Decay spectroscopy of ^{118m}Sb

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Introduction

The primary objectives of recent nuclear spectroscopy experiments are to extend the measurements to extremes of angular momentum, energy and isospin. However, to have a complete understanding of nuclear structure encompassing the entire nuclear chart from stability to drip lines, the existing knowledge of stable nuclei at low-spins as well as decay data need to be refined further. Most of these data have been collected almost at least two decades back [1]. Due to the improvement of experimental and theoretical tools, decay studies should be revisited for better understanding of the nuclear structure. Refined decay spectroscopy of several nuclei may result in completeness of the information on beta decay feeding of levels including level lifetimes, moments etc.

An irradiation experiment has been recently performed at Variable Energy Cyclotron Centre (VECC), Kolkata, to irradiate few foils to pursue decay spectroscopy of long-lived isotopes. In the present report, the results for the irradiated natural Indium foil will be presented.

Motivation

^{118}Sn, a stable isotope of Sn, with 68 neutrons lies almost at the middle of the 50-82 neutron shell. This stable nucleus has been mostly studied by decay spectroscopy and light ion reactions using Ge (Li) and NaI (Tl) detectors. Heaviest ion which has been utilized to populate high spin states in this nucleus is ^{7}Li [1]. Surprisingly, relatively higher spin states in this isotope of Sn are also populated from the electron capture (EC) decay of a high spin isomer (8^- at 250 keV) of ^{118m}Sb ($T_{1/2}$=5.00 h). Decay studies of this isomer have been performed in the sixties [1]. There are several uncertainties (like a few unplaced gammas) in these measurements which needs attention. There are isomers whose half-lives were also measured [1]. These isomers, moreover, in isotopes of Sn with N>64 are also interesting for studying evolution of intruder $h_{11/2}$ orbit [2] with increasing neutron number.

Theoretically, complete information on these isotopes are useful to validate the two body effective interaction in this shell used to explain isotopes of Sn from A=100 to 132.

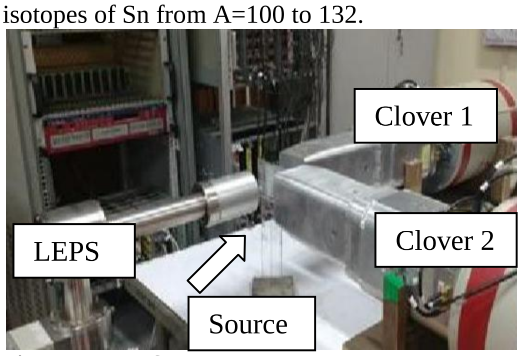

Fig. 1 Detector Set-up

Experimental Details

The irradiation experiment was carried out at K =130 cyclotron, VECC. Intense alpha beam of energy 32 MeV was bombarded to irradiate a foil (thickness 60 micron) of natural Indium (^{113}In: 4.28%; ^{115}In: 95.72%). The beam current was nearly 1 μA. We used the 0^{o} beam-line for irradiating the target material.

The irradiated foil was later carried to a close-by laboratory for gamma spectroscopic measurements. Two Clover detectors and one LEPS detector were used for the measurement. The Clovers were placed at 0^{o} and 90^{o} w.r.t the source. The LEPS detector was placed 180° w.r.t Clover 1 detector (Fig. 1). ORTEC amplifiers and other standard NIM electronics were used in the set up to collect data in singles as well as coincidence condition in LIST mode with a VME based data acquisition system (LAMPS software [3]).

In singles mode measurement, spectra had been collected in 10 minutes intervals to follow the half-lives for various decay transitions to identify their origin and confirm the half-lives of their parents. Two TAC (time to amplitude converter) spectra were generated for Clover 1-LEPS and Clover 1- Clover 2 combinations and also included in the list mode along with the energy information.

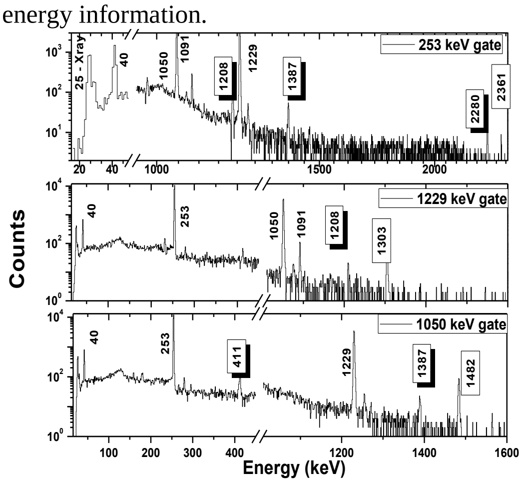

Fig. 2 Different energy gated spectra. The unplaced gammas are indicated in square boxes. Some new gammas seen are in shaded box.

Experimental Results

For the data analysis, LAMPS [3] and INGASORT [4] analysis software were used. To determine the relative efficiency of the detectors, data were collected for standard sources like ^{152}Eu and ^{133}Ba. In our experiment several long-lived isotopes / isomers [1] were produced. They are ^{117}Sb (2.8 h), ^{118m}Sb (5.0 h), ^{114m}In (49.5 days), ^{117m}Sn (14 days). In this report, only the information on ^{118m}Sb will be discussed.

To start with, the half-life of ^{118m}Sb, is determined by plotting the variation in the area under the peaks of gamma rays emitted by the excited daughter nucleus. Decay curves corresponding to 253 keV, 1050 keV, 1091 keV, 1229 keV, which are definitely known [1] to originate from the daughter ^{118}Sn, were plotted. The gamma rays which were seen by earlier workers [1] but not placed in the level scheme were also seen in the present work. The yields of these gamma rays, (*viz.* 1303 keV, 1482 keV), were also drawn against time.

Interestingly, the results indicate two interesting facts. They are: a) the strong gammas show similar half-lives. However, the average half-life (5.8 (3) h) is significantly different from the adopted value $T_{1/2}$=5.00(2) h [1]. b) The unplaced gammas show different half-lives (5.2 (5) h). The implications of these observations are being studied carefully to place these new gammas in the level scheme of ^{118}Sn, or understand their origin. The change in half-life shown by the measurement is also reviewed with additional constraints to confirm the change.

The gamma-gamma coincidence spectra are utilized to review the earlier placements (Fig. 2). Different suitably chosen gated spectra will be utilized to assign the nature of the unplaced gammas and a few additional gammas seen in the present work.

Conclusions

The half-life of ^{118m}Sb has been re-measured. It shows substantial difference from the adopted value. The unassigned gamma rays seen by earlier workers are also observed in the present work. Coincidence data are being analyzed to identify their origin.

Acknowledgment

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