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V.G.Soloviev

COMPARISON OF THE INTERACTING BOSON MODEL WITH THE QUASIPARTICLE-PHONON NUCLEAR MODEL

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The interacting boson model (IBM)[1-3] is widely used in describing the collective states of spherical, transitional and deformed nuclei. Undoubtedly, the model has a deep physical basis. In recent years, the IBM is being constantly improved by introducing new types of bosons and complicating the model Hamiltonian and transitional operators.

The structure of nuclear states can be understood from the comparison of the basic assumptions of the IBM with other models including the quasiparticle-phonon nuclear model (QPNM)[4-8]. To find the limits of applicability of the IBM, one should compare the IBM with other models and the results of calculations in the IBM and the QPNM with the experimental data. In the IBM, a small part of a large space of the nuclear shell model is separated, namely a space of collective states. The separation of a subspace of collective states is efficient if they are weakly coupled with other states. This takes place only for the first quadrupole and octupole states. Disregarding this coupling in the IBM limits its applicability, and one should clarify to what states and up to what excitation energies the IBM can be applied. It is well known that with increasing excitation energy the state structure becomes complicated thus leading to the formation of compound states. The complication of the state structure with increasing excitation energy is due to the coupling of collective and noncollective degrees of freedom or to the quasiparticle-phonon interaction as in the QPNM. Just this coupling is neglected in the IBM.

The simplicity of the IBM implying a strong limitation of the shell model space allows one to treat the low-lying states in terms of the s, d and f bosons. This simplicity becomes an essential drawback of the model, i.e. difficulties in describing the states lying above the first quadrupole and octupole states. Indeed, the IBM takes into account only those two-quasiparticle states that enter into the s, d, f bosons or s_p, d_p or s_n, d_n bosons.

The QPNM utilizes a limited space of shell configurations: a large number of two-quasiparticle states, mainly of the particle-hole type, and of four-quasiparticle states of the two-particle - two-holes type represented as phonons. In the QPNM, for the states with energies higher than 2÷3 MeV the strength distribution of one-phonon or two-quasiparticle states over many nuclear levels is calculated rather than the wave function of each state. Thus, the limitations for the shell configurations in the QPNM and IBM are different.

In the phenomenological IBM, an important role is played by the number of nucleons (or holes) in unclosed neutron and proton shells. The boson operators are coupled with the pairs of fermion operators. The number of pairs of neutrons N_n and protons N_p in unclosed neutron and proton shells determines in the IBM the spectra of collective states. Thus, the nuclear level energies of the rotational bands based on the ground, beta and gamma vibrational states with the same value of F spin are close to each other[9]. The F spin is a boson analog of the isotopic spin[10]. Moreover, the ratio of the energies E_{4_1}/E_{2_1} and the energies E_{2_1} for the bands based on the ground states are monotonous depending on the product $N_p \cdot N_n$[11]. Owing to an important role of the number of valence nucleons 2N, one can compare the wave functions of excited states in the IBM with the wave functions in the microscopic models, for instance, in the QPNM. This comparison is the aim of the present paper.

1. Cardinal difference between the QPNM and the IBM and improvement of the IBM

The description of states with $K_n^\pi = 0_3^+, 0_4^+, 2_2^+, 2_3^+, 4_1^+$ and 4_2^+ in deformed nuclei within the QPNM and the IBM has been compared in ref.[8] The wave functions of these states in the IBM have dominating two-boson components and in the QPNM the dominating one-phonon components, i.e. there is a cardinal difference in describing these states in the IBM and QPNM. In spherical nuclei, the states with dominating one-phonon components corresponding to the second and third roots of the secular equation in the random phase approximation (RPA) lie above the two-phonon states, and therefore, this discrepancy has not yet manifested itself in most of the cases. The description of the above-mentioned states in the sd IBM contradicts the experimental data for some deformed nuclei.

