Excitation function of ^{93}Nb(α,n)^{96}Tc nuclear reaction

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Introduction

Nuclear reactions play an important role in understanding the fundamental properties of the atomic nucleus, unraveling the mysteries of nucleosynthesis in stars, and advancing fields ranging from astrophysics to nuclear medicine. The study of nuclear structure is fundamental to understand the behavior of atomic nuclei, and it plays a crucial role in elucidating the underlying principles of nuclear physics [1, 2]. In this study, we have presented the excitation function of the ^{93}Nb(α,n)^{96}Tc nuclear reaction. The nuclear reaction cross sections measured in this study are compared with existing experimental data from the EXFOR data library, as well as theoretical results derived from the TALYS nuclear reaction code [3–6].

Experimental Details

The stacked-foil activation technique [7, 8] was employed, followed by offline gamma-ray spectrometry to measure the excitation function of ^{93}Nb(α,n)^{96}Tc reaction in the energy range of about 30 to 45 MeV. The stacked-foil activation method is a widely used technique in nuclear physics and nuclear reaction studies. This method involves irradiation a stack of multiple thin foils simultaneously with a monitor foil using an integrated particle beam. The monitor foil serves as a reference for monitoring the intensity and energy of the incident particles during the irradiation process. This allows precise control and measurement of the particle flux and energy, which are crucial parameters for accurately determining the excitation function of nuclear reactions [9–12]. In this experiment, thin metal foils of ^{93}Nb, ^{nat}Al and ^{nat}Cu with dimensions of 10 x 10 mm^2 were employed. The ^{93}Nb foil was employed as the target foil, while ^{nat}Al foil was used as both catcher and energy degrader foil. The ^{nat}Cu foil was employed as a monitoring foil in the experiment. The nuclear reaction ^{nat}Cu(α,x)^{67}Ga was utilized to determine the incident flux on the target foils. The thickness of ^{93}Nb, ^{nat}Cu and ^{nat}Al foils are 10.6 mg/cm^2, 9.9 mg/cm^2 and 6.8 mg/cm^2 respectively. This study involved the irradiation of two separate stacks to calculate the excitation function of the ^{93}Nb(α,n)^{96}Tc nuclear reaction at incident alpha-particle energies of about 30 to 45 MeV. A systematic arrangement of the stacked foils is shown in Fig. 1.

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Results and Discussion

In Fig. 2, we have presented the measured nuclear reaction cross-section values for the ^{93}Nb(α,n)^{96}Tc nuclear reaction. These measurements are accompanied by theoretical predictions obtained from the TALYS nuclear model, as well as previously calculated cross-section data available in the Experimental Nuclear Reaction Data (EXFOR) database. The nuclear reaction cross-sections for the ^{93}Nb(α,n)^{96}Tc nuclear reaction were calculated using a γ-ray with an energy of 849.86 keV and intensity of 98 % that decays from the ^{96}Tc radionuclide. The half-life of ^{96}Tc radionuclide is 4.28 days. There was a

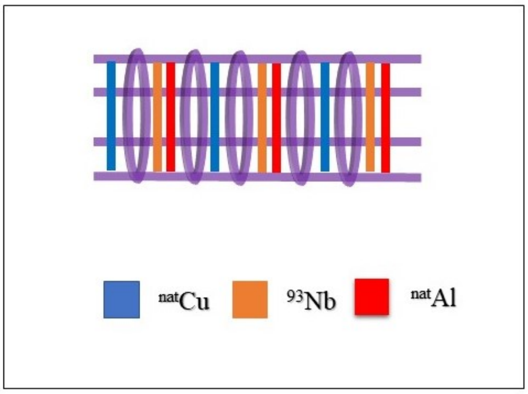

FIG. 1: The schematic diagram of the monitor-target-catcher foil arrangement.

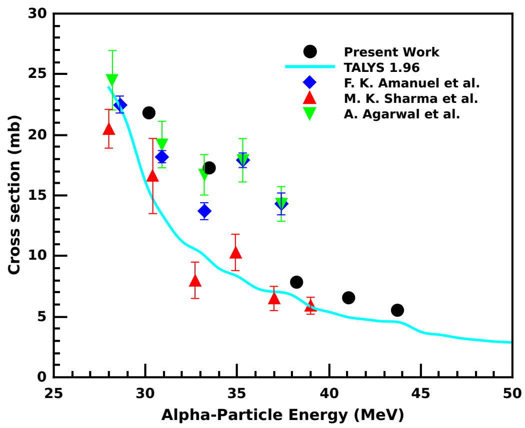

FIG. 2: Excitation function of reaction ^{93}Nb(α,n)^{96}Tc along with the experimental data taken from EXFOR and theoretical calculation from TALYS nuclear code

cooling period of around 8 days for counting of 849.86 keV γ-ray. The experimental results for the ^{93}Nb(α,n)^{96}Tc reaction obtained from this study are in good agreement with the previously reported reaction data by F. K. Amanuel *et al.*, M. K. Sharma *et al.*, and A. Agarwal *et al.* [13–15], as shown in Fig. 2. Theoretical results from the TALYS nuclear code, shown as a solid line in the color cyan, are consistent with the estimated experimental results.

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