vom Drehwinkel α des Teilkreisels relativ zum Rumpf abhängen (ν soll dabei für die Gesamtheit der elektronischen Quantenzahlen stehen).

Vernachlässigt man in (19) sämtliche Elektronen-Terme, rechnet also mit einem Modell starrer Punktladungen, so sollte man aus (19 c) schon ohne jede Störungsrechnung die Struktur des endgültigen „g-Tensors" für den Fall der internen Rotation erraten können. Einsetzen der Ausdrücke (8 a) für die Punktladungsanteile des „Zeeman-Vektors" ergibt dabei einen Ausdruck, der dem von HÜTTNER und FLYGARE in [6] angegebenen Operator entspricht, aber eine Reihe zusätzlicher Glieder enthält, deren Einfluß bei niedrigem Hinderungspotential schwer abzuschätzen ist. Da es sich bei dem in [6] untersuchten Molekül – Acetaldehyd – um eine Verbindung mit einem vergleichsweise hohen Hinderungspotential (V_3 = 1167 cal/Mol) handelt, bei der sich die interne Rotation noch nicht in einem Unterschied der Zeeman-Aufspaltung von A- und E-Spezies des Torsionsgrundzustands bemerkbar macht, wird die Auswertung der Acetaldehyddaten aber vermutlich von den Zusatzgliedern nicht beeinflußt.

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Low Energy Gamma Transitions in ^{171}Tm

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The low energy gamma-ray spectrum of ^{171}Er has been studied with the use of both Ge (Li) gamma-ray and a high resolution iron free double focusing beta-ray spectrometer. The data provide K-conversion coefficients and multipolarities of eight gamma-rays. Spin and parity assignments 7/2+, 3/2+, 5/2+ and 5/2+ are given to the 636, 676, 738 and 913 keV levels respectively.

Introduction

The decay properties of ^{171}Er were studied earlier by several groups [1–5], using different techniques. Recently, we have investigated [1] the decay scheme of ^{171}Er by means of an electron-gamma coincidence spectrometer and the existence of 32 transitions in ^{171}Tm was confirmed. In spite of the extensive studies of γ-transitions following the decay of ^{171}Er, the spin and parity assignments for most of the levels are questionable. Therefore, further studies are necessary in order to draw more definite conclusions about level properties.

The present study was undertaken to determine the internal conversion coefficients and multipolarities of some γ-rays from which information on excited states of ^{171}Tm could be deduced.

1. Experimental Procedures

The study of the internal conversion electron spectrum was carried out using a high resolution iron-free double focusing β-ray spectrometer [6] ($\varrho_0 = 50$ cm). With this instrument relative momentum measurements could be made with an accuracy of a few parts in 10^5. With a (0.2×2) cm^2 source and a 2 mm detector slit, a resolution of $\sim 0.15\%$ is obtained. The detector employed in the present studies was a G.M. counter with ~ 2 mg /cm^2 mica end window.

The gamma-ray intensity data were recorded using a 2.5 cm^3 Ge (Li) detector having a system resolution (FWHM) of 2.5 keV for the 661 keV γ-ray of ^{137}Cs. The detector was connected through low noise electronics to a 400 channel pulse-height analyser. The experimentally deduced relative efficiency correction curve for the germanium detector is estimated to be accurate to $\pm 3-5\%$. The energy calibration was carried out before and after each irradiation by using standard sources of well-known energies.

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The radioactive sources used in the present work were prepared by irradiating samples of Er_2O_3 (enriched to ~ 96% in ^{170}Er), at a thermal neutron flux of approximately 10^{12} n/cm²·sec. For electron conversion studies the sources were prepared by evaporating the erbium oxide in vacuo onto an aluminium foil of thickness 0.7 mg/cm². The thickness of the sources ranges between 40 – 80 μg/cm².

2. Measurements and Results

The γ-ray spectrum of energy below 350 keV was measured, and the Ge(Li) spectra used for the intensity measurements is shown in Figs. 1 and 2. The interest was focused on the low energy γ-rays for which conversion coefficients could be determined. There is no evidence in this spectrum for the previously reported 166 keV transition [7]. The steep rise in the back-ground in this energy region makes it difficult to estimate the upper limit for the intensity of a possible 166 keV transition. The relative intensities of the γ-rays were calculated from the areas under the full energy after due correction for the presence of preabsorbers, detection efficiency and the full energy peak-to-total ratio as a function of energy. The energies and relative intensities of the γ-rays of interest are given in the Table 1.