The discrepancy with some experimental data necessitates improving the sd IBM. In addition to the s and d bosons, the g boson with J=4 is introduced. The g boson is introduced along two lines: the first is the renormalization of the boson Hamiltonian without an explicit inclusion of the g boson[12], and the second is an explicit inclusion of the g boson[13-15]. In the first case the space of two-quasiparticle states does not become broader. With the explicit inclusion of the g boson in the IBM, in deformed nuclei there appear states with dominating one-boson components with $K^\pi = 1^+$, 3^+ and 4^+ and additional states with $K^\pi = 0^+$ and 2^+, i.e. the space of two-quasiparticle states with $K^\pi = 0^+$ and 2^+ becomes broader. In the sdg IBM there are states with $K^\pi = 0^+$, 2^+ and 4^+ with dominating two-boson components.

To describe collective states of the negative parity, in the sd IBM one introduces f bosons with $J = 3$[16] or f and p bosons (p boson with $J = 1$)[17,18]. Thus, collective states of the positive and negative parity are described in the framework of the spdf IBM. In ref.[17], the energies and B(E3)-values of the states with the negative parity in ^{168}Er have been calculated and a satisfactory description was obtained. Three levels with $K^\pi = 3^-$ with small B(E3)-values are treated in ref.[17] as the two-quasiparticle ones, and therefore, are beyond the IBM.

There are many papers on the boson representation of the pairs of fermion operators. It is important that the boson operators s, p, d, f, g, etc. consist of the pairs of fermions of the particle-particle type (or hole-hole) and only the highest terms of expansion are additionally multiplied by the particle-hole configurations. Just this point is the cardinal difference between the IBM and the microscopic models for describing vibrational states whose wave functions consist of the sums of particle-hole configurations, i.e. the IBM wave functions differ essentially from the wave functions in the RPA and consequently from the QPNM, the theory of finite Fermi systems and other models. The difference in the Hamiltonians, operators of γ-transitions, etc. is due to the afore-said. In the IBM the number N is conserved; it is half of the sum of neutrons and protons (or holes) in unclosed shells and in the wave functions the number of the creation operators of bosons equals N. At the same time, in the QPNM the wave function is represented as series over the number of phonons. The QPNM single-particle operator of the $E\lambda$ -transition has terms changing the number of phonons by unity and the term that does not change the number of phonons (of the type $\alpha^+_{q\tau} \alpha_{q'\tau'}$). The IBM operator of the $E\lambda$ -transition contains terms transforming the s boson into the d boson, d boson into g boson, g boson into f boson and so on. Therefore, in the IBM there are (under a certain choice of parameters) strong transitions between the states differing by the type of one boson. In the QPNM, the $E\lambda$ -transitions between one-phonon states proceed through the terms $\alpha^+_{q\tau} \alpha_{q'\tau'}$ and therefore are strongly hindered.

It is interesting to analyse how to distinguish experimentally excitations of the particle-hole type from those of the particle-particle type. This can be made by the one-nucleon transfer reactions and allowed unhindered ß-transitions but cannot be made by the γ -transitions from the ground states and two-nucleon transfer reactions[19].

In the sd IBM the whole space of two-quasiparticle states with $K^\pi = 2^+$ is concentrated in the d_2 boson. As a result of the interaction between bosons, the most strength of two-quasiparticle states belongs to a gamma-vibrational state and the remaining part is distributed among other states with $K^\pi = 2^+$. Therefore, if the gamma-vibrational state is strongly excited in a certain one nucleon transfer reaction, for instance, in (d,p) and is not excited, say, in (^{3}He,d), this should hold for all other $K^\pi = 2^+$ states.

