FINITE MASS EFFECT OF NUCLEON ON THE MOLECULAR ORBITALS

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In studying the molecular orbitals in heavy-ion collisions, it is necessary to take dynamical effects into account[1]. One of those effects, Coriolis force, has been included in our molecular orbitals (rotating molecular orbitals)[2]. Finite mass effect of nucleon which is often called recoil effect, however, has been only partially included so far by taking the average of the post and prior form of the interactions with the no-recoil approximation. In this paper the quantitative estimate of the recoil effect is reported through the numerical analysis of ^{12}C-^{13}C system and ^{16}O-^{17}O system.

We define the molecular orbitals by the interaction in coupled-reaction-channel (CRC) equation. Transfer form factor K in CRC equation becomes non-local because of the recoil effect. In order to obtain the local operators we take the momentum expansion of K up to 1st order. The radial part of the recoil effect is reflected in the 1st order term and the angular part is in K -mixing terms as well as in the total angular momentum J-dependence of the local operators.

K-mixing terms mentioned above are much smaller than Coriolis K-mixing terms and their contribution to the differential cross section is found to be negligible. Though the 1st order terms are fairly appreciable in ^{12}C-^{13}C system, we define the rotating molecular basis by employing only the 0th order terms . Recoil effect is small in the adiabatic potentials of the rotating molecular orbitals.

Characteristic changes arising from the recoil effect appear around the psuedo-crossings between the adaibatic potentials. As shown in Fig.1, those chnges can be seen in the sharp radial couplings of the Landau-Zener type.

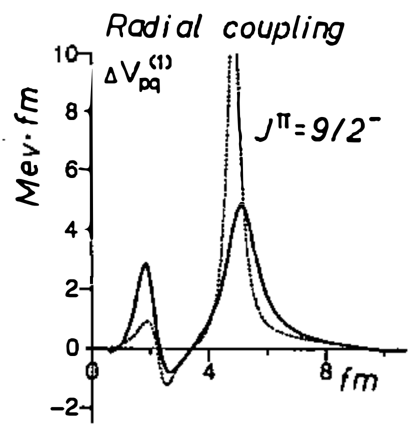

Fig.1 Radial couplings between the ground and the 1st excited states of the molecular orbitals calculated with (solid) and without (dotted) the recoil effect.

Sometimes the positions of the crossings themselves are affected too.

Therefore the recoil effect is best seen in the the system where the Landau-Zener transition occurs. Recently it was shown that in the $^{12}C-^{13}C$ system the inelastic transition to 2s1/2 state in the negative-parity states of the total system is the Landau-Zener transition and that in the positive-parity states transition occurs adiabatically. The partial cross section shows clearly that the recoil effect is larger in the negative-parity states than in the positive-parity ones. Thus as shown in Fig.2 the differential cross section of $^{12}C-^{13}C$ system exhibits the considerable amount of the change due to the recoil effect even at low bombarding energies.

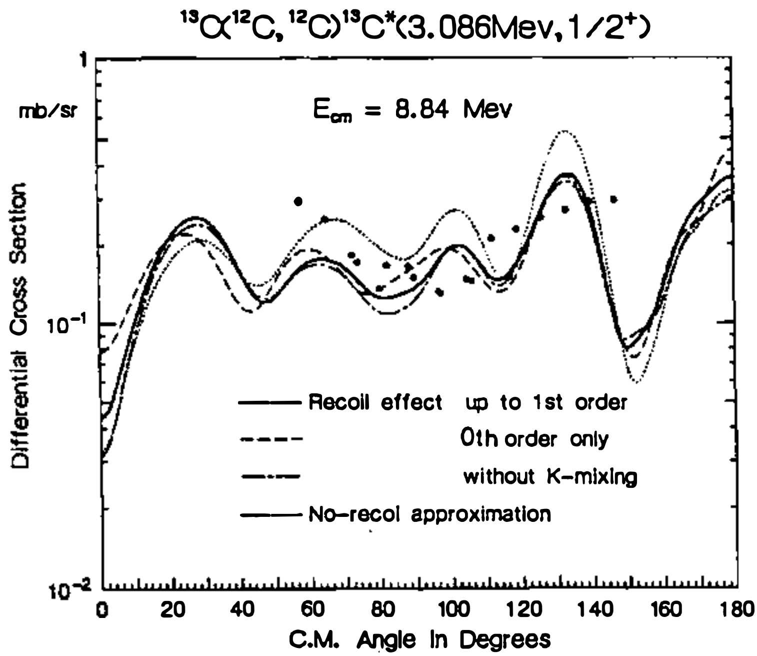

Fig.2 Differential cross sections of the inelastic scattering to the 2s1/2 state calculated with (solid line) and without (dotted) the recoil effect. Also shown are the values calculated without the 1st order terms (dashed) and the K-mixing tems (dash-dotted) respectively.

Refereneces

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2. B. Imanishi and W. von Oertzen, to be published in Phys. Rep.
3. B. Imanishi, W. von Oertzen and H. Voit, Phys. Rev. C35 (19