

K-K electron transfer and K-ionization in fast ion collisions with adenine and water using KLL Auger electron technique

Chandan Bagdia*, S. Bhattacharjee*, M. Roychowdhury*, A. Mandal*, Lokesh C Tribedi*¹

* Department of Atomic and Nuclear Physics, Tata Institute of Fundamental Research, Colaba, Mumbai – 400005, India.

Synopsis In this report, we present a study of K-shell ionization, state selective K-to-K electron capture cross sections from C and N atoms in the adenine and other gas molecules using K-LL Auger electron technique, which is applied for first time. Energy dependence of K-ionization and K-K electron capture has also been measured. The e-transfer cross section is found to be substantial compared to the K-ionization. Total σ_{KK} and σ_{KI} for the entire molecule was deduced.

In hadron therapy, DNA/RNA damages as a result of energy loss of projectile in bio-molecular system. Energy loss of projectile can take place via different processes like electron emission, electron capture from target. Study of damage of DNA/RNA or water via electron emission upon ion impact is hot topic in recent time [1-4]. Electron capture is a fundamental process in ion-molecule collision. We report here the first measurement of state selective, 1s-1s electron capture cross section from constituent atoms in nucleobase (adenine) molecule ($C_5H_5N_5$). The 1s-ionization (KI) cross section has also been measured.

For the first time, by measuring the projectile charge state dependence of KLL Auger electron emission, the K-K e-capture cross section has been obtained. Experiments have been performed using effusive vapor jet of adenine molecules. Electrons emitted upon ion impact has been measured using hemispherical electron energy analyzer mounted on turntable inside high vacuum chamber. Data has been collected at 150° from beam direction and then total cross section was calculated by assuming isotropic distribution of Auger electron emission. In some cases whole angular distribution was measured. Energy dependence of cross section has been measured for C, O and Si projectile of energy 2-5 MeV/u. Measurements for N_2 and CO_2 have been performed in flooded chamber experiment.

The data obtained from adenine has been compared with those from gas molecules (N_2 and CO_2). The KI cross sections, obtained using no-K-vacancy projectiles, has been compared

with the ECPSSR (Energy loss (E) and Coulomb deflection (C) perturbed stationary states (PSS) and relativistic corrections (R)) calculation and a good agreement has been observed (see Figure). The σ_{KK} , derived from the KLL yield with bare or H-like projectiles, shows almost energy independence for C and O ions. The σ_{KI} however tends to reduce with energy and well reproduced by the ECPSSR. Detailed analysis and results will be presented.

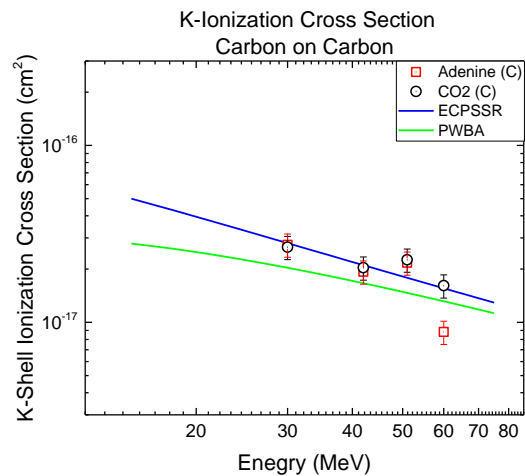


Figure 1. Energy dependence of KI for C on C from adenine and CO_2 along with ECPSSR and PWBA.

References

- [1] A. Agnihotri *et al.* 2013 *Phys. Rev. A* **87** 032716
- [2] A. Agnihotri *et al.* 2012 *Phys. Rev. A* **85** 032711
- [3] A. Agnihotri *et al.* 2013 *J. Phys. B* **46** 185201
- [4] S. Bhattacharjee *et al.* 2016 *J. Phys. B* **49** 065202

¹ E-mail: lokesh@tifr.res.in; ltribedi@gmail.com