EXCITED STATES OF ^{166}Er

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ABSTRACT

The low lying states of ^{166}Er are interpreted in terms of the rotational-vibrational energy as a function of I(I+1), and the Interacting Boson Model close to the SU(3) limit. The decay scheme of ^{166}Er is established on the basis of γ-γ coincidence studies using Ge and Ge(Li) detectors to measure the gamma rays resulting from the β decay of ^{166m}Ho ($t_{1/2}$ = 1200Y). Four new transitions at 351.21, 476.29, 895.59 and 1303.09 keV were observed. The first two of which are placed in the decay scheme as well as a new energy level at 1567.35 keV.

Keywords: program, SAMPO, mixing

INTRODUCTION

Extensive studies (Bohr, 1975; Fraser, 1964) of nuclei showing rotational-like structure have shown that improvement in the predictions of the geometrical model is obtained by the introduction of the two band γ-g mixing parameters Z_{γ}. The usefulness of this parameter was further established by (Mottelson, 1968; Reich & Cline,1970; Mikhailov, 1966), which included application to the Erbium isotopes. The interesting work by D.D Warner and R.F.

Casten on the collective states of ^{168}Er provided an exacting test for the theoretical descriptions close to the SU(3) limit of the interacting Boson Model IBM (Arima & Iachello, 1978). The most crucial result of their work was the prediction of the dominance of the gamma decay branch from the β to the γ band over that to the ground band. They further showed that such a dominance can be reproduced in the Bohr-Mottelson description by the explicit introduction of β-γ band mixing. In these respects, the neighboring ^{166}Er nucleus is also of interest as it exhibits excited collective bands (Raman, 1991; Jarrio & Wood, 1991).

In the past the level scheme of ^{166}Er has been studied with different techniques (Reich & Cline, 1970; Sooch, 1982; Sampson, 1978; Wangxin, 1992), the most comprehensive being that of Reich and Cline who measured γ-transition energies from the 1200Y decay of ^{166m}Ho, the 27h decay of ^{166}Ho and the 7.7h decay of ^{166}Tm using Ge(Li) detectors for single measurements. However, only 3in x 3in NaI(Tl) detectors were used for γ-γ coincidence studies.

Before applying either the Z_γ or the IBM analyses to ^{166}Er it was considered desirable to check experimentally the level scheme for ^{166}Er. In the present work, the states of ^{166}Er resulted from the 1200Y decay of ^{166m}Ho: the advantageously high spin 7^- of the ^{166m}Ho parent allowed levels with spins as great as 8 to be populated as a result of the γ-ray cascade process. Experimental measurements were performed using high resolution Ge(Li) detectors, both for singles and γ-γ coincidences, coupled with a Dual-parameter Data Collection System (Sulaiman & Thomas, 1979; Stewart & Shahban, 1980). The very low energy end of the spectrum was checked with a Ge detector and a Compton suppression system (Eid & Stewart, 1985).

EXPERIMENTAL PROCEDURE AND RESULTS

A 10 μCi ^{166m}Ho activity was produced by a 5-day irradiation of 25 mg of holmium metal, enriched to 99.99% in ^{165}Ho, in the DIDO Reactor of the Isotope Production Unit, Harwell, with a thermal neutron flux of 2 x $10^{14}cm^{-2}$ sec^{-1}. After irradiation, the sample, sealed in a thin lucite disk, was removed and allowed to decay for about one month to reduce the 27h ^{166}Ho activity (=18μCi) to a negligible level.

γ-ray Single Measurements

For the γ-ray energy and intensity measurements several spectra were analyzed: three from the 12% efficient Ge(Li) detector (70 cc volume, resolution 2.14 keV for the 1.332keV ^{60}Co peak), two from the Compton suppression system, and three fromthe Ge detector ($2cm^2$ surface, 0.5 thickness, resolution 500 eV at 122 keV) spanning the region 50-350 keV. Weighted averages were taken to give the final results.

