Change in Height of a Mesotron-Producing Layer of Air

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IN connection with the correlation studies on the effect of air conditions aloft on cosmic-ray intensity at the surface[1] it was convenient to apply the theory of Blackett[2] to a particular set of observations. Blackett assumed a mesotron-producing layer of air at about 16 km which had a mean change of height between summer and winter of 500 m and a mean temperature change of 10°C. From our data the mean density at this height is $0.1773\times 10^{-3}\,\mathrm{g\cdot cm^{-3}}$. By linear interpolation of density and pressure between 15–16 km and 16–17 km we computed the height Z_p of this density for each of the 123 days in 1939 for which the radiosonde flight at the Anacostia Naval Air Station reached the necessary height and also the Compton-Bennett shielded ionization meters were in operation at both Cheltenham and at Huancayo, Peru.

We made a least-squares determination of the constants in an equation connecting the variation of cosmic-ray intensity with (a) the mass of air above this mesotron-producing layer represented by P_z, (b) the height of the layer Z_p and (c) the mass, $(P_0=P_z)$, of air below this layer. We found

$$\delta I'/I'=-0.93\delta(P_0-P_z)-33.58\delta Z_p-1.15\delta P_z \quad \text{(pressures in mb)}$$

$\delta I'/I'$ is the variation from balance in units of 0.1 percent of the intensity at Cheltenham corrected for world-wide changes as measured by the meter at Huancayo. Let $\delta I''/I'$ be the variation in intensity because of the change in height of the mesotron-producing layer only. Then from $\delta I''/I'=-\delta Z/L$ we get the mean path before disintegration of the mesotrons as $L_p=29.8$ km. Blackett assumed 32 km.

A two-constant equation for these same data gives

$$\delta I'/I'=-0.92\delta P_0-32.35\delta Z_p$$

with $L_p=30.9$ km. In both these cases approximately 60 percent of the variance of I' is associated with the variables chosen.

From our present knowledge of cosmic rays, it seems probable that the mean mesotron-producing layer ought to be associated with a given pressure rather than with a given density. However, using a constant pressure of 107 mb we find

$$\delta I'/I'=-0.94\delta P_0-40.79\delta Z_p$$

with $L_p=24.52$ km and only 50 percent of the variance of I' associated with P_0 and Z_p.

These results indicate that Blackett's assumption of a decaying mesotron formed at a height which changes from day to day is a possible explanation for some of the variations observed in cosmic-ray intensity at the surface. Some method for using the probable fact that mesotrons are produced at varying rates at different levels will be needed to make this correlation more exact.

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[1] N. F. Beardsley, Phys. Rev. 59, 233 (1941).
[2] P. M. S. Blackett, Phys. Rev. 54, 973 (1938).

Capture Cross Sections for Slow Neutrons

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RECENTLY Rasetti[1] and Goldhaber and O'Neal[2] have determined the capture cross sections of various isotopes for C neutrons by comparing the intensities of β-rays from radioactive isotopes produced by capture with that of an isotope Mn^{56}, whose absolute cross section of formation was measured by Lapointe and Rasetti[3] and was found to be $\sigma=9.4\times 10^{-24}\ \mathrm{cm}^2$.

Since the summer of 1939, we have been measuring the capture cross sections for slow neutrons with a similar method by using a strong neutron source (Be+D) obtained with our cyclotron. We shall also give here our results. A paraffin cylinder 14 cm in diameter and 14 cm in height was placed about 30 cm away from the source, and subsubstances to be measured were placed at its center, together with a standard sample. The activity of the substance in question was then compared with that of the standard and thus the relative capture cross sections were determined for about fifty isotopes. The measurements of activity were made with a Geiger-Müller tube counter or a Lauritsen electroscope, both with a window of aluminum foil 0.013 mm thick.

Absolute capture cross sections were then calculated in the following manner. Dunning, Pegram, Fink and Mitchell[4] obtained large absorption cross sections for slow neutrons in the elements Rh, Ag, Re and Au. From the table of isotopes, we can conclude that these absorption processes are almost entirely due to the capture of slow neutrons. By comparing our results for these elements with the absolute cross sections of the above-mentioned authors, we can thus convert our relative cross sections into the absolute values. The results are given in Table I.

From this we can see that Rasetti's values are systematically larger than ours. The origin of the discrepancies

TABLE I. *Conversion of our relative capture cross sections into absolute values.*

ISOTOPE	DECAY PERIOD	σ IN 10^{-24} CM^2	ISOTOPE	DECAY PERIOD	σ IN 10^{-24} CM^2
Na^{23}	14.8 hr.	0.38	Ru^{104}	20 hr.	0.48
Mg^{26}	10.2 min.	0.028	Rh^{103}	4.2 min.	8.8
Al^{27}	2.4 min.	0.15	Rh^{103}	44 sec.	140
Si^{30}	170 min.	0.063	Pd^{108}	13 hr.	20
P^{31}	14.3 days	0.15	Pd^{110}	17 min.	0.55
Cl^{37}	37 min.	0.38	Ag^{107}	2.3 min.	26.7
K^{41}	12.4 hr.	0.7	Ag^{109}	22 sec.	70
Sc^{45}	85 days	2.8	In^{113}	48 days	24
V^{51}	3.9 min.	3.5	In^{115}	54 min.	125
Mn^{55}	2.59 hr.	6.0	Sb^{121}	2.8 days	8.0
Co^{57}	11 min.	48	Sb^{123}	60 days	1.6
Co^{59}	7 yr.	3.8	I^{127}	25 min.	6.5
Ni^{62}	2.6 hr.	0.35	Ba^{138}	86 min.	3.0
Cu^{63}	12.8 hr.	1.3	La^{139}	31 hr.	5.5
Cu^{65}	5 min.	1.5	Eu^{151}	9.2 hr.	530
Zn^{68}	57 min.	0.48	Dy^{164}	2.5 hr.	1600
Ga^{69}	20 min.	0.68	Ta^{181}	97 days	4.5
Ga^{71}	14 hr.	1.3	W^{186}	24 hr.	33
As^{75}	26.8 hr.	1.5	Re^{185}	90 hr.	85
Br^{79}	4.4 hr.	1.4	Re^{187}	16 hr.	63
Br^{79}	18 min.	4.3	Ir^{191}	60 days	190
Br^{81}	34 hr.	1.1	Ir^{193}	19 hr.	63
Y^{89}	60 hr.	0.73	Pt^{198}	31 min.	9.5
Nb^{93}	6.6 min.	0.005	Au^{197}	2.7 days	130
Ru^{102}	4 hr.	0.19	Tl^{203}	4 min.	0.19

