*$A_3 \rightarrow A + \gamma$ is allowed, Γ_γ has a normal value.

†It is possible that the best method of observing the quasi-stable level is to let the reaction proceed against the continuous spectrum of bremsstrahlung and to determine the maxima in the spectrum of the emitted neutrons from the time of flight, using a pulsed γ source.

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(d, t) REACTIONS ON MEDIUM AND HEAVY NUCLEI

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THE study of triton spectra from (d, t) reactions on light nuclei[1,2] has shown that mainly hole levels, corresponding to the ripping out of a neutron from the nucleus, are excited in this reaction. It is of interest to investigate the hole levels of medium and heavy nuclei, which differ in that they have a complex structure and a large number of filled shells. The neutron would be expected to be ripped out of various shells, with the excitation of hole levels with differing excitation energies, corresponding to the binding energies of the neutron in these shells.

In the present work, the spectra of tritons from (d, t) reactions in Fe, Zr, In, Au, and Bi were measured. Deuterons were accelerated in the cyclotron up to an energy of 20 Mev. The triton spectra were measured as previously[1-3] from the activity of tritium collected in stacks of foil.

Since the energies of tritons emitted from heavy nuclei depend only weakly on angle, tritons were collected in stacks of foil subtending a rather wide angular interval. There was one angular interval, 15 — 40°, for the targets of iron and indium, and two angular intervals, 8.5 — 23° and 24.5 — 39° for zirconium and gold. The maxima of distributions corresponding to practically all angular momenta l of the removed neutron lie within these angular intervals, with the exception of $l = 0$. The angular distribution of the tritons was measured for the bismuth target.

The measured triton spectra are given in Fig. 1. Along the abscissa are marked the excitation energies of the residual nucleus formed as a result of the reaction on the main isotope (Fe^{56} — 92%, Zr^{90} — 51%, In^{115} — 96%, Au^{179} — 100%, Bi^{209} — 100%). The magnitude of the energy resolution for each of the spectra is shown as a horizontal dash in the region of the main group. The magnitudes of the cross sections for Fe^{56}, Zr^{90}, and In^{115} were calculated from the atoms in a naturally occurring mixture of isotopes.

In all spectra, an intense group of tritons, which usually had two peaks, was observed corresponding to an excitation energy of 0 — 2 Mev. Excitation of states of the residual nucleus of energy higher than 2 Mev proceeds with substantially smaller probability. This means that in all of the nuclei studied, the main process is removal of the most weakly bound neutron, apparently out of the same outer (filled or unfilled) shell. The width of the group (1.5 — 2 Mev) is characterized by the spread in binding energies of the removed neutrons.

The character of the angular distributions, following from comparison of intensities of groups in the two angular intervals, agrees with known data on the character of that from outer shells.[4] In Zr^{90}, the outer neutrons are in $1g_{9/2}$ states; therefore the angular momentum of the removed neutron should be $l = 4$. The intensities of the first maxima in the Zr^{90}(d, t) spectrum are almost the same for the angular intervals 8.5 — 23° and 24.5 — 39°, in complete agreement with what one would expect for a large value of l.

On the other hand, the intensity of the group of tritons from reactions in the isotopes $Zr^{91,92,94}$ drops by a factor of 4 or 5 in going from the first to the second angular interval, in agreement with neutrons filling the $2d_{5/2}$ state above the closed shell.

In the spectrum of Au^{197}, both lines are more intense in the angular interval 24.5 — 39° than in the interval 8.5 — 23°. According to shell theory, the state of outer neutrons, $1i_{13/2}$, corresponds to a large value of the angular momentum $l = 6$. It should be noted that a reliable determination of angular momenta for medium and heavy nuclei cannot be made, since there is, up to now, no possibility of reliably calculating the effect of the Coulomb interaction on the angular distribution.

In Fig. 2 are shown angular distributions of three groups of tritons from the reaction

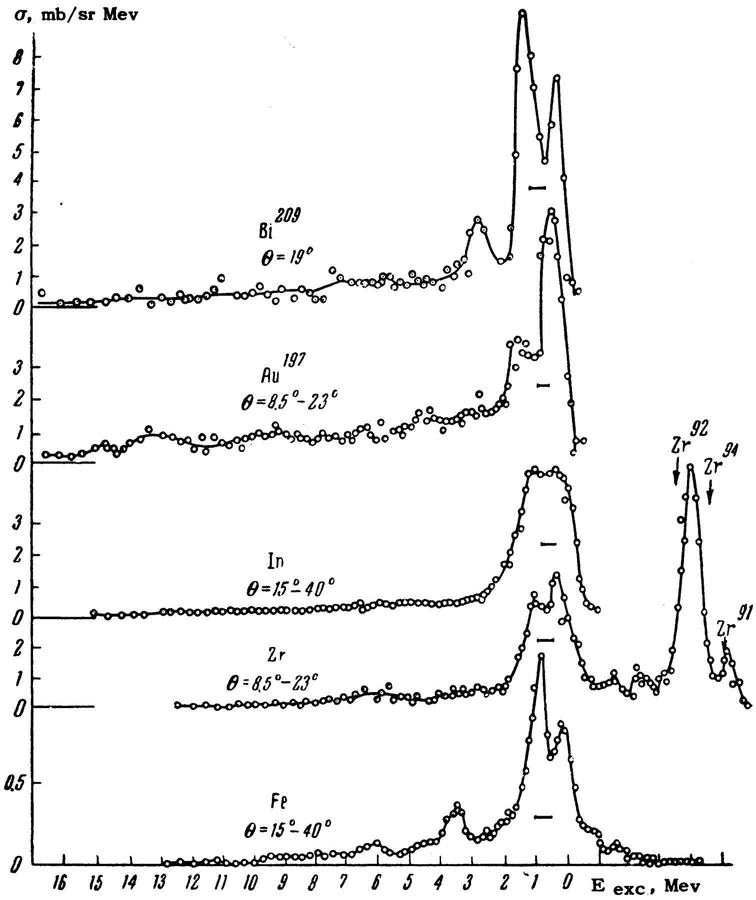

FIG. 1

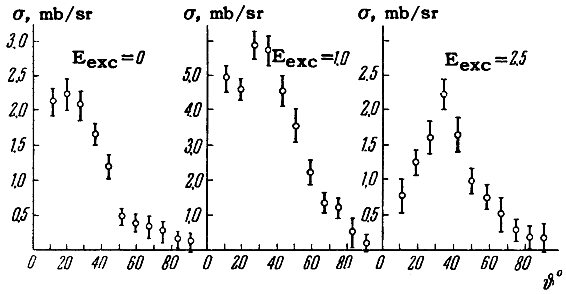

FIG. 2

Bi^{209} (d, t) Bi^{208}. One can assign the values of l (1, 1+3, 3) to them on the basis of available data[4] on the configuration of the levels of Pb^{207} (ground, $p_{1/2}$; 0.57 Mev, $f_{5/2}$; 0.90 Mev, $p_{3/2}$; 1.63 Mev, $i_{13/2}$; 2.35 Mev, $f_{7/2}$).

The most interesting characteristic of the measured spectra is their great similarity, manifesting itself in the fact that they all show at maximum triton energy a wide group with two more or less clear maxima, about 1 Mev apart. This is in spite of the fact that the target nuclei are completely different, both in the number of outer neutrons and with respect to the configuration being filled by these neutrons. The approximate equality of the absolute values of differential cross sections (with the exception of Fe) is of interest.

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