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Short note

Band structures in doubly-odd ^{100}Rh

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Abstract. High spin states of ^{100}Rh have been populated using the reaction ^{70}Zn+^{36}S at 130 MeV. γ-rays were detected with the EUROGAM2 array. The level structure of ^{100}Rh has been extended up to 14.41 MeV excitation energy. Several band structures are observed. A band based on a I^π=8$^-$ state is developed up to the I^π=24$^-$ level. It is assigned as the $\pi g_{9/2}^{-5} \nu h_{11/2}$ configuration.

PACS. 23.20.Lv Gamma transitions and level energies – 27.60.+j 90 ≤ A ≤149

Transitional nuclei with Z<50 and A≃100 are characterized by a very γ-soft potential and a small quadrupole deformation at low and moderate angular momenta. The doubly-odd nuclei have configurations which are dominated by the odd proton in orbitals ($g_{9/2}$, $p_{1/2}$, $f_{5/2}$) situated below the Z=50 gap and the odd neutron in orbitals ($d_{5/2}$, $g_{7/2}$, $h_{11/2}$) situated above the N=50 gap. This induces complex level structures for which the proton and the neutron occupy high-Ω and/or low-Ω orbitals. In addition, the coexistence of spherical and deformed shapes increases the complexity of the level structures. In this article high-spin data obtained for the doubly-odd (Z=45,N=55) nucleus ^{100}Rh are presented together with proposed configurations of observed band structures.

The reaction ^{70}Zn(^{36}S,p5n) at a bombarding energy of 130 MeV has been used to populate states in ^{100}Rh. The beam was provided by the Vivitron accelerator, Strasbourg. The target was made of two stacked self-supporting foils of Zn, enriched to 70% in ^{70}Zn, each with a thickness of 440 μg·cm^{-2}. The γ-rays were detected by using the EUROGAM Phase2 array [1]. Coincidence events were collected when at least four suppressed Ge detectors fired. A total of 6×10^8 Compton-suppressed events were written on magnetic tapes. After unpacking off-line the higher fold events, a non-gated and several gated $E_{\gamma 1} - E_{\gamma 2} - E_{\gamma 3}$ cubes have been produced and analysed using the LEVIT8R graphical spectrum analysis package [2]. R_{DCO} ratios and the linear polarisation of γ-rays have been measured.

Low-energy levels established by the ^{99}Ru+α [3] and ^{96}Mo+^{7}Li [3] [4] fusion-evaporation reactions were used as a starting basis for our level scheme (Fig. 1). In our experiment the reaction induced by ^{36}S ions favours strongly the population of yrast and yrare states. This explains why the positive-parity states based on the I^π=5$^+$,($T_{1/2}$=4.6 min) and I^π=7$^+$,($T_{1/2}$=140 ns) isomers are weakly fed and no new positive-parity level identified. The positive-parity states are not represented in the partial level scheme of Fig. 1. The I^π=8$^-$ state at an excitation energy of 1.163 MeV above the 4.6 min isomer [4] is the basis of a complex ensemble of states extending up to 14.41 MeV excitation. This ensemble is constituted of several band structures, two of them being discussed in the present paper:

Band 1: This band develops from I^π=8$^-$ up to I^π=24$^-$ and 21$^-$ for the α=0 and α=1 signature branches, respectively. It is strongly populated. The spacings between the lowest levels are very close to those observed in the isotope ^{102}Rh [5] [6] and neighbouring doubly-odd nuclei (e.g. ^{102}Ag [7] [8]).

The intensities of the stretched E2 transitions do not follow a pattern typical of a collective band. The I^π=15$^-$ level deexcites to both the I^π=14$^-$ level in band 1 and the I^π=14$^-$ level in band 2 by two intense M1 transitions (368 and 459 keV) while the 885 keV, E2 transition is extremely weak (one order of magnitude smaller than the other E2 transitions in the same signature cascade). The

