisfying the necessary selection criteria for pp and pn collisions in

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photoemulsions. These differences are easily explained by the inclusion of coherent interactions. The method of research is also explained in detail. Experimental data are presented and discussed. The results are discussed of processing the showers formed in photoemulsions by protons with 24 gev and satisfying the necessary criteria of selection of pn collisions. Measurements have been made previously by the authors, the number of particles being $n \geq 4$. The differences found indicate the possible existence of coherent interactions of protons with complex nuclei among the showers with three and four secondary charged particles at 10 and 24 gev. The authors also used measurements made at the Laboratory of High Energies of the Joint Nuclear Research Institute (OIYal) during investigation of inelastic pn interactions of protons with an energy of 10 gev with free and quasi-free nucleons of the photoemulsion. The authors are grateful to V. I. Veksler for permission to use the experimental data obtained at the LVE OIYal, and to M. I. Podgoretskiy for discussions of the work. Orig. art. has: 2 figures, 15 formulas, and 1 table. [GC]

SUB CODE: 20/ SUBM DATE: 12Mar65/ ORIG REF: 002/ OTH REF: 001/

Card 2/2 mjs

L 04702-67 FSS-2/EWT(1)/EWT(m)/FCC JKT/TT/GW

ACC NR: AP6028010 SOURCE CODE: UR/0007/66/000/008/0891/0899

AUTHOR: Vinogradov, A. P.; Surkov, Yu. A.; Chernov, G. M.; Kirnozov, F. F.; Nazarkina, G. B.

ORG: Institute of Geochemistry and Analytical Chemistry im. V. I. Vernadskiy, AN SSSR, Moscow (Institut geokhimii i analiticheskoy khimii AN SSSR)

TITLE: Measurement of gamma-radiation of the lunar surface by the Luna-10 spaceship [Paper presented at the Seventh COSPAR Meeting held in Vienna in May 1966]

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TOPIC TAGS: radiation measurement, gamma radiation, moon, lunar probe, scintillation spectrometer

ABSTRACT: The spaceship Luna-10, placed into a selenocentric orbit on 3 April 1966, was equipped with a 32-channel scintillation spectrometer to investigate the intensity and spectral composition of γ-radiation emitted from the lunar surface. The absence of an atmosphere sufficiently dense to absorb γ-rays makes it possible for a spaceship in lunar orbit to register γ-radiation. However, the counting rate measured from an orbiting spaceship decreases as a result of a decrease in the solid angle subtended by the visible surface

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of the Moon, which was 0.9π at periselene and 0.46π at aposelene in the initial orbit.

It is known that the content of natural radioactive elements (U, Th, K^{40}) in terrestrial rocks decreases from acidic to basic to ultrabasic rocks and that the decrease covers a range of several orders of magnitude. Therefore, it was expected that it would be possible to determine the type of rocks present in the lunar surface from the relative content of U, Th, and K established from the the γ-ray spectrum. In conducting the experiments, the fact that the level of γ-radiation from natural radioactive elements can be lower than the level of γ-radiation produced during the interaction of primary cosmic particles (primarily protons) with the lunar surface was taken into account by analyzing the characteristic γ-rays emitted during the interaction.

Instrumentation

The measurements were made with a scintillation spectrometer consisting of a 3 x 4-cm NaI(Tl) cylindrical crystal γ-ray detector with an FEU-16 photomultiplier and a pulse-height analyzer. To eliminate the back-

ground from charged particles, the NaI(Tl) crystal was enclosed in a container of a thin plastic scintillator. The pulses generated by charged particles were registered by the NaI(Tl) crystal and the plastic scintillator and were then separated from the pulses generated by γ-rays which went practically unregistered by the plastic scintillator.

The scintillation spectrometer recorded γ-ray spectra in the energy ranges between 0.3—3.1 and 0.15—1.5 Mev. The switching of energy ranges was performed by ground command. The detector and the analyzer of the spectrometer were located in a hermetically sealed compartment under a shell 1 g/cm^2 thick.

