Letters to the Editor

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SEARCH FOR EO TRANSITION IN ZINC-68

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The decay of Ga-68 has been recently reinvestigated by Horen (1959) who found evidence for levels in Zinc-68 at 1.07, 1.88 and 2.3 Mev. The levels were assigned the following spins and parities : 1.07(2^+), 1.88 (1^+ or 2^+) and 2.3(2^+). No cross-over gamma transition was observed from the 2.3 Mev level to the 0^+ ground state. This fact together with the result of angular correlation studies on the 1.07-1.24 Mev gamma cascade led Horen to suggest 2^+ to the 2.3 Mev level. Since the errors on the angular correlation data were rather large, this spin assignment was considered to be far from ambiguous. It seemed attractive to assign 0^+ to this state and still be consistent with the observed data. In fact, the near harmonic model of Scharff-Goldhaber and Weneser (1955) predicts the existence of 0^+ levels at about twice the energy of the first excited state

$0 \rightarrow 0$. No gamma transitions are strictly forbidden because of the transverse nature of the photon. Hence the de-excitation of the state in question can proceed either through internal conversion or through internal pair formation. Since the internal positron spectrum from the 2.3 Mev level (end-point 1.28 Mev) would be superposed on a rather high background of positrons from the beta decay of Ga-68 (end-point 1.88 Mev), it was decided to look for internal conversion electrons of 2.3 Mev. In order to observe the small peak due to conversion it was necessary to reduce the background to a minimum. This was accomplished by the use of an anti-coincidence arrangement.

The Ga-68 source was sandwiched between two plastic scintillators each 1-1/2 cm high and 3 cm in diameter ensuring 4π geometry, and mounted on the face of a Du Mont 6292 phototube. A second plastic scintillator surrounding the first one was mounted on another phototube and served as the anti-coincidence

counter. The sensitive volume of the counter was surrounded by 4″ of lead. Pulses in counter 1 not accompanied by pulses in counter 2 operated a gate which admitted to the 20-channel analyzer any pulse in the beta-counter occurring in an interval of 3.5 microseconds. The end-point of the positron spectrum was determined to be 1.89 ± 0.05 Mev, in agreement with the value reported by Daniel (1957). Phosphorus-32 with end-point energy of 1.72 Mev(Lidofsky, 1957) served as the calibration spectrum The search for internal conversion electrons lasted 105 hours, during which time the apparatus was periodically checked. From the total number of counts observed in the region where the conversion electrons were expected and the total number of counts in the beta-spectrum, an upper limit of $(5 \pm 25) \times 10^{-9}$ conversion electrons per Ga-68 decay could be set.

One can calculate the expected yield of 2.3 Mev internal conversion electrons as follows (assuming 0^+ level). The single-particle model gives the transition probability for the 1.24 Mev gamma-ray as $W_{1.24} = 10^{11}$ sec $^{-1}$. The K-conversion probability for the Eo transition is expressed by Church and Weneser (1956) as $W_K/\rho^2 = 7 \times 10^8$ sec $^{-1}$ where ρ^2 is a dimensionless parameter which measures the strength of the EO matrix element. We take $\rho \sim 0.11$ in accordance with experiment (Alburger, 1958). The yield can then be written

$$N_k = \left[(W_k/\rho^2)\rho^2 / \left(\frac{W_k}{\rho^2}\rho^2 + W_{1.24} \right) \right] fN$$

where N is the total number of disintegrations and f is the fraction of decays populating the 2.3 Mev level. From the data of Horen and the measured beta-spectrum Nf is about 2×10^5. The computed yield is 84×10^{-9} conversion electrons per decay, to be compared with the measured value $(5 \pm 25) \times 10^{-9}$.

If these estimates are indeed correct, then one can conclude that 0^+ is an unlikely assignment for the 2.3 Mev level. If, on the other hand, it turns out that the 1.24 Mev transition is 10 times faster than the single-particle estimate, by analogy with the situation in Ga-70, then our conclusions are somewhat weakened. Recent angular correlation measurements (Ramaswamy and Jastram, 1960) have indeed shown that the 2.3 Mev level is 2^+.

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