With the g boson introduced, the operators d^+_2 and g^+_2 enter with different weights into the wave functions of the $K^\pi_n = 2^+_1$ and 2^+_2 states [15]. As a result of the interaction between bosons a part of their strength belongs to the $K^\pi_n = 2^+_3$ state. Therefore, if a gamma-vibrational state is not even slightly excited in any one-nucleon transfer reaction, for instance, in (dt), the 2^+_2 and 2^+_3 states should not be excited in this reaction as well. In a one-nucleon transfer reaction one of the 2^+_1, 2^+_2 and 2^+_3 states should not be strongly excited and the remaining two states should not be excited at all. These specific properties of the sd IBM and sdg IBM can be and should be verified experimentally.

In the QPNM, the one-phonon parts of the wave functions of the $K^\pi_n = 2^+_1$, 2^+_2, 2^+_3 and 2^+_4 states are different. Therefore, one (or two) state can be excited in the (dt) reaction, the other in the (dp) reaction, the third in (^{3}He, d) or (^{3}He,α) and so on. This is a consequence of the large space of two-quasiparticle states taken in the QPNM into account. These cardinal differences between the IBM and the QPNM are to be verified experimentally.

The existence of collective two-phonon states is the central problem in the study of the structure of nonrotational states of doubly even deformed nuclei. The crucial contradiction between the QPNM on the one hand and the IBM, the Bohr-Mottelson model[20] and its microscopic analogs[21] and the self-consistent collective-coordinate method[22,23] on the other hand consists in the existence of two-phonon collective states. According to the QPNM, the deformed nuclei have no two-phonon collective states whereas other predict their existence.

According to the QPNM, in the two-phonon configurations the Pauli principle shifts the energy centroid by 1-2 MeV towards higher energies with respect to the energy sum of two RPA phonons. As a result , the energy centroid of a two-phonon collective state becomes larger than

3 MeV. If one of the two phonons, for instance $\lambda\mu i = 201$, turns out to be weakly collective, then the energy shift of the state $\{201,201\}$ or $\{\lambda\mu i, 201\}$ may be small. Nevertheless, due to a large energy of the 201 phonon the energy centroid is still larger than 3 MeV. At an energy above 3 MeV a two-phonon state should be fragmented over nuclear levels. The conclusion on the absence of two-phonon collective states in deformed nuclei has been made in ref.[7] on the basis of the above reasoning.

