LETTERS TO THE EDITORS

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Mass Numbers of the 35-hr. Krypton and of the 50-hr. Arsenic Activities

In the course of recent investigations with a mass spectrometer, mass assignments have been made of two activities resulting from deuteron bombardments in the cyclotron of this laboratory.

The spectrometer employed is a modification of a design by Graham, Harkness and Thode[1]. This has a Nier-type ion source necessitating the use of gaseous samples; the analyser tube is of normal design with 90° magnetic deflexion. At the collecting end the Faraday cup and the plate repelling the secondary emission were replaced by a pair of 'Nichrome-*V*' plates 0·025 in. apart held about 1 in. from the exit-slit plate and parallel to it. A 'target' of 0·015 in. copper sheet fixed to one end of a long glass rod and introduced through a vacuum gate can be inserted between the 'Nichrome' plates. A rectangular hole in the plate nearer the exit-slit plate allows the emergent beam of ions to impinge on this copper target between the plates.

With this modification to the mass spectrometer, beam currents can still be measured by connecting the D.C. amplifier to the target holder; thus the instrument can still be adjusted to focus any given mass number. The D.C. amplifier can then be disconnected and ions of this mass driven into the target. For this process an auxiliary accelerating voltage of about 30 kV. is applied between the exit-slit plate and the target holder. Afterwards the target, bearing the collected atoms, can be withdrawn through the vacuum gate. If some or all of these atoms are radioactive, measurements of the activity on the target may then be made by the well-known methods.

The apparatus may clearly be used to identify in some cases the isotope responsible for a particular activity. For example, as a preliminary investigation, it has been possible to show that the 35-hr. activity produced by the $(d,2n)$ reaction on bromine is due to krypton-79. This result has also been given by Bergstrom[2].

Recently, the 50-hr. arsenic activity produced by the (d,n) reaction on germanium has been shown to be due to arsenic-71. The arsenic was extracted as the trichloride from the germanium target by the method described by Irvine[3], and afterwards converted into arsine for introduction into the mass spectrometer.

Under the action of the electron beam in the ion source, some of the arsine is decomposed to give the unstable compounds AsH_2 and AsH, and arsenic itself. The four types of ions (AsH_3^+, AsH_2^+, AsH^+ and As^+) are, to within a factor of three, present in similar amounts. Hence, any one active arsenic isotope will appear at four mass numbers. Ions were collected as described at mass numbers 71, 72, 73, 74 and 75, and at the first four of these an activity with a half-life of approximately 50 hr. followed by one of 11 days was found. At mass number 75 a weak activity of half-life greater than 15 days was found. This last could result from the 17·5-day activity of arsenic-74 in the ion $^{74}AsH^+$.

The assignment of the 50-hr. activity to arsenic-71 was first made by McCown, Woodward and Pool[4] as a result of examining the shorter period in the arsenic obtained from deuteron bombardment of germanium, where, by subtracting other known activities, they were able to identify the 11·4-day X-ray activity corresponding to germanium-71. The cross-section for the formation of this they found to be approximately equal to that for the 50-hr. activity, which strongly suggests that the latter is the radioactive parent of gallium-71. Our observations confirm that this is indeed so. The full reaction may thus be written:

$$^{70}\mathrm{Ge}(d,n)^{71}\mathrm{As}\ ;\quad ^{71}\mathrm{As} \xrightarrow[\text{50 hr.}]{} {}^{71}\mathrm{Ge} \xrightarrow[\text{11·4 d.}]{} {}^{71}\mathrm{Ga}.$$

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D. F. Bracher
A. R. Crathorn

Physics Department,
University, Birmingham 15. Oct. 25.

[1] Graham, R. L., Harkness, A. L., and Thode, H. D., *J. Sci. Instr.*, **24**, 119 (1947).

[2] Bergstrom, I. *Phys. Rev.*, **82**, 112 (1951).

[3] Irvine, jun., J. W., *J. Phys. Chem.*, **46**, 910 (1942).

[4] McCown, D. A., Woodward, L. L., and Pool, M. L., *Phys. Rev.*, **74**, 1315 (1948).

Evidence for the Existence of Neutral Particles of Very Short Life-time

We have recently made observations on nuclear disintegrations recorded in photographic emulsions, which suggest that neutral particles exist, of mass 556 m_e and life-time less than 10^{-14} sec., which decay into two π-particles of opposite charge.

It is well known that the π-mesons arising in high-energy nuclear disintegrations may not invariably be the immediate products of the collision between nucleons. In principle, one may assume that they sometimes result from the decay of heavier particles of very short life-time which are themselves directly produced. Our attention was first directed to the possibility of establishing the existence of such a process by the following observation.

In a nuclear disintegration of type $10 + 2_n$, observed in a plate exposed at 65,000 ft., the two shower particles were ejected from the nucleus in directions inclined at only 4° to one another, and at about 155° to the downward vertical through the plates during the exposure. At 65,000 ft. the flux of energetic nucleons with a component in the upward direction is very small. It therefore appeared almost certain that the two shower particles were ejected at wide angles to that of the parent particle which produced the 'star'. If the secondary particles have no angular correlation, such a close pair must occur by chance and only rarely. The event was therefore examined in more detail.

The lengths of the tracks of the two particles were 5·6 and 3·2 mm. respectively, and it was therefore possible to determine the grain-density and scattering of the tracks. It was thus established that the particles were π-mesons with energies 76 ± 5 and 117 ± 10 MeV. respectively. The chance of finding such a close similarity in the energies of two shower particles is also small, and the event was therefore analysed on the assumption that it represents the spontaneous decay of a neutral particle, of life-time less than 10^{-14} sec., into a pair of π-particles, $\zeta^0 \rightarrow$