Letters to the Editor

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Interaction of Hard γ-Rays with Atomic Nuclei

IT is known that when a pencil of hard γ-rays of thorium-C″ passes through lead, in addition to the absorption by electrons of the shell, there exists a type of nuclear absorption, accompanied by the emission of characteristic radiations of frequencies different from the primary[1]. The intensity of such radiations has been estimated, and it has been found that the total energy of the characteristic radiations emitted is much smaller than the total energy of the primary radiation absorbed by the nuclei[2]. This would be expected, if we assume that a nuclear disintegration occurs in such a process, so that a part of the absorbed energy is spent. From this point of view, we have tried to detect electrons which might be ejected from the lead nuclei by the primary γ-quanta.

In our experiment, the γ-ray source was a radium-thorium preparation equivalent to 10 mgm. of radium. Two Geiger-Müller counters, one having an aluminium wall and the other a lead wall, were used. The counters had equal inner dimensions and approximately equal mass per square cm. of the wall (that is, 0·92 mm. thick for the aluminium counter and 0·22 mm. thick for the lead counter). Let N_{Al} and N_{Pb} be the number of electrons produced in equal time intervals by a given beam of γ rays in the aluminium and lead counters respectively. The ratio N_{Pb}/N_{Al} as a function of the wave-length λ of the incident γ-radiation will at first decrease with decreasing λ, due to the diminishing photoelectric absorption of lead. As the wave-length further decreases, the ratio N_{Pb}/N_{Al} might, however, rise again, if the heavy lead nuclei begin to be disintegrated by γ-quanta of wave-length less than a certain value and the electrons ejected from the lead nuclei in the disintegration process add themselves to N_{Pb}.

By using a beam of γ-rays of thorium-C″ filtered through 2 cm. of lead and scattered by iron at different angles, we measured the ratios N_{Pb}/N_{Al} for γ-rays of different wave-lengths. The experimental result is shown in the accompanying table, where N_{Pb}/N_{Al} is multiplied by a constant k such that the value kN_{Pb}/N_{Al} is unity for the scattered radiation at 23°.

	λ (x.u.)	kN_{Pb}/N_{Al}
Primary radiation	4·7	1·16 ± 0·04
Scattered radiation at 23°	6·6	1·00
Scattered radiation at 46°	12·1	1·23 ± 0·08

In the table, the ratio N_{Pb}/N_{Al} for λ = 6·6 x.u. is seen to be smaller than that for λ = 12·1 x.u., and for λ = 4·7 x.u. it again rises as was expected if electrons were ejected from the lead nuclei by the hard radiation. The difference of the two ratios for λ = 4·7 x.u. and 6·6 x.u. is about 16 per cent. Now, the increase of the ratio N_{Pb}/N_{Al} for λ = 4·7 x.u. might also result from a difference in the scattering effect of the lead nuclei and aluminium nuclei towards the Compton recoil electrons produced in the counter walls by the incident γ-rays. If this were the case, the difference of the ratios for γ = 6·6 x.u. and 4·7 x.u. should be more pronounced by using counters of thicker walls, since the effect of scattering increases with thickness of the wall. But the same result, namely, a difference of about 16 per cent between the two ratios, was obtained when the experiment was repeated with a lead counter with walls 0·3 mm. thick and an aluminium one with walls 1·2 mm. thick. Therefore the above result seems to support the view that the lead nuclei are disintegrated by the hard γ-rays.

The details of the experiment will be published elsewhere.

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[1] Chao, *Phys. Rev.*, 33, 1519; 1930. Gray and Tarrant, *Proc. Roy. Soc.*, A, 136, 662; 1932.
[2] Gray and Tarrant, *loc. cit.* Chao, Science Reports of National Tsing Hua University, 1st series, 1, 159; 1932.

IT is obvious from a letter to me which accompanied the above communication that Prof. Chao and Mr. Kung have not yet heard of the recent work concerning the positive electron, and in particular of the creation of a pair of electrons, a negative and a positive, by the conversion of a γ-ray of high energy in the strong electric field of a nucleus. The experiments they describe provide valuable additional evidence of this phenomenon, and would doubtless have been interpreted by them in this way rather than as a nuclear disintegration. It is interesting to note that the magnitude of the effect is about the same as is found in other experiments.

RUTHERFORD.

'Super-Contraction' and 'Set' in Animal Hairs

IN a recent communication[1] it is shown how the complex elastic behaviour of animal hairs is explicable in terms of a proposed molecular structure the main features of which are deduced from the X-ray photographs. This structure—the keratin 'grid'—consists of a series of 'main-chains' lying parallel to the fibre length, from which protrude, at regular intervals, 'side-chains' which serve to link laterally neighbouring main-chains. In the normal state of the fibre, the main-chains are folded or crumpled, but during extension of the fibre the folds are straightened out, a process producing considerable stresses in the lateral linkages. Under the combined influence of these stresses and the hydrolytic action of water, alkali, etc., breakdown of certain side-chains occurs, leading to the phenomenon of 'relaxation' or loss of tension when the fibre is held stretched. This rupture of cross-links is followed by a re-combination of the broken chains in new unstressed configurations, in consequence of which the fibre exhibits some reluctance to recover its original length when the stretching force is removed; and if the re-building becomes sufficiently pronounced, the fibre may ultimately acquire a 'set' at an extended length. Both breakdown and 'setting' proceed at greater rates as the temperature of the environment increases, and the recovery powers of the fibre after any degree