Quality Assurance of the experimental data extraction from the published results (plots) using Webplot-digitizer

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Introduction

The experimental data in nuclear physics, especially for nuclear reactions are available in the data website like National Nuclear Data Center(NNDC) [1] and also in the literature. But sometimes, we are unable to qualify our interesting phenomenological results with experimental data due to non-availability of data tables in the standard data website or literature. The experimental data tables (the scattering cross-section and barrier distribution data) were required for an interesting physics problem to study the deformation of nuclei using quasi-elastic scattering probe applying bayesian statistics. The experimental data for the phenomenological results are not available in NNDC or literature. We then compelled to extract experimental data from the published plots in literature using tools like webplot-digitizer [2]. The webplot-digitizer is a robust standard tool for data extraction. But sometimes full profile of data is not extracted. It is then required to study 'Quality Assurance'(QA)on the experimental data. Here, we have applied this QA test on the data of the fusion cross-section for low-mass to heavy mass nuclei, where the experimental data are available in the literature. We have extracted the fusion data from the plot using webplot-digitizer [2] and then compared it with the data from literature. The comparison of data obtained from two sources (literature and webplot-digitizer tool) give us the maximum propagating errors during the systematic study of three target-projectile combinations of fusion cross-section.

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Methodology of Data Extraction

In this work, we have used three systems of target-projectile combination starting from light mass to heavy mass for fusion reactions. The experimental data from literature (plots) for three different systems are extracted using webplot-digitizer [2] and compared with the experimental data published in the literature. The x- and y- axes represent the values of energy (in center of mass frame) and the cross-section of fusion reaction respectively. The values of energy and cross-section are taken from literature and webplot-digitizer represent with suffixes $_1$ & $_2$ respectively. The error has been calculated using as shown in equations (1) & (2).

For x axis error:

$$\Delta E_{cm} = \left| \frac{E_{cm_2} - E_{cm_1}}{E_{cm_1}} \right| \tag{1}$$

For y axis error:

$$\Delta\sigma = \left| \frac{(\sigma_2 - \sigma_1)}{\sigma_1} \right| \tag{2}$$

where ΔE_{cm} and $\Delta\sigma$ denote the error in energy and the cross-section respectively.

Results

The comparison of data for the fusion cross-section as a function centre of mass energy collected from two sources (literature and webplot-digitizer tool) are given in FIG.1, FIG.2 and FIG.3 respectively. The plots are in chronological order for low-mass to heavy-mass systems, such as ^{26}Mg+^{12}C, ^{92}Zr+^{35}Cl and ^{238}U+^{7}Be target-projectile combinations [3–5]. The Table I shows the detailed values of the data obtained from two sources (literature and webplot-digitizer tool) and the corresponding errors.

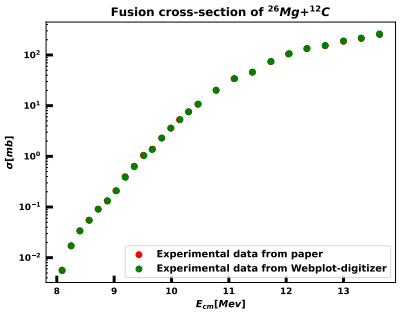

FIG. 1: The comparison of fusion cross-section data obtained from the literature [3] and webplot-digitizer for ^{26}Mg+^{12}C system.

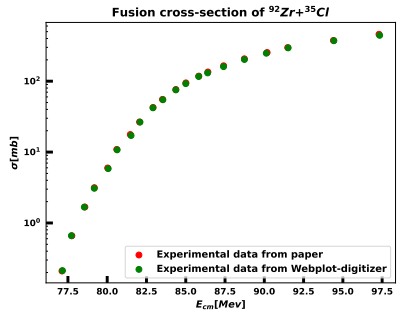

FIG. 2: The comparison of fusion cross-section data obtained from the literature [4] and webplot-digitizer for ^{92}Zr+^{35}Cl system. .

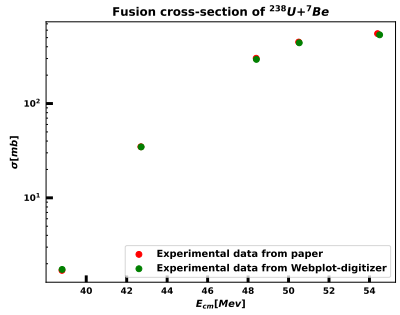

FIG. 3: The comparison of fusion cross-section data obtained from the literature [5] and webplot-digitizer for ^{238}U+^{7}Be system.

TABLE I: The detailed values of data for fusion reaction from the literature [5] and from the webplotdigitizer for ^{238}U+^{7}Be system.

Ecm_1	Ecm_2	σ_1	σ_2	ΔE_{cm}	$\Delta\sigma$
38.80	38.81	1.70	1.74	0.00026	0.024
42.70	42.72	34.80	34.65	0.00047	0.0043
48.40	48.41	302.10	293.90	0.00021	0.027
50.50	50.53	448.80	440.61	0.00059	0.018
54.40	54.50	551.10	535.30	0.0018	0.029

Summary

In this paper we are trying to establish a mechanism to utilize experimental data which are not available in the literature or in the standard website of collected data for nuclear physics. Our analysis is done taking data sets from two different sources, such as data set from the literature which has been compared with the same data set extracted from the plot using webplot-digitizer [2]. We have evaluated the errors for this comparison for the three systems (^{26}Mg+^{12}C, ^{92}Zr+^{35}Cl and ^{238}U+^{7}Be) where the errors in centre of mass energy varies from 0.06% to 0.18% and it varies for fusion cross-seciton from 2.9% to 3.4% respectively. Therefore, in general purpose, it seems that this technique of 'QA' is allowed to study any interesting phenomenological work in nuclear physics arena where the experimental data is to be extracted from the results (plots) of the literature and this minimal errors can be added in the systematic errors in the experimental data.

References

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