Band head spin assignment of Sr isotopes of superdeformed bands

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Introduction

Superdeformation was first proposed some thirty years ago to explain the fission isomers observed in some actinide nuclei [1]. The saerch for superdeformed (SD) bands in the nuclear region around mass 80 was first introduced by predictions for elongated shapes with a major-to-minor axis ratio of 2:1 in nuclei with atomic number Z=38-40 and neutron number N=42-45 [2]-[3]. Superdefromed bands (SD) have been found in $^{80-83}$Sr [4], $^{82-84}$Y [5], ^{83,84,86}Zr [6], ^{85,87}Nb [7], ^{88}Mo [8] and ^{89,91}Tc [9]. These bands are observed up to a rotational frequency of about 1.3 MeV/$\hbar$, a value twice as high as the maximum frequencies encountered for the SD bands in heavy region. Therefore the study of the different properties of SD bands left a challenging task. The SD nuclei in A=80 mass region are theoretically described as prolate deformed rotors with a quadrupole deformation of $\beta_2 \approx 0.5$. This study is supported by the large dynamic moments of inertia θ^2, obtained for the SD bands in the A=80 mass region, which have on average a value of $\approx 25\hbar^2/MeV^1$.

Spin Assignment of SDRB's in A< 100 Mass Region

For the deformed nuclei the collective excitation spectrum for rotational character in even-even nuclei is

$$E(I) = A\left[I(I+1)\right] \quad (1)$$

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where A is inertial parameter, hence

$$E_\gamma(I) = 4A(I - I/2) \quad (2)$$

The ratio of $E_\gamma(I)$ over spin I (EGOS) is given by

$$EGOS = \frac{E_\gamma(I)}{I - I/2} = 4A. \quad (3)$$

From energy relation of VMI model we can write

$$EGOS = \frac{E_\gamma(I)}{I - 1/2} = \frac{2}{J_0} + \frac{(I^2 - I + 1)}{CJ_0^4}. \quad (4)$$

For rigid rotor, EGOS plot is a horizontal line for correct I_0 and plots are parabolic for band head spin $I_0 \pm 2$. EGOS for a nuclei following the VMI equation of energy which will be given by three parabolic curves, and it represents the presence of second order term of Bohr-Mottelson $I(I+1)$ expansion [10].

Result and Discussion

Figure 1-2 shows the variation of EGOS against spin I. In this figure the solid circle represent the experimental values and solid line shows the calculated values of EGOS. The EGOS for ^{84}Zr(SD-1), ^{86}Zr(SD-1), ^{89}Tc(SD-1) isotopes is a horizontal line for the exact I_0 and will shift to parabola for ^{80}Sr(SD-1), ^{81}Sr(SD-1), ^{82}Sr(SD-1), ^{83}Sr(SD-1), ^{83}Zr(SD-2), ^{90}Tc(SD-1) when $I_0 \pm 2$ is assigned to I_0. That is, the regular structure in the one-quasi-neutron $\nu 1/2$-[521] negative-parity band is attributed to the decoupling effect [10].

Figure 3 shows the variation of dynamic moment of inertia with rotational frequency $\hbar\omega$ for ^{80}Sr(SD-1), ^{81}Sr(SD-1) nuclei. The ^{81}Sr can be represented by $\upsilon 5^1 \pi 5^0$ configuration, the up-bend in its dynamic moment of inertia after 1.1 MeV is mainly due to the rotational

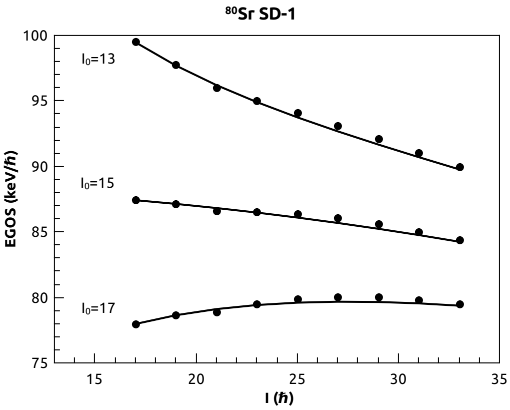

FIG. 1: EGOS versus spin to determine the band head spin for ^{80}Sr(SD-1) nuclei.

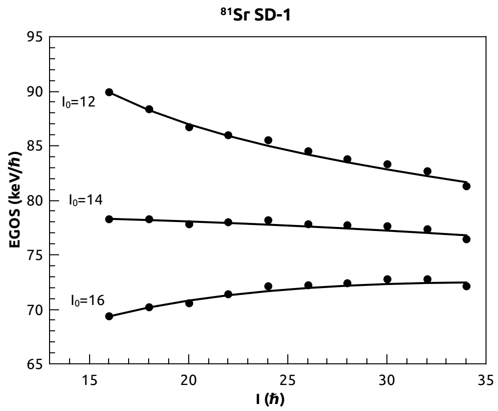

FIG. 2: EGOS versus spin to determine the band head spin for ^{81}Sr(SD-1) nuclei.

alignment of a pair of protons in the $h_{11/2}$ intruder orbital i.e. top of SD band in ^{81}Sr represents $v5^1\pi5^2$ configuration [10].

Acknowledgments

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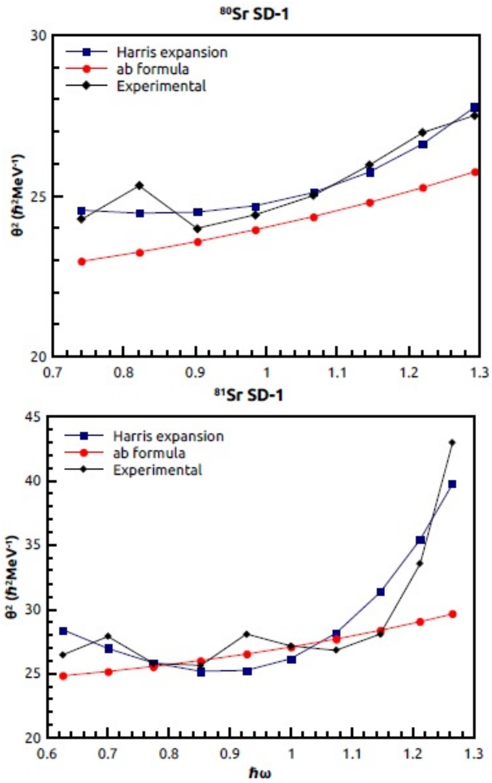

FIG. 3: Dynamic moment of inertia calculated using ab fitting and Harris ω^2 expansion.

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