INTERPRETATION OF THE MODEL STRUCTURE CVM2 NUCLEUS ^{134}Te

Irinel PRECUP[1], Emilian DRAGULESCU[2], Marian PETRE[3], Mihai DIMA[4], Chivuta BADITA[5], Carmelia PETRE[6], Vasile DOBRESCU[7]

In prezenta lucrare este prezentata utilizarea Modelului Vibratie – Cluster 2 CVM2 ca o aproximare a calculelelor extinse ale modelului în paturi pe nucleul de ^{134}Te (dezvoltări clasice şi recente: NPSM si MCSM). Calculele anterioare ale modelului în paturi au demonstrat o bună concordanţă a spectrelor de energie B (E2) şi a impulsurilor magnetice pentru stările de paritate pozitivă de spin scăzut. Rezultatele dovedesc ca modelul CVM2 reprezintă o aproximaţie foarte bună pentru modelul în paturi extins.

We report about the use of Cluster-Vibration Model 2 (CVM2) as an approximation of the extensive shell-model calculations on ^{134}Te nucleus (classic and recent developments: NPSM and MCSM). Previous shell – model calculations have shown good agreement for energy spectra B (E2) and magnetic moments for low-spin positive parity states. The results prove that the CVM2 model is a very good approximation for the extensive shell-model calculations.

Keywords: shell-model, cluster-vibration model

1. Introduction

The ${}^{134}_{52}Te_{82}$ nucleus with two - valence - proton $N = 82$ isotones just above double magic ${}^{132}_{50}Sn_{82}$ is situated away from the line of stability. The study of few – valence - particle neutron-rich nuclei above strongest double closed ${}^{132}Sn$ [1] is very interesting for the theoretical reasons.

[1] PhD student, Horia Hulubei National Institute of Physics and Nuclear Engineering - IFIN HH, Romania
[2] Researcher, Horia Hulubei National Institute of Physics and Nuclear Engineering - IFIN HH, Romania
[3] Ing., Horia Hulubei National Institute of Physics and Nuclear Engineering - IFIN HH, Romania, e-mail: petre_m@yahoo.com
[4] Researcher, Horia Hulubei National Institute of Physics and Nuclear Engineering - IFIN HH, Romania
[5] Researcher, Horia Hulubei National Institute of Physics and Nuclear Engineering - IFIN HH, Romania
[6] PhD student, Horia Hulubei National Institute of Physics and Nuclear Engineering - IFIN HH, Romania
[7] PhD student, "CAROL I " National Defence University, Romania

They offer an opportunity to obtain empirical N - N interactions as well as for application of spherical shell-model in truncated spaces and for more recent developments to describe the collective motions in term of shell- model. Some nuclear properties of these nuclei are important data inputs for astrophysical model calculations.

The experimental information about nuclei around ^{132}Sn situated far away from the line of β stability is derived by β decay of induced and prompt fission of actinides. The advanced techniques of production, separation, identification, and acceleration of radioactive nuclei, combined with large multidetector systems, have improved knowledge about these nuclei. The main information in ^{134}Te was obtained at Osiris facility [2] by detailed γ – ray spectroscopy and half-life measurements [3,4]. Magnetic moment of 6_1^+ isomeric state of ^{134}Te was measured by [5].

In ^{134}Te nucleus were obtained by coincidence measurements of prompt and delayed γ – ray cascades in ^{248}Cm fusion product analyzed with EUROGAM by [6] and [7] with GAMMASPHERE. These measurements led to fairly well established level scheme up to 7.723 MeV for positive parity states and 6.71 MeV for negative parity states.

More recently the B (E2, 0^+ - 2_1^+) values for first 2_1^+ states have been measured by projectile Coulomb excitation in inverse kinematics with the world first accelerated beams at HRIBF Oak Ridge Laboratory by D.C. Radford et al. [9, 10] and C.J. Barton et al. [11].

The experimental results achieved so far were summarized in Nuclear Data Sheets (NDS) compilation for ^{134}Te [12]. Previous shell – model calculations have shown good agreement for energy spectra B (E2) and magnetic moments for low-spin positive parity states. Many years ago, BT Wildenthal [13,14] has described comprehensive and generally successful calculations for all the $N = 82$ then known. K Heyde et al [15,16] has performed in a quasi-particle model calculations the electromagnetic properties (lifetime and magnetic moment) of 6_1^+ state in ^{134}Te , S. Sarkar and M.S. Sarkar [17,18] have been studied within shell model formalism using KH 5082 and CW 5082 interactions [19] fitted for ^{208}Pb and scaled to the ^{132}Sn the excitation energies transition probabilities and magnetic moments in ^{134}Te nucleus.

