TABLE I. *Observations in cosmic-ray absorption at different zenith inclinations.*

	$P=0$ cm Pb			$P=10$ cm Pb		
Inclin.	Coinc./min.	Showers/min.	C_0	Coinc./min.	Showers/min.	C_{10}
0°	$\frac{5688}{893}=6.38$	$\frac{184}{401}=0.46$	5.92 ± 0.08	$\frac{8075}{1675}=4.83$	$\frac{115}{582}=0.2$	4.63 ± 0.05
20°	$\frac{16415}{2807}=5.85$	$\frac{730}{1636}=0.45$	5.40 ± 0.05	$\frac{11819}{2533}=4.67$	$\frac{425}{2865}=0.15$	4.52 ± 0.05
30°	$\frac{14435}{3003}=4.81$	$\frac{958}{2569}=0.37$	4.44 ± 0.04	$\frac{11725}{2935}=4.00$	$\frac{448}{3067}=0.15$	3.85 ± 0.04
45°	$\frac{5064}{1574}=3.22$	$\frac{484}{1795}=0.27$	2.95 ± 0.045	$\frac{5519}{2249}=2.45$	$\frac{282}{2037}=0.14$	2.31 ± 0.04
60°	$\frac{8542}{5380}=1.59$	$\frac{378}{2231}=0.17$	1.42 ± 0.02	$\frac{4410}{3514}=1.255$	$\frac{244}{1956}=0.12$	1.13 ± 0.02
75.5°	$\frac{3491}{6771}=0.515$	$\frac{513}{4379}=0.117$	0.398 ± 0.007	$\frac{2956}{8021}=0.368$	$\frac{390}{4788}=0.081$	0.287 ± 0.007

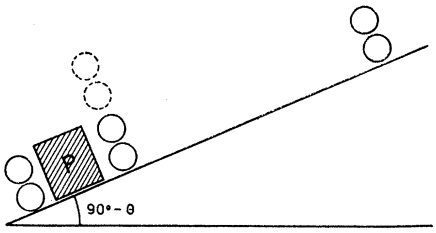

FIG. 1. Arrangement of counters.

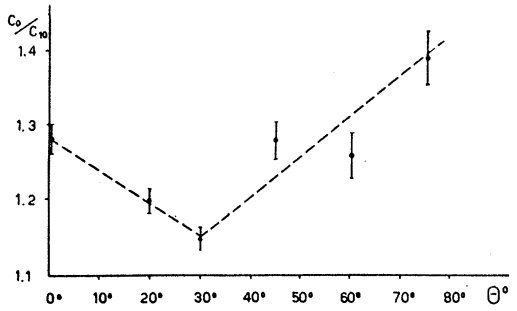

FIG. 2. Ratio for different zenith inclinations of the cosmic-ray intensity without lead absorption and with 10 cm of lead.

plicative theory is not yet known with exactness. On the other hand, we think that we can state that the scattering causes the increase in the percentage of the soft component at larger inclinations. It should be pointed out that in our measurements, the side showers were taken into consideration. In our case the correction of the showers is not very much, but it is certainly not to be neglected. Since this correction was not generally carried out before in measurements of this kind, the results obtained up to date do not lend themselves very well to comparison; in less suitable geometrical arrangements the showers can completely change the measurements.

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The Force on the Cathode of an Arc

Some years ago several papers[1] were published on the subject of the force exerted on the cathode of an arc. This phenomenon is interesting especially at low gas pressures because the force is then larger. Tanberg has explained this force by the reaction of a high velocity vapor stream emerging from the cathode. Although this explanation presumes very high speeds of the vapor stream no better explanation has been given.[2] Robertson[3] has again taken up this question and has investigated especially the variation of the force as a function of the gas pressure without giving an explanation of this dependence. The purpose of this note is to show that the variation with the gas pressure can also be explained by the high velocity stream.

If the density of the gas is high the high velocity stream is slowed down by giving its momentum to the gas. As this momentum is directed away from the cathode the transfer of it to the gas results in a diminishing of the gas pressure on the cathode and therefore partially compensates the force exerted on the cathode by the high velocity stream. If the gas pressure is low and the force exerted by it on the front surface of the cathode is much smaller than the reaction of the high velocity stream, the diminishing of the gas pressure can have no measurable effect. If, however, the gas pressure increases, the reduction of it in front of the cathode by the transfer of the momentum will be increased. This would explain the decrease of the total force on the cathode with increasing gas pressure measured by Robertson. On account of the uncertainty of the area of the cathode which must be taken into con-

sideration and of the ratio of the momentum transfer, the calculation of the decrease of the force is practically impossible. We can compute only whether the measured decrease of the total force *can* be caused by a decrease of the gas pressure.

