NUCLEAR STRUCTURE OF ^{69,71}Ge IN THE SEMIMICROSCOPIC MODEL

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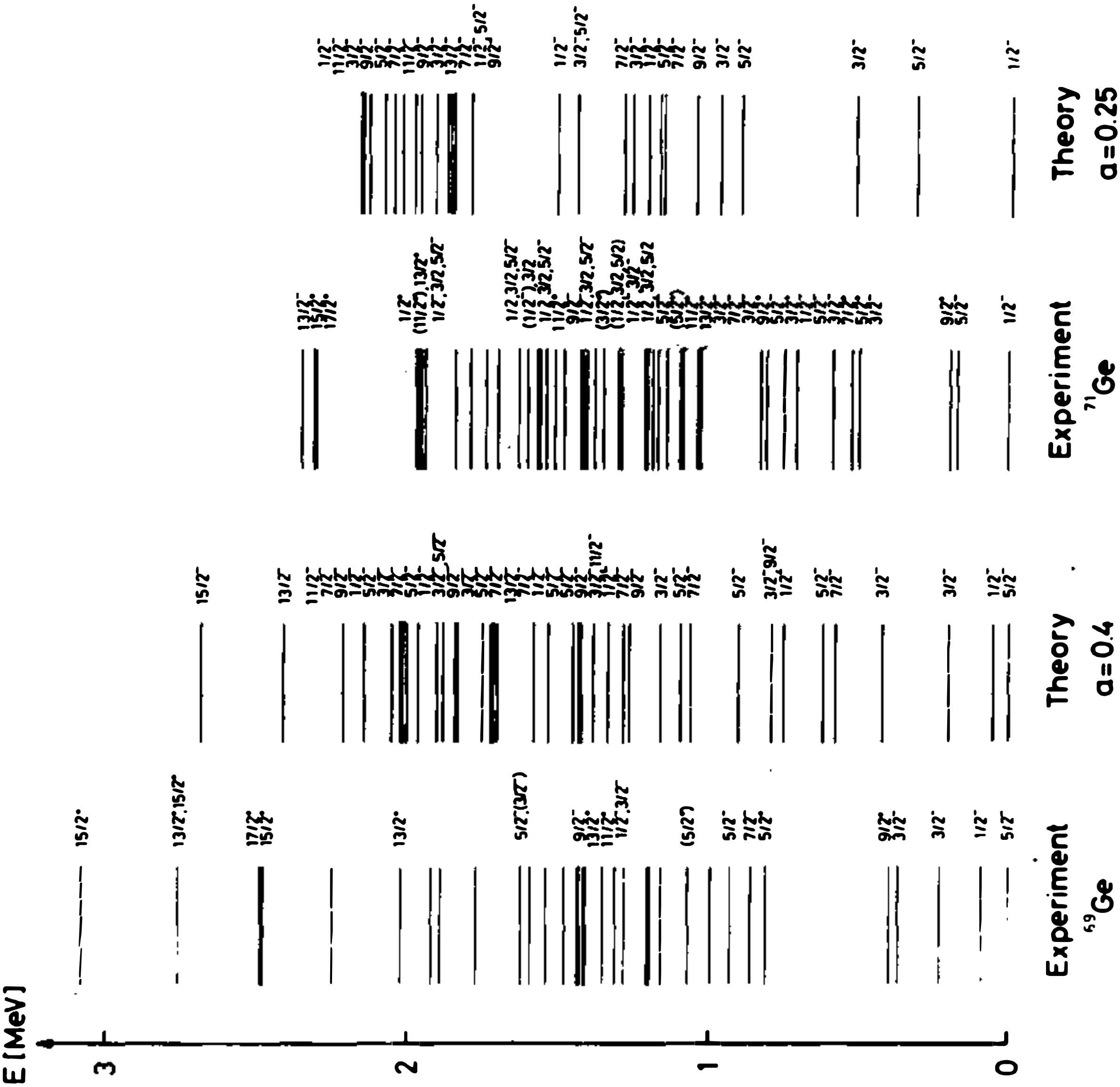
The new experimental data on ^{69,71}Ge |1| induced us to perform calculations for these nuclei. ^{69,71}Ge are described theoretically in the framework of the semimicroscopic model, by coupling neutron clusters to quadrupole vibrations. In the case of $^{69,71}_{32}Ge_{37,39}$ there are three and one neutron hole outside of the N=40 closed subshell, respectively. We try to simulate excitations of quasiproton pairs, as well as neutron excitations into higher shells, by the quadrupole vibrational mode. We present a rather rough approximation of this situation by coupling a neutron three- and one-hole cluster in the N=28-40 subshell ($1p_{3/2}$, $1p_{1/2}$, $0f_{5/2}$) for negative-parity states, respectively. It should be stressed that, in view of rather low-lying positive-parity states it is obvious that 4h-1p and/or more complicated states appear; however, since all 4h-1p states in the $\{p^{-1}_{3/2}, p^{-1}_{1/2}, f^{-1}_{5/2}\}$, $\{g_{9/2}\}$ space are of positive parity, they do not have direct influence on negative-parity three- and one-hole clusters in the $\{p_{3/2}, f_{5/2}, p_{1/2}\}$ subshell. On the other hand, the 5 hole - 2 particle states of negative parity contain the $(g_{9/2})^2$ cluster, so they have vanishing or small direct matrix elements with three- and one-hole negative-parity clusters in the $\{p_{3/2}, f_{5/2}, p_{1/2}\}$ subshell; thus, they to some extent play the role of inert spectator (without sizeably admixing into these clusters). Thus, for negative-parity states the N=40 neutron-sub-shell closure is expected to be reasonable. The results of the calculation for negative-parity states in ^{69,71}Ge are presented in fig. 1 and compared with experiment. The following neutron single-hole energies are used: $\varepsilon(f^{-1}_{5/2})-\varepsilon(p^{-1}_{1/2})$ = 0.3 MeV, $\varepsilon(p^{-1}_{3/2})-\varepsilon(p^{-1}_{1/2})$ = 0.6 MeV. The phonon energy is taken from the vibrator nucleus ^{72}Ge: $\hbar\omega_2$ = 0.83 MeV. The particle-vibration coupling constant a=0.25 and a=0.4 for ^{71}Ge and ^{69}Ge, respectively, give reasonable overall agreement with experiment. Two characteristics of these particle-vibration coupling strengths should be stressed: (i) The particle-vibration coupling strengths are appreciably lower than the bare values, the feature characteristic of some (2p $1f_{5/2}$) nuclei; for ^{69,71}Ge, they are similar in magnitude to those from Cu, Zn and Ga calculations |3|. (ii) The Q-Q component of the bare residual force, as well as the influence of high-frequency quadrupole modes, not included in the present calculation, appear for the n=3 case. For this case, they may be partly incorporated into the renormalization (enhancement) of the particle-vibration coupling strength from the n=1 case. Since the topological structure of these effects is the same, it is predicted that $|a(^{69}\text{Ge})|>|a(^{71}\text{Ge})|$, in qualitative agreement with the strengths used in the present calculation.

