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NON-ROTATIONAL STATES OF ODD-N DEFORMED NUCLEI IN THE REGION $153 \leqslant A \leqslant 171$

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The structure of odd-A deformed nuclei may be described most simply in the framework of the independent quasiparticle model.

The ground and a number of the excited states of an odd-A nucleus are then considered as one-quasiparticle states, higher states as three-quasiparticle ones and so on. A further step towards the study of the odd-A nucleus structure is the consideration of the interaction of the collective and one-quasiparticle motions.

Taking into account the fact that the odd-A nuclei, compared to the doubly even ones, have one additional quasiparticle, we consider the interactions of this quasiparticle with the phonons of a doubly even core by means of the multipole-multipole forces. A secular equation taking into account the quasiparticle-phonon interaction was first obtained in ref. /1/. The roots of this equation describe the ground and excited states of the nucleus. In subsequent papers /2-4/, using this equation the structure of a large number of odd-A deformed nuclei was analysed. It was shown that the lowest excited states are close to the one-quasiparticle ones. Higher states have a complex structure, i.e. the contribution to the wave function of these states comes from several components of the type quasiparticle plus phonon. Some states are of a purely collective nature, i.e. in their wave function a single component quasiparticle plus phonon is predominant.

The accuracy of the calculations performed is noticeably restricted by the uncertainties in the description of the average nuclear field by means of the Nilsson potential. Therefore the problem is to obtain a better description of the average field. In refs. /5-8/ the calculations are performed with the single-particle energies and wave functions of the Saxon-Woods potential /9/ having a number of advantages compared to the Nilsson potential.

A further refinement of the average field was made by taking into account the term with hexadecapole deformation in the formula for the expansion of the nuclear shape in multipoles /10/.

The present paper is devoted to the study of the structure of nuclei with odd-N in the region $153 \leq A \leq 171$. The main attention was paid to nuclei the spectra of which were not calculated earlier. The calculations are performed with the Saxon-Woods single-particle energies and wave functions at quadrupole deformation $\beta_{20} = 0.3$ and hexadecapole deformation $\beta_{40} = 0.04$. The calculations of the levels of ^{171}Er were carried out with the deformation parameters $\beta_{20} = 0.26$ and $\beta_{40} = -0.02$. The paper gives the energies and the structure of the ground and all the excited non-rotational states of nuclei up to 1.5 MeV and some states higher than 1.5 MeV.

The wave function for an odd-A nucleus describing the state with a given K^π is written in the form

$$\Psi_j(K^\pi) = \frac{1}{\sqrt{2}} C^j_\rho \sum_\sigma \{ a^+_{\rho\sigma} + \sum_{\lambda\mu i} \sum_\nu D^{\lambda\mu ij}_{\rho\nu\sigma} a^+_{\nu\sigma} Q^+_i(\lambda\mu) \} \Psi_0 , \qquad (1)$$

where $Q^+_i(\lambda\mu)$ is the phonon operator of multipolarity $(\lambda\mu)$, $a^+_{\nu\sigma}$ is the quasiparticle creation operator, $\sigma = \pm 1$, Ψ_0 is the wave function of the ground state of a doubly even nucleus. The quantity $(C^j_\rho)^2$ defines the contribution of the one-quasiparticle component ρ and the quantity $1/2\,(C^j_\rho)^2 \sum_\sigma (D^{\lambda\mu ij}_{\rho\nu\sigma})^2$ – the contribution of the component quasiparticle in the state $\nu\sigma$ plus phonon $(\lambda\mu i)$ to the state with given K^π.

The secular equation determining the energies η_j of the ground and excited states of an odd-A nucleus is of the form

$$\epsilon(\rho) - \eta_j - \frac{1}{4} \sum_{\lambda\mu i} \sum_\nu \frac{v^2_{\rho\nu}}{Y^i(\lambda\mu)} \frac{(f^{\lambda\mu}(\rho\nu))^2}{\epsilon(\nu) + \omega^{\lambda\mu}_i - \eta_j} = 0 . \qquad (2)$$

For the notations see, e.g. ref. /2/.

In every nucleus the least of all the $\eta_1(K^\pi_0)$ values is the energy of the ground state and the excited state energies are determined by the differences $\eta_j(K^\pi) - \eta_1(K^\pi)$.

