Study of one proton pick-up reaction ^{27}Al(d,^{3}He)

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[†] *DST project No. SR/FTP/PS067/2012, date 10.06.2012. and*

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Introduction

Single nucleon transfer reactions are good tools to extract spectroscopic information of nuclei. We can determine the excitation energy, spin, parity, orbital and total angular momentum and also the spectroscopic factors for single particle levels of the nuclei of interest; moreover, the experimentally deduced spectroscopic factors can be directly compared with the theoretically predicted spectroscopic factors from different nuclear models. The study of the nucleus ^{26}Mg is important in nuclear physics as well as nuclear astrophysics point of view as it is the radioactive decay product of ^{26}Al. The nucleus ^{26}Al is the first cosmic radioactivity detected through its characteristic γ rays in the interstellar medium, the detection of ^{26}Al at the present time indicates that nucleosynthesis is currently active in our galaxy. Very recently excited states of ^{26}Al had been studied using one neutron pick-up reactions ^{27}Al(d,t) [1–3] and also very recently, it was stated that the reaction ^{23}Na(α,p)^{26}Mg directly influences the production of ^{26}Al [4]. So the study of ^{26}Mg, is also important in nuclear astrophysics to understand the origin of ^{26}Al.

Here we report our recent measurement on ^{27}Al(d,^{3}He)^{26}Mg reaction at 25 MeV. In this work, we have extracted spectroscopic factors of the ground as well as excited states of ^{26}Mg and will compare our results with previously reported values using the same reaction probe at 29 MeV [5], 34.5 MeV [6], 52 MeV [7] and at 80 MeV [8]. In this work, we will also verify 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) [1].

1. 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. [1]. A typical excitation energy spectrum for ^{26}Mg populated via the reaction channel ^{27}Al(d,^{3}He) is shown in Fig.1.

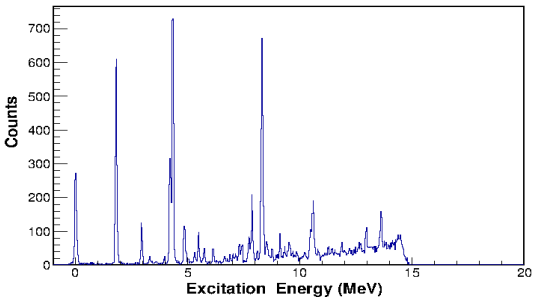

FIG. 1: Excitation energy spectrum of ^{26}Mg at θ_{lab} = 28° produced from the reaction ^{27}Al(d,^{3}He).

2. Results

The process of extraction of the optical model potential parameters for the entrance channel using the optical model search code

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ECIS94 [9] has been given in Ref. [1]. The optical model parameters for the ^{3}He + ^{26}Mg reaction in the exit channel were obtained from the relation for global fit parameters given by Perey and Perey [10]. The optical model potential parameters used in the distorted wave Born approximation calculation have been shown in Table I.

TABLE I: The best fit potential parameters used in DWBA for the reaction ^{27}Al(d,^{3}He).

parameters	[a)] d+^{27}Al	[b)] ^{3}He+^{26}Mg	B.S Potential
V_R(MeV)	89.209	151.97	V [c)]
R_R(fm)	1.061	1.20	1.20
a_R(fm)	0.701	0.72	0.65
W (MeV)		37.75	
W_D(MeV)	2.250		
R_I(fm)	1.360	1.40	
a_I(fm)	0.850	0.88	
V_{ls}(MeV)	9	2.50	
r_{ls}(fm)	1.061	1.20	
a_{ls}(fm)	0.801	0.72	
R_c (fm)	1.25	1.30	

[a)] Taken from Ref. [1],
[b)] Calculated using the relation given in Ref. [10],
[c)] Adjusted to give the required separation energy for the transferred particle.

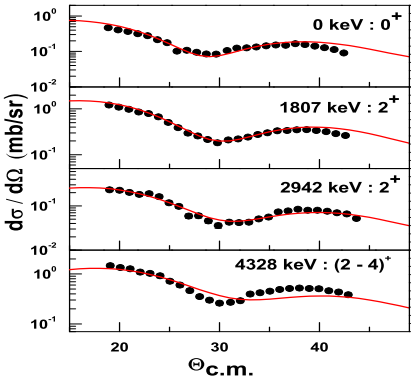

FIG. 2: Angular distributions of ground, 1807, 2942 and 4328 keV states of ^{26}Mg.

The experimental angular distributions for ground, 1807, 2942 and 4328 keV states of ^{26}Mg have been shown in Fig.2 by filled circles and these have been fitted with theoretical predictions from zero range distorted wave Born approximation using computer code DWUCK4 [11], shown by solid lines. In this work, we extracted the spectroscopic factors for different excited states of ^{26}Mg produced through the reaction ^{27}Al(d,^{3}He) assuming pick-up from $0d_{5/2}$ single particle orbital. The spin and parity assignments have been taken from National Nuclear Data Center (NNDC). The extracted values of spectroscopic factor will be compared with those reported earlier using the same reaction. Since the spectroscopic factors of T=1 analog states of ^{26}Mg and ^{26}Al should be same, so we will also verify the T=1 analog states of ^{26}Mg and ^{26}Al. Further analysis is in progress and the detail analysis and results will be presented during the conference.

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