High spin states in ^{37}Ar

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Introduction

Spectroscopic study of upper sd shell nuclei gives us a unique opportunity to investigate the interplay between single particle and collective excitations experimentally and interpret them theoretically through microscopic shell model calculation [1]. Evidence of collectivity at high excitation energy has been found in several upper sd shell nuclei [2]. Previously, we had studied even-odd ^{33}S and identified two strong *E*2 transitions [3]. The level life-lifetimes of these levels were measured using lineshape analysis and their deformations estimated from the measured transition strengths. Now, we concentrate on another upper sd shell even-odd nucleus ^{37}Ar (Z=18, N=19). This nucleus was studied mostly by proton and α beams and there were only a few measurements where heavy ions were used [1,4]. E.K.Warburton et al [5] in 1976 studied this nucleus through heavy ion induced fusion reaction. They extended the level scheme up to 7 MeV and established their spin and parity. Level lifetimes of a few levels were estimated by RDM measurement. In the present work, we have studied ^{37}Ar to extend the level scheme. Spins of newly assigned levels have been assigned by DCO measurements. Large basis shell model (LBSM) calculation has also been carried out for this nucleus.

Experiment

Excited states of ^{37}Ar were populated through ^{27}Al(^{12}C,np) fusion evaporation reaction at E_{lab}= 40 MeV. The ^{12}C beam was provided by the 14 UD Pelletron accelerator at Tata Institute of Fundamental Research (TIFR), Mumbai. The ^{27}Al target with thickness 0.5mg/cm^2 was prepared with 10mg/cm^2 ^{197}Au backing. The array of fifteen Compton suppressed clover detectors placed at six different angles (INGA array) has been used to detect the gammas. Coincidence data were collected by using digital data acquisition system based on Pixie-16 modules of XIA LLC. The details of the set up and data acquisition system can be found in ref. [6].

Results and Discussions

In order to investigate the level structure of ^{37}Ar, the raw data has been sorted into symmetric and asymmetric matrices. The data has been analyzed using the analyzing program INGASORT [7]. The level scheme of ^{37}Ar has been extended using the coincidence relationship and the relative intensities of the gamma transitions. From our analysis, we have confirmed the previous level scheme. Apart from that, 12 new gammas and 2 new excited levels (2325 keV and 6031 keV) have been identified and placed in the level scheme, Fig-2. Among the 12 new gammas, 3 gammas are observed from 2217 gated spectrum and the remaining are observed from 1611 gated spectrum (Fig-1).

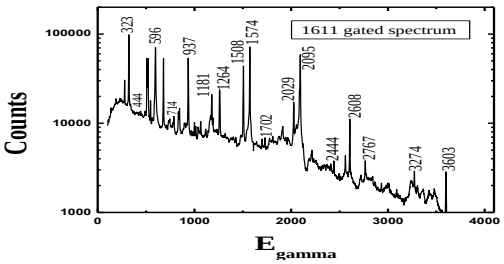

Fig 1: Background suppressed coincidence spectrum obtained by putting gate on 1611 keV transition.

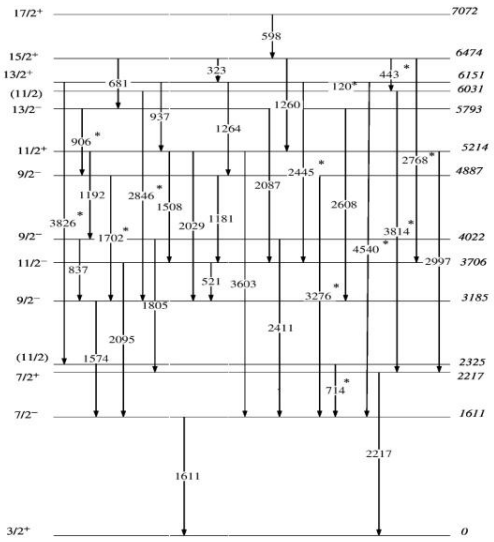

Fig. 2 Level scheme of ^{37}Ar, newly assigned gamma transitions are marked by *.

To assign the multi-polarity of the gamma transitions, the angle dependent asymmetric matrices have been used. We have measured the R_{DCO} values for a few known /new transitions to confirm/ assign the spin of the levels. Based on our results (Table-1), we have tentatively assigned the spin of the two new levels. The parities of these levels will be assigned by polarization measurement. The multipole mixing (δ) ratios of these transitions were extracted by using ANGCOR [8] program.

Table-1: R_{DCO} values for a few transitions in ^{37}Ar

E_γ (keV)	J_i	J_f	E_{gate} (keV)	ΔJ	R_{DCO}
323	**15/2$^+$**	**13/2$^+$**	**1611**	**2**	**0.55(1)**
443	**15/2$^+$**	**(11/2)**	**1574**	**1**	**0.8(2)**
714	**(11/2)**	**7/2$^-$**	**1611**	**2**	**0.8(3)**
906	**13/2$^+$**	**9/2$^-$**	**1611**	**2**	**1.1(2)**
1702	**9/2$^-$**	**9/2$^-$**	**1611**	**2**	**0.77(6)**
2095	**11/2$^-$**	**7/2$^-$**	**1611**	**2**	**0.77(2)**

In order to understand the microscopic origin of these states in ^{37}Ar, LBSM calculation have been carried out in sdpf model space using OXBASH [9] code. In the calculation, sdpfmw interaction [10] was used. We have generated the positive and negative parity states by exciting n=0 (Theo1-Pos), 1 (Theo1-Neg) and 2 (Theo2-Pos) no. of particles to the pf shell. Full sdpf model space was used and we have not changed the single particle energies of pf orbitals. The preliminary results (Fig-3) show reasonable agreement with the experiment. It shows that all the negative parity states were generated by 1p-1h configuration where as for positive parity states, above 7/2$^+$ 2p-2h configuration dominates. As the spin and parity of the new levels are still not confirmed, we do not make any comments for these levels. The data analysis is going on for further investigation.

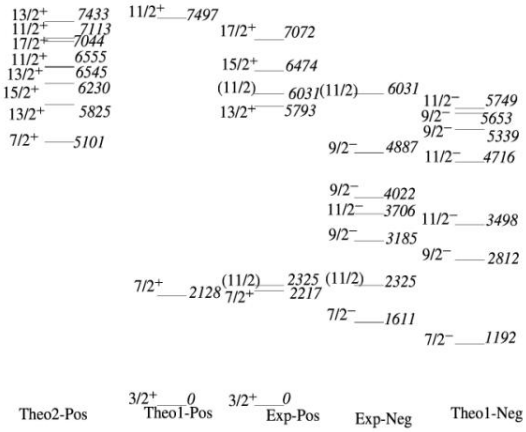

Fig-3: Comparison between experimental and theoretical levels in ^{37}Ar.

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