When two states with identical K^π have close quasiparticle energies, instead of the secular equation (2), a more complicated equation /1/, in which both quasiparticle states ρ_1 and ρ_2 are taken into account simultaneously, is used.

Of a special interest is the mixing of two single-particle states with $\Delta N = \pm 2$. In the region of nuclei under consideration the 660↑ and 400↑ states and 651↑ and 402↓ ones are strongly mixed. It is necessary to perform a detailed investigation of this mixing. This will be made later on and the characteristics of the above-mentioned states will be determined more accurately.

The energy and the structure of the state close to the one-quasiparticle state may essentially be affected by the deflection of the equilibrium deformation of the excited state from that of the ground state. The investigations performed in ref. /11/ showed that for the $505\uparrow$ state it may be 0.05. The qualitative analysis of this effect shows that it makes it possible to improve the description of the $505\uparrow$ state energies.

In the present calculations the Coriolis force, which is found to be especially important for the $i_{13/2}$ subshell levels, is not taken into account. Therefore the $660\uparrow$, $651\uparrow$, $642\uparrow$, $633\uparrow$, $624\uparrow$ and $615\uparrow$ state energies can change due to the Coriolis interaction.

The results of calculations of the energies and the wave functions for a number of odd-N nuclei are given in tables 1-8. The fourth column is the contribution (in percent) of several largest components, which is obtained from the normalization condition of the wave function, to the state under investigation. The second single-particle state having the K^{π} value identical to that for the state under consideration is tabulated when its value exceeds one percent. For example, to the $K^{\pi} = 1/2^{-}$ state of ^{155}Sm the one-quasiparticle $521\downarrow$ state gives 66% of the contribution, the one-quasiparticle $530\uparrow$ state - 5%, the components : a quasiparticle in the $521\uparrow$ state plus phonon $Q_1(22)$ - 15% and a quasiparticle in the $523\downarrow$ state plus phonon $Q_1(22)$ -10%. The experimental data are taken from ref. /13-17/. In the present paper, the theoretical calculations for the nucleus ^{171}Er are in better agreement with experiment than in ref. /8/. This is explained by the fact that the Saxon-Woods single-particle levels scheme and wave functions with which all the calculations have been performed are choosen more carefully.

It should be noted that a rather good description of the levels of odd-A deformed nuclei using the Nilsson single-particle energies and wave functions is, to a certain extent, artificial. This is due to the fact that the Nilsson parameters are chosen different for different subshells and, in addition, arbitrary shifts of some levels and subshells are performed. The calculations with the Saxon-Woods single-particle energies and wave functions show that the refinement of the description of the odd-A deformed nucleus levels is insignificant as compared to the calculations based on the Nilsson potential. However, the calculations with the Saxon-Woods potential are essentially more unambiguous compared with the calculations based on the Nilsson potential. The Saxon-Woods single-particle energies and wave functions are calculated with the same parameters for all the subshells without additional shifts of some levels and subshells. The calculations show that the Saxon-Woods single-particle energies and wave functions allow to describe well a large amount of experimental data on the nuclear levels in the region $153 \leq A \leq 171$. Besides, the position of some new levels of the region under consideretion is predicted.

