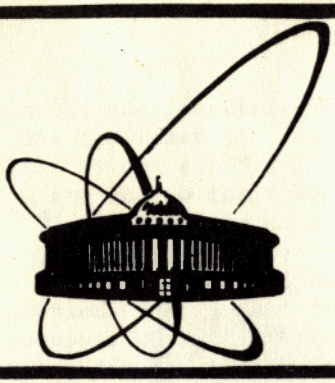

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EFFECT OF THE PAULI PRINCIPLE ON THE TWO-PHONON STATES IN SPHERICAL NUCLEI

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Within the quasiparticle-phonon nuclear model the fragmentation of one-quasiparticle and one-phonon states over many nuclear levels is described and the characteristics of atomic nuclei which are due to the fragmentation of these states are calculated [1-3]. In the case of doubly-even nuclei the wave functions contain one- and two-phonon components. In the two-phonon components of the wave functions one should take into account antisymmetrization with respect to the quasiparticle indices of different phonons. This fact necessitates summing of additional and more complex diagrams. The corresponding equations for doubly-even deformed nuclei have been derived in ref. [4]. The effect of the Pauli principle on the energy and structure of one- and two-phonon states has been studied in refs. [5,6]. In refs. [6,7] the centroid energies of two-phonon states have been calculated, and it was concluded that the collective two-phonon states cannot exist in deformed nuclei. The analysis of the experimental data has shown that the reliable data on these states are lacking. As the effect of antisymmetrization in the two-phonon components of the wave functions of deformed nuclei is very strong, it is expedient to study the influence of the Pauli principle on the two-phonon states in spherical nuclei.

A large number of two-phonon states is known for spherical nuclei [8]. The general picture of the low-lying state spectra of doubly-even spherical nuclei turned out [9-12] to be more complicated in comparison with that resulting from the simple vibrational model with a weak anharmonicity [13]. The simple vibrational model has been expanded in several papers. The mixing of the two-quasiparticle and phonon components in the wave functions of several spherical nuclei has been studied in refs. [14-16]. It was shown that the fragmentation of the lowest one- and two-phonon states is not strong. In ref. [17] the spectra and E0 and E2 -transition probabilities in doubly-even Sn and Cd isotopes have been described within a model allowing for the coupling of the quadrupole vibrations with the 2p-2h excitations. It was also shown that the simple vibrational model with a weak anharmonicity is violated.

Within the quasiparticle-phonon nuclear model a system of equations for doubly-even spherical nuclei is derived in the general form taking into account the summation of a wide set of diagrams. The transition has been made to an approximate system of equations, which will be used in the present paper to elucidate the influence of the Pauli principle and complex diagrams on the two-phonon states in doubly-even spherical nuclei.

1. APPROXIMATE EQUATIONS OF THE MODEL

The Hamiltonian of the quasiparticle-phonon nuclear model includes an average field as the Saxon-Woods potential, the pairing interactions and the multipole-multipole, spin-multipole - spin-multipole isoscalar and isovector including charge exchange interactions. The one-phonon states calculated in the RPA are used as a basis. The multipole forces are used to generate phonons with $J^{\pi} = 1^{-}, 2^{+}, 3^{-}, \ldots, 7^{-}$; and the spin-multipole, to generate phonons with $J^{\pi} = 1^{+}, 2^{-}, 3^{+}, \ldots, 7^{+}$.

The Pauli principle and complex diagrams have been taken into account, by means of exact commutation relations for the phonon operators [18] and the following expressions are obtained:

$$\sum_{\mu\mu'\mu_2\mu_2'} \langle\lambda'\mu'\lambda_2'\mu_2'|JM\rangle\langle\lambda\mu\lambda_2\mu_2|JM\rangle \times$$

$$\times \langle Q_{\lambda_2'\mu_2'i_2'} Q_{\lambda'\mu'i'} Q^{+}_{\lambda\mu i} Q^{+}_{\lambda_2\mu_2 i_2}\rangle = \tag{1}$$

