Data Assessment of $^{14}N(\alpha,\alpha_0)^{14}N$ Cross Sections

Index

Summary

The data sets on IBANDL were compared with the data in the original references. Details are given on the discrepancies found. A thorough search for other available experimental data was performed. The search was restricted to the (α,α_0) cross sections measured for ^{14}N and for backscattering angles in the 100-180º range as these are the most common angles encountered in Ion Beam Analysis Laboratories. Existing measured cross sections were compared and checked for discrepancies and gaps. Most discrepancies found occur around the resonances. Their exact height and position should be carefully studied. Also, most of the data correspond to scattering angles in the 160º- 170º region, between 3 and 9 MeV. Data should be obtained for energies between 3 and 10 MeV and for scattering angles between 125º and 150º.

1. Discrepancies between IBANDL data sets and original data

The data sets on IBANDL were compared with the data in the original references. When several data sets for the same angle and reference were present on IBANDL, a consistency check between them was also performed.

A good agreement was found for the majority of data sets. Two discrepancies were identified. A first discrepancy was observed for the 167º scattering angle (Φ) data sets from reference [FOS1993] present on IBANDL (data set nº 5 and 6 in table 1). The discrepancy consists of an energy shift between the data in set nº 6 and in set nº 5. Figure 1 shows a comparison of the two data sets taken from IBANDL. The reason for the energy shift may be related to the origin of the digitized data: set nº 6 could have been digitized from figure 2 in [FOS1993], which shows the resonance in detail, allowing for a much better energy resolution of the digitised data. Data set nº 5 was probably digitised from figure 1 in the original paper, which covers a much wider energy region, thus allowing for a less detailed digitalization.

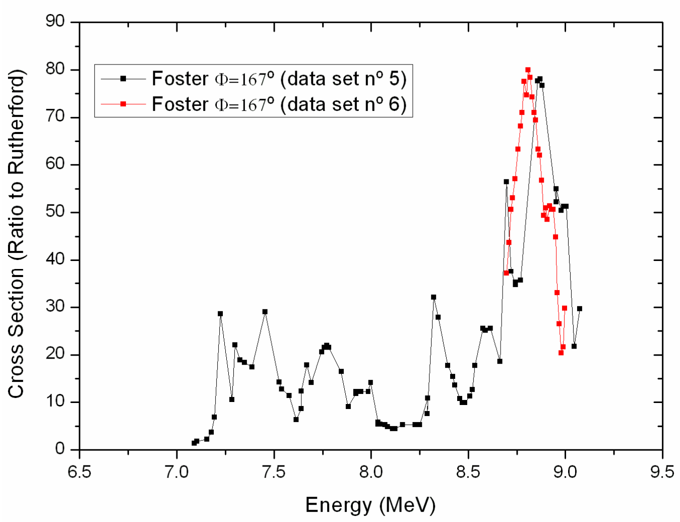

Fig. 1. Comparison between the IBANDL data sets for Φ=167º from [FOS1993].

A second discrepancy was observed for the 166º scattering angle data sets from reference [SIL1961] present on IBANDL (data set nº 7, 8 and 9 in table 1). The discrepancy consists of shift in cross section values in the overlapping energy regions of data sets nº 7, 8 and 9 as shown on figure 2. As before, the reason for the shift may be related to the origin of the digitized data: the data sets come from different insets in figure 4 of the original paper, each with a different scale, thus leading to different resolutions for the digitised data.

