Evaluation of Activation Cross Sections for (n,2n) and (n,γ) Reactions on $^{63, 65, Nat}Cu$

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Introduction

Copper is a very important structure material in nuclear fusion engineering. The neutron activation cross section are very useful in fusion research and other applications such as radiation safety, environmental, material damage and neutron dosimetry. More efforts are required to identify and resolve the differences and discrepancies in the existing activation cross sections from different laboratories.

The natural copper consists of two stable isotopes, i.e. ^{63}Cu, ^{65}Cu. The reaction *Q*-Values and abundances are listed in Table 1.

Table 1 Isotopic reaction Q-values and abundances

isotope	*Q*-Value/MeV(n,2n)	*Q*-Value/MeV(n,γ)	abun./%
63	10.854	7.916	69.17
65	9.9047	7.067	30.83

The cross sections of (n,2n) and (n,γ) for $^{63,65,Nat}Cu$ are recommended based on the latest experimentally measured data and theoretically calculated results[1] from threshold up to 20 MeV. The evaluated cross sections are given in Figs. 1~6 with experimental data and compared with other evaluated data. The present work was done for CENDL-3.

1 ^{63}Cu (n,2n) ^{62}Cu Reaction

For (n,2n) reaction, the experimental data were measured by Gruzdevich(93), Mclane(88), Ghanbari(86), Ryves(78), Majumder(77), Jarjis(78), Mogharrab(72), Andreev(68), Bardolle(65), Rayburn(63), Koehler(62), Glover and Fowler(50)[2~14] in the energy range from threshold up to 20.0 MeV, respectively. The evaluated data

were obtained by fitting experimental data from threshold energy to 20.0 MeV. The comparison of experimental data with evaluated ones is shown in Fig. 1.

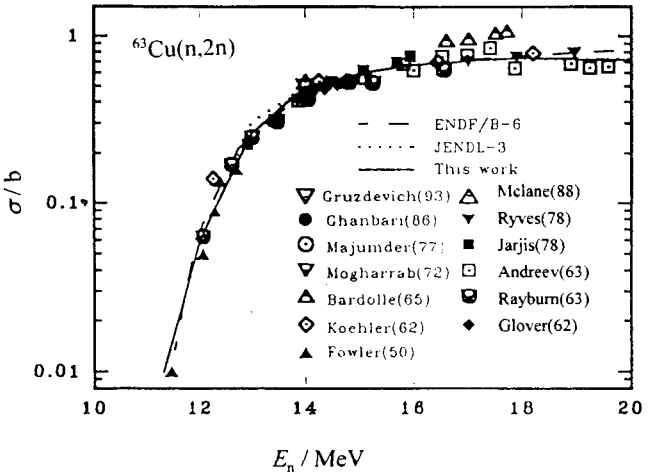

Fig. 1 ^{63}Cu (n,2n) cross section

2 ^{65}Cu (n,2n) ^{64}Cu Reaction

The experimental data were measured by Molla(94), Ghanbari(86), Winkler(83), Csikai(82), Ryves(78), Mannhart(75), Araminowicz(73), Robertson(73), Mogharrab(72), Qaim(72), Santry(65) and Prestwood(61)[14,15~25] from 10 to 20 MeV, respectively. The evaluated data were obtained by fitting experimental data from threshold energy to 20 MeV. The evaluated results are shown in Fig. 2.

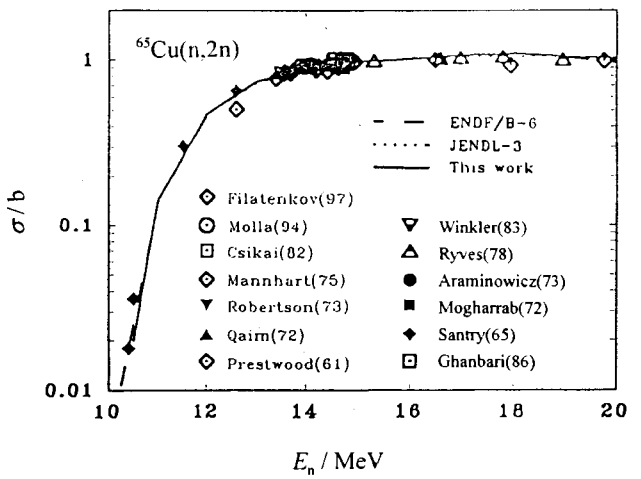

Fig. 2 ^{65}Cu (n,2n) cross section

3 ^{63}Cu (n, γ) ^{64}Cu Reaction

The experimental data were measured by Voignier(86), Diksic(70), Tolstikov(66), Zaikin(68), Perkin(58) and Xia Yijun(98)[26~31] from 0.1 MeV to 14.5 MeV. The evaluated data were obtained by fitting experimental data from 0.1 to 14.5 MeV. The recommended data were taken from calculated result, and normalized to the fitting experimental datum of 2.52 mb at 14.5 MeV. The comparison of experimental data with evaluated ones is shown in Fig. 4.

