EXFOR Compilation and systematic of evaporation residues' cross-section

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Introduction

Recent advancement in the field of detector and accelerator technologies has enabled the experimental physicists worldwide to generate a wealth of nuclear reaction data. These data are very important not only in the basic research but also in the applied field. It is therefore, very essential to compile these data. The International Atomic Energy Agency (IAEA) coordinates to get such data compiled and maintains them through the International Network of Nuclear Reaction Data Centres (NRDC). EXFOR (an abbreviation of Exchange FORmat) is the format in which the reaction data are compiled. EXFOR was initially used for the compilation of neutron data which was further developed and adapted to include other reaction data as well. Presently this includes neutron, charged particle, and photonuclear data files.

The compilation work also provides an opportunity for systematic study of the reaction data. A systematic study often leads to deeper understanding of the underlying physics. These are also suggestive for future experiments. We have compiled a few data sets which deal with cross-section measurements of the α- and heavy-ion induced fusion evaporation reactions. We have found some interesting results and have tried to understand the measured cross-section from PACE-IV calculations. We present here our compilations and some of our findings from those compiled sets which warrant more detailed future investigation.

EXFOR file and compiled data

Each EXFOR file contains a number of entries with a unique entry number. Normally, each entry correspond to a publication in refereed journal, symposium proceeding or lab report. Each of the entry is divided into a number of subentries (data sets). The subentries are composed of bibliographic (including descriptive and book keeping) information and the data. The data is further divided into data information that are common throughout the subentry (common data) and a data table. In order to avoid repetition of information that is common to all subentries, the first subentry contains only information that applies to all other subentries. It contains author information, publication reference, information about target, projectile, detector, the accelerator facility used, the method, error analysis etc. Many of the information are coded in the EXFOR. The details can be found in [1].

Table 1: List of our recent compilations

Entry No.	Reference	Reaction	No. of Sub entries
D6143	J,PRM,32,605,1989	^{4}He+^{121}Sb	2
D6161	J,NCR,104,(4),475,1991	^{4}He+^{55}Mn	7
D6181	J,NP/A,879,(1),107,2012	^{20}Ne+^{165}Ho	19
D6177	J,IMP/E,20,(3),645,2011	^{12}C+^{93}Nb	15
D6209	J,IMP/E,1,(2),389,1992	^{4}He+^{113}I, ^{115}In	10
D6212	J,EPJ/CS,38,17001,2012	^{16}O+^{45}Sc	11

In Table 1 our compilation on the cross-section measurements are summarized. Each entry has several subentries depending on the reaction channels discussed in the paper. The references in Table 1 are given in the EXFOR format. The evaporation residue (ER) cross-

sections (σ) following heavy-ion induced as well as α-induced fusion evaporation reactions were compiled in this work. The γ-ray spectroscopy method was employed for these measurements.

The compiled data contains the values as provided by the author in a tabular form in the publication. However, this may not be the case for all entries and often one has to digitize the data given as a figure in the publication, to get the numerical values. The software digitization is not absolutely free from error. Therefore, we often try to get the numerical values directly from the authors. This has been followed in some of our compilation.

Discussion

The measured excitation functions, obtained from our compiled data sets, the (α, xn) channels (with x = 2 ï 4) of the fusion evaporation reactions with different isotopes of Sb (Z = 51) and In (Z = 49) targets have been compared with the PACE-IV calculations. The (α, 2n) reaction cross-sections agree quite well with the calculations. The excitation function of the (α, 4n) channels are shown in Fig. 1 along with the PACE-IV calculations. It can be seen that although the absolute values do not match but there is a qualitative agreement between the calculated and experimental values except for the ^{115}In target. It may be noted that the compiled values for the α on ^{115}In reaction were obtained by digitization. The experimental data for α on ^{113}In is not measured and are not available in the EXFOR data base. Apparently, because of the shorter half-life of ^{115}Sb (32.1 m) the decay γ-rays method could not be employed for the above reaction. No effect in σ is noticed for In and Sb target with proton number below and above magic gap Z = 50.

Fig. 2 shows the excitation function with normalized σ for heavy ion induced reactions. The σ values were normalized with the peak value for each channel. The measured values agree quite well with the calculated values except for the ^{45}Sc(^{16}O, αn) channel. Measured absolute σ values for this channel was found to be much larger than the calculated values. This cannot be due to target impurity as the (α, 2n) channel with the same target agrees well with the calculations. Moreover, the same evaporation channel with more asymmetric system also agrees well with the calculations. Therefore, more experimental data are needed for the ^{45}Sc(^{16}O, αn) reaction for better understanding.

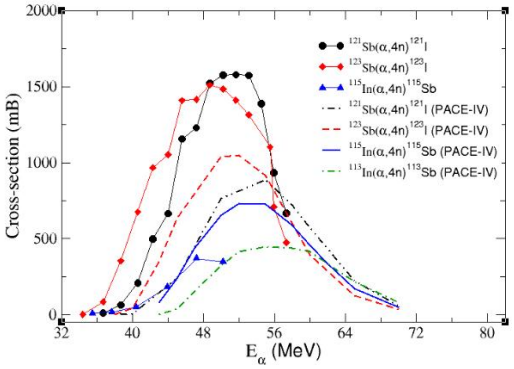

Fig. 1 Measured and calculated (by PACE-IV) excitation function of the 4n channels in α-induced fusion reaction on various targets.

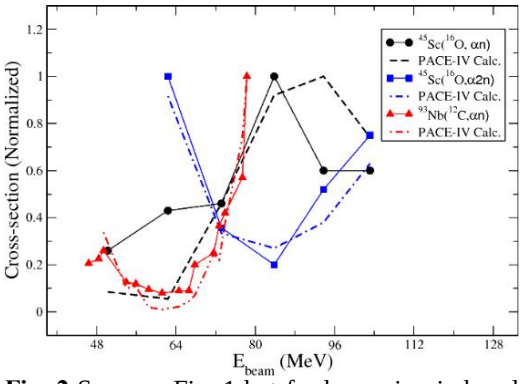

Fig. 2 Same as Fig. 1 but for heavy ion induced reactions. The cross-sections are normalized by the peak values of each channel.

Conclusion

The EXFOR compilation is important not only to organize the wealth of available data but also for systematic study of the reaction cross-section. New measurements are suggested from the present work.

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References

[1] http://www-nds.iaea.org/nrdc/basics/.