INVESTIGATION OF Mo\(^{92}(n, 2n)\)Mo\(^{91.91m}\) REACTION

By

J. Bacsó, J. Csikai

INSTITUTE OF NUCLEAR RESEARCH OF THE HUNGARIAN ACADEMY OF SCIENCES, DEBRECEN

and

A. Pázsit

INSTITUTE FOR EXPERIMENTAL PHYSICS, KOSSUTH UNIVERSITY, DEBRECEN

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The occurrence of Mo\(^{92}(n, 2n)\)Mo\(^{91m}\) reaction has been demonstrated at 14.8 MeV neutron energy and the isomeric cross-section ratio \(\sigma_g / \sigma_m = 10.6\) has been determined. For the reactions Mo\(^{92}(n, 2n)\)Mo\(^{91g, 91m}\) the cross-section values \(\sigma_g = 159\) mb, \(\sigma_m = 15\) mb were found.

Introduction

Previous investigations of \((\gamma, n)\) and \((n, 2n)\) reactions in Mo\(^{92}\) nuclei \([1, 2, 3, 4, 5]\) have shown that no short-life (nearly 1 minute) isomeric state of Mo\(^91\) will be produced by an \((n, 2n)\) reaction \([3]\), whereas in \((\gamma, n)\) reaction at energy \(E_\gamma = 14.5\) MeV the cross-section ratio of isomeric and ground states has been found to be 0.2 \([4]\).

For the \((n, 2n)\) reaction, the activity of the short half-life isomeric state was found only in traces at a bombarding neutron energy of even 18 MeV \([4]\). The threshold energy of the process (13.2 MeV) \([6]\) permits to produce a level of 658 keV above the ground state at a bombarding neutron energy of 14.8 MeV. The purpose of our investigations has been to demonstrate the existence of the above mentioned isomeric state under the conditions of \((n, 2n)\) reaction at an energy of 14.8 MeV, and to determine the isomer cross-section ratio \(\sigma_g / \sigma_m\).

Measurement and evaluation

Natural Mo metal was irradiated for 3 minutes by neutrons produced in D + T reaction at a bombarding energy of \(E_d = 250\) keV. The beta activity of the foil was measured by an end-window GM counter. The decay curve obtained is shown in Fig. 1. By analysing the complex decay curve, components with the following half lives were obtained: 60.5 hours, 74 minutes, 15.7 minutes, 60.4 seconds.

In addition to the 15.7 minute half life (pertaining to the ground state of Mo\(^91\)), there appeared two components with half lives of 60.4 second and 74 minutes, respectively. The latter may be assigned to an Nb\(^{97}\) isotope coming from the Mo\(^{97}(n, p)\) reaction also having a gamma-decay isomeric
state with a half life of 1 minute and an energy of 750 keV, which may as well be responsible for the production of a component with a half life of 1 minute. The end-window GM counter employed has a sensitivity of 0.5 per cent for gamma particles of 750 keV. To determine unambiguously the production

\[
\frac{dN}{dt} = -\frac{1}{\tau} N(t)
\]

of Mo\(^{91m}\), the decay curve was measured by means of a gamma spectrometer in such a way that only particles over 850 keV were detected. Under such circumstances, the activity with a half life of 1 minute was also obtained, which could only be produced by the positron decay of Mo\(^{91m}\) (Fig. 2) [7]. In order to determine the Mo\(^{91}\) isomer cross-section ratio, we had to study a possible contribution of the Nb\(^{97m}\) activity to the 1-minute half-life component measured by GM counter.

\[\text{Fig. 1. The analysed complex decay curve}\]

\[\text{Fig. 2. The measured decay curve}\]