Photoneutron cross sections on naturally present osmium isotopes

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The paper considers several practically important nuclear properties of the naturally-present isotopes of osmium, i. e., cross sections and yields of photon-triggered nuclear reactions in the energy range of the giant dipole resonance. Due to the ubiquitous nature of gamma-rays the photonuclear reactions play an important role in most nuclear processes and applications. We briefly review the available experimental measurements of photonuclear cross sections on the isotopes of osmium. Direct measurements of the cross sections had been made using quasimonochromatic annihilation [1] and laser-Compton scattered photons [2] and also bremsstrahlung was used in [3] to obtain the cross sections in an indirect fashion by solving the arising inverse problem by an unfolding procedure.

Results of an activation technique-based experiment are reported. The 70-MeV microtron of the SINP MSU was used to generate bremsstrahlung beam and irradiatie the osmium target. After the irradiation the activated nuclear reaction products were identified in the gamma-ray spectra and the yields of the corresponding photonuclear reactions were obtained. The yields of the following reactions were measured: ^{184,186,192}Os (γ, 1n), ^{182}Os(γ, 2n), ^{184}Os(γ, 3n), ^{187,189,190}Os(γ, 1p), ^{186,192}Os(γ, 1n1p), and ^{189}Os(γ, 2p). A first attempt of experimental analysis of reactions with outgoing protons has been made.

It had been observed previously that experimentally measured cross sections of photodisintegration often contain large systematic errors that can not be easily accounted for [4]. This, and also unavailability of experimental cross sections leads to a very widespread use of theoretical models for calculation of the photonuclear cross sections. We review the most popular approaches in this field and compare the model calculations with the experimental results.

Based on the technique described in detail in [4] we evaluate partial photoneutron reaction cross sections $\sigma(\gamma, 1n)$, $\sigma(\gamma, 2n)$, $\sigma(\gamma, 3n)$ on naturally-present osmium isotopes. Reliability criteria are used to estimate the proportion of incorrectly assigned outgoing neutrons in available experimental cross sections. We use the combined model of photonuclear reactions [5] to produce evaluated cross sections of partial photoneutron reactions.

We discuss the obtained results in connection with the shell structure of the osmium isotopes. As with other heavy nuclei in this region the osmium isotopes reveal a triaxial structure which influences the strength of electromagnetic transitions and thus the probability of photon interactions. Astrophysical aspects of ^{184}Os production in the p-process are considered.

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