The energy and efficiency calibrations were obtained by using standard radioactive sources. The deduced efficiency values were fitted by the function (Ahmad, 1982).

$$\varepsilon = [P_1 + P_2\, ln E + P_3\, (ln E)^2 + P_4\, (ln E)^3 + P_5\, (ln E)^5 + P_6\, (ln E)^7] / E \qquad (1)$$

where ε and E are the efficiency and γ-ray energy, respectively. The net peak area analyses and energy calibration were performed with the aid of the program SAMPO (Routti & Prussin, 1969) modified to run at the University of London Computer Center.

The energies and intensities of forty-nine γ-rays from the present work are listed in Table 1. Of these, four, at 351.21, 476.29, 895.59 and 1,303.09 keV, are new. The experimental intensity results of Sooch (1982); Sampson (1978) and Reich & Cline (1970) are also given in this table for comparison.

γ-γ Coincidence Measurements

The experimental arrangements used in the measurements of γ-γ coincidence spectra was described in previous publications (Sulaiman & Thomas, 1979; Eid & Stewart, 1985). In this work the spectra were written on four magnetic tapes and eight prominent γ-rays at 81, 184, 280, 366, 411, 671, 712 and 810 keV were taken to establish the decay scheme of ^{166}Er on the basis of coincidence between these gates and the rest of the spectrum. In each gate, the background and chance coincidence were subtracted (Fig.1). Transitions are classified as very strong (VS), strong (S), weak (W) or very weak (VW) according to the strength of an observed γ-rays relative to other γ-ray in the coincidence spectrum.

LEVEL SCHEME

The energy sum relations and the eight γ-γ coincidence gates have provided a very firm basis for the establishment of the decay scheme of ^{166}Er resulting from the β^- decay of ^{166m}Ho (Fig. 2). The Q_{β^-} value for the decay is (1,861.5 ± 2.6) keV (Buyrn, 1975), and as a result many excited states are populated. It is interesting to note that, in previous work (Reich & Cline, 1970; Krane & Moses, 1981; Buyrn, 1975), there are no indications of more than β^-

Figure 1. ^{166m}Ho spectrum in coincidence with the 280 keV γ-transition. (The expanded inset shows the new 351.21 keV transition).

Figure 2. Proposed energy level scheme for ^{166}Er.

feeding to two states at 1,787.00 and 1,827.65 keV. However, from the present measured branching ratios, a number of log ft values are newly assigned to previously well known levels. In this context, it should be emphasized that the spin and parity assignments for the ^{166}Er states are made on the basis of relative γ-ray intensities, log ft values and collective structure studies, the reason being the lack of information on the internal-conversion electron intensities which are needed to deduce the multipolarities of the transitions involved.

The New 1,567.35 keV level

From energy sum considerations a 351.21 keV γ-ray could depopulate this level to that at 1,216.14 keV. This new level is established from the S coincidence (Fig.1) of the newly observed 351.21 keV transition with the 280 keV gate, which is a well known transition from the 544.46 keV level, and also the most important gate in order to build up the ^{166}Er energy level scheme. Further support is given by the coincidence of the new 351.21 keV with the 671 keV gate, which depopulates the 1,216.14 keV level. The rotational model, Section 4.2, is consistent with this level being the band-head for the $K^{\pi} = 4^{-}$ band. The log ft = 14.3 which denotes a first forbidden unique transition with $\Delta I = 2$ and $\Delta\pi = -$, suggests a spin/parity assignment of 4^{-}.

DISCUSSION

The proposed decay scheme of ^{166}Er shown in Fig.2 offers a very good opportunity to investigate the applicability of the interacting boson approximation, IBA–1, model to the deformed ^{166}Er nucleus, and hence to study the specific characteristics of the SU(3) limit of the model (Arima & Iachello, 1978).

In this model the spectroscopies of the low-lying collective properties of even-even nuclei are described in terms of a system of interacting L=0 and L=2 bosons (s and d bosons).

