EXCITATION OF 3 min ACTIVITY IN ^{190}Re USING ^{190}OS (n, p) REACTION WITH 14.8 MeV NEUTRONS

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The cross-section for excitation of the 3 min ground state of ^{190}Re in (n, p) reaction on natural osmium is determined as (1.9 ± 0.3) mb at 14.8 MeV neutron energy.

1. Introduction

After irradiation of natural osmium with 14 MeV neutrons, gamma lines of 3 min half-life have been observed. They have been assigned to the decay of the ^{190}Re ground state to excited states of ^{190}Os [1]. This nucleus was a subject of considerable number of studies by neutron capture gamma-ray spectroscopy [2, 3], charged particle excitation [4], decay of the ground and isomeric states of ^{190}Ir [5] and decay of the ^{190}Re ground state created in ^{192}Os (γ, pn) photonuclear reaction [1]. The aim of the present work was to study the production of ^{190}Re in ^{190}Os (np) ^{190g}Re reaction.

2. Experimental procedure

Radioactive sources of Re were produced through the (np) reaction on natural osmium metal powder $(5g)$ of spectroscopic purity using 14.8 MeV neutrons from a neutron generator. The neutron flux varied in the sample position from $5\text{–}10^8\text{–}1.10^9$ neutrons/sec cm^2. The gamma spectrum was measured using a 5 cm^3 Ge(Li) spectrometer. In view of small intensities of gamma lines from the decay of Re, the Ge(Li) detector was shielded with

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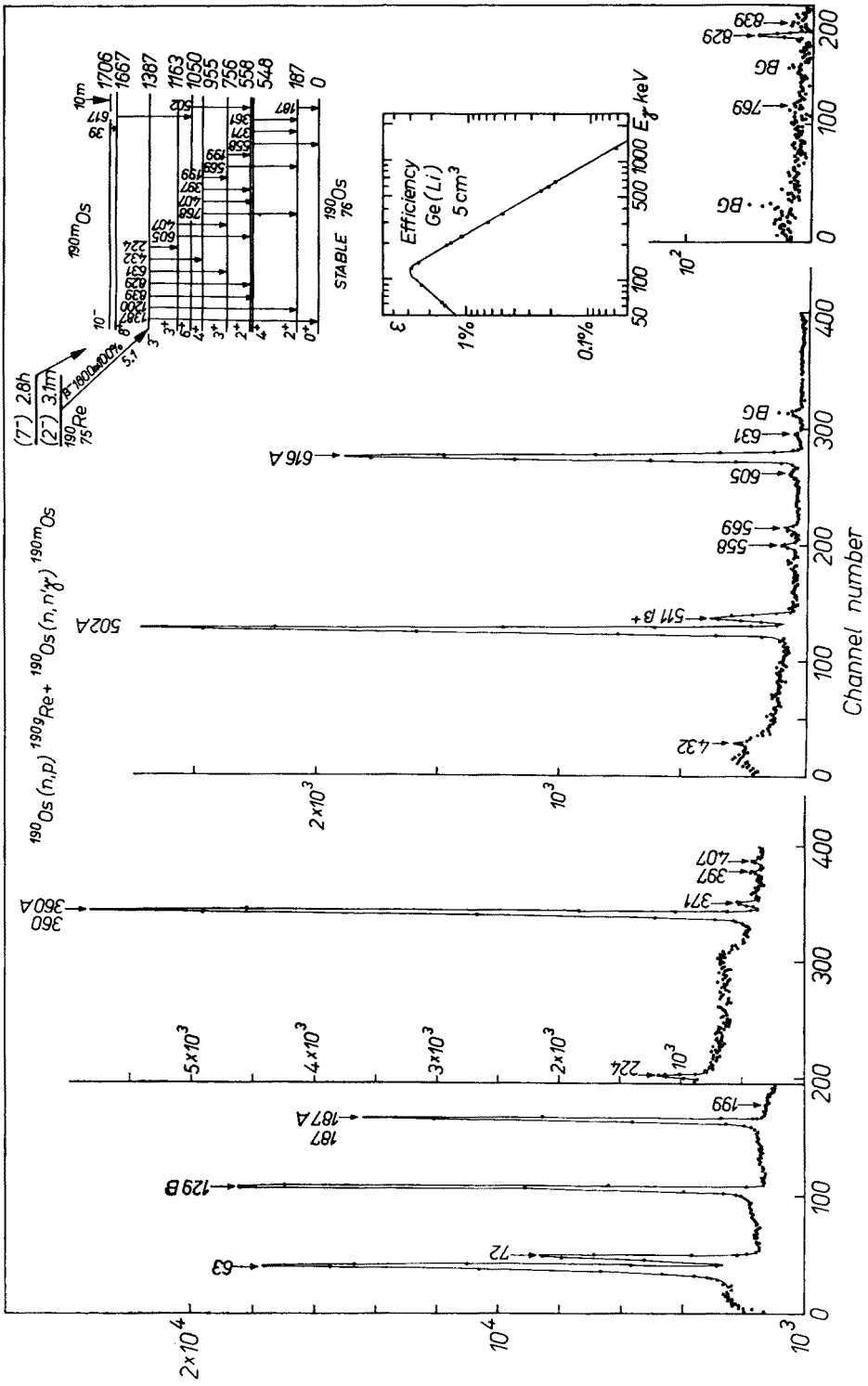

