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# Critical comparative analysis of some recent evaluations of the Al(n.α)Na evaluated cross sections*

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# Critical comparative analysis of some recent evaluations of the Al(n.α)Na evaluated cross sections*

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Critical comparative analysis of some recent evaluations of the $Al(n,\alpha)Na$ evaluated cross sections*

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The importance of the $Al(n,\alpha)Na$ reaction is well known for dosimetry purposes.

At present, there are available a sufficient number of partial and integral experimental data, which allow to obtain some evaluations, which are, generally speaking, in good agreement over the whole energy range. However, a critical comparative analysis of some of the most recent evaluations, allow us to make a few considerations which can be of some interest.

The authors had available five evaluations works on the $Al(n,\alpha)Na$ reaction, namely:

[1] ENDF/B-IV, USALAS (3.2487 MeV - 20 MeV; Q = -3.1316 MeV)

[2] KEDAK, GERKFK ($6.10^{-4}$ eV - 15 MeV; Q = -3.107 MeV)

[3] LLLENDL, USALLL ($3.2487\ 10^{6}$ eV - 20 MeV; Q = -3.1316 MeV)

[4] UKNDL, UKALD (5.0 MeV - 21 MeV; Q = -3.1310 MeV)

received from NDS-IAEA, and also

[5] DANEM, RUMBUC (5.0 MeV - 20 MeV; Q = -3.1310 MeV)

In fig. 1 a comparative plot of $\sigma_{n\alpha}$ evaluated cross sections versus energy contained in the quoted libraries for cross section values larger than $0.1\ 10^{-3}$ barns. is given.

A good agreement of the data supplied by the references [1], [3], [4], [5] is seen, both as general shape of the curve and as position and value of its peak.

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* Work suggested by H.D. Lemmel from NDS-IAEA

The evaluated data from KEDAK library [2] have a few particular aspects, nemely:

1) In the energy range from threshold up to 9 MeV, the cross-section curve has 3 peaks: at 7.2 MeV (24 mbn), at 7.7 MeV (34.5 mbn) and at 8.1 MeV (49 mbn).

2) Between 8.5 MeV and 12.5 MeV, the evaluated curve is located under the other evaluations.

3) Between 12.5 MeV and 14 MeV, the evaluated curve shows a peak over the peaks of the other evaluations.

An explanation of these particularities should be the following:

1) The evaluated data from KEDAK seem to pay more confidence to the variations of cross sections reported by H.W. Schmidt [6].

As it is pointed out by G. Vasiliu in [5], these fluctuations are not sustained by the experimental data of others.

Even J.P. Butler [7] which has results affected by errors in energy and cross-sections, comparable with these of Schmidt [6] doesn't give any confirmation.

2) The diferences between evaluated cross-sections from KEDAK library and the other evaluations, are of 20-30% for 8.5 - 10 MeV energy range, and 4-18% for 10 - 12 MeV energy range.

From the experimental works known by authors, only that of Tewes [8] gives in these energy ranges, cross section values under the average values of the others, but Tewes's report does not give the errors; generally Tewes's values, by renormalization with a factor of 1.37 - 1.39 [5],[9] become comparable with the other data. It should be mentioned that in this energy range, theoretical values computed by Butler [7] confirm most of experimental values.

3) Between 12.5 and 14 MeV, the evaluated cross sections

from KEDAK library are up to 8% larger than other evaluated data.

Over 15 MeV there are no evaluated data in KEDAK library, and of course no comparison was possible.

The above mentioned differences are, of course, reflected in the integral cross section averaged on neutron fission spectrum.

One approximate calculus of the microscopic integral cross sections averaged in the U-235 thermal fission neutron spectrum, using the evaluated data from these five evaluations, shows a good agreement of the ENDF/B, DANEM, UKNDL and LLLENDL values, and a smaller by 10% values using the KEDAK data. (The calculus was made up to 15 MeV).

As we have no data of the KEDAK evaluation, we made a comparison with 1966 KEDAK version, and we concluded that it is the same evaluation - quite an old one.

This means that KEDAK evaluators hadn't available the latest experimental data of Menlove [10] (1967) in the 6-8 MeV energy range, Ferguson [11] (1967) between 12.35 and 14.85 MeV, and especially the very good data of Vonach [12] (1970) between 13.15 and 14.9 MeV, which significantly modified the up to date evaluations, particularly around the peak.

In addition, many data ([13]-[19]) especially around 14 MeV, available for evaluation before 1965, are relative to different standards (56-*Fe*(*n*,*p*), 238-*U*(*n*,*f*), 63-*Cu*(*n*,2*n*), etc.) which now are reviewed and modified significantly some times.

We assume that KEDAK library has a more recent evaluation of the *Al*(*n*.α) reaction, which, unfortunately was not available to the authors of the present comparative analysis.