The occurrence of the high-spin isomeric state in ^{166m}Ho ($I^{\pi} = 7^{-}$) provides the opportunity for a detailed study of long sequences of rotational states in ^{166}Er as expressed by the expansion of the rotational energy in powers of I (Bohr & Mottelson, 1975):

$$E(I(I + 1)) = E_K + AI(I + 1) + BI^2 (I+ 1)^2 \tag{2}$$

Whe$_K$ is the intrinsic energy and is the same for all members of the band. K represents the projection of I on the nuclear symmetry axis. A and B are two normalizing parameters which can be determined from the experimental values of the energy levels.

IBA –1 Calculations and Results

The calculations were done using the IBA-1 computer codes PHINT for energies and FBEM for B(E2) values (Scholten, 1979). The inclusion of an f boson, to generate negative parity states, produces severe computational problems in terms of the dimensions of the matrices which must be diagonalized. For this reason, the calculations have been limited to the positive parity bands. A truncated multipole expansion of the IBA–1 Hamiltonian (Iachello, 1981) was used in the calculations, namely,

$$H = -kQ.Q - k'L.L + k'' P.P \qquad (3)$$

where the parameters k, k′ and k″ denote the strength of the quadruple, angular momentum and pairing interactions between bosons.
In the strict SU(3) limit, the last term of Eq.(3) is zero. In such a case, the energy levels can be described by the expression (Arima & Iachello, 1978)

$$E(N,(\lambda,\mu), K, I) = (0.75k - k')I(I+1) - kC(\lambda,\mu) \qquad (4)$$

where N is the total number of bosons, K is the quantum number as in Eq.(2), and (λ,μ) labels the representation of SU(3). The ground-band representation is denoted by (λ,μ)=(2N,0), while the next representation appears as (λ-4,2) =(2N-4,2) and includes the β and γ bands of the geometrical description with K=0 and K=2, respectively. λ is the number of valence particles, λ= 2N = 30 in ^{166}Er; C(λ,μ) is the quadratic Casmir operator with eigenvalues given by (Arima & Iachello, 1978) as

$$C(\lambda,\mu) = \lambda^2 + \mu^2 + \lambda\mu + 3(\lambda + \mu) \qquad (5)$$

The parameters k and k′ of Eq.(4) can be deduced, by combining Eqs.(4) and (5), in the following way

$$k = (E_2 - E_1) / 6 (\lambda - 1)$$
$$k' = 0.75 - E_1 /6 \qquad (6)$$

where E_2 and E_1 are the energy values of the second and first 2^+ states. The completely equivalent form to Eq.(3) is given, in PHINT, as (Scholten, 1979).

$$H = (QQ/4) \times \mathbf{Q.Q} + (ELL/2) \times \mathbf{L.L} + PAIR \times \mathbf{P.P} \qquad (7)$$

Where QQ = -4k, ELL = -2 k′ and the parameter PAIR was varied to obtain the final calculated sequence of levels.

With the program FBEM it is possible to calculate electromagnetic transition rates. The E2 operator which is needed for the calculation of B(E2) values is given by (Scholten, 1979)

$$T(E2) = E2SD[s^\dagger \times d + d^\dagger \times s]^{(2)} + (1/\sqrt{5})E2DD[d^\dagger \times d)^{(2)} \quad (8)$$

Where ($s^\dagger$, $d^\dagger$) and (s,d) are the creation and annihilation operators for s and d bosons. The two parameters E2SD and E2DD can be adjusted to approximate the measured B(E2, 2→0) for excitations of 2^+ members of the ground state and γ-vibrational bands.

In this way a perturbed SU(3) nucleus can be characterized. In the case of ^{166}Er, the introduction of the pairing term in Eq.(7) shows a perturbation in the direction of the O(6) limit (Arima & Iachello, 1979).

