Study of nano - second isomers near ^{146}Gd

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Introduction

The nuclei near ^{146}Gd show rich variety in their excitation spectra. Spectra exhibiting characteristics of extreme single particle, multi-particle-hole excitation, magnetic bands to strong collectivity manifested through superdeformation, and triaxial superdeformation have been widely studied [1]. One of the distinguishing features of this mass region is the existence of an island of high spin isomers which are excited in heavy ion reactions. These isomers can also indicate a sharp change of structural configurations within the same nucleus. There have been a considerable effort to study these isomers, but still there are a number of these isomers which are non-uniquely identified. There may be probably several undetected isomers as well. These isomers are interesting for testing the theoretical models. In the present work we have studied a few isomers in the mass $\simeq 150$ region using our RF - gamma coincidence data.

Experimental details and Results

We have studied the high-spin states in $^{151-154}Ho$, $^{152,153}Dy$ populated by $^{139}_{57}La(^{20}Ne, xn)$ reaction at a projectile energy of 139 MeV. The gamma-gamma coincidence measurements have been done using the multi-detector array of eight Compton suppressed Clover detectors (Indian National Gamma Array, INGA setup) at Variable Energy Cyclotron Centre (VECC), Kolkata, India. The relevant details of the experiment have been discussed in Ref.[2]. Along with these measurements we have also measured the RF - gamma time difference spectra. Figure 1 shows the TAC spectra without any gate on energy. The energies of the gammas detected range from $\simeq$ 100 - 4000 keV. In this condition the resolution of the TAC comes out to be $\simeq$27 ns. The TAC spectrum has

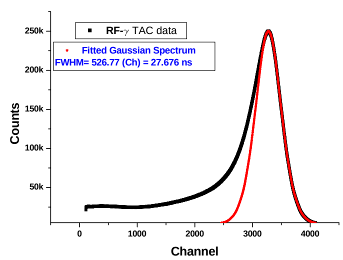

FIG. 1: The RF-γ TAC spectrum.

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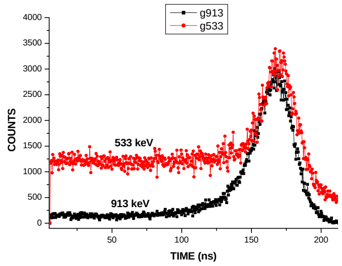

FIG. 2: Representative decay curves

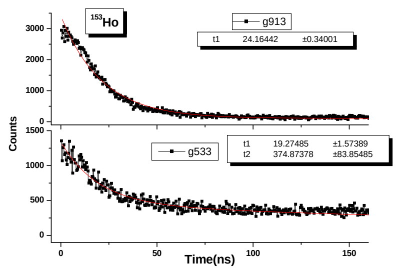

FIG. 3: Representative fits for isomers in ^{153}Ho

been taken within a range of 200 ns. The spectrum has been calibrated by introducing fixed delays.

A energy versus RF-gamma time difference spectra (RF-γ TAC) matrix has been generated. Later RF-γ TAC spectrum corresponding to each gamma of interest has been generated by putting gates on the energy axis. A typical example has been shown in Fig.2 for ^{153}Ho. In the figure, RF-γ TAC's correspond to, (i) 913 keV, a gamma which decays from a state above an isomer having half-life of 229 ns [1] and (ii) the 533 keV gamma, which is emitted from a state below the isomer. The decay curves clearly distinguishes the two.

Later, the lifetimes of the isomers have been determined by comparing a sequence of gamma gated TAC spectra and fitting them with one, two or three component exponential decay curves. Some of the representative fits and the corresponding data for isomers in $^{153,152}Ho$ isotopes are displayed in Figs. 3 and 4. In Fig.3, the decay curve of 533 keV gamma, which is emitted from a state below

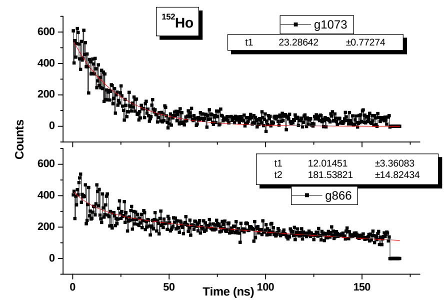

FIG. 4: Representative fits for isomers in ^{152}Ho

the 229 ns isomer, is fitted by two components of exponential decay. One of the decay curves correspond to a mean life 19.3 $\pm$ 1.63 ns, and the other component is 375 $\pm$ 84 ns. But for 913 keV decay, only one component gives a good fit with a mean life of 24.16 $\pm$0.34 ns. This isomer of $\simeq$ 20 ns mean life is not yet reported in the literature [1]. For ^{152}Ho, in Fig. 4, the 1073 keV (above a 47 ns isomer [1]) decay curve shows only a short mean life (23.3 $\pm$ 0.8 ns) component, but 866 keV (below the 47 ns isomer) decay has a short (12.0$\pm$ 3.4 ns) and a long mean life (181 $\pm$ 15 ns) component.

Conclusion

The RF-gamma TAC spectra have been used to determine the half -lives of a few nanosecond isomers in the A $\simeq$ 150 region. Theoretical calculation within the frame work of shell model has been done to understand the structure of these isomers.

Acknowledgments

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