High spin band structure of the chiral candidate ^{132}La and ^{134}Pr using Triaxial Projected Shell Model Approach

W. A. Dar[1],* J. A. Sheikh[1,2], and G. H. Bhat[1]
[1]*Department of Physics, University of Kashmir, Srinagar, 190 006, India and*
[2]*Department of Physics and Astronomy, University of Tennessee, Knoxville, TN 37996, USA*

The rotational motion of triaxial nuclei attains a chiral character if the angular momentum has substantial projections on all three principal axes of the triaxial density distribution. Since the suggestion of the chirality breaking in the rotation of triaxially deformed nuclei was given by Frauendorf and Meng [1]. Understanding the nature of rotational bands in odd-odd $A \sim 135$ have attracted great intrest, as it was suggested that the near degenracyof the two observed bands in ^{134}Pr [2]. The presence of near degenracy could be due to chiral symmetry breaking [1]. According to the concept of chiral scenrio, for triaxially deformed nuclear core with a few high-j valence particles and a few high-j valence holes, the three mutually perpendicular angular momenta can be arranged to form a right-handed or a left-handed system. The chirality has been probed in various mass regions, such as $A \sim 80$, 100, 130, 190. In mass region $A \sim 130$. chirality has been found in severl isotopes of silver and rhodium.

It is also intresting to study the obustness of chiral geometry against the increase of the intrinsic excitation energy, i.e. if the chiral geometry is sustained in the higher-lying bands of a certain chiral configuration. In all the known cases the chiral doublet corresponds to the two lowest-lying bands of a configuration. Even for $^{124,126,130,132}Cs$ [3] and $^{104,106}Ag$ [4], each chiral doublet structure corresponds to two lowest-lying bands with a distinct configuration.

The first experimental evidance for chiral doublet bands was found to be the odd Z-N=75 isotones [5], quite large number of experiments have been done in different mass regions like in 100,130 and 190 (odd-odd, odd-A and even-even) [6]. Many theoritical models have made attempts to describe the bands and to investigate it physical asspect. The models that are present via particle rotor model (PRM), tilte axis cranking (TAC) approximation, realistic TAC approaches, the strutinsky shell correction method. The different models predict the different properties i.e., with the TAC model the states (left and right handed system) are degenrate and hence not possible to calculate the energy difference between them which is an excellent example for not occuring the quantum meachnical tunneling between the two states. Other models like RPA also provides reasonable results for chiral bands. However TAC+RPA couldn't produce the smooth transition between these two systems.

In addition to it, there is a triaxial covariant density functional theory (CDFT) based on adiabatic and configuration-fixed which make possible to have multiple pairs of chiral doublet bands in a single nucleus.

The majority of the chiral bands are reported in odd-odd system with one proton (neutron) paricle and one valance neutron (proton) hole with $\pi h_{11/2} \otimes \nu h_{11/2}^{-1}$ configuration such as in Cs, Pr, Pm and La. Among these nuclei ^{134}Pr provides us the best example of level degeneracy for selected states of the same spin and parity in the doublet bands being separated by energies smaller than 60 keV has been so far taken as a sign of chiral bands.

The purpose of the present work is to shed light on the excited bands which are build on the chiral bands using triaxial projected shell model (TPSM) [7] approach. It has been

*Electronic address: `waheedphy@gmail.com`

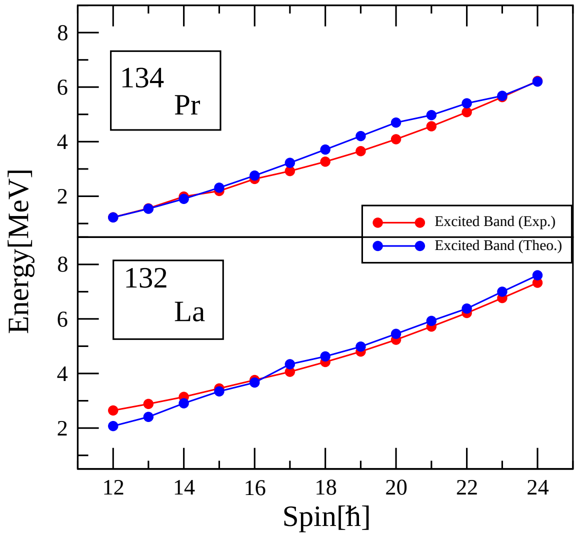

FIG. 1: (Color online) Excited band for ^{134}Pr and ^{132}La with experimental data given.

demonstrated that TPSM provides an accurate description of the high-spin properties of triaxial rotating nuclei.

The basis space of the TPSM approach for odd-odd nuclei is composed of one-neutron and one-proton quasiparticle configurations $\phi_k = a^\dagger_\nu a^\dagger_\pi$. The triaxial Nilsson Hamiltonian used in the present work is given by

$$\hat{H} = \hat{H}_0 - \frac{2}{3}\bar{h}\omega\epsilon\hat{Q}_0 + \epsilon^{'}\{\frac{\hat{Q}_{+2}+\hat{Q}_{-2}}{\sqrt{2}}\} \quad (1)$$

where $\hat{H}_0$ is the spherical single-particle shell model Hamiltonian, which contains the proper spin orbit force. In the first stage of TPSM study, the triaxial basis space is constructed by solving three-dimensional Nilsson potential with deformation parameters of ϵ and $\epsilon^{'}$. In the present calculation the set of parameters used for ^{132}La are 0.158 and 0.090 while as 0.220 and 0.100 for ^{134}Pr respectivley.

From the Fig, it is clear that the excited bands buit on chiral band shown for isotopes of La and Pr are quite similair with intransic configuation $\pi h_{11/2} \otimes \nu h_{11/2}$ for both isotopes [8]. The possible new band for both the isotopes forms a chiral band with one of the already observed ones. It is clear form the figure that the theoritical results carried out by TPSM agree with the experimental data.

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