TABLE 2

Parameters Obtained From the Programs PHINT and FBEM Using the IBA-1 Hamiltonian

QQ(MeV)	ELL(MeV)	PAIR(MeV)	E2SD(eb)	E2DD(eb)
-0.0165	0.0197	0.0156	0.1397	-0.1012

The results of the calculations for the energy levels are shown in Fig.4 and compared with experiment. The values of the parameters used are the first three of Table 2, whereas the remaining two are needed for the calculations of the B(E2) values. It should be noted that a fitting procedure applied to the energy levels by PHINT produces no considerable changes in the results of Figure 3 based on the parameters of Table 2. All the experimental transitions are assumed to be pure E2 and the corresponding B(E2) values, except for the B(E2, $2_1^+ \rightarrow 0^+_1$) (see below), were deduced from the relation (Cerney, 1974; Lobner, 1975).

$$B(E2) = 8.20 \times 10^{-10} (E\gamma)^{-5} \quad \lambda(E2) \quad [e^2fm^4] \quad (9)$$

$$\lambda_\gamma (L) = \lambda(L) N_\gamma (L) / (\Sigma_i N_i) \quad (10)$$

where E_γ is the γ-ray transition in MeV, λ_γ (L) and λ (L) are the partial and total transitions for a γ-ray of multipolarities L . $\Sigma_i N_i$ is the sum of the relative intensities of all transition depopulating the level of interest in the same relative units as the intensity N_γ (L) of the γ-ray transition with multipolarity L for which λ_γ(L) is to be calculated .

The relative intensity values of Eq.(10) were taken from the present measurements except for those transitions depopulating the 2_2^+ level at 786.07 keV ,whose relative intensities are quoted in (Buyrn, 1975). Also taken from this reference are the half-life values of the levels in order to compute Eq.(9). For the $B(E2,2_1^+ \rightarrow 0_1^+)$ calculation, the expression (Venkova & Andrejtscheff, 1981)

$$B(E2)=56.57/E^5_\gamma t_{1/2}(exp)(1+\alpha_T) \quad (11)$$

was used , where E_γ is the γ-ray transition in keV (80.59 keV), $t_{1/2}$ (exp) is the half-life of the 2_1^+ level ,whose value was taken from the present measurement ,and α_T is the total conversion coefficient and is given by α_T =6.9 (Venkova, 1981).

Figure 3. Proposed energy level scheme for ^{166}Er.

It can be seen from Figure 3 that the entire sequence of states has been well reproduced and a remarkable agreement is found with the experimental results. In the theoretical IBA-1 spectrum, the bands are labelled by K quantum numbers, $K^\pi = 0^+$ for the ground band and $K^\pi=2^+$ for the γ-band. The non-inclusion of the $K^\pi=0^+$, β-band, is due to the fact that no observed levels were detected as members of this band, whose displacement in the SU(3) symmetry above the γ-band increases with increasing pairing interaction.

Figure 4. Experimental levels in ^{166}Er compared with the results of the IBA-1 calculations.

Rotational Model Calculations and Results

- **Energies**

It is seen from Figure 4 that the observed levels in ^{166}Er can be arranged into rotational sequences characterized by the quantum numbers K and π. The states presented above each K^{π} are the predicted energies obtained by using the observed energies and applying the two term expansion of Eq.(2). The coefficients A and B of the ground-state rotational band $K^{\pi}=0^{+}$ have been obtained by fitting energies of the two lowest excited states at 80.59 and 265 keV by Eq.(2). For the remaining bands , an alternative form of Eq.(2) has been employed by replacing I(I+1) by I (I+1)-K^2. Such an expansion has proved to be a somewhat more natural one for the treatment of the rotational bands.

