Study of deuteron induced transfer reactions on ^{27}Al

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1. Introduction

Single nucleon transfer reactions such as (d,t), (d,^{3}He) etc. are good tools to extract spectroscopic information of nuclei. It gives us opportunity to determine the excitation energy, spin, parity, orbital and total angular momentum, the spectroscopic factors for different populated excited states of the recoil nucleus; moreover, the experimentally deduced spectroscopic factors can be directly compared with the theoretically predicted spectroscopic factors from different nuclear models.

The nucleus ^{26}Al is the first cosmic radioactivity detected through its characteristic gamma rays in the interstellar medium. Since its lifetime ($\sim 10^6$ y) is much shorter as compared to the time for galactic evolution ($\sim 10^{10}$ y), the detection of ^{26}Al at the present time indicates that nucleosynthesis is currently active in our galaxy and it is known that massive stars are the main sources for the origin of ^{26}Al [1, 2]. So, from astrophysics as well as basic nuclear physics points of view, the nucleus ^{26}Al has evoked lot of interest. It is, therefore, necessary to understand the formation and destruction of ^{26}Al in our galaxy in order to understand its evolution. Since ^{26}Mg is the radioactive (β^+) decay product of ^{26}Al, so the study of ^{26}Mg, is also important in nuclear astrophysics to understand the origin of ^{26}Al.

Since the spectroscopic factor is a fundamental property of the structure of any particular nucleus, it should not vary with bombarding energy or with the reactions chosen; but it is well known that the extracted values of the spectroscopic factors do not come out to be the same for all reaction channels, which could be due to the choice of the potential parameters [3–6]. So, with the motivation to investigate the spectroscopic factors using different reaction channels and using same reaction channel of different excited states of ^{26}Al and ^{26}Mg respectively is the primary motive of the present study. In this thesis work, the T=1 states of ^{26}Mg with their analog states of ^{26}Al reported in our previous study of the reaction ^{27}Al(d, t) [7] were also compared. In this work, the comparison of spectroscopic factors with previously reported values for the same was also performed.

2. Experimental Details

The experiment was performed at Variable Energy Cyclotron Centre, Kolkata using deuteron beam of energy 25 MeV on a self - supporting target ^{27}Al (90 μg/cm^2) and the experimental details have been given in Ref. [7]. A typical excitation energy spectrum of ^{26}Al and ^{26}Mg populated via the reactions ^{27}Al(d,t) and ^{27}Al(d,^{3}He) are shown in Fig. 1 and Fig. 2 respectively.

3. Results and Discussions

In the present thesis work two theoretical codes, ECIS94 [8] and DWUCK4 [9], were used for the analysis of elastic scattering and transfer channel data, respectively. The angular distribution of elastically scattered deuterons has been fitted using the optical model search code ECIS94. The zero distorted wave Born approximation calculation was performed to extract the spectroscopic factors for the observed states of both ^{26}Al and ^{26}Mg shown in Fig. 1 and Fig. 2. The observed states of ^{26}Al studied by assuming pick

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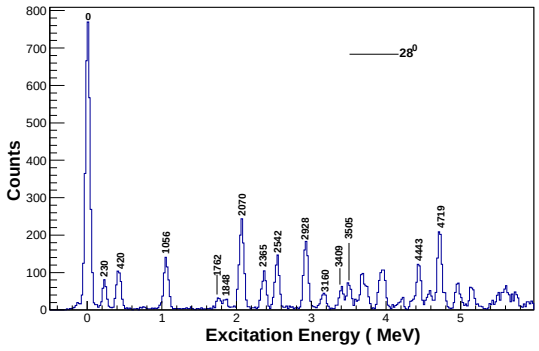

FIG. 1: Excitation energy spectrum of ^{26}Al at θ_{lab} = 28° produced from the reaction ^{27}Al(d,t).

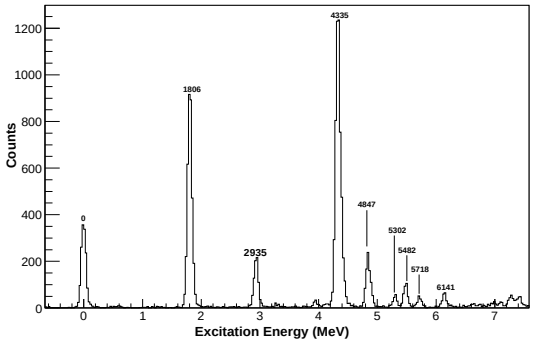

FIG. 2: Excitation energy spectrum of ^{26}Mg at θ_{lab} = 36° produced from the reaction ^{27}Al(d,^{3}He).

up from $0d_{5/2}$, $0g_{9/2}$ and $1s_{1/2}$ single particle orbitals. In a similar way, the observed states of ^{26}Mg were studied by assuming pick up from $0d_{5/2}$ single particle orbital but some of the states were studied assuming configuration mixing of $0d_{5/2}$ and $1s_{1/2}$ single particle orbitals. In the present study the extracted spectroscopic factors for the observed states of both of the nucleus were compared with the previously reported values. Keeping in mind the uncertainty in the absolute normalization between different reaction probes, the relative spectroscopic factors (keeping ground state spectroscopic factor to be 1) of the observed states of ^{26}Al and ^{26}Mg were compared and are found to be in good agreement with previously reported values. The finding of present thesis work about ^{26}Al and ^{26}Mg can be found in [7, 10–14]. The details of the analysis and results will be presented during the conference.

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