Low- and Medium-Spin Level Structure of neutron rich ^{96}Sr: Competition between Vibrational and Rotational modes of excitations

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Introduction

Nuclei in A $\sim$ 100 mass region exhibit large variety of interesting nuclear structure phenomena [1]. It has been observed that the nuclei with $N \leq 58$ display features that characterize a spherical vibrator (see Fig. 1). On the other hand, nuclei with $N \geq 60$ exhibit deformed rotor like behavior. It is obvious from Fig. 1(c) that there is a sudden increase in deformation along the chain of even-even Sr-isotopes as the neutron number increases from $N = 58$ to $N = 60$. Also, it is quite interesting to note that the deformation gets saturated for Sr-isotopes lying in the more neutron-rich side of ^{96}Sr. The sudden onset of deformation and its immediate saturation at $N \sim 60$ can be explained by the the occupation of the valence nucleons at the $g_{9/2}$ proton and $h_{11/2}$ neutron orbitals. Lying in the vicinity of highly deformed and nearly spherical region, ^{96}Sr occupies a critical position in the nuclide chart where the onset of multifaceted excitation modes can be expected. We are reporting here nuclear structure phenomena associated with ^{96}Sr in the low- and medium-spin regime following new spectroscopic information, obtained from an experiment employing thermal neutron induced fission.

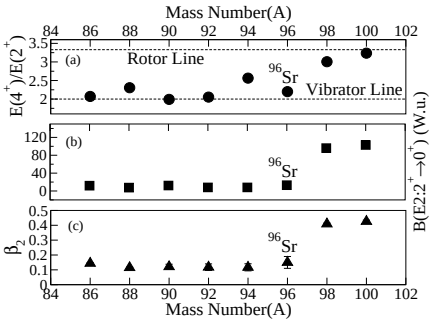

FIG. 1: Evolution of the low-lying spectroscopic properties along the chain of even-even Sr-isotopes. Variations of (a) $E_{4_1^+}/E_{2_1^+}$ values (b) B(E2: $2^+ \rightarrow 0^+$) values, and (c) β_2 values, as a function of mass number, A are shown.

Experimental Details and Data Analysis

The experiment was performed at the PF1B line of the high-flux reactor facility at the Institut Laue-Langevin (ILL), Grenoble, France. The collimated and thermalized neutron flux at the target position was of the order of 10^8 neutrons per sec. per square centimeter. Neutron-rich $A \sim 100$ nuclei were produced as fission fragments following thermal neutron induced fission of ^{235}U target. The target was in the form of UO_2 having thickness of ~ 600 $\mu g/cm^2$ with 99.7% enrichment in ^{235}U, and was sandwiched between thick backings. De-

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exciting γ rays from the fission fragments were detected by an array consisting of eight EXOGAM large clovers, six large coaxial detectors from GASP, and the two clovers from the ILL. BGO anti-Compton shields were used as Compton suppressors for the EXOGAM and GASP detectors in the array. The details of the experimental set up can be found in Ref.[2].

As the detailed off-line analysis is in progress, we are reporting here a few preliminary results. A representative triple-γ coincidence spectrum of neutron rich ^{96}Sr is shown in Fig. 2. Partial level scheme of ^{96}Sr, as obtained in the present study, is shown in Fig. 3(a). Several new γ transitions were observed and placed in the decay scheme. The newly observed 183-keV linking transition firmly establishes the position of the two close-lying 4^+ levels. As can be seen in Fig. 2, the yrast levels up to the spin of $12\hbar$ were populated. The observed levels have been grouped under two heads: Band-I and Band-II. The equally spaced sequence of levels at 815-, 1792- and 2785-keV apparently forms a harmonic vibrational like band structure (Band-I) corresponding to one-phonon, two-phonon, and three-phonon states. The preferential decay of the (6^+) level at 2785-keV to the lower-lying 4_1^+ level at 1792-keV is the possible indication that the levels at 815-, 1792- and 2785-keV belong to the same band. Band-II is suggestive of a deformed band with the 0_2^+ band head at 1229-keV. This feature is quite similar to what has been observed in the neighboring ^{98}Zr ($N = 58$ isotone of ^{96}Sr) [2]. However, it appears that the present reaction mechanism could not populate the 0_2^+ state with significant strength and hence the expected $2_2^+ \rightarrow 0_2^+$ transition could not be observed in the present data. The possible change in excitation mode of ^{96}Sr with increasing spin is highlighted in Fig. 3(b). It is also obvious from the figure that ^{96}Sr exhibits vibrator like behavior at low-spin regime (indicative from the sharp fall in ordinate values), whereas the higher spin levels exhibit the feature of highly deformed, stabilized rotational structure (owing to the saturation of ordinate values).

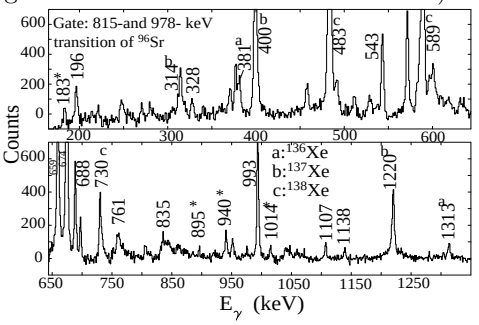

FIG. 2: A representative triple-γ coincidence spectrum with double-gates on 815- and 978-keV transitions, decaying from the two lowest levels of Band-I (see Fig. 3(a)) in ^{96}Sr. The newly observed transitions have been marked with $*$.

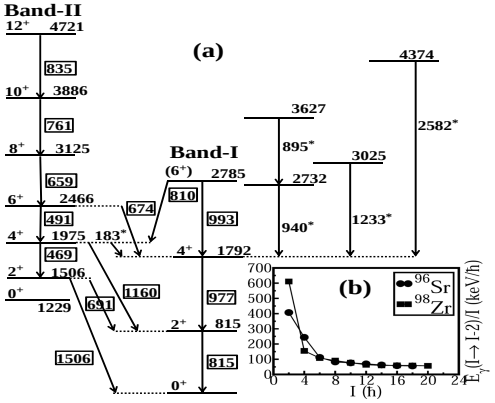

FIG. 3: (a) Partial level scheme of ^{96}Sr as obtained in the present work. (b) E-GOS curves for the yrast states of N = 58 isotones, ^{96}Sr and ^{98}Zr.

Acknowledgments

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References

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