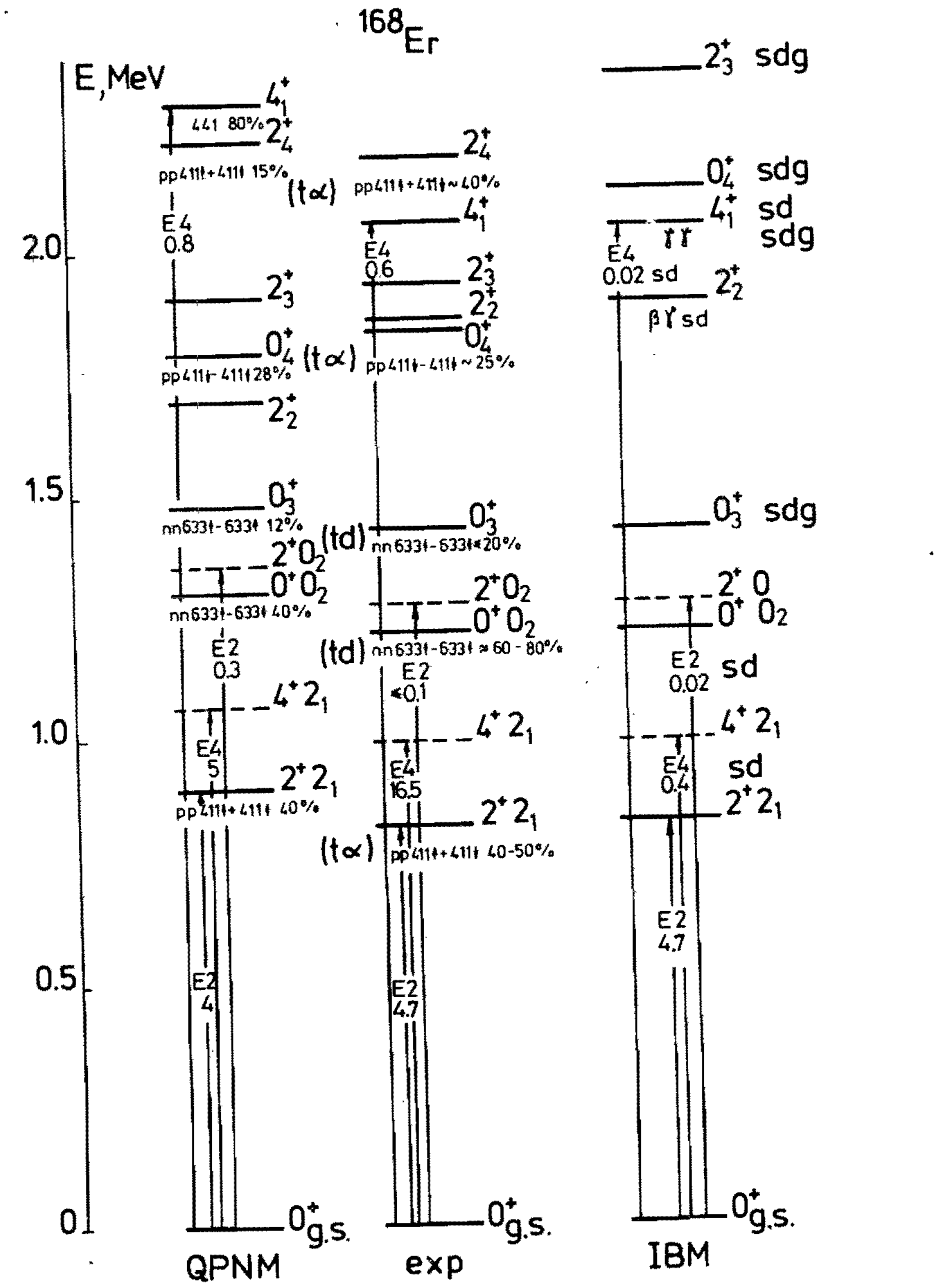
From the analysis of experimental data it has been concluded[24] that there are no reliably determined two-phonon collective states in deformed nuclei. Numerous experimental investigations in recent years did not lead to the detection of two-phonon states.

2. Comparison of the description of ^{168}Er in various models

The comparison of the results for the nonrotational states with $K^\pi = 0^+$, 2^+ and 4^+ calculated within various models between themselves and with the experimental data will be performed for ^{168}Er. The choice of ^{168}Er is caused by the rich experimental data[25-30] and numerous calculations[7,8,13-16,20-23,28,30-32]. The comparison is shown in fig.1, the experimental data for the (t,α) and (t,d) reactions are taken from ref.[27]; and for B(E2) and B(E4)-values (in the single-particle units), from ref.[30]. This figure presents the results of calculations within the QPNM[7,8,32], sd IBM[28,30] and the sdg IBM[14].

The results of calculations for ^{168}Er in the sd IBM[28,30,31] and sdg IBM[13] contradict the experimental data on 0^+_3, 0^+_4, 2^+_2, 2^+_3 and 2^+_4 states. In a new version of the sdg IBM[14] four types of the interaction with new parameters have additionally been introduced into the Hamiltonian. As a result, some discrepancies with the experimental data including those on the 0^+ state excitations in the (tp) reaction were removed. Nevertheless, in the calculations[14] one of the two states 0^+_3 or 0^+_4 as well as of $K^\pi_n = 2^+_2$ or 2^+_3 is a two-phonon state, which contradicts the experimental data. Moreover, according to ref.[27], the 2^+_4 state having a large two-quasiparticle pp$411\downarrow+411\uparrow$ component cannot exist within the sdg IBM[14], which has long ago been predicted in the QPNM calculations. Following ref.[14], the $K^\pi_n=4^+_1$ state has a two-phonon nature and the $K^\pi=4^+$ state with a large one-phonon hexadecapole component lies at 3.8 MeV. In all the calculations within the sd and sdg IBM the 4^+_1 state is the two-phonon one. The energies of $K^\pi_n=2^+_1$, 2^+_2, 0^+_2, 0^+_3 and 4^+_1 states, that are close to the experimental data, depend on the choice of parameters of the sdg IBM.

