Nuclear Spin of Cl^{37}

Elliott[1] in his study of the absorption spectrum of Cl_2 was able to identify the spectra of the two species of molecules, $Cl^{35}Cl^{35}$ and $Cl^{35}Cl^{37}$, but, due to their low intensity, was not able to identify lines belonging to the third species, namely $Cl^{37}Cl^{37}$. From the alternating intensity ratio in the lines due to $Cl^{35}Cl^{35}$ he was able to assign the value of 5/2 as the nuclear spin of Cl^{35}. With the view in mind of obtaining the alternating intensity ratio in the spectrum of $Cl^{37}Cl^{37}$ a sufficient amount of chlorine gas enriched in the heavy isotope was obtained for the purpose.

The enriched chlorine was obtained by the use of a multistage thermal diffusion column similar to that first developed by Clusius and Dickel.[2] The column employs hydrogen chloride gas at atmospheric pressure. The column consists of four sections each 3 meters long connected together by convective coupling to give a total effective length of 12 meters. To avail oneself of all the possible separation factor of the column in producing "heavy" HCl, a stream of fresh HCl is passed through the top of the column at a rate of 500 cc an hour.

After allowing the column to approach equilibrium for ten days a withdrawal of approximately 33 cm^3 of HCl daily was begun. Ten days falls short of the time needed to reach equilibrium with zero withdrawal but with a withdrawal of 33 cm^3 a day one will be operating at a considerable distance from equilibrium concentrations; hence, there is no need to reach equilibrium.

After 500 cm^3 of HCl was collected in this way it was converted into Cl_2. The Cl_2 was then placed in a specially constructed absorption tube designed for the longest possible light path with the smallest possible volume. A path length of 5 meters at a gas pressure of 41 cm was sufficient to obtain the $1\rightarrow 11$, $1\rightarrow 12$, $1\rightarrow 13$ vibration bands of the $^1\Sigma^+\rightarrow 0^+$ system of Cl_2 in the region 5100–5200A. The intensity ratio of lines due to $Cl^{35}Cl^{35}$ and $Cl^{37}Cl^{37}$ in the $1\rightarrow 12$ band was 1.76, giving 43 percent Cl^{37} in this sample as against 24.2 percent Cl^{37} in normal Cl_2. The complexity of the $1\rightarrow 11$ and $1\rightarrow 13$ bands prevented the identification of lines due to $Cl^{37}Cl^{37}$. The alternating intensity ratio of 24 available lines in the $1\rightarrow 12$ band for $Cl^{37}Cl^{37}$ was 1.28.

A determination from normal Cl_2 of the alternating intensity ratio of $Cl^{35}Cl^{35}$ for these three bands gave 1.30 as against Elliott's value of 1.34. As Elliott pointed out these values must be taken as lower limits of the intensity ratio since any overlying lines would lower the observed value of any actual intensity ratio. Thus these ratios most nearly correspond to a spin of 5/2 for which the ratio is 1.40. We may conclude that Cl^{35} and Cl^{37} have the same nuclear spin and its most probable value is 5/2.

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[1] A. Elliott, Proc. Roy. Soc. **127**, 638–657 (1930).

[2] K. Clusius and G. Dickel, Zeits. f. physik. Chemie **B44**, 397–473 (1939).

Neutron Capture by Uranium (238)*

In continuation of our work on separated uranium isotopes,[1] it was thought worth while to find out experimentally which isotope is responsible for the well-known 24-minute neutron capture product.

A sample of uranium (238) containing between 5 and 10 percent of the natural U^{235} content was prepared by one of us (A. O. N.) by means of a mass spectrometer. From the average value of the current and the time of deposit it was estimated that the weight of the sample was 19 micrograms. The uranium (238), deposited on a thin platinum foil, was placed in a cadmium box and irradiated with neutrons in a paraffin wax geometry near the Columbia cyclotron. A monitor of UX-free ordinary U_3O_8 was irradiated simultaneously in the cadmium box. After 1-hour exposure to neutrons, the uranium (238) oxide was quantitatively dissolved off the platinum foil with nitric acid and redeposited in the form of U_3O_8 upon a fresh platinum sheet. This was necessary in order to get rid of the induced beta-activity in the original platinum foil.

Ten minutes after the end of the neutron irradiation, the second platinum foil was placed around a thin-walled Geiger Müller counter, and its activity observed. The decay curve, corrected for a natural background of 18 counts per minute, is shown in Fig. 1. The initial activity was 56 counts per minute, and the decay half-life about 24 minutes. After the beta-activity had decayed the alpha-particles from the U^{238} were counted by means of a linear amplifier and found to be given off at an average rate of 5.1 ± 0.3 counts per minute. This corresponds to a weight of $U^{238}{}_3O_8$ of 17 ± 1 micrograms. This weight was further checked by direct differential weighing on a Sartorius microbalance, and found to be 15 ± 3 micrograms—all in reasonable agreement with the originally estimated amounts. Under the assumption that the alpha-value is the most reliable, an initial specific beta-activity of 3290 counts per minute per milligram of $U^{238}{}_3O_8$ follows.

