Exploring fragmentation dynamics and geometric structure of N_2O by using Ne^{8+} ion-induced Coulomb explosion imaging

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Synopsis: We report the concerted and sequential three-body fragmentation dynamics of the multiply charged N_2O^{q+} induced by 56 keV/u Ne^{8+} collision. The bond angle is reconstructed and bond distances are determined with sub-Angstrom precision.

Coulomb explosion imaging (CEI) is an alternative to spectroscopy for exploring molecular structure and fragmentation dynamics [1-6]. The basic principle of CEI consists of quickly ionizing a molecule by thin foils, photons, electrons or ions, and thereby creating a multiply charged molecular ion which dissociates quickly due to the Coulomb repulsion between the atomic cations. By measuring the final momentum vectors of the fragment ions in coincidence one can reconstruct the initial position and thus obtain an image of the molecule, as well as identify the fragmentation dynamics of molecular ions.

In this work, we report the experimental results on three-body fragmentation dynamics and geometric structure of linear N_2O with 56 keV/u Ne^{8+} collision. The experiment is performed by using Reaction Microscopes mounted on the 320 kV highly charged ions platform at the Institute of Modern Physics in Lanzhou. For the dissociation of N_2O^{3+}, we identified a one-step concerted Coulomb explosion process, $N_2O^{3+} \rightarrow N_t^+ + N_c^+ + O^+$, and two kinds of two-step sequential fragmentation processes, i.e., $N_2O^{3+} \rightarrow N_2^{2+} + O^+ \rightarrow N_t^+ + N_c^+ + O^+$ and $N_2O^{3+} \rightarrow N_t^+ + NO^{2+} \rightarrow N_t^+ + N_c^+ + O^+$.

For the dissociation of N_2O^{4+}, we observed three concerted fragmentation processes, i.e., $N_2O^{4+} \rightarrow N_t^{2+} + N_c^+ + O^+$, $N_2O^{4+} \rightarrow N_t^+ + N_c^{2+} + O^+$ and $N_2O^{4+} \rightarrow N_t^+ + N_c^+ + O^{2+}$, together with a two-step sequential fragmentation process, i.e., $N_2O^{4+} \rightarrow N_t^{2+} + NO^{2+} \rightarrow N_t^{2+} + N_c^+ + O^+$. According to the CEI results measured for the channel $N_2O^{4+} \rightarrow N_t^+ + N_c^{2+} + O^+$, as are shown in Figure1, the bond angle is reconstructed to be about 172°, indicating a linear structure. In addition, the bond distances of N-N and N-O are determined to be 1.16 Å and 1.19 Å, respectively, which are well agreed with the data from the conventional spectroscopy [7]. More information about the fragmentation dynamics and geometry reconstruction of multiply charged N_2O^{q+} will be presented in the poster.

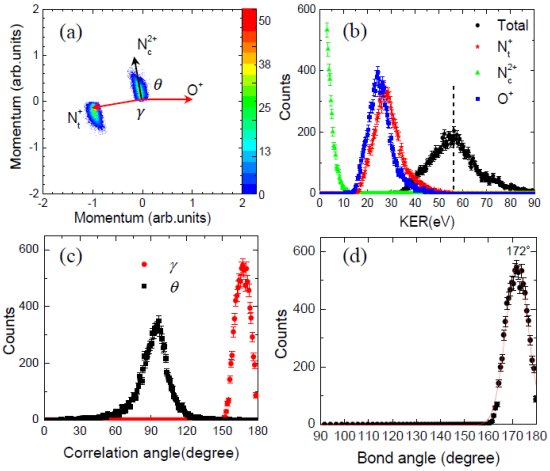

Figure 1 Experimental results of the dissociation channel $N_2O^{4+} \rightarrow N_t^+ + N_c^{2+} + O^+$. (a) Newton diagrams, (b) KER distributions, (c) Momentum correlation angles and (d) Bond angle of N-N-O. The vertical dash line in (b) represents the estimated value based on the pure Coulombic potential model.

References

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