$$= \delta_{\lambda\lambda'}\delta_{ii'}\delta_{\lambda_2\lambda_2'}\delta_{i_2i_2'} + \delta_{\lambda\lambda_2'}\delta_{ii_2'}\delta_{\lambda_2\lambda'}\delta_{i_2i'} +$$

$$+ K^{J}(\lambda_2'i_2', \lambda'i'|\lambda i, \lambda_2 i_2) .$$

Absolute value of the function $K^{J}(\lambda_2'i_2', \lambda'i'|\lambda i, \lambda_2 i_2)$ for $\lambda_2'i_2' \neq \lambda_2 i_2$ and $\lambda'i' \neq \lambda i$ are small, and therefore we shall keep only the diagonal $K^{J}(\lambda_2 i_2, \lambda i|\lambda i, \lambda_2 i_2)$ and quasidiagonal $K^{J}(\lambda_2 i_2, \lambda i'|\lambda i, \lambda_2 i_2)$ functions, i.e.,

$$K^{J}(\lambda_2 i_2, \lambda i'|\lambda i, \lambda_2 i_2) = \sum_{j_1 j_2 j_3 j_4} (-)^{j_2+j_4-J}(2\lambda+1)(2\lambda_2+1) \times \tag{2}$$

$$\times \begin{Bmatrix} j_1 & j_2 & \lambda_2 \\ j_4 & j_3 & \lambda \\ \lambda & \lambda_2 & J \end{Bmatrix} \times (\psi^{\lambda i'}_{j_3 j_4}\psi^{\lambda i}_{j_1 j_4}\psi^{\lambda_2 i_2}_{j_3 j_3}\psi^{\lambda_2 i_2}_{j_1 j_2} - \phi^{\lambda i'}_{j_3 j_4}\phi^{\lambda_2 i_2}_{j_3 j_2}\phi^{\lambda i'}_{j_1 j_4}\phi^{\lambda_2 i_2}_{j_1 j_2}),$$

where $\psi^{\lambda i}_{jj'}$ and $\phi^{\lambda i}_{jj'}$ are the phonon amplitudes.

The excited state wave function of the doubly-even spherical nucleus is

$$\Psi_{\nu}(JM) = \{\sum_{i} R_i(J\nu) Q^{+}_{JMi} + \sum_{\substack{\lambda_1 i_1 \\ \lambda_2 i_2}} P^{\lambda_1 i_1}_{\lambda_2 i_2}(J\nu) \times \tag{3}$$

$$\times \sum_{\mu_1\mu_2} \langle\lambda_1\mu_1\lambda_2\mu_2|JM\rangle \cdot Q^{+}_{\lambda_1\mu_1 i_1} Q^{+}_{\lambda_2\mu_2 i_2}\} \Psi_0 ,$$

where Ψ_0 is the ground state wave function, and $Q_{\lambda\mu i}\Psi_0 = 0$. The normalization condition of the wave function (3) in the case of a diagonal approximation of the function K^{J} has the form:

$$\sum_{i} (R_i(J\nu))^2 + 2 \sum_{\substack{\lambda_1 i_1 \\ \lambda_2 i_2}} (P^{\lambda_1 i_1}_{\lambda_2 i_2}(J\nu))^2 \times \tag{4}$$

$$\times \{1 + \frac{1}{2} K^{J}(\lambda_2 i_2\ \lambda_1 i_1|\lambda_1 i_1 \lambda_2 i_2)\} = 1 .$$

As in refs. [1, 2, 18] the average value of the model Hamiltonian is calculated by the state (3), and using the variational principle a secular equation is derived for finding the excited state energies

$$\det||(\omega_{Ji} - \eta_{\nu})\delta_{ii'} - \tag{5}$$

$$- \frac{1}{2} \sum_{\substack{\lambda_1 i_1 \\ \lambda_2 i_2}} \frac{U^{\lambda_1 i_1}_{\lambda_2 i_2}(Ji) U^{\lambda_1 i_1}_{\lambda_2 i_2}(Ji') \{1 + \frac{1}{2} K^{J}(\lambda_2 i_2 \lambda_1 i_1|\lambda_1 i_1 \lambda_2 i_2)\}}{\omega_{\lambda_1 i_1} + \omega_{\lambda_2 i_2} + \Delta\omega(\lambda_1 i_1 \lambda_2 i_2) - \eta_{\nu}}|| = 0 .$$

