Direct evidence of Interatomic Coulombic Decay in electron impact ionization of Ne dimer

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Synopsis The unambiguous evidence of the existence of Interatomic Coulombic Decay (ICD) of Ne dimer in (e, 2e) experiment with impact energy of 380 eV is observed. Our result suggests that the ICD electron accounted for more than 80% of low energy electron yields.

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.

One of energy transfer mechanisms is termed Interatomic Coulombic Decay (ICD) [1, 2], which is identified in numerous X ray and heavy ion impact experiments. However, the ICD investigation by electron impact is few. And the corresponding evidence is only obtained based on electron energy spectrum subtraction [3]. In order to get the ICD evidence directly, we performed the fragmentation experiment of Ne dimers induced by 380 eV electron impact using 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 transferred to ionize the electron of the other Ne atom, the sum energy of the 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 the detected ICD arises from initial states $Ne(2s^{-1})$-$Ne(2p^6)$. The present result provides the most direct evidence of ICD in (e, 2e) experiment so far.

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 range is observed in the ICD of neon dimer. It is concluded that, for the low energy area from 0 eV to 2 eV, the ICD electrons account for more than 80% of electron yields.

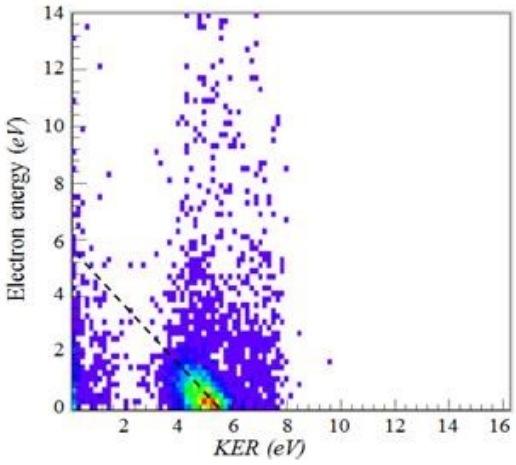

Figure 1. Correlation map between electron energy and KER. Black dashed line: position of ICD initial state $Ne(2s^{-1})$ -$Ne(2p^6)$.

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References

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