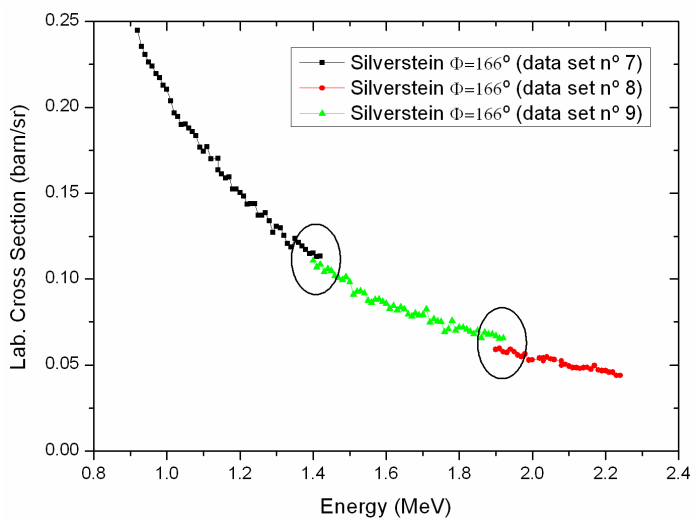

Fig. 1. Comparison between the IBANDL data sets for Φ=166° from [SIL1961].

Table 1 list all available data sets on IBANDL for the $^{14}N(\alpha,\alpha_0)^{14}N$ reaction and recommended actions to be taken, if any, regarding each particular case.

Table 1 – Original data sets from IBANDL.

Nº	Reaction	Lab. Scattering Angle	Energy Range (keV)	Reference	Comments	Recommended Actions
1	$^{14}N(\alpha,\alpha_0)^{14}N$	171.00°	7480-8180	[BER2002]		
2	$^{14}N(\alpha,\alpha_0)^{14}N$	171.00°	8980-9780	[BER2002]		
3	$^{14}N(\alpha,\alpha_0)^{14}N$	167.20°	2010-3840	[HER1958]		
4	$^{14}N(\alpha,\alpha_0)^{14}N$	167.00°	4550-6570	[FOS1993]		
5	$^{14}N(\alpha,\alpha_0)^{14}N$	167.00°	7090-9070	[FOS1993]	See text.	Create a single data file using data set nº 6 wherever possible.
6	$^{14}N(\alpha,\alpha_0)^{14}N$	167.00°	8700-9000	[FOS1993]	See text.	
7	$^{14}N(\alpha,\alpha_0)^{14}N$	166.00°	920-1420	[SIL1961]	See text.	
8	$^{14}N(\alpha,\alpha_0)^{14}N$	166.00°	1400-1920	[SIL1961]	See text.	
9	$^{14}N(\alpha,\alpha_0)^{14}N$	166.00°	1900-2240	[SIL1961]	See text.	
10	$^{14}N(\alpha,\alpha_0)^{14}N$	165.00°	1990-9060	[FEN1994]		
11	$^{14}N(\alpha,\alpha_0)^{14}N$	163.70°	2680-4700	[KAS1958]		
12	$^{14}N(\alpha,\alpha_0)^{14}N$	150.00°	3140-3770	[JIA2005]	Incomplete reference.	Change reference (see chapter 4).

2. Other available experimental data

A thorough search for other available experimental data was performed. The search was restricted to the (α,α_0) cross sections measured for ^{14}N and for backscattering angles in the 100-180º range as these are the most common angles encountered in Ion Beam Analysis Laboratories.

Data sets nº 13, 14 and 15 (see table 2) appeared in graphical form in the original references. The procedure used to digitize the cross section plots was as follows. The appropriate figure in the pdf file of the original paper was copied as a bmp file. This file was imported on to an ORIGIN© graph with the exact dimensions and scale of the bmp picture. Given that the resolution or scale of the original figure did not permit the exact position of each individual data point to be determined, a smooth curve was drawn by hand over the relevant experimental points. This smooth curve was then digitized at irregular intervals using the screen reader utility of ORIGIN©. This digitizing procedure is similar to the one used in reference [TES1995].

Table 2 list the additional data sets found in the literature, digitized and up-loaded into IBANDL.

Table 2 – Additional data sets found in the literature and digitized.