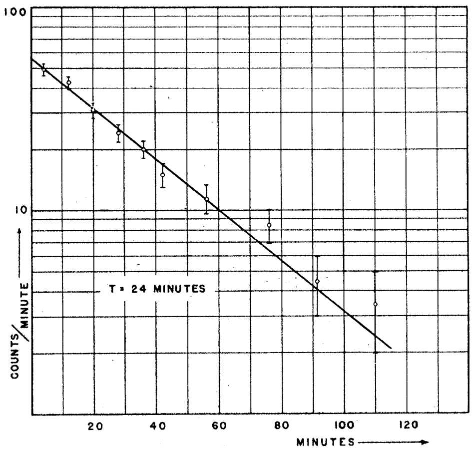

FIG. 1. Decay of resonance capture product of uranium (238).

In order to compare with unseparated uranium under identical geometrical conditions, 40 mg of U_3O_8 were deposited on a platinum surface of 3 square centimeters area, and were irradiated under the same conditions as in the preceding experiment. After irradiation an ether separation of fission products was made. From this sample 8.564 mg of U_3O_8 were deposited on a fresh platinum foil and the initial specific beta-activity determined as before. This gave a value of 3240 counts per minute per milligram of U_3O_8, in good agreement with the value 3290 obtained from the separated isotope.

Substantially the same results were obtained from another sample of 30 micrograms of $U^{238}{}_3O_8$.

The decay period and the specific activity of the neutron induced beta-activity in separated samples of U^{238} are in good agreement with those obtained from the capture in ordinary uranium and leave no doubt that the 24-minute resonance capture in uranium is due to U^{238}. This result was previously anticipated on theoretical grounds by N. Bohr and others.

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* Publication assisted by the Ernest Kempton Adams Fund for Physical Research of Columbia University.

[1] A. O. Nier, E. T. Booth, J. R. Dunning and A. V. Grosse, Phys. Rev. **57**, 748 (1940).

Period of Photon Emission in a Counter Discharge

That the ionization in a Geiger-Mueller counter takes place in a very early stage of the discharge and before the wire has changed appreciably in potential is an essential element in the mechanism proposed by C. G. Montgomery and D. D. Montgomery.[1] The investigation to be described here leaves no doubt that photon emission in a counter takes place during a short time interval following the initiation of the discharge, and that few, if any, photons are emitted during the greater part of the time required by the wire to reach its maximum negative potential.

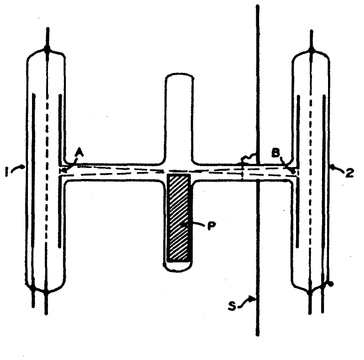

FIG. 1. Arrangement of Geiger-Mueller counters.

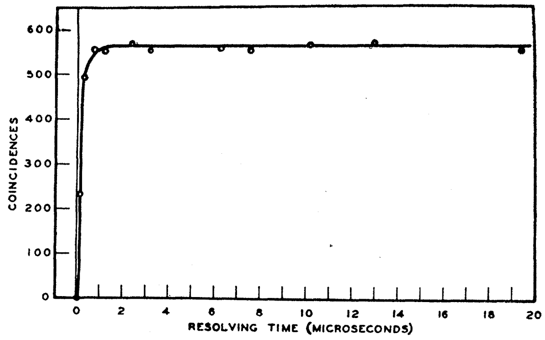

FIG. 2. Relation between coincidence rate and resolving time in experiment A.

Two counters, 1 and 2, Fig. 1, share a common glass envelope. Although the counter wires are carefully shielded electrostatically from each other by *S*, photons emitted by one may pass to the other through holes *A* and *B* in the counter cylinders. This photon transmission is controlled by the plunger *P* which may be moved to expose any desired portion of the transmitting and receiving areas *A* and *B*. The voltage pulses from these counters are applied to a coincidence circuit. The resolving time of this circuit may be varied from $<10^{-7}$ second to 10^{-3} second and special care is exercised to prevent this variation from influencing in any way the discharge phenomena in the counters themselves. These resolving times were determined experimentally employing a pulse generator previously described.[2] With *P* in such a position as to screen the openings *A* and *B* from each other, no coincidences are observed. As *A* and *B* are exposed to each other by moving *P*, coincidences appear, and a point is reached where all discharges in one counter are accompanied by discharges in the other.

In Fig. 2, representing an experiment to be called A, the coincident rate is plotted as a function of resolving time for the case where *P* was so placed that 90 percent of the discharges in one counter were accompanied by discharges in the other (resolving time 2.0×10^{-4} second). There is no observable increase in the number of coincidences between one and twenty microseconds. In another experiment (experiment B) where *P* was in such a position that the probability of one counter setting off the other in a time of 2.0×10^{-4} second was 0.42, there was an increase in the number of coincidences between one and twenty microseconds of only (3.1 ± 3.6) percent.

Measurements by the author[3] on a counter of the diameter and pressure used in these experiments indicate that the counter wire experiences one-half of its potential change in the interval between one and twenty microseconds. If the number of photons emitted by a counter in a given time interval were proportional to the change of potential of the wire during the interval, we should expect an increase of the coincidence rate between one and twenty microseconds which amounts to 20 percent for the case A, and 60 percent (or 20 times that found) for the case B. It is safe to assume that any condition, such as