Experimental Results

Six γ-ray spectra in the energy range 0.3—3.1 Mev were obtained during the first month of operation of Luna 10. In addition, the integrated intensity of γ-radiation in the same energy range was obtained at approximately 15 points. The measurements were conducted over relatively wide surface areas covering the continents and the seas on both the light and the dark sides of the Moon. The height and the approximate selenographic coordinates

of the regions above which the spectra were measured are given in Table 1.

Table 1. The Height Above the Lunar Surface and the Selenocentric Coordinates of the Regions Above Which Measurements Were Made

No. of spectrum	Date and time of measurement	Average height above surface	Selenographic latitude (Deg)		Selenographic longitude (Deg)	
			Start	End	Start	End
1	5 Apr 19 h 26 m	350	+70	+62	185	228
2	5 Apr 20 h 11 m	600	-22	-40	272	279
3	8 Apr 4 h 45 m	700	-47	-63	253	273
4	9 Apr 1 h 37 m	600	-53	-64	252	272
5	18 Apr 12 h 45 m	600	±30	+52	291	305
6	21 Apr 13 h 56 m	1000	-58	-45	208	220

Fig. 1 (ourve 1) shows one of the primary γ-ray spectra (spectrum No. 3 in Table 1), taken above the dark side of the Moon. The background due to

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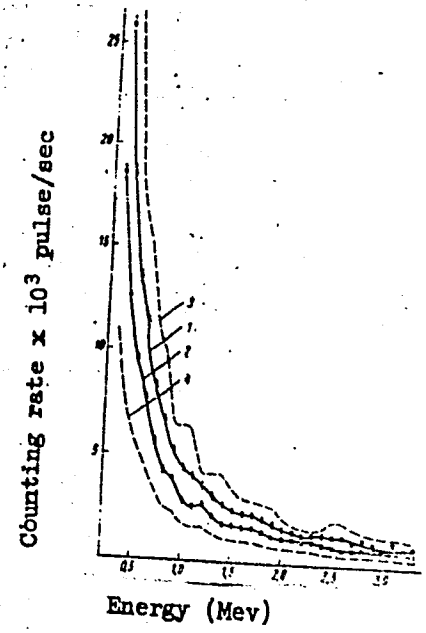

Fig. 1. Gamma-ray spectra obtained by Luna 10 while in orbit around the Moon and along the trajectory of the flight from the earth to the Moon

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1 - γ-ray spectrum of the lunar rocks together with the background; 2 - γ-ray spectrum of the background due to interaction of cosmic rays with the material of Luna 10 corrected for the screening by the Moon; 3 and 4 - same spectra as those given by 1 and 2, respectively, recalculated to represent measurements which would be taken at the surface of the Moon. The errors shown are root-mean-square errors.

interaction of cosmic rays with the substance of Luna 10, taking the screening by the moon into account, is also shown in Fig. 1 (curve 2).

Compared to the counting rate of γ-rays measured along the flight trajectory, the counting rate in orbit around the Moon increased by 30—40%.

As a result of the screening effect of the Moon, the background due to irradiation of the spaceship by cosmic particles near the Moon decreases and is equal to about 78—89% of the background encountered along the trajectory of the flight. The background spectrum was measured during the flight

of Luna 10 toward the Moon at a distance of about 230,000 km from the Earth. The principal part of the γ-ray background registered is associated with inelastic interactions of charged particles with the substance of Luna 10 and is not primary cosmic γ-radiation. The natural radioactivity was small due to the small amounts of K, Th, and U present in the spaceship. There were no radioactive sources aboard the Luna 10. Fig. 1 also shows curves calculated so as to represent measurements that would be obtained directly at the surface of the Moon. Curve 3 in Fig. 1 shows the γ-ray spectrum at the lunar surface together with the background due to irradiation of the spaceship, while curve 4 in Fig. 1 shows the background alone.

