Nuclear structure studies close to Z≈N≈50

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Introduction

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. Theoretical interpretation of band structures observed in the nuclei approaching major shell closures at $N = Z = 50$ have revealed diversity in the deformation-generating mechanisms. The proton particle-hole excitations across the major shell gap are energetically possible due to the strong proton-pair correlations and proton-neutron interaction between the spin-orbit partner orbitals. Investigations have revealed band structures resulting from the coupling of $g_{9/2}$, $d_{5/2}$, $g_{7/2}$ and $h_{11/2}$ valence nucleons, and the core-excited configurations.

Experimental details and data analysis

Excited states in the ^{96}Ru, ^{98}Rh, and ^{99}Rh nuclei were populated in fusion-evaporation reaction ^{75}As (^{28}Si, *xpyn*) 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 are stopped within target and the deexciting γ-rays were detected using the Indian National Gamma Array (INGA) at IUAC equipped with 18 clover detectors mounted in five rings configuration. A total of about 300×10^6 triple or higher-fold coincidence events were recorded in the experiment. The data were sorted offline using INGASORT [1] program to produce symmetrised E_γ-$E_\gamma$matrices and E_γ-E_γ-E_γ cube. RADWARE analysis package [2] was used to establish coincidence and intensity relationships for various γ transitions. The clover detectors were calibrated for γ-ray energies and efficiencies using the ^{133}Ba and ^{152}Eu radioactive sources. The photopeak efficiency of fully equipped INGA array at IUAC is around 5% at the 1.3MeV γ-ray energy. The level schemes were constructed on the basis of γ-γ coincidence relations, energy and intensity balances. A two dimensional angular correlation matrix between the detectors at near 90°and those at near 30° was constructed and used for the directional correlation of oriented states (DCO) ratio analysis to distinguish between quadrupole and dipole transitions. The clover detector at 90° was used as a Compton polarimeter to determine the electric or magnetic nature of the γ-rays by using the integrated polarization asymmetry (IPDCO) analysis with two asymmetric polarization matrices corresponding to the parallel and perpendicular segments of the clover detectors.

Results and discussion

In ^{98}Rh, the earlier reported level scheme has been extended substantially at lower and medium spins with the addition of about sixty transitions. Few new observed low-lying states are likely to be isomers. The linking transitions support their excitation energies to be to be lower than the previously assigned 2^+ ground state [3]. It suggests that the earlier proposed 2^+ ground state needs to re-assigned. Theobserved bands are interpreted to be based on the $\pi g_{9/2} \otimes \nu d_{5/2}$ and $\pi p_{1/2} \otimes \nu d_{5/2}$, $\pi g_{9/2} \otimes \nu g_{7/2}$, and $\pi g_{9/2} \otimes \nu g_{9/2}$ configurations.

The level scheme of ^{99}Rh established in the present work is shown in Fig. 1. It shows features similar to those observed in ^{101}Rh.

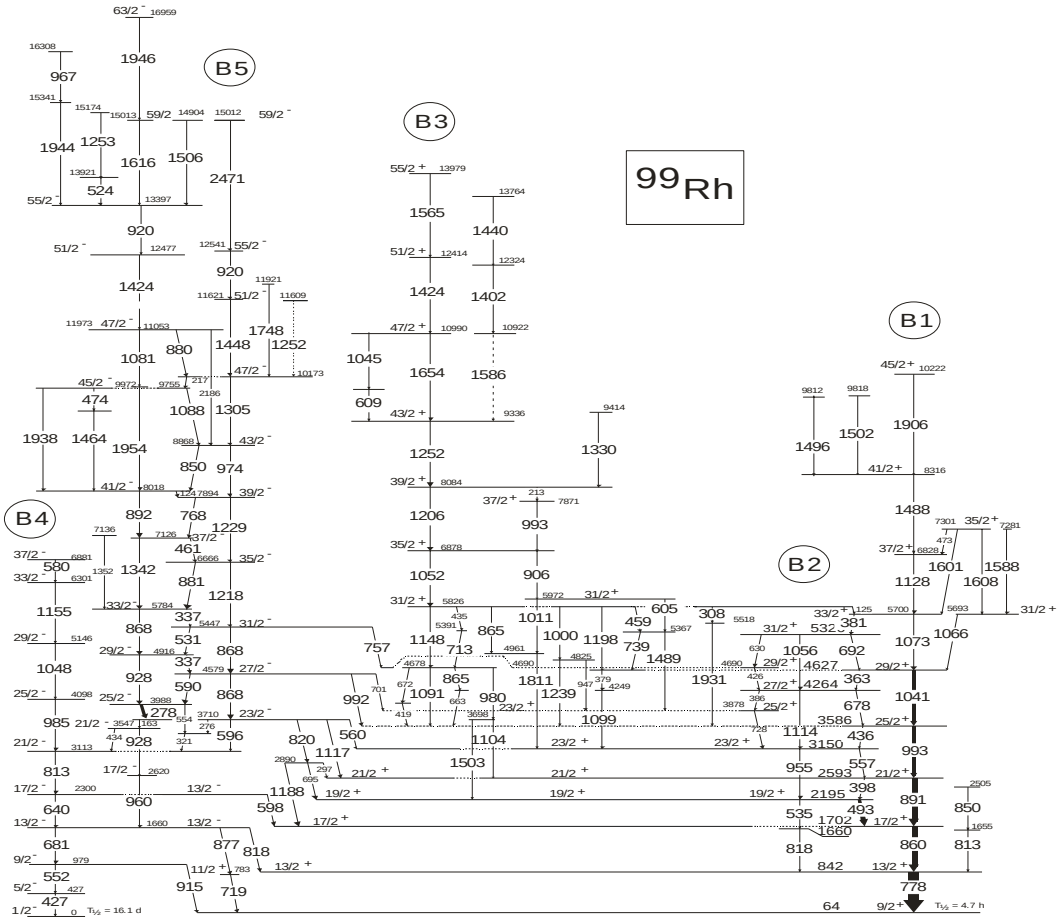

Fig.1The level scheme of ^{99}Rh developed in the present work.

The observed $65/2^+$ state is expected to be terminating with the $\pi[(g_{9/2})^5]_{12.5}$ $\nu[(d_{5/2}g_{7/2})^4]_{10}$ single-particle configuration. In the present work, this signature of the band could be observed up to spin $59/2^+$. For the negative parity bands configuration to be yrast at high spin. The observed $57/2^-$ state is also expected to be terminating one with $\pi[(g_{9/2})^5]_{12.5}$ $\nu[(d_{5/2}g_{7/2})^5]_{10.5}$ $[(h_{11/2})^1]_{5.5}$ configuration.

Level scheme of ^{96}Ru is built on the $I^{\pi}=0^+$ ground state. The present level scheme has been extended substantially with addition of about thirty new transitions. Three bands could be identified in the present level scheme, which is established up to ~10 MeV excitation energy and J~22$\hbar$. The level scheme is a significant extension to those reported in the earlier work [5]. The present level scheme preserves major features of the previously observed bands.

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