LEVEL WITH SPIN I = 16 *IN THE* Po^{212} *NUCLEUS*

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The spin of the Po^{212m} isomer level is determined. It is ascertained why no gamma transitions from this level are observed.

A level with spin $I \geq 16$ and half-life $\tau = 45$ sec was observed in the nucleus Po^{212} at a height of 2.93 MeV.[1] It was determined that only alpha decay to the ground and excited states of the Pb^{208} nucleus comes from this level. The latter circumstance is surprising because there would seem to be many paths for γ-transitions to lower-lying levels.

We studied the nucleus Po^{212} earlier.[2] Making use of the potential and residual pairing forces found from the analysis of excited states of nuclei in the region of Pb^{208}, we calculated the levels of Po^{212} up to an excitation energy of 2 MeV. These were the levels with spin $I \leq 4$, for which the energies, transition probabilities, and other observed quantities were obtained. Since higher levels were not known at that time, they were not studied. However, the method used in the study allows one to calculate the position and properties of levels with any spin. In the present note we examine levels with spin $I \geq 16$.

The lowest level with spin I = 16 comes from the general configuration $|j_n^2 J_n, j_p^2 J_p; I>$, where the neutrons are in the single-particle level $j_n = g_{9/2}$ the protons in $j_p = h_{9/2}$, $J_n = J_p = 8$, and the total spin I = 16.

Gamma transitions from the level $|j_n^2 8, j_p^2 8; 16>$ may go to levels of the configurations $|j_n^2 8, j_p^2 J; I>$ and $|j_n^2 J, j_p^2 8; I>$, where $0 \leq J \leq 8$ and $0 \leq 1 \leq 16$. Each of the indicated configurations gives 44 levels upon splitting. We determine the position of all 88 levels relative to the I = 16 level of interest to us. We calculate the matrix elements of the nn, pp, and np forces using the formulas and parameters of [2]. In Fig. 1 are presented the values of the diagonal matrix elements of the nn and pp forces as functions of the angular momentum of the pair J. In Fig. 2 are given the values of the diagonal matrix elements of the np interaction for different total spins I. The matrix elements $<|V_{np}|>$ depend also on

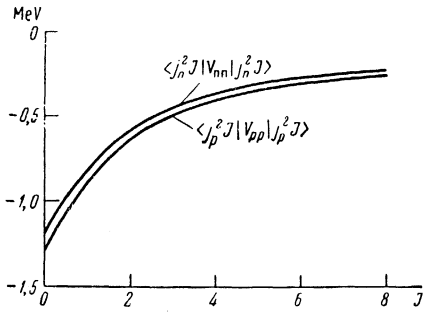

FIG. 1. The diagonal matrix elements of the nn and pp interaction as a function of J, the angular momentum of the pair.

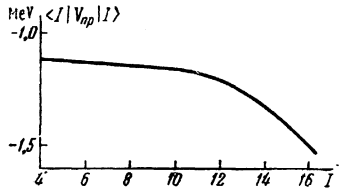

FIG. 2. The diagonal matrix elements of the np interaction as a function of the total angular momentum I.

J_n and J_p, but very weakly. Therefore, in actuality, for each of the values of I there is a set of close points which lie on the curve of Fig. 2 and somewhat higher. In the determination of the relative level positions it is possible to avoid calculating the off-diagonal matrix elements, since the latter cause an almost identical energy shift of the first levels with a given spin I.

Using the data presented in Figs. 1 and 2, we find that only two of the 88 levels lie below the level I = 16, namely, $|j_n^2 8, j_p^2 0; 8>$ and $|j_n^2 0, j_p^2 8; 8>$. To these levels could go γ-transitions of multipolarity $l = 8$. In the case of such a high multipolarity the lifetime with respect to γ radiation, τ_γ, would be much greater than 45 sec, and therefore no γ rays will be observed. Yet intense transitions down to the level I = 16 are possible by many paths. Such specific circumstances make the level I = 16 only an alpha-decay level. We note here that without account of np

forces, nothing like this would be obtained, because the relatively large downward shift of the level I = 16 is a consequence of the course of the curve of the matrix elements of the np interaction, and this course does not depend on the concrete form of the np forces.

Let us determine at what height the level I = 16 lies above the ground state I = 0. For this it is necessary to calculate the coupling energy, calculating the contribution not only of the diagonal, but also of the off-diagonal matrix elements. The coupling energy of the ground state was calculated before [2]. Analogous calculations for the level I = 16 give a coupling energy 2.4 MeV less than for the ground state. The value obtained can be made closer to the experimental value by refinement of the parameters.

A word now concerning the levels with spins I > 16. They come from other configurations, for example, $|(g_{9/2}\, i_{11/2})\, 10,\ h^2_{9/2}\, 8;\ 18\rangle$ or $|g^2_{9/2}\, 8,\ i^2_{13/2}\, 12;\ 20\rangle$ and lie higher than the level I = 16 because their single-particle coupling energy is less. From the levels I > 16 may go γ-transitions of low multipolarity, and they can not be discerned by their lifetimes.

Thus, a spin I = 16 should be assigned to the observed isomeric level.

[1] V. A. Karnaukhov, JETP 42, 973 (1962), Soviet Phys. JETP 15, 671 (1962). Perlman, Asaro, Ghiorso, Larsh, and Latimer, Phys. Rev. 127, 917 (1962).

[2] Band, Sliv, and Kharitonov, JETP 41, 1274 (1961), Soviet Phys. JETP 14, 908 (1962).

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