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III–27 Empirical Deduction of Anomalous g_l Factors of Nucleons

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Since our publication[1] on the empirical deduction of the anomalous g_l factor of nucleons, several new experimental data of magnetic moments have been reported, and some additional information on the g_l factors has been obtained, which are summarized here.

The g_l and g_s factors in the bare M1 operator for nucleons in nuclei are taken as $g_l^{\text{free}} + \delta g_l$ and $g_s^{\text{free}} + \delta g_s$, respectively. Then the magnetic moment of a single-particle state is expressed as

$$\mu = \mu_{\text{Schmidt}} + \Delta\mu_{\text{op}} + \Delta\mu_{\text{1st}} + \Delta\mu_{\text{higher}},$$

where μ_{Schmidt} is the Schmidt moment, $\Delta\mu_{\text{op}}$ is

$$\Delta\mu_{\text{op}} = \delta g_l \pm \frac{1}{2l+1}(\delta g_s - \delta g_l) \quad \text{for } j = l \pm 1/2$$

and $\Delta\mu_{\text{1st}}$ and $\Delta\mu_{\text{higher}}$ are the corrections due to the first- and higher-order configuration mixings in nuclear wavefunction, respectively. The first-order correction induces an inward deviation of magnetic moments from the Schmidt lines,[2] and the higher-order correction induces displacement from the Schmidt lines in such a way that g factors become closer to Z/A.[1]

We have evaluated the magnitudes of $\Delta\mu_{\text{1st}}$ and $\Delta\mu_{\text{higher}}$ to get the remaining part $\Delta\mu_{\text{op}}$. In a given closed-shell region we can determine δg_l and δg_s, when we have more than two experimental values, including those for both spin up ($j = l + 1/2$) and down ($j' = l' - 1/2$). Uncertainties in $\Delta\mu_{\text{1st}}$ cause a large ambiguity in δg_s but not in δg_l. The results are summarized in the Fig. 1. We see from the Fig. 1 that the δg_l values which should be ascribed to the bare M1 operator are

$$\delta g_l^{(\text{proton})} = 0.10 \sim 0.20,$$
$$\delta g_l^{(\text{neutron})} = -0.05 \sim -0.15.$$

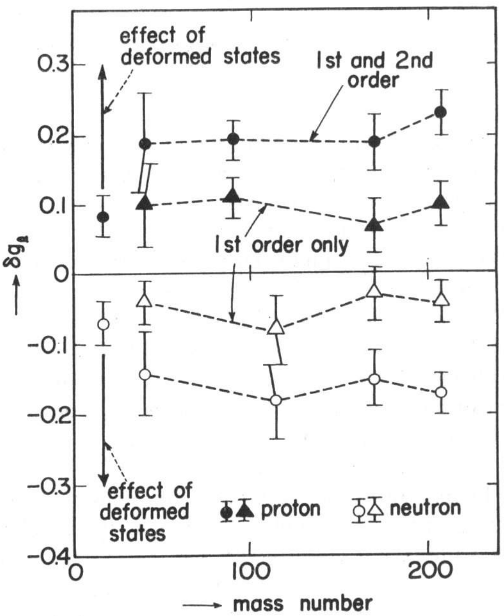

Fig. 1. Values of δg_l plotted versus mass number.

These values are compatible with the prediction by the meson exchange theories.[3]

References

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