Nº	Reaction	Lab. Scattering Angle	Energy Range (keV)	Reference	Comments
13	$^{14}N(\alpha,\alpha_0)^{14}N$	109.5º	2010-3840	[HER1958]	Data taken from fig. 3 in reference.
14	$^{14}N(\alpha,\alpha_0)^{14}N$	127.5º	2010-3840	[HER1958]	Data taken from fig. 3 in reference.
15	$^{14}N(\alpha,\alpha_0)^{14}N$	172.0º	5200-7500	[ART1992]	Data taken from fig. 1 in reference.
16	$^{14}N(\alpha,\alpha_0)^{14}N$	177.0º	2300-2540	[QIU1992]	Data taken from table 1 in reference.

3. Comparison of existing measured cross sections: discrepancies and gaps

Figures 3 and 4 present in graphical form all the cross sections listed in table 1 and 2. In the graphs both the energy and the cross section are given in the laboratory frame of reference, with energy units in MeV and cross section units in barn/sr.

Figure 3(a) shows the cross section values measured at low energy for a scattering angle of 166º. Figure 3(b) shows the cross section data available in the 109.5º-150º scattering angle range. It is clear that up to ~2.5 MeV, the cross section is very close to Rutherford. Above 2.5 MeV, the cross section shows many strong resonant structures. Figure 4 shows the cross section data available in the 163.7º-177º scattering angle range, measured for energies up to 9.750 MeV. The Kashy 163.7º data agree well with the Herring 167.2º data. The position of the resonances in the Kashy data is shifted towards higher energies when compared with the Feng 165º data. In the 4.500 – 7.000 MeV range the Feng 165º data and the Foster 167º data agree very well. However, above 7.000 MeV the position of the resonances in the Foster 167º data appear shifted to higher energies. The Artigalas 172º data reproduces the general features of the resonance structure, but the original energy steps during measurement were high (50 or 100 keV). From the discussion above it is clear that most discrepancies occur around the resonances. Their exact height and position should be carefully studied. Also, most of the data correspond to scattering angles in the 160º- 170º region, between 3 and 9 MeV. Data should be obtained for energies between 3 and 10 MeV and for scattering angles between 125º and 150º.