Fig. 2 (curve 1) shows the spectrum of γ-radiation of lunar rocks (after subtraction of the background) obtained by Lunar 10 while in orbit. This curve represents the difference between spectra represented by curves 1 and 2 of Fig. 1. Fig. 2 shows that the lunar γ-ray spectrum differs considerably from the spectrum of γ-radiation emitted by the surface of the Earth [not shown], the shape of which is primarily determined by the content of natural radioactive elements in the rocks. A distinguishing feature of the lunar γ-ray spectrum is its relatively flat slope and large number of

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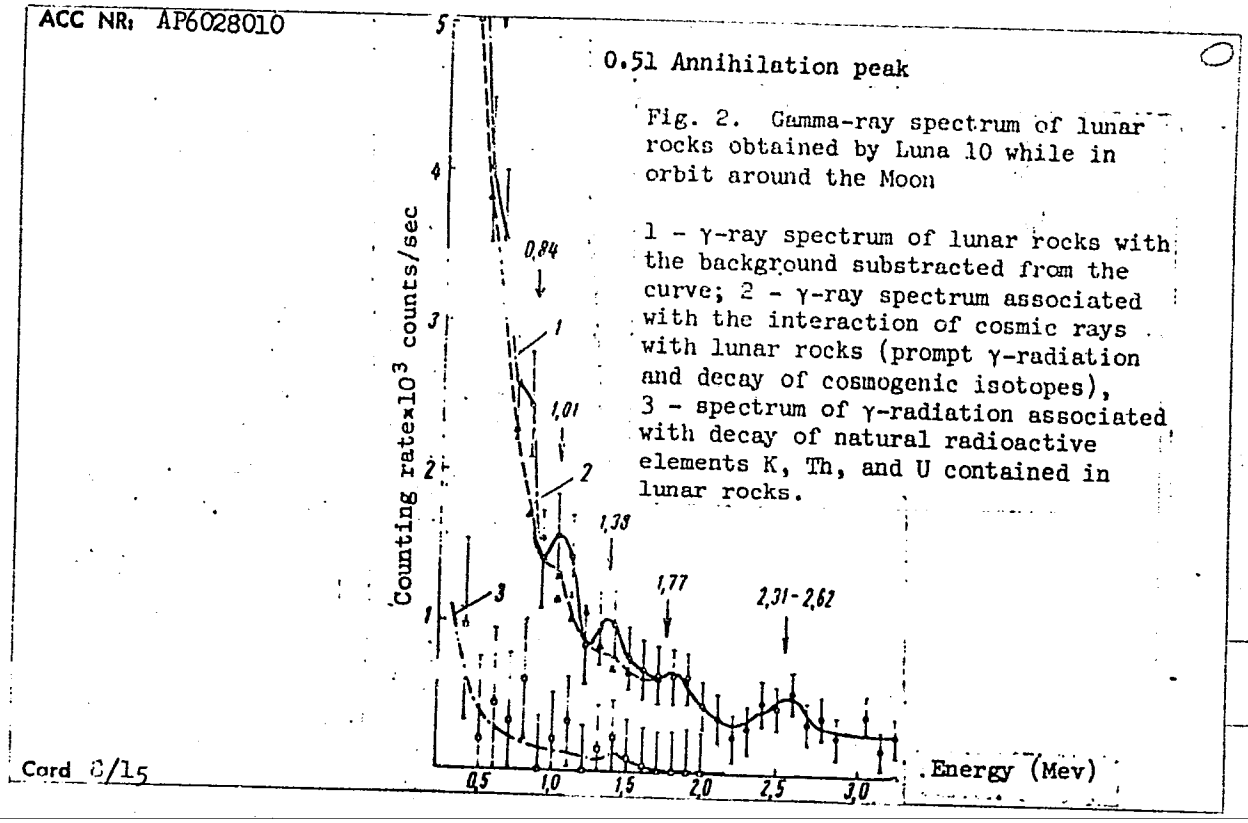

Fig. 2. Gamma-ray spectrum of lunar rocks obtained by Luna 10 while in orbit around the Moon

1 - γ-ray spectrum of lunar rocks with the background substracted from the curve; 2 - γ-ray spectrum associated with the interaction of cosmic rays with lunar rocks (prompt γ-radiation and decay of cosmogenic isotopes), 3 - spectrum of γ-radiation associated with decay of natural radioactive elements K, Th, and U contained in lunar rocks.

