

ON THE INFLUENCE OF THE 1^+ COLLECTIVE STATE
IN THE Pb REGION

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A number of experiments [1] have shown the existence of the isovector M1 collective state. The collectiveness of the state is affirmed by the fact that almost all of the available strength is concentrated in a very narrow region. In ^{208}Pb , for example, the total available strength is $36 \mu_N^2$ (μ_N - nuclear magneton) and $27 \mu_N^2$ is found around 8.2 MeV.

Following nuclear field theory ideas of Bohr and Mottelson [2] the particle-vibration coupling Hamiltonian assumes the form:

$$H_{pv} = \kappa \vec{\sigma} \vec{\alpha}(M1) \quad (1)$$

κ is the coupling strength, $\vec{\sigma}$ is the spin operator and $\vec{\alpha}$ stands for the collective spin field. The iso character is easily defined by replacing $\vec{\sigma}$ with $\tau_3 \vec{\sigma}$ in the isovector case. The particle moving in the oscillating spin field will through (1) have renormalized its spin part of the magnetic moment g_s . In the lowest order it is easy to evaluate $\delta g_s/g_s$ with the operator which besides the particle contains also the collective part. Assuming the linear response of the system, the energy of the collective state in terms of the unperturbed energy $\overline{\Delta \epsilon_{\vec{l}\vec{s}}}$ is given by

$$\hbar\omega(M1) = \left(\frac{1}{1 + \delta g_s/g_s} \right)^{1/2} \overline{\Delta \epsilon_{\vec{l}\vec{s}}} \quad (2)$$

$\overline{\Delta \epsilon_{\vec{l}\vec{s}}}$ is the mean value of the spin-orbit splitting of particles forming the spin vibrational state. In ^{208}Pb , $\overline{\Delta \epsilon_{\vec{l}\vec{s}}}$ is ~ 5.7 MeV and the experimentally found $\delta g_s/g_s \sim -0.5$ yields $\hbar\omega(M1) \sim 8$ MeV. It is interesting to note that the relation (2) holds for any kind of excitation provided that the transition strength is concentrated as

in the case of the example above.

The importance of the self-energy corrections to the single-particle energies due to the existence of collective states is demonstrated in ref. [3]. Therefore, it may be of interest to see the influence of the 1^+ spin vibrational state. Although the quenching of the g_s value is large (of the order of its value), evaluation gives $\kappa = 0.18$ for the coupling constant in the case of lead. The rather small value of the coupling constant and the largeness of the $\hbar\omega(M1)$, which is dominant in the energy denominator of the self-energy correction, indicate that the result should not be dramatic. Using the single-particle and single-hole spectrum in the neighbourhood of ^{208}Pb (see ref. [4]), the change in the distance of major shells [3] can be evaluated and indeed the result is only ~ 200 keV. Although small, it should be added to the result of ref. [3], and is certainly not negligible. The second question one may ask is whether there is a change in the spin-orbit splitting within the shells considered. The answer is that it is very small and practically negligible.

REFERENCES

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