Study of the negative parity band in ^{116}Sn

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Introduction

The negative parity states in ^{116}Sn have been described as being caused by two-neutron quasiparticle excitation[1]. However, in recent years, octupole correlations have drawn considerable attention to the description of the lower lying states in nuclei which have permanent stable octupole deformation. This phenomenon occurs when nucleons near the Fermi surface occupies levels of opposite parity and having angular momentum differing by $3\hbar$. Though the existence of the enhanced electric dipole and octupole transition rates are the primary and direct proof for such correlations, the odd-even spin staggering (S(I)) gives another indication for the same. For octupole correlations, S(I) have minima at odd spins which mean a cluster of states 3^-, (4^-, 5^-), (6^-, 7^-) and so on. Also, the measurement of dipole and quadrupole moment differentiates between the octupole vibration and octupole correlation where lowering of the negative parity band results in the case of the latter.

Nucleus having nucleon numbers near 34, 56, 88 and 134 have shown such correlations. Ba, Cs and Xe are a few examples near the Z=50 shell closure which has been tested for octupole correlation both theoretically and experimentally[2–4]. These observations serve as motivation for investigating the excitation mechanism for the negative parity band in ^{116}Sn by means of the existence of octupole correlation.

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Experimental Details

The excited states of ^{116}Sn were populated using fusion-evaporation reaction mechanism at Variable Energy Cyclotron Centre (VECC), Kolkata. Here, the self-supporting ^{114}Cd target of thickness 6.2 mg/cm^2 was bombarded upon by 34-MeV α-beam to populate ^{115,116}Sn nuclei and de-excited γ-rays were detected by the Indian National Gamma Array (INGA) spectrometer. The time-stamped list-mode data were merged using a set of codes, IUCPIX, developed by UGC-DAE CSR group [5] and were analyzed offline using INGASORT and RADWARE packages.

Results and Discussions

The level scheme in ^{116}Sn has been investigated throughout the entire energy region and modified with the inclusion of numerous γ-transitions. In our earlier study, the mixing

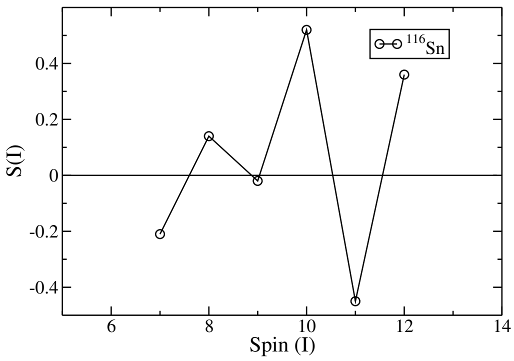

FIG. 1: The odd-even staggering[S(I)] of experimentally obtained negative parity states in ^{116}Sn.

between the positive parity intruder rotational band build on the 0+ state and three phonon quintuplet has been investigated [6]. The existing negative parity states were previously reported to be arising due to two neutron quasi-particle excitation[1]. However, the observed strong inter-band transitions (E1 and E3) between this and the ground band could be tested for the octupole correlations as well. The clustering of the states, primarily, indicates the existence of the staggering corresponding to the octupole type of excitations. The plot of S(I) vs. spin (I) as shown in FIG.1 support the same. However, both octupole vibrational and deformed nuclei could have the same kind of signature splitting[7]. Hence, to distinguish between the two, the following quantity, taken from ref. [8] is considered:

$$\delta E(I^-) = E(I^-) - \frac{E((I+1)^+) + E((I-1)^+)}{2} \quad (1)$$

where the $E(I\pm1)^+$energies are positive parity even-spin yrast states.

For strong octupole deformed band in even-even nuclei there occurs interleaved positive and negative parity rotational band. Hence, the quantity $\delta E(I^-)/E(2_1^+)$ should be zero. On the other hand, as octupole vibrational structures emerge, the positive and negative parity bands are separated and the value of $\delta E(I^-)/E(2_1^+)$ deviates from zero. The experimentally calculated value for the 3^- and 7^- states in ^{116}Sn are found to be 0.33 and 0.36, respectively.

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