High Spin Structure of ^{84}Sr Using Triaxial Projected Shell Model

N. Behera[1], G. H. Bhat[2], Z. Naik[1],* R. Palit[3], Y. Sun[4], and J. A. Sheikh[5]
[1]*School of Physics, Sambalpur University, Sambalpur, 768019, INDIA*
[2]*Govt. Degree College, Kulgam, 192231, INDIA*
[3]*Tata Institute of Fundamental Research, Colaba, Mumbai, 400005, INDIA*
[4]*Department of Physics and Astronomy, Shanghai Jiao Tong University, SHANGHAI 200240 and*
[5]*Department of Physics, University of Kashmir, Srinagar, 190006, INDIA*

Introduction

Study of A∼80 nuclei is interesting because of various shape evolutions and shape coexistences[1]. High spin structure in these nuclei is dominated by the $g_{9/2}$ orbitals and level density is smaller compared to the rare-earth nuclei. This leads to significant variations in nuclear configurations and quasiparticle alignment when going from one nucleus to another [2-4]. Thus, unlike the rare earths which have stable deformations, nuclei in mass∼80 region show pronounced structure changes. In these medium mass proton rich nuclei, neutrons and protons occupy the same single particle orbits. So, the pair alignments of neutrons and protons compete with each other as the nucleus rotates and under certain conditions they may align simultaneously. Again, in this mass region quasi-ground, quasi-β and quasi-γ bands have been introduced in the spherical regions which are complementary to the collective bands in the deformed region [5].

The purpose of present work is to study the yrast-band and gamma-band structure for the even-even ^{84}Sr nucleus using Triaxial Projected Shell Model(TPSM) approach [6]. This nucleus is of interest because it is a probable member of quasi-ground and quasi-γ bands of the spherical region and it is convincing to study the corresponding ground and γ bands in the deformed region [5].

*Electronic address: z.naik@suniv.ac.in

Outline Of The Model

The extended TPSM quasi-particle(qp) basis consists of angular momentum projected qp vacuum(0-qp) state, two -proton(2p), two neutron(2n) and 4-qp state i.e.,

$$\{ \quad \hat{P}^I_{MK} \mid \phi\rangle; \hat{P}^I_{MK}\ a^\dagger_{p1}a^\dagger_{p2} \mid \phi\rangle; \hat{P}^I_{MK}\ a^\dagger_{n1}a^\dagger_{n2} \mid \phi\rangle; \hat{P}^I_{MK} a^\dagger_{p1}a^\dagger_{p2}a^\dagger_{n1}a^\dagger_{n2} \mid \phi\rangle\} \tag{1}$$

In Triaxial Projected Shell model calculations, the pairing plus quadrupole-qudrupole Hamiltonian is used including quadrupole-pairing term:

$$\hat{H} = \hat{H}_0 - \frac{1}{2}\chi\sum_\mu \hat{Q}^\dagger_\mu \hat{Q}_\mu - G_M \hat{P}^\dagger \hat{P} - G_Q \sum_\mu \hat{P}^\dagger_\mu \hat{P}_\mu \tag{2}$$

The Triaxially deformed single particle basis is obtained from the Nilsson model. The corresponding triaxial Nilsson mean-field Hamiltonian is given by,

$$\hat{H}_N = \hat{H}_0 - \frac{2}{3}\hbar\omega\{\epsilon\hat{Q}_0 + \epsilon^{'}\frac{\hat{Q}_{+2}+\hat{Q}_{-2}}{\sqrt{2}}\} \tag{3}$$

Where ϵ and $\epsilon^{'}$ specify the axial and triaxial deformation respectively. ϵ and $\epsilon^{'}$ are related to conventional triaxiality parameter as $\gamma = tan^{-1}(\epsilon^{'}/\epsilon)$ [7]. In (3),$\hat{H}_0$ is the spherical single particle Hamiltonian containing a proper spin-orbit force. The monopole pairing strength G_M is of the standard form $G_M = [G_1 - G_2(N-Z)/A]A^{-1}$ for neutrons and $G_M = G_1/A$ for protons.

In the present calculation, we have taken $G_1 = 20.25$ and $G_2 = 16.20$ which is appropriate for the single-particle space employed in the model, where three major shells are used for each type of nucleons (N=2,3,4 for both neutrons and protons). The quadrupole pairing strength G_Q is proportional to G_M, and the proportionality constant is 0.18.

Results and Discussion

TPSM calculations have been performed for ^{84}Sr. We have employed $\epsilon = 0.24$ and $\epsilon^{'} = 0.14$ in the Nilsson potential to generate the deformed basis for ^{84}Sr. The value of ϵ and $\epsilon^{'}$ has been chosen so that the behaviour of the yrast band and γ band is properly described. The results obtained for yrast state

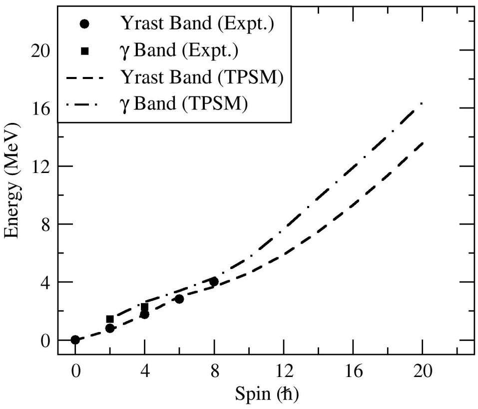

FIG. 1: Comparison of the calculated Yrast band and γ band energies with experimental data for ^{84}Sr. Experimental data taken from ref. [8].

band and γ band are compared with experimental values which is represented in Fig.1. For the yrast band, theoretical results are in good agreement upto spin I=8 available experimentally and is predicted upto spin I=20.

The experimental quasi-γ band (α=0) is well reproduced with $\epsilon^{'} = 0.140$. Experimental values are available upto spin I=4 for the quasi-γ band (α=0). However, with TPSM calculations the γ band is produced upto spin I=20 with a difference of 0.0024 MeV between experimental and theoretical band head energies.

The comparison of results shows that the calculated band spectra using TPSM are in good agreement with the experimental ones.

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