Covello A at al [20] and Andreozzi F et al [21] reported shell – model calculations using a realistic effective interaction derived from the Bonn-A NN potential. New shell-model calculations on Sn, Te and Xe nuclei in which the residual interaction is based on the CD – Bonn renormalized G matrix have done by Brown et al. [22]. They evaluated microscopically the single-particle spin effective g factors including core polarization and meson exchange currents effects. Jakob G et al [23] have done magnetic moment shell model calculations for the 2^+, 4^+, 6^+ states in $^{130-134}Te$ and $^{132-136}Xe$ using the surface delta interaction (SDI) with two sets of parameters.

The structure of ^{134}Sn and ^{134}Te nuclei around ^{136}Te were studied by the Monte Carlo shell model technique by Shimuzu et al [24,25] Zhao YM et al [26] applied the nuclear-pair shell model (NPSM) to the Sn, Te, Xe, Ba and Ce isotopes using the collective S and D pairs as building blocks.

Recently, Jia L.Y. et al.[27] have applied a collective S and D nucleon pair (NPSM) approximation of the shell model to even – even nuclei from Sn to Ba in the region of ^{132}Sn. These authors take in account monopole pairing, quadrupole pairing plus qadrupole-quadrupole interactions between the valence nucleons and quadrupole – quadrupole interactions between valence neutrons and valence protons in the even-even in $^{126-142}Te$ isotopes. These shell model calculations have been performed for the all mentioned isotopes around ^{132}Sn where the valence protons occupied the $Z = 50 - 82$ shell and the valence neutrons occupied the $N = 50 - 82$ shell or/and the $N = 82 - 126$ shell.

Terasaki et al [28] investigated the nature and single-particle structure, calculated B (E2, $0^+ \rightarrow 2^+$) and g factors of the 2^+ states in nuclei around ^{132} Sn in calculations based on separable quadrupole plus pairing hamiltonian and the quasiparticle random phase. Approximation Blomqvist J. has shown there is a great similarity (QRPA) of some properties for the two double shell region of ^{132}Sn and ^{208} Pb in sense that each single particle state (n,l,j) for ^{132}Sn has a corresponding state (n, l+1, j+1) for ^{208} Pb with some order and similar spacings.In addition, the single - proton states are fairly well separated in these regions. There, the structure of the two-proton valence nuclei ^{134}Te and ^{210}Po [3] characterized as two-proton excitation is split in three groups. More recently Benozer - Koller N. et al [30] measured g factor of the 2_1^+ state in $^{132}_{52}Te_{80}$ (two-neutrons - holes in $^{132}_{52}Te_{80}$) with radioactive beams by the transient field in vacuum. They found g = + 0. 28 (15) value which is in agreement with previous value measured by Stone N. et al [31] by the recoil-in- vacuum, but the sign of the g factor is measured on safe way 2_1^+. Measurement of the g factor for the $N = 82$ $^{136}_{54}Xe_{82}$ nucleus by Jakob G et al (g = ± 0.766 (45)) confirm that the proton excitations can be dominant in ^{134}Te as in $^{132}_{52}Te_{80}$ in comparison with neutron excitation.

In the present paper we have applied the cluster – vibration model (CVM2) to investigate two-proton-excitation states in ${}^{134}_{52}Te_{82}$ situated near spherical region of double shell ${}^{132}_{50}Sn_{82}$. This model includes the most important shell-model degrees of freedom of chester explicilly and averages over the rest of shell effects by incorporating them in collective vibrtions [32-36]. The coexistence between cluster and quadrupole vibrations leads to describe the nuclear properties in the range of vibrations quasirotational and shell-model patterns. Paar V and Brant S [37] have developed computer codes for even – A and odd – A nuclei in the spherical and transitional regions. Paar V and co-worker have successfully applied the CVM2 in different mass-regions [35,38-40,44].

2. Cluster – Vibration Model (CVM2)

In the Cluster – Vibration Model 2 (CVM2), the nucleus ${}^{134}_{52}Te_{82}$ is described by coupling two valences – shell protons as chester to the quadrupole vibration ${}^{132}_{50}Te_{82}$ core.

The CVM2 Hamiltonian is given as: $H=H_{SM}+H_{VIB}+H_{PV}+H_{RES}$ were H_{SM} describes two independent valence – shell protons which compose the cluster; H_{VIB} represents free quadrupole bosons; the term H_{PV} represents the cluster – quadrupole boson interaction summed over protons of the cluster; H_{RES} is the pairing residual force between 2 protons in cluster. The Hamiltoman is diagonalized in the base: [(j1, j2)] J, NR; I>. Here J is the angular momentum of the 2-proton cluster; N phonons coupled to angular momentum R. Cluster angular momentum J and boson angular momentum R, are coupled to the total angular momentum I. The parameters used in the diagonalization of CVM2 Hamiltonian are the following: quadrupole, boson energy, and single – particle energies pairing strength and fermion- boson coupling strength. By diagonalization we obtain energy spectra and wave functions in the basis.

