Relative Reaction Cross-section Measurements

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Introduction

High spin states in nuclei are investigated via heavy ion fusion evaporation reactions. The heavy ion fusion evaporation reactions can populate states of very high angular momentum up to 70-80ħ and therefore these reactions are most common tool for nuclear structure studies.

In fusion evaporation reaction wide variety of particles may be evaporated by taking away most of the excited energy but very low angular momentum from the excited nucleus. After the particle evaporation the excited nucleus decays to ground state mainly via gamma ray emission and depopulate its high angular momentum. These gamma lines carry important information about internal structures of a nucleus [1]. From the yields of characteristic gamma ray one can infer the relative probability of a particular reaction channel.

Excitation function is a quantity which indicates the expected yields for different reaction channels as function of incident beam energy. The information on excitation function is important for testing the statistical model calculations to understand the complex mechanism of the reaction. Monte-Carlo simulations codes like PACE4 [2] or CASCADE [3], are widely used to estimate the cross-sections and depend upon internal parameters. Sometimes these simulation codes do not provide proper estimation of reaction cross-sections, hence experimental investigations are needed.

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Experimental Details

The ^{124}Sn target was bombarded with ^{16}O beam in the range of energy, 75-95 MeV. The experiment was carried out using the 15 UD pelletron accelerator facility at Inter-University Accelerator Centre (IUAC), New Delhi. An isotopically enriched target of 1 mg/cm^2 was used in the experiment and Indian National Gamma Array (INGA) was used to detect the γ-rays from the excited nucleus. In this experiment, excited nucleus ^{140}Ce was formed which decays into several reaction channels i.e, 4n, 5n and 6n. The relative cross-section of these reactions changes with beam energy. The γ-γ- coincidence events were recorded by CAMAC-based data acquisition system [5]. The offline data analysis was carried out using the INGASORT computer program [6].

Results and Discussion

Relative reaction cross-sections (σ) of evaporation channels viz, 4n, 5n, 6n populated by fusion evaporation reaction have been determined form the relative intensities of decaying gamma rays from the 2^+ and 4^+ excited states of the residue nuclei, after efficiency and energy calibration. These relative cross-sections

are also compared using the PACE4 code. The experimental data and PACE4 data were normalized at 85MeV. These calculations are done by using the default parameters in the PACE4. Experimentally the strongest reaction channel was found to be 5n channel (^{135}Ce) for the both gamma-rays decaying from 2+ and 4+ states. The PACE4 calculations also predict highest population for the ^{135}Ce nucleus. The excitation functions for ^{134}Ce, ^{135}Ce, ^{136}Ce isotopes are displayed in figs, (1, 2, 3).

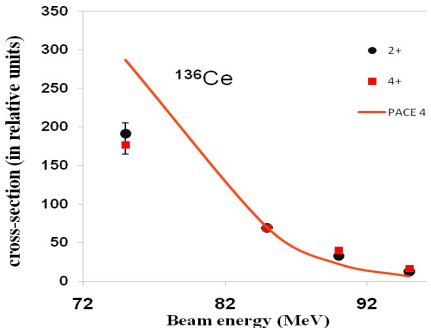

Fig.1: Comparison of cross section excitation function with PACE 4 calculations for ^{136}Ce gamma ray lines.

For the 4n channel i.e, ^{136}Ce [7], excitation function has been determined from the yield of the 552 and 762 keV γ-rays after correcting for the efficiency and intensity. PACE4 calculations also follow the same trend of cross-section and reproduce the experimentally measured cross-section (Fig.1).

For the 5n channel which is ^{135}Ce [8], excitation function has been determined from the yield of the 590, 700, 724 and 906 keV γ-rays

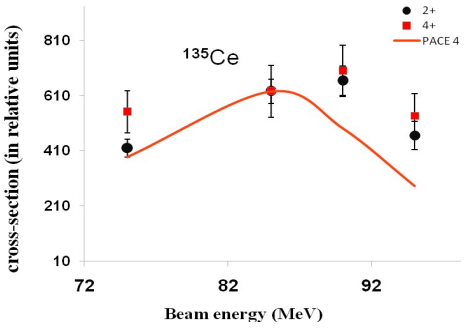

Fig.2: Comparison of cross section excitation function with PACE 4 calculations for ^{135}Ce gamma ray lines.

Similarly, the 6n channel i.e, ^{134}Ce [9], has been determined from the yield of the 409, 556, 640 and 965 keV γ-rays. Experimental data has been compared with the PACE4 calculations. Fig. (2,3). A satisfactory agreement is found for the evaporations associated with neutron emission. Data analysis is under progress, further details will be presented during the presentation in the Symposium.

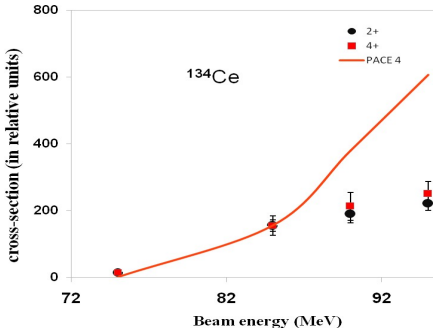

Fig.3: Comparison of cross section excitation function with PACE 4 calculations for ^{134}Ce gamma ray lines.

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