The γ-band with $K^{\pi} = 2^{+}$ is build on the band-head energy at 786.07 keV with 2^{+}, I^{π} assignment. An excellent agreement between the predicted and observed data is obtained. The $K^{\pi} = 2^{-}$ band is based on the experimental data at 1,458 keV (2^{-}) and 1,514 keV (3^{-}), summarized in (Buyrn, 1975). The remaining energies follow very closely the simple formula of Eq.(2). In the decay scheme of Figure 2, the spin/ parity assignments of 4^{-} at 1,596.28 keV and 6^{-} at 1,827.65 keV were supported by the predictions of the rotational model and are evidence of the remarkable agreement between theory and experiment achieved in this band. The newly observed level at 1,567.35 keV with 4^{-} assignment is considered as the band-head of the $K^{\pi} = 4^{-}$ rotational band. The A coefficient is the same as deduced for the $K^{\pi} = 2^{-}$ band ; this is attributed to the value of the moment of inertia of both bands being similar in magnitude.

- **Analysis of E2 transitions involving the ground-state $K^{\pi} = 0^{+}$ band and the gamma-vibration band**

The transitions between the $K^{\pi} = 2^{+}$ and $K^{\pi} = 0^{+}$ bands in ^{166}Er are assumed to be predominantly E2,as suggested by the K-selection rule ($\Delta I \leq 2$). The M1 admixtures, found from the angular correlation measurements, are at most a few percent in amplitude; therefore, no corrections for these admixtures have been made in the calculations of B(E2) values. Significant improvement in the predictions of the geometrical model for γ-g transitions is obtained by the introduction of the two band γ-g mixing , usually specified in terms of a mixing parameter Z_{γ} . However, the much more general approach to band mixing was analyzed in a form of a graphical technique known as Mikhailov plot (Mikhailov, 1966). For such an approach, the transition strengths are given by (Bohr & Mottelson, 1975) ,

$$B'(E2)=B(E2,I_iK=2\rightarrow I_f\,K=0)=2 < I_i\,2\text{-}\,2I_f\,0 >^2 [\,M_1 + M2\,(I_f\,(I_f+1)-I_i\,(I_i+1)]^2 \quad (12)$$

$$\text{where } M_1=<2|\,\mathcal{M}\,(E2)|\,0>-\,4M_2$$
$$M_2 = [15/\,8\pi]^{1/2} eQo\varepsilon_{\gamma} \quad (13)$$

Here ε_{γ} is the spin - independent parameter which depends on the detailed form of the moment of inertia and $Q_0 = (7.52\pm0.12)$b is the intrinsic quadruple moment deduced from the ground state using our measured $B(E2,2_1^{+} \rightarrow 0_1^{+})$ value and the expression :

$$B(E2,KI_i \rightarrow I_f) = (5/16\pi)e^2 Q_0^2 \;\; < I_i\,K20\;|\,I_f K>^2 .$$

Thus, on this basis, the square root of Eq.(12) can be represented by a straight line by plotting

$$R = [B'(E2)]^{1/2}/\langle I_i 22\text{-}2 \mid I_f 0\rangle$$

against $I_f(I_f+1)-I_i(I_i+1)$.

CONCLUSIONS

Gamma-gamma coincidence measurements following the decay of ^{166m}Ho have enabled the energy level scheme of ^{166}Er to be established. Two new transitions and the energy level at 1,567.35 keV were placed for the first time in the decay scheme. This level was established on the basis of the strong coincidence between the new transition at 351.21 keV and the 280 keV gate (Fig. 1), as well as the energy sum relations. It was considered as the band head of the $K^{\pi} = 4^{-}$ rotational band.

Significant improvements in the predictions of the rotor model were obtained by the introduction of γ-g band mixing as specified by the mixing parameter Zγ.

Calculations based on the IBA-1 model, for both energy and B(E2) values, reveal the essentially rotational behaviour of the ^{166}Er nucleus. However, the inclusion of the pairing term in Eq.(3) causes a breaking of the SU(3) symmetry which leads to a very good agreement of B(E2) values with experiment. This shows evidence for some slight perturbation towards an O(6) nucleus; and for energies between 1.5 and 2.5 MeV, the ^{166}Er shows a well deformed behaviour (Solviev, 1995).

