Coexistence of γ and octupole bands in ^{100}Ru

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Introduction

Nucleus can be considered as a finite many-body quantum system. So, it consists of myriad information on fundamental symmetry. As an example, symmetry breaking that arises from any kind of shape deformation, generally has lower energy. Spherical symmetry is mostly eliminated by the concept of surface vibration of a quadrupole deformed nuclei[1]. Oscillations may happen along the symmetry axis; giving rise to β vibrations. Or, it can break the axial symmetry if vibrations happen perpendicular to the symmetry axis, causing the γ vibrations. But for some combination of N and Z, mainly near the Fermi surface, the nuclear energies can be further lowered by octupole interaction, therefore losing the reflection symmetry[2]. The aim of our work is to discuss the nucleus ^{100}Ru, which stands unique as both octupole and γ deformed band have been observed.

Experiment

The low spin excited states in the ^{100}Ru have been populated using ^{100}Mo(^{4}He, 4n) reaction. The 50 MeV ^{4}He beam was delivered from K-130 cyclotron by VECC, Kolkata and the enriched target thickness was 2 mg/cm^2.

The prompt gamma rays were detected using a multi-detector gamma array consisting of 11 Compton suppressed clover HPGe detectors and 1 LEPS detector. The clover detectors were at three angles, 40^o(2 clovers), 90^o(6 clovers) and 125^o(3 clovers), while the LEPS detector was at 40^o.The PIXIE-16 digitizer-based data acquisition system and IUCPIX package [3] developed by UGC-DAE CSR, Kolkata, was used to record and process the data. The target was placed at a distance of 25 cm from the Al face of the Clover detectors. Data were collected both in singles and γ-γ coincidence mode with suitable triggers. For calibration and efficiency measurements of INGA3 Array, ^{152}Eu (for Clovers) and ^{133}Ba (for LEPS) radioactive sources were used.

Analysis and Results

Symmetric and angle dependent matrices were made using IUCPIX packages. For DCO measurements, coincidence events from the forward i.e. 40^o ring and the 90^o ring are considered. Having 6 detectors in the 90^o ring was very advantageous for making the parallel and perpendicular polarisation scattering matrices.

The correction factor 'a', that depends on the geometry of array, is defined as,

$$a = \frac{N(0^o)(unpolarized)}{N(90^o)(unpolarized)}$$

Unpolarized data is from the sources.

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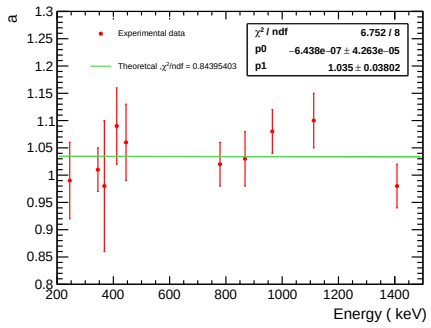

FIG. 1: Correction factor a as function of gamma ray energy at VECC-INGA3 array

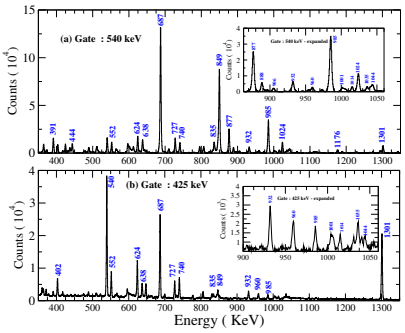

FIG. 2: (a): Coincidence spectrum of 540 keV (b): Coincidence spectrum of 425 keV

Radware software package [4] is extensively used to build up the level scheme and the gated spectra from the symmetric matrix. In Fig 2., two typical gated spectra are shown. . The spin and polarity of the observed gamma rays are determined by the measured DCO and PDCO values.

The intensities of the gamma transitions have been determined from the 3 detectors at 125^o, where the emission probabilities of dipole and quadrupole transitions are nearly the same.

One of the main things that distinguishes γ band from octupole band is energy staggering effect which is defined as ,

$$S(I) = \frac{[E(I) - (E(I-1)] - [E(I-1) - E(I-2)]}{E_2^+}$$

Literature survey has shown that for γ band,

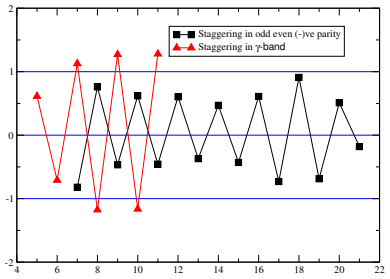

FIG. 3: Experimentally observed staggering signatures in quasi γ and octupole band of ^{100}Ru

the S(J) value is +ve for odd spin and -ve for even spin. This signifies that the levels are positioned in a couplet like 2^+_γ,(3^+_γ,4^+_γ) , (5^+_γ,6^+_γ),..., etc. The scenario is just reversed for the case of octupole band[5], which means the expected couplets of energy level are of the form 3^-, (4^-, 5^-),(6^-, 7^-),...,etc. This exactly matches with the scenario for two bands of targeted nuclei.

Discussions

Thus, in the low spin domain, ^{100}Ru exhibits the co-existence of gamma and octupole vibration.

Acknowledgements

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