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hard γ-rays with energies in excess of 1.5 Mev while the spectrum of natural radioactive elements is characterized by a steep slope at higher energies and the absence of γ-rays with energies greater than 2.62 Mev. This shows that most γ-radiation from the lunar surface is not associated with the natural radioactivity of U, Th, and K^{40} but is the result of the interaction of cosmic rays with the lunar substance and the decay of cosmogenic isotopes.

Table 2 shows the characteristic γ-rays identified from the lunar γ-ray spectra and the principal nuclear reactions involving the probable constituent elements of lunar rocks. It can be seen from Table 2 that O, Si, Al, and Mg are likely the most widely distributed elements in lunar rocks.

Table 2. Energies of Gamma Rays Identified From the Lunar Gamma-Ray Spectra

Energy (Mev)	Principal Nuclear Reactions Causing Emission of Characteristic Gamma-Rays
0,84	$Al^{27}(p,p'\gamma)\,Al^{27}$, $Si^{28}(p,2p\gamma)\,Al^{27}$, $Fe^{56}(p,p'\gamma)\,Fe^{56}$
1,01	$Al^{27}\,p,pn\gamma)\,Al^{26}$, $Si^{28}(p,2pn\gamma)\,Al^{26}$
1,37	$Mg^{24}(p,p'\gamma)\,Mg^{24}$, $Al^{27}(p,p\alpha\gamma)\,Mg^{24}$, $Si^{28}(p,p\alpha\gamma)\,Mg^{24}$
1,78	$Mg^{24}(p,p\alpha\gamma)\,Ne^{20}$, $Al^{27}\,p,2p\gamma)\,Mg^{26}$, $Si^{28}(p,p'\gamma)\,Si^{28}$
2,31 }	
2,62 }	$O^{16}(p,2pn\gamma)\,N^{14}$, $Mg^{24}(p,pn\gamma)\,Mg^{23}$, $Mg^{24}(p,2p\gamma)\,Na^{23}$, $Al^{27}(p,p\ln\gamma)\,Mg^{23}$

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Since the lunar surface is exposed to constant interaction with cosmic rays, all of the cosmogenic radioisotopes should be in radioactive equilibrium. Therefore, both long-lived and short-lived radioisotopes should be radioactive, and their content should be proportional to the effective cross section for their production. Calculations show that the main contribution to γ-ray emission is made by the decay of the following cosmogenic isotopes: O^{14} ($T_{1/2}$ = 72 sec, E_γ = 2.31 Mev), O^{19} ($T_{1/2}$ = 27 sec, E_γ = 1.37 Mev), F^{20} ($T_{1/2}$ = 10.7 sec, E_γ = 1.63 Mev), Na^{22} ($T_{1/2}$ = 2.6 hr, E_γ = 1.28 Mev), Na^{24} ($T_{1/2}$ = 15 hr, E_γ = 1.37 Mev and 2.76 Mev). These radioisotopes are formed with a considerable yield in nuclear reactions involving the same rock-forming elements: Mg, Al, and Si.

The peak at 0.51 Mev, which is especially pronounced in the lunar γ-ray spectra measured in the energy range 0.15—1.5 Mev, is produced by γ-radiation emitted during annihilation.

Analysis of the results shows that the γ-radiation intensity corrected for the difference in height is practically constant above the different regions of the lunar surface (intensities did not differ by more than 40%). This can probably be attributed to the fact that the main source of γ-rays is cosmic radiation. A preliminary analysis shows that the total dose rate of

γ-radiation above the lunar surface is somewhat higher than the dose rate above the rocks of the Earth's crust. The dose rate of γ-radiation emitted by the lunar surface is roughly 1.5—2 times greater than that emitted by terrestrial granites (14 μr/h).

