Band Structure and Deformed Configurations in ^{166}Er

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Introduction

The rare-earth region is well known for deformed band structures and quadrupole collectivity. In ^{166}Er the ground band is known upto $J=16^+$. An excited K=2^- band is also known upto $J=16^-$. Other bands are also known. Some information about B(E2) values is also available. We have done microscopic study of this nucleus using deformed Hartree-Fock (HF) and Angular Momentum Projection from various deformed configurations to get the theoretical band structures and the electromagnetic properties of the bands. Our Calculation reproduces the known bands at low energy and makes predictions about the high spin bahavior of the bands in ^{166}Er. We obtain results for both the even and odd branches of the RAL band, continuation of ground band, and electromagnetic properties of K=2^- band which are interesting experimentally.

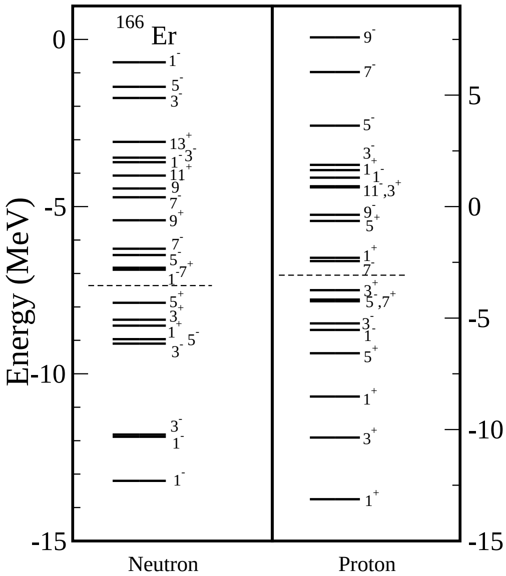

FIG. 1: Prolate deformed HF orbits of ^{166}Er.

Theoretical Framework

A deformed shape such as one described by slater determinant of deformed orbits $\mid \Phi_K >$ is localized in angle and, by the uncertainty principle, is not a state of good angular momentum (J). Thus $\mid \Phi_K >$ does not have a unique J quantum number and is a superposition of various J states [1–3],

$$\mid \Phi_K >= \sum_I C_{IK} \mid \Psi_{IK} > . \quad (1)$$

One needs to project out states of good angular momenta from the intrinsic state Φ_K with the Angular Momentum Projection operator,

$$P_K^{IM} = \frac{2I+1}{8\pi^2} \int d\Omega {D_{MK}^I}^*(\Omega) R(\Omega). \quad (2)$$

In general two states $\mid \Psi_{K_1}^{JM} >$ and $\mid \Psi_{K_2}^{JM} >$ projected from two intrinsic configurations are not orthogonal to each other even if $\mid \Phi_{K_1} >$ and $\mid \Phi_{K_2} >$ are orthogonal. Thus, whenever necessary, we do band-mixing using the following equation:

$$\sum_{K'} (H_{KK'}^J - E_J N_{KK'}^J) C_{K'}^J = 0. \quad (3)$$

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Results and Discussion

The deformed HF orbits are calculated with a spherical core of ^{132}Sn with sdg$_{7/2}$h$_{11/2}$h$_{9/2}$ space for protons and pfh$_{9/2}$i$_{13/2}$ space for neutrons. We use surface delta matrix elements as the residual two-body interaction elements in this space which works well for a broad range of nuclei [5]. The prolate Hartree-Fock solution is the lowest in energy and the orbits for this solution is plotted in Fig.1. We calculate the spectra of this nucleus for various intrinsic states using Angular Momentum Projection techniques [1–3] shown in Fig.2. We have K=0$^+$ ground band, and K=2$^-$ excited band also have the K=1$^+$ RAL band obtained by neutron excitation from i$_{13/2,5/2^+}$ to i$_{13/2,7/2^+}$. Apart from the energy spectra we have calculated the reduced transition matrix elements BE(2) for this nucleus and the calculated results are depicted in Fig.3

Conclusions

In conclusion, we studied the high spin states of ^{166}Er nucleus. This nucleus has interesting quadrupole deformation properties and band structures. Our study gives the continuation of ground, odd branches of RAL band and high spin of K=2$^-$ band. Again the RAL band crosses the ground band at 12$\hbar$. We have also shown the behavior of BE(2) for ground state and other bands of this nucleus indicating the collective nature of the levels. The microscopic structure of rare-earth nuclei is still much interest [9] and in this work we have some qualitative results using deformed HF and Angular Momentum Projection.

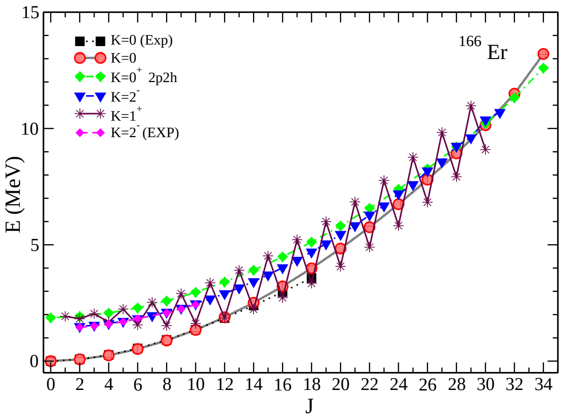

FIG. 2: Energy spectra with deformed HF model of ^{166}Er. The experimental data are taken from [4].

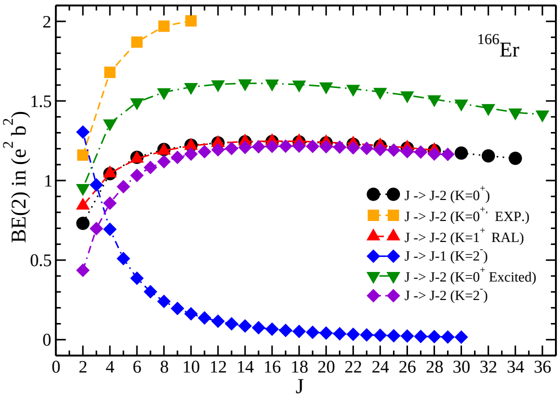

FIG. 3: BE(2) values of various bands of ^{166}Er. The experimental data are taken from [4, 6–8]

Acknowledgments

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