For this purpose we shall take the forces at 15 amp. measured by Tanberg in vacuum and by Robertson at 1 mm Hg for a copper arc indicated in Fig. 4 of Robertson's paper. We assume that the transfer of the momentum of the stream to the gas diminishes the gas pressure to one-half. The measured forces in vacuum and at 1 mm Hg are 270 dynes and 160 dynes, respectively. The reduction is 110 dynes and the reduced gas pressure must then be effective on 0.168 cm². It naturally must be not larger than the area of the face of the cathode spot but may be larger than the area of the cathode spot. The face of the cathode in the experiments of Robertson had an area of 0.316 cm². The area of the cathode spot is 0.00105 cm² at 15 amperes if we calculate it with the ratio of 0.007 mm² amp. measured in vacuum by Tanberg and Berkey. At 1 mm Hg the current density is rather higher and the area of the cathode spot therefore smaller. We see that the calculated area lies between the two limits. The explanation seems therefore to be possible.

Lamar[4] also has pointed out that the absence of the force on the cathode in an arc at higher gas pressures may be due to the compensating effect of holding back the gas pressure from the cathode spot. But, according to his opinion this effect occurs as the result of convection currents set up around the cathode if this is of relatively small dimensions and therefore can not occur if the cathode has a large surface area.

Now, if my explanation of the effect is right the compensating effect is not confined to small cathode areas because the reduction of the gas pressure in front of the cathode spot and its near surroundings does not augment the gas pressure on areas of the cathode which lie further away from the cathode spot and because the high velocity stream is only slowed down by the gas and is not reflected back to the cathode. On the contrary for the full development of the compensating effect the area of the cathode must be larger than a certain minimum.

In conclusion I should like to thank Dr. F. Luedi for his suggestion to explain the results obtained by Robertson.

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Induced β-Activity of Uranium by Fast Neutrons

In the course of experiments on the fission of uranium by fast neutrons,[1] besides fission products the uranium fraction showed a β-activity with a period 6.5 days.

This activity was induced appreciably only by fast neutrons obtained by bombarding lithium with 3-Mev. deuterons from our cyclotron. The experimental procedure was as follows.

A few grams of uranium oxide, U_3O_8, carefully purified and freed from its disintegration products were exposed to fast neutrons for more than fifty hours. After the exposure, a uranium fraction (U_3O_8) was separated and purified from all possible elements produced by fission as well as from its own disintegration products. The most care was given to the removal of lanthanum from the sample, the procedure taking as long as one day. The activity of the irradiated uranium was compared with that of a nonirradiated sample, in order to subtract the growing β-activity due to disintegration products of uranium. The difference thus obtained shows a 6.5-day period. This activity is probably due to U^{237} produced from U^{238} through loss of a neutron, as in the case of the production of UY from thorium.[2] If this is the case, we have here a member of the missing radioactive family $4n+1$.

The sign of the β-rays was shown to be negative and consequently we suspected the production of a radioactive element of atomic number 93, the chemical properties of which are probably homologous to rhenium. From the decay curve it is clear that its period must be very long, if it exists. To search for such an element, the irradiated uranium oxide, which was freed from fission products as well as its own disintegration products as above mentioned, was left for about 7 days, and was then dissolved in nitric acid. The solution, after an addition of perrhenic acid, was treated with ammonium sulphide and then acidified with sulphuric acid. The precipitated rhenium sulphide, after the removal of contaminated sulphur by carbon bisulphide, was examined for β- and α-activities. Neither of them could be found within the error of our experiments. We may thus conclude, as in the case of 23-minute uranium,[3] that the 6.5-day uranium decays also into a very long-lived 93 element. The detailed accounts of the experiments will be given elsewhere.

The above investigations were carried out as a part of the work of the Atomic Nucleus Sub-Committee of the Japan Society for the Promotion of Scientific Research. We acknowledge the assistances given by our laboratory colleagues in connection with the irradiation of samples and by Messrs. N. Saito and N. Matuura regarding the chemical separations.

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