Gamma-Radiation from N^{13}

The momentum distribution of the photoelectrons ejected from lead by the gamma-radiation from N^{13} has been investigated by means of a large cloud chamber recently constructed at this laboratory. A lead radiator of thickness 0.0017 cm was stretched across the center of the cloud chamber, and measurements were made of the radius of curvature of the tracks of the electrons ejected from it. The beam of gamma-rays from the source was collimated with lead so that no recoil electrons could originate in the floor or roof of the chamber. The source of N^{13} was prepared by bombarding a small amount of ash-free charcoal (impurities less than 0.01 percent) with deuterons from the cyclotron.

The source was first surrounded with carbon so that all the positrons were stopped near the source. The distribution obtained in this case is shown in Fig. 1. There are obviously two groups of tracks. The momentum of the most energetic group corresponds closely with that to be expected from the ordinary 510 kv annihilation radiation. This group of tracks is produced by photoelectrons and Compton recoils in about equal numbers, as shown by the smooth curves in the figure. The maximum energy available to the Compton electrons is 340 kv while the energy of the photoelectrons ejected from the K shell of lead should be 420 kv. It is seen that the data obtained are in accord with these predictions. The contribution of the Compton process to the less energetic group of tracks can be neglected, of course. Thus, using the distribution as indicated by the smooth curve, we obtain an energy of 285 ± 30 kv for the gamma-radiation ejecting the photoelectrons. The relative intensity of the two lines can be estimated fairly well from the number of tracks in each. Taking into account the relative cross section for photoelectric absorption at the two energies, one obtains the result that there are 2.5 quanta of 0.5 Mev radiation per quantum of 0.3 Mev radiation. In other words, there are 0.8 quanta of 0.3 Mev radiation for every positron emitted by N^{13}. This intensity estimate is uncertain by a factor 1.5.

It is not difficult to understand why this radiation was not observed in previous experiments, where a radiator of low atomic number was used, since a radiator of lead is much more sensitive in the low energy region.

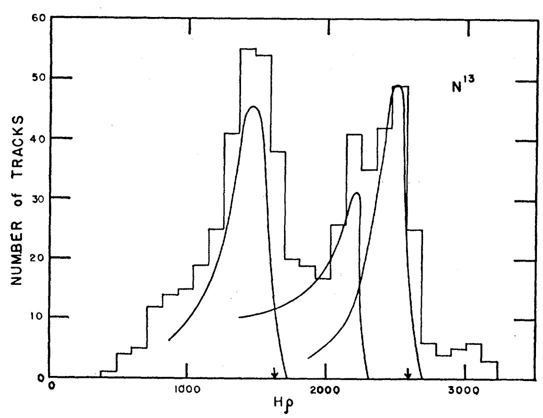

FIG. 1. Distribution of photoelectrons ejected from lead by gamma-radiation from N^{13}.

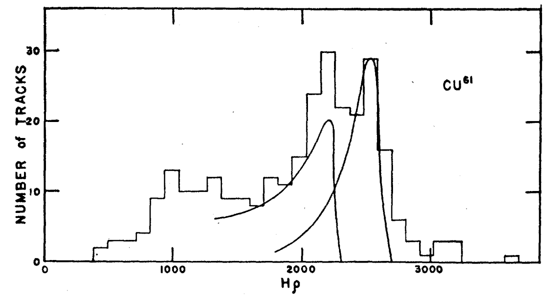

FIG. 2. Distribution of photoelectrons produced by radiation from Cu^{61}.

Two subsidiary experiments were performed, in order to ascertain if the radiation was connected with the slowing down or annihilation of the positrons from N^{13}. The radiation from a source of Cu^{61}, a positron emitting substance prepared by bombarding nickel with deuterons,[1] was investigated with the same geometrical arrangement and radiator, and the distribution obtained is shown in Fig. 2. It is seen that there are very few tracks which could be ascribed to the low energy group. One would expect a small number of tracks (15) in this region due to the radiation emitted when a positron is annihilated while in motion.[2]

Finally, a thin source of N^{13} was arranged so that most of the positrons were annihilated behind the lead collimating shield. This increased the relative intensity of the low energy line by a factor three, which is all one could hope for, in practice. Thus it is apparent that this radiation is probably nuclear in origin.

The "inspection" upper limit of the positron spectrum of N^{13} is in such apparently good agreement with the difference in the masses of N^{13} and C^{13} (1.25 Mev *vs.* 1.28 Mev) that one hesitates to postulate a gamma-ray of 0.3 Mev following the positron emission. It is possible, of course, that there are two alternative positron transitions, one of 1.3 Mev and one of 1.0 Mev followed by the 0.3 Mev gamma-ray.

Another alternative, which for theoretical reasons would seem much less likely, is that the 0.3 Mev radiation is associated with the process of K electron capture proposed as a possibility by Roberts and Heydenburg[3, 4] to account for the difference in yield of positrons *vs.* neutrons in the formation of N^{13}. It is possible that these questions could be answered by an exact investigation of the positron spectrum of N^{13}.

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