Nuclear Data for Science and Technology (1988 MITO), 315- 318, Copyright © 1988 JAERI.

NEUTRON ACTIVATION CROSS SECTIONS MEASUREMENTS IN FUDAN UNIVERSITY

Wu Zhihua, Wu Songmao, Xu Zhizheng, Song Linggen
You Junsheng, Li Jianwei and Ding Meisong

Department of Nuclear Science,
Fudan University, Shanghai, China

Abstract: Activation cross section is important for the application of nuclear physics and technology. We have measured some neutron cross sections by using the method of activation. They are $^{87}Sr(n,n')^{87m}Sr$, $^{115}In(n,2n)^{114m}In$, $^{113}In(n,2n)^{112m}In$ and $^{103}Rh(n,n')^{103m}Rh$.

(neutron cross section, activation, experimental result, fast neutron, neutron flux)

Neutron sources and flux measurements

Monoenergetic neutrons are produced by nuclear reactions. Deutrons are accerelated in our 3 MeV Van der Graaff machine. Targets are TiT or TiD. Therefore, we can obtain monoenergetic neutron in the range from 15-18 MeV or 2-6 MeV accordingly. Proton beam and TiT target are used to produce the neutrons with the energy lower than 2 MeV.

Neutron flux is measured by means of recoil proton telescope with semiconductor detector. A BF_3 long counter located 3 meters away from target at 45 degree with beam direction was used as neutron monitor.

Neutron energy and energy spread are calculated according to reaction kinematics, thickness of target, solid angle sustained by sample to target and the angle of sample related to beam direction. In our cases, energy spread is about tens of KeV to hundreds of KeV. Beam energy is calibrated with the reaction $^{7}Li(p,n)^{7}Be$ and resornance reaction $^{27}Al(p,r)^{28}Si$. Beam current is about 5-10 microampere. Targets were cooled with water or pressured air jet.

Sample

In and Rh are natural metal films. Their element purity was checked with PIXE method and was found 99.90% for In and 99.28% for Rh. No serious impurity could affect our measurements. ^{87}Sr is isotope pure which was provided by Institute of Atomic Energy in Beijing. It contain 52.64% of ^{87}Sr. We weighed the sample using analytical balance and pressed the powder into a pellet. The size of sample is listed in table 1.

Table 1

Chemical contain	Thickness mg/cm^2	Diameter mm
$Sr(NO_3)_2$	21.03--126.3	11.0
In	300 --500	20.0-30.0
Rh	62.86	10.8

The sample is hung upon a special shelf which can be adjusted so that we can set the centre coincidence with the beam direction easily.

Measurement of activation

According to decay mode we select different radiation to measure. The energies and detectors used are listed in table 2 in detail.

Table 2

Nuclide	Radiation	Energy(KeV)	Detector
^{87m}Sr	gamma	388	3" NaI
^{114m}In	gamma	190	Ge(Li)
^{112m}In	gamma	156	Ge(Li)
^{114m}In	Ka X	24.1	Si(Li)
^{103m}Rh	Ka X	20.17	Si(Li),NaI
^{103m}Rh	Kb X	22.7	Si(Li),NaI

The efficiency of the standard 3"NaI detector was evaluated by calculation. The efficiency of the other detectors was calibrated with a set of standard sources. When the efficiency was calibrated, special attention had been paid to corrections, such as air absorption, window absorption, multigamma sum effect, solid angle correction and others.

Result and discussion

1. As regards $^{87}Sr(n,n')^{87m}Sr$ cross section, Temerley's data/3/ were the only evidence published prior to our experimental result. Futhermore, our experiment has compensated for the lack of data in the range from 1 MeV to 5 MeV, all the data/1/ are illustrated in Fig. 1.

2. Having analysed and checked with the $^{115}In(n,2n)^{114m}In$ cross sections altogether, we found that the spread between the results is relevant to the measurement method of neutron flux. When Fe or Al was used as a standard sample, it was discovered that the smaller result is for Fe and the bigger result is for Al. On the other hand, when the associated particle method was used as an absolute measurement of neutron flux, the final result is deviant to bigger, while the telescope method was used to flux measurement, the result remains in the middle.

We used three different methods of measurement at the same energy point, 15.754 MeV, in $^{115}In(n,2n)^{114m}In$ cross section measurement/4/. The results are given in table 3.

Table 3

Method	Cross section (mb)
Fe	1293 ± 52
Al	1349 ± 62
telescope	1345 ± 108

It is proved that the systematic deviations still exist. In order to find the reason for the spread between the data, it is valuable to measure activation cross section with better precision.

