surprising when one considers the possibility of intense local heating resulting from the large amount of kinetic energy dissipated in a small space by the slowing down of the fission products. From the activity of an ionization chamber lined with uranium oxide[1] the number of fissions per gram of uranium oxide was estimated to be 60 per minute. A typical sample contained $\frac{1}{2}$ g uranium oxide, while, under favorable conditions, the average exposure time required to produce detonation was 40 minutes. These figures give 1200 fissions per detonation or an efficiency of 0.1 percent.

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[1] Data kindly supplied by W. A. Schneider, R. C. Waddel and D. Callihan.

Energy Distribution of Uranium Fission Fragments*

The energy distribution of the fragments resulting from uranium fissions produced by slow neutrons has been further investigated[1-3] under better defined conditions.

Uncollimated chamber.—A thin layer of uranium oxide (1 mm air equivalent) was electrolytically deposited on gold and served as the central portion of the high voltage electrode in a parallel plate ion chamber which contained argon at a pressure sufficient to absorb the total range of the fission particles. A collecting potential of 2200 v minimized recombination of ions in the 0.6-cm deep chamber.

The ionization pulses from this chamber when exposed to neutrons from the cyclotron were amplified and recorded by an amplifier oscillograph system, of tested linearity. The results obtained (Fig. 1) with the uncollimated chamber show that the fission fragments are divided into at least two major energy groups. The maximum energies in each group were determined by comparison with the U II alpha-particles to be approximately 100 Mev and 72 Mev, respectively.

If these two maximum energies are associated with a single fission process, the total kinetic energy would be about 175 Mev, and the ratio of the masses of the two fragments would be approximately 96/140.

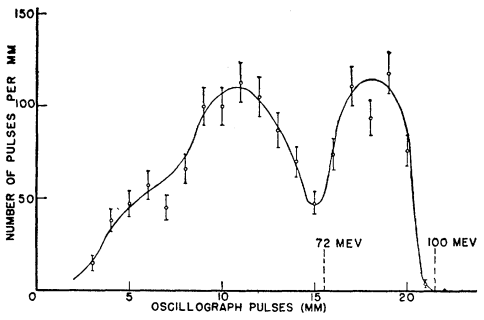

FIG. 1. Total ionization of fission particles in argon.

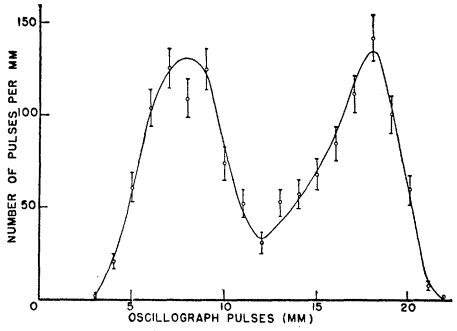

FIG. 2. Ionization of fission particles in argon (collimated).

The difference between this and 200–210 Mev predicted for this process may be accounted for by excitation of the fragments, resulting in beta-, gamma- and neutron emission[4-6] and possibly in part by incomplete collection of ions from the densely ionized tracks.

Collimated chamber.—In order to obtain higher resolution of the energy distribution, and to reduce the effect of energy losses within the uranium target for particles emerging obliquely, a 6-mm deep chamber was constructed for the fission fragments, which employed collimating channels 1 mm long, 0.6 mm diameter. The results obtained with it are shown in Fig. 2. On account of the energy loss within the collimating channels the distance between the peaks is increased and the true origin is displaced to the left of that indicated.

The fission fragments here are clearly divided into two approximately equal major groups, and the widths are considerably less than with the uncollimated chamber. The asymmetry of the low energy group in Fig. 1 has disappeared in Fig. 2, showing that this was probably due to large energy loss suffered by oblique particles. Fine structure within each group may be present, but is not definitely resolved in these experiments.[7, 8]

It should be noted that if fine structure is present in the distribution, then the sum of the kinetic energies of the two fragments would, on the average, be appreciably less than 175 Mev. This could be true if there were high excitation of the fragments, or if collection of the ions were less complete than expected.

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