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References

1. V.G. Soloviev. Phys. Lett., 16, 308 (1965).
2. V.G. Soloviev, P. Vogel. Nucl. Phys., A92, 449 (1967).
3. Л.А. Малов, В.Г. Соловьев. ЯФ, 5, 566 (1967).
4. В.Г. Соловьев, П. Фогель, Г. Юнгклауссен. Изв. АН СССР, сер.физ., 31, 518 (1967).
5. А.А. Корнейчук, Л.А. Малов, В.Г. Соловьев, С.И. Федотов, Г. Шульц. ЯФ, 9, 750 (1969).
6. Л.А. Малов, В.Г. Соловьев. С.И. Федотов. ДАН СССР, 189, 987 (1969).
7. Л.А. Малов, В.Г. Соловьев, У.М. Файнер. Изв. АН СССР, сер. физ., 33, 1244 (1969).
8. Л.А. Малов, В.Г. Соловьев, С.И. Федотов. Сообщение ОИЯИ, Р4-5228, Дубна, 1970.
9. Ф.А. Гареев, С.П. Иванова, Б.Н. Калинкин. Изв. АН СССР, сер.физ., 32, 1690 (1968).
10. Ф.А. Гареев, С.П. Иванова, Н.Ю. Ширикова. Сообщения ОИЯИ, Р4-4259, Дубна, 1969.
11. Д.А. Арсеньев, Л.А. Малов, В.В. Пашкевич, В.Г. Соловьев. Изв. АН СССР, сер.физ., 32, 866 (1968).
12. Н.И. Пятов, М.И. Черней. Препринт ОИЯИ, Р4-4966, Дубна, 1970.
13. R.K. Smither, E. Rieber, T. von Egidy, W. Kaiser, K. Wien. Phys. Rev., 187, 1632 (1969).
    R.A. Kenefick, R.K. Sheline. Phys. Rev., 139, 1479 (1965).
14. P.O. Tjøm, B. Elbek. Mat. Fys. Medd. Dan. Vid. Selsk., 36, 8 (1967).
15. T. Grotdal, K. Nybø, B. Elbek. Mat. Fys. Medd. Dan. Vid. Selsk., 37, 12 (1970).
16. R.A. Harlan, R.K. Sheline. Phys. Rev., 168, 1373 (1968).
17. P.O. Tjøm, B. Elbek. Mat. Fys. Medd. Dan. Vid. Selsk., 37, 7 (1969).

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Table 1

Nucleus ^{153}Sm

K^{π}	Energy(kev)		Structure
	experiment	theory	
$3/2^+$	0	0	651↑ 92%, 660↑+Q_1(22)1%
$3/2^-$	35,8	57	521↑ 88%, 521↓+Q_1(22)5%, 633↑+Q_1(32)3%
$1/2^+$	-	190	660↑ 89%, 550↑+Q_1(30)2%
$3/2^+$	-	230	402↓ 79%, 400↑+Q_1(22)15% 404↓+Q_1(22)3%
$5/2^+$	91	290	642↑ 92%, 521↑+Q_1(31)2%
$1/2^+$	-	310	400↑ 72%, 402↓+Q_1(22)20% 402↑+Q_1(22)6%
$11/2^-$	65	470	505↑ 97%,
$3/2^-$	127	540	532↓ 80%, 521↑ 3%, 530↑+Q_1(22)7%, 660↑+Q_1(32)2%
$1/2^-$	-	560	530↑ 72%, 521↓ 3%, 532↓+Q_1(22)10% 660↑+Q_1(30)5%
$5/2^-$	322	570	523↓ 89%, 521↓+Q_1(22)6%, 642↑+Q_1(30)3%
$1/2^-$	698	780	521↓ 52%, 530↑ 4%, 521↑+Q_1(22)25% 523↓+Q_1(22)12%
$7/2^+$	-	1040	633↑ 61%, 651↑+Q_1(22)18% 521↑+Q_1(32)18%
$5/2^+$	-	1250	402↑ 31%,
$1/2^+$	-	1280	660↑+Q_1(20)100%
$3/2^-$	-	1300	521↑+Q_1(20)99%
$5/2^-$	-	1350	512↑ 54% 642↑+Q_1(30)21% 523↓+Q_1(20)10%
$7/2^+$	-	1390	404↓ 18% 402↓+Q_1(22)78% 651↑+Q_1(22)3%
$11/2^+$	-	1440	615↑ 2% 505↑+Q_1(30)97%
$7/2^-$	-	1540	503↑ 4% 505↑+Q_1(22)94%
$1/2^-$	-	1560	660↑+Q_1(30)100%

