Anisotropic two-body dissociation by highly charged ion impact

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Synopsis The angular distribution of fragment emission with respect to the incoming beam direction is measured. In case of two body breakup of di-cationic molecular ions, such as D_2O^{2+} and $C_2H_2^{2+}$, a strong anisotropy is observed when one of the fragments is an H^+ or D^+. These molecular ions were produced by impact of slow highly charged ions on neutral species. The technique of recoil ion momentum spectroscopy was used to measure the complete momentum vectors of all fragments in coincidence.

From the studies on fragmentation of charged molecular ions, it is becoming increasingly apparent that the emission of dissociation fragments is anisotropic in nature. In case of laser induced fragmentation, anisotropy had been observed with reference to the laser polarization axis [1] while for fragmentation induced by charged particles, the anisotropy is with respect to the incoming projectile beam [2]. Many of the studies reported in literature have focussed on diatomic molecules and results for polyatomic molecules are rather scarce.

We carried out experiments to address the anistropic emission of fragment ions in two-body dissociation of few hydrogen (or deuteron) containing polyatomic molecules, such as D_2O^{2+} and $C_2H_2^{2+}$, induced by impact of highly charged ions. The molecules considered for this study have very different geometries. The experiments were carried out at the Low Energy Ion Beam Facility (LEIBF) of Inter-University Accelerator Centre, Delhi, India and also at the ARIBE-GANIL facility in Caen, France. At both these facilities an electron cyclotron resonance (ECR) ion source was used to extract beams of highly charged ions. At LEIBF a recoil ion momentum spectrometer was used to measure the momenta of all ions in coincidence with the target gas being supplied by an effusive gas jet. At ARIBE-GANIL a COLTRIMS setup was used where the cold target molecules were produced using supersonic expansion. The facility at GANIL was also equipped with a post collision charge state analyzer which enabled us to separate events coming from pure ionization from the ones involving capture of one or two electrons.

The results of our experiments show strong anisotropic effects in the emission of recoil ion fragments with respect to the incoming projectile beam direction. These effects are common to all the molecules considered during this investigation. As an example, the angular distribution of fragments H^+ and C_2H^+ produced from dissociation of $C_2H_2^{2+}$ is shown in the figure below.

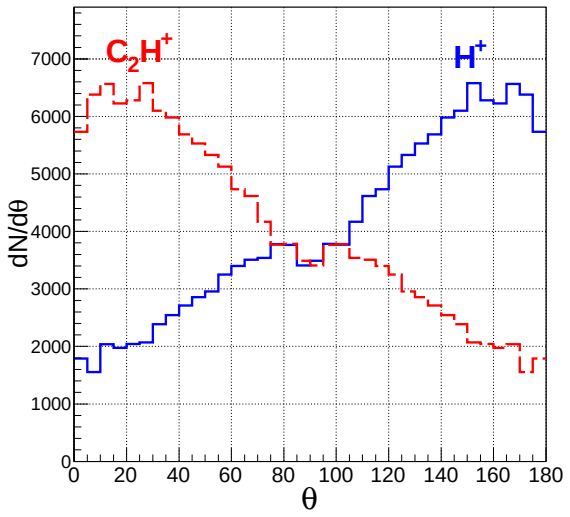

Figure 1. Fragment angular distribution for two body breakup of $C_2H_2^{2+}$. Angle θ represents the angle between the fragment momentum vector and direction of the incoming projectile beam.

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