In this case we take into account the diagrams a), b) and c) in fig. 1. Here $\omega_{\lambda i}$ are the one-phonon energies, and the functions $U^{\lambda_1 i_1}_{\lambda_2 i_2}(Ji)$ are given in refs. [1, 18], and

$$\Delta\omega(\lambda_1 i_1 \lambda_2 i_2) =$$

$$= -\frac{1}{8} \sum_{r, i_3} \{ \frac{X^{\lambda_1 i_1}_{M}(r) + X^{\lambda_1 i_3}_{M}(r)}{\sqrt{y^{\lambda_1 i_1}_{r}\, y^{\lambda_2 i_3}_{r}}} K^{J}(\lambda_2 i_2, \lambda_1 i_3|\lambda_1 i_1, \lambda_2 i_2) + \tag{6}$$

$$+\frac{X_M^{\lambda_2 i_2}(r)+X_M^{\lambda_2 i_3}(r)}{\sqrt{y_r^{\lambda_2 i_2}\; y_r^{\lambda_2 i_3}}}\,K^J(\lambda_2 i_3,\lambda_1 i_1|\lambda_1 i_1,\lambda_2 i_2)\Big\}. \qquad (6)$$

The functions $X_M^{\lambda i}(r)$ and $y_r^{\lambda i}$ can be found in ref.[18].

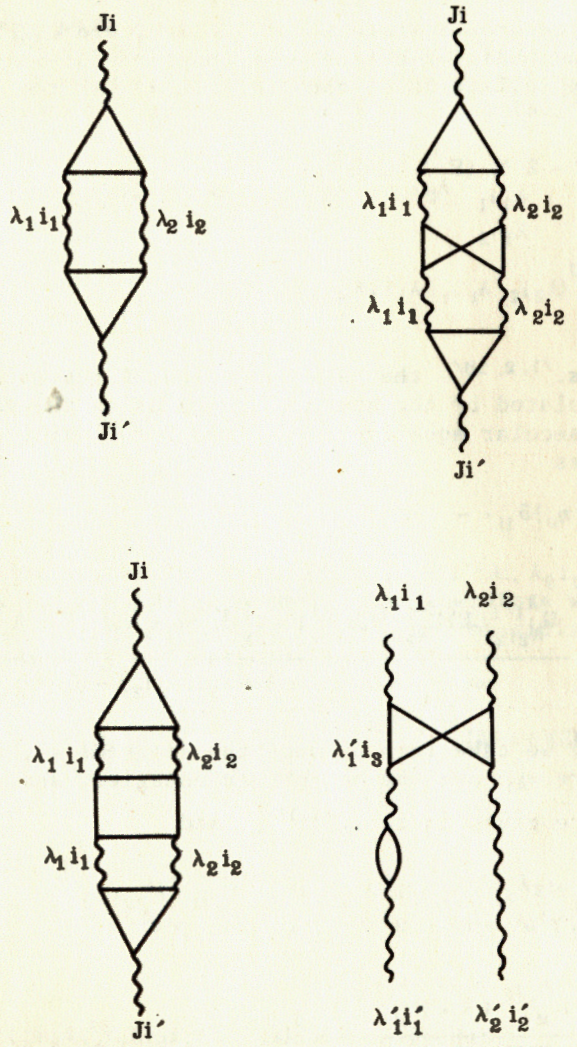

Fig. 1

Table 1. Functions $K^J(\lambda_2 i_2 \lambda_1 i_1 | \lambda_1 i_1 \lambda_2 i_2)$ for $J^\pi = 2^+,\ 4^+$ states