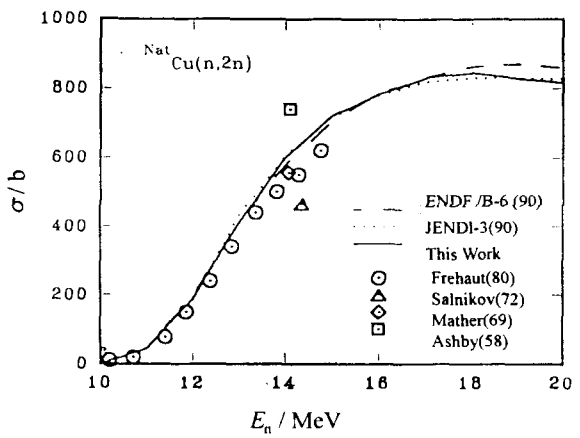

Fig. 3 ^{Nat}Cu (n,2n) cross section

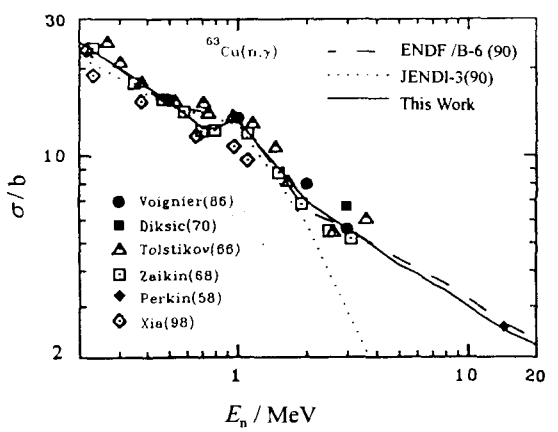

Fig. 4 ^{63}Cu (n,γ) cross section

4 ^{65}Cu (n, γ) ^{66}Cu Reaction

The experimental data were measured by Mclane(88), Voignier(86), Zaikin(68), Colditz(68), Peto(67), Tolstikov(64), Stavisskii(61), Lyon(59)[3,27,29,30,32~35] and Johnsrud(59)[36] from 0.1 to 14.5 MeV. The evaluated data were obtained by fitting

experimental data from 0.1 to 14.0 MeV. Above 14 MeV, the recommended data were taken from calculated result, and normalized to the fitting experimental datum of 0.47 mb at 14.0 MeV. The comparison of experimental data with evaluated ones is shown in Fig. 5.

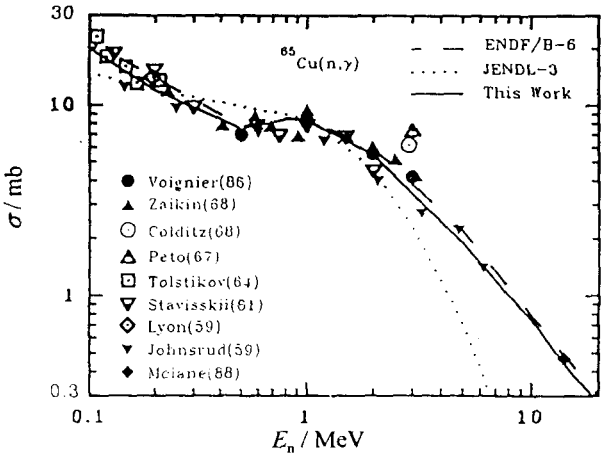

Fig. 5 ^{65}Cu (n,γ) cross section

5 The (n,2n) and (n, γ) Reaction for Natural Copper

For (n,2n) reaction, the experimental data were measured by Frehaut(80), Salnikov(72), Mather(69) and Ashby(59)[37~40] from 10.19 to 14.76 MeV. For (n,γ) reaction, the experimental data were measured by Voignier(86), Diven(60) and Stavisskij(63)[27,41~42] from 0.1 to 3.0 MeV. The recommended data were obtained from summing the isotopic data weighted by the abundance. The comparison of present evaluated data with experimental data and other evaluated data is shown in Fig. 3, 6.

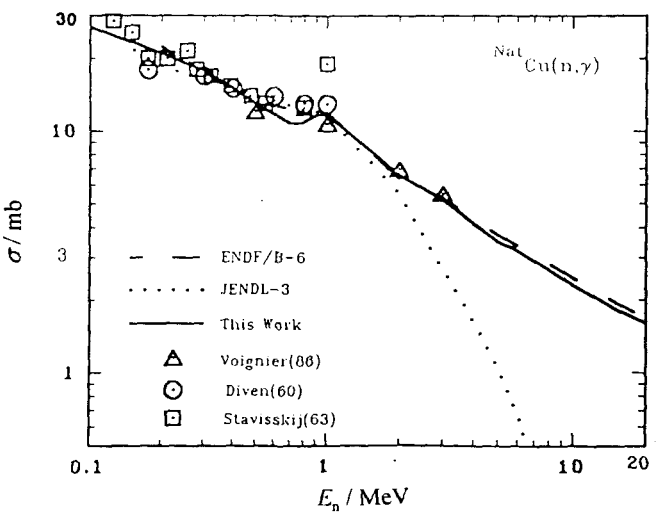

Fig. 6 ^{Nat}Cu (n,γ) cross section

6 Summary

^{63,65,Nat}Cu (n,2n) and (n,γ) cross sections were evaluated and compared with ENDF/B-6 and JEENDL-3. The recommended data could reproduce experimental data very well.

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Evaluation of Neutron Cross Sections for ^{115}In

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Introduction

This is a new evaluation for neutron cross sections of ^{115}In. The experimental data mainly taken from EXFOR, and the recommended data are compared with ENDF/B-6, JENDL-3.2 and JEF-2.

1 Total Cross Section

There are only two experimental data at one energy point[1,2] for ^{115}In. The experiment data[3~14] for natural In were taken to evaluate the total cross section for ^{115}In(Fig. 1).