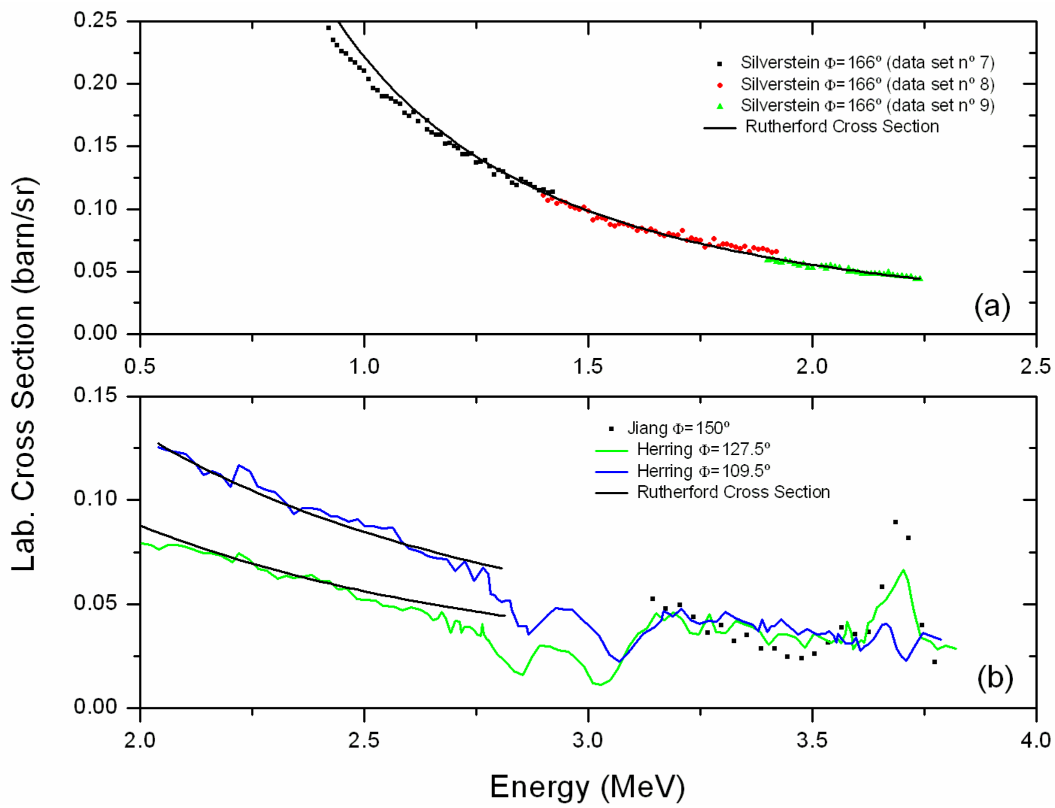

Fig. 3. Cross section for the $^{14}N(\alpha,\alpha_0)^{14}N$ reaction. (a) Cross section values measured at low energy for a scattering angle of 166º. (b) Cross section values measured at scattering angles in the 109.5º-150º range.

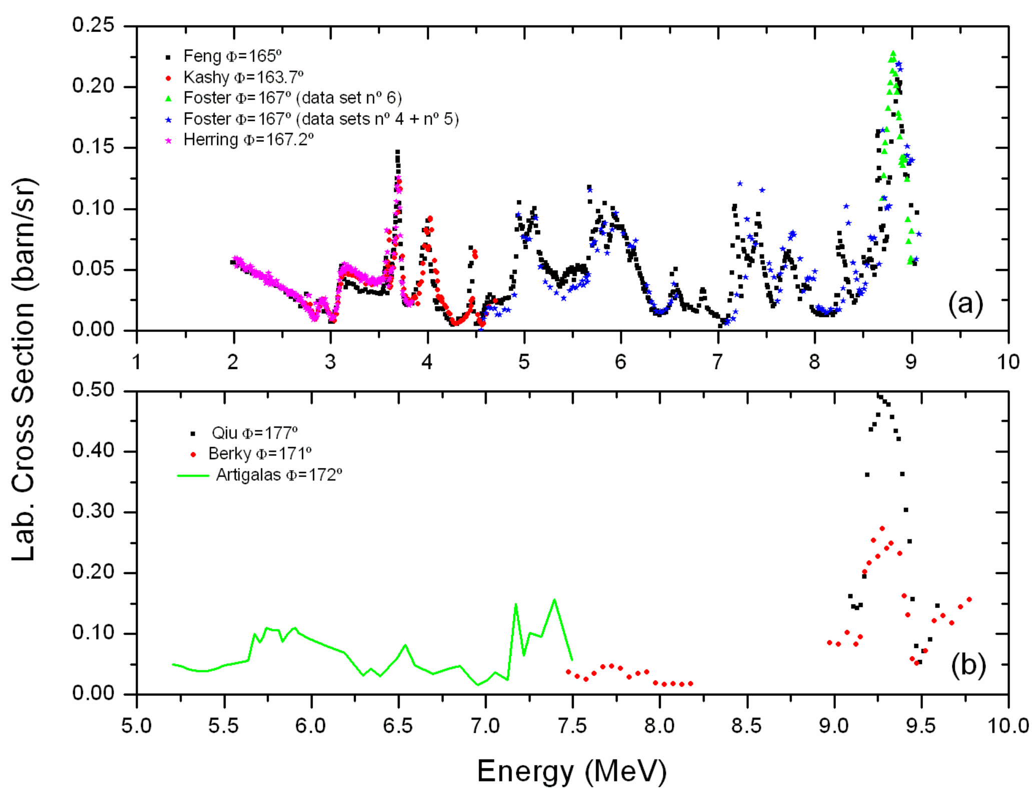

Fig. 4. Cross section for the $^{14}N(\alpha,\alpha_0)^{14}N$ reaction at scattering angles in the 163.7º-177º range, measured for energies up to 9.750 MeV.

4. References

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