TABLE 3

Experimental and IBA-1 Predicted B(E2) Values for γ-ray Transitions Depopulating the 1,159 keV Level Considered as a Member of the β-band in ^{166}Er.

Initial State K_i,I_I^{π}	Eγ (level) (keV)	Final State K_f,I_f^{π}	Eγ (level) (keV)	B(E2) values (e^2b^2) Experiment Ref. **25**	IBA-1 Present
$0,2^+$	1,159	$0,0^+$	0	0.00084 ± 0.00012	0.0009
		$0,2^+$	80.59	0.00096 ± 0.00020	0.0013
		$0,4^+$	265.00		0.0029
		$2,2^+$	786.07	0.0045 ± 0.0009	0.0260

As well as the good agreement of the data with the perturbed SU(3) IBA-1 model for a deformed nucleus, there was found to be an apparent dominance of the γ-decay branch from the β to the γ band over that to the ground. This feature was singled out from the results of the study of the collective states of ^{168}Er within the framework of the SU(3) limit of the IBA-1 (Warner & Casten, 1981). Its appearance in the ^{166}Er level scheme is provided by the decay of 2^+ state at 1,159 keV which was observed in the ^{168}Er(p,t)^{166}Er reaction (Buyrn, 1975). Table 3 summarizes the results of the IBA-1 B(E2) predictions for transitions depopulating the 1,159 keV level considered as a member of the β-band. The experimental B(E2) values were taken from (McGowan, 1981).

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LIST OF TABLE CAPTIONS

transitions depopulating the 1,159 keV level considered as a member of the β-band in ^{166}Er.

LIST OF FIGURE CAPTIONS

Fig.1 γ-ray singles spectrum following the β^- decay of ^{166m}Ho (peak energies in keV)

Fig.2. ^{166m}Ho spectrum in coincidence with the 280 keV γ-transition. (The expanded inset shows the new 351.21 keV transition).

Fig.3. Proposed energy level scheme for ^{166}Er.

Fig.4. Experimental levels in ^{166}Er compared with the results of the IBA-1 calculations.

Fig.5. Low-lying rotational K^{π} bands in ^{166}Er compared with experiment.

The experimental levels at (2^-) and (3^-) were taken from (Buyrn, 1975). The A and B coefficients given in the figure have been determined from the energies of the lowest excited states in each band.

Fig.6. Mikhailov plot for E2 transitions between gamma and ground state bands in ^{166}Er. The line represents a linear least squares fit to the experimental data listed in Table 4.

TABLE 1
Relative Intensities of γ-rays Emitted From the Decay of ^{166m}Ho
Instensity Related to I(184) = 100