Using wave functions obtained by the diagonalisation of CVM2 Hamiltonian, we can calculate different nuclear properties, electromagnetic properties as: reduced transition probabilities, magnetic and quadrupole moments, branching ratios.

The quadrupol boson energy is $\hbar\omega$ = 1.66 MeV which is 0.41 MeV from the energy of the 2^+ state (1.201 MeV) in the doubly – closed – shell ${}^{132}Sn$. The pairing strength G = 0,20 Mev ≈ 0,22 MeV in accord with standards [42]. In the present calculations we use the particle vibration coupling strength a = 0.22 which gives over-all agreement with experimental data.

The effective charges and gyromagnetic ratios were taken in accordance with Ref. [36]. Used CVM parameters are summarized in Table 1.

The proton single - particle energies in the $Z = 50 - 82$ shell are same with CW 5082 interaction [19] and in accordance with recent experimental data of the $^{133}_{51}Sb_{82}$ nucleus obtained by Sanchez – Vega M. et al [41]. The neutron shell-model excitation is immersed in the average quadrupole vibration field, i.e. they are described in an approximate way only in terms of effective collective variables. The present parameters and single – particle proton energies are summarized in Table1 and Table 2.

Table 1

CVM2 Parameters used for ^{134}Te nucleus

$E_{2^+}[MeV]$	$\hbar\omega[MeV]$	$a[MeV]$	$G[MeV]$	$e_{s.p.}[e]$	$e_{VIB}[e]$	g_R	g_l	g_s
1.279	1.660	0.33	0.22	1.0	1.9	0.388	1.0	2.234

Table 2

Single-particle energies for Z > 50 proton orbital's from the CW5082 interaction [19]

Orbital	$1g_{7/2}$	$2d_{5/2}$	$2d_{3/2}$	$3s_{1/2}$	$1h_{11/2}$
ε_{Nlj}	0.0	0.920	2.641	2.668	2.758

3. Cluster-vibration model (CVM2) results

The calculated and the experimental levels in ^{134}Te are compared in Fig. 1.

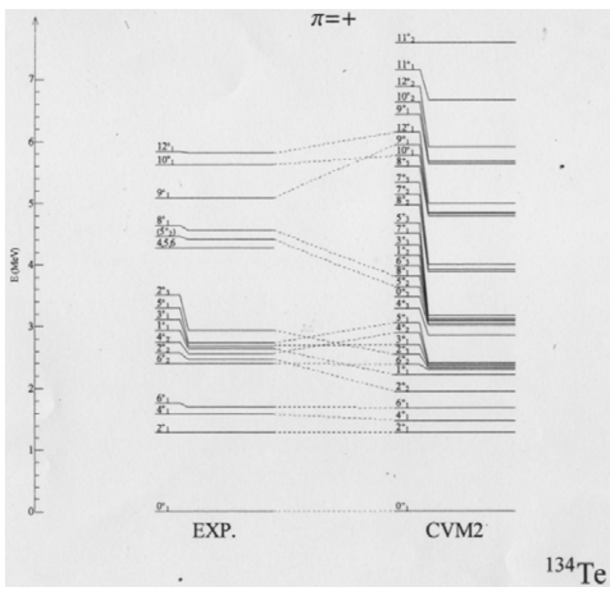

Fig. 1. The experimental levels are compared with present calculated CVM2 levels in ^{134}Te nucleus

A common feature of the calculated spectra is the appearance of a vibration - like pattern characterized by a first excited 2_1^+ state and 0_2^+, 2_2^+, 4_1^+

triplet at an energy nearly twice the energy of the 2_1^+ state. The ordering of the triplet states and their splitting are sensitive to the parameters used. Particularly, the 0_2^+ state is pushed up and an additional state 2_3^+ appears systematically in the energy region of the triplet. Above 2 MeV excitation energy it is a region where other states appear 1_1^+, 3_1^+, 3_2^+, 4_2^+, 4_3^+, 5_1^+ similar pattern was also obtained by shell-model calculations [21].

The cluster - vibration model, which employs spherical representation, generally introduces the elements of the rotation-like structure/bands/around the yrest line, both in even - A and odd - A nuclei. The calculation for ^{134}Te clearly reproduces the ground state band: $10_1^+ \rightarrow 8_1^+ \rightarrow 6_1^+ \rightarrow 4_1^+ \rightarrow 2_1^+ \rightarrow 0_1^+$ with strong E2 transitions inside the band.

The negative-parity states were obtained by using the same parameterization as for positive - parity states. The calculated negative-parity states are too high with respect to the experimental states. The negative-parity spectrum in CVM2 exhibits a group of states based on the negative- parity clusters: $(1g_{7/2}1h_{11/2})\,2^- - 9^-$ and $(2d_{5/2}1h_{11/2})\,3^- - 8^-$. For negative-parity states, the band: $11_1^- \rightarrow 10_1^- \rightarrow 9_1^- \rightarrow 8_1^- \rightarrow 7_1^- \rightarrow 5_1^-$ is more pronounced.