A	$J^\pi = 2^+$		$J^\pi = 4^+$	
	$\lambda_2 i_2\ \lambda_1 i_1$	$\mathcal{H}^J$	$\lambda_2 i_2\ \lambda_1 i_1$	$\mathcal{H}^J$
^{114}Sn	21 21	-0.12	21 21	-0.22
	21 22	-0.17	21 22	-0.13
	21 23	-0.17	21 23	-0.16
^{116}Sn	21 21	-0.14	21 21	-0.22
	21 22	-0.18	21 41	-0.16
	21 23	-0.11	21 24	-0.30
	21 21	-0.13	21 21	-0.13
	21 22	-0.09	21 22	-0.370
	21 23	-0.013	21 23	-0.20
	22 22	-0.014	22 22	-1.7
^{144}Sm	21 21	-0.26	21 21	-0.30
	21 22	-0.27	21 22	-0.30
	21 23	-0.12	21 23	-0.21
	21 24	-0.13	22 22	-0.11
^{146}Sm	21 21	-0.32	21 21	-0.30
	21 22	-0.32	21 22	-0.26
	21 23	-0.06	21 23	-0.13
	22 22	-0.53	22 22	-0.45
^{148}Sm	21 21	-0.24	21 21	-0.29
	21 22	-0.32	21 22	-0.25
	21 23	-0.19	21 23	-0.13
	21 24	-0.13	21 24	-0.13

Table 2. Functions $K^J(\lambda_2 i_2 \lambda_1 i_1 | \lambda_1 i_1 \lambda_2 i_2)$ for $J^\pi = 3^-$ states

A	$\lambda_2 i_2\ \lambda_1 i_1$	$\mathcal{H}^J(\lambda_2 i_2 \lambda_1 i_1 \| \lambda_1 i_1 \lambda_2 i_2)$
^{114}Sn	21 31	-0.05
	21 32	-0.005
^{116}Sn	21 31	-0.10
	21 32	-0.01
^{142}Sm	21 31	-0.14
	21 32	-0.005
^{144}Sm	21 31	-0.24
	21 32	-0.008
^{146}Sm	21 31	-0.14
	21 32	-0.51
^{148}Sm	21 31	-0.16
	21 32	-0.006

Consider equation (5). The rank of the determinant is equal to the number of one-phonon states in the first term of the wave function (3). We assume it to be equal to 5, as we consider only the low-lying states. The factor $(1+\frac{1}{2}K^J(\lambda_2 i_2, \lambda_1 i_1 | \lambda_1 i_1, \lambda_2 i_2)$ is caused by the influence of the Pauli principle on the two-phonon terms of the wave function (3). In the case of maximal violation of the Pauli principle $K^J = -2$ and the corresponding term is excluded from the sum over $\lambda_1 i_1, \lambda_2 i_2$. The two-phonon pole $\Delta\omega(\lambda_1 i_1 \lambda_2 i_2)$ is shifted allowing for the diagrams of the type of fig. 1d). Using the equations and normalization condition (4) we get

$$R_i(J\nu) = A_{ii}\Big\{\sum_{i'} A_{ii'}^2 + \frac{1}{2}\sum_{\substack{\lambda_1 i_1 \\ \lambda_2 i_2}} \frac{1+\frac{1}{2}K^J(\lambda_2 i_2\ \lambda_1 i_1|\lambda_1 i_1 \lambda_2 i_2)}{[\omega_{\lambda_1 i_1}+\omega_{\lambda_2 i_2}+\Delta\omega(\lambda_1 i_1 \lambda_2 i_2)-\eta_\nu]^2}\cdot\times$$

$$\times\Big[\sum_{i'} A_{ii'} U^{\lambda_1 i_1}_{\lambda_2 i_2}(Ji')\Big]^2\Big\}^{-1/2}. \qquad (7)$$

where $A_{ii'}$ is the minor to the determinant (5).

