Evaporation residue spin distribution for ^{30}Si,^{31}P+^{170}Er

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Introduction

Super heavy elements (SHE) are predicted to exist with extra stability owing to shell corrections. To reach the SHE region experimentally, it is important to know what kind of role shell closure plays in fusion dynamics. Studies revealed that shell closure of target affect the fusion dynamics [1] and enhances the ER cross section. Several studies have shown effect of shell closure of Compound Nucleus (CN) [2–4]. We have chosen the spin distribution of Evaporation Residue (ER) as a tool to study reaction dynamics and effect of shell closure, if any. ER cross section gives the information of survival of CN from fission, whereas ER spin distribution gives information in a detailed way i.e. contribution of different partial waves. Our aim is to see if the Z=82 shell closure of CN affects the spin distribution of ER. For the present study we have chosen two systems namely, ^{30}Si + ^{170}Er and ^{31}P + ^{170}Er. They form CN ^{200}Pb and ^{201}Bi, respectively. Both the CN have same number of neutrons and ^{200}Pb has proton shell closure Z=82. The objective was to compare ER spin distributions for CN ^{200}Pb and ^{201}Bi at similar excitation energies.

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Experimental details

The experiment was carried out at Inter University Accelerator Centre. ^{30}Si and ^{31}P beams of energies from 146 MeV to 188 MeV were provided by Pelletron + LINAC accelerator. Target of ^{170}Er of thickness 130 μg/cm^2, sandwiched between two Carbon layers of thicknesses 45 and 23 μg/cm^2, was used in the experiment. The HYbrid Recoil mass Analyzer (HYRA) [5] was used to select ERs. ERs were detected at the focal plane with the help of a Multi Wire Proportional Counter (MWPC) of area 6" X 2" followed by a double sided silicon strip detector with 16 strips at each side [6]. HYRA was operated in gas filled mode, with Helium gas at a pressure of 0.15 Torr. Gamma ray multiplicity was detected with the help of TIFR 4π spin spectrometer [7] coupled to HYRA [8]. The complete array of the spin spectrometer consists of 32 NaI detectors (12 pentagonal detectors and 20 hexagonal detectors). Out of 32 , 29 detectors were used in this experiment covering a solid angle of 91% of 4π Sr giving an absolute efficiency of 77%. 2 pentagonal detectors were removed for beam line and one hexagon was removed for target ladder. Time of flight of ERs from target chamber to focal plane was of the order of 1.5 μs. Pulsed beam of repetition rate 2 μs was taken and Time to Amplitude Converter (TAC) was set between the anode signal of MWPC and the RF signal from beam pulsing system. The TAC spectrum allowed separation of ERs from other contaminants.

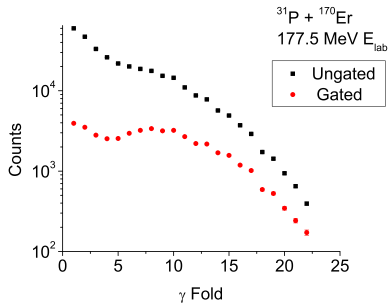

FIG. 1: Raw and gated gamma fold distribution for $^{31}\mathrm{P} + {}^{170}\mathrm{Er}$

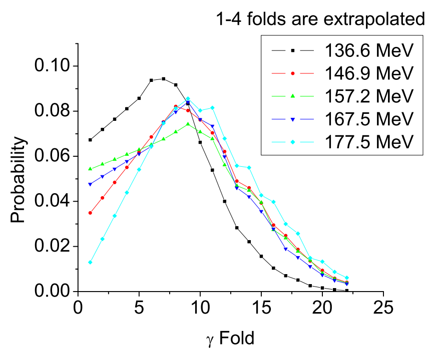

FIG. 2: γ fold distribution for $^{31}\mathrm{P}+^{170}\mathrm{Er}$ at five different energies..

Time Of Flight (TOF) gate was put on the multiplicity to get ER gated experimental γ multiplicity or γ fold distribution. Data were collected in beam-off condition too in order to quantify background in first few folds which could help in incorporating appropriate corrections to ER gated γ fold distribution.

Preliminary Results

ER gate was put on experimental gamma fold to clean other non-compound events. 1-4 folds are contaminated by huge background and have to be extrapolated for further analysis. Fold distributions for $^{30}\mathrm{Si}$ $+^{170}\mathrm{Er}$ and $^{31}\mathrm{P}$ $+^{170}\mathrm{Er}$ are shown in Fig.3 at almost the same excitation energy. A preliminary analysis shows that there is no significant change in gamma fold distribution for the two reactions and is presented in figure 3.

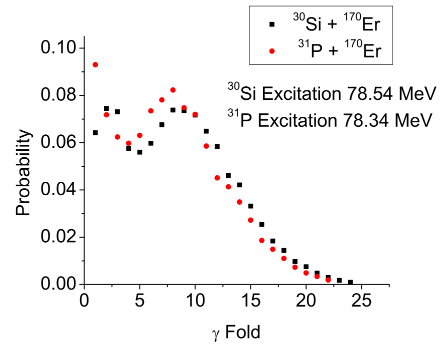

FIG. 3: γ fold distribution for $^{30}\mathrm{Si}+^{170}\mathrm{Er}$ and $^{31}\mathrm{P}+^{170}\mathrm{Er}$ at comparable excitation energies.

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