Next graphic representation of negative-parity states in ^{134}Te is given in Fig. 2. The ordering of levels is obtained by coupling of quadrupole bosons and an additional shift is expected owing to the mixing with octupole phonons.

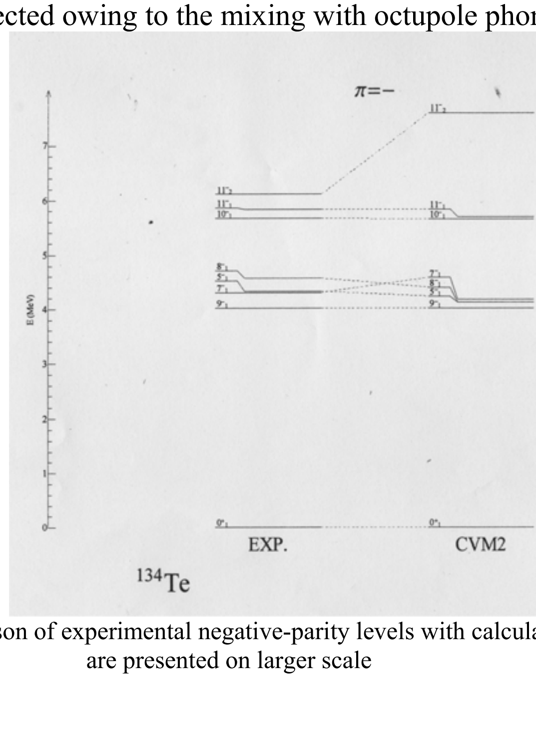

Fig. 2. Comparison of experimental negative-parity levels with calculated CVM2 levels are presented on larger scale

The 3^- state in this spherical (magic) nucleus arises from surface octupole vibrations which are normally of collective origin. Considerable effort has been made to experimentally explore and theoretically understand the structure of these low-lying states in $N = 82$ nuclei with the values ranging from 50 to 72 [12].

The present available information on the excitation energies of the lowest 2^+, 4^+ and 3^- states in these nuclei is shown in Figure 3. It seen that the 3_1^- remains unidentified only in ^{134}Te. In ^{132}Sn the 3_1^- state has dropped even below the first 4_1^+ level. We present here the position of CVM2 calculated level of 3_1^-.

The wave functions for several low-lying positive parity states calculated with the sets from Table 1 and Table 2 are shown below:

$$\begin{aligned}
\left|0_1^+;0.0MeV\right\rangle = &+0.87\left|\left\{(1g_{7/2})^2\,0,00\right\}0\right\rangle + 0.32\left|\left\{(2d_{5/2})^2\,0,00\right\}0\right\rangle \\
&+0.14\left|\left\{(2d_{3/2})^2\,0,00\right\}0\right\rangle - 0.21\left|\left\{(1h_{11/2})^2\,0,00\right\}0\right\rangle \\
&+0.09\left|\left\{(3s_{1/2})^2\,0,00\right\}0\right\rangle + 0.04\left|\left\{(1g_{7/2})^2\,0,20\right\}0\right\rangle \\
&-0.20\left|\left\{(1g_{7/2})^2\,2,12\right\}0\right\rangle + 0.05\left|\left\{(1g_{7/2}2d_{5/2})2,12\right\}0\right\rangle \\
&-0.10\left|\left\{(1g_{7/2}2d_{3/2})2,12\right\}0\right\rangle - 0.05\left|\left\{(2d_{5/2})^2\,2,12\right\}0\right\rangle
\end{aligned} \tag{1}$$

$$\begin{aligned}
\left|2_1^+;1.28MeV\right\rangle = &-0.42\left|\left\{(1g_{7/2})^2\,0,12\right\}2\right\rangle + 0.11\left|\left\{(2d_{5/2})^2\,0,12\right\}2\right\rangle \\
&-0.05\left|\left\{(2d_{3/2})^2\,0,12\right\}2\right\rangle + 0.84\left|\left\{(1g_{7/2})^2\,2,00\right\}2\right\rangle \\
&+0.04\left|\left\{(1g_{7/2}2d_{3/2})2,00\right\}2\right\rangle + 0.13\left|\left\{(1g_{7/2})^2\,2,12\right\}2\right\rangle \\
&-0.09\left|\left\{(1g_{7/2}2d_{3/2})2,12\right\}0\right\rangle + 0.06\left|\left\{(1g_{7/2})^2\,2,20\right\}0\right\rangle \\
&+0.05\left|\left\{(1g_{7/2})^2\,2,22\right\}2\right\rangle + 0.08\left|\left\{(1g_{7/2})^2\,2,24\right\}2\right\rangle \\
&+0.04\left|\left\{(1g_{7/2}2d_{5/2})3,12\right\}2\right\rangle - 0.06\left|\left\{(1g_{7/2}2d_{3/2})3,12\right\}2\right\rangle \\
&-0.21\left|\left\{(1g_{7/2})^2\,4,12\right\}2\right\rangle
\end{aligned} \tag{2}$$