An evaluation of the natural radioactivity and the concentration of natural radioactive elements can be made by substracting the effect of γ-radiation produced in the ineraction of cosmic rays with lunar rocks from the overall lunar γ-ray spectrum. Although the exact shape of the γ-ray spectrum induced by cosmic rays is unknown, approximate results can be obtained by using the shape of the spectrum obtained along the flight trajectory of Luna 10 from the Earth to the Moon. Curve 2 in Fig. 2 shows the spectrum of γ-radiation from the Moon produced by cosmic rays, determined by combining the γ-ray spectra obtained along the flight trajectory with the γ-ray spectrum of the lunar rocks in the energy range exceeding 2 Mev (the contribution of the natural isotopes is almost zero). This approximation is justified only if the γ-ray spectra induced by cosmic rays in the spaceship and in the lunar rocks have the same shape and differ only in intensity. This assumption was demonstrated to be justified by both theoretical calculations and modeling experiments performed by the authors. The validity of this

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assumption follows from the fact that the spaceship and its components were made of light alloys of Si, Al, and Mg with very little Fe, i. e., the dominant elements in the composition of rocks. Curve 3 in Fig. 2, obtained by subtracting curve 2 from curve 1, shows the γ-ray spectrum produced by the decay of natural radioactive elements. Fig. 2 shows that 90% of the intensity of gamma radiation emitted by lunar rocks is produced by radioactivity induced by cosmic rays and no more than 10% by decay of K, Th, and U.

Prior to the flight the γ-spectrometer aboard the spaceship was precalibrated using samples with a measured amount of K, Th, and U and also with rock samples containing different amounts of these elements. This procedure made it possible to calculate the γ-ray spectra, which should be obtained by the orbiting spaceship, emitted by rocks with different amounts of natural radioactive elements (it was assumed that the radiation produced by cosmic rays is absent). Fig. 3 shows such spectra which would be obtained at a height of 350 km with the background subtracted from the spectrum. The hatched areas correspond to range of concentrations of radioactive elements for given types of rock. The average values of concentrations of K, Th, and U were taken from a paper by A. P. Vinogradov (Geokhimiya, no. 7, 1962).

Comparison of the lunar γ-ray spectra with those of terrestrial rocks with a known content of K, Th, and U shows that at least in the regions of the Moon over which measurements were conducted there are no rocks on the lunar surface, or at a depth not exceeding 27 cm, containing the same amount of K, Th, and U as do the acidic terrestrial rocks, such as granites. The intensity of γ-radiation due to natural radioactivity (Fig. 2, curve 3) tends to indicate the presence of basic rocks such as basalts. However, at the present time it is impossible to exclude the possibility that the concentration of natural radioactive elements was estimated a bit too high. It is interesting to note that tektites, which have almost the same composition and amounts of U, Th, and K as acidic rocks, cannot be of lunar origin.

Conclusions

The main results obtained from the measurements of the intensity and spectral composition of γ-radiation by the Luna 10 can be summarized as follows:

1. The overall level of γ-radiation of the lunar surface slightly exceeds that of the Earth. Preliminary results show that the intensity of γ-radiation of

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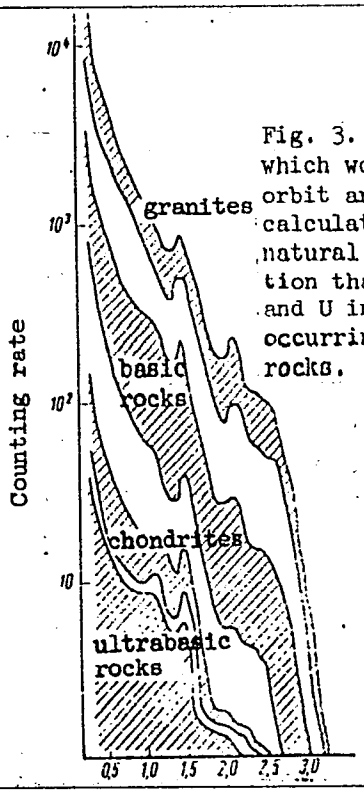

Fig. 3. The γ-ray spectra of lunar rocks which would be observed by a spaceship in orbit around the Moon. The spectrum was calculated from the γ-ray spectra of natural radioactive elements on the assumption that the relative contents of K, Th, and U in lunar rocks correspond to those occurring in the most important terrestrial rocks.