Fig. 1. Gamma-ray spectrum of the $^{190g}Re + ^{190m}Os$ source after 10 min irradiation, 1 min delay and 10 min counting periods repeated 7 times for each energy range. Energies in keV. Unlabelled: ^{190}Re transitions, A: ^{190m}Os transitions, B: ^{191}Os transitions, BG — background radiation.

15 cm Pb (Cd + Cu lined). In this experiment a cycle of 10 min irradiation, 1 min pause to avoid the 6 sec ^{192}Re activity from ^{192}Os (np) ^{192}Re reaction and 10 min counting period was applied.

3. *Results and discussion*

The measured gamma spectrum of ^{190g}Re + ^{190m}Os is shown in Fig. 1. The energy values and intensities of gamma lines from the decay of ^{190g}Re are in good agreement with the results of Haustein and Voigt [1]. These authors show that one particular level 3$^-$ in ^{190}Os at 1387 keV is populated in $\approx 100\%$ beta decay branch. Besides the gamma lines from the decay of ^{190g}Re, lines belonging to the 10 min isomer in ^{190}Os are prominent. This fact allows us to determine the ^{190}Os (np) ^{190g}Re reaction cross-section relative to the ^{190}Os ($nn'\gamma$) ^{190m}Os reaction by comparing the intensities of the neighbouring lines in the spectrum belonging to Re and Os respectively. The conversion coefficients and branching ratios were taken from Refs [1, 5]. Using the ^{190}Os ($nn'\gamma$) ^{190m}Os reaction cross-section as the internal monitor with $\sigma = 15 \pm 1.5$ mb [6], the cross-section of the ^{190}Os (np)^{190g}Re reaction was found to be $\sigma = 1.9 \pm 0.3$ mb.

Attempts were made to produce the 2.8 h activity reported by Baro *et al.* [7] and Aten and de Feyfer [8] and ascribed to the isomer of ^{190m}Re. Our results confirm the existence of a few lines with similar half-life. The half-life of the strongest line of energy 187 keV was found to be $T_{1/2} = 3 \pm 0.5$ h.

The error in the determination of the cross-section for ^{190}Os (np) ^{190g}Re reaction is the root-mean-square error and arises from statistical and systematic errors using the propagation law. The statistics of the peaks for monitoring reaction ^{190}Os ($n, n'\gamma$) ^{190m}Os was high. For ^{190}Os (np) ^{190}Re reaction the statistics of the observed peaks is poor and was within 10%. The correction of the cross-section for ^{190}Os (np) ^{190g}Re reaction for the decay of 2.8 h isomeric state in ^{190m}Re was found to be negligible in comparison with the other sources of errors and therefore was neglected.

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