Shell model calculations in ^{96}Tc

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Introduction

Nuclei with neutron number in vicinity of the major shell closure at $N = 50$, and the proton number lying between the semi-closed $Z = 40$ and the closed $Z = 50$ shells provide particularly good laboratories to probe the weakly deformed nuclei. Theoretical interpretations of level structures from new spectroscopic studies in these nuclei have revealed novel deformation-generating mechanisms[1, 2]. The nuclei approaching the neutron and proton major shell closures at N=Z=50 provide a unique opportunity to study interplay between the single-particle and collective degrees of freedom, and influence of the valence orbitals on deformation. Various new deformation generating mechanisms have been identified in theoretical interpretation of the observed band structures. Theoretical interpretations of level structures from new spectroscopic studies in these nuclei have revealed novel deformation-generating mechanisms.

Experimental details

High angular momentum states in the ^{96}Tc nucleus were populated in the fusion-evaporation reaction ^{75}As(^{28}Si,4p3n) at E_{lab} = 120 MeV. The ^{28}Si beam was delivered by the 15UD Pelletron accelerator at Inter University Accelerator Centre (IUAC), New Delhi. The ^{75}As target of thickness 3 mg/cm^2 onto a 10 mg/cm^2 thick Pb backing was prepared by vacuum evaporation followed by rolling. The recoiling nuclei were stopped within target and the backing. The deexciting γ rays from the populated nuclei have been investigated through in-beam γ-ray spectroscopic techniques using the Indian National Gamma Array (INGA) [3] equipped with 18 clover detectors mounted in five rings configuration. The photopeak efficiency of the array is ∼5% at the 1.3 MeV γ-ray energy with all the 24 clover detectors in place in INGA. A total of about 300 million triple or higher-fold coincidence events were recorded in the experiment. The RADWARE software package [4] was used to establish the energy, intensity, and coincidence relationships for various observed γ-ray transitions, and perform the angular correlation and polarization analyses.

Results

The present level scheme of ^{96}Tc is built on the $I^{\pi} = 7^{+}$ ground state shown in Fig. 1. The level scheme of ^{96}Tc has been extended substantially with addition of about new twenty five transitions. Four bands labeled B1-B4 could be identified in the present level scheme, which is established up to 10 MeV excitation energy. The level scheme is a significant extension to those reported in the earlier work by Gugre et al. [5] and Bucurescu et al.,[6]. The present level scheme preserves major features of the previously observed bands B1-B3. The order of 282,474, and 938-keV transitions in band B1 is confirmed in the present work which is differed in earlier work [6]. Multi-fragmentations at the positive parity bands at spins around 18 is observed, which are likely to be maximally spin aligned states similar to the ones observed in ^{101}Rh. Spherical shell-model description These calculations are also quite feasible for the ^{96}Tc nucleus as there are not too many active particles. The shell model

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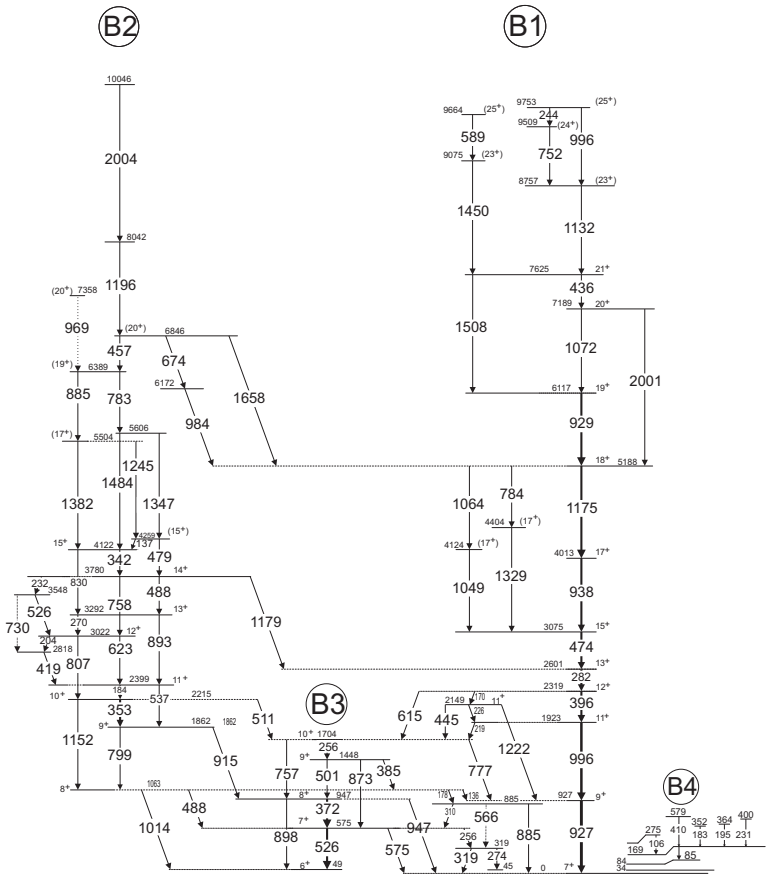

FIG. 1: Partial Level scheme of ^{96}Tc obtained from present work.

provides a microscopic basis for the collective types of approach. In order to interpret the level structure of ^{96}Tc, state-of-the-art shell-model calculations have been performed using NuShell [7] computer code. The calculations have been carried out by taking $^{88}_{38}$Sr as core and $jj45pn$ model space involving valence protons distributed over the single particle $2p_{1/2}$ and $1g_{9/2}$ orbitals and neutrons occupying $1g_{7/2}$, $2d_{5/2}$, $2d_{3/2}$, $3s_{1/2}$ and $h_{11/2}$ orbitals. The details of the wave functions for the excited higher spins states of positive parity states of ^{96}Tc corresponding to the experimental ones are in agrement, and will be presented.

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