Life-time Measurement of levels in $^{160-162}$Dy nuclei

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Introduction

The level lifetime measurement is essential to study the nuclear structure and its variations with increasing spin, excitation energy and isospin. Our motivation is to perform a systematic study in A$\simeq$ 150 mass region to study structural evolution in Ho (Z=67) and Dy (Z=66) isoptopes and their neighbours. We have reported [1] for ^{153}Ho how the study of yrast isomers can be useful to follow the evolution of structure of a nucleus with increasing excitation energy. Lifetime measurement of levels in even-even ^{152}Dy have been reported in our previous work [2] where a comparison with Shell Model calculation was also presented. We have investigated structural changes with increasing spin in these nuclei. In all these cases we have utilised in-beam data for our study.

However, it has been seen in many of these nuclei, there are several low-lying isomers which are deterrent to access low-spin levels in them. In the present work, thus we intend to study the low-lying levels of $^{160-162}$Dy nuclei through decay spectroscopy of Ho isotopes. There are a few lifetimes of 1-1000 ps order [3] which can be remeasured using the Mirror Symmetric Centroid Difference (MSCD) technique more accurately. Thus we report here the result of our effort to revalidate the previous measurements of lifetimes of levels in these nuclei.

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FIG. 1: The VENTURE array [4].

Experimental details

The experiment was performed at VECC, Kolkata using the K-130 Cyclotron. A ^{159}Tb target of 42.5 μm thickness was bombarded with alpha beams of $\simeq$ 27 MeV. The beam of 32 MeV was passed through a natural Indium foil to degrade it. ^{161}Ho ($T_{1/2}$=2.48 h) was the main product in this reaction. Another set of foil was irradiated at 37 MeV alpha - where primarily ^{160}Ho ($T_{1/2}$=25.6 min, Metastable state: $T_{1/2}$=5.02 h) was produced. The irradiated Tb foil was placed at the centre of the VENTURE [4] array (Fig.1) consisting of six $CeBr_3$ detectors.

Data was taken in LAMPS. The isotopes of Ho, $^{160-162}$Ho decay into $^{160-162}$Dy by electron capture process.

Experimental technique

We have used MSCD technique to measure the lifetimes of the levels. This setup [4] is able to measure lifetimes in the range of 8-1000 ps. Data have been collected with standard ^{152}Eu source to generate prompt Response difference(PRD) curve (Fig.2) which describes γ-γ time walk characteristics of two detector timing system. In Fig.3, Δc (without background substraction) is the centroid difference of delayed and anti-delayed spectra of the Time-to-Amplitude Converter (TAC) of two coincident gammas. Later, we calculated the lifetimes from the equation: Δc=2τ+PRD(feeder,decay) [4].

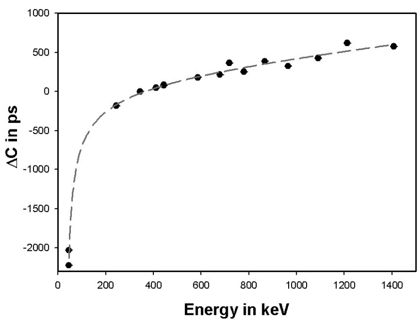

FIG. 2: The PRD curve.

Results and discussions

We have calculated lifetime of 4^+ level of ^{162}Dy [shown in Table 1]:

TABLE I: Comparison of our result with the reported value.

Cascade (keV)	Δc (ps)	PRD (ps)	Half-life (ps) Present	Prev.[5]
283-185	523^a	197	113(10)	132(8)

^{a}After background substraction.

The result agrees reasonably well with the reported value. We will also verify our result using other cascades for the same level. The measured lifetimes will be later compared with systematics and shell model calculations, if possible.

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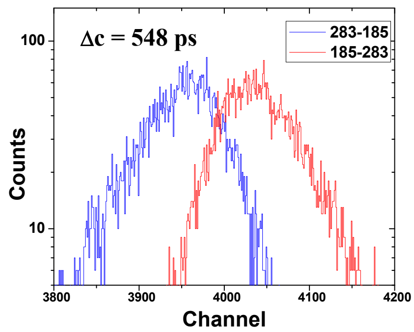

FIG. 3: The delayed and anti-delayed TACs of 283-185 keV cascade .

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References

[1] D. Pramanik *et al.*, Phys. Rev. C **94** (2016) 024311.
[2] D. Pramanik *et al.*, Proc. DAE-BRNS Symp. on Nucl. Phys. **62** (2017) 342.
[3] www.nndc.bnl.gov
[4] S.S. Alam *et al.*, Nucl. Inst. and Meth. A **874** (2017) 103 and references therein.
[5] A.C. Li and A. Schwarzschild, Phys. Rev. **129** (1963) 2664.