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# Nuclear Moments of the Anomalous Coupling States

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It has long been known that the so-called anomalous coupling $7/2^+$ and $5/2^+$ states in the nuclei with $Z$ or $N = 43, 45$ and 47 are observed around the ground state. In the simple shell model these states are assigned by the multiparticle configuration $(g_{9/2})^{3,5,7}$. The shell model calculations[1] have however shown that the $7/2^+$ state never go down below the $9/2^+$ states for the values of the range parameter less than 2.0. In elucidating the nature of the anomalous coupling $7/2^+$ and $5/2^+$ states, it may be pertinent to consider the following information: (i) For nuclei with $N = 41$, low-lying anomalous coupling states are observed. (ii) Some E2 transitions between the anomalous coupling states and the $9/2^+$ states are strongly enhanced. The enhancements of the transitions are compared to those of phonon transitions in neighboring even-even nuclei. (iii) Observed static quadrupole moments of some anomalous coupling states are almost ten times as large as those expected from the nuclear shell model. (iv) Some observed M1 transitions between the $9/2^+$ and $7/2^+$ states are rather weakly hindered. (v) Observed magnetic moments for the $7/2^+$ state of odd neutron nucleus are negative.

In a previous paper,[2] we have tried to explain these properties of the anomalous coupling states on the basis of the BCS method and random phase approximation. Although the calculation were made in the scheme of pairing plus quadrupole forces, the results are much improved by adding the spin-quadrupole force to those forces. Ratio of the strength of the spin-quadrupole force to that of the quadrupole one, $k_1/k_0$, which fits the experiments is about 0.2–0.4. The calculations were performed by taking account of all states of the two major shells ($N = 3$ and 4) and of up to four quadrupole phonons. The results for $k_1/k_0 = 0.3$ of the electromagnetic moments on odd neutron nuclei are listed in tables.

## References

1) B. H. Flowers: Proc. Roy. Soc. **215** (1952) 398.
2) H. Ikegami and M. Sano: Phys. Letters **21** (1966) 323.

Table I.

| Nucleus | $Q$ moment/$(e \cdot \mathrm{cm}^2 \cdot 10^{-24})$ | | | $\mu$ moment/$(e\hbar/2\mathrm{Mc})$ | | |
|---|---|---|---|---|---|---|
| | $9/2^+$ | $7/2^+$ | $5/2^+$ | $9/2^+$ | $7/2^+$ | $5/2^+$ |
| $^{75}$Se | −2.30 | −1.68 | −1.25 | −1.35 | −0.23 | −1.45 |
| $^{77}$Se | −1.59 | −1.59 | −1.32 | −1.68 | −0.45 | −1.50 |
| $^{79}$Se | −0.06 | −1.18 | −0.94 | −1.87 | −0.85 | −1.60 |
| $^{81}$Se | +1.00 | −1.02 | −0.43 | −1.87 | −0.52 | −1.65 |
| $^{83}$Se | +0.84 | −0.68 | −0.17 | −1.89 | −0.15 | −1.70 |

| Nucleus | $B(\mathrm{E2})/(e^2 \cdot \mathrm{cm}^4 \cdot 10^{-49})$ | | | $B(\mathrm{M1})/(e\hbar/2\mathrm{Mc})^2$ | |
|---|---|---|---|---|---|
| | $5/2^+ \rightarrow 7/2^+$ | $7/2^+ \rightarrow 9/2^+$ | $5/2^+ \rightarrow 9/2^+$ | $5/2^+ \rightarrow 7/2^+$ | $7/2^+ \rightarrow 9/2^+$ |
| $^{75}$Se | 0.50 | 0.06 | 1.05 | 0.48 | 2.48 |
| $^{77}$Se | 0.39 | 0.21 | 1.20 | 0.44 | 2.04 |
| $^{79}$Se | 0.12 | 0.23 | 0.74 | 0.32 | 1.06 |
| $^{81}$Se | 0.03 | 0.05 | 0.36 | 0.12 | 0.39 |
| $^{83}$Se | 0.01 | 0.02 | 0.27 | 0.06 | 0.47 |