In comparison with the calculations of one-phonon states in ref.[32], the calculations of ^{168}Er within the QPNM in ref.[33] and the sub-



sequent calculations redefined the constants $\kappa_0^{(42)}$ and $\chi_0^{(42)}$ (to decrease the B(E2)-values for the 2^+0_2 state excitation) and the blocking effect. In calculating the $K^\pi=2^+$ states the hexadecapole $\lambda\mu=42$ forces were taken into account together with the quadrupole $\lambda\mu=22$ ones. The values of the two-quasiparticle components (%) in fig. 1 are presented with the inclusion of the relevant phonon contribution to the wave function normalization. A correct description of the experimental data has been obtained. It is very important that there are no any explicit discrepancies with them. The calculated two-quasiparticle components of the wave functions of the $K^\pi_n = 0^+_2, 0^+_3, 0^+_4, 2^+_1$ and 2^+_4 states are in agreement with the experimental data on the (td) and ($t\alpha$) reactions /27/. The calculated isoscalar B(E4)-values of the 4^+2_1 state excitation are three times as less as the experimental values obtained in ref./30/ from the (α,α') reaction in spite of the fact that the 2^+_1 wave function contains a large contribution from the hexadecapole component with $\lambda\mu=42$. By the calculations, the one-phonon $\lambda\mu i=441$ component gives an 80% contribution to the notmalization of the $K^\pi_n = 4^+_1$ wave function whereas the contribution of the two-phonon $\{221,221\}$ configuration is still about 1%. The 4^+_1 state energy at B(E4)=0.8 spu appeared to be higher than the experimental one. The experimental data /30/ on B(E4)-values for the 4^+_1 state excitation indicate the presence of a large one-phonon component in the wave function. Since the hexadecapole $\lambda\mu=42$ forces are taken into account together with the quadrupole $\lambda\mu=22$ ones, when calculating the $K^\pi_n=2^+_1$ states, the pole of $K^\pi=4^+\{221,221\}$ is somewhat less shifted. Nevertheless, the energy centroid of this state is a little higher than 4 MeV. The energy centroids of the two-phonon $K^\pi=2^+\{221,201\}$, $0^+\{221,221\}$ and $0^+\{201,201\}$ configurations are in the interval (3.0-3.5) MeV.

The problem of large anharmonicity of the two-phonon γ- vibrational states in ^{168}Er has been discussed in ref./21/ and is being studied in ref./23/ by means of the self-consistent-collective-coordinate method/22/. A large anharmonicity is thought to be due to γ- deformation in ^{168}Er. According to ref./23/, the energy minimum has been obtained at $\gamma_0=13^o$ and the energy difference in comparison with $\gamma=0$ is 1 MeV. It should be noted that the calculations/34/ of the ^{168}Er shape by the shell correction method indicate the softness of the ^{168}Er with respect to γ deformation but the energy minimum is attained at $\gamma_0=0$. According to calculations/23/, the energies of the two-phonon states $4^+_{\gamma\gamma}$ and $0^+_{\gamma\gamma}$ are 2.25 MeV and 2.95 MeV, respectively. At the energy 3 MeV the two-phonon state should be fragmented, and in this case for 0^+ there is no obviuos discrepancy with the QPNM. The inclusion of the

