

Data review of $^{23}\text{Na}(p,p_0)^{23}\text{Na}$ cross-sections

M. Chiari

INFN Florence - Italy

As a first step, the only existing data set on IBANDL was compared with the data in the original reference [1] and the agreement was good.

The second step was a thorough search in the literature and in nuclear databases for other available experimental data. Very few data of interest for application in Ion Beam Analysis (i.e. for backscattering angles in the 100° - 180° range) were retrieved [2-5]. Another paper [6] was found, anyway it was considered of limited interest since it focuses only in the measurement of the width of a resonance at 3.90 MeV proton energy. The data appearing in graphical form in the original references were digitized using the DataThief software [7]. All the relevant quantities were converted to the laboratory frame of reference when necessary. Table 1 lists the data sets found in the literature, both already existing on IBANDL and new ones. These new data will be uploaded into IBANDL if deemed appropriate.

| Reference | Data source | θ_{lab} | E_p (MeV) | Target | Quoted uncertainties | Data presentation |
|-----------|----------------|---|-------------|--|-------------------------------|-----------------------|
| [1] | IBANDL | 156.5° | 0.57-1.48 | Metallic sodium evaporated on Nylon films | - | Tabular |
| [2] | Original paper | 123.2° 139.2° 158.9° | 0.4-1.0 | Na metal evaporated on a C backing | - | Graphical |
| [3] | EXFOR | 165° | 1.08-3.50 | 1-3 $\mu\text{g}/\text{cm}^2$ Na evaporated on Au coated (1 $\mu\text{g}/\text{cm}^2$) C foils (5 $\mu\text{g}/\text{cm}^2$) | 1-2% statistical | Tabular |
| [4] | Original paper | 135° | 2.25-2.50 | 10 $\mu\text{g}/\text{cm}^2$ Na evaporated on C foil (10 $\mu\text{g}/\text{cm}^2$) | - | Graphical; arb. units |
| [5] | Original paper | 150° | 2.2-5.2 | 63 $\mu\text{g}/\text{cm}^2$ NaBr evaporated on C foil (30 $\mu\text{g}/\text{cm}^2$) | 6% statistical and systematic | Graphical |

Table 1: Available data in the literature on $^{23}\text{Na}(p,p_0)^{23}\text{Na}$ cross-sections.

Figures 1 and 2 present in graphical form all the cross-sections listed in Table 1 (data from [4] are not shown since they are presented in arbitrary units); data referring to similar scattering angles are shown together. In the graphs the proton energy and the differential cross-section are given in the laboratory frame of reference, with energy units in MeV and cross-section units in mbarn/sr.

