Study of channel coupling effects on sub barrier fusion of ^{16}O + ^{124}Sn reaction

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Introduction

Heavy-ion fusion reaction dynamics near and below the Coulomb barrier has been an interesting phenomenon for the last few decades, since the quantum tunnelling effects play a significant role at sub barrier energies. It has been observed that fusion cross section is significantly enhanced at sub-barrier energies compared to the 1-DBPM calculations [1]. Such enhancement occurs due to the coupling of various internal degrees of freedom of the colliding nuclei such as deformation, vibration and nucleon transfer. Coupled channel calculations have successfully explained the enhancement of sub barrier fusion cross sections by accounting for the coupling of inelastic excitation's, nuclear vibrations and deformation of the interacting nuclei [2]. However, the role of neutron transfer channels is not completely understood [3]. In order to investigate the effect of inelastic excitation's and role of neutron transfer channels, we have studied the fusion excitation function for the reaction ^{16}O + ^{124}Sn.

Experimental Details

The experiment was performed at IUAC, New Delhi by using the Heavy Ion Reaction Analyzer (HIRA) [4]. Pulsed beam of ^{16}O, with a repetition rate of 4 µs was delivered by 15UD Pelletron accelerator facility. ^{16}O beam was bombarded on ^{124}Sn target of thickness 100 µg/cm^2 with carbon backing of approximately 20 µg/cm^2. Two silicon surface barrier detectors (SSBD) were mounted inside the sliding seal scattering chamber at ± 20° angle with respect to the incident beam direction in order to normalize the evaporation residue cross section and beam centering. HIRA rejects the intense beam background and transports the ER's to the focal plane. Fusion excitation measurements were performed in the laboratory energies ranging from 51 MeV to 74 MeV covering 10% below the barrier to 32% above barrier in steps of 1.0 MeV. The ER's were detected in the focal plane using a two dimensional position sensitive Multi Wire Proportional Counter (MWPC) with an active area of 150 x 50 mm^2 [5].

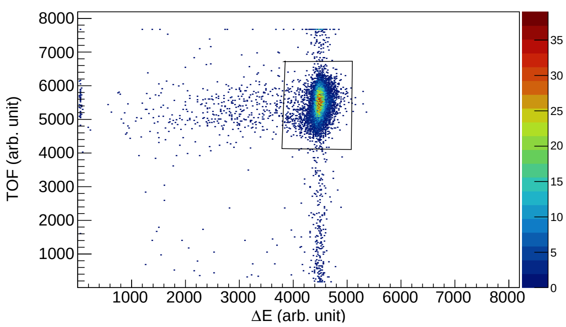

FIG. 1: ΔE versus time-of-flight (TOF) spectrum for the reaction ^{16}O + ^{124}Sn at 72 MeV beam energy.

A typical 2D spectrum of energy loss in MWPC ΔE and time-of-flight (TOF) of the

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ER's is shown in Fig. 1. From the spectrum it can be observed that beam like particles are clearly separated from the ER's.

Results and Discussions

The fusion cross section can be calculated by using the equation

$$\sigma_{ER} = \frac{Y_{ER}}{Y_{mon}} (\frac{d\sigma}{d\Omega})_R \Omega_M \frac{1}{\epsilon_{HIRA}} \quad (1)$$

where Y_{ER} is ER yield at the focal plane detector, Y_{mon} is the yield of Rutherford events recorded by the monitor detectors, $(\frac{d\sigma}{d\Omega})$ is the differential Rutherford scattering cross section, Ω_M is the solid angle subtended by the monitor detectors and ϵ_{HIRA} is the transmission efficiency of the HIRA.

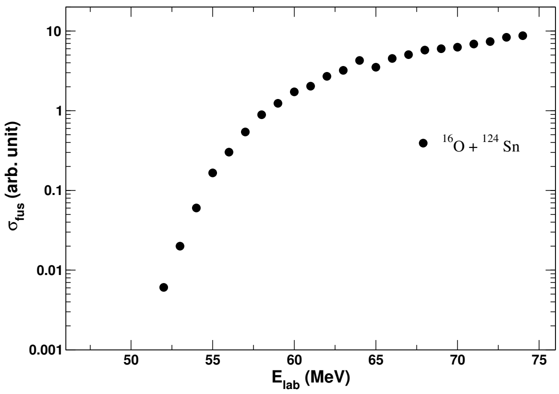

FIG. 2: Excitation function for the reaction ^{16}O + ^{124}Sn in arbitrary units.

The fusion excitation function for the reaction ^{16}O + ^{124}Sn is shown in FIG. 2 without including the efficiency of HIRA. The transmission efficiency of HIRA will be calculated by using the semi-microscopic Monte Carlo code [TERS] [6]. After including the efficiency of HIRA, the coupled channel calculations will be performed to investigate the influence of various coupled degrees of freedom on the enhancement of fusion cross sections at sub barrier energies. Detailed results will be presented at the conference.

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