OBSERVATION OF PICK-UP OF THREE NEUTRONS AND STRIPPING OF THREE PROTONS IN INTERACTIONS BETWEEN N^{14} *AND* Ne^{20} *IONS WITH* C, Al, Cu, *AND* Ta *NUCLEI*

V. V. VOLKOV, L. POMORSKI,* J. TYS,† and G. N. FLEROV

Joint Institute for Nuclear Research

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In the interaction between heavy ions and nuclei, reactions may occur in which one or several nucleons are transferred from one nucleus to the other without formation of a compound nucleus. Reactions of this type, which usually occur in edgewise collisions between the incoming nucleus and the target nucleus, have been called "transfer" reactions. They have been the subject of many papers (see, for example, [1-11]), most of which, however, pertain to stripping of one neutron.

In the present investigation we studied reactions of a new type, namely the pick-up of three neutrons and the stripping of three protons. The experimental procedure was based on counting the delayed neutron activity of N^{17} nuclei. The target was periodically irradiated with a beam of heavy ions and the neutrons due to the decay of N^{17} were registered during the intervals between bombardments. In bombardment by N^{14} and Ne^{20} ions, the production of the N^{17} nuclei may be due to the pickup of three neutrons and to stripping of three protons, respectively:

$$ {}_Z X^A + N^{14} \to {}_Z X^{A-3} + N^{17}, \qquad (1)$$

$$ {}_Z X^A + Ne^{20} \to {}_{Z+3} Y^{A+3} + N^{17}. \qquad (2)$$

Because of the unique character of the delayed neutron activity in the region of nonfissioning nuclei, the use of N^{17} as the detected particle effectively eliminates the background due to products of other reactions.

It should be noted that the data concerning the changes in the target nucleus are speculative in nature, because one cannot exclude the emission of free nucleons as a result of collisions between the nuclei.

The experiments were made with the internal beam of the heavy-ion cyclotron of the Joint Institute for Nuclear Research. Thick targets of C, Al, Cu, and Ta were irradiated. The average beam intensity was several microamperes; the ion energy was measured by displacing the target "along the radius." The neutrons were registered with proportional BF_3 counters placed in a Plexiglas moderator. A more detailed description of the experimental apparatus is given in [12].

The irradiation lasted 30 seconds (until saturation was reached), after which the high voltage on the dees was turned off and the neutron activity registered for 30 seconds. Several irradiation cycles were carried out for each value of ion energy.

Figure 1 shows the decay of the neutron activity on irradiation of Ta by Ne^{20} ions. Similar curves were obtained for C, Al, and Cu. The half-lives agreed in all cases, within the limits

