Brief Reports

Brief Reports are short papers which report on completed research or are addenda to papers previously published in the **Physical Review**. *A Brief Report may be no longer than $3\frac{1}{2}$ printed pages and must be accompanied by an abstract.*

Absolute photoneutron cross section of ^{127}I

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The reaction cross section of ^{127}I(γ,xn) has been measured from 8 to 23 MeV. The reported measurement is discussed with particular reference to the differing results obtained at Saclay and Lawrence Livermore National Laboratory, and reconciles the differences.

The systematic behavior of integrated photoneutron cross sections for nuclei with $A>100$ has been studied by various laboratories over the years. In particular, studies using quasimonoenergetic photons have been made at the Lawrence Livermore National Laboratory (LLNL) and at the Centre d'Etudes Nucleaire de Saclay (Saclay); a compilation of these results can be found in Ref. 1. In some cases, the results obtained at these laboratories have been at variance. In an effort to resolve the discrepancies, Berman *et al.*[2] reported new measurements of several of these photoneutron cross sections.

In general the differences were resolved, but the paper pointed to a real and significant disagreement in both the shape and absolute magnitude of the ^{127}I photoneutron cross section as reported previously by LLNL (Ref. 3) and Saclay (Ref. 4). One recommendation of Ref. 2 was that the LLNL data for ^{127}I should not be used, and that the best representation of the ^{127}I(γ,sn) cross section is the Saclay measurement normalized by a factor of 0.80.

We have recently made an independent measurement of the ^{127}I(γ,xn) cross section using the 35 MeV betatron in this laboratory. The yield of neutrons from a 103-gram sample of solid iodine, placed at the center of a Halpern-type detector, was determined from the number of neutrons detected for a measured bremsstrahlung dose. The dose was measured using a thin-walled transmission chamber, which was accurately calibrated against a standard $P2$ ionization chamber. The efficiency of the neutron detector, which was determined using calibrated neutron sources and confirmed from a measurement of the ^{2}H(γ,n) reaction,[5] was 0.14 ± 0.01 for neutrons with energies ranging from 0.5 to 8 MeV. A total of five yield curves was measured with the sample in the beam, at bremsstrahlung energies ranging from 8 to 25 MeV in 200 keV intervals, from which an average yield curve was determined. A procedure similar to that described above was used to determine an average background yield curve with no sample present. This was small, amounting to 0.02% of the target-in yield at 15 MeV and rising to 0.4% at 28 MeV. The count rate during the experiment was maintained at a level which ensured that dead-time corrections were less than 5%. After making corrections for these effects and allowing for other sample parameters, an absolute yield curve was obtained, which was unfolded using the Variable Bin Penfold Leiss (VBPL) method[6] to give the ^{127}I(γ,xn) cross section. This cross section is the sum of the (γ,n) cross section plus two times the contribution of the $(\gamma,2n)$ cross section. In order to obtain the ^{127}I(γ,sn) cross section for comparison with the measurements from LLNL and Saclay, allowance for the ^{127}I$(\gamma,2n)$ cross section must be made. This was done on the basis of a statistical decay model which has been well tested for medium to heavy nuclei.[7]

Figure 1 shows the final ^{127}I(γ,sn) cross section together with the estimated ^{127}I$(\gamma,2n)$ cross section. The error bars are statistical, and there is an overall systematic uncertainty of 7% due primarily to the uncertainty in the efficiency of the neutron detector. The shape of the cross

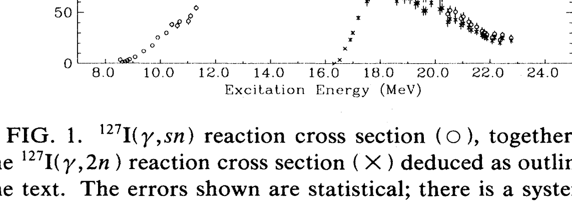

FIG. 1. ^{127}I(γ,sn) reaction cross section (○), together with the ^{127}I$(\gamma,2n)$ reaction cross section (×) deduced as outlined in the text. The errors shown are statistical; there is a systematic uncertainly of 7% associated with the absolute scale.