2. DETAILS OF THE CALCULATION AND RESULTS

The parameters of the Saxon-Woods potential and the pairing constants have been taken the same as in refs.[19,20]. The energies $\omega_{\lambda i}$, amplitudes $\psi^{\lambda i}_{jj'}$, $\phi^{\lambda i}_{jj'}$ of the one-phonon states and the functions $U^{\lambda_1 i_1}_{\lambda_2 i_2}(Ji)$ have been calculated by the GIRES[21]. The constants of the isoscalar κ_0 and isovector κ_1 multipole interactions with $\lambda = 2$ and 3 have been chosen so as to obtain the first 2 and 3 state energies close to the experimental values. The rest constants have been chosen as in refs.[19,20].

The results of calculation of the functions $K^J(\lambda_2 i_2 \lambda_1 i_1|\lambda_1 i_1 \lambda_2 i_2)$ for $^{114,116}Sn$ and $^{142,144,146,148}Sm$ in the case of $J^\pi = 2^+$ and 4^+ are given in table 1; and in the case of $J^\pi = 3^-$, in tabl. 2. It is seen from the tables that for two collective phonons the absolute values of K^J are in the interval 0.1-0.3. For the states with one collective and one noncollective phonon the absolute values of K^J vary in a wide interval and get the values somewhat less than 2. The shifts of the two-phonon poles for any two collective phonons vary in the interval (0.01-0.6) MeV, that is much less than in the deformed nuclei.

Table 3. Energy and structure of states with $J^\pi = 2^+$

A	Energy exp. MeV	With the Pauli principle				Without the Pauli principle			
		Energy theor., MeV	λi	$R_i(2^+\nu)^2$ %	$\lambda_1 i_1 \lambda_2 i_2$	$\rho^{\lambda_1 i_1}_{\lambda_2 i_2}(I\nu)$ %	Energy theor., MeV	λi	$R_i(2^+\nu)^2$ %	$\lambda_1 i_1 \lambda_2 i_2$	$\rho^{\lambda_1 i_1}_{\lambda_2 i_2}(I\nu)$ %
^{114}Sn	1. 1.300	1.36	21	95.4	21 21	-	1.29	21	90.4	21 21	1.3
	2. 2.170	2.63	22	26.6	21 21	53	2.53	22	21.4	21 21	58.2
^{116}Sn	1. 1.294	1.00	21	92.3	21 21	1.3	0.94	21	90.1	21 21	2
	2. 2.112	2.38	22	16.8	21 21	61	2.24	22	15	21 21	63
^{142}Sm	1. 0.768	0.68	21	81.6	21 21	3.3	0.64	21	79.3	21 21	4.6
	2. 1.658	1.64	22	15.4	21 21	29.1	1.52	22	39.4	21 21	34
^{144}Sm	1. 1.660	1.60	21	95.5	21 21	2	1.57	21	94	21 21	4
	2. 2.423	2.57	22 23	64.6 29.5	21 41	3	2.58	22 23	66 33	21 41	2
^{146}Sm	1. 0.747	0.72	21	81.5	21 41	9	0.70	21	80.6	21 41	7.5
	2. 1.648	2.12	22	71.8	21 21	15	1.99	22	57	21 21	28
	1. 0.550	0.51	21	79	21 21	6	0.41	21	76	21 21	9.4
	2. 1.454	2.33	22	62.3	21 21	18	2.23	22	35	21 21	36

Table 4. Energy and structure of states with $J^\pi = 4^+$

A	Energy exp. MeV	With the Pauli principle					Without the Pauli principle				
		Energy theor., MeV	λi	$(R_i(4^+\nu))^2$%	$\lambda_1 i_1\ \lambda_2 i_2$	$P^{\lambda_1 i_1}_{\lambda_2 i_2}(J\nu)^2$%	Energy theor, MeV.	λi	$(R_i(4^+\nu))^2$%	$\lambda_1 i_1\ \lambda_2 i_2$	$P^{\lambda_1 i_1}_{\lambda_2 i_2}(J\nu)^2$%
^{114}Sn	2.189	2.71	42	29	21 21	58	2.60	42	22	21 21	57
^{116}Sn	2.392	2.60	44	15	21 21	63	2.31	44	12	21 21	72
^{142}Sm	1.791	1.77	41 42	32 28	21 21	12.3	1.60	41 42	26.01 24.8	21 21	23
^{144}Sm	2.190	2.39	41	96.5	31 71	2	2.38	41	96	31 71	2.1
^{146}Sm	1.381	1.60	41	76	21 21	12	1.48	41	67	21 21	21
^{148}Sm	1.180	2.00	41	66	21 21	21	1.84	41	45	21 21	40

