Lifetime measurement in N = 88 Sm using VENTURE array

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Introduction:

The nuclei around N = 90 and with proton number close to the Z = 64 subshell closure are known to exhibit deformed structures. A rapid evolution of shapes and deformation are experimentally identified in these nuclei [1,2]. The deformed band structures could be characterized with stable prolate deformation in the ground state along with the presence of octupole shapes at very low excitation [3,4]. The presence of deformation driving orbitals for the mid-shell neutrons along with the $\Delta J = 3$ orbitals for protons, gives rise to the possibility of different degree of deformation to the nuclear surface in this mass region. In addition, the vibrational structures are also observed in these nuclei around stable quadrupole [5] as well as octupole shapes [6].

Till date, the lifetimes have been measured in N = 88 Sm, mostly by using neutron excitation with Doppler Shift and Grid techniques. The measured lifetimes of the negative parity levels [7-9] strongly confirms the existence of octupole shapes and correlation in this nucleus as observed from other spectroscopic results. Another important aspect is the lifetime of the 0_3^+ level that has displayed interesting structure phenomenon in the neighboring Sm nuclei [10].

The literature survey of lifetime data in ^{150}Sm indicates the need for lifetime measurements in several low lying levels to study the evolution of nuclear structure. In the present work, the lifetime measurement has been attempted in ^{150}Sm using gamma-gamma fast timing spectroscopy with VENTURE array [11] at VECC, Kolkata. The obtained lifetimes and the corresponding transition probabilities have been systematically compared with those known in the neighboring nuclei.

Experiment:

The excited levels of ^{150}Sm have been populated through beta the decay of ^{150}Pm produced with ^{150}Nd(p,n) reaction using 8 MeV proton beam from K-130 cyclotron at VECC, Kolkata. The beta delayed gamma transitions were detected with VENTURE array [11], having eight $CeBr_3$ detectors, coupled to VENUS array of six Compton suppressed Clover HPGe detectors. The lifetime measurement was performed by using Generalized Centroid Difference method with Common Start timing electronics. Further details on the pulse processing electronics and measurement techniques can be found in Ref. [11].

Results:

The γ-energy spectrum of ^{150}Sm obtained with the $CeBr_3$ detectors compared to that obtained from the Clover HPGe detectors, are shown in Fig, 1. The gated projections relevant to several cascades in ^{150}Sm are shown in Fig. 2. These coincidences were used to generate the delayed and anti-delayed time spectra from the VENTURE array and were in turn used for further measurement of level lifetimes.

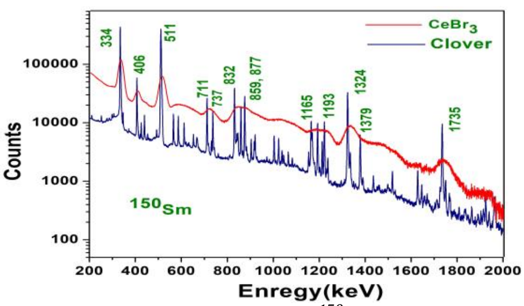

Fig. 1: *Energy spectrum of ^{150}Sm gamma lines obtained with VENTURE and VENUS arrays.*

The background analysis were also performed following the techniques described in Ref. [12] in order to correct for the effect of underlying Compton contribution in the fast timing data. The delayed and anti-delayed spectra of several cascades are shown in Fig. 3. The Prompt Response Distribution function generated for the array has been used for the measurement of lifetimes from the measured centroid difference values.

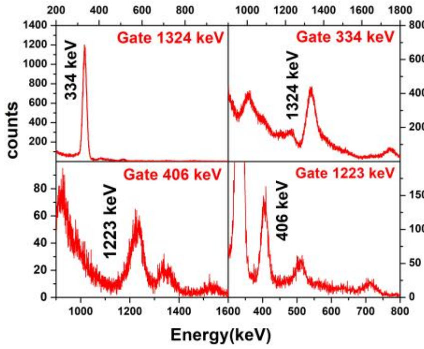

Fig. 2: *The gated energy projections for few cascades in ^{150}Sm, representing 334 keV (top) and 740 keV (bottom) levels respectively.*

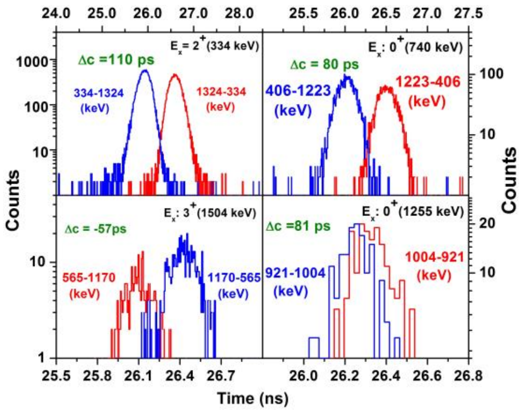

Fig. 3: *The delayed and anti-delayed time spectra obtained from $CeBr_3$-$Cebr_3$ coincidences for levels in ^{150}Sm, as indicated inside the figure.*

The systematics of excitation energy of the 0_3^+ level in the nuclei neighboring to ^{150}Sm is shown in Fig. 4 and it is observed that level lifetime is known only in ^{152}Sm. The corresponding lifetime data for the 0_3^+ level could be obtained for ^{150}Sm in the present work along with few more positive and negative parity levels of interest, viz., 2^-, 1658 keV; 3^+, 1504 keV and other low lying levels for which lifetimes are known.

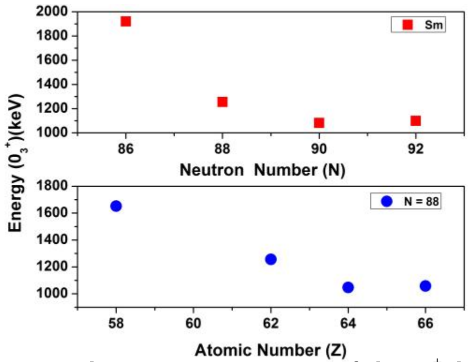

Fig. 4: *The energy systematics of the 0_3^+ level around ^{150}Sm*

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