$$\begin{aligned}\left|4_1^+;1.48MeV\right\rangle = &+0.04\left|\left\{(1g_{7/2})^2 4,12\right\}2\right\rangle + 0.20\left|\left\{(1g_{7/2})^2 2,12\right\}4\right\rangle \\ &+0.04\left|\left\{(1g_{7/2}2d_{3/2})2,12\right\}4\right\rangle + 0.05\left|\left\{(1g_{7/2}2d_{5/2})2,12\right\}4\right\rangle \\ &+0.09\left|\left\{(1g_{7/2}2d_{3/2})3,12\right\}4\right\rangle - 0.05\left|\left\{(1g_{7/2}2d_{3/2})4,00\right\}4\right\rangle \\ &+0.07\left|\left\{(1g_{7/2}2d_{3/2})4,12\right\}4\right\rangle + 0.16\left|\left\{(1g_{7/2}2d_{3/2})4,00\right\}4\right\rangle\end{aligned} \quad (3)$$

$$\begin{aligned}\left|6_1^+;1.49MeV\right\rangle = &-0.13\left|\left\{(1g_{7/2})^2 4,12\right\}6\right\rangle - 0.04\left|\left\{(1g_{7/2}2d_{5/2})4,12\right\}6\right\rangle \\ &-0.10\left|\left\{(1g_{7/2}2d_{3/2})4,00\right\}6\right\rangle - 0.07\left|\left\{(1g_{7/2}2d_{3/2})5,12\right\}6\right\rangle \\ &+0.95\left|\left\{(1g_{7/2})^2 6,00\right\}6\right\rangle - 0.05\left|\left\{(1g_{7/2}2d_{5/2})6,00\right\}6\right\rangle \\ &-0.21\left|\left\{(1g_{7/2})^2 6,12\right\}6\right\rangle + 0.05\left|\left\{(1g_{7/2}2d_{5/2})6,12\right\}6\right\rangle\end{aligned} \quad (4)$$

The composition of CVM2 wave functions for negative-parity states in ^{134}Te nucleus are presented in equations (5) - (9). Calculations indicate that negative-parity states also exhibit a quasi rotational feature**.** Composition of 3^- state is presented mainly by cluster $(1g_{7/2}1h_{11/2})3^-$ coupled with zero phonons (-0.93).

$$\begin{aligned}\left|3_1^-;4.19MeV\right\rangle = &-0.93\left|\left\{(1g_{7/2}1h_{11/2})3,00\right\}3\right\rangle - 0.23\left|\left\{(1g_{7/2}1h_{11/2})2,13\right\}3\right\rangle \\ &-0.04\left|\left\{(1g_{7/2}1h_{11/2})3,20\right\}0\right\rangle + 0.17\left|\left\{(1g_{7/2}1h_{11/2})4,12\right\}3\right\rangle \\ &+0.19\left|\left\{(1g_{7/2}1h_{11/2})5,12\right\}3\right\rangle\end{aligned} \quad (5)$$

$$\begin{aligned}\left|5_1^-;2.62MeV\right\rangle = &-0.96\left|\left\{(1g_{7/2}1h_{11/2})5,00\right\}5\right\rangle + 0.18\left|\left\{(1g_{7/2}1h_{11/2})3,12\right\}5\right\rangle \\ &+0.05\left|\left\{(1g_{7/2}1h_{11/2})5,12\right\}5\right\rangle + 0.16\left|\left\{(1g_{7/2}1h_{11/2})6,12\right\}5\right\rangle\end{aligned} \quad (6)$$

$$\begin{aligned}\left|7_1^-;4.35MeV\right\rangle = &+0.97\left|\left\{(1g_{7/2}1h_{11/2})7,00\right\}7\right\rangle + 0.15\left|\left\{(1g_{7/2}1h_{11/2})5,12\right\}7\right\rangle \\ &+0.09\left|\left\{(1g_{7/2}1h_{11/2})9,12\right\}4\right\rangle + 0.13\left|\left\{(2d_{3/2}1h_{11/2})7,00\right\}7\right\rangle\end{aligned} \quad (7)$$

$$\begin{aligned}\left|9_1^-;4.18MeV\right\rangle = &-0.06\left|\left\{(1g_{7/2}1h_{11/2})^2 7,00\right\}7\right\rangle + 0.04\left|\left\{(2d_{5/2}1h_{11/2})8,12\right\}9\right\rangle \\ &+0.93\left|\left\{(1g_{7/2}1h_{11/2})9,00\right\}7\right\rangle - 0.34\left|\left\{(1g_{7/2}1h_{11/2})9,12\right\}9\right\rangle \\ &+0.04\left|\left\{(1g_{7/2}1h_{11/2})9,20\right\}9\right\rangle - 0.04\left|\left\{(1g_{7/2}1h_{11/2})9,22\right\}9\right\rangle \\ &+0.06\left|\left\{(1g_{7/2}1h_{11/2})9,24\right\}9\right\rangle\end{aligned} \quad (8)$$