The present results compare well with the recent data of RAESIDE et al. [5]. As it was the main purpose

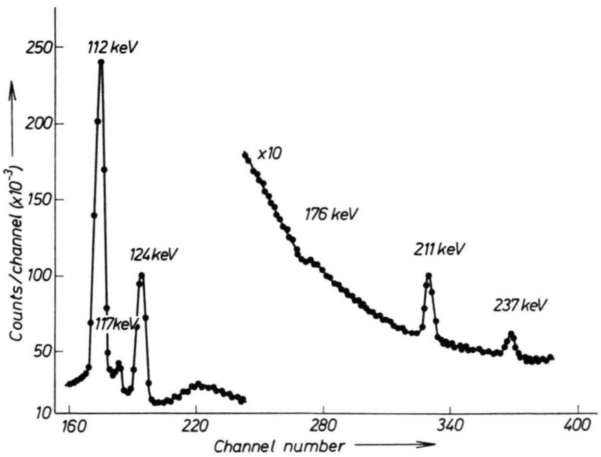

Fig. 1. The low energy portion of the γ-ray spectrum of ^{171}Er to an energy of 240 keV.

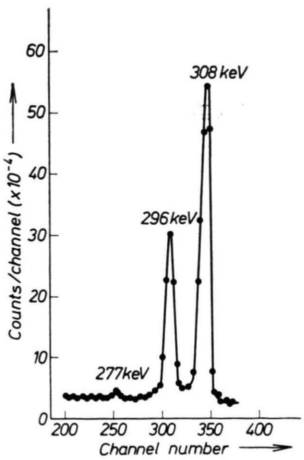

Fig. 2. Gamma spectrum of the 277, 296 and 308 keV transitions in ^{171}Tm.

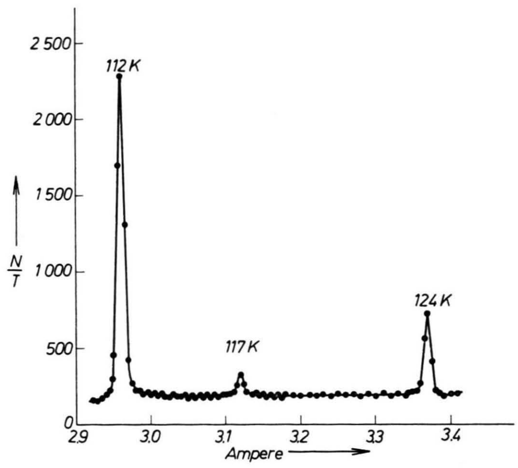

Fig. 3. The internal K-conversion lines of the 112, 117 and 124 keV transitions in ^{171}Tm.

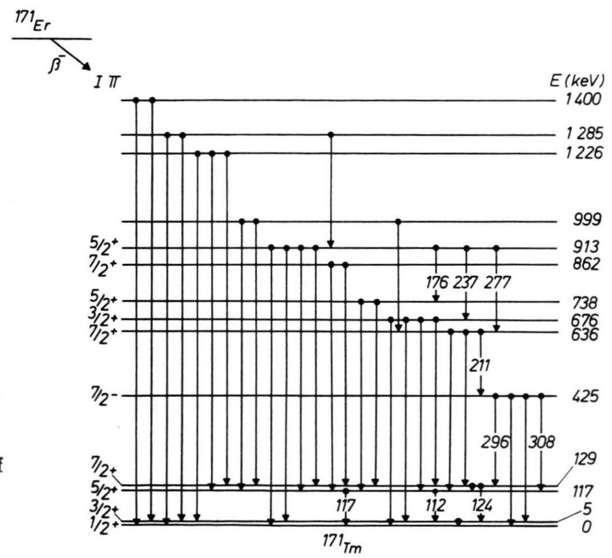

Fig. 4. The level scheme of ^{171}Tm populated in the beta decay of ^{171}Er.

