

Orientation-dependent dissociation dynamics of H_2O_2

M. Nrisimhamurty, C. Bagdia, L. C. Tribedi, and D. Misra¹

Department of Nuclear and Atomic Physics
Tata Institute of Fundamental Research, Dr. Homi Bhabha Road, Colaba, Mumbai-400005, INDIA

Synopsis The ion-induced fragmentation dynamics and the angular anisotropy effects in collisions of 1 MeV Ar^{8+} ions with H_2O_2 is studied.

Multiple ionization and subsequent fragmentation of molecules by energetic highly-charged ions is of fundamental importance, but remained elusive for quite a long time due to their multi-electronic nature and complexity involved during ion-induced breakup. Few decades ago, the advent of the state-of-the-art recoil-ion momentum spectroscopy (RIMS) [1] technique brought an upsurge in the ion-induced fragmentation studies. Moreover, it provided robust kinematically-complete information about the various dissociation channels involved, in terms of kinetic energy release, momentum distributions and angular correlations. Not only that, RIMS also aided in the development of next generation theoretical methodologies to unravel the ion-induced dissociation dynamics. With the help of momentum-imaging technique, dissociation dynamics of a plethora of di- and tri-atomic molecules have been investigated, but many polyatomic molecules are still unexplored. Here, we report on the ion-impact induced dissociation studies of H_2O_2 .

Hydrogen peroxide (H_2O_2), a non-planar molecule, is a subject of interest due to its significance in the atmospheric chemistry of ozone. H_2O_2 is also found to be one of the main oxidants that decomposes sulfur dioxide (SO_2) in cloud droplets which eventually leads to acid rains. Besides being an important oxidant H_2O_2 , along with HCHO, plays a decisive role in the behavior of oxidation power and self cleaning capacity of the atmosphere [2, 3]. Dissociation studies on H_2O_2 is scanty because it is highly unstable and slowly decomposes into oxygen and water. This could be also a reason for the formation of water on the dust grains in the interstellar medium and is supported by the recent identification of interstellar hydrogen peroxide [4]. In addition, hydrogen peroxide plays an important role in understanding the radiation damage of biological matter [2]. Hence, current observations on dissociation dynamics of H_2O_2 are of immense importance.

In the present work, 1 MeV Ar^{8+} ions are obtained from the electron cyclotron resonance ion accelerator (ECRIA) at TIFR, Mumbai. Electrons that are created during the fragmentation are detected by

a channel electron multiplier detector which serve as the start signal. Ion fragments are projected onto a position- and time-sensitive detector [5]. From the coincidence observations, we found two dissociation channels for two-body decay of H_2O_2 whereas H_2O_2 fragments into H^+ , H^+ and O_2^+ in a three-body dissociation process. Interestingly, a signature of angular anisotropy is observed as shown in the Fig. 1. This could be attributed to post-collisional effects. Thus, these results are of paramount importance in the context of orientation and alignment dependent dissociation dynamics.

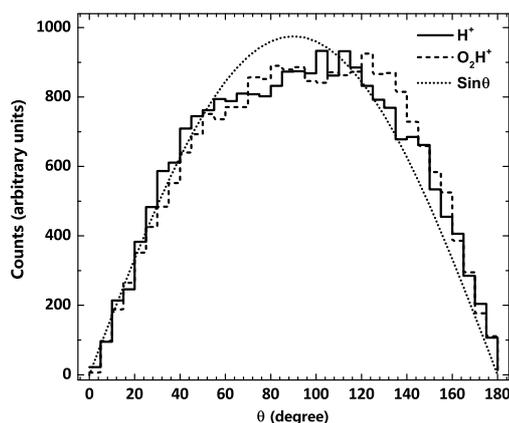


Figure 1. Angle between the individual momentum vectors and beam direction for the dissociation channel $\text{H}_2\text{O}_2^{2+} \rightarrow \text{H}^+ + \text{O}_2\text{H}^+$. Solid and dashed line corresponds to H^+ and O_2H^+ fragments, respectively. The dotted curve corresponds to isotropic distribution ($\sin\theta$).

References

- [1] J. Ullrich *et al.* 1997 *J. Phys. B* **30** 2917
- [2] D. Nandi *et al.* 2003 *Chem. Phys. Lett.* **373** 454
- [3] T. Klippel *et al.* 2011 *Atmos. Chem. Phys.* **11** 4391
- [4] F. Du *et al.* 2012 *Astron. Astrophys.* **538** A91
- [5] A. Khan *et al.* 2015 *Rev. Sci. Instrum.* **86** 043105

¹E-mail: dmsira@tifr.res.in

