Regression analysis of experimental reaction cross-section data of ^{241}Am(n, 2n)^{240}Am

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Abstract

Pre-processing of experimental nuclear data is very essential in the nuclear data evaluation. Nuclear data evaluation is very vital in nuclear science and technology because nuclear data are necessary constituents in numerous applications including the nuclear power plants design, management of nuclear waste, radioisotopes production, research of fusion energy, materials inspections, nuclear safeguards, materials inspections, nuclear safeguards and many more. Since the quality and accuracy of these nuclear data sets can affect the efficiency of their applications, evaluation of nuclear data is mandatory.

In the evaluation process [1], experimentally measured data are analyzed and skillfully combined with the predictions of nuclear model calculations, to obtain the true values of nuclear data. The excellence of evaluated data depends on the correctness of experimental data and theoretical data. Therefore both these data should not have error or uncertainty which is practically not possible. It is certain that uncertainties can be encountered in the measured quantity of nuclear experiments because nuclear reactions are a random activity, and measurements based on detection of the emitted particles from the nuclear reactions are affected by some statistical fluctuations which are unavoidable. Therefore, in the evaluation process, the pre-processing of the experimental data before combining it with the theoretical data is essential (Fig 1).

In this paper, a pre-processing on nuclear cross-section data for nuclear reaction ^{241}Am(n, 2n)^{240}Am has been considered. Required experimental data has been acquired from EXFOR [2]. As per Fig1, Pre-processing of experimental nuclear data involves two steps, one is removal of outlier from data and second one is

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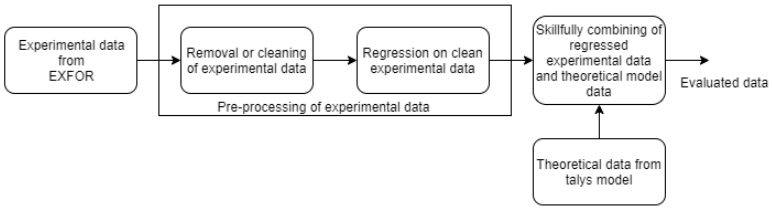

Fig. 1: Block diagram for evaluation of nuclear data

regression on clean experimental data. Presence of outlier in the available nuclear data set may affect the analysis of data or the accuracy of the result, in this paper, Studentized residual and Standardized residual have been adopted for detection of outliers. After cleaning or removal of outlier from data, regression method has been applied on clean experimental data.

Regression is important in pre-processing of experimental data, in nuclear science, as more than one person performs the same experiment in different parts of different countries, they may get different cross section values for the same energy because each experimenter uses different methods or equipment, such situation may create ambiguity in the selection of data for future applications. In such cases, it is essential to make a single cross-section value for same energies. Also experimental data usually do not cover the whole range of incident energies that are of interest. Therefore, the predictions of nuclear models are required to fill the gaps. Regression analysis is the best tool to overcome all these problems. Regression analysis is the most effective method for predicting the value based on available evidence. In this paper, polynomial regression and Gaussian Process Regression (GPR) [3] have been applied to regress the nuclear cross-section data of reaction ^{241}Am(n, 2n)^{240}Am and also covariance matrix and uncertainty have been calculated using GPR. Among them GPR is found to be giving better result for reaction ^{241}Am(n, 2n)^{240}Am.

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