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the surface of the Moon is 20—30 μr/h.

2. About 90% of the γ-rays emitted by the surface of the Moon is produced during interaction of cosmic rays with lunar substance (prompt γ-rays and decays of cosmogenic isotopes).

3. The basic rock-forming elements of the lunar surface are believed to be O, Mg, Al, and Si.

4. No difference was noted in intensity of γ-rays emitted by different regions of the lunar surface including the seas and the continents (variation of intensity did not exceed 40%).

5. The decay of K, Th, and U in lunar rocks does not contribute more than 10% to the total γ-ray emission of the lunar surface.

6. Comparison of the intensity of γ-radiation from the decay of natural radioactive elements K, Th, and U with the results obtained by a calibrated instrument from terrestrial rocks shows that the concentration of radioactive elements in lunar rocks is close to that of basic terrestrial rocks and differs greatly from acidic rocks. However, it can not be posiiively stated that the lunar surface contains no ultrabasic (meteoritic) substance. At the present time an attempt is being made to determine the relative content of O, Mg, Al, and Si in lunar rocks from the available γ-ray spectra produced in interactions with cosmic rays. Orig. art. has: 3 figures and 3 tables. [FSB: v. 2, no. 10]

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TITLE: Investigations of the intensity and spectral composition of lunar gamma radiation on the automatic station "Luna-10"

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TOPIC TAGS: gamma spectrum, gamma spectrometer, scintillation spectrometer, bremsstrahlung, cosmic radiation, meson, lunar satellite, photomultiplier/Luna-10 lunar satellite, FEU-16 photomultiplier

ABSTRACT: "Luna-10" carried a scintillation gamma spectrometer with a detector of γ-radiation; this was a NaI(Tl) crystal measuring 30 x 40 mm, connected to a FEU-16 photomultiplier, and a pulse amplitude analyzer. The instrument made it possible to measure the spectrum of γ-radiation against a background of charged particles. The instrument recorded the spectrum of γ-radiation in two ranges: from 0.3 to 3.1 MeV and from 0.15 to 1.5 Mev. During the first month of operation of "Luna-10" it was possible to obtain 6 spectra of γ-radiation in the energy range from 0.3 to 3.1 MeV. In addition, at approximately 15 points the intensity of γ-radiation was measured in this same range of energies. The measurements covered rather extensive areas of the surface, including both the "continents" and "seas" on both the visible and far sides. Analysis of the form of the lunar γ-spectra revealed that they differ

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considerably from the spectra of terrestrial γ-radiation, whose form is determined for the most part by the content of natural radioactive elements in rock. For the moon the greater part of the γ-radiation is that arising during interaction of cosmic rays with lunar matter and from the decay of cosmogenic radioisotopes. The principal contribution is from the following cosmogenic isotopes: O^{14}, O^{19}, F^{20}, Na^{22}, and Na^{24}. Table 1 gives the energy of gamma rays identified in the lunar gamma spectrum. In addition to nuclear reactions leading to the emission of characteristic γ-quanta (instantaneous γ-radiation and the decay of cosmogenic isotopes) there is some contribution from processes of the decay of π^0 mesons and the bremsstrahlung of electrons and protons. Preliminary data indicate that the total intensity of gamma radiation on the lunar surface exceeds the intensity over the rocks of the earth's crust by 1.5-2 times and changes little from one part of the lunar surface to another. About 90% of the gamma radiation of lunar rocks can be attributed to the effect of cosmic rays and not more than 10% is due to the decay of K, Th and U. Orig. art. has: 1 figure and 1 table. [JPRS: 38,677]

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