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Delayed Neutrons

IN his paper "Mechanism of Nuclear Fission", Bohr[1] has explained the emission of delayed neutrons from certain members of the fission chains as due to the product being in a sufficiently highly excited state after the emission of β-particles. Of the other possibilities, production of delayed neutrons by (γ,n) reaction by the γ-rays after a β-disintegration, following Bohr, can be excluded simply because of the absence of sufficiently energetic γ-rays in fission chains reported in the Plutonium Project Report[2].

There is, however, another type of reaction, namely, electro-disintegration or (e,n) reaction, the possibility of which for the emission of delayed neutrons cannot be ruled out. Recent experiments of such reactions on heavy elements by Skaggs *et al.*[3] have shown that these reactions have cross-sections less than those for photo-disintegration only by a few hundred times, and the reports[4,5] of photo- and electro-disintegration of Be^{9} show definitely that their threshold energies are exactly equal. These facts lead to the conclusion that photo- and electro-disintegrations are sister reactions differing in their cross-sections only. As a matter of fact, we may infer that delayed neutrons would be ejected, by a process similar to electro-disintegration, spontaneously in the nucleus itself, by those particles of unusually high energy emitted by certain members of the fission chains, for example, Kr^{87} and Xe^{137}. As a result, though the neutron emission is instantaneous, they will be emitted throughout the half-life of β-emission analogous to the case of the γ-emission which, though instantaneous, yet follows the preceding β-life. This has been found actually to be the case for Kr^{87} and Xe^{137}, where neutrons follow the β-life. Our inference is that the high-energy electrons are responsible for ejection of neutrons from Kr^{87} and Xe^{137} by electro-disintegration.

Recently, workers[6] in the Berkeley Laboratory have detected a delayed neutron emitter in the low mass-number region by bombardment of the oxygen nucleus with 195 MeV. deuterons. According to them, N^{17} changes to O^{17} by emission of β-rays, and this O^{17} in its turn ejects delayed neutrons. But from the point of view of electro-disintegration, we may infer that it is N^{16} which emits β-rays of $\sim 6 \cdot 2$ MeV. and goes over to O^{16}. The remaining nuclei of N^{16} are undergoing electro-disintegration simultaneously by these high-energy β-particles, and become N^{15} by emission of delayed neutrons, so that N^{16} and not O^{17} is the delayed neutron emitter. This assignment of N^{16} fits in exactly with the scheme of disintegration found in the case of Kr^{87} and Xe^{137}, whereby the nuclei of the same element emit β-radiation and neutrons simultaneously.

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Reduction of Dead Times in Geiger–Müller Counters

THE significance of the positive ion sheath, formed in the immediate vicinity of the wire in a Geiger–Müller counter during a discharge, has been discussed by the Montgomeries[1] and by Stever[2]. According to them, the positive ion sheath is directly responsible for the dead time occurring in the counter after each discharge; the dead time is identified with the time necessary for the sheath to move sufficiently far from the wire for the field to be restored to a value at which the next event can be detected. Following this, Simpson[3] and Hodson[4] investigated the possibility of reducing the dead time by bringing the ion sheath back to the central wire and collecting it there. For this purpose they employed circuits by means of which the wire potential could be switched about 100 volts negative with respect to the cathode for a few microseconds after each discharge. Dead times as low as 20–30 microsec. were obtained in this way.

A consideration of this problem suggested that the major part of the reduction in dead time achieved was not due to positive ion collection but to the localization of the ion sheath, which is thus prevented from spreading along the whole of the wire, leaving the remainder of the counter sensitive to further ionizing events. This possibility is consistent with the known spread velocity of the ion sheath[5-7] and with the estimated operating speed of the circuit.

In order to confirm this suggestion, and to show that it is not necessary to reverse the wire potential and resort to ion collection to obtain shorter dead times, a circuit has been used to reduce the wire potential to within 20–30 volts of that of the cathode for about 1 microsec. after each count. Pulses from a counter operated in this way have been observed on a triggered cathode ray oscillograph, and dead times of 3–4 microsec. have been obtained, the limit being imposed by the recovery time of the electronic circuit. The dead times in this case refer to the counter as a whole; individual parts of the counter involved in any one count may be insensitive for much longer periods.

Further confirmation has been obtained in an experiment using a brass-walled counter, 38 cm. long