Energy(keV	Present Work	Sooch, 1982	Sampson, 1978	Reich & Cline, 1970
80.60(2)	17.59(2)	17.8(4)	17.51(5)	17.1(8)
94.84(3)	0.22(1)	0.22(1)	0.221(1)	0.19(1)
119.34(3)	0.26(1)	0.27(2)	0.222(11)	0.25(3)
121.31(3)	0.45(1)	0.45(2)	0.337(13)	0.36(4)
135.51(4)	0.13(1)	0.14(1)	0.126(10)	0.14(1)
141.03(7)	0.06(1)	0.06(1)	0.059(9)	0.059(14)
160.41(5)	0.11(2)	0.14(1)	0.109(8)	0.134(14)
161.66(5)	0.14(2)	0.15(1)	0.135(8)	0.15(1)
184.40(2)	100	100	100	100
190.76(3)	0.31(2)	0.31(1)	0.304(14)	0.30(3)
215.74(2)	3.63(9)	3.67(9)	3.54(10)	3.6(3)
231.25(4)	0.29(2)	0.30(1)	0.284(14)	0.33(3)
259.83(2)	1.49(4)	1.53(3)	1.446(43)	1.50(8)
280.46(2)	40.96(99)	41.0(5)	40.79(115)	40.7(20)
300.74(2)	5.15(17)	5.17(8)	5.12(15)	5.12(26)
339.74(6)	0.21(4)	0.21(1)	0.234(15)	0.23(3)
351.21(8)	0.033(2)			
365.77(3)	3.43(7)	3.49(6)	3.327(96)	3.44(18)
410.96(3)	15.96(39)	15.9(2)	15.25(43)	15.8(8)
451.54(3)	4.19(10)	4.17(5)	4.02(12)	4.18(20)
464.84(4)	1.71(5)	1.67(3)	1.651(51)	1.68(11)
476.29(7)	0.07(1)			
496.98(5)	0.19(2)	0.18(3)		
521.07(6)	0.22(2)	0.22(3)		
529.86(3)	13.63(32)	13.3(2)	13.10(37)	13.9(7)
571.03(3)	7.81(18)	7.65(9)	7.53(22)	7.86(40)
594.40(5)	0.84(4)	0.77(2)	0.773(30)	0.96(5)
611.63(4)	2.01(6)	1.86(4)	1.951(61)	1.90(11)
640.13(7)	0.12(1)	0.12(1)	0.122(16)	0.22(7)
644.61(9)	0.19(2)	0.19(1)	0.213(19)	0.25(3)
670.52(4)	7.76(18)	7.53(9)	7.37(21)	7.88(40)
691.25(5)	1.97(5)	1.87(4)	1.871(58)	2.09(11)
711.69(3)	78.25(1.75)	75.7(8)	74.48(221)	80.2(40)
736.62(8)	0.50(2)	0.51(2)	0.506(24)	0.14(4)
752.29(4)	17.56(39)	17.0(2)	16.57(47)	17.9(10)
778.86(4)	4.43(10)	4.25(6)	4.17(12)	4.51(23)
810.31(4)	83.26(1.88)	80.1(8)	78.66(223)	85.7(42)
830.61(4)	14.03(31)	13.5(2)	13.34(38)	14.5(8) 1.08(8)
875.77(6)	0.99(4)	0.99(4)	0.993(29)	
895.59(6)	0.26(1)			4.15(20)
951.07(5)	3.79(9)	3.89(6)	3.71(11)	0.12(1)
1010.36(9)	0.100(8)	0.11(1)	0.096(7)	0.31(3)
1120.66(6)	0.32(3)	0.35(1)	0.327(13)	0.30(3)
1146.97(6)	0.29(1)	0.30(1)	0.271(13)	1.37(7)
1241.55(6)	1.28(4)	1.21(4)	1.142(34)	0.31(3)
1282.19(6)	0.253(6)	0.29(1)	0.246(12)	
1303.09(9)	0.034(1)			0.75(4)
1400.74(6)	0.75(3)	0.74(2)	0.686(21)	0.81(4)
1427.23(6)	0.69(3)	0.72(2)	0.667(2)	

Table 4

$$R = [B(E2;I_iK = 2 \rightarrow I_fK = 0)]^{1/2} / < I_iK = 22 - 2 \ | = 0>$$

for transitions originating from states of the γ-band in ^{166}Er

Transition	$I_f (I_f + 1) - I_i (I_i + 1)$	R(eb)
$2\gamma \rightarrow 0g$	-6	0.38 ± 0.01
$2\gamma \rightarrow 2g$	0	0.43 ± 0.01
$2\gamma \rightarrow 4g$	14	0.59 ± 0.02
$4\gamma \rightarrow 2g$	-14	0.29 ± 0.02
$5\gamma \rightarrow 4g$	-10	0.32 ± 0.01
$6\gamma \rightarrow 4g$	-22	0.19 ± 0.02
$7\gamma \rightarrow 6g$	-14	0.29 ± 0.01
$8\gamma \rightarrow 8g$	0	0.41 ± 0.04