Unambiguous detection of Interatomic Coulombic Decay of Ne dimer by electron impact

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Synopsis An experimental investigation of Interatomic Coulombic Decay (ICD) of Ne dimer by 380 eV electron impact was performed. A diagonal line, indicating the sum of electron energy and KER to be constant, is observed. This is the unambiguous evidence of the existence of ICD in (e, 2e) experiment. Our result suggests that the ICD electron accounted for more than 80% of low energy electron yields in our experiment.

The collision between the radiation particle and biological tissue will produce lots of secondary electrons, which will interact with neighboring molecule further, and lead to secondary charge and energy transfer between molecules and their environment. The (e, 2e) study of small clusters can be used to simulate these secondary processes.

The most famous energy transfer mechanism is termed Interatomic Coulombic Decay (ICD) [1, 2], which is identified by numerous X ray and heavy ion experiments. However, the ICD investigation by electron impact is few. And the corresponding evidence is only obtained based on electron energy spectrum subtraction [3]. Now, in order to get the ICD evidence more directly, we performed the fragmentation experiment of Ne dimers by 380 eV electron impact at the Reaction Microscope in the Institute of Modern Physics, CAS [4].

By detecting the Ne^+/Ne^+ ions and the emitted electron in coincidence, the momenta and energy of all charged products, as well as the Kinetic Energy Release (KER), are obtained. As shown in Figure 1, the relationship of the electron energy and the KER is presented in a two dimensional map, in which a diagonal island at electron energy from 0 to 2 eV and KER from 4 to 6 eV is observed.

According to the energy conservation law, if a 2s electron of one Ne atom is ionized, and the transition energy from 2p to 2s is used to ionize the electron of another Ne atom, the sum energy of ICD electron and KER will be a constant (5.5 eV). In figure 1, this constant is presented as a dashed line. Obviously, most events in the diagonals island locate around this line. This means that we detect ICD arising from initial states $Ne(2s^{-1})$-$Ne(2p^6)$. Our result provides the unambiguous evidence of ICD in (e, 2e) experiment.

In addition, by comparing the electron energy spectrum of Ne dimer with that of Ne atom, a significant enchantment of electron yield in low energy area is observed in Ne_2 case. We conclude that, for the low energy area from 0 eV to 2 eV, the ICD electron accounted for more than 80% of electron yields.

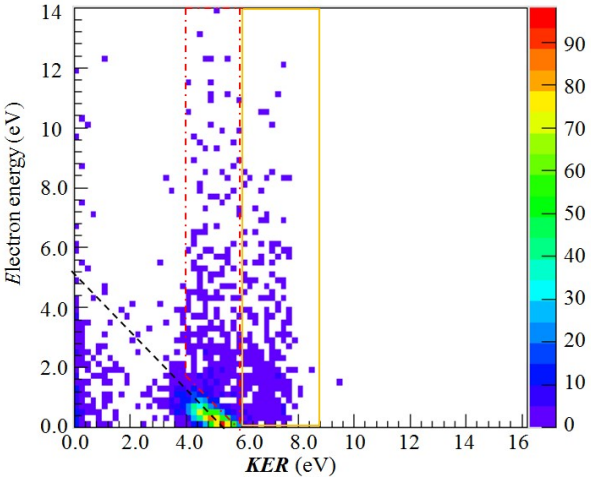

Figure 1. Correlation map between electron energy and KER. Black dashed line: position of ICD initial state $Ne(2s^{-1})$ -$Ne(2p^6)$.

References

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