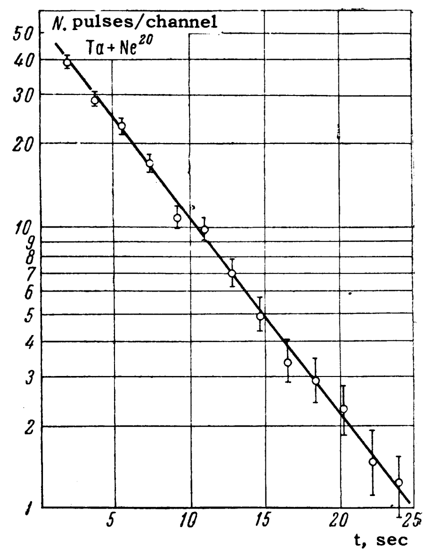

FIG. 1

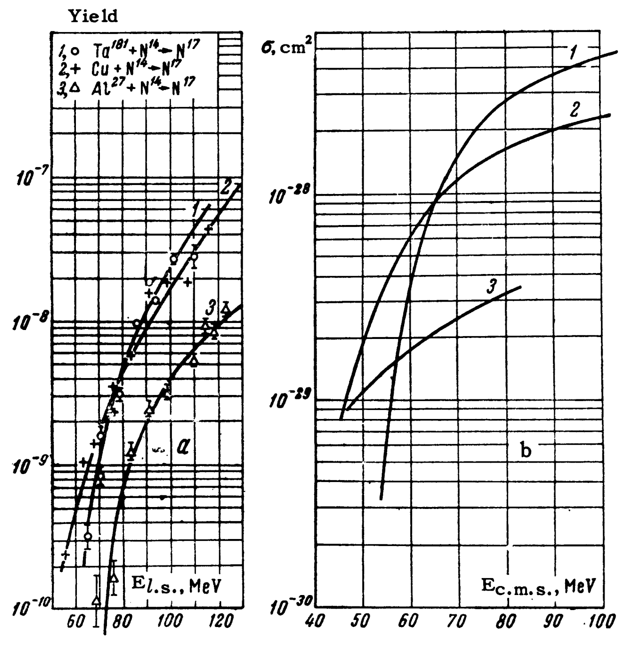

FIG. 2

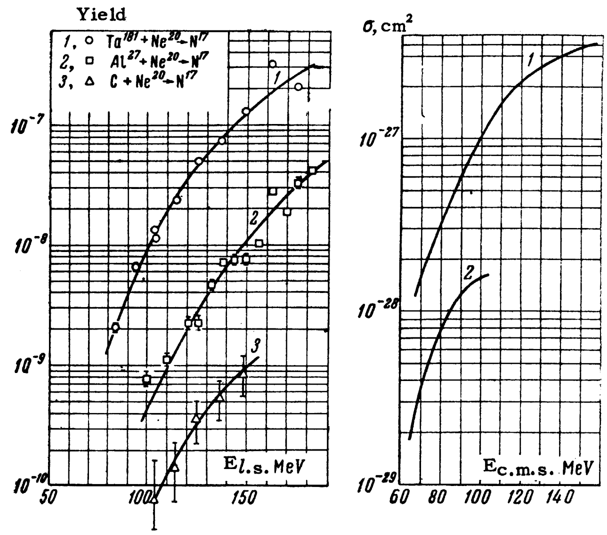

FIG. 3

of errors, with the tabulated half-life of N^{17} (4.15 sec). The background produced by the scattered ions falling on the dees was appreciable only at the lowest ion energies, and could be neglected in all other cases.

Figures 2 and 3 show the experimental data for the yield of N^{17} from thick targets (a) and for the effective reaction cross sections (b), obtained by the usual method of differentiating the yield curves. The free paths of the N^{14} and Ne^{20} ions, needed for these calculations, were taken from the paper by Northcliffe [13] or calculated from the formulas given in this paper.

The energy dependence of the cross sections is close to that obtained by Kaufmann and Wolfgang [11] for reactions involving the transfer of several nucleons. This permits us to think that the formation of N^{17} nuclei by bombardment with N^{14} ions is apparently due to the pickup of three neutrons, while in bombardment by Ne^{20} it is due to the stripping of three protons.

*Nuclear Physics Institute, Krakow, Poland.
†Nuclear Research Institute, Warsaw, Poland.

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OBSERVATION OF THE MÖSSBAUER EFFECT IN A TIN-CONTAINING POLYMER

V. A. BRYUKHANOV, V. I. GOL'DANSKII, N. N. DELYAGIN, E. F. MAKAROV, and V. S. SHPINEL'

Institute of Chemical Physics, Academy of Sciences, U.S.S.R., and Nuclear Physics Institute, Moscow State University

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In view of the enormous possibilities for studying the structure of solids which have been opened up by the Mössbauer effect, it is a very attractive idea to try to observe the effect in a polymer. At first glance, if we use the simple pictures of the Mössbauer effect, such an effect in polymers should be extremely small because of the predominant effects of the light atoms (C, H, etc), and because of the absence of any clearly marked crystal structure in polymers. Nevertheless our attempts to observe the Mössbauer effect in tin-containing polymers have been successful.

We studied the tin-containing compound