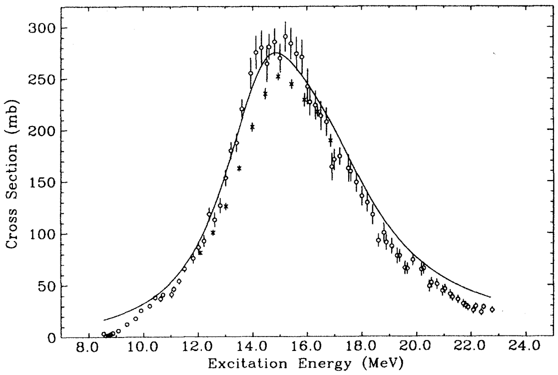

FIG. 2. Comparison of various measurements of the ^{127}I(γ,sn) reaction cross section: (a) present data - (○); (b) data from Ref. 2 - (×); (c) two-Lorentz curve fit to the data from Saclay (Ref. 4) scaled by a factor of 0.9.

section reported here is in very good agreement with that of Saclay,[4] although the magnitude is generally about 10% lower. The cross section as measured at LLNL,[2] although agreeing in shape, is lower in magnitude than both of these results. A two-Lorentz curve fit to the Saclay data (see Table 1 of Ref. 1) gives a peak cross section value of 307 mb, compared to a value of 280 mb for the present measurement. On the other hand, the peak cross section from the LLNL result[2] is only 252 mb. One should note that the peak magnitude of the ^{127}I(γ,n) cross sections is unaffected by any contribution from the (γ,2n) cross section, since the threshold for this reaction occurs at 16.2 MeV, above the peak of the (γ,sn) cross section.

It is difficult to offer an explanation for the discrepancy with the ^{127}I(γ,sn) cross section recently published by Berman *et al.*[2] This measurement was performed using a comparative method, where a number of photonuclear reaction cross sections were measured, together with that of ^{141}Pr, which was used as a benchmark. The peak values of the ^{141}Pr(γ,sn) cross section, as measured on six previous occasions at four different laboratories (see Ref. 2 for details), are in agreement to within 10%. It should be noted that this range, obtained by direct comparison of the published cross sections, is more realistic than the range of 2–3 % quoted in Ref. 2, where comparisons of Lorentz parameters were used (see Table II of Ref. 2). With this in mind, it should be expected that the ^{127}I(γ,sn) cross sections reported there would lie within a similar 10% range. Taking the upper extreme of this limit would give a peak cross section of 277 mb for the recent measurement,[2] which is consistent with the data presented here.

This measurement confirms some of the conclusions of Ref. 2—that the shape of the ^{127}I photoneutron cross section is best represented by the Saclay measurement, and that the absolute magnitude of the Saclay measurement should be decreased. However, the size of the correction needed appears to be too large. We suggest that a factor of about 0.9 rather than 0.8 would be more appropriate. Figure 2 shows the present data together with a two-Lorentz curve fit to the Saclay result after multiplying it by a factor of 0.9; agreement with the present data is quite satisfactory. The data from the recent LLNL paper is also shown in Fig. 2.

We note in passing the case of the ^{89}Y(γ,n) cross section, where the suggested normalization factor (according to Ref. 2) to bring the Saclay data into agreement with LLNL is 0.82. However, a measurement of this cross section at Illinois,[8] where one of the ^{141}Pr benchmark measurements was also done, gives a peak value for the ^{89}Y(γ,n) cross section, which is intermediate between the LLNL (Ref. 9) and Saclay (Ref. 10) results. Indeed a normalization factor of 0.9 in this case, as for ^{127}I, might be more appropriate, since it would result in good agreement between the Saclay and Illinois results for ^{89}Y(γ,n) and bring about consistency between all three measurements within the experimental uncertainties. In general, it may be that the suggested corrections to the Saclay data reported in Ref. 2 may be too large by as much as 10%.

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