Structure of extreme neutron-rich Barium and Xenon nuclei

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1. Introduction

Recent experiments at RIKEN RI Beam factory have identified [1] a number of medium and heavy mass nuclei with very large neutron excess using In-Flight Fission of high energy ^{238}U ions. Some of these nuclei are of interest in the rapid capture process of synthesis of nuclei. The structure of these nuclei produced at the RIKEN experiments is much interest. Among these nuclei found in the above experiment is ^{152}ba and we have studied the structure of this nucleus theoretically in considerable detail using deformed Hartree-fock and Angular Momentum Projection formalism [2–4].

2. Theoretical Framework

We use a model space of s, d, $g_{7/2}$, $h_{9/2}$, $h_{11/2}$ protons and $pfh_{9/2}i_{13/2}$ neutrons with the active nucleons (6 protons and 14 neutrons for ^{152}ba) with a surface delta interaction. From deformed Hartree-Fock calculation we find that ^{152}ba is a highly prolate deformed nucleus (it has the largest quadrupole deformation among all the neutron-rich Ba nuclei). The oblate Hartree-fock minimum is about 5 MeV higher in energy than the prolate minimum. The expectation values of r^2Y_{20} operators for protons and neutrons for ^{152}Ba are $8.83b^2$ and $19.87b^2$ respectively (b being the harmonic oscillator length parameter) for the prolate shape.

3. Results and discussions

Here we report on the band structures of ^{152}ba obtained by angular momentum projection from various intrinsic states based on the prolate Hartree-fock minimum. We have the $K = 0^+$ ground band, $K = 1^+$ band of neutron $i_{13/2}$ origin (the rotation-aligned or RAL band) and a $K = 1^-$ band. (The $K = 1^+$ and $K = 1^-$ bands are the lowest particle-hole excitations across neutron Fermi surface.) The results are plotted in the Figures. Figure 1 shows the intensity distributions C_J^2 of various angular momenta in these bands. The energy spectra are plotted in Figure 2. The $K = 1^+$ (RAL) band shows considerable signature-splitting and the even-branch of this band crosses the ground at $10\hbar$. The J projection spectra from some of the K isomeric configurations based on the oblate Hartree-Fock are also shown in Figure 2.

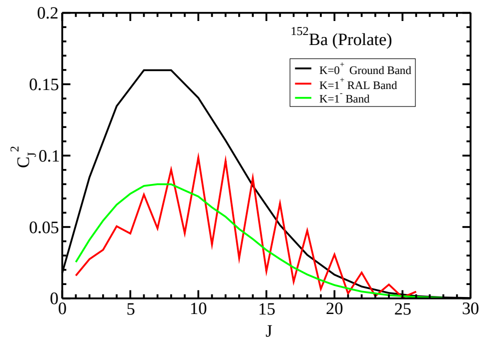

FIG. 1: The intensities as a function of J for ^{152}Ba.

Electromagnetic transitions from these isomeric states are hindered on two counts: (a) $K-$isomerism and (b) difference in quadrupole deformation from the lower energy prolate configurations. We also have results for other Barium and xenon nuclei ^{148}Xe etc.

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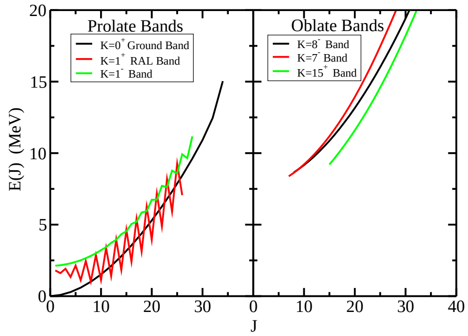

FIG. 2: The Bands of ^{152}Ba with angular momentum projection.

4. Summary

Deformed Hartree-Fock and Angular Momentum Projection gives a complete description of the structure of deformed nuclei in various regions of mass. We have applied this formalism to study the structure of ^{152}Ba and ^{148}Xe and other neighboring exotic nuclei. For ^{152}Ba a rich band structure is predicted including K and Shape Isomers at 10 MeV or less of excitation energy.

Acknowledgments

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References

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