MOLECULAR EFFECTS IN THE $^{12}C+^{13}C$ EXIT CHANNEL OF THE REACTION $^{16}O+^{9}Be$

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Angular distributions of the reaction $^{9}Be(^{16}O,^{12}C)^{13}C$ leading to the ground state of ^{13}C and the $1/2^{+}$ and $5/2^{+}$ states at 3.088 MeV and 3.854 MeV, respectively, have been measured at energies close to the Coulomb barrier. It was attempted to reproduce the data by means of exact finite range DWBA calculations performed up to second order. The optical model parameters used for the calculations fit the elastic data in the entrance and exit channel, the spectroscopic factors are known.

The transitions which have been found to contribute mainly to the measured cross sections are depicted in Fig. 1 for the case of the ground state reaction. The relative importance of these transitions can be seen in Fig. 2. It is interesting to note that the cross section of the successive α-n transfer is comparable to that of the on-step α-particle transfer.

The final results of the calculations for the ground state reaction are shown in Fig. 3 together with the experimental data. It is obvious from this figure that the calculations are able to account for the absolute magnitude of the measured cross sections. They fail, however, in reproducing the structures particularly those measured at the two lowest energies. We conclude from this failure that higher order processes than considered in the present calculations are necessary to reproduce the data. These processes are most probably successive transitions between states of the $^{13}C+^{12}C$ channel; they can be viewed at as an indication for the formation of molecular orbitals. In a previous study [1] we have shown that molecular

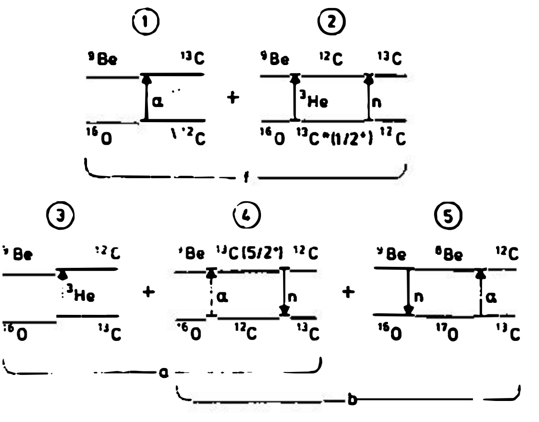


Fig. 1. Transitions which contribute mainly to the cross section of the reaction $^{9}Be(^{16}O,^{12}C)^{13}C$. The label a indicates the coherent sum of processes 3 and 4 etc..

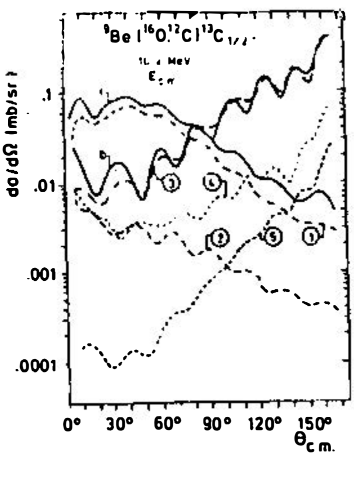
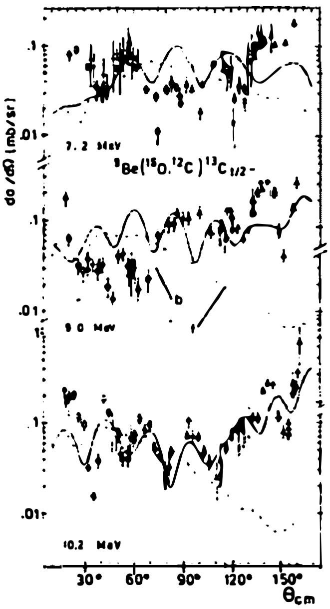


Fig. 2. Relative importance of the transitions given in Fig. 1.

orbits exist in the $^{13}C+^{12}C$ collision at low bombarding energies. The same system is populated in the present investigation from a different initial configuration having the advantage that all interactions in the $^{13}C+^{12}C$ system can be studied without the huge contribution of the elastic channel.



A second observation indicates that molecular effects are present in the reaction studied: the angular distributions exhibit rapid changes within small energy steps (see Fig. 3 for the ground state transition). Similar changes have been observed in the $^{13}C+^{12}C$ collision and could be explained as being due to nucleon promotion at avoided crossings in the adiabatic molecular level scheme of the $^{13}C+^{12}C$ system [2]. The transfer reaction from the $^{16}O+^{9}Be$ system samples the region of the avoided crossing in a comparable manner as in the case where $^{13}C+^{12}C$ is the entrance channel. The transfer reaction actually has the advantage that the effects are observed relative to the rather weak α-particle and ^{3}He transfer reactions.

Fig. 3. Angular distribution of the reaction $^{9}Be(^{16}O,^{12}C)^{13}C$ and second order DWBA calculations (solid lines). For the labels f and b see Fig. 1.

1. W. von Oertzen, B. Imanishi, H.G. Bohlen, W. Treu, and H. Voit, Phys. Lett. 93B (1980) 21
2. B. Imanishi, W. von Oertzen, and H. Voit
Phys. Rev. C35 (1987) 359