## Conclusions

According to CINDA, it seems that there are no experimental data or calculations about $Al(n,\alpha)$ reaction, more recent than those taken into account by, at least, ENDF/B, LLLENDL and DANEM libraries. In this case, we can appreciate that, at least for dosimetry purposes, there are available a few evaluations of 27-$Al(n,\alpha)$ reaction (ENDF/B, UKNDL, LLLENDL, DANEM libraries), quite precise, in good agreement with each others. They supply microscopic integral cross section averaged in the Uranium-235 thermal fission neutron spectrum, also in good agreement with the experimental integral cross section (0.725 ± 0.045 mbn) [20], [21].

The cross-section variations in 6-8 MeV energy range, and, also, those pointed out by G. Vasiliu [5] around of 13 MeV remain of some theoretical interest.

Of course, the knowledge of the $Al(n.\alpha)$ cross sections more accurate is an open problem for the future, although no significant modifications of the general shape of evaluated curve are expected.

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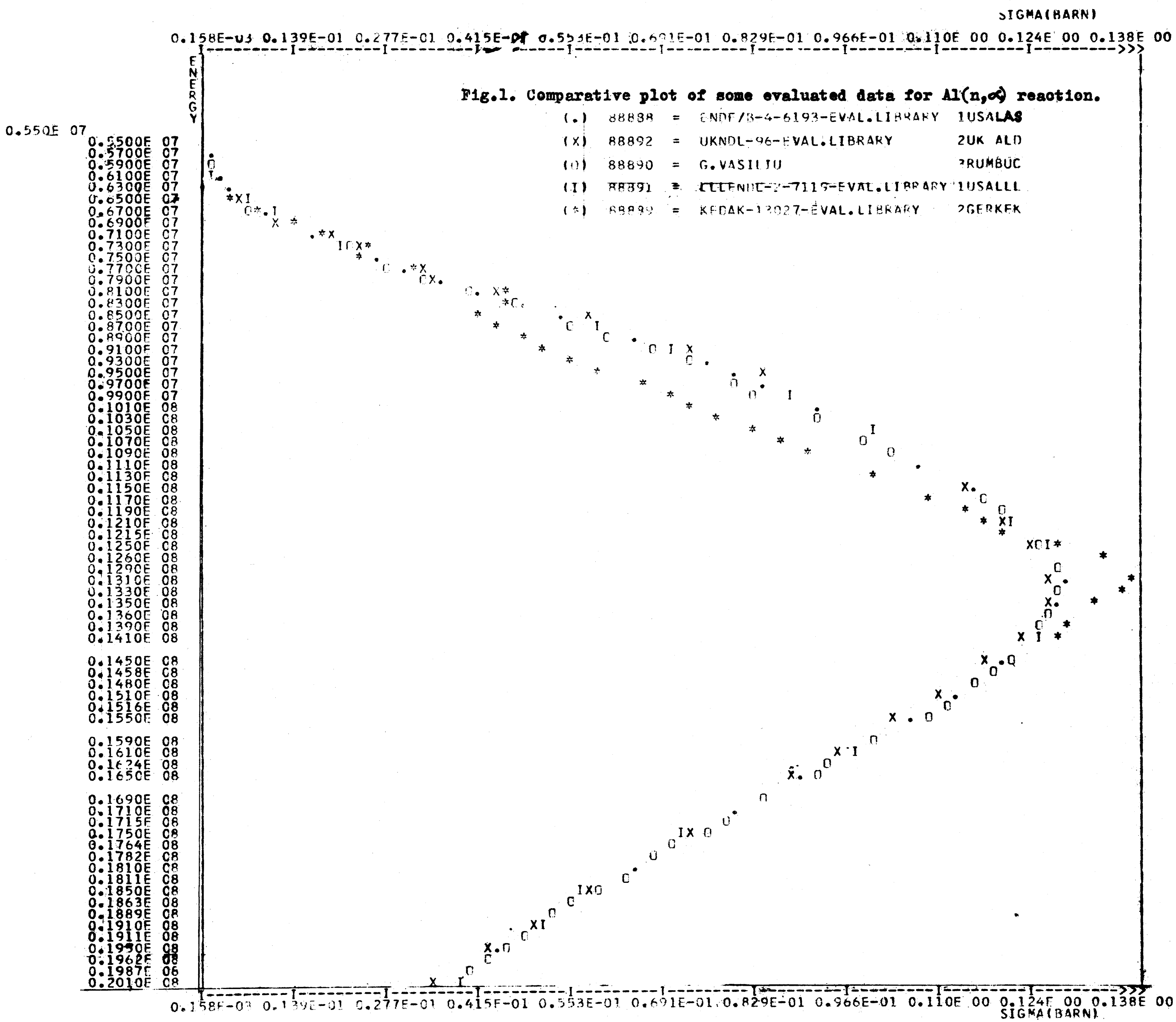


**Fig.1. Comparative plot of some evaluated data for Al(n,α) reaction.**