

THE DESIGN AND CONSTRUCTION OF A MASS-SELECTED ION-MOLECULE CLUSTER BEAM APPARATUS FOR PHOTO-FRAGMENT SPECTROSCOPY.

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Cluster research offers doorways to establish connections between the macroscopic features of solutions- and condensed phase materials and the properties of their microscopic constituents. Apart from studying the solvation of diverse molecules and the properties of solvated electrons, clusters have also been employed to explore the mechanisms of intra-cluster charge transfer processes. In electron attachment processes, upon photoexcitation of the cluster or ion-molecule complex, the excess electron in ion can be transferred to the molecule. Numerous previous studies have shown that I^- is a proficient intra-cluster donor.

Here, a new apparatus for ultrafast photofragmentation studies is described for investigating the charge transfer process and subsequently detecting the fragments from the photoexcitation of iodide-molecule clusters. Ions and ion-clusters are produced by perpendicularly oriented pulsed gas jet and continuous electron beam, accelerated and separated by a time-of-flight mass spectrometer, and then size-selected (iodide-molecule clusters) by a mass filter. The iodide molecule clusters are focused into the interaction region and are excited by UV laser pulse propagating perpendicularly. A linear-plus-quadratic (LPQ) reflectron capable of operating over a large voltage range is used to reverse the trajectories of the anions and mass-resolve the anion fragments and parent anion. The instrument can detect both charged and neutral fragments simultaneously.

To test the performance of the instrument, $CF_3I.I^-$ is photoexcited by 266 nm UV laser pulse. Anion fragments I^- and CF_3I^- are detected and identified with neutral fragments. Detection of CF_3I^- provides evidence of the charge transfer inside the $CF_3I.I^-$ cluster when it is excited by 4.66 eV photons and implies the existence of charge-transfer excited state of $CF_3I.I^-$.