Table 5. Energy and structure of states with $J^\pi = 3^-$

A	Energy Exp. MeV	With the Pauli principle					Without the Pauli principle				
		Energy theor. MeV	λi	$(R_i(3^-\nu))^2$%	$\lambda_1 i_1\ \lambda_2 i_2$	$[P^{\lambda_1 i_1}_{\lambda_2 i_2}(J\nu)]^2$%	Energy theor. MeV	λi	$(R_i(3^-\nu))^2$%	$\lambda_1 i_1\ \lambda_2 i_2$	$P^{\lambda_1 i_1}_{\lambda_2 i_2}(J\nu)^2$%
^{114}Sn	2.275	2.23	31	91.7	21 31	8.2	2.22	31	91.3	21 31	8.5
^{116}Sn	2.266	2.05	31	90.7	21 31	6	2.03	31	89.6	21 31	6.7
^{142}Sm	1.174	1.80	31	93.5	21 31	5.5	1.76	31	90.8	21 31	8
^{144}Sm	1.810	1.86	31	95	21 31	4.7	1.82	31	93	21 31	6.8
^{146}Sm	1.380	1.44	31	34.5	21 31	12.5	1.37	31	81	21 31	16
^{148}	1.116	1.08	31	80.3	21 31	17.2	0.95	31	75.3	21 31	22

The energies and structure of the first 2^+ and first 4^+ and 3^- states in ^{114,116}Sn and ^{142,144,146,148}Sm, calculated with and without taking into account the Pauli principle, are presented in tables 3, 4 and 5. The calculated energies and B(Eλ) - values for the first 2^+ and 3^- states are in good agreement with the experimental data.

Consider the 2^+ states given in table 3. The first 2^+_1 states are the one-phonon states, and they are slightly influenced by the Pauli principle. The 2^+ states with small two-phonon components are also slightly influenced by the Pauli principle. When the two-phonon components in the second 2^+ states are large, the Pauli principle does not lead to radical changes. For instance, in ^{116}Sn the second 2^+_2 state has a large two-phonon component [21, 21], that is confirmed by the experimental data /9/. The Pauli principle led to an increase in the 2^+_2 state energy by 0.14 MeV and to a decrease in the contribution of the two-phonon component from 63% to 61%. Thus, in the cases we have investigated, the influence of the Pauli principle on the first four 2^+ states is insignificant.

Consider the first 4^+ states. It is seen from table 4 that the first 4^+ states in ^{114,116}Sn have large two-phonon components, that is in agreement with the experimental data for ^{116}Sn /9/. In comparison with the 2^+_2 states they are somewhat stronger influenced by the Pauli principle, though considerably less than in the deformed nuclei. For the Sm isotopes the calculated 4^+_1 states have no large two-phonon components, that contradicts the experiment /12/ for ^{146}Sm. They are not strongly influenced by the Pauli principle. As is seen from table 5 the first 3^- states are also slightly influenced by the Pauli principle.

Based on the above results we can conclude that in some spherical nuclei the effect of the Pauli principle on the two-phonon components of the wave functions does not lead to a significant energy shift and to a change in the structure of the first 2^+, 3^+ and 4^+ states. A crucial difference is observed for deformed nuclei, the centroid energies of the collective two-phonon states of which are always strongly shifted towards the high energies.

