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INVESTIGATION OF COULOMB EXCITATION OF THE FIRST Mo^{92} LEVEL

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The Mo^{92} nucleus has a closed neutron shell and hence the Coulomb excitation cross section is small and the background γ radiation due to nuclear reactions on light impurities makes it difficult to observe the Coulomb excitation of Mo^{92}. The γ-radiation background was reduced by recording coincidences between inelastically scattered bombarding particles and γ quanta emitted in the deactivation of the first excited state. The target enriched with Mo^{92} isotopes was irradiated by 40-MeV N^{14} ions accelerated in a cyclotron. The scattered ions were recorded with help of pn-silicon detectors. The energy of the first Mo^{92} level was found to be 1.52 ± 0.03 MeV and the reduced transition probability $0.19 \pm 0.08\ e^2 10^{-48}\ cm^4$.

EXPERIMENTAL values of the energy (ΔE) of the first excited level with characteristic 2^+ and of the reduced probability $B(E2)$ for the electric quadrupole transition from the ground state to the excited state have been obtained by now for most even-even stable isotopes. The nucleus Mo^{92} is one of the few for which neither the energy of the first level 2^+ nor the reduced probability of the transition to this level were established so far. Yet this information is of great interest if the systematics of the data on the first levels of even-even nuclei is to be completed.

Numerous attempts were made at the cyclotron laboratory of the Physico-technical Institute to investigate the Coulomb excitation of the first level of Mo^{92} by registering the direct spectrum of the γ quanta emitted in the deactivation of the excited states. The measurements were carried out with the aid of nitrogen ions with $E = 16-50$ MeV and Ne^{20} ions with $E = 30$ MeV. All experiments ended in failure.

This is connected with the fact that the neutron shell of Mo^{92} is closed. In this case, as follows from the data on the systematics, the value of ΔE is large and $B(E2)$ is relatively small. Because of these two factors, the Coulomb-excitation cross section is small and the relative contribution of the background γ radiation emitted in nuclear reactions with light-element impurities (principally carbon and oxygen) turn out to be so large that it is impossible to observe the Coulomb excitation.

In our experiments we used, along with a target of natural molybdenum also metallic targets enriched with Mo^{92}, with more than five times the Mo^{92} content in natural molybdenum. The presence of small oxide impurities in the enriched specimens has led to a sharp increase in the background γ radiation, and this did not enable us to investigate the Coulomb excitation of the first Mo^{92} level when targets enriched with Mo^{92} were used.

In order to reduce sharply the relative contribution of the background γ radiation, we undertook to investigate the Coulomb excitation of the first Mo^{92} level by measuring the coincidences of the inelastically scattered bombarding particles and the γ quanta emitted in the deactivation of the first excited state.

The bombarding particles were nitrogen ions with $E = 40$ MeV, detected with the aid of four silicon pn-detectors with total area 100 mm^2. Their resolution for nitrogen ions with $E = 40$ MeV amounted to 2%.

The details of the experiment were described earlier [1]. The arrangement of the coincidence circuit was such that along with the sum of the true and random coincidences we were able to measure simultaneously the random-coincidence counting rate.

Figure 1 shows the spectrum of the γ quanta in coincidence with the inelastically scattered N^{14}. The target used was metallic molybdenum. Curve 1

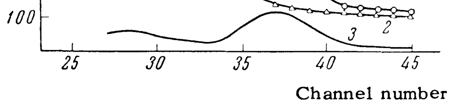

FIG. 1. γN coincidence spectrum.

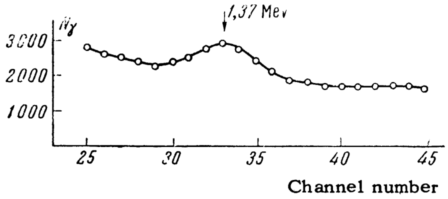

FIG. 2. Direct spectrum of γ radiation.

shows the summary spectrum of the true and random coincidences, and curve 3 shows the spectrum of the true coincidences, obtained by subtracting the data of the random-coincidence curve 2 from the corresponding data of curve 1. From curve 3 follows clearly the presence of a peak with $E = 1.52 \pm 0.03$ MeV, which corresponds to excitation of the first level of Mo^{92}. For comparison, Fig. 2 shows the direct γ-ray spectrum, obtained upon bombardment of Mo^{92} with N^{14} ions with $E = 40$ MeV. We see that an examination of the direct spectrum does not show any indications of the presence of a peak with $E = 1.52$ MeV. The 1.37-MeV line is part of the background and is connected with the C + N nuclear reactions. In a control experiment under analogous conditions, we plotted the γN-coincidence spectrum for bombardment of a target enriched with Mo^{98} by N^{14} ions. No 1.52-MeV line was observed in these experiments.

To calculate the value of B(E2), we used reference measurements of the Coulomb excitation of the first level of Mo^{98} with $\Delta E = 0.78$ MeV. The line with $\Delta E = 0.78$ MeV is clearly seen both in the direct γ-radiation spectra, and in the spectra of the γN coincidences. Experiments enable us to calculate the ratio of the γ-ray yields, registered in the peaks of the total energy in the direct spectrum and in the coincidence spectrum. We have verified in special experiments that when the bombarding-particle energy is lower than the Coulomb barrier, this ratio depends little on the energy of the excited level. We used the value of this ratio to determine the absolute yield of the γ rays of Mo^{92} with $\Delta E = 1.52$ MeV in the peak of the total energy in the direct γ-radiation spectrum. With the aid of well known formulas, starting from the absolute γ-ray yield, we have determined the value of B(E2), which turn out to be $(0.19 \pm 0.08)\,e^2 \times 10^{-48}$ cm^4.

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[1] Afonin, Gangrskiĭ, Lemberg, and Nabichvrishvili, JETP **43**, 1604 (1962), Soviet Phys. JETP **16**, 1113 (1963).

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