# Study of higher excited states of $^{26}$Al

Vishal Srivastava[1,2],* C. Bhattacharya[1], T. K. Rana[1], S. Manna[1], S. Kundu[1], S. Bhattacharya[1], K. Banerjee[1], P. Roy[1], R. Pandey[1], G. Mukherjee[1], T. K. Ghosh[1], J. K. Meena[1], T. Roy[1], A. Chaudhuri[1], M. Sinha[1], A. K. Saha[1], Md. A. Asgar[1], A. Dey [1], Subinit Roy[3], and Md. Moin Shaikh[2,3].

[1] *Variable Energy Cyclotron Centre,1/AF, Bidhan Nagar, Kolkata 700064, India.*

[2] *Present Address: Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi-110067, India.*

[3] *Saha Institute of Nuclear Physics,1/AF, Bidhan Nagar, Kolkata 700064, India.*

## Introduction

Spectroscopic informations about the structure of nuclei can be easily extracted using transfer reactions. We can also extract spectroscopic factors to study the structure of single particle orbitals of the nuclei of interest which measures the degree to which a particular state is a pure single particle state or not. The experimentally extracted spectroscopic factors can be compared with those predicted theoretically using different nuclear models for the same and also we can test the predictions from shell model for the same. Study of the nucleus $^{26}$Al is very significant from nuclear as well as nuclear astrophysics point of view because it is the first cosmic radioactivity ever detected and detection of $^{26}$Al at present indicates that nucleosynthesis is presently active in our galaxy. Many references on the importance of $^{26}$Al and study of its different states can be found in Ref. [1]. Very recently several excited states of $^{26}$Al below 8 MeV had been studied by the present authors using the reaction $^{27}$Al(d,t) [1–4] and spectroscopic factors for the structure of single particle orbitals of the different observed states had been extracted. Although several states of $^{26}$Al has been identified and studied using single as well as two nucleon transfer reactions in previous years, yet there is possibility to search for new excited states of $^{26}$Al. Recently, *Chipps et. al;* [5] have identified five new excited states of $^{26}$Al between 8 to 10 MeV excitation energy. In this work, we will present spectroscopic factors for the excited states of $^{26}$Al identified at higher excitation energy using the reaction $^{27}$Al(d,t) at 25 MeV. The results of the closest reported excited states were also compared in the present study for the same.

*Electronic address: vis.vip22@gmail.com

## 1. Experimental Details

The experiment was performed at Variable Energy Cyclotron Centre, Kolkata using deuteron beam of energy 25 MeV on a self - supporting $^{27}$Al target (thickness$\sim$90 $\mu$g/cm$^2$). The experimental details have been given in Ref. [1]. A typical higher excitation energy spectrum for $^{26}$Al populated in the present study of reaction $^{27}$Al(d,t) is shown in Fig.1.

## 2. Results

The ECIS94 [6] code has been used to extact optical model potential parameters (OMP) for the entrance channel (d + $^{27}$Al). The process of extraction of OMP and the extracted OMP used in the present work can be found in [1]. The OMP for the exit channel (t + $^{26}$Al) were obtained from the global fit parameterization given by Perey and Perey [7].

The preliminary assigned levels for the higher excited states of $^{26}$Al, are shown in Fig. 1 and experimentally extracted angular distribution of these excited states are shown in Fig. 2 by solid points. In this work, the spectroscopic factors for higher excited states of $^{26}$Al will be extracted. The experimentally extracted angular distributions of these

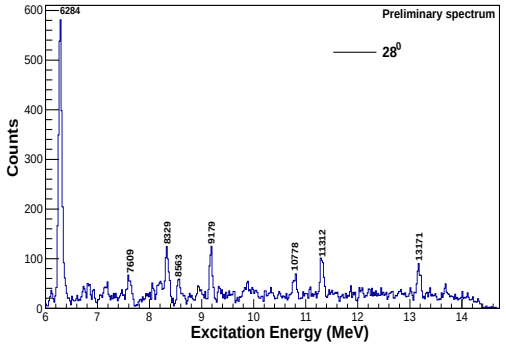


FIG. 1: Excitation energy spectrum of $^{26}$Al at $\theta_{lab} = 28^{\circ}$ produced from the reaction $^{27}$Al(d,t). Preliminary assigned excited states of $^{26}$Al (levels are in keV) are shown inside the figure.

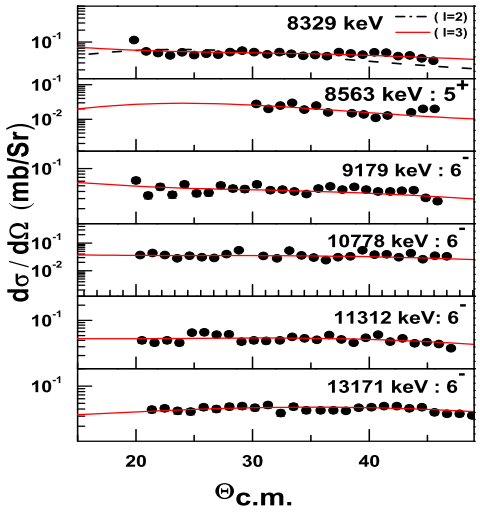


FIG. 2: Fitted angular distributions of differential cross-sections of higher excited states of $^{26}$Al. The preliminary assigned levels of the states are shown inside the figure.

states were fitted with the theoretically predicted cross sections (shown by solid and dash-dash lines in Fig. 2) using zero range distorted wave Born approximation using computer code DWUCK4 [8]. Theoretical cross sections were calculated by assuming pick up from $0d_{5/2}$ and $0f_{7/2}$ single particle orbitals and corresponding $l$ values were also shown inside the Fig. 2. The spectroscopic factor values for these states will be extracted and compared with the results of the closest reported excited states. Further analysis is in progress and the detailed results will be presented during the conference.

## 3. Acknowledgement

The authors thank the cyclotron operating staff for their cooperation during the experiments. One of the authors (A.D.) acknowledges with thanks the financial support provided by the Science and Engineering Research Board, Department of Science and Technology, Government of India vide project No. SR/FTP/PS067/2012 dated 10/06/2012. One of the authors (S.B.) acknowledges with thanks the financial support received as Raja Ramanna Fellow from the Department of Atomic Energy, Government of India.

## References

[1] Vishal Srivastava *et al.*, Phys. Rev. C **91**, 054611 (2015).
[2] Vishal Srivastava et al., EPJ Web of Conferences **86**, 00055 (2015).
[3] Vishal Srivastava et al., Proceedings of the DAE Symp. on Nucl. Phys. 59, 358 (2014).
[4] Vishal Srivastava et al., EPJ Web of Conferences 117, 07022 (2016).
[5] K. A. Chipps *et al.*, Phys. Rev. C **86**, 014329(2012).
[6] J.Raynal, Notes on ECIS94, NEA 0850/16.
[7] C. M. Perey and F. G. Perey, Atomic Data and Nuclear Data Tables**17** , l-101 (1976).
[8] http://spot.colorado.edu/ kunz/DWBA.html.