3D imaging of molecular-ion dissociation induced by slow atom impact: alignment and orientation dependence in soft and hard collisions

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Hard collisions between few keV molecular ions and atoms can lead to vibrational excitation and subsequent dissociation as well as target ionization. Previous experimental efforts were unable to resolve the vibrational process from the competing electronic excitation complicating comparison with theory [1]. Moreover, target ionization has been largely ignored.

Employing 3D coincidence imaging of the ion-beam fragments and recoil ions, shown in Fig. 1, we study collision induced dissociation (CID), where vibrational (vCID) and electronic (eCID) processes are experimentally separated, giving new insight into the vibrational mechanism [2]. In particular, vCID occurs predominantly for molecular ions aligned perpendicular to their velocity ($\cos\theta$=0) and when the momentum "kick" is along the molecular axis ($\cos\alpha$=±1), as shown in Fig. 1(c). Similarities and differences between HeH^+ and H_2^+ CID and other processes occurring in such collisions will be discussed.

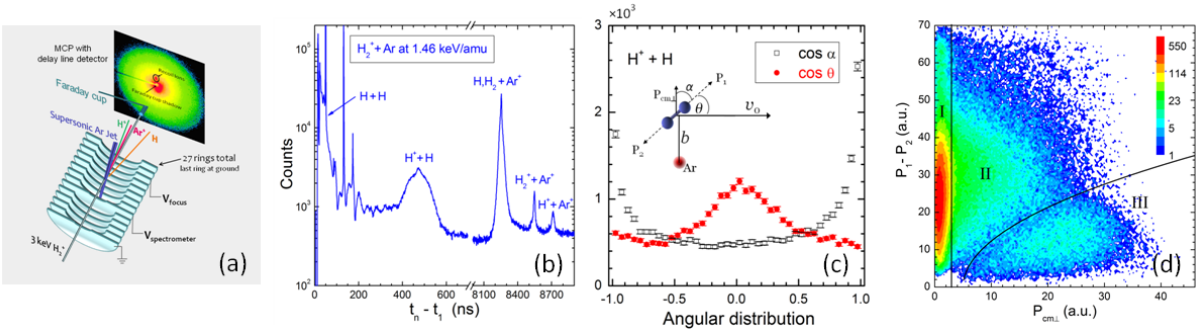

Figure 1: (a) Experimental setup, (b) time of flight difference of all hits, (c) Angular distribution of H^++H fragments, and (d) a density plot of the H^+ and H momenta allowing the separation of eCID following soft (I) and hard (II) collisions, and vCID (III).

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References

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