Nuclear Photo-electric Effect in Deuterium

CHADWICK and Goldhaber[1] in their experiments on the splitting of deuterium by γ-rays from thorium ($h\nu = 2{\cdot}62 \times 10^7$ ev.) measured, by means of an amplifier and a recording oscillograph, the ionisation of each 'photo'-proton produced. They found the average size of this ionisation to be 7,200 ion-pairs, which, assuming 33 ev. as the ionisation energy of deuterium and adopting for the masses of hydrogen and deuterium 1·0081 and 2·0142 respectively, leads to the value 1·0084 for the mass of the neutron.

By means of a very sensitive electrometer and a semi-automatic compensating and registering device (constructed by G.I.), the ionisation produced in deuterium by each photo-proton was measured (by M. H.). The ionisation chamber, with a volume of 1,700 c.c., was made of silvered glass and divided in two symmetrical halves, the walls of which were charged to opposite potentials. On account of this symmetrical arrangement, the electronic ionisation produced by the γ-rays only resulted in a slight wandering of the electrometer needle, while a photo-proton manifested itself by a 'kick' in one direction or the other, depending upon the half of the chamber in which it originated. The electrometer had a sensitivity corresponding to 2,900 ions per scale division, its time of indication being about 6 seconds.

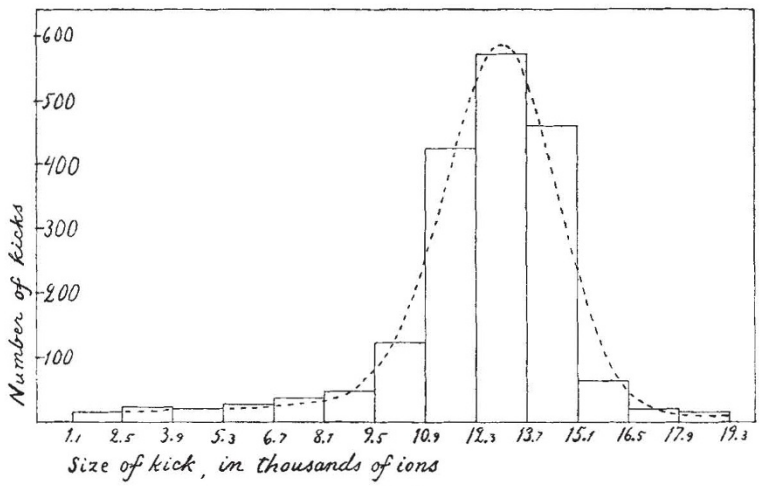

FIG. 1.

The γ-ray sources consisted of mesothorium and radiothorium preparations with some radium, equivalent in all to about 3·7 mgm. radium. The γ-rays were only slightly filtered; two of the sources being shielded only by a few millimetres of glass and the other two by about 2 mm. of brass in addition. In spite of this simple filtering, there was no trouble with background. In the main experiment, the frequency of registering was about 140 'kicks' per hour. Only 10 per cent of them were null effects.

Fig. 1 shows the distribution in size of 2,000 kicks, after subtracting the null effect. The essential features of the curve correspond to one definite size of the kicks with a Gaussian distribution of observational errors superimposed. The top of the curve lies at 13,000 ions which, with the assumptions mentioned above, will give 1·0080 as the mass of the neutron.

The mean error in the determination of the size of a kick amounted to about 1,300 ions and was mainly (to about 3/5) due to the Brownian fluctuations of the electrometer needle.

Further details concerning the experiments will be published later.

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[1] *Proc. Roy. Soc.*, A, **151**, 479 (1935).

X-Ray Investigation of the Glassy State

X-RAY diffraction has been used to examine vitreous silica prepared by different methods, and also to study a series of soda-silica glasses subjected to thermal treatments of different duration. Experimental conditions: filtered $K\alpha$ copper rays ($\lambda = 1{\cdot}538$ A.) were used, the diameter of the cylindrical camera being 29·0 mm.

Vitreous Silica. A factory sample of pure quartz glass showed on the X-ray diffraction diagram (Fig. 1, No. 67), in addition to an intense maximum at a scattering angle $2\theta = 21° 16'$, a very feeble and indistinct second maximum corresponding to a much greater scattering angle (approximately 83°) which, although observed by Randall[1], was not regarded by him as really existing in view of its feebleness; this maximum has also been observed by Warren[2] at a scattering angle of 71° approximately.

This slight maximum was more pronounced in a sample of quartz-glass obtained by us from quartz and by melting in the Tammann furnace (at 1,760° for 20 min.), and in addition traces of new maxima appeared, clearly visible in the X-ray pattern of the sample melted by us in identical conditions from a mixture of crystobalite with tridymite (see Fig. 1, No. 101).

On this X-ray diagram, five maxima have been obtained by us corresponding approximately to the following angles of scattering: 21° 16′, 36°, 48°, 64° and 83°. All these maxima coincide with groups of lines on the X-ray diagrams of devitrified 'quartz' glass (Fig. 1, No. 67*a*) and of micro- and macro-crystalline mixtures of crystobalite with tridymite (Fig. 1, Nos. 74 and 89).

All samples of the vitreous silica have been observed with a polarisation microscope, and no traces of crystallisation have been observed.

Soda-Silica Glasses. Five different sorts of soda-silica glasses with the following composition were investigated:

Specimen	Molecular percentage		Weight percentage	
	SiO_2	Na_2O	SiO_2	Na_2O
1	50·00	50·00	49·21	50·79
2	62·50	37·50	61·76	38·24
3	66·66	33·33	65·96	34·04
4	73·00	27·00	72·36	27·64
5	77·00	23·00	74·43	23·57