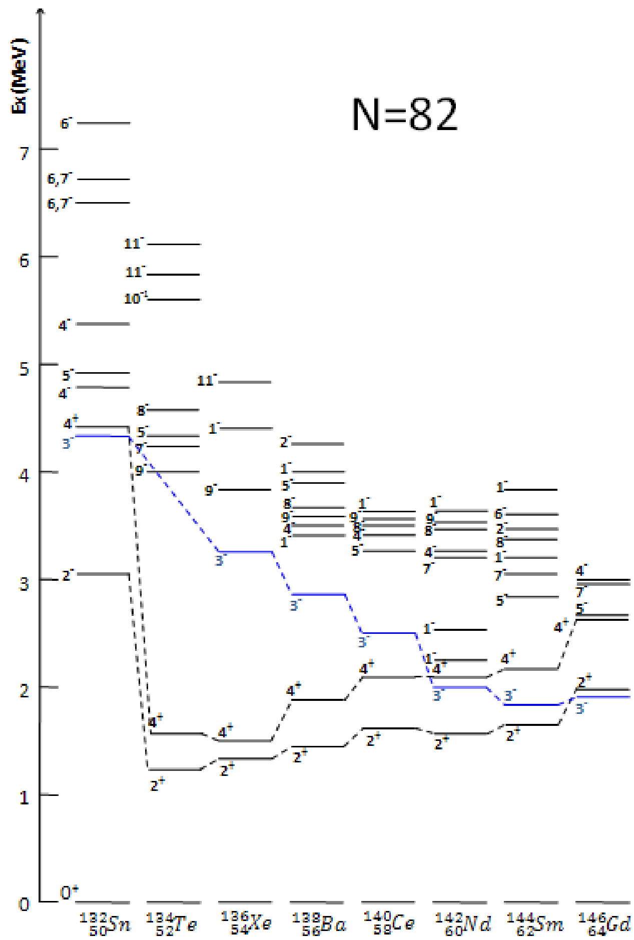

Fig. 3. Experimental low-lying levels in the even-even N=82 nuclei with the Z values ranging from 50 to 72 [12]. For ^{134}Te nucleus is drawn as bold the position of 3^- present CVM2 level not experimental observed up to now.

Electromagnetic properties are a sensitive test of global correlations among wave functions, i.e. they reveal the collective effect of the states. The experimental B (E2) values for the first transitions in ^{134}Te nucleus are compared with the present CVM2 calculations and previous theoretical model calculations in Table 3. It is a very good agreement with NPSM-A and NPSM-B calculations. The previous calculations are dedicated especially to 2_1^+ state.

Table 3

Comparison of experimental B(E2) values with present CVM2 calculations and previous theoretical models in ^{134}Te nucleus

$I_i^\pi \rightarrow I_f^\pi$ ($\hbar$) ($\hbar$)	B(E2) ($e^2.b^2$) CVM2	B(M1) (μ_N^2) CVM2	BR (%)	
			EXPT.	CVM2
$2_2^+ \rightarrow 2_1^+$	0.0052	0.043	8	4
$\rightarrow 0_1^+$	0.019		92	96
$2_3^+ \rightarrow 2_1^+$	0.00052	0.0072	95	79
$\rightarrow 0_1^+$	0.00054		5	21
$4_2^+ \rightarrow 2_1^+$	0.0018		100	98
$\rightarrow 2_2^+$	0.0041			2
$6_2^+ \rightarrow 6_1^+$	0.0029	0.00074	100	99
$\rightarrow 4_1^+$	0.00002			
$1_1^+ \rightarrow 0_1^+$		0.00006	48	55
$\rightarrow 2_1^+$	0.0032	0.00053	46	34
$\rightarrow 2_2^+$	0.0083	0.0336	6	11
$3_1^+ \rightarrow 4_2^+$	0.00065	0.0983	22	26
$\rightarrow 2_2^+$	0.004	0.0124	4	6
$\rightarrow 2_1^+$	0.002	0.00037	74	68
$5_1^+ \rightarrow 4_2^+$	0.00005	0.083	4	5
$\rightarrow 6_2^+$	0.00037	0.055	45	24
$\rightarrow 4_1^+$	0.0018	0.00064	51	71
$10_1^+ \rightarrow 8_1^+$	0.071		62	75
$\rightarrow 9_1^+$	0.0027			
$8_1^- \rightarrow 9_1^-$	0.00035	0.036	95	91
$\rightarrow 7_1^-$	0.00012	0.067	5	9
$11_1^- \rightarrow 9_1^-$	0.031			
$\rightarrow 10_1^-$	0.0026	0.153	100	100

Table 3 gives the calculated B (E2), B (M1) and Branching Ratios for several transitions and compares them with the available experimental data for ^{134}Te .

