Erratum: Photoneutron cross-section measurements in the $^{209}\text{Bi}(\gamma, xn)$ reaction with a new method of direct neutron-multiplicity sorting [Phys. Rev. C **96**, 044604 (2017)]

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We found it necessary to take into account the effect of the electromagnetic interaction (pair production, Compton scattering, and photoelectric absorption) of high-energy γ -ray beams in the thick (7-mm or 10-mm) ^{209}Bi target material on (γ, xn) cross sections reported in the original paper. The interaction produces secondary γ rays, which can induce the giant dipole resonance most effectively in the peak (≈ 13 MeV) region governed by the (γ, n) channel. Thus, the secondary γ rays produce extra neutrons which we previously assigned to reaction neutrons of the (γ, n) channel associated with the primary γ rays. We have corrected the (γ, xn) cross section by means of a GEANT4 [35] simulation. As a result, the (γ, n) cross section is significantly reduced above 30 MeV, whereas the (γ, xn) cross section with $x = 2-4$ remains the same. In this Erratum, we revise the neutron yield cross section in Fig. 9, total photoneutron cross section in Fig. 11, and partial cross sections in Fig. 12. It is to be noted that we have improved the procedure of unfolding photoneutron cross sections from their integration over the energy spread of the γ -ray beam [60]. Here, we present cross sections as a function of the peak energy of the γ -ray beam instead of the average energy.

The revised cross sections are compared with the model calculation based on the Hartree-Fock-Bogolyubov plus the quasiparticle random-phase approximation using the Gogny D1M interaction. As shown in Fig. 11, the asymptotic value of the total cross section is reproduced by the default preequilibrium calculation with an ordinary value ($L = 6.5$) of the Levinger parameter for the quasideuteron contribution. Previously, we discussed the large cross section at the high energies in terms of an increase of the L value and the surface effect. With the corrected cross sections, however, there is no need to require a large value of $L = 20$ nor to invoke the surface effect anymore. One can see an extra bump around 26 MeV in the total cross section that is attributed to the (γ, n) channel as seen in Fig. 12. We are unable to reproduce at this stage such a structure nor some scatter observed in the (γ, n) cross section at the highest energies, in particular, the 12-mb cross section at 37.4 MeV.

FIG. 9. Comparison between present data and existing positron in flight annihilation [29,30] and bremsstrahlung [31] data on the neutron yield cross-section $\sigma(\gamma, Sn) = \sum_{x=1}^4 x\sigma(\gamma, xn)$.

FIG. 11. Comparison of our total experimental cross-section $\sigma(\gamma, \text{tot}) = \sum_{x=1}^4 \sigma(\gamma, xn)$ with previous measurements [30] and with the TALYS predictions for two values of the Levinger parameter $L = 6.5$ (solid line) and $L = 20$ (dashed line).

FIG. 12. Comparison of the experimental partial cross-section $\sigma(\gamma, xn)$ ($x = 1-4$) with the TALYS calculation obtained with the default preequilibrium parametrization (solid lines), the modified parameter $L = 20$ but no surface effects (dashed lines), and $L = 20$ with surface effects ($E_{\text{surf}} = 1$ MeV) (dotted lines).

FIG. 13. Comparison of the experimental average energy of the emitted neutrons $\langle E_n \rangle$ as a function of the photon energy with the TALYS estimates obtained with different nuclear level-density descriptions [56–59] of the low-lying states in ^{208}Bi . The dotted black curve referred to as “Maximum” corresponds to the emission of neutrons directly and uniquely to the ground state of ^{208}Bi .

Finally, we revise the TALYS calculation of the average neutron kinetic energy in Fig. 13 by correcting for the contribution of the low-lying discrete levels in ^{208}Bi neglected in the original paper. The Hauser-Feshbach average neutron energy now rises from the neutron threshold at 7.46 MeV but, above 8 MeV, remains lower than experimental data that are indicative of a dominating decay to the ^{208}Bi ground state. The conclusion is unchanged; the large average neutron energy measured is underestimated by statistical model calculations.

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