Fast ion collisions with nucleobase-molecules at Bragg peak

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Synopsis Recent studies on fast ion collisions with large biomolecules will be reviewed. There has been a good progress in the theoretical and experimental investigations on this topic. The recent results on the energy and angular distribution of electron emissions from such DNA/RNA base molecules, angular asymmetry, total recoil-ion emission will be presented based on the experiments by different groups whith special emphasis on our own studies on uracil, adenine, halo-uracil and water molecules. Effort on deriving scaling laws will also be included.

Collisions of high velocity projectile ions with large molecules are not only important for basic molecular physics but also significant for its practical importance in the field of radiation biology. Such collisions inside biological matters produces a large number of secondary electrons which, in turn, produce further ionization or fragmentation events. Study of the total cross sections as well the energy distribution of these electrons from biological molecules are thus particularly important. The energy loss of fast ions inside human body, as mostly characterized by Bragg peak, is sensitive to various collision processes: ionization, electron transfer, transfer-ionization which are influenced by the many body effects. The double differential distributions provide an adequate test to the various theoretical models developed.

In present work we have studied the double differential cross sections (DDCS) of the emitted electrons from vapour phase adenine, uracil and water molecule under the impact of a few MeV/u C^{6+} projectile. The keV-to-MeV energy protons, C, O and F-ions are also used as fast projectiles from a tandem pelletron accelerator as well as 14.5 GHz ECRIA at TIFR Mumbai. The DDCS spectrum was obtained using an electrostatic hemispherical e-analyzer. The TOF recoil-ion spectrum was also measured. A heated oven at a temperature of ~180^0 C was used for adenine. Figure-1 shows a typical DDCS spectrum of emitted electrons for adenine. The CDW-EIS model calculation provides an excellent agreement with the adenine and water data. The forward backward asymmetry parameter, reveals an oscillatory behavior for adenine which is in con- trast to the smooth behavior obtained for uracil, water molecule or other atoms

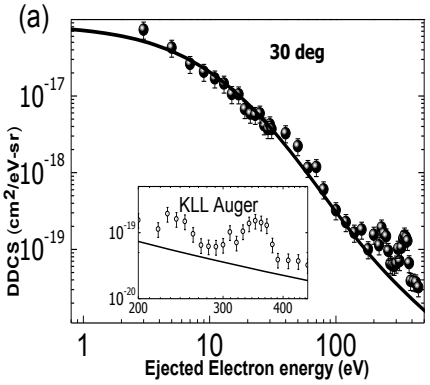

Figure 1. e-DDCS spectrum for adenine (C5H5N5) in collisions with 3.5 MeV/u $C6^+$ ions. Inset shows C, N KLL Auger electron peaks.

The angular distribution data clearly shows an enhanced forward-backward asymmetry for both the uracil and adenine compared to that for water or other smaller molecules. The nano solvated bio-molecules are proposed to be used as radio-sensitizers to enhance the e-emission i.e. to increase radio-biological effectiveness. Towards this we will present some initial results for halouracils under such collisions. The connection with the observed plasmon mediated enhancement of electron emissions from C_{60}-fullerene will be indicated [1-6].

References

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