A MICROSCOPICALLY MODIFIED BAND CROSSING MODEL AND ITS APPLICATION TO THE $^{12}C + ^{12}C$, $^{12}C + ^{16}O$, AND $^{16}O + ^{16}O$ SYSTEMS

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In phenomenological application, the band crossing model [1] assumes a single, channel-independent molecular band and predicts structures in the inelastic cross sections whenever the respective bands cross. However, recent experimental data (like the structures[2] seen in the ℓ-mismatched 0_2^+-channel in $^{16}O + ^{16}O$ or the assignment of non-identical spins[3] to $^{12}C + ^{16}O$ doublet structures) are incompatible with the simple band crossing model. In this contribution, we present a modified version based on general properties of the nucleus-nucleus interaction as obtained in microscopic calculations. These calculations[4] predict i) a coexistence of bands of shape resonances and molecular states and ii) a possible parity-splitting of bands due to the parity dependence of the range of the Pauli-repulsion.

In such a modified model, based on a microscopic $^{16}O + ^{16}O$ potential and the Pauli principle, structures observed in $^{16}O + ^{16}O$ reactions to 8 inelastic channels have been accounted for in all cases[5]. Properties i) and ii) turned out essential for interpreting the data. Similar analyses of other heavy-ion systems are not yet possible, since reliable nucleus-nucleus potentials are missing. However, we can discuss qualitatively the influence of the properties (i), (ii) of the nuclear interaction on band crossing diagrams for various systems with experimentally observed resonant structure:

1) For the $^{28}Si + ^{28}Si$ system, inelastic channels with positive channel parity are expected to dominate the cross section in the energy range investigated up to now. Hence, the problem of parity splitting of the rotational structures does not appear. The coexistence of shape and molecular resonances leads to intermediate structure[6] similar to the observed one.

2) Doublet-like resonances are observed[7] in the $^{12}C + ^{16}O$ cross section at E = 19.7 and 20.5 MeV and at 22.0 and 22.6 MeV. Experimentally, different spins were assigned to the maxima within one doublet, while the band crossing model explained doublet-like resonances as evidence for a double-resonance mechanism[8] which necessarily assigns the same spin to both maxima of a doublet. In the microscopically modified band crossing model it becomes conceivable that one maximum is caused by the coupling of a molecular resonance in the inelastic channel to an elastic shape resonance, while the other is due to the direct excitation of a molecular state in the elastic channel. This reasoning is in agreement with the experimentally determined width of the 14^+ state at 19.7 MeV (ref. 9) and with the results of a microscopic $^{12}C + ^{16}O$ study[10], predicting 14^+, 15^- molecular resonances and 13^-, 14^+ shape resonances in exactly the energy region of the doublet-structures. Due to (ii) a strong parity splitting is expected in the $^{12}C + ^{16}O$ band structure and should be incorporated into band cross analyses.

3) The resonant structure in the $^{12}C + ^{12}C$ system has been suggested to be due to band coexistence[11]: At higher energies the structure is caused by a double resonance mechanism, while the subbarrier resonant structure is due to a direct excitation of molecular states which serve as doorways to more complex compound nucleus configurations. We have performed a qualitative band crossing diagram for the single and mutual 2^+ channels based on the hypothesis of band coexistence, adopting the molecular band of ref. 12 in agreement with other calculations[13]. A parity splitting of the band structure is not relevant, since both inelastic channels have positive parity. The band crossing diagram (Fig.1) predicts coupling of the elastic channel to the 2^+ channel for $E \approx 11$-37 MeV and for the mutual 2^+ channel for $E \approx 17$-37 MeV, both in agreement with the structures seen in experiment. Due to (ii), the band structure in the 3^- channel will be affected by the parity dependence of the Pauli repulsion. A band crossing diagram based on the elastic band structure might not be appropriate for this case.

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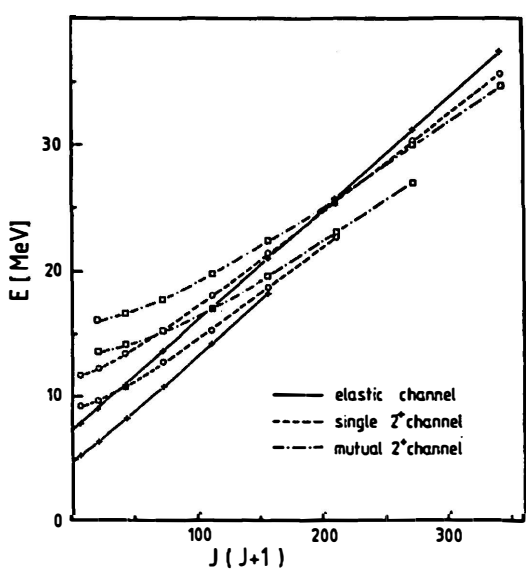

Fig. 1 Band crossing diagrams for $^{12}C + ^{12}C$ based on the band structure suggested in refs. 11,12.