Table 2

Nucleus ^{155}Sm

K^{π}	Energy(kev)		Structure
	experiment	theory	
$3/2^-$	0	0	521↑ 93%, 521↓+Q_1(22)2%
$5/2^+$	25	90	642↑ 94%, 523↓+Q_1(30)1%
$3/2^+$	-	170	651↑ 92%, 660↑+Q_1(22)2%
$5/2^-$	338	310	523↓ 90%, 512↑ 2%, 521↓+Q_1(22)3%, 642↑+Q_1(30)2%
$1/2^+$	-	440	660↑ 87%, 651↑+Q_1(22)4%, 550↑+Q_1(30)2%
$3/2^+$	-	560	402↓ 82%, 400↑+Q_1(22)13% 404↓+Q_1(22)3%
$1/2^+$	-	680	400↑ 74%, 402↓+Q_1(22)19% 402↑+Q_1(22)4%
$11/2^-$	-	800	505↑ 98%,
$1/2^-$	824	810	521↓ 66%, 530↑ 5%, 521↑+Q_1(22)15% 523↓+Q_1(22)10%
$7/2^+$	-	980	633↑ 81%, 521↑+Q_1(32)12% 651↑+Q_1(22)2%
$3/2^-$	-	990	532↓ 75%, 651↑+Q_1(30)13% 530↑+Q_1(22)4%
$1/2^-$	-	1000	530↑ 65%, 521↓ 5,5%, 660↑+Q_1(30)11% 532↓+Q_1(22)5%
$5/2^-$	-	1220	512↑ 45%, 523↓ 5%, 642↑+Q_1(30)42% 510↑+Q_1(22)2%
$3/2^-$	-	1370	651↑+Q_1(30)100%
$5/2^+$	-	1500	523↓+Q_1(30)98%
$11/2^+$	-	1560	615↑ 2% 505↑+Q_1(30)98%
$1/2^-$	-	1650	660↑+Q_1(30)100%

Table 3

Nucleus ^{157}Gd

K^{π}	Energy(kev)		Structure
	experiment	theory	
$3/2^-$	0	0	$521\uparrow$ 92%, $521\downarrow+Q_1(22)4\%$
$5/2^+$	64	140	$642\uparrow$ 95%,
$3/2^+$	-	180	$651\uparrow$ 90%, $660\uparrow+Q_1(22)4\%$
$5/2^-$	435	270	$523\downarrow$ 88%, $512\uparrow$1,6%, $521\downarrow+Q_1(22)6\%$,
$3/2^+$	475	380	$402\downarrow$ 75%, $400\uparrow+Q_1(22)19\%$, $404\downarrow+Q_1(22)4\%$
$1/2^+$	684	430	$400\uparrow$ 67%, $402\downarrow+Q_1(22)25\%$, $402\uparrow+Q_1(22)6\%$
$1/2^+$	-	440	$660\uparrow$ 83%, $651\uparrow+Q_1(22)9\%$, $550\uparrow+Q_1(30)1\%$
$1/2^-$	704	570	$521\downarrow$ 60%, $530\uparrow$ 2,3%, $521\uparrow+Q_1(22)21\%$, $523\downarrow+Q_1(22)14\%$
$1/2^-$	-	720	$530\uparrow$ 63%, $521\downarrow$ 2,4%, $532\downarrow+Q_1(22)13\%$, $651\uparrow+Q_1(31)6\%$
$11/2^-$	426	830	$505\uparrow$ 98%,
$3/2^-$	700	1020	$532\downarrow$ 81%, $530\uparrow+Q_1(22)9\%$, $651\uparrow+Q_1(30)3\%$
$7/2^+$	-	1030	$633\uparrow$ 79%, $521\uparrow+Q_1(32)10\%$, $651\uparrow+Q_1(22)6\%$
$5/2^-$	-	1250	$512\uparrow$ 65%, $523\downarrow$1,7%, $523\downarrow+Q_1(20)13\%$, $642\uparrow+Q_1(30)7\%$
$3/2^-$	-	1450	$521\uparrow+Q_1(20)100\%$
$5/2^+$	-	1500	$402\uparrow$ 28%, $400\uparrow+Q_1(22)56\%$, $521\uparrow+Q_1(31)10\%$
$7/2^-$	-	1520	$523\uparrow$ 2%, $521\uparrow+Q_1(22)97\%$
$9/2^+$	-	1550	$624\uparrow$ 9%, $642\uparrow+Q_1(22)90\%$
$1/2^-$	-	1560	$521\uparrow+Q_1(22)100\%$
$7/2^-$	-	1570	$521\uparrow+Q_1(22)100\%$
$7/2^+$	1825	1590	$404\downarrow$ 14%, $402\downarrow+Q_1(22)53\%$ $651\uparrow+Q_1(22)32\%$
$7/2^+$	-	1660	$404\downarrow$ 5%, $651\uparrow+Q_1(22)68\%$ $402\downarrow+Q_1(22)26\%$