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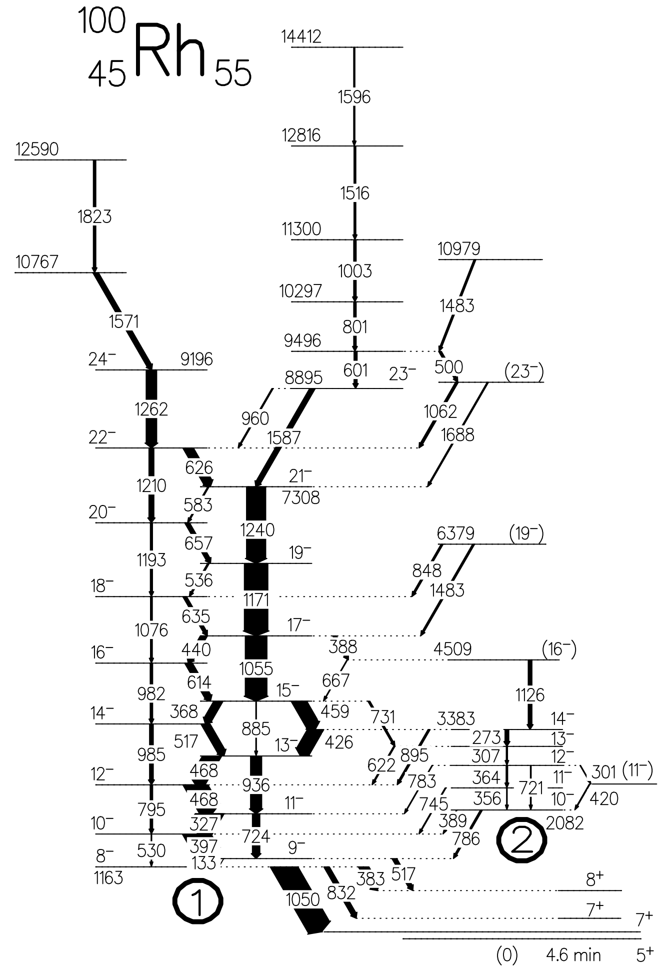

Fig. 1. Partial level scheme of ^{100}Rh obtained in the present work. Level and γ-ray energies are given in keV. The level energies are relative to the 4.6 min isomer. The width of the arrows is proportional to the γ-ray intensity

experimental B(M1, I→I-1)/B(E2, I→I-2) ratios (Fig. 2), assuming pure M1 transitions, clearly point an anomaly at spin 15. The highly-fragmented deexcitation pattern and large amplitude of the B(M1)/B(E2) ratio at the I^{π}=15$^-$ state is very likely due to the fact that the I^{π}=14$^-$ level at 3383 keV in band 2 is yrast. A very similar situation exists in ^{102}Ag [8]. In ^{102}Rh [5] [6] where the equivalent of band 2 is slightly higher in energy, the B(M1)/B(E2) ratios evolve smoothly as a function of spin.

Total Routhian Surface calculations show a very shallow minimum in the potential energy surfaces, which agrees with the poorly collective character of band 1. This ΔI=1-type band is produced by the coupling of a quasiproton in a high-Ω orbital to a strongly aligned (Ω=1/2) quasineutron. It is assigned as the $\pi g_{9/2}^{-5}\nu h_{11/2}$ configuration as in the heavier odd-odd Rh and Ag isotopes. The stabilization of a deformed shape at $\beta_2 \approx 0.10 - 0.15$ is induced by the $h_{11/2}$ neutron.

Band 2: This ΔI=1 band is constituted of five levels at least which are connected by M1 transitions. The spin

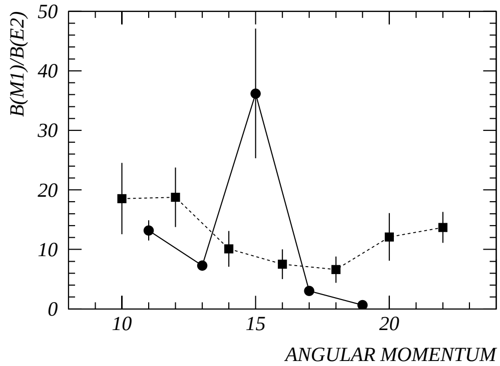

Fig. 2. Experimental B(M1, I→I-1)/B(E2, I→I-2) ratios in units of $\mu_N{}^2$/e^{2}b^2 for the levels in band 1 as a function of angular momentum I

and parity I^{π}=14$^-$ of the 3383 keV level are firmly established by the measured R$_{DCO}$ ratio and linear polarisation of the 459 and 426 keV lines. The levels decay to band 1 mainly via ΔI=1 magnetic transitions. The configuration of band 2 may be inferred from the level structures observed in neighbouring nuclei. It is known that in odd-A Rh and Ag isotopes the $1/2^-(\pi p_{1/2})$ and $9/2^+(\pi g_{9/2})$ intrinsic states are very close in energy. Shell model calculations performed for the doubly odd ^{100}Ag [9] show that a six-quasiparticle configuration $\pi(g_{9/2}^{-2}p_{1/2}^{-1})\nu(d_{5/2}g_{7/2})^3$ may become yrast or may be strongly mixed with a four-quasiparticle configuration $\pi g_{9/2}^{-3}\nu h_{11/2}$. On the basis of these comparisons, we think that the dominant configuration in band 2 of ^{100}Rh could be $\pi(g_{9/2}^{-4}p_{1/2}^{-1})\nu(d_{5/2}g_{7/2})^5$.

A detailed analysis of the results will be given in a forthcoming publication.

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