

A study of reactions with the emission of charged particles at $E_{\max} = 55$ MeV on natural tantalum and tungsten targets

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A research of the cross-sections and level filling yields of high-spin isomeric states in reactions with the emission of charged particles allows one to obtain diverse information both about the structure of excited levels in the continuous and discrete regions of excitation and about the mechanisms of nuclear reactions. Therefore, the aim of our work is to study the production yields of ^{178m}Ta , ^{180m}Hf , and ^{182m}Hf isomers in reactions with bremsstrahlung with energies exceeding the giant dipole resonance energy.

The weighted average yields were measured by the activation method using bremsstrahlung of electrons with a 55 MeV maximum energy and natural tantalum and tungsten targets.

The spectra of irradiated targets were measured by Canberra and Ortec gamma spectrometers with ultra-pure semiconductor detectors with a (15–40)% detection efficiency compared to a $3' \times 3''$ NaI(Tl) detector. The energy resolution of the spectrometers was 1.8–2.0 keV on the 1332 keV ^{60}Co γ -line.

In the studied spectra, γ transitions from the decay of $^{178m,g}\text{Ta}$, ^{180m}Hf , ^{182m}Hf , and ^{185}Ta are reliably identified.

For the first time, the weighted average filling level yields of ^{182m}Hf in the $^{186}\text{W}(\gamma, \alpha)^{182m}\text{Hf}$ -reaction and of ^{180m}Hf in the $^{184}\text{W}(\gamma, \alpha)^{180m}\text{Hf}$ -reaction were measured at a 55 MeV maximum energy of bremsstrahlung gamma quanta.

The bremsstrahlung simulation was carried out with the Geant4 software code.

The following weighted average yields were obtained: for $^{181}\text{Ta}(\gamma, 3n)^{178g}\text{Ta}$ -reaction $-1.6(1)$ mbn, for $^{181}\text{Ta}(\gamma, 3n)^{178m}\text{Ta}$ -reaction $-420(25)$ mbn, for $^{186}\text{W}(\gamma, \alpha)^{182m}\text{Hf}$ -reaction $-3.5(8)$ μbn , for $^{184}\text{W}(\gamma, \alpha)^{180m}\text{Hf}$ reaction $-3.6(2)$ μbn , for $^{181}\text{Ta}(\gamma, p)^{180m}\text{Hf}$ reaction $-36(4)$ μbn and for $^{186}\text{W}(\gamma, p)^{185}\text{Ta}$ - reaction $-660(30)$ μbn . With such energy of bremsstrahlung, the isomeric yield ratio for the reaction $^{181}\text{Ta}(\gamma, 3n)^{178m,g}\text{Ta}$ is $Y_m/Y_g = 0.26(3)$. It was measured for the first time.

According to the modeling results, within the TALYS-1.9 and EMPIRE-3.2 program codes, non-statistical processes dominate.

A discussion of the findings is ongoing.

Primary author: Prof. ZHELTONOZHISKY, Viktor (Lomonosov Moscow State University)

Co-authors: ZHELTONOZHISKAYA, Marina (Lomonosov Moscow State University); Dr SAVRASOV, Andrey (Institute for Nuclear Researches National Academy of Science of Ukraine); Prof. CHERNYAEV, Alexander (Moscow State University)

Presenter: Prof. ZHELTONOZHISKY, Viktor (Lomonosov Moscow State University)

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