probably lies in the difference in the absolute values taken for reference in converting the relative cross sections into absolute ones.

A more detailed report is now in press and will soon appear in the *Scientific Papers of the Institute of Physical and Chemical Research* (Tokyo).

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[1] F. Rasetti, Phys. Rev. **58**, 869 (1940).
[2] M. Goldhaber and R. D. O'Neal, Phys. Rev. **59**, 109A (1941).
[3] C. Lapointe and F. Rasetti, Phys. Rev. **58**, 554 (1940).
[4] J. R. Dunning, G. B. Pegram, G. A. Fink and D. P. Mitchell, Phys. Rev. **48**, 265 (1935).

Radioactive $_{21}Sc^{41}$, $_{18}A^{35}$ and $_{16}S^{31}$

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THE production of these Wigner-type nuclei has already been reported.[1] Energy measurements of the emitted positrons have now been completed by means of a cloud chamber with air and alcohol vapor at atmospheric pressure.

Targets were held in the beam and then placed in a holder which could be swung up to a thin window on the side of the cloud chamber. A picture was taken within two seconds after the sample was removed from the beam. The cyclotron was on only during the actual bombardments which varied from 0.5 to 5 seconds, depending on the sample used. Only one photograph was made for each bombardment, and four bombardments were made per minute. To eliminate the influence of longer periods induced in the samples, six samples were used successively.

The half-life for $_{21}Sc^{41}$ was reported as 0.87 ± 0.03 second.[1] Figure 1 shows the spectrum for the positrons observed from the reaction $_{20}Ca^{40}(d,n)_{21}Sc^{41}$. The magnetic field used was 1276 oersteds; the observed ρ maximum was 142 mm. The upper energy limit obtained for the $_{21}Sc^{41}$ positrons is 4.94 ± 0.07 Mev.

The maximum energy of the positrons and the half-life of A^{35} and S^{31} have been recently also reported by the Princeton group.[2] Their value of 3.2 ± 0.02 seconds for the half-life and 3.85 ± 0.07 Mev for the upper limit of the positrons for S^{31} are in good agreement with our values, 3.18 ± 0.04 seconds[1, 3] and 3.87 ± 0.15 Mev, respectively.

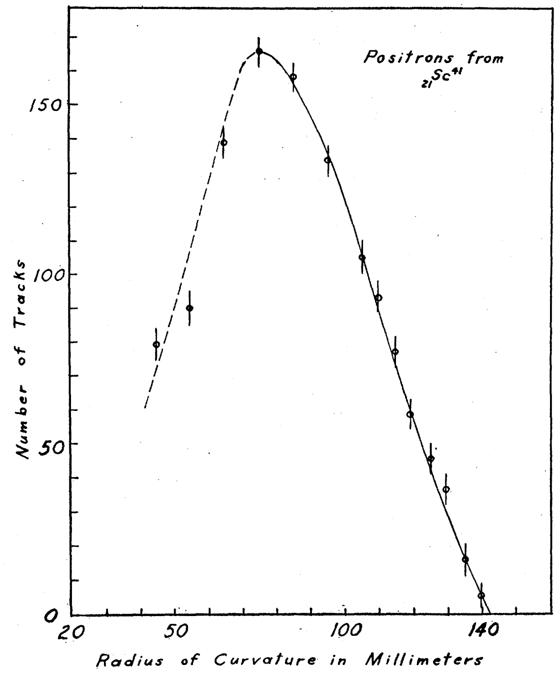

FIG. 1. Positrons from Sc^{41}. Maximum energy 4.94 ± 0.07 Mev, half-life 0.87 ± 0.03 second.

For A^{35} the value of 2.2 ± 0.2 seconds for the half-life and 4.38 ± 0.07 Mev for the maximum positron energy, obtained at Princeton are to be compared with our values of 1.91 seconds and 4.41 ± 0.09 Mev.[1, 3] Since the half-life for A^{35} did not agree with the Princeton results, this period was remeasured with greater accuracy giving 1.88 ± 0.04 seconds. Because of the high energy of the positrons from all of these isotopes, it has been possible to place suitable filters between the samples and the counter so that practically pure periods were obtained.

All of these results are in good agreement with calculated values.[2]

[1] L. D. P. King and D. R. Elliott, Phys. Rev. **59**, 108A (1941).
[2] White, Cruetz, Delsasso and Wilson, Phys. Rev. **59**, 63 (1941).
[3] L. D. P. King and D. R. Elliott, Phys. Rev. **58**, 846 (1940).