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VI–5 Studies on Energy Levels and Electromagnetic Properties in $N = 82$ Nuclei Using Pseudo *LS* Coupling Shell Model

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In $N = 82$ nuclei, there occurs strong configuration mixing, especially, between $0g_{7/2}$ and $1d_{5/2}$ single-particle orbits. Our aim is to study how does it affect energy levels and electromagnetic properties of low-lying states.

Using the seniority scheme of pseudo *LS* coupling[1,2,3] in the configuration $(1d_{5/2}\ 0g_{7/2})^{Z-50}$, shell model calculation is carried out for $Z = 51 - 59$ nuclei with $N = 82$. States with seniority $v \leqq 4$ and those with $v \leqq 3$ are exactly treated for even- and odd-nuclei, respectively. The two-body interaction is assumed to be

$$\text{Elliott's realistic force } -p\sqrt{(2j_1+1)(2j_2+1)}\delta(J, 0) -q \cdot r_1^2 r_2^2 (C_1^{(2)} \cdot C_2^{(2)}) \ , \tag{1}$$

where the last two terms represent the core-polarization effect. To evaluate a many-body matrix element of the interaction (1), we first express the interaction as the sum of central, vector and tensor force defined in pseudo *LS* space:

$$\text{interactions (1)} = \sum_{k=0}^{2} G^{(k)}. \tag{2}$$

Next, we make use of new reduction relations[4] for many-body matrix elements of $G^{(k)}$. Particle-hole interaction[5] $\bar{G}^{(k)}(k = 0 \sim 2)$ plays an important role in the present formalism. The magnetic moment operator is expressed in the pseudo space as

$$13.0U^{(01)} - 1.71U^{(10)} + 16.2U^{(12)}, \tag{3}$$

where $U^{(xy)}$ is the unit tensor operator of degree x with respect to S and of degree y with respect to L, and $g_l = 1$ and $g_S = 5.58$ are used.

Level spacing between single-particle orbits $1d_{5/2}$ and $0g_{7/2}$ is kept to be observed value 0.963 MeV. We vary coupling constants p and q in the interaction (1), and find that energy spectra for even- and odd-nuclei are well reproduced with $p = 0.082$ and $q = 0.0013$. Some of results are shown in Fig. 1. The interaction (1) is found to have very small non-central parts $G^{(1)}$ and $G^{(2)}$. Wave functions of low-lying states of $Z \geqq 54$ nuclei are expressed, in a good approximation, in terms of the possible lowest

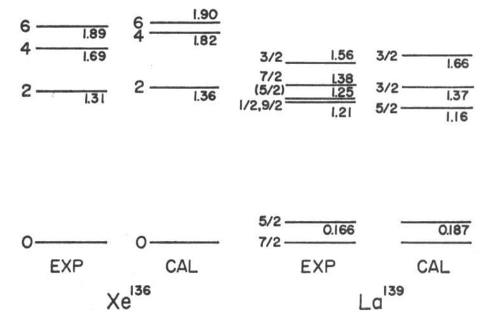

Fig. 1

seniority. Occupation probability $\langle n \rangle$ of $0g_{7/2}$ in ground states are evaluated to be 2.57, 3.06, 3.77, 4.25, 4.80 and 5.31 for $Z = 53 \sim 58$, respectively, which agrees with results obtained from nuclear reaction.[6]

Using the operator (3), g factors of ground states are evaluated to be 0.4924 in Cs^{137} and 0.4912 in La^{139}. These are almost equal to the single-particle g factor $g_{sing} = 0.4911$, while observed g factors are 0.811 in Cs^{137} and 0.794 in La^{139}. For l-forbidden transition from 5/2 to 7/2 in odd nuclei, retardation is thousand times too large in comparison with observed values.

As another type of residual interaction, we use a central force with a Gaussian radial shape. We find that Rosenfeld force mixture with the force range 0.55 and the depth 35 MeV reproduces energy spectra very well. The l-forbidden transition can be fairly explained. However, g factors in odd nuclei are almost the same as g_{sing}.

It is interesting that observed level schemes of $Z = 81$, 82 and 83 nuclei with $N = 126$ resemble somewhat to those of $Z = 51$, 52 and 53 nuclei with $N = 82$, respectively. It is then suggested that the strong coupling model, *i.e.* pseudo *LS* coupling, defined in the $(1f_{7/2}\ 0h_{9/2})^{Z-82}$ configuration, would be also appropriate to describe $N = 126$ nuclei for the case $(Z - 82) \gtrsim 3$.

If low-lying states of $N = 126$ nuclei can be described by the main configuration $(0h_{9/2})^{Z-82}$ and small configuration mixing, we get the following identity among g-factors of $N=126$ nuclei, assuming[5] that effective magnetic moment is expressed in terms of one- and two-body operators:

$$g(9/2)+g(21/2)=(2g(6)+8g(8))/5, \tag{4}$$

where $g(9/2)$ represents the g factor of the ground state of Bi^{209} and $g(21/2)$ is that of the $21/2^-$ state of At^{211} and $g(6)$ ($g(8)$) is that of 6^+ (8^+) state of Po^{210}. Observed g factors,[7] however, do not seem to satisfy the identity (4), though observed g factors are not accurate enough to get definite conclusion. If really the identity (4) does not hold, we should have to expect very strong configuration mixing also in $(Z-82)\gtrsim 3$ nuclei with $N=126$.

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