Spectroscopy of neutron rich nucleus ^{82}Ge in the Deformed Shell Model

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Introduction

In recent years, there has been considerable interest in the study of neutron rich nuclei in the mass region A=60-100. These nuclei are expected to provide insight into the quenching of the spherical shell gap at N=50. Again the neutron rich nuclei like ^{82}Ge, ^{84}Se, ^{86}Kr are waiting point nuclei for r-process nucleosynthesis. Many experiments have been initiated to study the spectroscopic properties of these nuclei (with N=50) and in a few cases detailed energy spectra have been reported.

Recently, Hwang et al. have identified three collective bands with $K = 0^+$ in ^{82}Ge [1]. It would be quite interesting to study these bands within our Deformed shell model (DSM). The DSM has been quite successful in describing many spectroscopic properties of nuclei in the d-s shell, lower pf-shell and upper pf shell over the last three decades. Some of the recent references are given in ref. [2]. The model is essentially an approximation to full shell model calculation.

Results and Discussion

The details of the Deformed Shell model based on Hartree Fock states have been described in many of our earlier publications [2]. In this model, for a given nucleus, starting with a model space consisting of a given set of single particle orbitals and effective two-body Hamiltonian, we obtain the lowest prolate and oblate intrinsic states by solving the Hartree-Fock (HF) single particle equation self-consistently. Excited intrinsic configurations are obtained by making particle-hole excitations over the lowest intrinsic state. These intrinsic states do not have good angular momentum. Hence states of good angular momentum are projected from these intrinsic states. In general good angular momentum states coming from different intrinsic states are not orthogonal to each other. Hence they are orthonormalized by performing a band mixing calculation.

In our calculation, we have taken ^{56}Ni as the inert core. Our basis space includes the confugurations $2p_{3/2}$, $1f_{5/2}$, $2p_{1/2}$, $1g_{9/2}$, $2d_{5/2}$ and $1g_{7/2}$. The effective interaction for this model space is not available in the literature. The effective two-body interaction is obtained using the charge-independent CD-Bonn interaction via many-body perturbation theory to third order, employing a renormalized nucleon-nucleon interaction including folded diagrams to finite order [3]. The effective interaction has not been corrected for any possible monopole changes. The spherical single particle energies for protons are taken as 0.0, 0.78, 1.08, 3.50, 8.28 and 8.28 MeV. For neutrons, the same s.p.e. have been taken for the first four orbits. For $2d_{5/2}$ and $1g_{7/2}$ orbits, the spherical single particle energies for neutrons are 7.78 and 8.38 MeV.

The HF single particle spectrum for ^{82}Ge is given in Fig. 1. The oblate solution is lower than the prolate solution by about 0.5 MeV. The neutrons occupy all the $pfg_{9/2}$ s.p. levels. In addition to the lowest intrinsic state, we generated excited configurations by making particle hole excitations to higher excited states. We have considered a total of 17 intrinsic configurations. As explained above, Good

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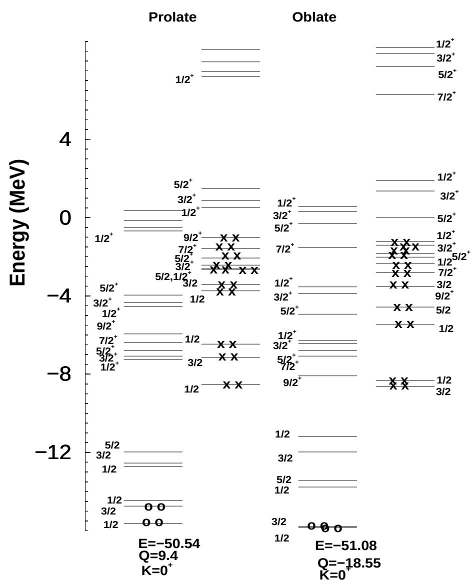

FIG. 1: The spectrum of single particle states for the lowest energy prolate and lowest energy oblate intrinsic HF states.

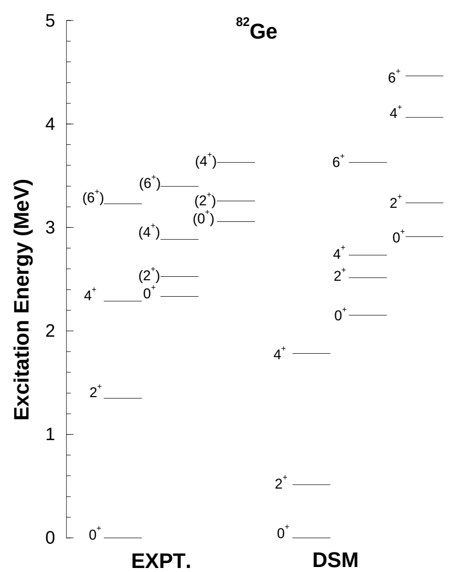

FIG. 2: Experimental and calculated excitation energies for ^{82}Ge

angular momentum states are generated from each of these intrinsic configurations and then a band mixing calculation is performed. The resultant $K = 0^+$ bands are compared with experiment in Fig. 2.

The ground band is compressed compared to experiment. It originates mainly from the lowest oblate and prolate solutions. The two excited $K = 0^+$ bands agree reasonably well with experiment. They originate mainly from the configuration obtained by exciting two neutrons from the $1g_{9/2}$ orbital to $2d_{5/2}$ orbital. It has large deformation compared to the ground band.

In our earlier DSM calculations, we were taking $2p_{3/2}$, $1f_{5/2}$, $2p_{1/2}$ and $1g_{9/2}$ spherical orbits. This is the first DSM calculation where the higher spherical orbits $2d_{5/2}$ and $1g_{7/2}$ have been included. More detailed calculation with more number of HF configurations and with the effective interaction refined so as to reproduce better quantitative agreement with experiment is being undertaken.

RS is thankful to UGC for financial support.

References

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