mode-mode coupling decreases the energies of the two-phonon $4^+_{\gamma\gamma}$ and $0^+_{\gamma\gamma}$ states up to 2.1 MeV and 2.27 MeV, respectively. It is to be noted that the mode-mode coupling is much simpler than the quasiparticle-phonon interaction in the QPNM. Moreover, according to ref./23/ $\mathcal{E}(4^+_{\gamma\gamma}) < \mathcal{E}(0^+_{\gamma\gamma})$ whereas in the QPNM an inverse equality $\mathcal{E}(4^+_{\gamma\gamma}) > \mathcal{E}(0^+_{\gamma\gamma})$ for the energy centroids is valid since the effect of the Pauli principle for the sum of K-values of two phonons is considerably larger than for their difference.

The results obtained in ref./23/ concern only γ-vibrational and two-phonon states $4^+_{\gamma\gamma}$ and $0^+_{\gamma\gamma}$ in ^{168}Er whereas a set of nuclear states including ß-vibrational ones are to be described. It should be explained why the two-phonon states of the type $\{221,201\}$, $\{221,311\}$, $\{221,321\}$, etc. are not observed. The contribution of the hexadecapole component to γ-vibrational state is to be described. A large B(E4)= =0.6 spu of the 4^+_1 state excitation/30/ contradicts the conclusion /14,23/ on the two-phonon structure of this state.

3. Discrepancies between the spdfg IBM and the QPNM

The necessity of introducing the g boson in the case of deformed nuclei is clearly demonstrated by the example of ^{168}Er. The g boson is also necessary for describing the 4^+_2 states in spherical nuclei. Obviously, collective states with the positive and negative parity should be described in the framework of one model. There is no point in describing the states with the two-boson dominating components separately. Indeed, the f^+f^+ states have the positive parity whereas the d^+f^+ and f^+g^+ states have the negative parity. Therefore, deformed nuclei should be described within the spdfg IBM if one does not restrict himself to the ß-, γ- and first octupole states with the corresponding rotational bands. Such a version of the IBM is still to be consistently formulated. For the deformed nuclei, the QPNM should be compared with the spdfg IBM in the general form. According to the QPNM, the wave functions of the $K^\pi_n = 0^\pm_2, 0^\pm_3, 0^\pm_4, 1^\pm_2, 1^\pm_3, 2^\pm_2, 2^\pm_3, 2^\pm_4, 3^\pm_2, 3^\pm_3, 4^+_1$ and 4^+_2 states have dominating one-phonon components corresponding to the second, third and fourth roots of the secular equation in the RPA. The experimental detection of these states with the positive parity is exemplified in refs./8,32/. The following experimental data are available on the states with the negative parity: for $K^\pi_n = 3^-_2$ with the energy 1.828 MeV, 1^-_2 with 1.936 MeV, 3^-_2 with 1.999 MeV and 2^-_2 with 2.230 MeV in ^{168}Er /35/; for $K^\pi_n = 2^-_2$ with the energy 1.567 MeV, 2^-_3 with 1.857 MeV in ^{178}Hf/36/; for $K^\pi_n = 0^-_2$ with the energy 1.237 MeV in ^{234}U and others.

In the spdfg IBM in doubly even deformed nuclei in the energy range from 1.5 to 2.5 MeV there should be states with $K^{\pi}_{n} = 0^{-}_{2}, 0^{\pm}_{3}, 0^{+}_{4}, 1^{\pm}_{2}, 2^{\pm}_{2}, 2^{\pm}_{3}, 3^{\pm}_{2}$ and 4^{+}_{1}, whose wave functions have dominating two-boson components. These states are not yet observed experimentally. Does the spdfg IBM pretend to the description of these states? If yes, there is an essential discrepancy of the spdfg IBM with the QPNM and with several experimental data.

