Lifetime measurement in ^{104}Cd using differential plunger technique

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Introduction

^{104}Cd nucleus lies in the transitional region of A∼100. It exhibits single particle as well as collective excitations. The lifetime measurement reported for ^{104}Cd in the literature majorly carried out using the differential decay curve method [1, 2]. The aim of the present experiment was to test our new plunger device in INGA at IUAC and also try to determine lifetime of excited states in ^{104}Cd using coincidence differential plunger technique [3].

Experimental Details

The high spin states in ^{104}Cd were populated using ^{93}Nb (^{14}N, 3nγ) fusion evaporation reaction at a beam energy of 56 MeV. The ^{14}N beam was delivered by the 15-UD Pelletron facility at IUAC, New Delhi. The self supporting target and stopper of thickness ∼1 mg/cm^2 and ∼8 mg/cm^2 respectively were prepared by using the cold rolling method. The target and stopper foils were mounted on separate aluminium frames and stretched using spring and a polished aluminium cone arrangement. The distance between the target and stopper can be varied by changing the position of target with respect to the stationary stopper with the help of the piezoelectric motor.

The target and stopper frames are supported by three steel rods each. The rods supporting the stopper are fixed while those supporting the target can move and are mechanically connected to three piezoelectric motors.

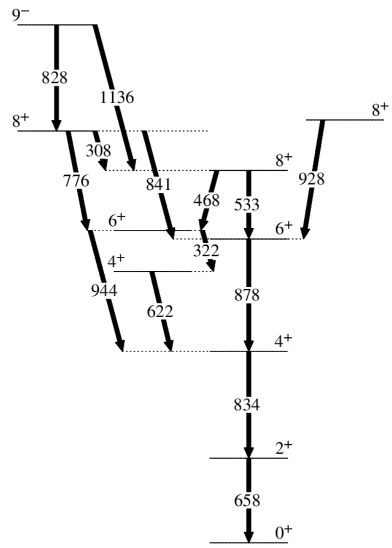

FIG. 1: Partial level scheme of ^{104}Cd [1].

The minimum distance between the target and the stopper foil was determined using the capacitance method [4] and was about 20 micron. The data was taken for 15 distances between the target and the stopper ranging from the minimum distance to about 7000 microns. The de-exciting γ-rays were detected by the Indian National Gamma Array (INGA) at IUAC [5], having 14 clover detectors during the experiment. The detectors were mounted at six different angles *viz.*, 32°, 57°, 90°, 123° and 148° with respect to the beam direction. The data were recorded in the list mode by CANDLE data acquisition system [6] and sorted into the angle dependent asymmetric matrices. The energy and efficiency calibra-

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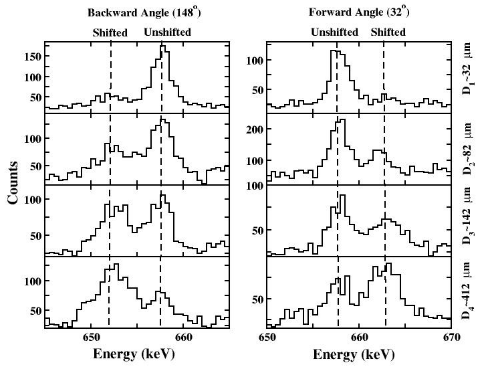

FIG. 2: Representative gated γ-spectrum to show the intensities of the shifted and unshifted components of E_γ = 658 keV ($2^+ \rightarrow 0^+$) γ-transition in ^{104}Cd at two different angles ($\theta = 148^\circ, 32^\circ$) and for four different distances, $D_1\sim$ 32 μm, $D_2\sim$ 82 μm, $D_3\sim$ 142 μm, $D_4\sim$ 412 μm between the target and the stopper. The gate is set on the Doppler shifted component of $4^+ \rightarrow 2^+$ transition

tion was done by using the standard ^{152}Eu source. The lifetime of state in ^{104}Cd were determined by using the Differential Decay Curve Method (DDCM) and can be calculated from the equation [3]

$$\tau = \frac{1}{\upsilon}\frac{I(\gamma^{unshifted}, \gamma_f^{shifted}; x)}{dI(\gamma^{shifted}, \gamma_f^{shifted}; x)/dx} \qquad (1)$$

where $I(\gamma^{unshifted}, \gamma_f^{shifted}; x)$ is the intensity of unshifted component of γ-transition in the coincidence spectrum with the gate set on the Doppler-shifted component of feeding transition (γ_f). $I(\gamma^{shifted}, \gamma_f^{shifted}; x)$ is the intensity of shifted component of γ-transition in the coincidence spectrum with the gate set on the Doppler-shifted component of feeding transition (γ_f) and υ denote the recoil velocity.

Result and Discussion

In Fig. 2 shifted and unshifted gamma ray peaks for 658 keV transition ($2^+ \rightarrow 0^+$) are shown with gate on the shifted component of the feeding transition (833 keV $4^+ \rightarrow 2^+$) for 4 target-stopper distance. From the figure we can see variation of intensity of the shifted and the unshifted peak as a function of distance. However, in the present analysis there is an added complication due to the overlap of shifted peak of 833 keV transition ($4^+ \rightarrow 2^+$) with transitions 827keV ($9^- \rightarrow 8^+$) and 841 keV ($8^+ \rightarrow 6^+$) as can be seen from Fig. 1. We thus need to remove the contribution of these transitions from the unshifted intensity of 658 keV ($2^+ \rightarrow 0^+$) transition at different distances. From our preliminary analysis the lifetime of 2^+ state was found to be 10.1($\pm$ 1.5) picosecond.

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