Band structures in ^{98,99}Rh Nuclei

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Introduction

The high spin structure of odd-A nuclei in mass region A ~ 100 has attracted many experimental and theoretical investigations in recent years because of several structural phenomena such as prediction of high spin terminating bands, magnetic rotation, and chiral rotation[1]. Further the study of nuclei close to doubly magic provide necessary insight into evolution of collective degrees from single particle ones. The ^{98,99}Rh isotopes have odd proton in the $g_{9/2}$ and $p_{1/2}$ orbitals situated below the Z=50 gap and neutron occupy high-Ω orbitals. Strongly prolate driving low- Ω unique parity $h_{11/2}$ neutron orbital is accessible at low excitation energies for the nuclei with neutron number receding the N=50 shell closure. The coexistence of spherical and deformed shapes increases the complexity of the level structures.

In the present work, high spin data obtained for the ^{98,99}Rh isotopes are presented. Previously the ^{98}Rh had been studied by Chattopadhyay et al. [2] and Ghugre et al. [3] using the heavy ion reactions. The level scheme of ^{99}Rh is previously reported work by Singh et al. [4] using 8 Ge detector array.

Experimental details and data analysis

The present work reports in-beam γ-ray spectroscopic measurements to study level structures in ^{98,99}Rh isotopes. Excited states in ^{98,99}Rh were populated in fusion-evaporation reaction ^{75}As (^{28}Si, xpyn) at E_{lab} = 120 MeV. The de-excitations have been investigated through in-beam γ-ray spectroscopic techniques. 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 target and the de-excitations γ-rays were detected rolling. The recoiling nuclei were stopped within using the Indian National Gamma Array (INGA) equipped with 18 clover detectors mounted in a five rings configuration.

A total of about 300×10^6 triple or higher-fold coincidence events were recorded in the experiment. The clover detectors were calibrated for γ-ray energies and efficiencies using the ^{133}Ba and ^{152}Eu radioactive sources. The data were sorted offline using INGASORT program to produce symmetrised E_γ-E_γ matrices and E_γ-E_γ-E_γ cubes. The level schemes were establish using coincidence and intensity relationships for various gamma transitions. The spin-parity assignments to levels were made using DCO and polarization measurements. The previously known level scheme of ^{98}Rh and ^{99}Rh has been extended considerably with the addition of about 60 new γ-rays in each case. The placement of transitions observed in the previous work are revised and established.

Results and discussion

The present level scheme of ^{99}Rh (Fig. 1) has been established up to J = 59/2$\hbar$. The identified bands have been labeled as B1-B5. The low lying band structures are based on $\pi p_{1/2}$ and $\pi g_{9/2}$ quasiparticles which further evolve into high spin structures following $(\nu h_{11/2})^2$ alignment. The level scheme is a significant extension to those reported in the earlier work by Singh et al. [4]. The present level scheme preserves major features of the previously observed band to be based on $\pi g_{9/2} \otimes (\nu h_{11/2})^2$. The previously observed single quasiparticle bands based on $h_{11/2}$, $g_{7/2}$, and $d_{5/2}$ neutron orbitals have been substantially extended. Multifragmentations at the positive parity and negative parity bands at spins around 20$\hbar$ is observed, which are likely to be maximally spin aligned states similar to the ones observed in ^{101}Rh [5].

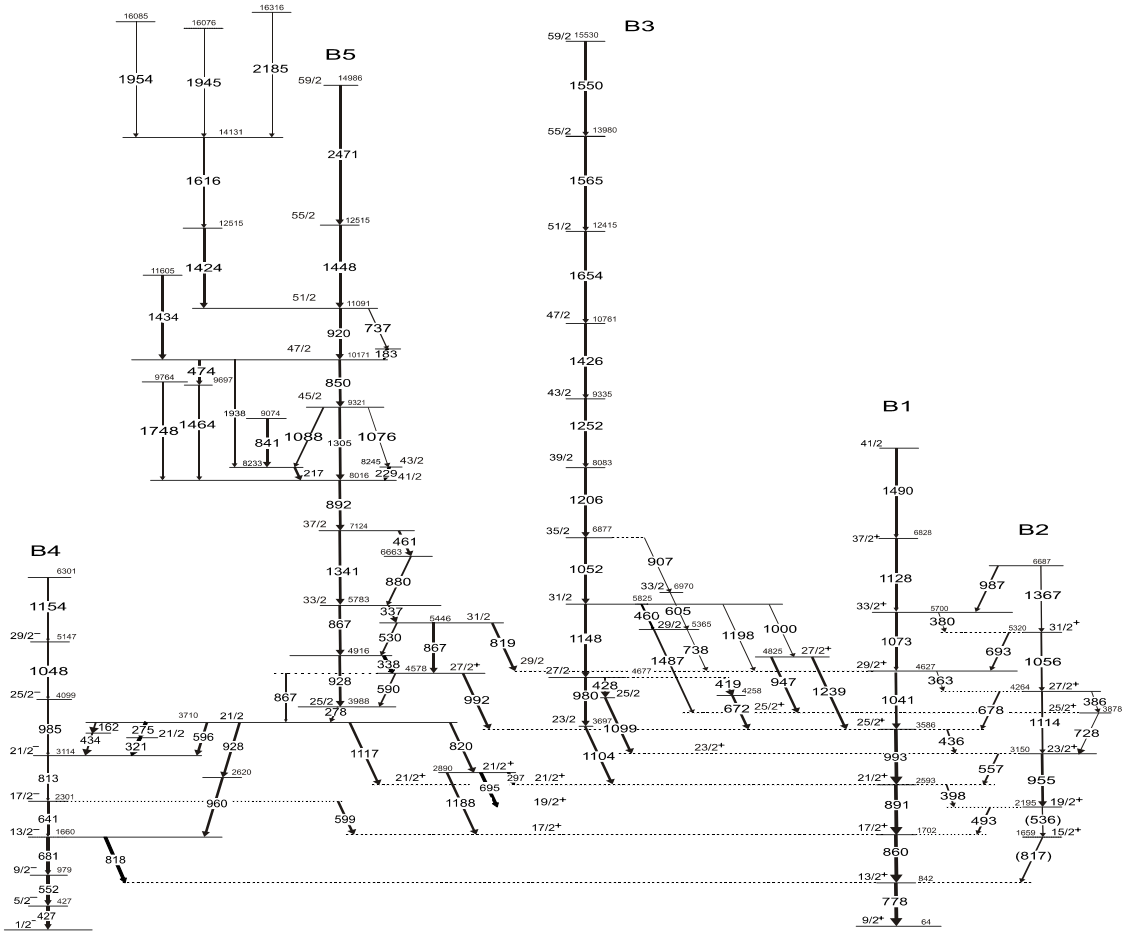

Fig.1 The level scheme of ^{99}Rh developed in the present work.

The present level scheme of ^{98}Rh has been established up to E ~ 10 MeV and J = 21$\hbar$. The level scheme has been extended substantially at the low excitation energies. A few low-lying states likely to be isomers are observed in the present level scheme with excitation energy lower than the previously assigned 2^+ ground state. It suggests that the earlier proposed 2^+ ground state needs to reassigned. Major changes in the level scheme of ^{98}Rh and its interpretation is expected in the present investigations.

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