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Evaluation of Photonuclear Reaction Data 209Bi at 13 and 17 MeV photon energy

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Photonuclear reaction cross-section data are essential for electron accelerator shielding design and possibly nuclear transmutation. So far, photonuclear cross-sections of various target materials have been evaluated up to a photon energy of 200 MeV within the nuclear data libraries, such as JENDL-5 [1]. Almost all data in JENDL-5 have been evaluated based on the experimental reaction cross-section data. However, the evaluations using to the reaction cross-section data are inadequate to provide all information about the emitted secondary particles, for instance, their energy distributions. Recently, the photoneutron energy spectra on the medium and heavy targets at 13 and 17 MeV photon energies have been measured [2–4]. The 13 and 17 MeV photon beams are nearly monoenergetic and have high intensity. Among the data given in [2–4], ^{209}Bi is one of monoisotopic elements with the available data at both 13 and 17 MeV photon energies, we evaluated the photonuclear data of this target based on the reaction cross-section data by I. Gheorghe \textit{et al}. [5], and the measured photoneutron energy spectra in [2–3]. The evaluation procedure was conducted on the CCONE code system [6]. The photo-absorption cross-sections were evaluated with the giant dipole resonance (GDR) and quasi-deuteron (QD) models. The emission of photoneutrons is described by the exciton model for the preequilibrium process and the statistical model for the compound process. The photoneutron energy spectra have been compared to the experimental data [2–3] to find the connection between the theoretical reaction models and experiment. An adjustment of the multiplying factor for the single neutron average density in the exciton model was made to improve the energy distribution calculations. For 13 MeV photon energy, this evaluation by CCONE code can reach the measured data well. In contrast, the underestimate to the experimental data is still observed for 17 MeV photon energy when the preequilibrium photoneutrons increase.

References

[1] O. Iwamoto, N. Iwamoto, S. Kunieda, \textit{et al}., “Japanese evaluated nuclear data library version 5: JENDL-5”, J. Nucl. Sci. Technol., 60(1), (2023), pp. 1-60.

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