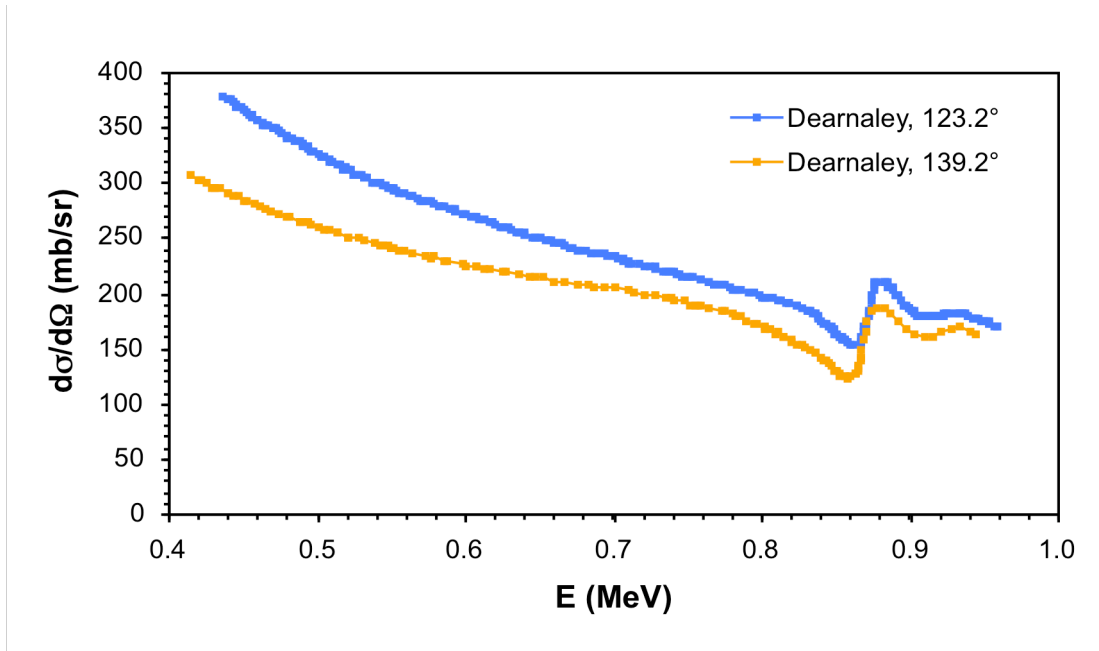


Figure 1: Cross-section values of proton elastic scattering on ^{23}Na versus proton energy at scattering angles in the 123° - 140° range. All the quantities are given in the laboratory frame of reference.

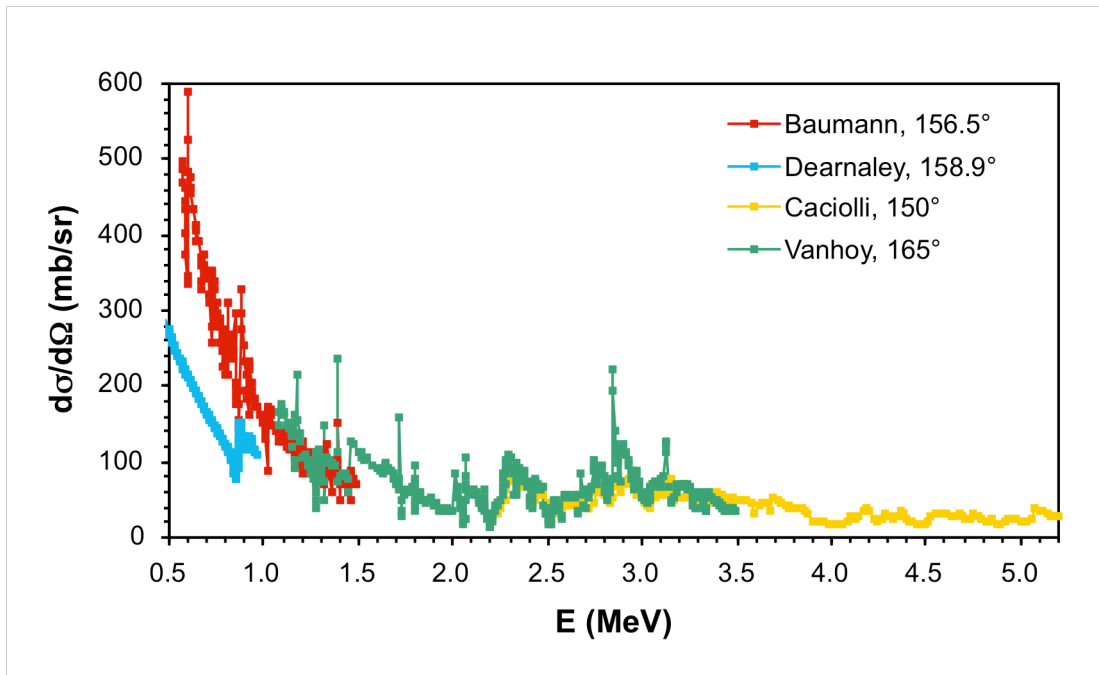


Figure 2: Cross-section values of proton elastic scattering on ^{23}Na versus proton energy at scattering angles in the 150° - 165° range. All the quantities are given in the laboratory frame of reference.

From Figure 2 a striking discrepancy is observed for the data from [2]: these data are about a factor 2 lower than those from [1] and several resonances are missing. On the contrary - keeping in mind that they refer to different scattering angles- the overall agreement between data from [1] and [3], and between data from [3] and [5] is reasonably good; however, some resonances are not well reproduced in the data from [5] due to the finite steps of the measurements, often exceeding the proton energy loss in the target. In addition, note that the cross-section values for the three scattering angles from [2] are consistently lower than the Rutherford value even at proton energies of a few hundreds keV.

References

- [1] N.P. Baumann et al., Phys. Rev. 104 (1956) 376
- [2] G. Dearnaley, Philos. Mag. ser. 8, 1 (1956) 821
- [3] J.R. Vanhoy et al., Phys. Rev. C vol. 39 (1987) 920
- [4] Y. Hiratate et al., J. Phys. Soc. Jpn. 24 (1968) 690
- [5] A. Caciolli et al., in press in Nucl. Instr. and Meth. B
- [6] J.F. Wilkerson et al., Nucl. Phys. A549 (1992) 223
- [7] <http://www.datathief.org/>