Positive-parity states within the 28-50 shell are dominated by the $g_{9/2}$ single-particle state. In the present, very rough approximation of such a situation, we consider these states starting from 4 hole - 1 particle and 6 hole - 3 particle neutron clusters (with respect to the N=40 subshell). By assuming the inclusion

Fig.1


E [MeV]
3
2
1
0
Experiment
^{69}Ge
Theory
a=0.4
Experiment
^{71}Ge
Theory
a=0.25

of hole pairs into the average field, we describe these situations by one and three particles, respectively, coupled to the phonon field. However, the restriction to the $g_{9/2}$ shell-model configuration has to be relaxed, because its non-spin flip partner $d_{5/2}$ (with the very large matrix element $<d_{5/2}||Y_2||g_{9/2}>$) lies about 4 MeV about this level. For three-particle clusters, the lowest-lying cluster $(g^3_{9/2})9/2$ is decreased due to pairing. It is followed by $(g^3_{9/2})$ clusters of seniority three and a one-phonon multiplet based on $(g^3_{9/2})9/2$. Among these states, the $7/2^+_1$ and $5/2^+_1$ are systematically lowered with respect to the others. The Pauli principle, amplified by the effects of the particle-vibration interaction leads to lowering of the $7/2^+_1$ state, which, for a sufficiently strong coupling strength a can even cross the $j=9/2^+_1$ state (I=j-1 anomaly) |2|. On the other hand, the $d_{5/2}$ single-particle state, which is a non-spin-flip partner of the unique parity state $|j>=g_{9/2}$ strongly influences the $j-2 = 5/2^+_1$ state, producing an appreciably shift downwards. For sufficiently strong particle-vibration coupling strengths this state can even cross the $j-1 = 7/2^+_1$ and $j=9/2^+_1$ states (I=j-2 anomaly) |3|. Thus, for unique-parity states, in the situation of the present type, we expect a low-lying triplet of states I=j,j-1,j-2, with a relative ordering sensitive to the coupling strength a and to the position of the single-particle state of angular momentum I=j-2 and of the same parity as the corresponding unique-parity state |3|.

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