Lifetimes and transition probabilities in ^{129}Te through γ–γ fast timing measurement

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Introduction

The development of nuclear models characterizing the structure of nuclei at or near the drip lines greatly depends on experimental data on nuclei far from the stability line. A number of features of the protons and neutron' effective interaction become visible when the N/Z ratio rises, offering fresh perspectives on the nuclear structure. In this setting, nuclear model predictive accuracy is rigorously tested, particularly in cases when it is possible to determine the electromagnetic transition probabilities between nuclear states [1, 2].

Particular significance is given to nuclei around doubly magic ^{132}Sn (Z = 50 and N = 82) because their research sheds light on nucleon-nucleon interaction and provides information on two body matrix element.

^{129}Te, having two proton particles and five neutron holes provides crucial information on the long range *pn* interaction and its role in emergence of collectivity as one moves away from double shell closure. The emergence in collectivity has already been recently reported in ^{129}Sb ($\pi^1 \otimes \nu^{-4}$) by the observation of enhanced electric quadrupole strength [3].

In this, present work, measurement of level lifetime of low-lying states in ^{129}Te has been carried out though β–decay of ^{129}Sb for which γ–γ fast timing method has been employed.

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Experiment

The excited states of ^{129}Te have been populated from the beta decay of ^{129}Sb. The neutron rich ^{129}Sb fragments were produced through neutron-induced fission at Institut Laue-Langevin (ILL), Grenoble, France using a 0.13 mg/cm^2 ^{239}Pu target. The A = 129 fragments were separated in mass (M) and kinetic energy (E) using LOHENGRIN separator [34. The fragments were detected with an ionization chamber (IC) placed at the focal plane.

The γ–rays following the β–decay of ^{129}Sb were measured with an array of four 1.5"x1.5" $LaBr_3$(Ce) detectors, kept at an angle of 90^o with respect to each other. In addition, two Clover HPGe detectors were also placed near the focal plane for clean identification of γ–rays from the fission fragments separated in M and E. The details of the setup and fast timing measurement technique can be found in Ref. [5]. The present fast timing measurement was carried out from the γ -γ coincidences among two $LaBr_3$ detectors when they are in anticoincidence with IC, to ensure that the excited levels in ^{129}Te are populated only through the β-decay of the parent.

Discussion

The γ–γ coincidence spectrum, both $LaBr_3$-$LaBr_3$ and $LaBr_3$-Clover, from the present experiment are shown in Figure 1.

Generalized centroid difference measurement of level lifetime, have been performed for several low-lying states in ^{129}Te, such as $5/2^+$, $7/2^+$, $15/2^{(-)}$, $19/2^{(-)}$. Two separate cascade, 1030 keV -

813 keV and 915 keV - 813 keV, have been used to measure the level lifetime of $7/2^+$ state at 812 keV. The delayed and anti-delayed TAC spectra from 1030-813 cascade is shown in figure 2.

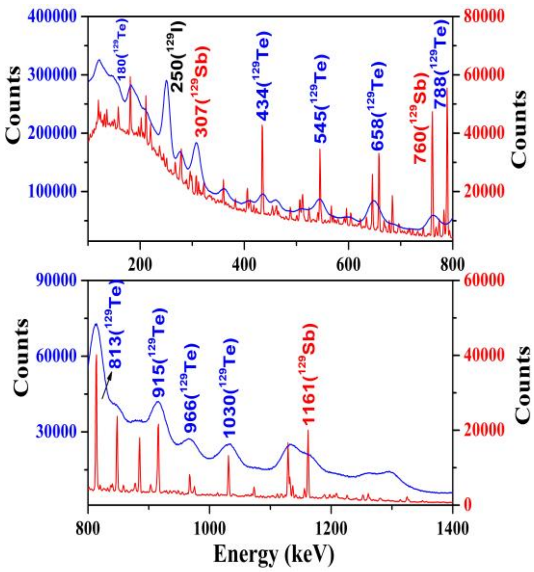

Figure 1: γ–γ projections from $LaBr_3$-$LaBr_3$ and $LaBr_3$-Clover coincidence.

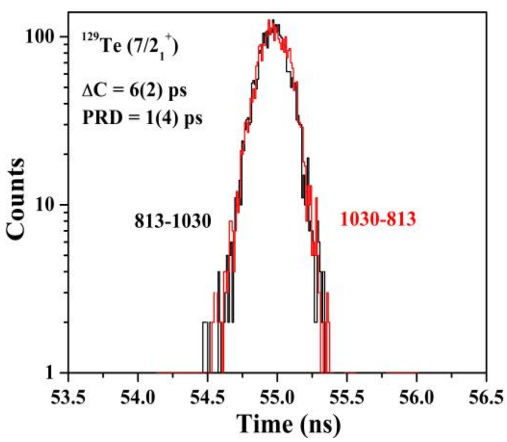

Figure 2: The delayed and anti-delayed TACs for $7/2^+$ using 1030 keV-813 keV γ–γ cascade.

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The measured lifetime were corrected for the Compton background contribution using the method described in ref. [6]. The B(E2) transition probabilities corresponding to the decay of low-lying levels in ^{129}Te have been deduced from the measured lifetimes. For the $7/2^+$ level at 813 keV, has been estimated as, B(E2) > 19.73 (in W.u). The large basis shell model calculations were performed, to interpret the level structure and the electromagnetic transition rates, using the NuShellX code [7]. The calculations have been performed distributing the proton and neutron particles above the ^{100}Sn core over the 50–82 subshell space. The considered model space was comprised of ($g_{7/2}$ $d_{5/2}$, $d_{3/2}$, $s_{1/2}$, $h_{11/2}$) orbitals for both protons and neutrons. The calculations were carried out in full valence space without any truncation and using the sn100pn interaction [8].

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