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REFERENCES

1. Соловьев В.Г. Теория сложных ядер, Наука, М., 1971.
2. Соловьев В.Г. ЭЧАЯ, 1978, 23, с. 1149.
   Soloviev V.G. Nucleonica, 1978, 23, p.1149.
3. Малов Л.А., Соловьев В.Г. ЭЧАЯ, 1980, 11, с. 301.
4. Джолос Р.В. и др. ТМФ, 1979, 40, с. 245.
   Jolos R.V. et al. Z.Phys. - Atoms and Nuclei, 1980, A295, p. 147.
5. Соловьев В.Г. и др. Известия АН СССР, сер.физ., 1981, 45, с. 1834.
6. Soloviev V.G., Shirikova N.Yu. Z.Phys. - Atoms and Nuclei, 1981, A301, p. 263.
7. Соловьев В.Г., Ширикова Н.Ю. ЯФ, 1982, 36, с. 1376.
8. Hadermann J., Raster A.C. Nucl.Phys., 1974, v. A231, p. 120.
9. Kantele J. et al. Z.Phys., 1979, v.A289, p. 157.
   Bäcklin A. et al. Nucl.Phys., 1981, v. A351, p. 490.
10. Julin R. et al. Z.Phys., 1980, v. 296, p. 315.
    Passoja A. et al. Nucl.Phys., 1981, v. A363, p. 399.
11. Van Poelgeest A. et al. Nucl.Phys., 1980, v. A346, p. 70.
12. Rozak S. et al. Phys.Rev., 1982, c. C25, p. 3000.
13. Бор О., Моттельсон Б. Структура атомного ядра, М., Мир, 1977, т. 2.
14. Вдовин А.И., Стоянов Ч., Кырчев Г. ТМФ, 1974, т.21, с. 137.
    Вдовин А.И., Соловьев В.Г., Стоянов Ч. ЯФ, 1974, т.20, с. 1131.
15. Вдовин А.И., Стоянов Ч. Изв. АН СССР, сер.физ., 1974, т.38, с. 2598, с. 2604; 1975, т. 39, с. 1618.
16. Takada K., Tazaki S. Prog.Theor.Phys., 1979, v.61, p. 1666.
17. Wenes G. et al. Phys.Rev., 1981, v. C23, p. 2291.
    Wenes G. et al. Phys.Lett., 1981, v. 98B, p. 398.
    Hayde K. et al. Phys.Rev., 1982, v. C25, p. 3160.
18. Soloviev V.G., Voronov V.V. JINR, E4-83-58, Dubna, 1983.
19. Вдовин А.И. и др. Известия АН СССР, сер.физ., 1979, 43, с. 999.
20. Ponomarev V.Ju. et al. Nucl.Phys., 1979, A323, p. 446.
21. Пономарев В.Ю.,Стоянова О.,Стоянов Ч. ОИЯИ, Р4-81-704, Дубна, 1981.

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Соловьев В.Г., Стоянов Ч., Николаева Р. E4-83-166

Влияние учета принципа Паули на двухфононные состояния в сферических ядрах

Исследовано влияние учета принципа Паули в двухфононных компонентах волновых функций на низколежащие коллективные состояния четно-четных сферических ядер. Расчеты выполнены для $^{114,116}Sn$ и $^{142,144,146,148}Sm$ и показано, что учет принципа Паули оказывает слабое влияние на состояния с большими одно-фононными или двухфононными компонентами. Сделан вывод, что в некоторых сферических ядрах могут существовать достаточно чистые двухфононные состояния.

Работа выполнена в Лаборатории теоретической физики ОИЯИ.

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Soloviev V.G., Stoyanov Ch., Nikolaeva R. E4-83-166

Effect of the Pauli Principle on the Two-Phonon States in Spherical Nuclei

The effect of the Pauli principle in the two-phonon components of the wave functions on the low-lying collective states in spherical nuclei is investigated. The calculations are performed for $^{114,116}Sn$ and $^{142,144,146,148}Sm$. It is shown that the Pauli principle slightly influences the states with large one- and two-phonon components. A conclusion is made about the existence of pure enough two-phonon states in some spherical nuclei.

The investigation has been performed at the Laboratory of Theoretical Physics, JINR.

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