3. In order to determine the ^{103}Rh cross section, it's necessary to measure the intensity of low energy X radiation. Since the absolute measurement of X ray detector efficiency curve is still not accurate enough, the data in Fig. 4 are presented as tentative and preliminary.

REFERENCES

1. Song Linggen et al.: Chinese Journal of Nuclear Physics 7, 58(1985)
2. K.Z.Xie et al.: Jour. of Applied Science(Chinese) 3, 341(1985)
3. L.K.Temperley et al.: Nucl. Sci. Eng. 32, 195(1961)
4. J.W.Li et al.: Chinese Journal of Nuclear Physics, to be published.
5. R.J.Prestwood et al.: Phys. Rev. 121, 1438(1961)
6. H.O.Menlove et al.: Phys. Rev. 163, 1308(1967)
7. P.Decowski et al.: Nucl. Phys. A204, 121(1973)
8. E.Holub et al.: J.Phys. G2, 405(1976)
9. A.Reggoug et al.: N.I.M. 227, 249 (1984)
10. A. Paulsen et al.: Nucl. Sci. Eng. 76, 331(1980)
11. D.C.Santry et al.: Can. J. Phys. 52, 1421(1974)
12. L.Kimura et al.: J.Nucl. Sci. Technol. 6, 485(1969)