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Energy (keV)	Relative gamma-intensity	Experimental K-conversion coefficient	Multipolarity
111.60 ± 0.004	31.2	1.6 ± 0.2	M1+27% E2
116.71 ± 0.007	3.1	0.70 ± 0.06	E2
124.12 ± 0.005	14.7	0.61	E2
175.71 ± 0.04	0.014	0.5 ± 0.07	M1
210.63 ± 0.04	1.0	0.047 ± 0.006	E1
237.21 ± 0.05	0.5	0.20 ± 0.03	M1+35% E2
277.32 ± 0.06	0.9	0.13 ± 0.02	M1+40% E2
296.10 ± 0.02	45	0.017 ± 0.002	E1
308.18 ± 0.02	100	0.016 ± 0.002	E1

Table 1. Low energy gamma transitions in the decay of ^{171}Er.

of this work on the decay of ^{171}Er to determine the conversion coefficients of low energy γ-rays, the internal conversion spectra for the transition of interest were studied carefully by means of a double focusing β-ray spectrometer. The K-conversion lines have been observed, see Fig. 3, and their relative intensities were obtained. By means of the photon intensities and conversion electron data, we calculated the absolute K-conversion coefficients which are presented in Table 1. Normalization between the two series of data is obtained by assuming that the 124 keV transition is a pure E2 transition as it was previously [1] proved by coincidence measurements. In order to determine the multipole orders of the transitions, the values of conversion coefficients are compared with theoretical ones interpolated from the tables calculated by SLIV and BAND [8].

The 210.63, 296.10 and 308.18 keV γ-rays were found to be pure electric dipole transitions, while the 116.71 and 124.12 keV γ-rays are pure electric quadrupole transitions. The 111.60 keV transition has magnetic dipole character with an admixture of 27% E2. The 175.71 keV γ-ray was proved to have a magnetic dipole character, however an admixture of E2 cannot be excluded. The 237.21 and 277.32 keV γ-rays have a magnetic dipole character with an admixture of 35% E2 and 40% E2, respectively. The conversion coefficient as well as the multipolarity results determined for the 111.60, 116.71, 124.12, 296.10 and 308.18 keV γ-rays are in good agreement with the previously reported results [1] and with the proposed decay scheme given in Fig. 4.

3. Discussions

The decay scheme of ^{171}Er has been investigated in detail and several new excited states have been confirmed [5]. The ^{171}Tm nucleus is a deformed odd-proton nucleus [9] having a ground state spin of 1/2. The curves given by MOTTELSON and NILSSON [10] for odd-proton orbitals in a deformed nuclear potential predict a 1/2+ [411] orbital for the ground state of ^{171}Tm. Since the 5 keV γ-ray has been shown [11] to be emitted as M1+E2 transition, the spin and parity of the first excited state are 3/2+. The 111.60 and 116.71 keV transitions have been proved to be M1 and E2 respectively. This confirms that the spin and parity of the second excited state are 5/2+. The 124.12 keV transition is E2 in character and the 12 keV transition [11] is M1+E2, consequently the spin-parity assignments of the 129 keV level are 7/2+. These first three excited states together with the ground state are considered [10] to form a rotational band. The first intrinsic excited state in ^{171}Tm occurs at 425 keV and appears to correspond to the 7/2− [523] orbital. This is consistent with the E1 character of the 296.10 and 308.18 keV transitions found de-exciting it to the 129 (7/2+) and 117 (5/2+) keV levels, respectively. The 636 keV level is most likely the second intrinsic excited state and, from consideration of the neighbouring $Z=69$ nucleides, appears to correspond to the 7/2+ [404] orbital. These assignments are in agreement with the E1 character given to the 210.63 keV γ-ray. Relative transition probabilities [4] of the γ-rays de-exciting the 676 keV state suggest it to have spin and parity 3/2+ and Nilsson numbers 3/2+ [411]. The 738 keV state has been taken to be the second member of a rotational band based upon the 676 keV state, so it has spin-parity values 5/2+. The 862 keV level can be considered as the third member of the rotational band commencing with the 676 keV state. Therefore, the spin and parity of the 862 keV state are 7/2+. The multipolarity assignments for the 175.71, 237.21 and 277.32 keV γ-rays de-exciting the 913 keV level suggest spin-parity parameters of 5/2+ which are in agreement with Nilsson numbers 5/2+ [413].

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