Letters to the Editor.

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Observations on the Penetrating Radiation in the Antarctic.

OBSERVATIONS upon the variation of intensity of the penetrating or cosmic radiation with latitude were carried out by the B.A.N.Z. Antarctic Research Expedition during the recent summer cruise of the *Discovery*, November 1930 to March 1931.

All observations during the voyage were made by Mr. A. L. Kennedy, physicist to the expedition. The apparatus employed was a Geiger-Muller electron tube counter, with single-stage amplifier, relay, and automatically recording chromograph. The tube-counter was contained in a Pyrex glass tube, into which tungsten leads were sealed and filled with argon gas at a pressure of approximately three centimetres mercury. The tube was mounted between lead blocks in such a way that, except for the holes through which the ends of the tube projected, four inches of lead surrounded the tube on every side.

The pressure of the argon was adjusted to give a counting-voltage between 450 and 500 volts, and a series resistance of the order of 1500 megohms consisting of a suitably proportioned mixture of xylol and alcohol in a hermetically sealed Pyrex capillary gave potential 'kicks' for each discharge through the tube. The whole apparatus was mounted in a small room on the deck of the *Discovery*, adjoining the wireless room. Of six tubes made in the physics laboratory of the University of Adelaide, only one survived the voyage. Fortunately, counts were obtained on this tube over a region ranging from Hobart to Adelie Land, that is, over a range of geographical latitude from 43° S. to 68° S.

Counts were made on thirty-four days during the voyage, and the total number of 'kicks' recorded was 28,350 in a total time of 4502 minutes, giving an average rate of 6·3 'kicks' per minute. Except on two occasions, when values of 7·5 and 7·2 were obtained, the variations from this mean are of the order due to probability variations, and both these high values occurred early in the voyage with values of a 'counting-voltage' higher than was usual. The counts for the two stations nearest to the magnetic pole, with the ship stationary off Adelie Land, show values of 5·9 per minute and 6·3 per minute. There is thus no definite indication of variation with magnetic latitude.

Unfortunately, an overcast state of the sky was so general that no attempt at a correlation of electron counts with auroral intensity is possible. On the one occasion on which the log-book records the occurrence of a brilliant aurora, the count was, however, unusually low (5·6 per minute).

The mean value (6·3 per minute) of all counts on the voyage is identical within the limits of experimental error with the value (6·1) obtained for a count of four hours in the physics laboratory of the University of Adelaide.

The result of the observations thus tends to confirm those of Böthe and Kohlhörster in the North Atlantic (kindly communicated in a letter from Dr. Böthe), of Corlin at Abisko, and of Millikan at Churchill in Canada, in showing that the intensity of the penetrating radiation does not vary to any considerable extent with magnetic latitude even within 250 miles of a magnetic pole.

The accuracy of the observations probably does not exceed ten per cent at best, but it should be noted that they were taken in circumstances of exceptional difficulty, illustrated by the following extracts from the log-book: "Roll 40°." "Stopped. Radio transmission started." "Very big seas, stormy, rolling heavily . . . bottle P_2O_5 rolled on to instrument, putting it temporarily out of action."

Difficulties with regard to temperature, which affects the voltage of the H.T. battery, and humidity, which affects the insulation, were also formidable.

The former could not be controlled, but the latter was successfully countered by using sulphur as an insulating material and by surrounding the end of the Pyrex tube with a sleeve containing phosphoric anhydride.

The preliminary work of adjusting gas-pressure in the counting-tube, determining the counting-voltage, etc., was carried out by Mr. Iliffe, of the staff of the physics laboratory.

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May 8.

The Nuclear Moments of Cæsium, Rubidium, and Indium.

IN my work [1] on the hyperfine structure of the lines of the principal series of cæsium, I suggested that $\frac{1}{2}$ was the value of i, the quantum number of the rotation of the nucleus; but I pointed out that it might well be higher, it being impossible to determine it with certainty owing to the hyperfine structure of the P levels being too fine to resolve. In the meantime Schüler [2] has shown that the value of nuclear quantum number can be determined quite simply from the intensity ratio of the components of the hyperfine structure doublets. In cæsium the two components are of very nearly equal intensity; so that the value of i must be high: it may well be 9/2, or perhaps higher; in order to find the exact value, experiments are being made to determine very accurately the intensity ratio of the components.

I have also examined the structure of the lines $1S_{\frac{1}{2}} - 3\,{}^2P_{\frac{1}{2}}$ and $1S_{\frac{1}{2}} - 3\,{}^2P_{\frac{3}{2}}$ of rubidium. These possess a doublet structure with a separation of about 0·1 cm.$^{-1}$; but the intensity ratio of the two components is about 2 : 1; this corresponds to a value of 1/2 or 3/2 for i; the values of the intensity ratio being respectively 3 : 1 and 5 : 3 for these two values. The structure is probably affected to some extent by the isotope of higher atomic weight; but as this is only present to the extent of about 25 per cent, the value of i for the principal isotope must still remain within the limits given.

The value of i for indium [3] is given as one; this is almost certainly too low. It was calculated by Goudsmid's cosine law [4] from the separations of two very close levels. The ratio of these separations was found to be $0{\cdot}072 \pm 006 : 0{\cdot}045 \pm 006$; that is some value between 2 : 1 and 1·3 : 1. The corresponding value of i is between 1 and 7/2, if these limits of experimental accuracy are taken into consideration. But here again additional evidence is given by consideration of the intensity ratios of the fine structure components; this corresponds to a high value of i. It is therefore to be assumed that the upper limit of the range of values found by the cosine law, namely, 7/2, is the more probable.

The experimental results are of course in no way affected by this revised theoretical interpretation.

Goudsmid has suggested that my experimental results for the hyperfine structure of indium are