Fusion in ^{6}Li + ^{197}Au at near barrier energies

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Introduction:

The study of effect of breakup on fusion processes with weakly bound nuclei at near barrier energies has gained importance in recent years [1]. In order to gain insight into the influence of the projectile structure on the fusion process, we have carried out measurements with ^{6,7}Li on ^{197}Au. Amongst stable nuclei, ^{6}Li has the lowest breakup threshold $S_{\alpha/d}$=1.475MeV. In this paper we present fusion excitation function of ^{6}Li + ^{197}Au over the energy range $0.8 \leq E/V_b \leq 1.5$. The fusion excitation function for ^{7}Li ($S_{\alpha/t}$=2.45MeV) + ^{197}Au over a range $0.6 \leq E/V_b \leq 1.5$ was reported earlier [2].

Experimental Details:

The experiment was performed at Pelletron LINAC facility, Mumbai with ^{6}Li beam of 10-20 pnA. The targets of ^{197}Au foils of thickness 1.25-2 mg/cm^2 were irradiated at beam energies from 26MeV to 44MeV in steps of 2MeV. The experimental setup and offline data collection procedures are similar to the earlier measurement [2]. For efficient use of beam time, two cascaded targets with Al foil of appropriate thickness as a degrader (~1-3 MeV loss) were used in this experiment. The energy after the degrader was calculated using TRIM [3]. At lowest energies the data was collected in a close geometry inside the lead house.

Table 1 lists the characteristic γ-rays and half-lives of different reaction products. All the fusion and transfer products could be clearly identified and half-lives also have been verified.

Table 1: Characteristic γ-rays and half-lives

Nuclide	E_γ (keV)	$T_{1/2}$
^{201}Pb (2n)	331.15	9.33 hrs
^{200}Pb (3n)	257.19, 268.36	21.5 hrs
^{199}Pb (4n)	353.39,720.24	90 min
^{198}Pb (5n)	173, 290	2.4hrs
^{198}Au (1n-stripping)	411.8	2.69 days
^{196}Au (1n-pickup)	333.03, 355.7	6.17 days
^{197m}Hg (d,2n)	134	23.8hrs

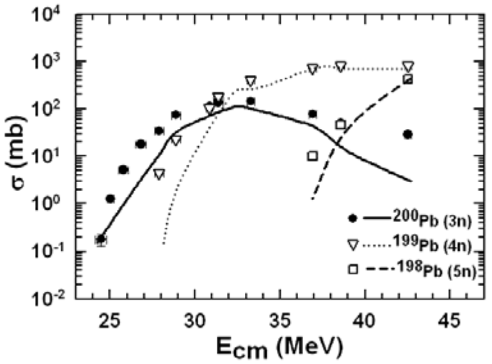

Figure 1: Measured excitation function (symbols) for residues from complete fusion in ^{6}Li+^{197}Au reaction together with statistical model PACE calculations (lines).

The excitation functions of the direct reaction channels namely, 1n-pickup and 1n stripping are shown in figure 2. In case of a d/t transfer, the products (Hg isotopes) are stable and could not be measured by present technique However, ^{197m}Hg ($13/2^+$) arising from (d,2n) is observed.

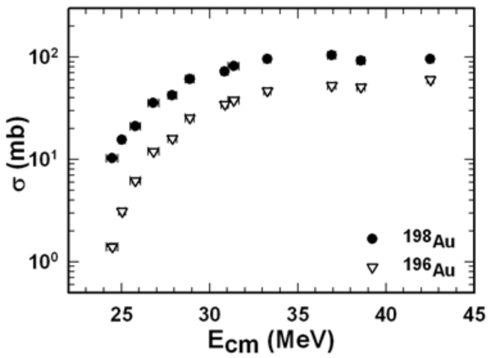

Figure 2: Measured excitation function for 1n-stripping (^{198}Au) and 1n-pickup (^{196}Au) reaction.

As can be seen from figure 2, the 1n-stripping cross-section is larger than 1n-pickup.

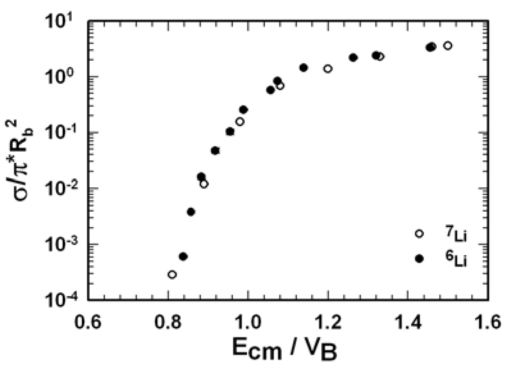

Figure 3: Reduced cross-sections for compound nuclear fusion in ^{6}Li and ^{7}Li with ^{197}Au (Errors are smaller than the symbol size)

Figure 3 shows the reduced cross-sections for both ^{6}Li and ^{7}Li on ^{197}Au as a function of scaled energy. The barrier parameters are derived from Akyüz Winther potential. It can be seen that there are no significant differences in reduced fusion cross-sections of ^{6}Li and ^{7}Li. The coupled channel calculations and the barrier distribution will be presented.

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