SOVIET PHYSICS JETP VOLUME 19, NUMBER 2 AUGUST, 1964

Brief Communications*

ENERGY LEVELS OF THE Rh^{104} *NUCLEUS*

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Submitted to JETP editor July 17, 1963

J. Exptl. Theoret. Phys. (U.S.S.R.) 46, 807-809 (February, 1964)

In recent years there have been a number of publications dealing with the γ radiation from the $Rh^{103}(n, \gamma)Rh^{104}$ reaction: the $\gamma\gamma$-coincidence spectra have been measured [1,2], and the energies of the γ rays have been established with a high degree of accuracy by means of diffraction spectrometers ([3], and also a private communication from U. Grueber, B. Mayer, and O. Schult of the Munich Technical Institute). The characteristics of three low-lying excited levels have also been reliably determined from the decay of the Rh^{104m} isomer [4-6]. By combining these data, it has been possible to make more accurate and to supplement substantially the scheme of the energy levels of the odd-odd Rh^{104} nucleus.

The level scheme and the transitions between levels were obtained by combined analysis of the results of the quantitative processing of measurements of the coincidences between γ rays in defined energy regions (scintillation spectrometer) and of the exact values of the γ-line energies in these regions (diffraction spectrometers). The γ-line intensities n_γ [1,3] were used as the connecting link for locating correspondences between the γ transitions detected in measurements made by varying methods. Fulfilment of the Ritz combination law was also kept as a necessary condition for the construction of the scheme.

The results of such an analysis are given below. We intend to publish at a later data a more complete account of the work, which was issued earlier in the form of a preprint [7].

The proposed Rh^{104} level scheme includes the 26 most intense γ transitions which we detected in the coincidences, and also 86 γ-lines which were found by means of diffraction spectrometers, i.e., approximately half of the known γ rays in the 30—800 keV range. All the γ lines with energies $E_\gamma < 260$ keV and intensities $n_\gamma > 0.8\%$ were used, except for the γ line with $E_\gamma = 169.04$ keV and $n_\gamma = 3.85\%$. The level scheme divides up naturally into four systems, with the levels in each interconnected by intense transitions leading to the well-populated low-lying excited states with energies 51.422 [2^-], 97.114 [2^+], 180.86 [$2^{(+)}$] and 215.49 [$(2)^+$] keV, from which transitions mostly to the ground state are observed. The list of Rh^{104} energy levels is shown in the table. The multipolarities of some transitions (31.58, 51.422, 97.114, 100.79, 127.32, and 134.62 keV) were determined in terms of α_K, found from the K-radiation intensities in the $\gamma\gamma$-coincidence spectra. In these cases, the determination of the spin and, particularly, the parity assignments for the levels was sufficiently well-founded. In the remaining cases, the level characteristics enclosed in parentheses in the table and in the text, were found in terms of the intensities of the competing E1, M1, or E2 transitions to levels with known characteristics, on the assumption that the ratio B(E1)/B(M1) of the given probabilities is several orders less than for single-particle transitions.

Most of the states included in the system with the reference level 51.422 keV have negative parity and appear in the (d, p) reaction [8]. It is probable that levels 51.422 [2^-] and 269.34 [3^-] form a doublet of configuration $p_{1/2}$, $d_{5/2}$ (their energy splitting conforms with the analogous quantity in the adjacent nuclei [9]). From the intensity ratio of the transitions to the components of this doublet [10], a configuration $p_{1/2}$, $d_{3/2}$ can be assigned to the level 384.98 [(2^-)] keV. The levels with energies 186.04, 213.10, 216.72, and 266.75 keV can be the fundamental multiplet [11] of the first excited level [2^-] and have the characteristics 3^-, 2^-, 1^-, and 0^-.

The states from which transitions lead to the 97.11 [2^+] keV level have positive parity and spin values 2, 3, 4, and 5. The low-lying levels of this

*In view of the editorial backlog, only brief summaries of the results of some investigations will be published here. A detailed version will either be published elsewhere, or will be on deposit at VINITI (All-union Institute for Scientific and Technical Information).

Rh^{104} energy levels

Reference level	States associated with the given reference level
51.422 [2^-]	**186.04** [$1,2^-$]; 213.10 [($1,2^-$)]; **216.72** [(3^-)]; 266.75; **269.34** [3^-]; **384.98** [(2^-)]; **426.32** [($2,3^-$)]; **606.9**; **660.4** [(2,3)]; 804.2
97.114 [2^+]	**128.97** [5^+]; **197.90** [$(3)^+$]; **224.43** [$(3)^+$]; **329.80** [(4^+)]; **368.24** [$(3)^+$]; 400.74 [$(2,3)^+$]; **420.94** [$(2,3)^+$]; 515.23; **645.5** [$(2)^+$]; 950
180.86 [$2^{(+)}$]	**212.44** [$3^{(+)}$]; 235.62 [(5^+)]; **297.79** [(4^+)]; **316.09** [($2,3^+$)]; **358.67** [($1,2^+$)]; 418.04
215.49 [$(2)^+$]	178.84 [$(2)^+$]; **353.21** [$(3)^+$]; **433.96** [$(3)^+$]

Note: The figures in bold type denote the energies of reliably determined levels, and those in light type denote those which are less reliably determined, but not contradictory to $\gamma\gamma$-coincidence data. The level energies are in keV, and the level characteristics J^π are shown in square brackets.

system can apparently be explained by a mixture of the configurations $(g_{9/2})^5_{7/2}$, $d_{5/2}$ and $g_{9/2}$, $d_{5/2}$, in the same way as in the Ag^{104} nucleus [12].

About $\frac{1}{5}$ of the total number of transitions to the ground state ($n_\gamma(180.86) \approx 20\%$) pass through the reference level with energy 180.86 keV. From the levels included in this system there occur only transitions to the ground state and to the levels of the same system, but no transitions to levels with negative parity. These facts can be explained naturally, if it is assumed that the states of this system have positive parity. On the basis of this assumption, the spin alternation and energy splitting of levels 0[1^+], 180.86[$2^{(+)}$], 212.44[$3^{(+)}$], 235.62 [(5^+)], and 297.49[(4^+)] keV are in agreement with the calculated results [13] for the configuration $g_{9/2}$, $g_{7/2}$.

Thus, despite the fact that proton-neutron interaction in the odd-odd Rh^{104} nucleus makes the system of energy levels highly complex, many of them can be interpreted within the limits of existing theories on the nature of the excited states of undeformed nuclei.

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Translated by Rita R. Inston
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