Large-scale shell model calculations for the odd-even ^{69}Ga nucleus

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Introduction

For the interpretation of the observed level structures in A ≈ 70 nuclei, various nuclear models like interacting boson model, cranking model, spherical and deformed shell models, etc. have been utilized. Danko *et al.*. [1] suggested the presence of complex excitations in ^{65,67}Ga. In ^{63,65}Ga, collective rotational like band structures were observed [2]. U.S. Ghosh *et al.* considered the JUN45pn [3] and jj44bpn [4] effective interactions in the $f_{5/2}pg_{9/2}$ configuration space consisting of the the $1f_{5/2}$, $2p_{3/2}$, $2p_{1/2}$, and $1g_{9/2}$ orbitals lying outside the ^{56}Ni core to conduct shell model studies for the odd-even ^{63,65,67}Ga [5] nuclei and the odd-odd ^{66}Ga [6] nucleus. A majority of the theoretical outcomes agreed well with observed data. The JUN45pn interaction, however, was found to be more suitable than jj44bpn for ^{67}Ga. The JUN45 [3] interaction has been chosen by us to perform large-scale shell model calculations (the computer code, NuShellX@MSU [7] have been used) in the aforementioned configuration space for the low and intermediate-spin states (yrast and yrare) in ^{69}Ga, which have nearly semi-magic number of neutrons. We have considered another interaction, GXPF1A [8] that is associated with the full *fp* configuration space. We have not truncated the configuration spaces. The set of proton and neutron effective charges associated with our calculations is (1.80e, 0.65e).

Results and Discussion

Fig. 1 shows the level schemes corresponding to the yrast negative and positive parity

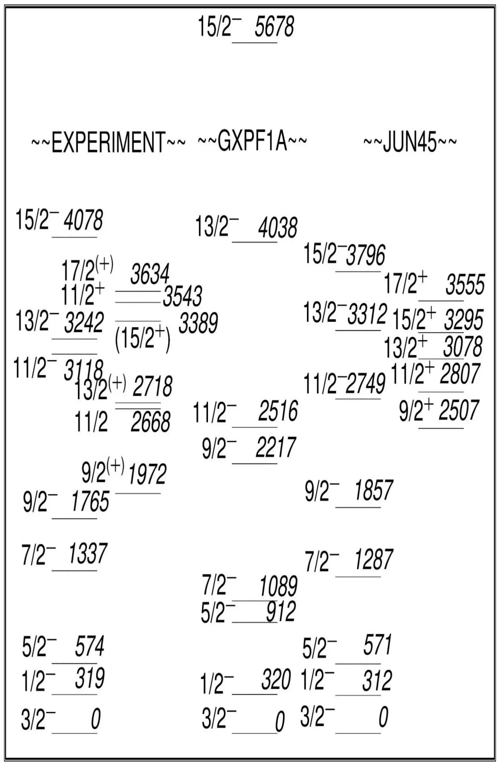

FIG. 1: Comparison of the experimental level energies [9] (in keV) of ^{69}Ga with the theoretical ones as predicted by our shell model calculations, considering the GXPF1A and JUN45 interactions.

states. The remaining level energies and all of the calculated lifetimes, transition strengths, magnetic moments, quadrupole moments will be discussed in the symposium. The calculation with either effective interaction is being able to reproduce the observed ground state spin-parity. The two calculated energies of the $1/2^-$ state are nearly equal to the experimental values. The deviation in the case of the

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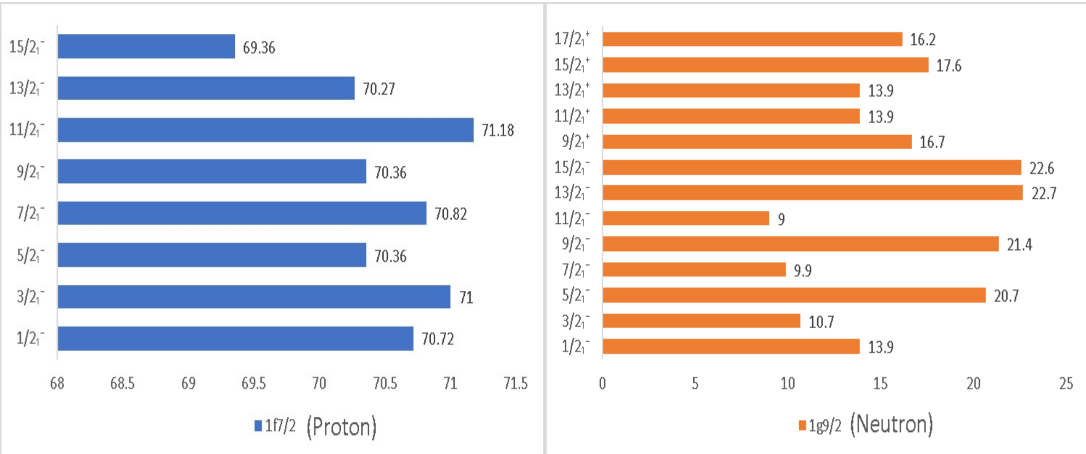

FIG. 2: Occupation probabilities of the $\pi(1f_{7/2})$ and $\nu(1g_{9/2})$ orbitals in percent.

GXPF1A calculation is just 1 keV. Regarding the next higher energy state, on the other hand, the energy estimated by the JUN45 interaction deviates by 3 keV only. The calculations with this interaction has reproduced much better energy values than those with GXPF1A for every higher-lying negative parity state. The JUN45 predicted excitation energies corresponding to the 3389 keV, $(15/2^+)$ state and the 3634 keV, $17/2^{(+)}$ state are about 100 keV different from the experimental analogs. The occupation probabilities (in percent) of the $1f_{7/2}$ proton orbital and the $1g_{9/2}$ neutron orbital are shown in Fig. 2. The significance of the $1g_{9/2}$ neutron orbital is not high for any state. The neutron orbitals, $1f_{5/2}$ and $2p_{3/2}$ are much more significant here. The contribution of the $1f_{7/2}$ proton orbital in generating the wave functions corresponding to the negative parity states is much higher than that of any of the remaining *fp* configuration space orbitals, $2p_{3/2}$, $1f_{5/2}$, and $2p_{1/2}$.

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