Coincidence Study between internal conversion electrons and gamma-rays in ^{152}Eu

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Introduction

One of the important objectives of nuclear structure physics is to study different processes that are involved during the nuclear de-excitation process. Gamma-ray emission is one of the dominant processes which de-excite nuclei. In case of low energy excitation, for E0 transition, or for transition having higher multipolarity in heavier nuclei, the internal conversion process competes with gamma emission, where an orbital atomic electron is ejected. The kinetic energy of the emitted electron corresponds to the transition energy less the binding energy of that particular electron orbital. The internal conversion coefficient is defined to be the ratio of the probabilities of deexcitation through electron emission to the gamma-ray emission. However, detecting conversion electrons in an in-beam experiment involves dedicated setups.

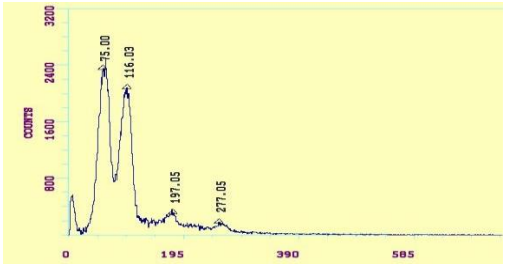

Fig.1 Internal conversion electron spectra for ^{152}Eu

In the present work, we shall discuss a small compact setup, in extreme close geometry without a vacuum chamber for correlation studies with gamma-rays, especially to study isomers in decay spectroscopy. To test the effectiveness of the setup- we have used a standard radioactive source ^{152}Eu to revalidate [1] the earlier results with the present setup.

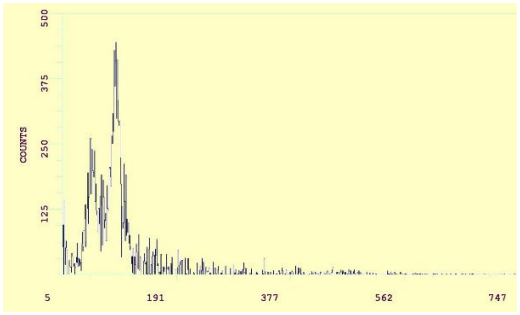

Fig.2 244 keV gated internal conversion electron spectra for ^{152}Eu

Experimental details Analysis, and Results:

In the setup, electrons are detected with a Si PIN diode having an active area of 25 mm^2 and thickness of 300μm developed by Bharat Electronics Limited (BEL). A detailed description of the characteristics of this diode can be found in our previous work [2]. The experimental set up contains another 3"x3" NaI(Tl) for the detection of gamma rays.

The data have been acquired using a CAEN 5780M digitizer (14 bit, 100MS/s, 16k channel) using MC^2 analyzer software. Both preamplifier and detector bias have been provided by the digitizer itself as it contains two mixed high voltage power supplies. A charge sensitive ORTEC142B preamplifier has been used for the

Si-PIN signal. Whereas, the direct output of the scintillator detector has been fed directly to the digitizer for further pulse processing.

The source has been prepared with special care on a thin mylar foil so that electrons are not stopped. In coincidence condition, the data has been acquired in `list mode` to get the energy and temporal information.

To pre-sort the data, a simple program in MATLAB has been used. Further analysis has been done using LAMPS [3], and INGASORT [4] software. In Fig. 1, the internal conversion electron spectrum for ^{152}Eu is shown.

To analyze the data, a two dimensional matrix (gamma–electron) has been plotted. From this, gating 115 keV (i.e. L conversion of 121 keV), the gamma spectra from NaI(Tl) detector has been projected as shown in fig 3. The spectrum shows 244 keV peak as well as 1408keV. On the other hand, fig 4, shows internal conversion electron spectra by gating 344 keV in gamma detector.

Overall, this composite set up works well without any vacuum chamber. This set up also can be used to measure the beta end point energy. In future, we intend to improve the setup by cooling the photodiode, that might improve the resolution of the detector.

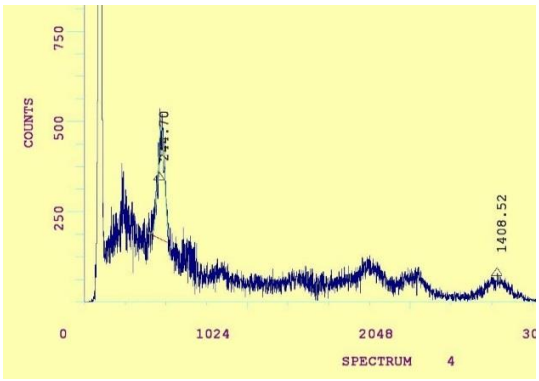

Fig.3 115 keV conversion electron gated gamma spectra from NaI(Tl) detector

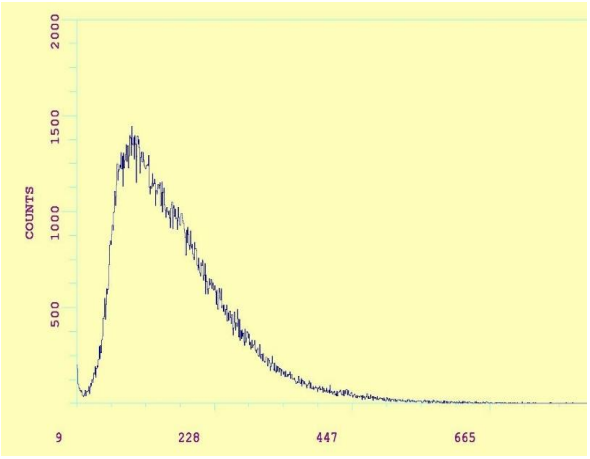

Fig.4 344 keV gated internal conversion electron spectra for ^{152}Eu

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3) http://www.tifr.res.in/~pell/lamps_files/download.html.

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