Origin of the sequential dissociation of $(CO_2)^{3+}$ by heavy ion impact

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Synopsis An experimental investigation of sequential dissociation of CO_2 by Ne^{4+} ion impact at incident energies 1.12 MeV was performed. Two initial states of $(CO_2)^{3+}$ ions were observed in the first fragmentation step. But for the second fragmentation step, our result suggests that both the metastable ions $(CO)^{2+}$ are populated in $^3\Sigma^+$ states.

If a triatomic molecule is multiply charged, the sequential and nonsequential dissociation processes will be invoked. Although these processes were studied extensively in the past [1, 2], the corresponding initial states, e.g. why these processes could take place, are not clearly so far.

We carried out the CO_2 fragmentation experiment in Reaction Microscope by Ne^{4+} ion impact at incident energies 1.12 MeV, aimed to investigate the origin of the sequential dissociation of $(CO_2)^{3+}$ ions. By coincidently detecting the $C^+/O^+/O^+$ ions, the Newton plot representing the momentum relation among the three ions, as well as the Kinetic Energy Release (KER) distribution of each step, are obtained.

As shown in figure 1, there is a circular ring in Newton plot, in which the momentum sum of the C^+ and the second O^+ ion is constant, this characteristic is consistent with the sequential fragmentation[2]. That is, in the first step the $(CO_2)^{3+}$ fragment into CO^{2+} and O^+, and in the second step another dissociation takes place inducing CO^{2+} fragment into C^+ and O^+. The corresponding events are chosen to reconstruct the total KER distribution. As displayed in figure 2, two narrow peaks (the corresponding peak values are 22.5 eV and 29 eV) are observed, which means that two decay channels can cause the sequential dissociation. The two peaks corresponding to lower and higher KER are labeled A and B. From the KER of the first and the second fragmentation steps obtained, we can investigate the fragmentation details of both channels mentioned above. It is found that, for channel A, the KER of peak value in the first step is 7.5 eV, while that in the second step is 15eV. But for channel B the corresponding values are 8 eV and 21 eV, respectively. This indicates that, for the first steps of channel A and B, the initial $(CO_2)^{3+}$ ions are populated in different states. But for the second steps, both the intermediate states ions $(CO)^{2+}$ are populated in $^3\Sigma^+$ states.

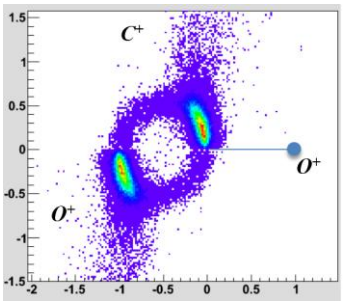

Figure 1. Newton plot of the $C^+/O^+/O^+$ ions from the fragmentation of $(CO_2)^{3+}$.

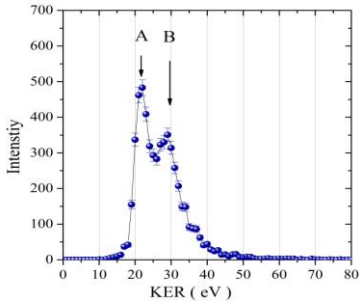

Figure 2. KER distribution of the $C^+/O^+/O^+$ ions from sequential dissociation of $(CO_2)^{3+}$.

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References

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