Table 4

Comparison of experimental B(E2) values with present CVM2 calculations and previous theoretical models in ^{134}Te nucleus

Transition	EXP	CVM2	SM [6,7]		SM [3,4]	QRPA [8]	NPSM [9]		MCSM [10]
			KH5082	CW5082	CD-Bonn		Calc I	Calc II	
	0.0192(24) [3, 4]								
$2_1^+ \rightarrow 0_1^+$		0,023			0,0176	0,0176	0,0234	0,0276	0,0192
	0.026(8) [5]								
$4_1^+ \rightarrow 2_1^+$	0,0175(16) [1]	0,0150	0,0150	0,0174					
$6_1^+ \rightarrow 4_1^+$	0,0083(20) [1]	0,0095	0,0070	0,0097					

In the simple vibration model the 2_1^+ state and 0_2^+, 2_2^+, 4_1^+ states would be interpreted as a one-phonon state and two-phonon triplet, respectively.

The $0_2^+ \rightarrow 2_1^+$, $2_2^+ \rightarrow 2_1^+$ and $4_1^+ \rightarrow 2_1^+$ E2 transitions are strong, comparable with the $2_1^+ \rightarrow 0_1^+$ E2 transitions. The transition $2_2^+ \rightarrow 0_1^+$ which is strictly forbidden in the pure vibration model is only approximately hindered in the CVM2. The calculated B (E2) values show a small gradual increase going up the ground state band. The static magnetic dipole and electric quadrupole moments are given in Table 4.

Table 5

Experimental values of static magnetic and Q quadrupole moments in comparison with calculated CVM2 and previous theoretical models in ^{134}Te nucleus

	$\mu_N(nm)$										Q(e.b)
State	EXP	CVM2	SM [6,7]		SM [12]	QRPA [8]	SM [11]		MCSM [10]	TWO-PART [13]	CVM2
			KH5082	CW5082	CD-Bonn NN		CCalc. I	CCalc. II		Res. Gaussian	
2_1^+		+1.54			+1.666	+1.390	+1.622	+1.716	+1.0		+0.141
4_1^+		+3.46			+3.32		+3.240	+3.292			-0.0028
6_1^+	+5.08(15) [2]	+5.13	+5.01	+5.10	+5.03		+4.896	+4.902		5.05	-0.362
8_1^+		+5.88									-0.345
10_1^+		+6.68									-0.322
5_1^-		+5.33									+0.017
7_1^-		+7.20									-0.237
9_1^-		+9.17									-0.652

Magnetic moments are an indispensable source of information on the microscopic structure of atomic nuclei. It results from the fundamental difference of the spin g factors of protons and neutrons, in sign and magnitude.

The experimental result is available only for dipole moment: $\mu = +5.08(15)$ of 6_1^+ state is in agreement with our CVM2 calculations, $g_s(p) = +5.586$ and $g_s(n) = -3.826$ which enables to determine the nucleonic components of the wave functions of nuclear states.

It is a general feature, that the nuclei near closed shells, in particular with the magic neutron and proton numbers, are characterized by specific single particle components in the wave functions which changes into collective structures when departing from shell closures. The competition between single particle and collective degrees of freedom is sensitively probed by magnetic moments as well as E2 rates.

Table 5 shows experimental values of μ_N static magnetic and Q quadrupole moments in comparison with calculated CVM2 and previous theoretical models in ^{134}Te nucleus. There are a lot of theoretical dipole moment calculations which have been implemented in different simulation codes for different are of interest [16-18, 22-26, 28, 34, 43] but not experimental measurements for 2_1^+ state in ^{134}Te nucleus. All calculations show a characteristic of proton excitation (sign +). The calculated quadrupole moment within present CVM2 is $Q = +0.141$(eb) for 2_1^+ state and changes the sign to - for upper states and increased value with their spin.

6. Conclusions

The **Cluster-Vibration Model (CVM2)** applied to ^{134}Te nucleus should be considered as a good approximation to extensive shell-model calculations (classic and recent developments: **NPSM** and **MCSM).**

Two-protons in the 50-82 valence shells are treated explicitly while all other shell-model excitations are immersed in the average quadrupole vibration field (neutron configurations and protons below 50 shells excited in the 82-126 and higher proton shell).