The comparison of different models should be performed for many deformed nuclei in the rare-earth and actinide regions so that the specific features of one nucleus could not distort the general picture. Thus, there are still discrepancies between the sdg IBM and the experimental data in describing the $K^{\pi}_{n} = 4^{+}_{1}$ and 4^{+}_{2} states in $^{156,158}Gd$ and $^{160,164}Dy$ and the $K^{\pi}_{n} = 3^{+}_{1}$ and 3^{+}_{2} states in $^{172,174}Yb$. The sdg IBM encounters difficulties in describing the $K^{\pi}_{n} = 2^{+}_{2}$ states with large B(E2)-values that are observed in many nuclei. The absence of two-phonon $0^{+}\{301,301\}$ states in the Th and U isotopes, in which there is no stable octupole deformation, is yet to be explained within the spdfg IBM, the Boh-Mottelson model, the method used in ref.[23] and other models. It may be asserted that many-quasiparticle or many-boson components of the wave functions are not essential in well deformed nuclei in the states with an energy up to 2 MeV.

It should be noted that the structure of nonrotational states of doubly even deformed nuclei in the rare-earth and actinide regions is correctly described within the QPNM. In these calculations one uses the single-particle energies and wave functions as well as the one-phonon RPA states calculated more than 15 years ago.

4. Critical comments of giant resonances in the IBM

The attempts have been made[38,39] to describe the isovector dipole and isoscalar monopole and quadrupole giant resonances in the Sm isotopes within the IBM. The particle-hole operators of the p′, s′ and d′-bosons were introduced; the operators of E1, E0 and E2 transitions were written in the form

$$T_1 = D_1(p'^{+}+p), \quad T_0 = D_0(s'^{+}+s'), \quad T_2 = D_2(d'^{+}+d').$$

The relevant Hamiltonians have the terms describing the interaction of the p′, s′ and d′ bosons with the s and d bosons. They are responsible for the fragmentation of one-boson states forming giant resonances. The parameters D_0 and D_2 in ref.[39] are found from the energy weighted sum rule and D_1 is assumed in ref.[38] to be a free parameter. It is to be noted that in describing giant resonances, the IBM uses particle-hole

operators. Therefore, in this case there is no essential discrepancy with the RPA calculations in other microscopic model as well.

In refs.[38,39] the whole set of collective states forming the giant resonances for each K is described in terms of one boson. It is to be answered whether the whole variety of states forming the giant resonance can be described in terms of one boson.

The QPNM calculations show that the giant resonances are formed due to the fragmentation of a large number of one-phonon states. The exception is the isoscalar quadrupole resonance in ^{90}Zr, $^{112-120}Sn$, ^{144}Nd and other nuclei formed by two one-phonon states[40-42]. As is shown in Fig. 3, in ref.[42] the fragmentation of two one-phonon states in ^{118}Sn is different. As a rule, five-ten and more one-phonon states in spherical nuclei exhaust the most strength of the isovector dipole and isoscalar quadrupole resonance. The quasiparticle-phonon interaction causes the fragmentation of one-phonon states manifesting itself in the resonance fine structure. Thus, a large number of 2^{+} states forming the isoscalar quadrupole resonance in ^{208}Pb has experimentally been observed in ref.[43]. The QPMN calculations[43] have shown a fine structure of this quadrupole resonance consistent with the results of ref.[43]. In deformed nuclei, many one-phonon states participate in the formation of giant resonances. Thus, according to ref.[5] 150 one-phonon states exhaust 80% of the energy weighted sum rule of the isovector dipole resonance in ^{238}U. In calculating the giant quadrupole resonances in the rare-earth and actinide regions, 2000-3000 one-phonon states are taken into account.

It follows from the microscopic calculations that a large set of two-quasiparticle states is necessary for the formation of the giant resonance (especially in deformed nuclei). Therefore, one can hardly expect that a large number of shell configurations forming the giant resonance can be described by one boson for each value of K.