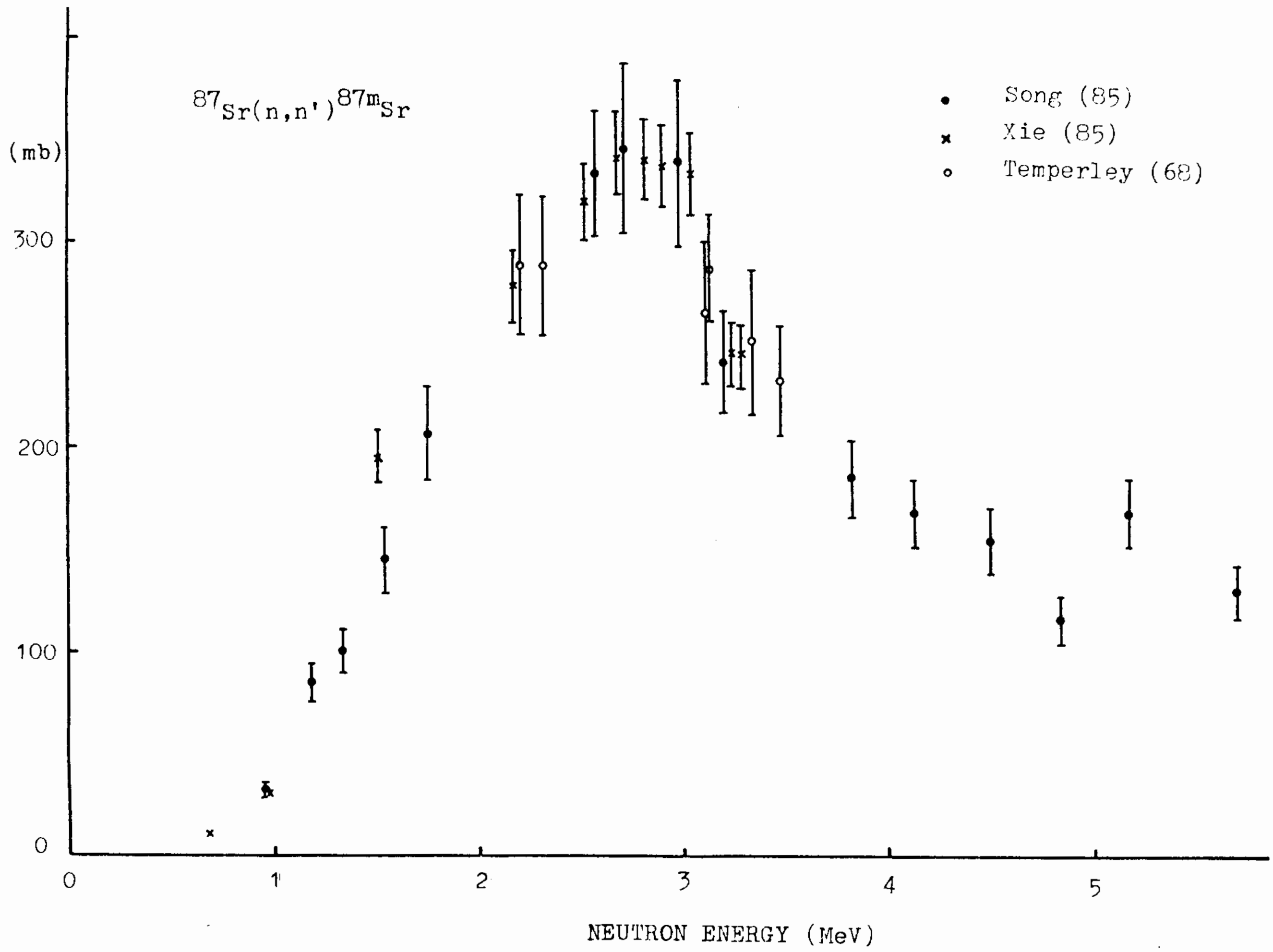

Fig. 1 $^{87}Sr(n,n')^{87m}Sr$ cross section

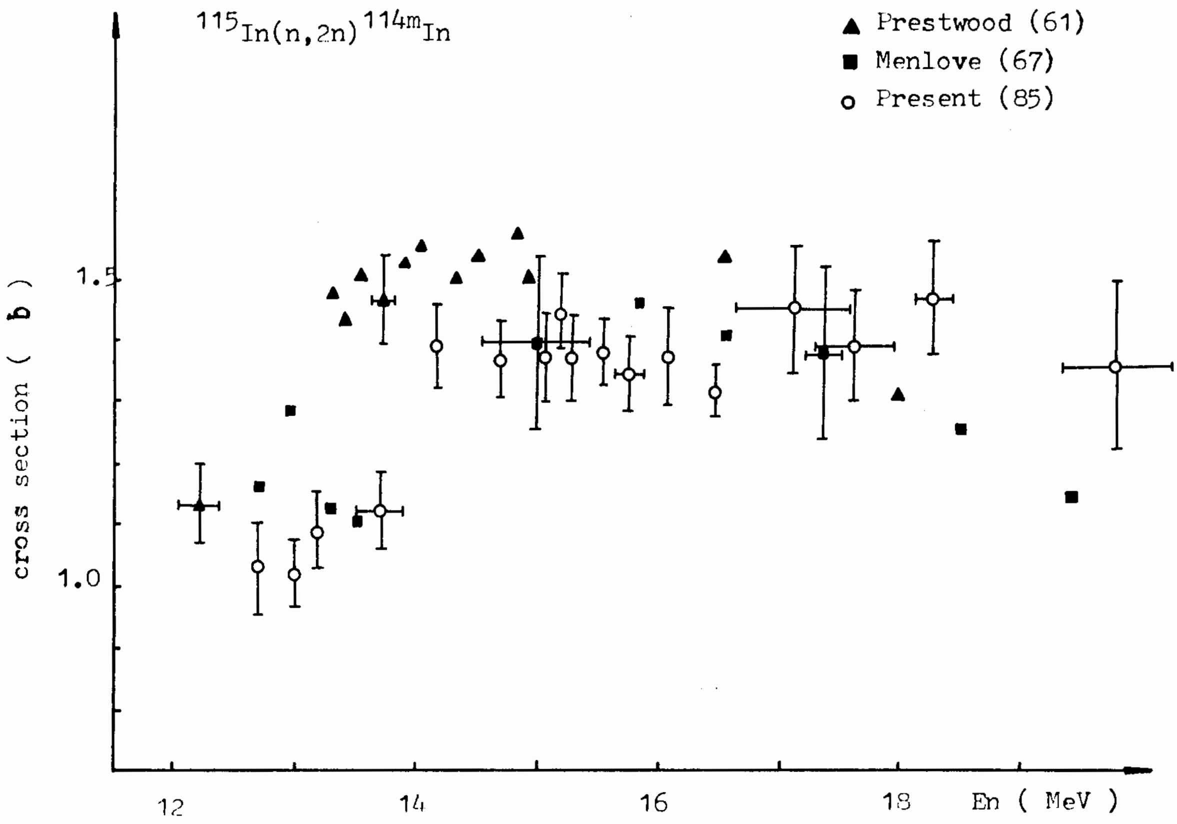

Fig. 2 $^{115}In(n,2n)^{114m}In$ cross section

