Shell model study of different band structures for ^{67}As

Vikas Kumar[1*] and P. C. Srivastava[2†]
[1] *Department of Physics, Central University of Kashmir, Ganderbal - 191201, INDIA and*
[2] *Department of Physics, Indian Institute of Technology Roorkee, Roorkee - 247667, INDIA*

Introduction

The recent study in nuclear structure physics shows interest in investigating the structure of the nuclei in the mass region $A = 60$–100. The nuclear shape and structure of even-even nuclei changes with change in nucleon number in this region [1]. The evidence for collective oblate rotation for ^{68}Se nucleus in $N = Z$ region is reported in Ref. [2]. A shape transition from prolate to oblate along the yrast line occurring in ^{76}Se reported in Ref. [3]. The comprehensive shell model (SM) study in full $f_{5/2}pg_{9/2}$ model space of recently available experimental data [4] with four $T = 0$ bands and one $T = 1$ band in the odd-odd $N = Z$ nucleus ^{66}As are presented in Ref. [5].

In Ref. [6], the energy levels and γ-ray decay scheme of ^{67}As nucleus have been studied using ATLAS facility at Argonne National Laboratory through ^{40}Ca(^{36}Ar, 2αp)^{67}As reaction. In this work they have reported several new transitions in the decay scheme, they also reported two new positive-parity band structures, further these bands are compared with theoretical calculations using cranked Nilsson-Strutinsky model.

Motivated with recent experimental data for different bands in ^{67}As [6], we have done comprehensive shell model study corresponding to different bands within $f_{5/2}pg_{9/2}$ model space.

Details of Calculation

The SM calculations have been performed in full $f_{5/2}pg_{9/2}$ model space without any truncation with JUN45 interaction [7]. ^{56}Ni is taken as the inert core. The JUN45 interaction is developed by Honma, it is a realistic interaction based on the Bonn-C potential further two-body matrix elements are fitted by 400 experimental binding and excitation energy data with mass numbers $A = 63 - 96$. The single-particle energies for the $1p_{3/2}$, $0f_{5/2}$, $1p_{1/2}$ and $0g_{9/2}$ single-particle orbits employed in the JUN45 interaction are -9.8280, -8.7087, -7.8388, and -6.2617 MeV respectively.

Discussion

Several new high-spin positive parity states up to the excitation energy 18.648 MeV are observed in Ref. [6], two tentative spins $(\frac{45^+}{2})$ and $(\frac{51^+}{2})$ are also observed in this experiment, these tentative spins are confirmed by the SM. The observed ground state spin and parity i.e., $\frac{5^-}{2}$ is also predicted by SM as a ground state with the configuration $\pi(pf)^5_{4.5}(g_{9/2})^0_0\nu(pf)^6_4(g_{9/2})^0_0$, where (pf) refers to the $p_{3/2}$, $f_{5/2}$ and $p_{1/2}$ orbits, the upper number represents the number of particles in the specified orbits and the lower number represents the maximum spin contribution from particles in these orbits. The SM successfully produce the other observed negative parity energy states (for e.g. $\frac{3^-}{2}$ and $\frac{7^-}{2}$), and the configuration corresponding to these states are same as the ground state configuration.

The configuration corresponding to positive-parity spin $\frac{45^+}{2}$ in band 1 is $\pi(pf)^4_6(g_{9/2})^1_{4.5}\nu(pf)^4_6(g_{9/2})^2_8$, this configuration suggest that three particles are needed in $g_{9/2}$ orbital to achieve $I_{max} = \frac{45^+}{2}$ in this band. The highest observed tentative spin of band 2 is $(\frac{51^+}{2})$, the configuration corresponding to this spin is $\pi(pf)^3_{4.5}(g_{9/2})^2_8\nu(pf)^3_{4.5}(g_{9/2})^3_{10.5}$, this tentative high-spin positive-parity state can only

*Electronic address: vikaskumar@cukashmir.ac.in
†Electronic address: pcsrifph@iitr.ac.in

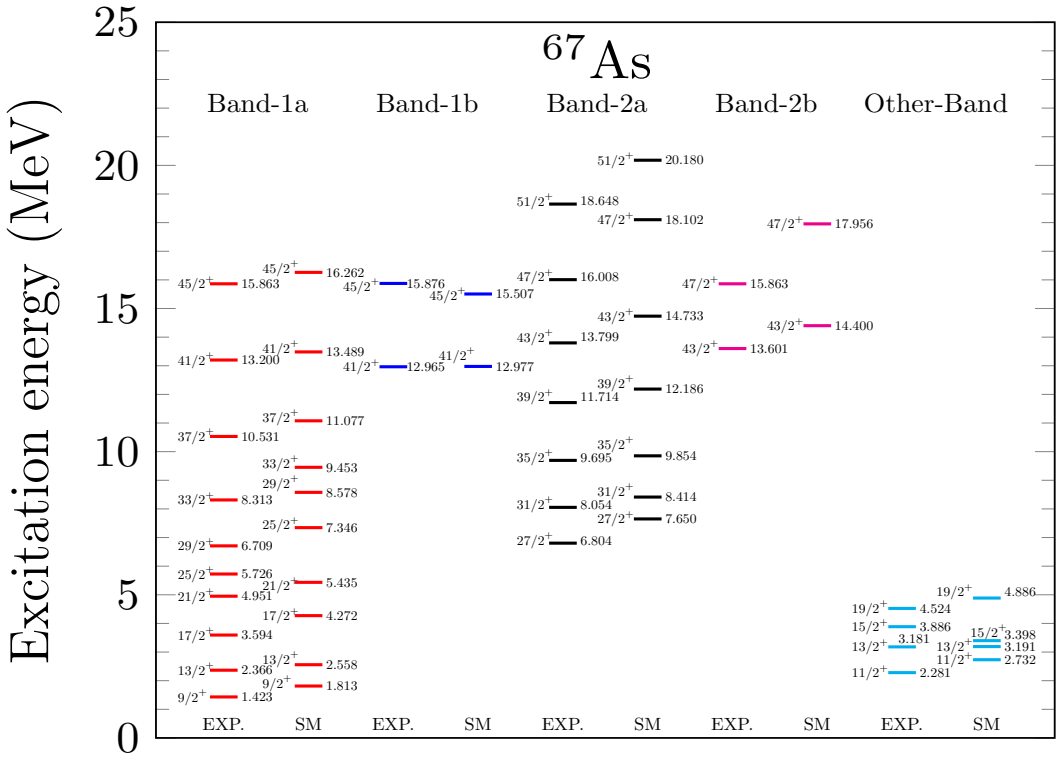

FIG. 1: Comparison of shell model results with experimental data for different bands with JUN45 interaction. The band numbers in the figure are as per the convention used in the experimental paper [6].

be formed in configurations involving five particles in $g_{9/2}$ orbital. We have connected different bands using dominant $B(E2)$ values from the shell model.

Summary

In order to compare the high-spin energy states for different bands with experimental data [6]. We have performed shell model calculations. The shell model results are in good agreement with the available experimental data. This study will add more information to Ref. [6] where experimental data along with cranked Nilsson-Strutinsky (CNS) results are reported.

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