Half life measurement of ^{199}Pb in study of reaction ^{6}Li + ^{197}Au

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Introduction

Fusion reactions induced by weakly bound stable nuclei like ^{6,7}Li, ^{9}Be have been extensively studied in recent years[1]. In order to study the influence of direct reactions on fusion mechanisms we have carried out simultaneous measurements of these processes for reactions ^{6,7}Li + ^{197}Au at near barrier energies. The products originating from complete fusion and transfer reactions are predominantly beta active with long half lives and were measured by offline gamma spectroscopy. The offline spectroscopy helps in precise identification of each compound nuclear evaporation residue by following its half life. The excitation functions for fusion and transfer reactions for ^{6}Li + ^{197}Au reaction have been measured and reported in [2]. We report in this paper the half life of ^{199}Pb, the result of the analysis of reaction ^{6}Li + ^{197}Au. Data on ^{199}Pb is scarce and precise measurement shows discrepancy in the half life. The residue ^{199}Pb (4n evaporation channel) is the most dominant channel at 44MeV (σ = 400mb), data at this energy has been used for half life measurement.

Experimental Details

The experiment was performed using Pelletron LINAC facility, Mumbai. Self supporting rolled target foil of ^{197}Au (∼1.5-1.65 mg/cm^2 thick) was irradiated with ^{6}Li beam of energy 44 MeV (I∼20pnA). Data was recorded in list mode using CAMAC based acquisition system named LAMPS. The experimental setup and offline data collection procedures are similar to as mentioned in [3].

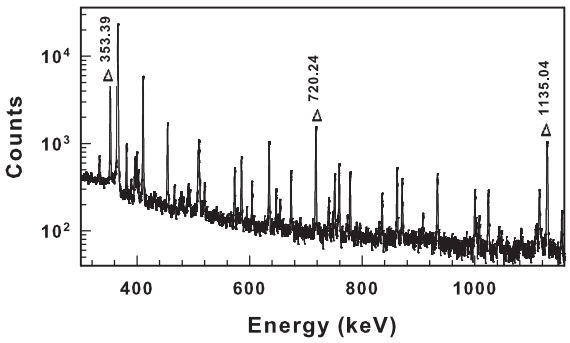

FIG. 1: The offline gamma spectrum at 44MeV showing all the lines of 4n channel

TABLE I: Characteristic γ rays for ^{199}Pb

Nuclide	E_γ (keV)	$T_{1/2}$ (m)
^{199m}Pb	424.1	12.2
^{199}Pb	353.39, 720.24, 1135.04	90

In order to reduce dead time due to high count rate at this energy we collected data at 15cm from the detector for first 1 hour. Table 1 lists the characteristics gamma lines and the half life of ^{199}Pb from reference. Fig. 1 shows a typical offline gamma spectrum at 44MeV where γ lines of ^{199}Pb are clearly seen. The half life of ^{199m}Pb was measured from data collected at 15cm from the detector. Since isomeric state decays to ground state with half

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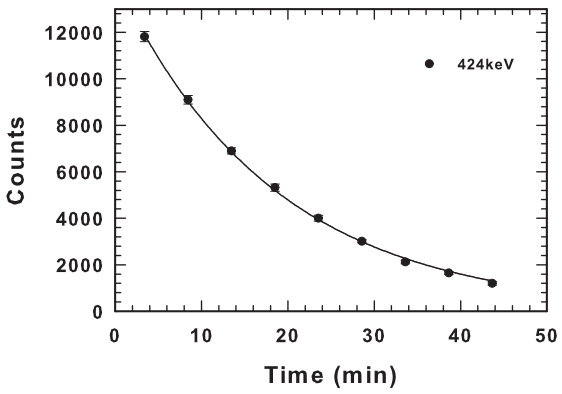

FIG. 2: The decay plot of ^{199m}Pb.

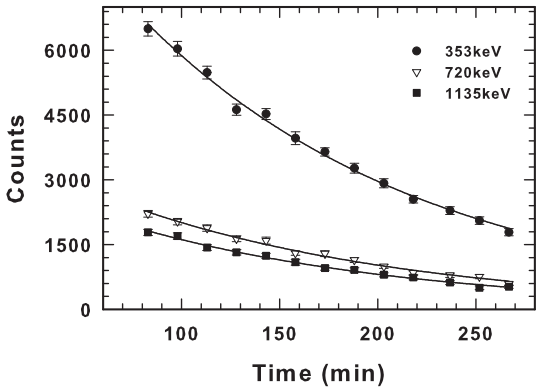

FIG. 3: The decay plot of ^{199}Pb for three different γ lines.

life of 12 mins, data collected after 1.2 hr (∼6 half lives) at 10 cm was considered for ^{199}Pb. The yields of interested lines were extracted from each 5min interval data of the list file. The yield is given by the formula

$$Yield = \int_{t_1}^{t_2} \frac{dN}{dt} dt \qquad (1)$$

Where t_1 and t_2 are start and stop time and Δt equals to t_2-t_1. With simple principles of radioactivity and straightforward calculations it leads to

$$Yield = N_0 e^{-\lambda t_1}(e^{-\lambda \Delta t} - 1) \qquad (2)$$

Fig. 2 and fig. 3 show the decay plot of ^{199m}Pb and ^{199}Pb respectively when fitted with above function. The errors are the statistical errors in the yield. The half life values from corresponding γ lines are given in table 2. The

TABLE II: Measured Half lives for ^{199}Pb.

E_γ (keV)	$T_{1/2}$ (m)
424.1	12.6 ± 0.2
353.39	103 ± 2
720.24	105 ± 3
1135.04	102 ± 2

half life of ^{199}Pb from all the three γ lines are consistent and averaged to 103 mins. It can be seen that measured half life of ^{199m}Pb is in agreement with the reference value but is significantly different for ^{199}Pb.

Acknowledgments

We would like to thank Ms. Deepa Thapa for target preparation, Mr. M.S. Pose and Mr. K.S. Divekar for help during the experiment and the accelerator staff for smooth operation of machine.

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