Nucleus ^{159}Gd

K^{π}	Energy(kev)		Structure
	experiment	theory	
$3/2^-$	0	0	$521\uparrow$ 93%, $521\downarrow+Q_1(22)3\%$
$5/2^+$	68	-70	$642\uparrow$ 95%, $660\uparrow+Q_1(22)1\%$
$5/2^-$	146	40	$523\downarrow$ 92%, $512\uparrow$1,4%,$521\downarrow+Q_1(22)4\%$
$3/2^-$	-	260	$651\uparrow$ 85%, $660\uparrow+Q_1(22)6\%$, $521\uparrow+Q_1(30)3\%$
$1/2^+$	780	480	$660\uparrow$ 75%, $651\uparrow+Q_1(22)12\%$,$642\uparrow+Q_1(22)6\%$
$1/2^-$	506	490	$521\downarrow$ 74%, $523\downarrow+Q_1(22)14\%$,$521\uparrow+Q_1(22)10\%$
$3/2^+$	743	580	$402\downarrow$ 74%, $400\uparrow+Q_1(22)21\%$,$404\downarrow+Q_1(22)4\%$
$1/2^+$	973	640	$400\uparrow$ 65%, $402\downarrow+Q_1(22)28\%$,$402\uparrow+Q_1(22)5\%$
$7/2^+$	-	740	$633\uparrow$ 92%, $521\uparrow+Q_1(32)4\%$
$5/2^-$	875	920	$512\uparrow$ 73%, $523\downarrow$ 2,4% $642\uparrow+Q_1(30)9\%$,$510\uparrow+Q_1(22)6\%$
$11/2^-$	681	1100	$505\uparrow$ 99%,
$1/2^-$	-	1150	$530\uparrow$ 58%, $660\uparrow+Q_1(30)12\%$,$532\downarrow+Q_1(22)10\%$
$3/2^-$	1109	1200	$532\downarrow$ 60%, $651\uparrow+Q_1(30)27\%$,$530\uparrow+Q_1(22)6\%$
$5/2^+$	-	1330	$523\downarrow+Q_1(30)98\%$
$9/2^+$	-	1340	$624\uparrow$ 9%, $642\uparrow+Q_1(22)89\%$
$1/2^-$	-	1410	$510\uparrow$ 2%, $521\uparrow+Q_1(22)85\%$,$523\downarrow+Q_1(22)10\%$
$7/2^-$	-	1420	$521\uparrow+Q_1(22)100\%$,
$3/2^-$	-	1430	$521\uparrow+Q_1(20)100\%$
$1/2^-$	-	1440	$510\uparrow$ 7%, $523\downarrow+Q_1(22)71\%$,$521\uparrow+Q_1(22)15\%$
$9/2^-$	-	1470	$523\downarrow+Q_1(22)100\%$
$7/2^+$	-	1570	$404\downarrow$ 1% $523\downarrow+Q_1(31)97\%$
$1/2^-$	1602	1640	$510\uparrow$ 35% $512\uparrow+Q_1(22)34\%$,$523\downarrow+Q_1(22)18\%$
$11/2^+$	-	1820	$615\uparrow$ 2% $505\uparrow+Q_1(30)97\%$
$7/2^+$	-	1840	$404\downarrow$ 2%, $651\uparrow+Q_1(22)91\%$,$402\downarrow+Q_1(22)6\%$
$7/2^+$	1960	1850	$404\downarrow$ 15%, $402\downarrow+Q_1(22)74\%$,$651\uparrow+Q_1(22)9\%$

