Spectroscopic studies of *sd* and *fp* shell $N \sim Z$ nuclei

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Introduction

During the last few years considerable efforts have been devoted to the investigations of the level structures of $N \sim Z$ nuclei. The study of the level structure of these nuclei, provide us with an unique opportunity to address the question of what "collective" features could be exhibited by magic or nearly magic nuclei [1, 2].

In the present paper we report our results on the level structure of $N \sim Z$, ^{29}Si and ^{41}Ca.

The earlier reported low-lying positive-parity states of ^{29}Si have been well explained, by the full *sd*-shell wave-functions of the Universal-SD (USD) Hamiltonian. The negative parity states could be explained only after incorporating excitations from the sd shell to the fp shell. Further, notwithstanding the success of shell model, attempts have also been made to interpret the structure of ^{29}Si by the rotational model. There are indications for the existence of a prolate deformation in this nucleus.

Lister and co-workers [1] have emphasized the need for detailed spin parity assignments in ^{41}Ca, to disentangle the configurations dominating the observed sequences, originating from the np-nh excitations. It is worth mentioning that the 3369 keV transition ($11/2^+ \rightarrow 7/2^-$) has been assigned a E3/M2 nature. This seems similar to the 1876 keV ($4^- \rightarrow 2^+$) transition in ^{34}P [3]. It would be of interest to revisit the mixing ratio measurements for the 3369 keV transition and compare it with the theoretical predictions.

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Experimental details and analysis

^{29}Si

The reaction ^{16}O + ^{18}O at an incident beam energy of $\sim$ 34 MeV was used to populate the high angular momentum states in this nuclei. The ^{16}O beam was provided by the 15UD Pelletron facility at Inter University Accelerator Centre (**IUAC**), New Delhi. The de-exciting γ rays were detected by the **I**ndian **N**ational **G**amma **A**rray (**INGA**), at IUAC consisting of 18 clover detectors.The detectors were placed at 148°,123°, 90°, 57°, 32° with respect to the beam direction.

The data was analyzed using IUCSORT and RADWARE software packages using the conventional $E_\gamma^N, N = 2, 3$ histograms. Several transitions belonging to this nuclei have been identified and are being placed in the level schemes. The preliminary level scheme is illustrated in Fig. 1. The occupation of the deformation driving *fp* shells results in the negative parity sequences. The results are being interpreted within the large basis conventional shell-model. Attempts are also being made to investigate the level structure within the framework of rotational models, since the earlier reports indicate moderate success for both these models.

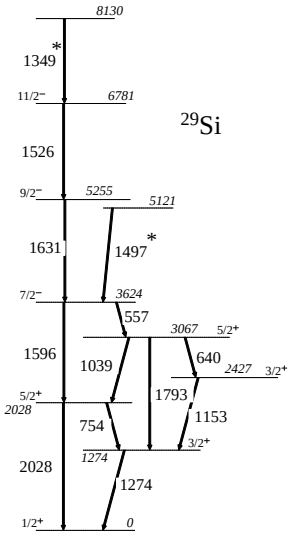

FIG. 1: Preliminary level scheme for ^{29}Si as developed from the present investigations.

^{41}Ca

During the above experiment, partially the beam was incident on the Al frame. The ^{16}O + ^{27}Al reaction resulted in the population of nuclei such as ^{38}Ar, ^{41}K, ^{41}Ca to name a few. This provides us a figure-of-merit for the power of the INGA array in detecting such channels originating from secondary reactions.

Several new transitions have been identified and are being placed in the level schemes. A representative preliminary level scheme for ^{41}Ca is presented in Fig.2. The main yrast sequence has been extended and bears a qualitative resemblance to a collective structure plausibly based on core-excitation.

The observed angular correlations and the linear polarization measurements are being analyzed simultaneously to obtain a consistent information on the spin-parity of the levels.

It is envisaged that these results will encourage detailed microscopic calculations in these nuclei.

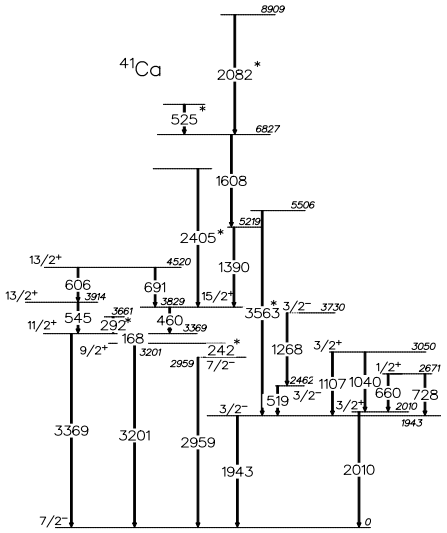

FIG. 2: Preliminary level scheme for ^{41}Ca as developed from the present investigations.

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