Search for isomeric state in odd-odd ^{150}Pm

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Introduction

Nuclear isomers are excited quantum-mechanical states of a nucleus, in which a combination of various nuclear structure effects like single particle configuration of the states involved, inhibits its decay. It endows it with a lifetime that is longer than expected. These isomers continue to be a frontier area of nuclear physics research since early days, and were first foreseen by Soddy in 1917 [1]. Several isomeric states have been predicted and observed in odd-odd nuclei with N$\geq$89 and 61$\leq$Z$\leq$77 [2, 3]. In almost half of the known cases, the excited isomers in these odd-odd nuclei have a half life greater than the lower lying ground state, the decay of which is highly forbidden to the ground state. The systematics of these isomers around Z=61 and N=89 nucleus arouses curiosity to check for the presence/absence of the same in case of ^{150}Pm. This is very important to understand the properties of the associated single particle states, the p-n interaction and also to understand the process of neucleosynthesis by slow neutron capture ref.[4]. Isomers with $t_{1/2}\sim$sec or more can not be detected in an in-beam spectroscopy and the decay measurement becomes very crucial. Measurement of β-decay end-point energies and following the half-lives of γ-rays of daughter nucleus are some of the possible routes for the identification of such isomeric states. In the present work, the main objective is to search for the existence of any long-lived isomeric state in ^{150}Pm by following the β-decay half-lives for the γ-rays of its daughter ^{150}Sm, studying their coincidence relationships and determining the β-endpoint energies for different β-decay branches of ^{150}Pm $\rightarrow$ ^{150}Sm.

Experiment

^{150}Pm was produced by the reaction ^{150}Nd(p, n)^{150}Pm [5] using 8.0 MeV proton beam from the K=130 cyclotron at VECC which then, following β-decay, produces the excited states of ^{150}Sm. The 900 μg/cm^2 thick ^{150}Nd target(97% enriched) was prepared by electro-deposition on a 7.5 μm thick Al foil. The decay half life was measured using one Clover HPGe detector while increasing the statistics with repeated measurements. The coincidence set up consisted of four Clover Ge detectors and two LEPS detectors. The Clover Ge detectors were used for the detection of delayed γ transitions and the planer Ge detectors were used to facilitate the detection of β-decay from ^{150}Pm. Details of the electronic set-up and the acquisition system used in this experiment has been described in ref.[6]. For the collection of β-γ coincidence data, a MASTER logic of ($M_\gamma\geq$ 1 within four CLOVER).AND.($M_{\gamma\beta}\geq$ 1 in two LEPS) was established. The detailed technique for the measurement of β-decay end point energy has been described in ref.[7]. In addition to the measurement of decay half lives and β-decay end-point energy, data has also been gathered for the measurement of γ-γ coincidence with a MASTER logic of ($M_\gamma\geq$ 2 within four CLOVER).OR.($M_\gamma\geq$ 1 in two LEPS).

Data Analysis and Results

The obtained data has been sorted using the LAMPS software to construct the RADWARE compatible γ-γ and β-γ matrices. Fig. 1 shows the half-lives measured for different γ-rays observed in the decay data and for most of them, the presence has been confirmed in the level scheme of ^{150}Sm. It has been observed that the half-lives measured for most of the ob-

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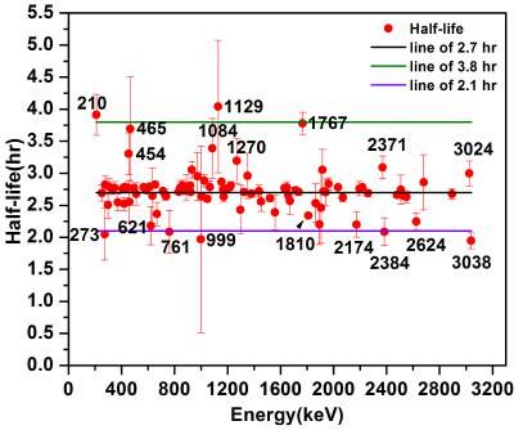

FIG. 1: Half-lives obtained for the observed transitions in the present work

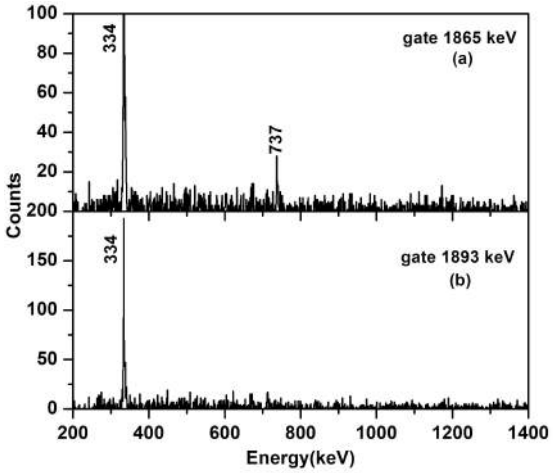

FIG. 2: Gated spectrum of (a)1865 and (b)1893 keV respectively,which are the two of the transitions showing $t_{1/2}$∼2h

served γ-rays show ∼2.68 h corresponding to the ground state of ^{150}Pm whereas there are two other groups of γ-rays that follow the half life∼3.8 h and ∼2.2 h respectively. The γ-γ coincidences, studied for all of the transitions showing the half lives of ∼2.2 h, confirms their presence in the level scheme of ^{150}Sm. This has been shown in Fig. 2, and indicates the presence of an isomeric state for the first time in the N = 89 ^{150}Pm nucleus. The γ-γ coincidence relationships for the other group of transitions, which have been confirmed not to be from any other possible sources, is in progress. The β-decay end-point energies corresponding to several known excited states of ^{150}Sm, populated from β-decay of ^{150}Pm [8], have been measured for the first time using the technique

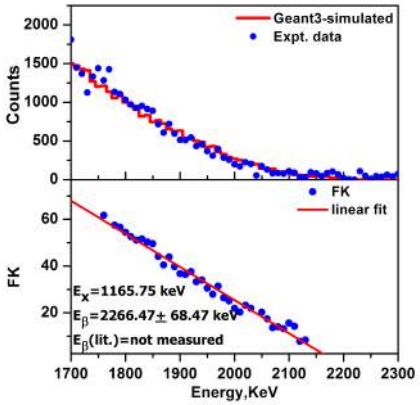

FIG. 3: β-spectrum and FK plot for the decay of ^{150}Pm(gs)→1165 keV state of ^{150}Sm

described in ref.[7]. Fig. 3 shows the representative β-spectrum and the corresponding FK-plot for the decay to 1165 keV state of ^{150}Sm. The measurement of β-decay end-point energies corresponding to the newly observed levels fed by the isomeric state in ^{150}Pm will also be attempted.

Acknowledgments

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