Table 5

Nucleus ^{161}Gd

K^{π}	Energy(kev)		Structure
	experiment	theory	
$5/2^-$	0	0	523↓ 94%, 512↑ 1,4%, 521↓+Q_1(22)3%
$5/2^+$		90	642↑ 95%, 660↑+Q_1(22)3%
$1/2^-$	356	290	521↓ 89%, 523↓+Q_1(22)8%
$3/2^-$	313	300	521↑ 96%,
$7/2^+$	-	420	633↓ 98%,
$3/2^+$		590	651↑ 75%, 402↓ 1,1%, 660↑+Q_1(22)12%
$5/2^-$	809	610	512↑ 84%, 523↓ 2,5%, 510↑+Q_1(22)8% , 521↓+Q_1(22)2%
$1/2^+$	-	640	660↑ 49%, 400↑ 1,2%, 642↑+Q_1(22)29%, 651↑+Q_1(22)12%
$3/2^+$	-	840	402↓ 68%, 651↑ 1,2%, 400↑+Q_1(22)25%, 404↓+Q_1(22)3%
$1/2^+$	-	890	400↑ 58%, 660↑ 1%, 402↓+Q_1(22)33%, 402↑+Q_1(22)5%
$1/2^-$	-	1060	510↑ 7%, 523↓+Q_1(22)85%, 512↑+Q_1(22)7%
$9/2^-$	-	1070	523↓+Q_1(22)100%
$9/2^+$	-	1090	624↑ 6%, 642↑+Q_1(22)93%
$1/2^-$	1309	1220	510↑ 27%, 512↑+Q_1(22)38%, 521↑+Q_1(22)16%
$7/2^-$	-	1240	521↑+Q_1(22)100%
$3/2^-$	-	1450	512↑ 3%, 521↓+Q_1(22)52%, 521↑+Q_1(20)44%
$3/2^-$	-	1460	532↓ 1%, 521↑+Q_1(20)98%
$11/2^-$	-	1490	505↑ 99%,
$11/2^+$	-	1530	615↑ 1%, 633↓+Q_1(22)99%

Table 6

Nucleus ^{159}Dy

K^{π}	Energy(kev)		Structure
	experiment	theory	
$3/2^-$	0	0	521↑ 91%, 521↓+Q_1(22)5%
$5/2^+$	178	197	642↑ 97%,
$3/2^+$	549	240	651↑ 89%, 660↑+Q_1(22)7%
$5/2^-$	310	290	523↓ 91%, 521↓+Q_1(22)7%
$3/2^+$	418	300	402↓ 72%, 400↑+Q_1(22)22%, 404↓+Q_1(22)4%
$1/2^+$	560	330	400↑ 63%, 402↓+Q_1(22)29%, 402↑+Q_1(22)6%
$1/2^+$	-	500	660↑ 79%, 651↑+Q_1(22)16%, 400↑+Q_1(20)1%
$1/2^-$	534	530	521↓ 55%, 521↑+Q_1(22)27%, 523↓+Q_1(22)17%
$11/2^-$	352	820	505↑ 99%
$7/2^+$	-	1000	633↓ 64%, 521↑+Q_1(32)21%, 651↑+Q_1(22)13%
$3/2^-$	627	1040	532↓ 80%, 530↑+Q_1(22)13%, 660↑+Q_1(32)3%
$1/2^-$	-	1100	530↑ 66%, 532↓+Q_1(22)20%, 651↑+Q_1(32)4%
$5/2^-$	-	1200	512↑ 64%, 523↓+Q_1(20)22%, 510↑+Q_1(22)7%
$7/2^-$	-	1270	523↓ 2%, 521↑+Q_1(22)97%,
$1/2^-$	-	1315	521↑+Q_1(22)100%
$9/2^+$	-	1320	624↑ 5%, 642↑+Q_1(22)94%
$5/2^+$	-	1340	402↑ 26%, 400↑+Q_1(22)68% 660↑+Q_1(22)4%
$3/2^-$	-	1350	521↑+Q_1(20)100%
$7/2^+$	-	1360	404↓ 7%, 651↑+Q_1(22)63% 402↓+Q_1(22)29%
$1/2^-$	-	1500	510↑ 3%, 523↓+Q_1(22)93%, 512↑+Q_1(22)2%
$9/2^-$	-	1520	523↓+Q_1(22)99%