If the giant resonance is formed due to the fragmentation of one boson, there should follow certain regularities for the probabilities of its decay with the emission of a neutron and a proton or by γ-transitions to the ground or excited states when passing from the low-energy part of the resonance to its upper part. Direct indications may be given by the one-nucleon transfer reactions if the valence particle-particle (or hole) configurations provide a large contribution to the wave functions of states forming the giant resonance. The operators of γ-transitions from the giant resonances proceed between the states differing by a particle-hole boson. Thus, to the gamma vibrational states there proceed γ-transitions from the components s'^{+} or p'^{+} or d'^{+} multiplied by the d^{+} boson of the wave functions of the states forming the giant resonance. In the IBM, such probabilities of γ-transitions to the beta-, gamma- and first octupole states should be calculated for some deformed nuclei. The comparison of these calculations with the experimental data will probably answer the question whether a giant resonance can be formed by one boson.

Conclusion

It is a rare case in the theory of atomic nucleus that various models differ essentially in describing certain nuclear characteristics. Removing these contradictions leads as a rule to a deeper understanding of the nuclear structure. In describing some states of doubly even deformed nuclei in the excitation energy interval from 1.5 to 2.5 MeV, the IBM, QPNM and other models have essential contradictions. The latter necessitate new more exact experiments. First of all, the experiments are necessary on the measurement of the contribution of two-quasiparticle components to the wave functions of rotational bands based on the $K^{\pi}_{n} = 0^{-}_{2}, 0^{\pm}_{3}, 0^{\pm}_{4}, 1^{\pm}_{2}, 1^{\pm}_{3}, 2^{\pm}_{2}, 2^{\pm}_{3}, 2^{\pm}_{4}, 3^{\pm}_{1}, 3^{\pm}_{2}, 4^{+}_{1}, 4^{+}_{2}$ and other states and on the search of two-phonon collective states.

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Соловьев В.Г. Е4-87-45

Сопоставление модели взаимодействующих бозонов с квазичастично-фононной моделью ядра

Проведено сопоставление основных положений квазичастично-фононной модели ядра с моделью взаимодействующих бозонов. Для единого описания коллективного состояния с положительной и отрицательной четностью необходимо разработать вариант модели взаимодействующих бозонов с spdfg бозонами. Показано, что имеются кардинальные различия в основных положениях моделей и в описании состояний четно-четных деформированных ядер с $K^{\pi}_{n} = 0^{-}_{2}, 0^{\pm}_{3}, 0^{\pm}_{4}, 1^{\pm}_{2}, 2^{\pm}_{2}, 2^{\pm}_{3}, 2^{\pm}_{4}, 3^{\pm}_{2}, 3^{\pm}_{3}, 4^{+}_{1}$ и 4^{+}_{2}. Дана критика описания гигантских резонансов в модели взаимодействующих бозонов. Утверждается, что необходимы новые более точные экспериментальные исследования структуры состояний деформированных ядер с энергиями возбуждения (1,5 - 2,5) МэВ.

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Soloviev V.G. E4-87-45

Comparison of the Interacting Boson Model with the Quasiparticle-Phonon Nuclear Model

Basic assumptions of the quasiparticle-phonon nuclear model are compared with those of the interacting boson model. For a unique description of collective state with the positive and negative parity, one should develop a version of the interacting boson model with the spdfg bosons. It is shown that there are cardinal differences in the basic assumptions of the models and in describing the states of doubly even deformed nuclei with $K^{\pi}_{n} = 0^{+}_{2}, 0^{\pm}_{3}, 0^{\pm}_{4}, 1^{\pm}_{2}, 2^{\pm}_{2}, 2^{\pm}_{3}, 2^{\pm}_{4}, 3^{\pm}_{2}, 2^{\pm}_{3}, 4^{+}_{1}$ and 4^{+}_{2}. Critical comments on the description of giant resonances within the interacting boson model are given. It is asserted that new, more exact experimental investigations of the state structure of deformed nuclei with excitation energies (1.5 - 2.5) NeV are necessary.

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

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