Disintegration of Nucleus by Cosmic Radiation.

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ABSTRACT.

In the course of the experimental works using a Wilson chamber, dense tracks showing the explosions of atomic nuclei by cosmic radiations were observed. Feature of the disintegration is discussed.

§ 1. Introduction.

Ever since Compton and Bethe proposed that the primary cosmic rays consist in part of very high energy proton and alpha particles, many theoretical and experimental works have been appeared. The employment of a Wilson chamber is most promising for the investigation of this problem.

Of late, there have been appeared two papers by Anderson and Neddelmeyer on the one hand and Brode, MacPherson and Starr on the other, the former stating that out of a set of 9188 exposures taken on Pike Peak showed strongly ionizing particles associated with the cosmic radiations, most of which seem to be protons. The particles reported by them are not alpha particles arising from any radioactive contaminations. The larger percentage of spatial distributions of dense tracks are mainly horizontal and in several instances they projected upward indicating themselves to be, in general, secondaries resulting from nuclear disintegrations.

The same authors obtained a photograph of disintegration of argon in the argon gas by non-ionizing ray. Brode and others observed a total of 80 dense tracks of random directions in 8500 photographs as well as three pictures of disintegrations where heavy particles were emitted. A photograph taken by Blackett of disintegration (A1) produced by non-ionizing ray should be also noticed.

§ 2. Disintegration of nucleus by non-ionizing ray.

So far a horizontal Wilson chamber has been used always for the past six months, eight dense tracks have been noticed, two of them being shown in Fig. 1 and Fig. 2.

Fig. 1 shows two tracks radiating nearly from the middle point
the angle between the two tracks being slightly less than $2\pi$ (a glass plate of the chamber being very uniform, it is not due to its un-uniformity). Although, in this experiment, stereo-camera was not used, two tracks can be seen clearly end within the chamber. The left-hand side track is practically horizontal, having a range about 1.26 cm. in the normal state, the other being nearly 1 cm. If any contaminations of radioactive substances were present, only single track would be expected which will be perhaps of more long range. Two tracks of this branched type is hardly expected. Neutron experiments have been not carried out at all in or near this laboratory. Hence, it may be certain that these tracks were caused by the disintegration of a nucleus immediately after the collision with a cosmic ray of photon-type (because we can not see such electron tracks from the disintegration point). From the photograph, it may be concluded that, in order to satisfy the two conservation laws, a nucleus should disintegrate itself into three masses, two of which are not very different from each other, the other being a neutron.

Fig. 2 is an another photograph, showing three branched-type. Two tracks radiate upward and the other downward.

§ 3. Discussion.

As the chamber contained an air of one atmospheric pressure and
ethyl alcohol, a disintegrated nucleus in the case of Fig. 1 must be one of C, N, and O.

To estimate the order of the incoming ray, we shall consider tentatively the following reaction process, though it is possible to think about other processes:

\[ \text{Li}^n \rightarrow \text{Li}^+ + \text{Li}^+ + \text{e}^+ \]  

Rough calculations with the experimental formula \( R = k \mu Z^2 \beta^2 \) show that the velocities of each Li-nucleus are about \( 0.9 \times 10^9 \text{ cm/sec} \). Therefore, their total energy becomes to be nearly \( 0.5 \times 10^8 \text{ e.v.} \). Adding to it the energy of the explosion \( 0.25 \times 10^8 \text{ e.v.} \) (we assume that the mass of \( \text{Li}^+ \) is \( 6.0170 - 1.0090 = 5.0080 \)), the energy of the incoming ray is nearly the order of \( 10^8 \text{ e.v.} \) in spite of neglecting the energy of the neutron. On the reaction processes other than (1), it is still possible to estimate the order of the ray which becomes also to be greater than \( 10^8 \text{ e.v.} \).

It should be avoided to put forward strongly the view that the reaction occurred belongs to the process (1). However, there is a certain justification in stating that the phenomena is due to the cosmic ray of the photon-type, its energy being greater than \( 10^8 \text{ e.v.} \).

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REFERENCES:

(3) E. Bretsch: Kernphysik (Springer), p. 508.