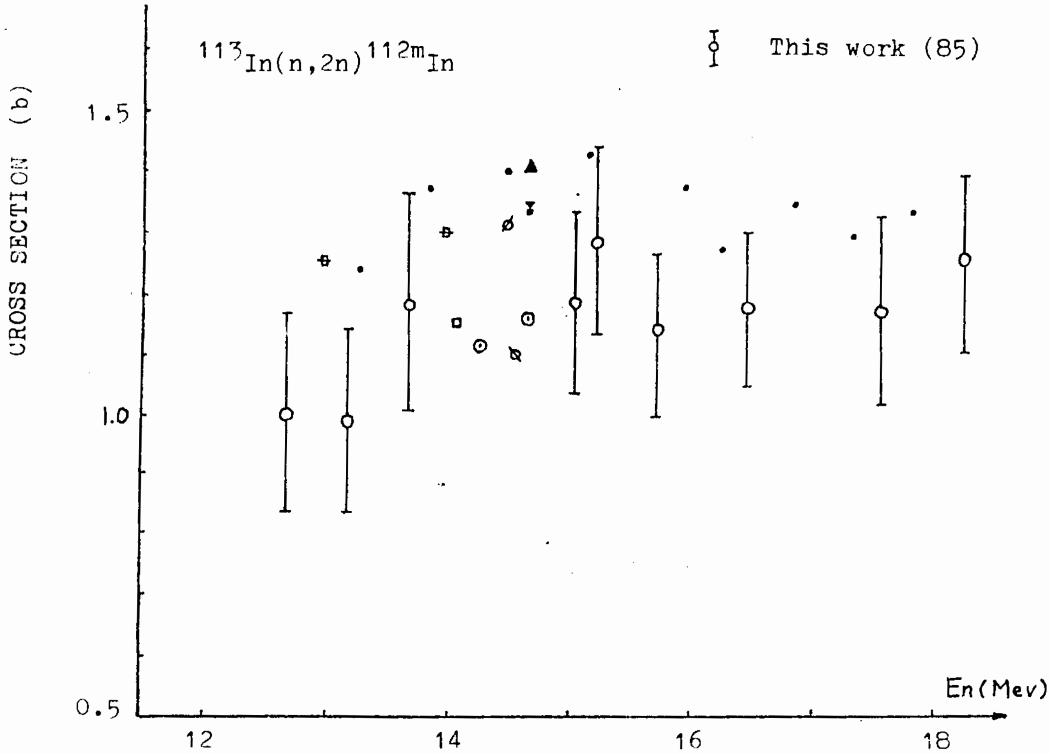

Fig. 3 $^{113}In(n,2n)^{112m}In$ cross section

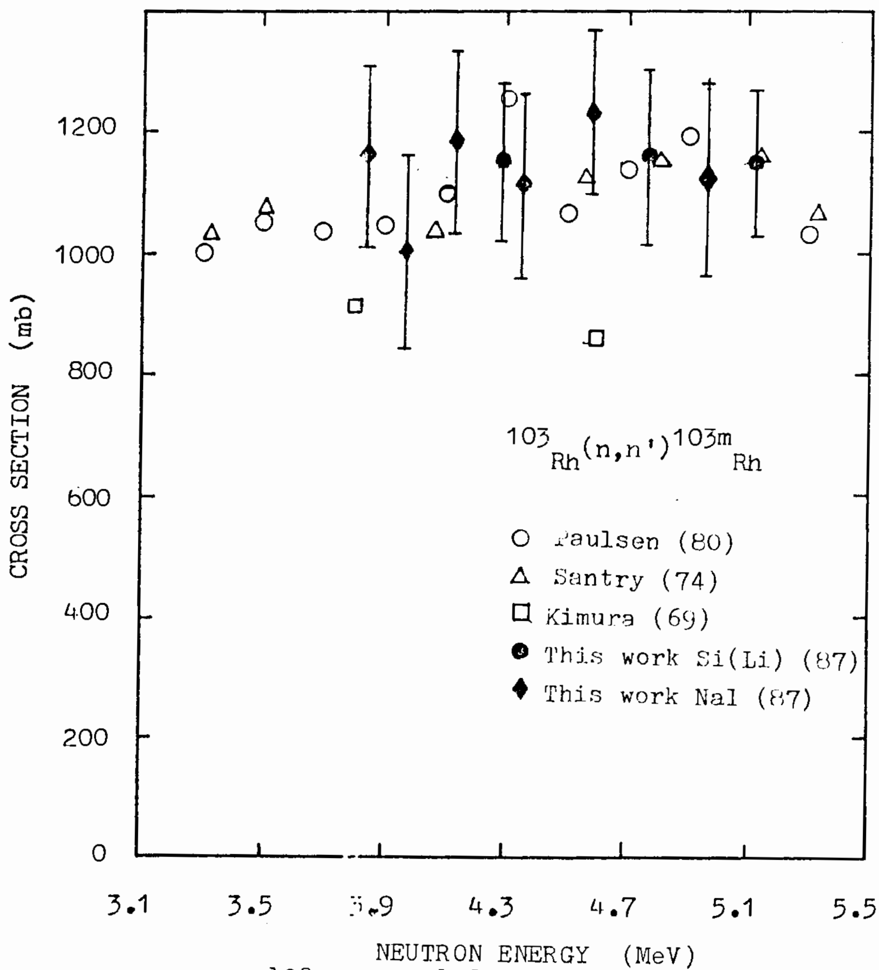

Fig. 4 $^{103}Rh(n,n')^{103m}Rh$ cross section