Light particles emissions in $^{6}$Li + $^{12,13}$C, $^{6,7}$Li + $^{16}$O reactions

Sarbjeet Kaur$^1$,∗ BirBikram Singh$^1$,† and S. K. Patra$^2$

$^1$Department of Physics, Sri Guru Granth Sahib World University, Fatehgarh Sahib-140406, India
$^2$Institute Of Physics, Sachivalya Marg, Bhubaneswar-751005, India

Introduction

During the last two decades of preceding century, $^{6,7}$Li induced reactions at low energies had been studied extensively to understand the related fusion reaction mechanism. The characteristics gamma-rays of the residual nuclei followed by the reactions these reactions had been measured at low energies around the Coulomb barrier [1, 2]. The cross sections for different exit channels are available out of which np channel was found to be the most dominant one with 40% and 30% contribution in the $^6$Li + $^{16}$O and $^7$Li + $^{16}$O reactions, respectively. The binding energy consist of both the macroscopic (liquid drop energy) part and the microscopic proximity potential and angular momentum dependent potential, respectively. The binding energy consist of both the macroscopic (liquid drop energy) part and the microscopic

other nuclei. It is important to point out here that for the CN under study i.e. $^{18,19}$F$^*$ and $^{22,23}$Na$^*$ the data for LPs exit channels were measured quite extensively using gamma-ray yield as well as ER techniques [1, 2]. So, it would be quite exciting to look into LPs/ERs in different exit channels within the DCM which takes into consideration penetration of relatively preformed fragments in the decay of compound nucleus. Furthermore, present work extend the application of DCM to lighter mass region further. It is relevant to mention here that this dynamical model has been successfully applied to various mass regions including super heavy mass nuclei [5]. The next section presents the methodology in brief, followed by the calculation and discussions in the subsequent section.

Methodology

In DCM [3–5] of Gupta and collaborators, the compound nucleus decay cross-section for $\ell$ partial waves, is defined as

$$\sigma = \frac{\pi}{k^2} \sum_{\ell=0}^{\ell_{\text{max}}} (2\ell + 1)P_0 P; \quad k = \sqrt{\frac{2\mu E_{\text{c.m.}}}{h^2}}$$  \hspace{1cm} (1)

where, $P_0$, the preformation probability, refers to $\eta$-motion and P, the penetrability, to R-motion. The $\ell_{\text{max}}$-value in Eq. (1) is the maximum angular momentum, fixed for the vanishing of the light particles cross-section, i.e., $\sigma_{LPs} \rightarrow 0$.

The $P_0$ contains the structure information of compound nucleus via the fragmentation potential comprises of $B_i$, $V_C$, $V_p$ an $V_t$ i.e., the temperature dependent binding energies of the two nuclei, Coulomb potential, nuclear proximity potential and angular momentum dependent potential, respectively. The binding energy consist of both the macroscopic (liquid drop energy) part and the microscopic

*Electronic address: sarbjeetsangha13@gmail.com
†Electronic address: birbikransingh@sggswu.edu.in

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(shell correction) part, defined within the Strutinsky renormalization procedure [6].

Calculations and Discussions

Fig. 1(a and b) and Fig. 2(a and b) presents the fragmentation potential as a function of fragment mass $A_2$ for the decay of CN (a) $^{22,23}Na^*$ and (b) $^{23}Na^*$ for the spherical considerations of the nuclei, at angular momentum value $\ell = 0\hbar$.

However, in Fig. 2, compound nucleus $^{19}F^*$ (Fig. 2(b)) has $^5He$ or $^{\alpha}l$ as the most prominent fragment followed by the $^2H$ in contrast to compound nucleus $^{19}F^*$ (Fig. 2(a)) which is having $^2H$ as most predominant fragment followed by the fragment $\alpha l$ or or equivalently $^{\alpha}l$. This result is also well supported by the experimental data [2], which shows that though pn exit channel has maximum cross sections for the compound nucleus $^{18}F^*$ but for $^{19}F^*$ system it is surpassed by $\alpha l$ exit channel cross sections [2]. It will be quite interesting to investigate the effects of higher angular momentum values along with deformation and orientation effects on the fragmentation profile of CN under study. Subsequently, the $P_0$ and $P$ will be calculated with all these effects included in order to explore the underline reaction mechanism within the DCM. Moreover, the effects of different centre of mass energies will be explored for these CN along with the calculations of the cross sections for different exit channels and their comparison with the available experimental data. Work is in progress.

References