EXCITATION CURVE FOR THE REACTION $^{181}Ta(n, p)\,^{181}Hf$ IN THE 13 TO 17.5 MeV ENERGY RANGE

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The activation method was applied in measurements of cross-sections in the reactions $^{181}Ta\,(n, p)\,^{181}Hf$ in the 13 to 17.5 MeV neutron energy range. Experimental results were compared with those predicted theoretically by the statistical model. This comparison shows that the process of compound nucleus formation makes only a small contribution to the reaction in question.

1. *Introduction*

One of the most valuable sources of information about the contribution of various mechanisms to a nuclear reaction is provided by measurements of excitation curves.

In a broader study concerning the analysis of the mechanism of a reaction induced by fast neutrons in heavy nuclei [1], [2], [3], attention was turned to the reaction $^{181}Ta(n, p)$ ^{181}Hf. It seems worthwhile to compare the cross-section with the theoretical prediction made on the basis of a statistical model with careful account for the competitive processes, especially gamma-neutron competition. The region of heavy nuclei is especially poor in experimental data of this kind.

2. *The experiment*

The cross-section for the reaction $^{181}Ta\,(n, p)\,^{181}Hf$ was determined by the activation method. Neutrons of energy from 13 to 17.5 MeV were obtained from the reaction $^{3}H\,(d, n)\,^{4}He$. Deuterons were accelerated in a Van de Graaff generator. Eleven samples

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in the form of packets sandwiched between tantalum and aluminium foils were placed on a ring which had a tritium target as its centre. Irradiation lasted approximately 150 hours. The angular distribution of the neutron flux found by measuring the activity of the products from the reaction ^{27}Al (n, α) ^{24}Na and the well-known excitation curve for this reaction [4], [5], [6]. The time variations of the neutron flux were determined by monitoring recoil protons.

In order to measure the cross-section of the reaction under study, *i. e.*, ^{181}Ta (n, p) ^{181}Hf, measurements were made of the intensity of the line $E_\gamma = 482$ keV accompanying the decay of ^{181}Hf. This measurement was performed by means of a scintillation spectrometer with a $2'' \times 2''$ NaI(Tl) crystal (resolution approximately 10 percent for the ^{207}Bi line, $E_\gamma = 570$ keV). In view of the long half-lives observed ($T = 42.29$ days in the case of

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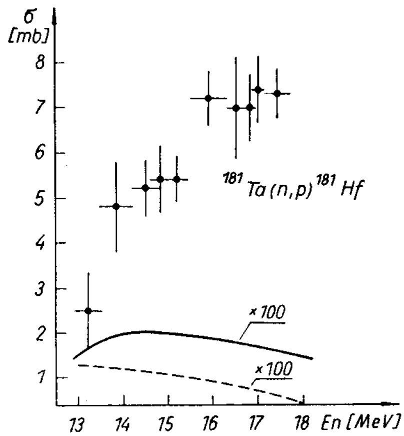

Fig. 1. The ^{181}Ta (n, p) ^{181}Hf cross-section. Solid line — theoretical predictions taking account of the gamma-neutron competition; dotted line — without the gamma, neutron competition

TABLE I

Measured cross-section

$E_n \pm \Delta E_n$[MeV]	$\sigma(n, p) \pm \Delta\sigma$[mb]	$\sigma(n, \alpha) \pm \Delta\sigma$ mb [4], [5], [6]
13.21±0.32	2.6±0.8	129±4
13.84±0.33	5.1±1.0	128±4
14.50±0.34	5.4±0.5	121±4
14.82±0.20	5.6±0.8	116±3
15.20±0.36	5.7±0.5	112±3
15.92±0.32 0.36	7.5±0.6	101±3
16.54±0.24 0.31	7.4±1.2	91±3
16.86±0.08	7.1±0.7	85±2
17.02±0.23	7.7±0.8	83±2
17.46±0.23	7.6±0.5	75±2

^{181}Hf and T = 115 days in the case of ^{182}Ta which constituted the background) the measurement lasted 120 days.

The half-lives and activities were found by the least-square method [7]. The results are presented in Fig. 1 and Table I. This is the first measured excitation curve for the reaction ^{181}Ta (n, p), ^{181}Hf. Previously, only the values of the cross-section for neutron energies of about 14 MeV were known [8].

3. *Discussion*

The theoretical values of the cross-sections of the reaction under consideration were calculated on the basis of the statistical theory of the compound nucleus.

The transmission coefficients were taken from ref. [9], while the level density was taken in the form given by Lang and Le Couteur [10] with the parameter $a = 22.5$ MeV^{-1} [11]. The moment of inertia of the nucleus assumed to be 25 percent of the moment of a nucleus regarded as a rigid body [12].

It is evident from Fig. 1 that the calculated values are two orders of magnitude smaller than the experimental values. An attempt to attain agreement with experiment by taking account of the gamma-neutron competition in the individual stages of the reaction was not successful; the theoretical cross-section increased somewhat, but not enough.

It seems, therefore, that process of compound nucleus formation makes only a small contribution to the reaction in question.

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