NATURE OF EXCITED STATES OF $^{154-158}$Gd ISOTOPES

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The nature of the 0+ states is the most controversial subject in even-even deformed nuclei. Especially, the structure of the lowest one has become a research fields by it self. Observation of a large number 0+ states in 158Gd in a recent (p,t) experiment stimulated new studies on this field. For that reason, it is important to understand the origin of such a large number of the 0+ modes. So far, although many theoretical studies on the 0+ excitations in deformed nuclei have been made in the last decades, there has not been any study considering the situation up to ~ 3 MeV because of the the lack of such an earlier data.

In this paper, we considered 158Gd isotope that to study on the nature of the 0+ excitations and analyse the general behaviour of the quantities and characterize it. And also we calculate the energy levels and the electric quadrupole transition probabilities B(E2;Ii →If) of 154-158Gd isotopes in terms of sd-df boson Hamiltonian.

The 158Gd nucleus is at the beginning of the deformation region $150 < A < 190$. The nucleus is a rotor which shows a developed γ-vibrational band. To explain the form of a nucleus; the binding energy of the nucleus, the transition probabilities between different energy levels, electric and magnetic multipole moments the quadrupole moments and the rest of the observable quantities must be known properties. The pairing and the quadrupole forces are important in deformed nuclei. These forces especially influence the particles in the unfilled states. The pairing force keeps the nucleus in spherical symmetry. The quadrupole charge distribution causes what is known as the quadrupole force. This force takes the nucleus to the deformed state. The relation between the pairing and the quadrupole forces determines the form of the nucleus.

Recently the 0+ states in 158Gd have been studied by many workers. Sun et al.[1] have studied the 0+ excitations in 158Gd using the Projected Shell Model in the framework of the Tamm-Dancoff approximation (TDA). Iudice et al. [2] used QPM including monopole and quadrupole

pairing with a quadrupole-quadrupole force term. Making a detailed analysis, they presented the calculations on the microscopic properties including energies, E2, E0 transitions and two-nucleon spectroscopic factors with the shell and multiphonon structure of the 0+ states. Another study has been made in [3] by using the pairing-plus-quadrupole model (PPQ), including only monopole pairing; a good description has been given for the distribution and the nature of the 0+ states.

As a result, the whole developments mentioned above imply that new microscopic models and interactions that can give new contributions are necessary. Certainly, various collective 0+ modes can exist and it is clearly of interest to determine how many such excitations appear below ~ 3 MeV. In this paper, in order to study the nature of the 0+ excitations in the 158Gd isotope and investigate the general behaviour of the quantities that characterize them, we use the model Hamiltonian including sd- and df- boson terms in the framework of the Interacting Boson Approximation (IBA).

We also calculate the energy levels and the electric quadrupole transition probabilities B(E2;Ii →If) of 154-158Gd isotopes in terms of sd-df boson Hamiltonian.

Recently, a remarkable (p,t) experiment [4] using the Q3D spectrometer at the University of Munich MP tandem accelerator laboratory established the existence of 13 excited 0+ states below ~ 3.2 MeV in 158Gd. A few of these were previously known [5, 6] but many are new. One or two are somewhat tentative. Nevertheless, it is clear that there are a large number of 0+ excitations at relatively low energies in this deformed nucleus.

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