Fission of $^{59}Cu^*$ formed in $^{35}Cl +^{24} Mg$ reaction

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Introduction

The de-excitation of the excited compound nucleus (CN) in to light particles, fission fragments are studied extensively using the Dynamical cluster-decay model (DCM) of Gupta and collaborators [1]. The model is worked out interms of the charge (mass) asymmetry and separation distance of the fragments. With the use of DCM, several low energy heavy ion reactions are studied in different mass regions.

In DCM, one of the main ingredient is the temperature (T) dependent binding energies (BEs). Recently, the effect of T-dependent BEs in DCM for the decay of $^{56}Ni^*$ [2] with the use of Krappe [3] and Guet et al., B.E. formulae is analysed. The results indicate that the refitting of the co-efficient in T dependent B.E.'s are not required and the structural effects in the fragmentation potentials are shown as the inherent property of the BE formula one uses.

In this work, the reformulated DCM is applied to study the decay of odd-A compound system $^{59}Cu^*$ formed in the reaction $^{35}Cl +^{24} Mg$ at E_{lab}= 275 MeV. This reaction is studied for the the first time using DCM.

Experimentally, the compound system $^{59}Cu^*$ is formed in the reaction $^{35}Cl+^{24}Mg$ is studied at two incident energies E_{lab}= 275 and 282.4 MeV [4]. The evaporation residue (ER) cross sections are 722±197 and 660±110 mb respectively at E_{lab}= 275 and 282.4 MeV. The fission fragment (FF) cross sections at these energies are also measured, they are 137±5 and 168±30 mb respectively at E_{lab}= 275 and 282.4 MeV.

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Methodology

The T-dependent fragmentation potential in DCM is,

$$V(\eta,T) = -\sum_{i=1}^{2}[BE_{LDM}(\eta,T)] + \sum_{i=1}^{2}\delta U_i(T) + V_C(T) + V_P(T) + V_\ell(T) \quad (1)$$

The first term refers to the liquid drop proper calculated as in [2] for the use of Krappe's B.E.'s and second term is the shell correction, which goes to zero exponentially with T. The other three terms corresponds to the T-dependent Coulomb, proximity and centrifugal potentials respectively. The decay cross section in DCM, is defined as,

$$\sigma = \frac{\pi}{k^2}\sum_{\ell=0}^{\ell_{max}}(2\ell+1)P_0P; k = \sqrt{\frac{2\mu E_{c.m.}}{\hbar^2}} \quad (2)$$

where P_0 and P are the preformation probability referring to η motion and the penetrability referring to R motion respectively.

Results and discussion

The T-dependent fragmentation potentials for the binary breakup of $^{59}Cu^*$ formed in the reaction $^{35}Cl +^{24} Mg$ at fixed T=4.45 MeV and R=R_t fm are calculated for different ℓ-values as shown in the upper panel of Fig. 1. From this figure, it is seen that strong minima is present for the α-structured nuclei. However, the non-α even fragments are having strong maxima and hence are not energetically favored when compared to its neighbours. In the lower panel, we present the summed values (summed upto ℓ_{max}) of P_0, P and σ as a function of fragment mass number. The explicit preference of four-nucleon transfer as seen in the potential (upper panel) is seen in the P_0 and σ values. This reaction favours a higher cross section

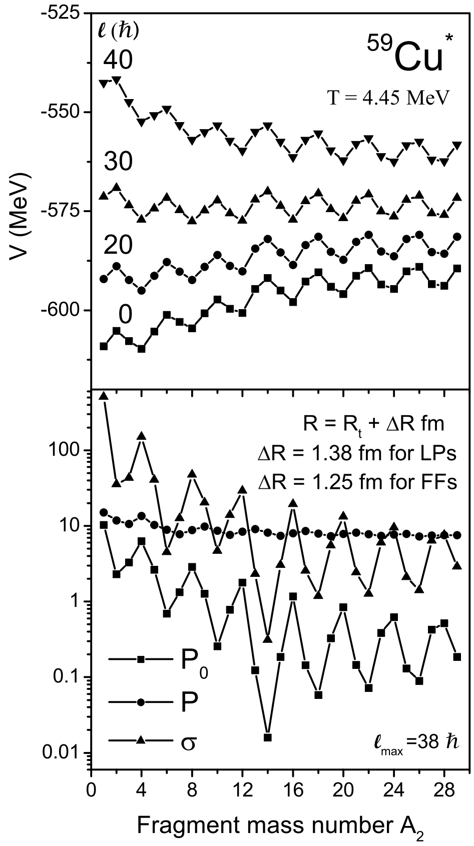

FIG. 1: The T-dependent fragmentation potentials of $^{59}Cu^{*}$ in upper panel and the summed P_0, P and σ in lower panel.

for mass asymmetric channels over symmetric breakup. Since, experimentally the cross sections are measured for the charge distribution, we present in the next figure our calculated cross-sections as a function of charge number. In Fig. 2 the calculated fragment cross sections for the decay of $^{59}Cu^{*}$ are compared with the experimental values [4] and two other models viz., EHFM+CASCADE and TSM. Since the charge distribution is measured in experiments, the calculated cross sections for each charge are summed over the energetically favoured masses of the fragments. The energetically favored masses of the fragments are found by charge minimising the potential. Though the calculated summed cross sections of ER and FF (734.85 and 136.18 mb respectively) fits well with experimental values (722±197 and 137±5 mb respectively), however, the comparison of the individual channel cross sections are not well reproduced with respect to experimental values atleast for some cases. The signature of a ternary breakup in this reaction is also studied and these results will be presented.

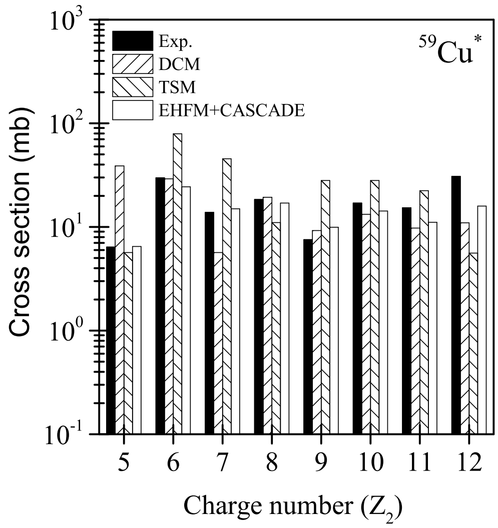

FIG. 2: The calculated fragment cross sections as a function of charge number (Z_2) are compared with the values of experiment [4], EHFM+CASCADE and TSM models.

Acknowledgments

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References

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