Table 7

Nucleus ^{161}Dy

K^{π}	Energy(kev)		Structure			
	experiment	theory				
$5/2^+$	0	0	642↑ 96%,		660↑$+Q_1(22)$2%	
$3/2^-$	75	20	521↑ 94%,		521↓$+Q_1(22)$3%	
$5/2^-$	27	28	523↓ 93%,		521↓$+Q_1(22)$5%	
$3/2^+$	679	270	651↑ 84%,	402↓ 2,3%,	660↑$+Q_1(22)$10%	
$1/2^-$	370	400	521↓ 66%,		523↓$+Q_1(22)$19%,	521↑$+Q_1(22)$14%
$1/2^+$	608	410	660↑ 49%,	400↑ 14%,	651↑$+Q_1(22)$20%,	642↑$+Q_1(22)$14%
$3/2^+$	551	440	402↓ 68%,	651↑ 2,7%,	400↑$+Q_1(22)$24%,	404↓$+Q_1(22)$3%
$1/2^+$	774	500	400↑ 47%,	660↑ 15%,	402↓$+Q_1(22)$31%,	402↑$+Q_1(22)$5%
$7/2^+$	-	760	633↑ 91%,		521↑$+Q_1(32)$5%	
$5/2^-$	-	950	512↑ 80%,	523↓ 2%,	510↑$+Q_1(22)$9%,	521↓$+Q_1(22)$3%
$11/2^-$	486	1100	505↑ 99%,			
$9/2^+$	-	1120	624↑ 5%,		642↑$+Q_1(22)$94%	
$1/2^-$	-	1130	530↑ 4%,		521↑$+Q_1(22)$92%	
$7/2^-$	-	1180			521↑$+Q_1(22)$99%	
$1/2^-$	-	1214	510↑ 3%,		523↓$+Q_1(22)$93%,	512↑$+Q_1(22)$2%
$9/2^-$	-	1230			523↑$+Q_1(22)$100%	
$3/2^-$	-	1300	532↓ 75%,		530↑$+Q_1(22)$14%,	642↑$+Q_1(31)$3%
$5/2^+$	-	1450	402↑ 7%,		521↑$+Q_1(31)$79%,	400↑$+Q_1(22)$12%
$1/2^-$	-	1460	510↑ 5%,		642↑$+Q_1(32)$86%,	512↑$+Q_1(22)$6%
$3/2^-$	-	1470	512↓ 0,4%,		521↑$+Q_1(20)$99%	
$7/2^+$	-	1480			521↑$+Q_1(32)$100%	
$7/2^+$	1416	1490	404↓ 2,4%,		651↑$+Q_1(22)$82%,	523↓$+Q_1(31)$8%
$3/2-$	-	1500			642↑$+Q_1(31)$100%	
$3/2^-$	1977	1840	512↓ 4%,		521↓$+Q_1(22)$93%	

Table 8

Nucleus ^{171}Er

K^{π}	Energy(kev)		Structure			
	experiment	theory				
$5/2^-$	0	0	512↑ 91%,		510↑$+Q_1(22)$4,7%,	624↑$+Q_1(32)$1,7%
$1/2^-$	194	280	521↓ 89%,			
$7/2^-$	531	390	514↓ 93%,		512↑$+Q_1(22)$5%	
$7/2^+$	-	400	633↑ 92%,		521↑$+Q_1(32)$3%,	651↑$+Q_1(22)$3%
$9/2^+$	378	420	624↑ 93%,		512↑$+Q_1(32)$4,5%	
$1/2^-$	706	630	510↑ 49%,		512↑$+Q_1(22)$40%,	512↓$+Q_1(22)$8%
$3/2^-$	906	860	512↓ 45%,	521↑ 1,7%,	514↓$+Q_1(22)$34%,	510↑$+Q_1(22)$12%
$5/2^+$	-	920	642↑ 85%,		660↑$+Q_1(22)$8%,	521↓$+Q_1(32)$1,5%
$3/2^-$	-	980	521↑ 35%,	512↓ 2,2%,	521↓$+Q_1(22)$50%,	633↑$+Q_1(32)$5%
$3/2^+$	-	1000	651↑ 53%,		633↑$+Q_1(32)$33%,	660↑$+Q_1(22)$7%
$5/2^-$	-	1050	523↓ 40%,		521↓$+Q_1(22)$55%,	512↑$+Q_1(20)$2%
$1/2^+$	-	1120	660↑ 60%,		642↑$+Q_1(22)$21%,	651↑$+Q_1(22)$12%
$1/2^-$	-	1320			512↓$+Q_1(22)$100%	
$9/2^-$	-	1330			512↑$+Q_1(22)$100%	
$3/2^-$	-	1410			521↓$+Q_1(22)$100%	
$11/2^+$	-	1420	615↑ 4%,		633↑$+Q_1(22)$95%	
$3/2^+$	-	1430			633↑$+Q_1(22)$100%	
$1/2^+$	-	1460	400↑ 11%,		512↑$+Q_1(32)$81%	
$7/2^-$	-	1470	503↑ 35%,		514↓$+Q_1(20)$54%,	501↑$+Q_1(22)$4%
$1/2^+$	-	1560	651↑ 1%,		512↑$+Q_1(32)$98%	