The shell-model with considerable computer time and sophisticated interactions predicts some elements of nuclear structure but the agreement of the calculated electromagnetic properties is limited and is mainly focused on the first 2^+, 4^+ and 6^+ states.

The agreement with experiment is comparable with that obtained in recent shell-model calculations as far as the spectra are concerned, and is better for the electromagnetic properties (Two positive-parity bands and one negative parity band)

The present results confirm:

- Coexistence of the quasi-vibration and quasi-rotational characteristics of even-even ^{134}Te
- Calculated wave functions recognize the building blocks: pairing phonons

New experimental data are needed concerning transition probabilities, magnetic and quadrupole moments for excited states in ^{134}Te .

B I B L I O G R A P H Y

[1] *Fogelberg B et al.*, 1994 Phys.Rev.£ett. **73** 2413
[2] *Fogelberg B et al.,* 1990 Phys. Rev. *C* **41** Rl 890
[3] *Omtvedt J P et al.*, 1995 PhysRev.Lett. **75** 3090
[4] *Mineva M N et al.*, 2001 Eur. Phys. J. A**11** 9
[5] *Wolf A and Cheifetz E,* 916 Phys.Rev.Lett. **36** 1072
[6] *Zhang C T et al*., 1996 PhysRevLett. **77** 3743
[7] *Saha SKet al.*, 2002 Phys. Rev. C **65** 017302
[8] *Hwang J K et al*., 2004 Phys. Rev. C **69** 057301
[9] *Radford D C et al.*, 2002 PhysRev.Lett. **88** 222501
[10] *Radford D C et al.*, 2004 Nuci. Phys. A **74** 683c
[11] *Barton C J et al.*, 2003 Phys. Lett. B **551** 269
[12] *Sonzogni A A,* 2004 Nuclear Data Sheets for A =.1341
[13] *Wildenthal B H*, 1969 Phys. Rev. Lett. **22** 118
[14] *Wildenthal BH and Larson D,* 1971 Phys.Lett B **37** 286
[15] *Waroquier HK and Vanden B,* 1991 Phys. Lett. B **35** 211
[16] *Waroquier HK et al., 1577 Phys. Rev.* C **6$** 489
[17] *Sarkar S and Sarkar MS*, 2001 Phys. Rev. C **64** 014312
[18] *Sarkar S and Sarkar MS*, 2004 Eut-. PhysR. A **21** 61
[19] *Chou W T and Warburton EK*, 1992 Phys. Rev. C **45** 1720
[20] *Coveil O et al*., 1997 Prog. Part. Nucl. Phys. **38** 165
[21] *Andreozzi et al*., 19-97 Phys. Rev. C **56** R16
[22] *Brown B A et al.,* Phys.Rev. C **71** 0443
[23] *Jacob G et al*., 2002 Phys. Rev. C **65** 024316
[24] *Shimizu N et al.*, 2004 Phys. Rev. C **70** 034313
[25] *Shimizu N et al.,* 2006 Phys. Rev. *C* **74** 03903
[26] *Zhao M et al.,* 2000 Phys. Rev. C **62** 014315
[27] *Jia L Y et al*., 2007 Phys. Rev. C **75** 034307
[28] *Terasaki J et al.,* 2002 Phys. Rev. C **66** 054313
[29] *Bloniqvist J*, CERN Report No. 81-09, CERN, Geneva, 1981, p536
[30] *Benczer-Koller N et al*., 2008 Phys. Lett. B **664** 241
[31] *Stone N J et al*., 2005 Eur. Phys. J. A **25** 205
[32] *Raz B J*, 1959 Phys. Rev. **114** 1116
[33] *Alaga G and Ialongo G*, 1966 Phys Lett. **22** 619
[34] *Mitrica B,* 2008 AIP conf. proc., **972**, 500-504

[35] *Paar V*, 1973 Nucl. Phys. A **221** 29
[36] *Paar V*, 1975 *Problems of VibratianalNuclei* (Amsterdam: North-Holland) p 15
[37] *Paar V and Bumt S,* 1979 Computer codes CVM (Zagreb University)
[38] *Paar V and Meyer R A*, 1979 J. Phys. G: Nucl. Phys. 5 L **75**
[39] *Lopac V and Paar V*, 1978 Nucl. Phys. A **297** 471
[40] *Meyer R A Scholten O Brant S and Paar V,* 1990 Phys. Rev. C **41** 2386
[41] *Sanchez-Vega et al.*, 1999 Phys. Rev. C **60** 024303
[42] *Marshallek E R and Rasmussen J O,* 1963 Nucl. Phys. **43** 438
[43] *Sterian A.*, 2007 Lecture notes in computer science, **4705**, 436-449
[44] *Paar V*, 1972 Nucl. Phys. A **185** 544