On the I=j-2 Anomaly and the Doublet-Triplet Condition

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The lowering of the I=j-1 and I=j-2 states, referred to as the I=j-1 and I=j-2 anomalies, is a pronounced feature in $f_{7/2}$ nuclei. These nuclei exhibit an outstanding asymmetry: in $f_{7/2}^{-3}$ odd-A nuclei ($^{51}_{25}Mn_{29}$, for example), the low-lying doublet $7/2^-, 5/2^-$ appears, while in $f_{7/2}^{3}$ odd-A nuclei (such as the cross-conjugate $^{45}_{22}Ti_{23}$ nucleus), the ground-state triplet $7/2^-$, $5/2^-$, $3/2^-$ appears. The I=j-1 and I=j-2 anomalies have also been discovered in other regions of the periodic table.

We point out here that the only I=j-2 anomaly appears as a second-order effect in the CVM, analogously to the I=j-1 anomaly[1)]. We show that the only possible sizable influence on the splitting of the one-phonon multiplet $|(j^3)j,12;I\rangle$ is due to the possible presence of the single-particle configurations $|j'=j\pm2\rangle$. Owing to the $|j-2\rangle$ single-particle state in the second order the contribution from the cluster $|(j^2)0,j';I=j'\rangle$ leads to a strong shift downwards of the $|I=j-2\rangle$ state, without affecting sizably other members of the multiplet. In the asymptotic limit this shift is even larger than for the I=j-1 state, and the $|I=j-2\rangle$ state becomes the ground state.

Based on the CVM discussion, we introduce a new asymptotic rule, a doublet-triplet condition, and exemplify it throughout the nuclear systematics.

1) V. Paar, Nucl. Phys. A211 (1973) 29.