MULTISTEP COMPOUND PROCESSES IN HEAVY-ION INDUCED REACTIONS

R. Bonetti, L. Colli Milazzo, M. Melanotte
Istituto di Fisica dell'Università - Milano, Italia

M. S. Hussein
Instituto de Fisica da Universidade de Sao Paulo, Brasil

The importance of the Statistical Multistep Compound Emission (SMCE) was recently pointed out in order to explain the spectrum shape, angular distribution and values of the correlation width Γ in some light-ion induced reactions, which were exhibiting quite large deviations from the pure compound nucleus predictions . In particular, the wide range of the extracted Γ values was interpreted as arising from the different steps through which the SMCE chain develops[1] .

In this paper, we similarly suggest the SMCE to explain the presence of several correlation widths that characterize the fluctuations of the excitation functions for different final channels in the reaction $^{15}N(^{12}C,\alpha)$, measured by J. Gomez del Campo in the energy range 9.5I-I7.33 MeV in the c.m.[2].

We found that the range of values of Γ extracted using Ericson's one-class expression for the cross section autocorrelation function, was much wider than allowed by the classical compound nucleus correlation width formulae. We therefore reanalized the data in terms of autocorrelation function, allowing the presence of simultaneous, distinct Γ values, according to the autocorrelation function of Friedman et al.[3], generalized to the case of n classes of overlapping doorways:

$$C_{ab}(\varepsilon) = \left| \sum_{n=1}^{n} \frac{\sigma_{n\,ab}}{1 + i\,\varepsilon/\Gamma_n} \right|^2$$

In such a way all data for about 20 excitation functions could be explained by the simultaneous presence of at least two correlation widths, Γ_1 =400 KeV and Γ_2 = 70 KeV, with different relative cross section σ_n . Fig. I shows an example for a particular group of final levels.

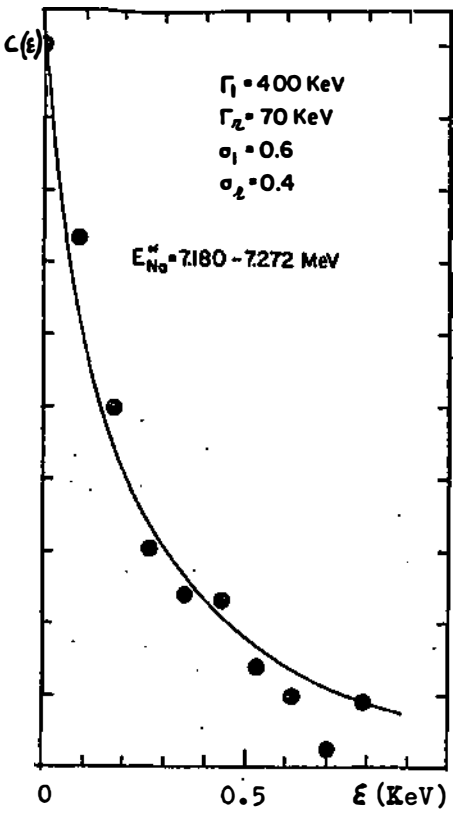

Fig.I

In the frame of the SMCE, these values have very simple physical interpretation: the smaller value, which is the one typical for the equilibrated compound nucleus is attributed to the final stage of the SMCE chain (r term). The larger value, on the other hand, is due to the simplest class of overlapping doorways, having the shortest life time, $\hbar / \Gamma_1$.
It is clear that this kind of analysis could shed light on the heavy-ion fusion mechanism, in particular providing us with informations on the nuclear configurations involved (i.e. number of excitons etc.)

References

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